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Electrical Propulsion Rotating Equipment - Off-Road Dumper

RATIONALE

The content of this standard is becoming obsolete, and there is no longer support to update this standard. The Con-Ag effort is supporting the creation of ISO 14990, which should supersede SAE J1317 in about 2 years.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE CTTC C2, Electrical Components and Systems Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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***Foreword*—**This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. ***Scope*—**This recommended practice applies to the rotating equipment in the electrical propulsion systems on electrically propelled dumpers. It also applies to the rotating equipment installed on trailers connected to electrically propelled dumpers. The recommended practice does not apply to rotating equipment such as windshield wiper motors, battery charging generators, etc. that may be used on dumpers.

1.1 **Purpose—**This recommended practice establishes criteria for environmental service conditions, ratings, and test methods of electrical propulsion rotating equipment.

2. ***References*—**There are no referenced publications specified herein.

3. ***Definitions***

3.1 **Characteristic Curve—**Any curve describing the electrical and/or mechanical performance of the rotating propulsion equipment.

3.2 **Electrical Propulsion System—**A system usually consisting of electric traction motors, a generator or alternator, controls and excitation which provides tractive and retarding capability.

3.3 **Full Power Regulation Curve of Main Generator—**The full power output of the main generator maintained constant by variation of its excitation. The external characteristic of the generator (terminal voltage as a function of load current) therefore becomes approximately hyperbolic.

3.4 **Guaranteed Rating—**Rating such as voltage, current, speed or power, guaranteed by the rotating equipment manufacturer.

3.5 **Main Generator/Traction Generator—**The rotating equipment which converts the mechanical power from the engine or other power source to the electric power for the traction motors.

3.6 **Routine Tests—**Those tests carried out on all rotating equipment.

3.7 **Traction Motors—**Electric motors which are used for dumper propulsion and/or dynamic retarding.

3.8 **Type Tests—**Those tests carried out on at least one machine of a new design or of a new supplier. This machine shall be identical in all essential respects with those supplied on an order.

4. ***Service Conditions—***Unless otherwise specified by the dumper manufacturer, the following operating conditions are assumed:

a. Altitude—Height above sea level not exceeding 1200 m (4000 ft).
b. Temperature—Ambient temperature not exceeding 40 °C (104 °F).

Whenever this equipment is intended to operate where one or both of these limits will be exceeded, special arrangements should be made by agreement between dumper manufacturer and supplier.

5. ***Identification Plate and Marking of Rotating Equipment—***All the rotating equipment covered by this document shall carry an identification plate which may include the most important characteristics and shall include the rotating equipment manufacturer's name, model designation, serial number, and year of manufacture.

6. ***Ratings—General***

6.1 **Rating of a Machine—**The rating of electrical rotating machinery is the combination of simultaneous values of electrical and mechanical quantities assigned to the machine by the rotating equipment manufacturer. The purpose of the rating is to enable the performance of the rotating equipment to be confirmed by test and to serve as a basis both for an assessment of its suitability for the specified duty and for a comparison of other rotating equipment.

6.2 **Performance Rating—**The rotating equipment manufacturer shall provide time-current ratings and maintenance schedules for specified horsepower ratings to correspond to three classes of machine life. Life is that time period resulting in 50% of the machines being in service with the original electrical insulation system. It is to be understood, both by the dumper manufacturer and the rotating equipment manufacturer, that a conscientious effort will be made to predict the insulation life of a given motor in a given application to serve as a guideline for the dumper manufacturer. However, no warranties are expressed or implied by the rotating equipment manufacturer when electing to specify one or more of these classifications. The three motor life classes are:

Class I 15 000—20 000 engine hours
Class II 20 000—25 000 engine hours
Class III 25 000—35 000 engine hours

A normal maintenance schedule which shall include brush changes, commutator turning, cleaning, and other operations deemed essential to rotating equipment life is expected.

6.3 **Maximum Current Rating—**The maximum current rating is that current which should not be exceeded in service. For traction motors and main generators, it shall be clearly shown on the characteristic curves.

6.4 **Rated Voltage of an Engine-Driven Main Generator—**The rated voltage of the generator shall be specified by the rotating equipment manufacturer and correspond to the higher of the two continuous ratings defined to paragraph 7.2.

6.5 **Rated Voltage of a Machine—**The rated voltage shall be specified by the rotating equipment manufacturer and correspond to the highest voltage required to achieve a guaranteed power rating.

