UL 1004-5

STANDARD FOR SAFETY

Fire Pump Motors

UL Standard for Safety for Fire Pump Motors, UL 1004-5

Second Edition, Dated May 9, 2014

Summary of Topics

This revision of ANSI/UL 1004-5 dated November 1, 2022 includes the following changes in requirements:

– Correction to Table 8.4

– Locked Rotor KVA Marking; 11.5

– Inverter Duty Motor Service Factor Marking; 11.8

– Direction of Rotation Marking; 11.9

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated July 29, 2022.

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UL 1004-5

Standard for Fire Pump Motors

First Edition – September, 2008

Second Edition

May 9, 2014

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through November 1, 2022.

The most recent designation of ANSI/UL 1004-5 as an American National Standard (ANSI) occurred on November 1, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 This Standard is intended to be read together with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1. The requirements in this Standard supplement or amend the requirements in UL 1004-1. The requirements of UL 1004-1 apply unless modified by this Standard.

1.2 This Standard covers motors that are intended for use in fire pump applications as defined by NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.

1.3 This Standard does not cover the fire pump controller. These controllers are covered by the Standard for Fire Pump Controllers, UL 218.

1.4 These requirements do not cover motors intended for use in hazardous locations as defined in the *National Electrical Code*®, NFPA 70.

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2 Glossary

2.1 For the purpose of this Standard, the following definitions apply.

2.2 BREAKDOWN TORQUE – Maximum torque developed when a motor is run at rated voltage and frequency, without an abrupt loss in speed.

2.3 DESIGN B – A squirrel-cage motor designed to certain minimum torque values and a maximum locked-rotor current with a slip of less than 5 percent at rated load.

2.4 DRIP PROOF – A motor intended for indoor use and designed to provide a degree of protection against a limited amount of falling water and dirt.

2.5 LOCKED-ROTOR TORQUE – Minimum torque developed when a motor with the rotor locked is operated at rated voltage and frequency.

2.6 MODELING – A process to simulate an actual load under laboratory conditions. This is usually used when testing a motor for the Duty Cycle Test, Section 9. The loading device may have more severe starting conditions than the fire pump. In order to avoid overheating the motor during testing, it is required to reduce the number of starts and stops.

2.7 PULL-UP TORQUE – Minimum torque developed at any speed between zero and the speed corresponding to the breakdown torque, when the motor is operated at rated voltage and frequency.

2.8 RADIUS OF GYRATION – The distance from an axis that one could put a single particle of weight equal to the weight of a rigid body and have this particle have the same total weight (force) moment of inertia as the original body. The radius of gyration is expressed in the units of distance (meters or feet) squared, i.e., m^2 or ft^2.

2.9 SLIP SPEED – The difference between the synchronous speed and the measured speed of a motor.

2.10 SLIP – Defined as Slip Speed divided by Synchronous Speed.

2.11 SYNCHRONOUS SPEED (of a motor) – Defined by the equation, $\eta_s = 120 \times f / p$

in which:

η_s = the synchronous speed in revolutions per minute

f = the line frequency in hertz

p = the number of motor poles

2.12 TOTAL WEIGHT (FORCE) MOMENT OF INERTIA – The total weight moment of inertia is a measure of the distribution of the weight of an object relative to a given axis. The total weight moment of inertia is the product of weight times the radius of gyration. The total weight moment of inertia, "I", is the expressed in units of distance squared times weight (or mass), i.e., $kg \cdot m^2$ or $lb \cdot ft^2$. In the case of a fire pump, it is a characteristic of the pump which will dictate the amount of time, "t", that it will take a motor with a torque, "T", to accelerate the pump to a given speed. Conversely, it is a characteristic that will dictate the amount of time that a given pump, coupled to a given motor, will take to decelerate to a stop.

CONSTRUCTION

3 General

3.1 *Deleted*

3.2 Fire pump motors intended for use with variable speed drives shall additionally meet the requirements of the Standard for Inverter Duty Motors, UL 1004-8.

