20.2 Undervoltage operation

20.2.1 A unit connected to the output of a high-voltage power supply or high-voltage signaling unit shall perform its intended signaling operation while the power supply or signaling unit is energized at 85 percent of its rated input voltage.

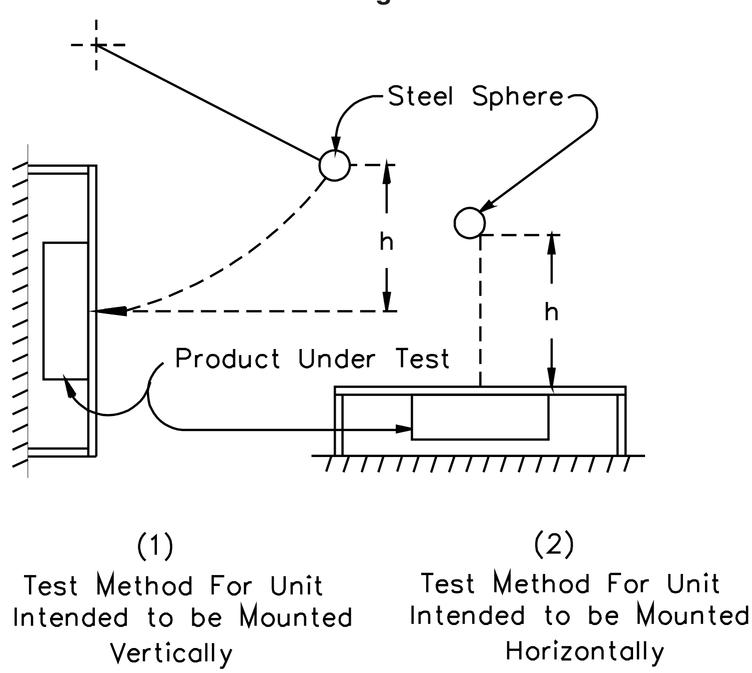
20.2.2 For this test the unit is to be energized from a rated source of supply in the standby condition for at least 3 hours, following which the voltage is to be reduced to 85 percent of its rated input voltage and the unit is to be tested for signaling performance.

21 Jarring Test

21.1 A signaling unit shall withstand jarring resulting from impact and vibration such as experienced in service, without causing signaling operation of any part and without impairing its subsequent operation.

21.2 The device is to be mounted in a position of intended use to the center of a 6- by 4-foot (1.8- by 1.2-m), nominal 3/4 inch (19.1 mm) thick plywood board that is secured in place at four corners. An impact is to be applied to the center of the reverse side of this board by means of a 1.18-pound (0.53-kg), 2-inch (50.8-mm) diameter steel sphere, sufficient to apply 3 foot-pounds (4.2 J) of energy. The impact is to be applied by swinging the sphere through a pendulum arc from a height (h) of 2.54 feet (0.77 m), or dropping the sphere from a height (h) of 2.54 feet, depending upon the mounting of the equipment. See Figure 21.1.

Figure 21.1
Jarring test



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21.3 For this test, the unit is to be energized in the standby condition and connected to a rated source of supply. Following the jarring, the unit is to be tested for signaling operation.

22 Temperature Test

22.1 The materials employed in the construction of a unit shall not be adversely affected by the temperatures attained under any condition of intended operation, while connected to a source of rated voltage and frequency.

22.2 A material will be regarded as being adversely affected if it is subject to a temperature rise greater than the applicable values specified in Table 22.1.

Table 22.1
Maximum temperature rises

Device or material	°C	(°F)
Any point on rectifiers:		
a. Copper oxide	30	54
b. Germanium	50	90
c. Magnesium-copper sulphide	95	171
d. Selenium	50	90
e. Silicon	75	135
Rubber or thermoplastic insulation	35[a]	63[a]
Varnished-cloth insulation	60	108
Fuses	65	117
Surfaces adjacent to or upon which the unit is capable of being mounted in service	65	117
Wood or other combustible material	65	117
Fiber used as electrical insulation	65	117
Class 105 insulation	65[c]	117[c]
Class 130 insulation	85[c]	153[c]
Phenolic composition used as electrical insulation	125	225
Capacitors	40[f]	72[f]
Solid-state devices (transistors, silicon-controlled rectifiers, integrated circuits)	See footnote d	
Wire-wound resistor	150[b]	302[b]
Carbon resistor	See footnote e	
Sealing compound	15°C (27°F) less than the melting point[b]	

[a] This limitation does not apply to an insulated conductor or a material that has been investigated and determined to be acceptable for a higher temperature.

[b] The specified values are limiting temperatures, not maximum temperature rises.

[c] 10°C (18°F) higher temperature rise is acceptable on coil insulation if measured by change-in resistance method.