6.6 **The Maximum or Minimum Voltage of a Motor or Generator—**The maximum or minimum voltage is the highest or lowest voltage which the machine will be called upon to withstand in service with transient voltages being excluded.

6.7 Rated Speed of a Main or Auxiliary Generator—The speed agreed upon between the dumper manufacturer and rotating equipment manufacturer not to exceed the guaranteed speed rating. If the generator is used at different speeds, the rated speed shall be the highest.

6.8 Maximum Speed of Rotating Equipment—The highest rotational speed permitted by the rotating equipment manufacturer.

7. Ratings—Classes

7.1 Continuous Rating of Rotating Equipment—The rating that corresponds to a load that the machine can withstand during a test for an unlimited period under the conditions specified in paragraph 8.2.1 without exceeding the limits given in paragraph 8.2.3. All other appropriate requirements in these rules shall also be satisfied.

7.2 Continuous Rating of the Special Case of Engine-Driven Main Generators—A traction generator driven from an engine on a dumper will usually have a variable voltage, variable current characteristics.

The high voltage capabilities of this generator are of interest since they will stress the commutator, or power conditioning devices in the case of alternators, and the field windings since they will be operating at a high current level. High current is of interest from the standpoint of heating of the armature and any power conditioning devices. Thus, a generator must be considered as having two continuous ratings which will both normally be depicted on its characteristic curve. The continuous current rating of a generator is the highest output current which it is capable of sustaining for an unlimited period. The continuous current rating for an alternator with rectifiers is the continuous value of the rectified direct current at the output of the rectifiers. The continuous voltage rating is the highest output voltage which it is capable of sustaining for an unlimited period.

7.3 One-Hour Rating—The rating that corresponds to a load the rotating equipment can withstand for a one-hour test without exceeding the limits given in paragraph 8.2.3, the test being started with the equipment cold (between 20 and 40 °C) and carried out under the conditions specified in paragraph 8.2.1. In the case of main generators and the traction motors fed from them, the one-hour rating shall fall on the characteristic curve specified by the rotating equipment manufacturer at a point limited by the temperature rise of windings through which the load current flows.

NOTE—In special cases, and after agreement between dumper manufacturer and rotating equipment manufacturer, the one-hour rating may be replaced by a shorter time rating.

7.4 Short Time Rating—The short time rating of a traction motor shall be at a load point for a given period of time as agreed upon between the dumper manufacturer and rotating equipment manufacturer so as not to exceed the limits given in paragraph 8.2.3.

7.5 Guaranteed Current Rating of a Traction Motor—Normally, the guaranteed current rating is the continuous rating. The one-hour rating is not guaranteed; it is given by the rotating equipment manufacturer for information only, and is accurately determined during the type tests in order to be used, as required, as a basis for the routine tests. In special cases, the one-hour or another short time rating may be used as the guaranteed rating after agreement between dumper manufacturer and rotating equipment manufacturer.

7.6 Guaranteed Current Rating of an Engine-Driven Main Generator—The guaranteed current rating of the main generator is the continuous rating established by the rotating equipment manufacturer. One-hour or short time ratings shall not be considered or provided unless specifically requested by the dumper manufacturer.

7.7 Guaranteed Rating of Auxiliary Rotating Equipment—The rotating equipment manufacturer guarantees the auxiliary rotating equipment to be suitable for its application in the system.

8. Test

8.1 Categories of Tests—There are two categories of tests; Routine (paragraph 3.6) and Type (paragraph 3.8).

8.1.1 SPECIAL RULES FOR TRACTION MOTORS INTENDED FOR USE ON SINGLE-PHASE OR MULTI-PHASE RECTIFIED POWER SOURCES—Tests on these motors may be carried out on direct current, provided that the relationship between temperature rise, commutation, and speed characteristics on both direct current and rectified alternating current are known.

8.1.2 SPECIAL RULES FOR ALTERNATORS—For alternators intended to be used with a rectifier for the main current, it is not necessary to test the rectifier to be used on the dumper. However, the test rectifier should have similar characteristics. The excitation of the alternator can be supplied by any suitable source. However, in the case of self-excited alternators, the test shall be carried out with the self-excitation equipment or test equipment with similar characteristics.

8.1.3 GENERAL TEST CONDITIONS—General test conditions shall be determined by the rotating equipment manufacturer.

8.2 Temperature Rise Tests—Temperature-rise tests include type tests and routine tests. The tests shall be carried out under the conditions specified in paragraph 8.2.1 and 8.2.2.

