JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 1247:2023

STANDARD FOR SAFETY

Diesel Engines for Driving Stationary Fire Pumps

Approved American National Standard

ANSI/UL 1247-2023

SCC FOREWORD

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UL Standard for Safety for Diesel Engines for Driving Stationary Fire Pumps, ANSI/CAN/UL 1247

Sixth Edition, Dated November 2, 2023

SUMMARY OF TOPICS

The Sixth Edition of ANSI/CAN/UL 1247, dated November 2, 2023, has been issued to reflect the latest ANSI and SCC approval dates, and to incorporate the proposal dated July 21, 2023.

The requirements are substantially in accordance with Proposal(s) on this subject dated July 21, 2023.

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1

ANSI/CAN/UL 1247:2023

Standard for Diesel Engines for Driving Stationary Fire Pumps

The first through fourth editions were titled Standard for Diesel Engines for Driving Centrifugal Fire Pumps.

First Edition – July, 1981
Second Edition – August, 1989
Third Edition – May, 1995
Fourth Edition – September, 2004
Fifth Edition – May, 2007

Sixth Edition

November 2, 2023

This ANSI/CAN/UL Safety Standard consists of the Sixth Edition.

The most recent designation of ANSI/UL 1247 as an American National Standard (ANSI) occurred on November 2, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This Standard has been designated as a National Standard of Canada (NSC) on November 2, 2023.

No Text on This Page

CONTENTS

INSTRUCTIONS

Preface

This is the Sixth Edition of ANSI/CAN/UL 1247, Standard for Diesel Engines for Driving Stationary Fire Pumps.

ULSE is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 1247 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

This Edition of the Standard has been formally approved by the Technical Committee (TC) on TC 448.

This list represents the TC 448 membership when the final text in this Standard was balloted. Since that time, changes in the membership may have occurred.

TC 448 Membership

Name	Representing	Interest Category	Region
Kerry Bell	UL Solutions	Testing and Standards Organization	USA
Art Black	Carmel Fire Protection Associates	AHJ	USA
Dave Brush	Flotronix Corp	Supply Chain	USA
Brian Buscher	Xylem INC	Producer	USA
William Carney	W R Carney	General Interest	USA
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Michael Dembkowski	Clarke Fire Protection Products INC	Producer	USA
Sunil Deshpande	SPP Pumps Inc	Producer	USA

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TC 448 Membership Continued

Name	Representing	Interest Category	Region
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This Standard is intended to be used for conformity assessment.

The intended primary application of this Standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

INTRODUCTION

1 Scope

1.1 These requirements cover diesel engines for driving centrifugal fire pumps.

1.2 The engines covered by these requirements are intended for installation and use in accordance with the Standard for the Installation of Stationary Fire Pumps for Fire Protection, NFPA 20.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this Standard, or

b) Is superseded by a requirement in this Standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

3.1 Where values of measurement are specified in both SI and U.S. Customary units, it is the responsibility of the user of this Standard to determine the unit of measurement appropriate for the user's needs.

4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following publications are referenced in this Standard:

ASTM D975, *Standard Specification for Diesel Fuel*

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

NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*

SAE J 1349, *Engine Power Test Code – Spark Ignition and Compression Ignition – As Installed Net Power Rating*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 218A, *Battery Contactors for Use in Diesel Engines Driving Centrifugal Fire Pumps*

CONSTRUCTION

5 General

5.1 A diesel engine shall provide the rated power output throughout its service life. See 21.3.3.

5.2 Engines may be provided with or without a supercharge/turbocharge feature.

6 Instrumentation and Controls

6.1 The following instrumentation and control devices shall be securely mounted on the engine:

a) A tachometer to indicate engine rpm, including zero, at all times. Tachometers with digital display shall be permitted to be blank when the engine is not running. If the tachometer is not of the totalizing type, an hour meter shall be provided to indicate total time of operation;

b) An oil pressure display to indicate engine lubricant pressure;

c) A temperature display with numerical indication of the primary coolant loop temperature;

d) A means to activate a common supervisory signal to a fire pump controller at a high coolant temperature specified by the manufacturer. This signal shall incorporate a time delay as specified by the manufacturer to avoid the potential for a nuisance alarm upon engine restart, but in no case shall the signal be delayed for more than 30 seconds after starting;

e) An ammeter or voltmeter(s) to indicate the direction of alternator or generator charge;

f) For pneumatic or hydraulic starting, a display to indicate reservoir pressure and a means to activate a signal to a fire pump controller at a low pressure specified by the manufacturer;

g) A means to activate a common supervisory signal to a fire pump controller at a low engine lubricant pressure specified by the manufacturer;

h) An adjustable speed controller (governor) that is lockable at the required setting;

i) A means to monitor engine speed and shut down the engine (with manual resetting) when the speed is between 110 and 120 percent of its rated speed and activate a signal to a fire pump controller when the engine is shutdown;

j) A speed-sensitive means to signal engine running and crank termination conditions;

k) For an engine equipped with electronic fuel management control, an automatically and manually operated selector switch, which has no off position, shall be provided;

l) For an engine equipped with electronic fuel management control, a visual indicator on the engine and common supervisory signal to a fire pump controller shall be provided when the engine is being operated by the alternate ECM;

m) For an engine equipped with electronic fuel management control, a common supervisory signal shall be provided to a fire pump controller for any condition of fuel injection malfunction, low fuel pressure, or primary sensor malfunction;

n) For an engine equipped with electronic fuel management control, a common supervisory signal to a fire pump controller shall be provided when a failure occurs of the Primary or Alternate ECM, when selected;

o) For an engine equipped with electronic fuel management control, a signal shall be provided when a failure occurs of both the primary and alternate ECMs;

p) For an engine equipped with electronic fuel management control, a means shall be provided to prevent cranking motor damage during automatic switching while the engine is rotating. See 21.6.4(g).