Table 22.1 Continued on Next Page

Table 22.1 Continued

Device or material	°C	(°F)

[d] The temperature of a solid-state device (such as a transistor, SCR, or integrated circuit) shall comply with one of the following:

1) Not exceed the temperature limits specified in both a) and b):

a) 50 percent of its rated junction temperature, or storage temperature when not rated for junction temperature, during the normal standby condition and during any non-emergency-call signaling condition.

b) 75 percent of its rated junction temperature, or storage temperature when not rated for junction temperature, under the emergency-call condition or any other short term condition of operation which produces the maximum temperature dissipation of the component.

For reference purposes, 32°F (0°C) shall be determined as 0 percent. For integrated circuits, the loading factor shall not exceed 50 percent of its rating under the normal standby condition and 75 percent under any condition of operation.

2) Not exceed 100 percent of its rating under any condition of normal use and the component is subjected to one of the following:

a) The component complies with the requirements of MIL-STD 883E.

b) A quality control program established by the manufacturer consisting of inspection and testing of all pertinent parameters of 100 percent of components either on an individual basis, as part of an assembly, or the equivalent.

c) EEach assembled production unit is subjected to a burn-in test under the condition which results in the maximum temperatures for 24 hours, while connected to a source of rated voltage and frequency in an ambient of at least 120°F (49°C), followed by an operation test for normal signaling performances.

d) Component reliability data based on actual performance in a similar application, or the Military Handbook: Electronic Reliability Design Handbook, MIL-HDBK-338, such that the failure rate is equal to or less than 2.5 failures per million hours of operation.

[e] The maximum temperature on a carbon resistor shall not be greater than 50°C (122°F) during the normal standby condition and not greater than 75°C (167°F) during a signaling condition.

[f] In lieu of complying with these temperature limits, a reliable component shall be used. The reliability of the component may be based on derating or on reliability data recorded for the particular component. Suitable sources are.

a) The capacitor derating parameters as specified in Table 22.2.

b) The Military Handbook: Electronic Reliability Design Handbook, MIL-HDBK-338, and

c) Component reliability data based on actual performance in a similar application, such that the failure rate is equal to or less than 2.5 failures per million hours of operation.

Table 22.2
Capacitor derating parameters
(see footnote f of Table 22.1)

Type	Derating parameter	Derating level [a]
Mica, film, glass	Normal operating DC voltage	60 percent
	Temperature from maximum limit	10°C
Ceramic	Normal operating DC voltage	60 percent
	Temperature from maximum limit	10°C
Electrolytic Aluminum	Normal operating DC voltage	80 percent
	Temperature from maximum limit	20°C
Electrolytic Tantalum	Normal operating DC voltage	60 percent
	Temperature from maximum limit	20°C
Solid Tantalum	Normal operating DC voltage	60 percent
	Maximum operating temperature	85°C

[a] Percent of derated value to the rated normal operating DC voltage.

22.3 All values for temperature rises apply to equipment intended for use at ambient temperatures that usually are not higher than 25°C (77°F). If equipment is intended specifically for use at a prevailing ambient temperature consistently higher than 25°C, the test of the equipment is to be made at such higher ambient temperature, and the maximum temperature rises specified in Table 22.1 are to be reduced by the amount of the difference between the higher ambient temperature and 25°C.

22.4 Temperature measurements on equipment intended for recessed mounting are to be made with the unit installed in an enclosure of 3/4-inch (19.1-mm) plywood having clearances of 2 inches (50.8 mm) on the top, sides, and rear, and the front extended to be flush with the signaling unit cover.

22.5 Except at coils, temperatures are to be measured by thermocouples consisting of wires no larger than 24 AWG (0.21 mm^2). The temperature of a coil is to be measured by either the thermocouple or change-in-resistance method, except that the thermocouple method is not to be employed for a temperature measurement at any point where supplementary thermal insulation is employed.

22.6 If thermocouples are used in the determination of temperatures in connection with the heating of electrical devices, it is standard practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type indicating instrument. Such equipment is to be used whenever referee temperature measurements by thermocouples are required.

22.7 The temperature of a copper coil winding is to be determined by the change-of-resistance method by comparing the resistance of the winding at the temperature to be determined with the resistance at a known temperature by means of the formula:

$$T = \frac{R}{r}(234.5 + t) - 234.5$$

in which:

T is the temperature to be determined in degrees C;

R is the resistance in ohms at the temperature to be determined;

r is the resistance in ohms at the known temperature; and

t is the known temperature in degrees C.

22.8 As it is generally required to de-energize the winding before measuring R, the value of R at shutdown is to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. It is possible to extrapolate the value of R at shutdown by plotting a curve of the resistance values and time.

22.9 A temperature is regarded as constant when three successive readings, taken at 5-minute or greater intervals, indicate no change.