8.2.1 TEMPERATURE RISE TYPE TESTS—Type tests are carried out at the guaranteed ratings. For large alternators, after agreement between dumper manufacturer and rotating equipment manufacturer, the test on full load may be replaced by a test on short circuit (between terminals of the alternator) at the current deemed to give comparable temperature rise of the stator winding as a test at full load.

Alternators designed to operate with fully rectified output shall be type-tested with a suitable rectifier. Rotating machines shall be type tested with the ventilation as specified for service, with all those parts of the machines in place which would affect its temperature rise.

Where cooling is by forced ventilation, the static pressure drop and the air volume shall be measured on the machine so that a table giving the relationship between these two quantities may be drawn up for use by the dumper manufacturer. In general, no cooling corresponding to that produced by the motion of the dumper shall be provided.

8.2.2 TEMPERATURE RISE ROUTINE TESTS—Routine temperature rise tests shall be run for a suitable period, by the rotating equipment manufacturer, to test soundness of the mechanical parts, such as bearings, commutator, etc.

8.2.3 LIMITS OF TEMPERATURE RISE—The rotating equipment manufacturer shall determine the temperature rise limits necessary to accomplish expected rotating equipment life.

8.3 Measurement Method

8.3.1 MEASUREMENT ACCURACY—The error of measurement techniques shall be less than 5% of the quantity measured, unless otherwise specified. Temperature measurement accuracy shall be ±2 °C.

8.3.2 MEASUREMENT OF COOLING-AIR TEMPERATURE DURING TEMPERATURE RISE TESTS—In the case of machines with ventilation ducts, the temperature of the air measured where it enters the machine shall be considered as the cooling-air temperature during the tests.

In all other cases, the cooling-air temperature shall be measured at different points around the machine at a distance of 1–2 m and protected from all heat radiation and drafts.

The value to be adopted for the temperature of the cooling air during a test shall be the mean of the readings as mentioned above, taken at least three times at equal intervals of time during the last quarter of the duration of the tests.

8.3.3 METHODS OF MEASURING TEMPERATURES OF ROTATING MACHINE PARTS—Commonly used methods of determining temperatures include the following:

a. Resistance Method
In this method, the temperature rise of the insulated windings is determined by their increase in resistance.

For copper windings, the temperature rise at the end of the test is determined by the following formula:

$$T_r = t_2 - t_a = \frac{R_2}{R_1}(234.5 + t_1) - (234.5 + t_a) \quad \text{(Eq. 1)}$$

where:

T_r = temperature rise, above the cooling air temperature, in Celsius degrees, of the winding at the end of the test.
t_a = temperature, in Celsius degrees, of cooling air at the end of the test.
t_2 = temperatures in Celsius degrees, of the winding at the end of the test.
t_1 = temperature, in Celsius degrees, of the winding when cold at the moment of the initial resistance measurement.
R_2 = resistance of the winding at the end of the test.
R_1 = initial resistance of the winding when cold.

NOTE 1—For materials other than copper, the figure 234.5 in the above formula should be replaced with the reciprocal of the temperature coefficient of resistance at 0 °C for the material.
NOTE 2—All measurements must have ±0.25% accuracy.

b. Electrical Thermometer Methods

1. The temperature of the accessible parts of the commutator, slip-rings and uninsulated parts of the windings are determined by means of electrical thermometers which are applied immediately after the rotating equipment is stopped at the spots presumed to be the hottest.
2. Embedded detectors are used for continuous temperature measuring and are located at the spots presumed to be the hottest.

8.3.4 INITIAL RESISTANCE—Before measuring the initial resistance, it is necessary to ascertain that the temperatures of the windings of the machine are within 5 °C of the mean temperature of the ambient air. In the case where the ambient air temperature of the test area exceeds 40 °C, special arrangements may be agreed upon by dumper manufacturer and rotating equipment manufacturer.

8.3.5 MEASURING OF RESISTANCES AND TEMPERATURES DURING THE TEST AND CORRECTION OF MEASUREMENT—The resistance of a winding carrying direct current during the test shall be measured periodically while the machine is running. The resistance of the winding shall be plotted against time in order to obtain the temperature rise at the end of the test.

For windings, the d.c. resistance of which cannot be measured during operation, measurements of resistance shall be made after the machine has stopped. For type tests and for tests carried out to establish the declared cooling curves to be used as a basis for routine tests, cooling curves for each winding shall be plotted and extrapolated to the time of "commencement of cooling."