4 Frame and Enclosure

4.1 A fire pump motor enclosure shall be rated a minimum of Type 2 (drip proof), IPX2, or higher, or shall be provided with the instructions specified in 12.1 to indicate a Type 2 or equivalent drip proof enclosure is required for the use environment.

PERFORMANCE

5 General

5.1 The voltage of the test circuit for the performance tests shall be at rated voltage unless stated otherwise in the individual tests.

5.2 The tests are capable of being conducted in any order, as long as the Dielectric Voltage-Withstand Test of UL 1004-1 is conducted on a motor in a heated condition.

5.3 When a single motor sample is used for several or all tests, only one Dielectric Voltage-Withstand Test of UL 1004-1 shall be performed on the sample. It shall be performed after all other tests for that sample have been completed and the motor sample is in a heated condition. When a single motor sample is used for each test, the Dielectric Voltage-Withstand Test of UL 1004-1 shall be performed as required on each sample.

6 Variation from Rated Voltage Test

6.1 An induction fire pump motor shall operate when subjected to a voltage of 10 percent higher and 10 percent lower than the nameplate voltage for each voltage rating. For motors with a voltage range, the test

specified in 6.2 shall be performed on the highest voltage for the 110 percent test and the lowest voltage for the 90 percent test.

6.2 One sample of a fire pump motor is to be connected to a source of supply and loaded to rated horsepower, times any rated service factor. The motor is to be operated at rated frequency and voltage. The voltage is then to be reduced to 90 percent of the rated voltage and operated for one minute. The voltage is then to be increased to 110 percent of the rated voltage and operated for one minute.

7 Temperature Test

7.1 The Temperature Test of UL 1004-1 is to be conducted with the machine under test delivering full rated mechanical output. This test is then to be repeated with the machine under test delivering full rated mechanical output, multiplied by any service factor if provided.

8 Locked Rotor Test for Fire Pump Motors

8.1 A fire pump motor rated 600 V or less and 500 hp or less, including those rated for use with an inverter, is to be operated continuously for 12 seconds at rated voltage and frequency with the rotor locked. The locked-rotor current is to be measured during the first 3 seconds of the test.

8.2 A fire pump motor rated from 601 V – 7.2 kV, or greater than 500 hp, is to be operated continuously when initially at room ambient temperature for 8 seconds at rated voltage and frequency with the rotor locked. The locked rotor current is to be measured during the first 3 seconds of the test.

8.3 A fire pump motor shall continue to operate and show no evidence of electrical breakdown as a result of the locked-rotor current evaluation specified in 8.1 or 8.2.

8.4 The measured locked-rotor current for a polyphase motor rated 600 V or less and 500 hp or less shall not exceed the values in Table 8.1 for 60 Hz motors and Table 8.2 for 50 Hz motors when adjusted to the rated voltage. For voltages other than 230 V or 380 V, the locked-rotor current shall be inversely proportional to the voltages. (For example, for a 460 V motor, the maximum locked-rotor current at a given horsepower rating is half the maximum value at 230 V.)

8.5 The measured locked-rotor current for a motor rated from 601 V – 7.2 kV, or greater than 500 hp, shall not exceed the values in Table 8.1 for 60 Hz motors and Table 8.2 for 50 Hz motors when adjusted to the rated voltage, unless marked as indicated in 11.7.

8.6 After the locked-rotor operation, and while still in a heated condition, the motor shall be subjected to the Dielectric Voltage-Withstand Test of UL 1004-1 without evidence of electrical breakdown. The motor shall operate after the application of the dielectric potential.

