PERFORMANCE STANDARD FOR

GENERATOR OVERCURRENT PROTECTION 600 VOLTS AND BELOW

EGSA 100D, 1992a

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1. SCOPE

This standard covers the most common techniques for protecting generators from damage due to overcurrent conditions. It is directed specifically toward single generator installations where proper protective methods may be easily overlooked.

2. REFERENCE STANDARDS

NFPA 70 1990	National Electrical Code
EGSA 101E 1984	Glossary of Terms - Electrical
EGSA 101M 1984	Glossary of Terms - Mechanical
IEEE 100-1988	IEEE Standard Dictionary of Electrical Terms
IEEE 45-1983 (REAFF. 1988)	Recommended practice for Electrical Installations on Shipboard (ANSI)
MG1-1987	NEMA: Motors and Generators
UL 489	Underwriters Laboratory: Standard for Molded Case Circuit Breakers
UL/ANSI 198D	Underwriters Laboratory: Standard for High Interrupting Class K Fuses
UL 198C	Underwriters Laboratory: Standard for High Interrupting Fuses, Current Limiting
CFR46, Chapter I, Subchapter J	U.S. Coast Guard Regulations, Subchapter on Electrical Engineering

3. DEFINITIONS

Decrement Curve. A time current curve for a generator showing it's thermal capacity limits.

Excitation Support. Controls which make it possible for the generator to put out higher levels of current for longer periods of time than would otherwise be possible.

Field Circuit Breaker. A circuit beaker connected in the leads carrying excitation current to the generator field as a means of overcurrent protection for the generator.

Generator Full Load Rating. The maximum current the generator is intended to produce under steady state conditions as defined by the generator nameplate.

Inrush Current. The value of current which will flow when the load is first connected to the generator.

Overcurrent. Current in excess of the full load rating of the generator.

a) **Overload**. A value of current from 101% to 500% of a full load rating of the generator.

b) **Fault Current (Short Circuit)**. A value of current in excess of 500% of the generator full load rating.

Overcurrent Protective Device (Circuit Breaker or Fuse). A device which will open the circuit if the current reaches a value that will cause an excessive or dangerous temperature in conductors or conductor insulation.

Overcurrent Relay. current sensitive protective relays which usually have adjustable current pickup and time characteristic.

Thermal Capacity Limit. The maximum combination of time and current which a generator may tolerate without permanent thermal damage.

Thermistor. A thermally sensitive semiconductor whose primary function is to exhibit a change in electrical resistance with a change in its body temperature. Readout instrumentation accurately measures the resistance and translates it into temperature data.

Thermocouple. The remote mountable temperature sensor of a thermocouple thermometer.

Thermostat. An electromechanical device that will operate a set of electrical contacts when the body temperature of the thermostat is raised above a preset level, and automatically return the contacts to their former position when the body temperature is lowered below the operating point.

Wire-Type Resistance Temperature Detector (RTD). An electromechanical device that will operate a set of electrical contacts when the body temperature of the thermostat is raised above a preset level, and automatically return the contacts to their former position when the body temperature is lowered below the operating.

4. RATINGS

4.1 **Overcurrent Protective Device**

4.1.1 Continuous Current Rating

4.1.2 Voltage Rating

4.1.3 Interrupting Rating

4.1.4 Ambient Temperature Rating

4.1.5 Time-Current Characteristics

4.2 **Thermostat**

4.2.1 Operating Temperature Range

4.2.2 Contact Configuration (NO or NC)

4.2.3 Contact Rating

4.3 **Thermocouple**

4.3.1 Material: Iron-constantan (ANSI symbol J)
Copper-constantan (ANSI symbol T)
Chromel-alumel (ANSI symbol K)
Chromel-constantan (ANSI symbol E)

4.3.2 Operating Temperature Range

4.4 **Wire-Type Resistance Temperature Detector (RTD)**

4.4.1 Material:

Copper	10 ohm @ 25 Cent.
Platinum	100 ohm @ 0 Cent.
Nickel	120 ohm @ 0 Cent.
Nickel-Iron.	676 ohm @ 25 Cent.

4.4.2 Operating Temperature Range

4.4.3 Number of leads: 2, 3, or 4.

4.5 **Thermistor**

4.5.1 Operating Temperature Range

4.6 **Field Circuit Breaker**

4.6.1 Continuous Current Rating

4.6.2 Voltage Rating

4.6.3 Ambient Temperature Rating

4.6.4 Time-Current Characteristics

4.7 **Overcurrent Protective Relay**

4.7.1 Current and Time Range adjustments

4.7.2 Voltage Ratings

5. CLASSIFICATIONS

5.1 **Legally Required Overcurrent Protection**. use mandated by applicable municipal, state, federal, or other codes (i.e. Article 445 of NFPA-70 1990).