q) A means to activate a common supervisory signal to a fire pump controller at a minimum engine temperature specified by the manufacturer when the engine is in standby condition; and

r) A means to activate a common supervisory signal to a fire pump controller at a high raw water temperature specified by the manufacturer when the engine is running.

6.2 All signals provided to the fire pump controller, as referenced in 6.1, shall be of the negative-to-ground type. See Figure 12.1 and Table 12.1.

Exception: The signals described in (i) and (j) are not required to be of the negative-to-ground type.

6.3 All circuits providing signals to the controller shall be sized as specified in Table 12.1.

6.4 All signals provided to the fire pump controller from the ECM shall be electrically isolated, such as by the use of relay contacts or other devices that provide for electrical isolation.

6.5 An engine and its instrumentation shall be capable of operation when the fire pump controller is not connected or operational, including the capability to energize a solenoid valve supplying water to cool the engine (if required) when in the manual run mode. Engines provided with a normally open (energize to stop) fuel solenoid shall energize a solenoid valve supplying water to cool the engine in both the manual and automatic modes.

6.6 Instrumentation and ECM selector switch vibration shall be reduced by a method or means such as vibration isolation mounts. In addition, the instrumentation shall be located to reduce the risk of injury to operating personnel from hot surfaces, moving parts of the engine, pump, and power transmission equipment.

6.7 Over-current protection shall be permitted to be used to protect instrumentation, control wiring, and control devices provided a resettable, inverse time, nonadjustable protective device is used. It shall be sized in accordance with Table 6.1. See 6.8 for engine circuits providing signals to the fire pump controller.

6.8 Engine circuits designed to withstand 1 amp as referenced in Table 12.1 and send a signal to the fire pump controller shall be permitted to be provided with a resettable, inverse time, nonadjustable over-current protective device having a rating of not less than 2 amps.

Table 6.1
Sizing of Overcurrent Protection

Conductor size		Over-current protection, amps
AWG	(mm^2)[a]	Minimum
20	(0.52)	7
18	(0.82)	10
16	(1.3)	15
14	(2.1)	25
12	(3.3)	30
10	(5.3)	45
8	(8.4)	65

[a] Wire sizes between those specified in this table shall use the next larger wire size for determining the minimum overcurrent protection required.

6.9 Power for the engine running and crank termination signal shall be supplied by the batteries.

6.10 In the event of overspeed shutdown, manual resetting to the normal operating position shall be required before restarting the engine can be accomplished.

6.11 A means to verify the function of the engine overspeed shutdown shall be provided. Verification of the shutdown functionality at a speed less than the intended engine shutdown speed shall be permitted.

6.12 A means to verify the function of the following signals to the fire pump controller shall be provided:

a) Low engine lubricant pressure;

b) High engine coolant temperature;

c) Low engine temperature; and

d) High raw water temperature.

6.13 The engine, including primary ECM, shall not continuously draw a current greater than 0.5 amps during standby (non-operating) conditions.

6.14 The enclosures and polymeric materials used to construct instrumentation enclosures, or used to construct opening covers or components projecting through metal enclosures that form part of the enclosure shall comply with the applicable requirements of UL 50 and UL 50E with a minimum Type 2 rating.

7 Supplemental Overspeed Shutdown Device

7.1 A supplemental overspeed shutdown device that closes the air supply to the engine shall be permitted when all of the following requirements are met:

a) The supplemental overspeed shutdown device operates in parallel with the primary overspeed shutdown method and complies with 21.5;

b) The supplemental overspeed means complies with 6.10 and 6.11; and

c) A visual indicator of the position for the supplemental overspeed shutdown device is provided.

8 Fuel Injection and Speed Controller

8.1 General

8.1.1 Unit injector and in-line pump fuel injection systems shall be provided with check valves as referenced in 8.1.2 to prevent contamination of the engine lubrication oil with diesel fuel.

8.1.2 For the fuel injection systems described in 8.1.1, a differential pressure check valve shall be installed in the fuel supply line and a separate check valve shall be installed in the fuel return line to the fuel storage tank. The differential pressure check valve in the fuel supply line shall have an upstream pressure rating for leak tightness of at least 125 percent of the pressure that correlates to the maximum fuel height permitted in the manufacturer's installation, operation and maintenance instructions. See 25.1(k).

8.2 Mechanical fuel management control

8.2.1 Mechanical fuel management control shall provide a mechanical means to control the fuel injection process, and a mechanical or electrical means to control engine speed. If an electrical means is used to control engine speed, this control shall comply with all of the following:

a) Only receive input from the engine speed sensor(s) and a demand for engine shutdown to achieve its intended purpose;

b) Provide override speed control within 10 percent of the rated speed; and

c) In the event of a failure of the electric governing card or speed sensor used as a part of the electrical control assembly (excluding loss of input power to governing card), the engine shall be arranged to return to the rated speed as required in 21.4 by means such as the use of a redundant governing card or by a mechanical override.