22.10 To determine compliance with this test, a unit and related devices are to be connected to a supply circuit of rated voltage and frequency and operated under each of the following conditions:

a) Standby – 16 hours or until constant temperatures are reached,

b) Normal Signaling, 20 Percent of Maximum Rated Load, Discharged Battery – 1 hour, and

c) Abnormal Signaling, Maximum Rated Load – 7 hours.

22.11 For an emergency call system having provision for the connection of multiple call initiation stations, 20 percent of the total number of stations, but in no case fewer than three, are to be energized during the normal signaling condition. Prior to conducting this test, a rechargeable battery is to be discharged, see 22.13. During the abnormal signaling condition, all stations are to be actuated. It is not prohibited that the temperatures specified in Table 22.1 be exceeded, but there shall be no risk of fire or electric shock and the unit shall operate in its intended manner following the test. If an overcurrent protective device is employed, the loading specified in 22.10 (c) is to be 110 percent of the protective device rating. For this test it is not prohibited that the overcurrent protective device be shunted.

22.12 If the emergency call system has a power supply-battery charger combination, the test sequence is to be as follows:

a) The power supply section is to be delivering maximum rated output power and the battery charger section is to be connected to a discharged battery, see 22.13, of the maximum capacity prescribed by the manufacturer.

b) After operation for 1 hour, the temperature rises shall not exceed the values shown in the second column (Signaling Condition – Short Term Operation) of Table 22.1.

c) The ECS is to be operated for a total of 48 hours of continuous operation with the load specified in 12.2.2.

d) At the conclusion of the 48 hour period, the product is to be subjected to the Battery Charging Test, Section 12.3.

22.13 With reference to 22.11 and 22.12, a discharged battery is one that has been:

a) Fully charged, in a new condition, according to the manufacturer's instructions then

b) Delivering the load specified in 12.2.2 for 24 hours with primary power disconnected.

23 Overload Test

23.1 Signaling unit

23.1.1 A signaling unit shall operate as intended following 50 cycles of signal operation at a rate of not more than 6 cycles per minute with the supply circuit energized at 115 percent of rated test voltage and at rated frequency. Each cycle is to consist of starting with the unit energized in the standby condition, actuation for a signal, and restoration to standby.

23.1.2 Rated test loads are to be connected to the output circuits of the unit that are energized from the unit power supply. The test loads are to be those devices intended to be connected, or the equivalent. If an equivalent load is employed for a device consisting of an inductive load, a power factor of 60 percent is to be employed. The rated test loads are to be established initially with the unit connected to a source of rated test supply voltage and frequency, following which the voltage is to be raised to 115 percent of the rated test voltage.

23.1.3 For a DC signaling circuit, an equivalent inductive test load is to have the required DC resistance for the test current and the inductance is to be calibrated to obtain a power factor of 60 percent when connected to a 60 hertz potential equal to the rated DC test voltage. When the inductive load has both the required DC resistance and the required inductance, the current measured with the load connected to an AC circuit is to be equal to 0.6 times the current measured with the load connected to a DC circuit when the voltage of each circuit is the same.

23.2 Separately energized circuits

23.2.1 Each signaling unit shall operate as intended following 50 cycles of signal operation at a rate of not more than 6 cycles per minute while connected to a source of rated test voltage and frequency and 150 percent rated loads applied to output circuits (dry contacts) that are not energized from the unit power supply. There shall be no electrical or mechanical failure of any of the components.

23.2.2 The test loads are to be set at 150 percent of rated current at 0.6 power factor while connected to a separate power source of rated voltage and frequency.

24 Endurance Test

24.1 A signaling unit shall operate as intended after being subjected to the number of test cycles specified in Table 24.1. There shall be no electrical or mechanical malfunction or breakdown, or evidence of such malfunction or breakdown of the components.

Table 24.1
Endurance test cycles

Type of device	Number of signaling operations[a]
Main control equipment	1,000,000
Call Notifications station	100,000
Residents' stations	100,000
Emergency communication stations	100,000
Any emergency signaling device	30,000
Dome lights	6,000
Any nonemergency supplementary stations	6,000
Reliable light source	100,000

[a] For solid-state switching devices, used within their rated voltage and current. It is not prohibited that the number of signaling operations be reduced to 50,000 cycles after the device has reached thermal equilibrium during the test.

24.2 The individual devices are to be operated by an automatic switching device at a rate of 6 cycles per minute while connected to a rated test voltage and frequency and maximum normal load. See 23.1.2.

Exception: It is not prohibited that a test rate greater than 6 cycles per minute be used if requested by the equipment manufacturer, but the rate shall not exceed 30 cycles per minute.

25 Variable Ambient Temperature Test

25.1 A signaling unit shall operate as intended when the temperature of the ambient air is within the range of 10°C to 49°C, ±2°C (50°F to 120°F, ±3°F).