5.2 **Optional Overcurrent Protection**. Overcurrent protection which is optional and/or desirable but not legally required. Note that some optional OC protection is specifically not allowed in applications where its operation could cause a greater hazard to persons than allowing the generator to operate to failure.

6. APPLICATION DATA

6.1 **Legally Required Generator Overcurrent Protection**. The type of overcurrent protection required by code is usually an overcurrent protective device (circuit breaker or fuse). The ratings of such devices will be rigidly specified by those same codes, such as Articles 220 and 445 of NFPA-70 1990.

6.2 **Optional Overcurrent Protection**. In many cases, the legally required OC protective device may not be adequate to protect the generator from damage due to overcurrent conditions. OC protective devices should perform in accordance with UL 489, UL 198C, and UL 198D, which are intended for the protection of cable and cable insulation. Thus, their operating time characteristics may exceed the thermal capacity limit of the generator.

In addition, the unpredictability of short circuit currents beyond the first cycle and the variety of excitation support systems add to the likelihood of application difficulties. Optional devices can offer the added advantage of detecting dangerous operating temperatures due to blocked air vents, clogged filters, or high ambients.

7. PERFORMANCE SPECIFICATIONS

7.1 **Overcurrent Protective Device** (Circuit Breaker or Fuse). The continuous current rating must be selected in accordance with the applicable standard. If a circuit breaker with an adjustable short circuit trip is selected, the short circuit trip point should be set as low as possible without causing an inadvertent trip when load is applied due to normal inrush current. Such a setting will maximize the likelihood of an instantaneous trip under short circuit conditions.

7.2 **Thermostats**. The thermostat selection should be based on size compatibility and the operating range desired. Due to their physical size, the thermostat is often placed on the end turns of the generator, rather than in the slot. The contact configuration should be selected based on the desired action when a preset temperature is reached. A NO contact which closes in the activated mode would be used to sound an alarm or annunciate the condition, while an NC contact which opens when activated would be used to open a circuit and shut down the system.

7.3 **Thermocouples**. Thermocouple selection is based on the operating range desired. The generator manufacturer should be contacted, in advance if possible, to see if such devices can be factory coordinated and installed.

7.4 **Wire-Type Resistance Temperature Detectors (RTD)**. The most common RTD is a three-lead device which will compensate for the lead resistance and thus offer the most accurate readings. Two and four lead units are also available. The RTDs are usually inserted in the stator slot and can measure temperatures at points that are otherwise inaccessible. They are used as input devices with temperature relays which can be wired for alarm or shut down operation. The type RTD selected will be based on the desired operating range and can often be factory installed.

7.5 **Thermistors**. Thermistors are used in conjunction with a control module and work on the basis that an increase in temperature causes an increase in resistance. They are classified as "fail-safe" since a failure will cause maximum resistance and thus trigger the control module to signal alarm or shut down as desired. Like thermostats, thermocouples, and RTDS, thermistors are selected based on the required operating range.

7.6 **Field Circuit Breaker**. A Field Circuit Breaker may be used to detect sustained "full on" signal from the voltage regulator which can indicate the generator is attempting to maintain output while connected to a major overload or short circuit condition. If the field breaker's operating characteristics are properly coordinated with the generator's thermal capacity limit it should trip and shut down the generator before thermal damage occurs.

7.7 **Overcurrent Protective Relays**. Overcurrent protective relays should be chosen to protect the generator from damaging overcurrent conditions by coordinating their operating characteristics with the decrement curve for the specific generator.

8. OPTIONAL PERFORMANCE SPECIFICATIONS

8.1 **Overcurrent Protective Device**. If enough detail is known about the system loads and the generator characteristics, a circuit breaker with adjustable trip units can be selected which will enable fine tuning of the breaker operating characteristics to most closely match the needs of the generator.

8.2 **Thermostat**. Multiple thermostats can be used so that a pre-shutdown condition can be annunciated. The second unit can also serve as a spare should the first fail.

8.3 **Thermocouple**. Added protection can be obtained by installing sets of three, one in each phase. Multiple sets can be installed for pre-alarm or back-up service.

8.4 **Wire-Type Resistance Temperature Detector (RTD)**. Added protection can be obtained by installing sets of three, one in each phase. Multiple sets can be installed for pre-alarm or back-up service.

9. INSTALLATION

All installations shall be in accordance with manufacturers recommendations and applicable codes. Where possible, temperature sensors should be factory installed to preclude damage to the windings or blockage of ventilation paths.

10. MAINTENANCE

Periodic inspections should be carried out to ensure that all parts of the system are operable. Electrical and mechanical connections should be checked for tightness and continuity.