8.2.2 A governor control DC solenoid utilizing battery current shall be permitted for run-stop control.

8.2.3 A governor control solenoid mounted externally to the governor that requires energy for the engine to run, shall be provided with a manual means to allow the engine to run in the event of solenoid failure.

8.2.4 The engine shall be equipped with an adjustable speed governor to maintain the engine speed within a range of no more than 10 percent variation between no load and maximum load conditions.

8.3 Electronic fuel management control

8.3.1 Electronic fuel management control as referenced herein incorporates an electronic means, such as an Electronic Control Module (ECM), to control engine speed and the fuel injection process.

8.3.2 An electronic fuel-controlled engine shall be equipped with a primary ECM and an equivalent functioning alternate ECM to control the fuel injection process. Engines that require more than one primary ECM to manage the engine performance shall be provided with an equivalent number of alternate ECMs.

8.3.3 The primary and alternate ECM, automatic switching module, and contacts of the selector switch shall be installed in an enclosure complying with the applicable requirements of UL 50 and UL 50E with a minimum Type 2 rating. The ECM's integral enclosure shall be permitted to be used to comply with the requirements of UL 50 and UL 50E with a minimum Type 2 rating.

8.3.4 The engine shall be equipped with an adjustable speed controller to maintain the engine speed within a range of no more than 10 percent variation between no load and maximum load conditions.

8.3.5 Both the primary and alternate ECMs shall be protected from transient voltage spikes and reverse dc current.

8.3.6 The circuitry for an engine shall be designed so that the primary and alternate ECM(s) are not operating simultaneously to manage the engine performance. The primary and alternate ECM(s) shall be permitted to be powered-on during the normal operating mode provided that only the primary or only the alternate ECM(s) is managing the engine performance.

8.3.7 An ECM shall be designed or programmed to not intentionally cause a reduction in the engine's ability to produce the rated power output for any reason such as high coolant temperature, low lubricant pressure, or the like.

8.3.8 Redundant sensor(s) shall be provided when a sensor is necessary for the function of the ECM and affects the engine's ability to produce its rated power output. Redundant sensors shall be arranged to operate automatically in the event of a failure of the primary sensor.

8.3.9 Redundant sensors are not required for non-critical sensor(s) that do not affect the engine's ability to produce its rated power output.

9 Starting System

9.1 The starting system shall allow manual emergency starting in the event of fire pump controller malfunction or electrical separation.

9.2 An engine equipped with electric starting components shall be constructed to accommodate two storage battery units.

9.3 For engines with only one cranking motor, a main battery contactor with a manual mechanical operator shall be installed between the cranking motor and each storage battery unit.

9.4 Engines with two cranking motors shall be constructed to have one cranking motor dedicated to each storage battery unit. Each cranking motor shall have an integral solenoid relay. Each cranking motor shall be capable of being energized from a manual operator.

9.5 Battery units are not required to be supplied with the engine.

9.6 Main battery contactors for engines using battery starting shall comply with UL 218A and shall be rated for the maximum starting current required by the engine.

9.7 A pneumatic starting system intended for connection to an automatic controller shall include all necessary components such as solenoid valves and other interfacing devices for connection to the automatic controller.

9.8 A primary starting system shall be provided and tested in accordance with 21.1 (Starting). For engines provided with any secondary starting components, the manufacturer's installation, operation, and maintenance instructions shall reference testing in accordance with NFPA 20. See 25.1(n).

10 Automatic Heater

10.1 An automatic heater shall be installed on the engine to maintain the coolant at a minimum of 120 °F (48.9 °C) in the water jacket of the engine block when the ambient temperature (still air) is 40 ±2 °F (4.4 ±1.1 °C). The outlet side of the automatic heater shall be provided with piping, a hose with a braided stainless-steel jacket, or other hose appropriate for use in such application.

11 Engine Cooling System

11.1 General

11.1.1 The cooling system shall automatically maintain the engine within the intended operating temperatures. The cooling system shall be included as part of the engine assembly and shall be of the following closed-circuit types:

a) A heat exchanger type that includes a circulating pump driven by the engine, a heat exchanger, and an engine jacket temperature regulating device; or

b) A radiator type that includes a circulating pump driven by the engine, a radiator, an engine jacket temperature regulating device, and an engine driven fan for providing positive movement of air through the radiator.

11.1.2 The cooling system shall be provided with at least one opening in the primary loop for replenishing the coolant and checking the liquid level. An expansion reservoir shall also be provided to minimize loss of coolant due to thermal expansion and contraction.

11.2 Heat exchanger type

11.2.1 The heat from the closed primary loop shall be dissipated to a secondary, open, raw water-cooling circuit. The heat exchanger shall be provided with a tapped or flanged inlet to accommodate piping supplying coolant from the fire pump discharge and with a tapped or flanged outlet to accommodate drain piping. The tapped or flanged outlet shall be one size larger than the tapped or flanged inlet. The heat exchanger shall have a minimum rated pressure of 60 psig (414 kPa).