Table 8.1
Maximum (polyphase) locked-rotor current based on 230 V, 60 Hz

Power rating		Locked-rotor current, A, at 60 Hz	Motor designation (NFPA 70 locked rotor indicating code letter) “F” to and including
kW	(hp)		
0.37	(1/2)	20	R
0.56	(3/4)	25	P
0.75	(1)	30	N

Table 8.1 Continued on Next Page

Table 8.1 Continued

Power rating		Locked-rotor current, A, at 60 Hz	Motor designation (NFPA 70 locked rotor indicating code letter) "F" to and including
kW	(hp)		
1.12	(1-1/2)	40	M
1.49	(2)	50	L
2.24	(3)	64	K
3.73	(5)	92	J
5.59	(7-1/2)	127	H
7.46	(10)	162	H
11.2	(15)	232	G
14.9	(20)	290	G
18.6	(25)	365	G
22.4	(30)	435	G
29.8	(40)	580	G
37.3	(50)	725	G
44.7	(60)	870	G
55.9	(75)	1085	G
74.6	(100)	1450	G
93.2	(125)	1815	G
112	(150)	2170	G
149	(200)	2900	G
186	(250)	3650	G
224	(300)	4400	G
261	(350)	5100	G
298	(400)	5800	G
336	(450)	6500	G
373	(500)	7250	G

NOTE 1 – Motors rated for different voltages shall have a proportionately higher (or lower) locked-rotor current [e.g. a 460 V, 746 W (1 hp) motor would have a 15A locked-rotor current limit.]

NOTE 2 – Motors rated higher than 373 kW (500 hp) shall have a proportionately higher locked-rotor current [e.g. a 230 V, 746 kW (1000 hp) motor would have a 14500 A locked-rotor current limit.]

Table 8.2
Maximum (polyphase) locked-rotor current values based on 380 V, 50 Hz

Power rating		Locked-rotor current, A, at 50 Hz	Motor designation (NFPA 70 locked rotor indicating code letter) "F" to and including
kW	(hp)		
0.75	(1 or less)	20	P
1.12	(1-1/2)	27	N
1.49	(2)	34	M
2.24	(3)	43	L
3.73	(5)	61	K
5.59	(7-1/2)	84	J

Table 8.2 Continued on Next Page

Table 8.2 Continued

Power rating		Locked-rotor current, A, at 50 Hz	Motor designation (NFPA 70 locked rotor indicating code letter) "F" to and including
kW	(hp)		
7.46	(10)	107	H
11.2	(15)	154	H
14.9	(20)	194	H
18.6	(25)	243	H
22.4	(30)	289	H
29.8	(40)	387	H
37.3	(50)	482	H
44.7	(60)	578	H
55.9	(75)	722	H
74.6	(100)	965	H
93.2	(125)	1207	H
112.0	(150)	1441	H
149.0	(200)	1927	H
186.5	(250)	2534	H
223.8	(300)	3026	H
261.1	(350)	3542	H
298.4	(400)	4046	H
335.7	(450)	4539	H
373.0	(500)	5069	H

NOTE 1 – Motors rated for different voltages shall have a proportionately higher (or lower) locked-rotor current [e.g. a 190 V, 746 W (1 hp) motor would have a 40 A locked-rotor current limit.]

NOTE 2 – Motors rated higher than 373 kW (500 hp) shall have a proportionately higher locked-rotor current [e.g. a 380 V, 746 kW (1000 hp) motor would have a 10138 A locked-rotor current limit.]

Table 8.3
Maximum (single-phase designated design N) locked-rotor current values for 115/230 V, 60 Hz

Power rating		Locked-rotor current, A, at 60 Hz, 115/230 V	Motor designation (NFPA 70 locked rotor indicating code letter) "F" to and including 115/230 V
kW	(hp)		
0.373	(1/2)	45/25	M/N
0.625	(3/4)	61/35	L/M
0.75	(1)	80/45	L/M

Table 8.4
Maximum (single-phase designated design L) locked-rotor current values for 115/230 V, 60 Hz

Power rating		Locked-rotor current, A, at 60Hz, 115/230 V	Motor designation (NFPA 70 locked rotor indicating code letter) "F" to and including 115/230 V
kW	(hp)		
0.373	(1/2)	45/25	M/N
0.625	(3/4)	61/35	L/M
0.75	(1)	80/45	L/M
1.12	(1-1/2)	-/50	-/J
1.49	(2)	-/65	-/J
2.24	(3)	-/90	-/H
3.73	(5)	-/135	-/G
5.59	(7-1/2)	-/200	-/G
7.46	(10)	-/260	-/G