25.2 The unit is to be maintained at each appropriate temperature extreme (or higher operating temperatures as specified by the product's operating manual), until thermal equilibrium is reached, but at least 3 hours, and then tested at that temperature for operation while connected to a source of rated test voltage and frequency.

26 Humidity Test

26.1 A signaling unit shall operate as intended while energized from a source of rated test voltage and frequency following exposure for 24 hours to air having a relative humidity of 85 ±3 percent non-condensing at a temperature of 30 ±2°C (86 ±3°F). The performance is to be determined with the unit in the high humidity ambient.

26.2 Leakage current measurements are to be recorded following the 24-hour exposure to the humidity environment in accordance with the Leakage Current Test, Section 28.

27 Electric Shock Current Test

27.1 If the open circuit potential, between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part, exceeds 42.4 volts peak, the part shall comply with the requirements of 27.2 and 27.4, as applicable.

27.2 The continuous current flow through a 500-ohm resistor shall not exceed the values specified in Table 27.1 when the resistor is connected between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part.

Table 27.1
Maximum current during operator servicing

Frequency, hertz[a]	Maximum current through a 500-ohm resistor, milliamperes peak
0 – 100	7.1
500	9.4
1000	11.0
2000	14.1
3000	17.3
4000	19.6
5000	22.0
6000	25.1
7000 or more	27.5

[a] Linear interpolation between adjacent values is not prohibited from being used to determine the maximum allowable current corresponding to frequencies not shown. The table applies to repetitive nonsinusoidal or sinusoidal waveforms.

27.3 The duration of a transient current flowing through a 500-ohm resistor connected as described in 27.2 shall not exceed the following:

a) The value determined by the following equation:

$$T \leq \left(\frac{20\sqrt{2}}{I} \right)^{1.43}$$

in which:

T is the interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 milliamperes and the time that the current falls below 7.1 milliamperes for the last time;

I is the peak current in milliamperes; and

b) 809 milliamperes, regardless of duration.

The interval between occurrences shall be equal to or greater than 60 seconds if the current is repetitive. Typical calculated values of maximum allowable transient current duration are shown in Table 27.2.

Table 27.2
Maximum transient current duration

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes peak, seconds
7.1	7.22
8.5	5.58
10.0	4.42
12.5	3.21
15.0	2.48
17.5	1.99
20.0	1.64
22.5	1.39
25.0	1.19
30.0	0.919
40.0	0.609
50.0	0.443
60.0	0.341
70.0	0.274
80.0	0.226
90.0	0.191
100.0	0.164
150.0	0.092
200.0	0.061
250.0	0.044
300.0	0.034
350.0	0.027
400.0	0.023
450.0	0.019

Table 27.2 Continued on Next Page

Table 27.2 Continued

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes peak, seconds
500.0	0.016
600.0	0.013
700.0	0.010
809.0	0.0083

27.4 The maximum capacitance between the terminals of a capacitor that is accessible during operator servicing shall comply with the following equations:

$$C = \frac{88{,}400}{E^{1.43}(\ln E - 1.26)} \quad \text{for} \quad 42.4 \le E \le 400$$

$$C = 35{,}288\,E^{-1.5364} \quad \text{for} \quad 400 \le E \le 1000$$

in which:

C is the maximum capacitance of the capacitor in microfarads and

E is the potential in volts across the capacitor prior to discharge; E is to be measured 5 seconds after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like.

Typical calculated values of maximum capacitance are shown in Table 27.3.

Table 27.3
Electric shock

Potential across capacitance prior to discharge, volts	Maximum capacitance, microfarads
1000	0.868
900	1.02
800	1.22
700	1.50
600	1.90
500	2.52
400	3.55
380	3.86
360	4.22
340	4.64
320	5.13
300	5.71
280	6.40
260	7.24
240	8.27
220	9.56
200	11.2
180	13.4
160	16.3
140	20.5
120	26.7
100	36.5
90	43.8
80	53.8
70	68.0
60	89.4
50	124.00
45	150.00
42.4	169.00

27.5 With reference to the requirements in 27.2 and 27.3, the current is to be measured while the resistor is connected between ground and each accessible part individually or all accessible parts collectively if the parts are simultaneously accessible. The current also is to be measured while the resistor is connected between one part or group of parts and another part or group of parts, if the parts are simultaneously accessible.

27.6 With reference to the requirements in 27.5, parts are considered to be simultaneously accessible if they are able to be contacted by one or both hands of a person at the same time. For the purpose of these requirements, one hand is to be considered to be able to contact parts simultaneously if the parts are within a 4- by 8-inch (102- by 203-mm) rectangle; and two hands of a person are considered to be able to contact parts simultaneously if the parts are not more than 6 feet (1.83 m) apart.