11.3 Radiator type

11.3.1 The heat from the primary loop of a radiator shall be dissipated by a fan included with, and driven by, the engine. The radiator heat exchanger shall be designed to maintain normal engine operating temperatures with an inlet air temperature of 120 °F (48.9 °C). A duct connection shall be provided to allow for conveyance of the coolant air exhaust outside the pump room.

12 Wiring

12.1 All wiring used with the engine shall be used within its rated current and voltage, and shall be mechanically secured in place. Wiring susceptible to mechanical damage shall be protected; conduit meets the intent of this requirement.

12.2 All connecting wires from the engine to the terminal block referenced in 12.8 shall be:

a) Harnessed or flexibly enclosed to reduce the risk of mechanical, thermal, or chemical damage to the insulation;

b) Mounted on the engine;

c) Connected in an engine junction box to terminals numbered to correspond with numbered terminals in the controller, for ready wiring in the field between the two sets of terminals; and

d) Sized to accommodate the maximum ampacity specified in Table 12.1.

12.3 A terminal to which field wiring is to be connected shall be a solder lug or pressure wire connector.

Exception: A terminal to which 10 AWG (5.3 mm^2) or smaller wiring connections are to be made are not prohibited from consisting of a clamp or wire-binding screw with a terminal plate having upturned lugs or the equivalent to hold the wire in position.

12.4 A wire-binding screw to which field-wiring connections are made shall be No. 6 or larger.

12.5 A terminal plate tapped for wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick for a 14 AWG (2.1 mm^2) or smaller wire, and not less than 0.050 inch (1.27 mm) thick for a wire larger than 14 AWG. There shall be at least two full threads in the plate.

Exception: Two full threads are not required when fewer threads result in a secure connection in which the threads do not strip upon application of a 20 pound-inch (2.3 N·m) tightening torque.

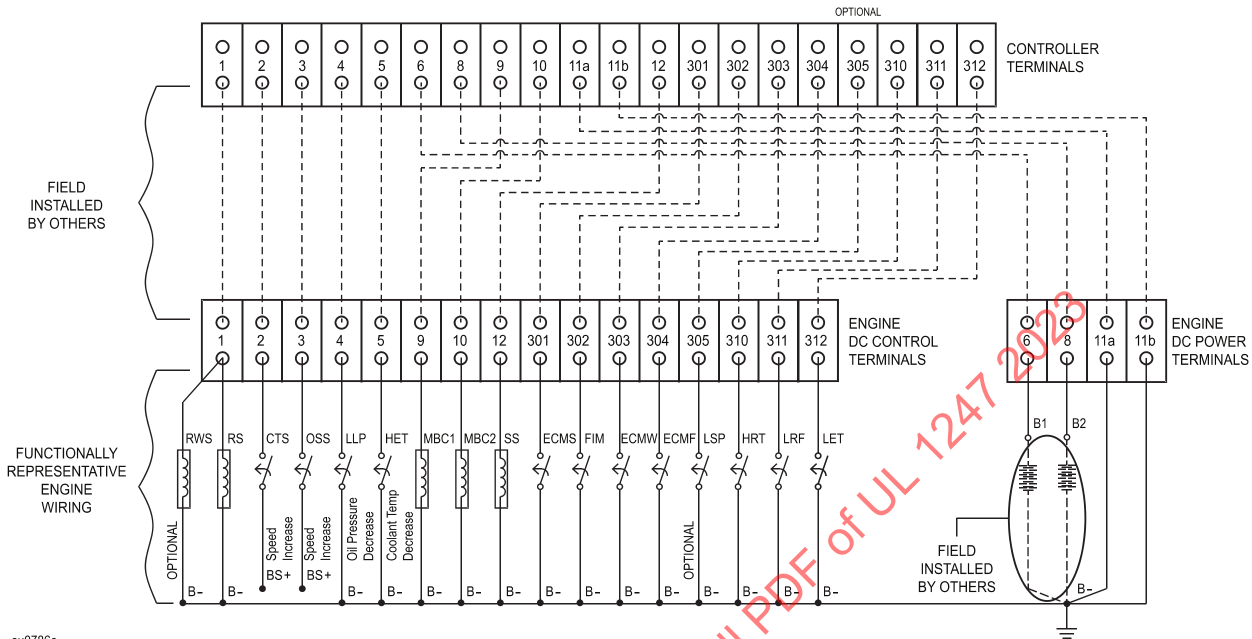
12.6 A wire-binding screw shall thread into metal.

12.7 The clearance between the end of a wire connector or terminal block for connection of a field installed wire, and the wall of the enclosure shall be not less than 1/2 inch (12.7 mm). The clearance is to be measured between live electrical parts and the enclosure.

12.8 An engine terminal block arrangement to facilitate connection of the engine to the controller shall include, as necessary, the engine terminals referenced in Figure 12.1 and Table 12.1.