9 Duty Cycle Test

9.1 One sample of the motor is to be started at no load. The loading device is to then be adjusted so that the motor operates at rated voltage, frequency, and horsepower, including the service factor, for 5 minutes. After five minutes, the load is to be reduced to no load, the sample is to be disconnected from the power source, and is to coast to a complete stop. Immediately after a complete stop is attained, the sample is to be started again. A total of twelve cycles of starting and stopping the motor are to be performed.

9.2 When the characteristics of the intended pump are known and quantified and when agreeable to those concerned, the total number of cycles shall be reduced by "modeling". The modeling method shall create the same level of heat that is generated in the field when the motor is connected to the pump. The modeling is to use the inertias and load levels and acceleration and deceleration times that would be experienced by the motor when coupled to the intended pump. When using inertias, consideration is to be given to the motor-pump inertia versus the motor-test load (Dynamometer, for example) inertia. See Table 9.1 for examples of pump inertia.

Table 9.1
Pump Inertia Examples

Motor Horsepower	Pump total weight moment of inertia ($lb \cdot ft^2$)
50	4
75	6
100	8
150	52
200	60
300	70
400	94
500	112

NOTE 1 – These values do not represent actual pump values.

NOTE 2 – For motors rated above 500 hp, the value should be proportionately higher (e.g. a 1000 hp motor would have 224 $lb \cdot ft^2$.)

9.3 After the twelve cycles have been performed, the sample shall be subjected to the Dielectric Voltage-Withstand Test of UL 1004-1 and shall exhibit no electrical breakdown and be operational.

10 Operational Test

10.1 The test methods used shall be in accordance with IEEE 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

10.2 For three-phase motors rated 600 V or less and 500 hp or less, the locked-rotor torque, breakdown torque, and pull-up torque shall be equal to or greater than the values in Table 10.1, Table 10.2, and Table 10.3.

10.2.1 For motors rated 600 V or less and 500 hp or less not included in Table 10.1, Table 10.2, and Table 10.3 and motors rated from 601 V – 7.2 kV, or greater than 500 hp, the breakdown torque and pull-up torque shall be equal to or greater than the values in Table 10.4.

10.2.2 Single-phase motors built using a NEMA two-digit frame size and marked in accordance with 11.3 shall comply with the locked-rotor torque, breakdown torque, and pull-up torque limits in NEMA MG-1, Part 12: Test and Performance – AC Motors for Design N.

10.2.3 Single-phase motors built using a NEMA three-digit frame size and marked in accordance with 11.4 shall comply with the locked-rotor torque, breakdown torque, and pull-up torque limits in NEMA MG-1, Part 12: Test and Performance – AC Motors for Design L.

Table 10.1
Minimum locked-rotor torque, as a percentage of full load torque

Horsepower, hp	Synchronous speed, rpm (60/50 Hz)						
	3600/3000	1800/1500	1200/1000	900/750	720/–	600/–	514/–
1/2	–	–	–	140	140	115	110
3/4	–	–	175	135	135	115	110
1	–	275	170	135	135	115	110
1-1/2	175	250	165	130	130	115	110
2	170	235	160	130	125	115	110
3	160	215	155	130	125	115	110
5	150	185	150	130	125	115	110
7-1/2	140	175	150	125	120	115	110
10	135	165	150	125	120	115	110
15	130	160	140	125	120	115	110
20	130	150	135	125	120	115	110
25	130	150	135	125	120	115	110
30	130	150	135	125	120	115	110
40	125	140	135	125	120	115	110
50	120	140	135	125	120	115	110
60	120	140	135	125	120	115	110
75	105	140	135	125	120	115	110
100	105	125	125	125	120	115	110
125	100	110	125	125	115	115	110
150	100	110	120	120	115	115	–

Table 10.1 Continued on Next Page