Figure 12.1

Diesel Engine/Controller Terminal Wiring Diagram



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Legend	Description
B-	Common Battery 1 and 2 Negative
B1	Battery 1 Positive
B2	Battery 2 Positive
BS+	Battery System Positive
CTS	Crank Termination Switch
ECM	Electronic Control Module
ECMF	Electronic Control Module Failure
ECMS	Electronic Control Module Switch
ECMW	Electronic Control Module Warning
ETR	Energized To Run
ETS	Energized To Stop
FIM	Fuel Injection Malfunction
HET	High Engine Temperature
HRT	High Raw Water Temperature
LET	Low Engine Temperature
LLP	Low Lubricant Pressure
LRF	Low Raw Water Flow (Required by others)
LSP	Low Suction Pressure (Optional - required for variable speed suction limiting control engines)
MBC1	Main Battery Contactor 1 coil or Battery Relay 1 coil
MBC2	Main Battery Contactor 2 coil or Battery Relay 2 coil
OSS	Overspeed Switch
RS	Run Solenoid/Circuit
RWS	Raw Water Solenoid Valve (when used)
SS	Shutdown Solenoid/circuit

NOTE – Figure 12.1 and Table 12.1 includes requirements and information related to the terminal connections for both diesel engines for driving stationary fire pumps and fire pump controllers. For this Standard, only the requirements for diesel engines for driving stationary fire pumps are to be applied.

Table 12.1
Additional Notes for Figure 12.1

Terminal	Diagram circuit function (as seen by terminal strip)	Circuit shall be designed to accommodate these amperes continuously	Terminal shall accommodate these wire sizes (for inter-connection wires to controller)
1[b]	Receives battery positive from the fire pump controller (FPC) when the FPC acts to cause the engine to run. The FPC shall remove this battery positive upon receiving an overspeed signal on terminal #3. Optional RWS shall also be permitted to be connected to this terminal. (This circuit functions as a run circuit.) NOTE: ETR engines cannot run (except Manual Operation at engine) without this battery positive and will stop running when this battery positive from the FPC is removed.	10	10
2[a]	Receives battery positive from the engine when engine speed reaches crank terminate speed. (Accomplished on increasing speed).	1	14
3[a]	Receives battery positive from the engine when engine speed reaches an overspeed condition. This battery positive shall be maintained until a manual reset has been performed at the engine. (Accomplished on increasing speed).	1	14
4[a]	Receives battery negative from the engine when engine lubricating pressure falls below a minimum pressure. (Accomplished on decreasing lubricating pressure while engine is running).	1	14
5[a]	Receives battery negative from the engine when engine reaches excessively high coolant temperature. The engine shall open this circuit when the engine is not running. (Accomplished on increasing coolant temperature).	1	14
6[cdef]	Receives B1 battery positive from the engine. The size of the wire shall be selected for both ampacity and resistance. See Note 1F. NOTE: This circuit provides battery current for FPC function and for battery charging by the FPC.	10	8
7	Reserved for future use. (Not shown in figure)		
8[cdef]	Receives B2 battery positive from the engine. The size of the wire shall be selected for both ampacity and resistance. See Note 1F. NOTE: This circuit provides battery current for FPC function and battery charging by the FPC.	10	8
9[b]	Receives battery positive from the FPC when the FPC acts to cause the engine to crank utilizing B1. Connected to and provides battery positive to Battery Relay #1 which is used in the description for MBC1.	10	10
10[b]	Receives battery positive from the FPC when the FPC acts to cause the engine to crank utilizing B2. Connected to and provides battery positive to Battery Relay #2 which is used in the description for MBC2.	10	10
11a[cdef]	Receives common ground and common battery negative for both B1 and B2 from the engine. The	10	8
11b[cdef]		10	8

Table 12.1 Continued on Next Page

Table 12.1 Continued

Terminal	Diagram circuit function (as seen by terminal strip)	Circuit shall be designed to accommodate these amperes continuously	Terminal shall accommodate these wire sizes (for inter-connection wires to controller)
	size of the wire shall be selected for both ampacity and resistance. See Note 1F. NOTE: This is not intended to create a fully isolated battery negative or ground system, and/or prohibit the use of a internally grounded component.		
12[b]	Receives battery positive from the FPC when the FPC acts to cause the engine to stop running. This shall be connected to the SS on engines designed for ETS.	10	10
301[a]	Receives battery negative from the engine when the ECM selector switch is in the alternate ECM position. Accomplished when the ECM's is transferred to the alternate ECM position for engines with ECM.	1	14
302[a]	Receives battery negative from the engine when a FIM is identified by either ECM for engines fitted with ECM. (Accomplished on fuel injection malfunction).	1	14
303[a]	Receives battery negative from engine when a single ECM fails for engines fitted with ECM.	1	14
304[a]	Receives battery negative from the engine when both ECM's have failed for engines fitted with ECM.	1	14
305[a]	Receives battery negative from engine when a low suction pressure is identified. (Accomplished on decreasing suction pressure). NOTE: Required for optional variable speed suction limiting control on engine.	1	14
306-309	Reserved for future use. (Not shown in figure)		
310[a]	Receives battery negative from engine when the raw water temperature is too high. (Accomplished on increasing raw water temperature while engine is running).	1	14
311[a]	Receives battery negative from engine when the raw water strainer in the cooling loop becomes clogged or low flow is detected. NOTE: This feature is provided for some installations.	1	14
312[a]	Receives battery negative from the engine when engine minimum temperature is not maintained. (Accomplished on decreasing engine temperature when the engine is not running).	1	14

NOTE – Figure 12.1 and Table 12.1 includes requirements and information related to the terminal connections for both diesel engines for driving stationary fire pumps and fire pump controllers. For this Standard, only the requirements for diesel engines for driving stationary fire pumps are to be applied.

[a] Circuits on terminals 2, 3, 4, 5, 301, 302, 303, 304, 305, 310, 311 and 312 shall be capable of up to 1 ampere load.
[b] Circuits on terminals 1, 9, 10 and 12 shall be capable of up to 10 ampere load.
[c] Circuits 6, 8, 11a and 11b shall be permitted to carry, over a 24-hour period when both batteries are charging at the maximum rate of 10 amps average, up to 18 amps RMS depending on the battery charger design.
[d] For engines requiring more than 200 Amp-hrs. of battery capacity per bank, the current rating of terminals 6, 8, 11a and 11b shall be proportionally increased to accommodate the proportional increase in the battery charger current output that is necessary to maintain a 24-hour recharge requirement.
[e] Circuits on terminal 11a and 11b combined, shall be capable of the sum of the maximum charging currents from the FPC on terminals 6 and 8.
[f] The average voltage drop between terminal 6 and terminals 11a and 11b, and between terminal 8 and terminals 11a and 11b, at the junction box, with a 10-amp load at the battery terminals, shall not exceed 0.2 volts on a average basis.

13 Lubrication System

13.1 An engine shall be equipped with a pressure type lubrication system. The system shall consist of a direct engine driven pump, a filter, and distribution system. It shall have the capacity necessary to maintain lubricant temperature and the pressure within the range rated for the engine.

13.2 The lubrication system shall be free of visible leakage. The lubricant filter media shall be replaceable or the filter shall be of a type that is intended to be cleaned and reused.

13.3 Means for checking, draining, and replenishing the lubricant supply shall be provided.

14 Air Induction System

14.1 The air induction system shall be equipped with a filter having a filter media that is replaceable or a filter of the type that is intended to be cleaned and reused.

14.2 The air induction system shall be provided with a water shield that fully surrounds the top and sides of the air filter to minimize the potential for direct water impingement on the air filter in the event of the overhead discharge of water. This shield shall be permitted to be omitted if it can be demonstrated that the overhead discharge of water from a sprinkler system does not adversely impact filter and engine performance.

15 Exhaust System

15.1 The exhaust system shall be gas-tight throughout the operating range of exhaust temperatures and pressures. It shall be constructed with an outlet connection to allow for ducting exhaust gases outside the pump room.

15.2 The exhaust manifold shall be liquid cooled, insulated or otherwise shielded to reduce the risk of burn injury to operating personnel. When insulation is provided, the exposed surface shall be nonporous.

16 Fuel System

16.1 The fuel system shall include at least one fuel filter with a replaceable medium. The fuel system shall be leak free throughout all conditions of engine operation, and the inlet to the fuel system shall be capable of being connected to a fuel supply line.

17 Power Takeoff

17.1 An engine shall provide power takeoff directly from the engine's rotating shaft or flywheel.

18 Charging System

18.1 A battery charging generator or alternator and a voltage regulator shall be provided for an engine equipped with an electric starter.

18.2 A generator or alternator shall deliver the output current to the batteries and not deliver output current directly to the fire pump controller through terminal 7, if provided.

19 Engines With Rated Speed Ranges

19.1 An engine rated for a speed range shall be limited to the following construction features:

a) No hardware changes or substitutions shall be necessary to comply with the requirements of Engine Tests, Section 21, throughout the specified speed range for the engine; and

b) Only adjustments to the speed controller (governor) and speed switch shall be required to change speed settings.

PERFORMANCE

20 General

20.1 These tests shall be conducted with the engine arranged to operate without the fire pump controller and all the power consuming accessories attached. In addition, the engine is to be tested with the starting system and cooling system that is intended to be provided with the engine.

20.2 For the performance tests, an engine shall be supplied with a grade of diesel fuel specified by the engine manufacturer as not capable of providing power output greater than No. 2-D diesel fuel as described in ASTM D 975.

21 Engine Tests

21.1 Starting

21.1.1 Inactive starting for all starting systems

21.1.1.1 When tested in accordance with 21.1.1.2, an engine shall start and accelerate from cranking speed to the maximum sustainable power output at the highest rated speed within 20 seconds. If the maximum sustainable power output at a lower speed is more than 10 percent higher than the maximum sustainable power output at the highest rated speed, the engine shall also be subjected to the cold start test at the maximum sustainable power output associated with the lower rated speed.

21.1.1.2 With the automatic heater in 10.1 disconnected and after a minimum of 8 hours of non-operation, the engine is to be started, accelerated as quickly as possible to rated speed (±20 rpm) and maximum sustainable power output, operated at that speed and power output for not more than 30 seconds. For electric starting systems, the engine air intake, room ambient temperatures and starting equipment shall be conditioned to a temperature not exceeding 80 °F (26.6 °C) prior to the engine start. For hydraulic starting systems, the engine air intake, room ambient temperatures and starting equipment shall be conditioned at 32 °F (0 °C) prior to the first engine start.

21.1.1.3 In addition to the testing specified in 21.1.1.1 and 21.1.1.2, tests shall be conducted on a representative sample engine(s) to verify compliance with the engine operation requirements described in 6.5.

21.1.2 Hot starting for all starting systems

21.1.2.1 For each trial specified in 21.1.2.2 and 21.1.2.3, an engine shall start and accelerate from cranking speed to the maximum sustainable power output associated with the lowest and highest rated speeds within 20 seconds.

21.1.2.2 Immediately following the 4-hour endurance test specified in 21.2, the engine is to be shut down, and subsequently started, accelerated as quickly as possible to the maximum sustainable power output associated with the highest rated speed (±20 rpm) and operated at that speed and power output for not more than 30 seconds, and stopped, for three trials at intervals of:

a) Immediately after shutdown from the endurance test;

b) 2.5 minutes after shutdown from the first hot start trial; and

c) 5 minutes after shutdown from the first hot start trial.

21.1.2.3 Immediately following the 1-hour endurance test specified in 21.2 for the lowest rated speed, the engine is to be shut down, and subsequently started, accelerated as quickly as possible to the maximum sustainable power output associated with the lowest rated (±20 rpm) speed for three trials as specified in 21.1.2.2.

21.1.3 Electric starting system cranking

21.1.3.1 An engine equipped with electric starting components shall demonstrate the capability of providing at least twelve consecutive 15-second cranking attempts, with 15 second interval between attempts, at full rated cranking speed with two battery units sized as referenced in 25.1(l).

21.1.3.2 After conditioning for a minimum of 8 hours at 40 °F (4.5 °C) including the battery units with only the automatic heater operating, an engine shall be subjected to 15 second cranking cycles without fuel supplied to the engine. The 15 second cranking cycles, with a 15 second interval between attempts, shall be alternated between the two battery units. The cranking revolutions per minute shall be recorded. At the end of the last cranking cycle, fuel shall be supplied to the engine and the engine shall start.

21.1.4 Pneumatic starting system cranking

21.1.4.1 An engine equipped with pneumatic starting components shall be tested to demonstrate the capability to provide 180 seconds of continuous cranking at a speed (rpm) necessary to start the engine.

21.1.4.2 After a minimum of 4 hours at room temperature and no fuel supplied to the engine, an engine equipped with pneumatic starting components shall be subjected to 180 seconds of continuous cranking without recharging the air supply. The cranking speed in revolutions per minute shall be recorded. At the end of the 180 seconds of cranking, fuel shall be supplied to the engine and the engine shall start.

21.1.5 Hydraulic starting system cranking

21.1.5.1 An engine equipped with hydraulic starting components shall be tested to demonstrate the capability of at least six consecutive 15-second cranking attempts with the cranking at a speed (rpm) necessary to start the engine. Each cranking attempt is to be conducted with the intake air temperature, ambient temperature, and the hydraulic cranking system at 32 °F (0.0 °C).

21.1.5.2 After conditioning for a minimum of 8 hours at 32 °F (0.0 °C) with only the automatic heater operating, an engine shall be subjected to six 15-second cranking cycles without fuel supplied to the engine. The first three cranking cycles are to be initiated by simulating an automatic start and the last three cranking cycles shall be initiated with a manual engine start control. At the end of the last cranking cycle, fuel shall be supplied to the engine and the engine shall start. The cranking speed in revolutions per minute shall be recorded.

21.2 Endurance

21.2.1 When tested as specified in 21.2.3 and 21.2.4, an engine shall not:

a) Lose coolant following establishment of proper coolant level;

b) Lose lubricating oil; or

c) Develop a coolant temperature above 210 °F (99 °C) during operation.

21.2.2 When tested as specified in 21.2.3 and 21.2.4, the cooling system shall automatically maintain the engine within its specified range of operating temperatures:

a) When a heat exchanger cooling system is used, the raw water flow shall not exceed the flow rate specified in Table 21.1 with raw water having a minimum temperature of 60 °F (15.6 °C).

b) When a radiator cooling system is used, a means is to be provided to maintain the coolant and combustion air temperature at a minimum of 120 °F (48.9 °C) during the endurance testing; and

c) When a radiator cooling system is used, a 0.5-inch (13 mm) water column restriction shall be created between the air supply and discharge. This external air restriction shall be in addition to the radiator, fan guard, and other engine component obstructions.

Table 21.1
Maximum Raw Water Flow Rate Through Heat Exchanger

Horsepower rating range	GPM	(L/min)
≤50	a	a
50 – 70	12.5	(47.4)
71 – 90	19	(72.0)
91 – 135	25	(94.8)
136 – 175	37.5	(142.2)
176 – 225	50	(189.6)
More than 225	a	a

[a] Flow rate shall not exceed 0.25 gpm (0.95 L/m) times the engine's horsepower rating.

21.2.3 For engines intended for specific speed ratings, the engine is to be run continuously at the maximum sustainable power output associated with the highest rated speed (±20 rpm) for a minimum of 4 hours and for 1 hour at each additional rated speed. See 21.2.5 and 21.2.6. If the maximum sustainable power output at a lower speed is more than 10 percent higher than the maximum sustainable power output at the highest rated speed, the engine shall be permitted to be run continuously for a minimum of 4 hours at the maximum sustainable power output at the associated lower speed (±20 rpm) in lieu of the highest rated speed.

21.2.4 For engines intended for use within a specified speed range or ranges, the engine is to be operated continuously at the maximum sustainable power output associated with the highest rated speed (±20 rpm) for a minimum of 4 hours, 1 hour at the minimum rated speed, and 1 hour at a minimum of one intermediate speed (±20 rpm) within the specified speed range. See 21.2.5 and 21.2.6. If the maximum sustainable power output at a lower speed is more than 10 percent higher than the maximum sustainable power output at the highest rated speed, the engine shall be permitted to be run continuously for a minimum of 4 hours at the maximum sustainable power output at the associated lower speed (±20 rpm) in lieu of the highest rated speed.

21.2.5 During the test specified in 21.2.3 or 21.2.4, at least the following data is to be recorded every 30 minutes:

a) Rotational speed;

b) Power output;

c) Ambient air pressure and temperature;

d) Fuel consumption rate;

e) Raw water inlet and outlet temperature and flow rate;

f) Coolant temperatures at the jacket; and

g) Lubricant pressure and temperature.

21.2.6 The engine is to be shut down immediately after completion of the test specified in 21.2.3 or 21.2.4 or longer period of continuous operation, and subjected to the hot starting tests described in 21.1.2.

21.3 Power rating

21.3.1 After the test described in 21.2.6 has been completed, the maximum sustainable power output is to be determined for each rated speed. For engines rated for a speed range or ranges, the maximum sustainable power outputs within the specified speed range or ranges are to be determined by the use of a linear interpolation between the horsepowers developed at minimum and maximum speeds. Intermediate speed power outputs developed by the engine shall be equal to or greater than the interpolated values for those speeds. Sustainable power output is defined as the power output available during testing under engine conditions consisting of stable or increasing lubricant pressure, and stable or decreasing coolant temperature, lubricant temperature, and fuel consumption.

21.3.2 For the purposes of the power rating determinations, an engine is to be rated using SAE J 1349 conditions for 29.61 inches Hg (100.3 kPa) barometer (approximately 300 feet (91.44 m) above sea level) and 77 °F (25 °C).

21.3.3 The maximum sustainable power output at standard atmospheric conditions (P_s) referenced in 21.3.2 (recorded at the shaft during the test described in 21.2.3 or 21.2.4) is to be calculated using the following formula:

$$P_s = \frac{1.278 P_t (T + 460)^{1/2}}{p_a}$$

in which:

P_s = Maximum sustainable power output at standard atomspheric conditions of 77 °F (25 °C) and 29.61 inches Hg (100.3 kPa);

P_t = Power output obtained during testing using recorded atmospheric conditions;

T = Air inlet temperature in °F; and

p_a= Recorded atmospheric pressure in inches of mercury.

21.3.4 The maximum sustainable power output (P_s) is then to be divided by 1.1 to obtain the rated power output (P_r) as indicated in the following formula:

$$P_r = \frac{P_s}{1.1}$$

NOTE: This reduced horsepower rating is intended to provide reserve power for intended performance and an allowance for a reduction of power output over the engine's anticipated service life.

21.4 Speed controller

21.4.1 The speed controller shall control the engine speed within ±10 percent when tested at the minimum and maximum speed ratings during the test specified in 21.4.2 and 21.4.3.

21.4.2 The speed controller of the engine is to be set to maintain rated speed (±20 rpm) at the maximum sustainable power output load at that speed. The engine is then to be started, allowed to reach proper operating temperatures, and the speed controller adjusted until the engine delivers maximum sustainable power output and rated speed (±20 rpm).

21.4.3 Without disturbing the speed controller setting, the load is to be reduced to 25 percent of the maximum sustainable power output load. The load is then to be increased from 25 percent maximum sustainable load to full load in 25 percent increments. At each load increment the load is to be dropped rapidly to a no-load condition.

21.5 Overspeed shutdown

21.5.1 When tested as specified in 21.5.2 and 21.5.3, the overspeed shutdown feature shall demonstrate the capability to shut down the engine at a speed between 110 and 120 percent of a rated engine speed and send a signal as referenced in 6.1(i) and Table 12.1.

21.5.2 For engines with a mechanical fuel management control, the overspeed shutdown feature of an engine is to be set in accordance with the manufacturer's recommendations and the primary speed controller adjusted to allow an operating speed in excess of the overspeed shutdown setting. The engine is then to be started and allowed to accelerate until the overspeed shutdown feature operates.

21.5.3 For engines with an electronic fuel management control, the function of the overspeed shutdown feature shall be permitted to be tested at a speed less than the rated speed of the engine. The overspeed shutdown feature is to be set at a predetermined speed. The engine is then to be started and allowed to accelerate until the overspeed shutdown feature operates. The speed at shutdown shall be within ±5 percent of the overspeed shutdown setting.

21.6 Engines with electronic fuel management control

21.6.1 In addition to demonstrating compliance with 21.2 and 21.3 with the Primary ECM operating under normal conditions, an engine equipped with an electronic fuel management control shall be tested to demonstrate that the maximum sustainable power output associated with the highest rated speed (±20 rpm) is provided as described in 21.3 when subjected to the test conditions described in 21.6.2 – 21.6.9.

21.6.2 The engine, with the dynamometer connected, is to be started and operated under each of the conditions described in Table 21.2 and Table 21.3.