NATO STANDARD

AEP-4133

ELECTRICAL POWER SUPPLIES: STANDARD TYPES AND ROTATING GENERATING SETS (AC-DC)

Edition A Version 1
MARCH 2017

NORTH ATLANTIC TREATY ORGANIZATION

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO STANDARDIZATION OFFICE (NSO)

NATO LETTER OF PROMULGATION

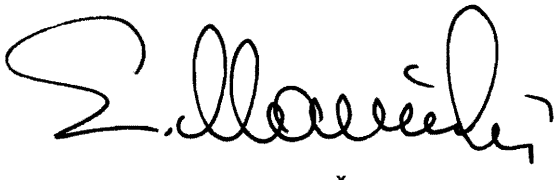
24 March 2017

1. The enclosed Allied Engineering Publication AEP-4133, Edition A, Version 1, ELECTRICAL POWER SUPPLIES: STANDARD TYPES AND ROTATING GENERATING SETS (AC-DC), which has been approved by the nations in the NATO Army Armaments Group, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4133.

2. AEP-4133, Edition A, Version 1, is effective upon receipt.

3.

4. This publication shall be handled in accordance with C-M(2002)60.



Edvardas MAŽEIKIS
Major General, LTUAF
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.	

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RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]
BEL	Due to national legislation, BEL will only procure systems capable of generating 50 Hz.
CAN	Amplifying Information: see 244-4133 (DCSEM, dated 04 February 2016
NOR	Norway reserve the right not to implement the STANAG in equipment procedure prior to 1 January 2017. The Norwegian regulation for low voltage (FEL1998) will prevail over STANAG 4133 in case they differ.
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.	

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ELECTRICAL POWER SUPPLIES: STANDARD TYPES AND ROTATING GENERATING SETS (AC-DC)

Annexes:

A. Definitions
B. Agreed values of characteristics

Related documents:

ISO 8528. Reciprocating internal combustion engine driven alternating current generating sets
MC 469/1, NATO Military Principles and Policies for Environmental Protection (EP) dated 13 October 2011
STANAG 2581 (Edition1), Environmental Protection Standards and Norms for Military Compounds in NATO operations (AJEPP-1) dated 7 September 2011
STANAG 2582 (Edition 1), Best Environmental Protection Practices for Military Compounds in NATO Operations (AJEPP-2) dated 17 August 2011

AIM

1. The aim of this agreement is to define standard types of electrical power for general purposes, used by the NATO land-forces and to standardize certain electrical characteristics of rotating 28-volt DC and alternating current (AC) generating sets of the various electrical power supply and equipment.

2. The current edition of this STANDARD is a merger of STANAG 4133 (Edition 3) Method of specifying electrical power supplies: standard types of electrical power, STANAG 4134 (Edition 3) Electrical Characteristics of rotating 28-volt DC generating sets and STANAG 4135 (Edition 3) Electrical characteristics of rotating alternating current generating sets.

3. Power production for base camps accounts for a major portion of the non-aviation fuel required to conduct operations. Any reduction in the amount of fuel used will result in significant savings in cost and logistics support effort, with the attendant reduction in casualties and potential increase in combat power. Efficient generators, power optimization, energy saving solutions and sustainability are key concepts that can contribute to a reduced fuel demand. Implementing these principles as early in the planning process as possible will further augment their effectiveness. Energy efficiency and security challenges arising from environmental issues have also been identified as important at the NATO political level. Electrical power production is one area where NATO-led forces are obligated to follow NATO policy and agreements and in doing so can enhance the effectiveness of operations.

AGREEMENT

4. Participating nations agree that the method of specifying NATO standard electrical power characteristics for equipment using power from electrical generators (28V-DC and AC) for armed forces use shall be as defined below, and will be used in the design and construction of new equipment whenever practicable and possible. They also agree that one or more of the types of electrical power shall be selected from the table including paragraph 8.

5. The following, which are covered by other STANAGs, are excluded from this agreement:
   - Generators or generating sets on board vehicles, ships, or aircraft;
   - Aircraft ground servicing equipment;

6. Nations may propose alterations to the standard characteristics at any time should they consider them to have become obsolete or require improvement. Such proposals should be submitted, at the earliest possible opportunity, to the NATO Standardization Office and the Defence Investment Division where they will be processed in the same manner as the original agreement.

NATO STANDARD EXPRESSIONS FOR SPECIFYING ELECTRICAL POWER

7. The NATO Standard expressions for specifying electrical power are given in the following sub-paragraphs.

7.1. Method of expressing type of power

Type of power shall be specified by the following symbols and in the following sequence:

1st position:	Number of active conductors like 1 for a single phase system or 3 for a three phase system
2nd and 3rd position:	Other conductors like N for the neutral conductor and/or PE for protective earth or equipotential conductor
4th position:	Type of Output current like DC for direct current or AC for alternating current
5th position:	Frequency expressed in cycles per second followed by the symbol "Hz".
6th position:	Rated voltage expressed in Volts followed by the symbol "V".

The specification of a type of power using this system need not fill all positions. In that event, the blank spaces should be omitted.

7.2. Method of expressing rated power

Where it is necessary to specify electrical power, it shall be expressed in Watts or kilo-Watts (as a number, followed by W or kW) and, in the case of alternating current power, the power factor shall be expressed as a decimal number followed by the words "power factor" or as "Cos Ø" followed by a decimal number. A leading power factor shall be indicated by adding the word "leading".

7.3. Terminals

7.3.1. In addition to any other form of output connection that may be provided, terminals, of a size and design appropriate to the rated Output of the generating set, shall be provided to permit interoperable connection of cables bare ends.

7.3.2. For Direct Current (DC) systems the live conductor shall be marked "+" (plus) and "-" (minus) respectively. The terminal for earthing or grounding shall be marked PE.

7.3.3. For single phase systems, the live conductor shall be marked L1 with the neutral marked N. The terminal for earthing or grounding shall be marked PE.

7.3.4. For three phase systems, the live conductor shall be marked L1-L2-L3 with the neutral marked N. The terminal for earthing or grounding shall be marked PE.

LIST OF NATO STANDARD TYPES OF POWER (RATED VALUES)

8. The NATO Standard types of power are as given in the following table A for direct and alternating current respectively:

TYPE OF POWER
DC Systems:
2 DC 28 V
Single Phase AC Systems:
1/N/PE AC 50 Hz 230 V
1/N/PE AC 60 Hz 240 V
1/N/PE AC 60 Hz 120 V
Three Phase AC Systems:
3/N/PE AC 50 Hz 400/230 V
3/N/PE AC 60 Hz 416/240 V
3/N/PE AC 60 Hz 208/120 V

TABLE A

9. REQUIREMENTS FOR MILITARY CHARACTERISTICS OF EQUIPMENTS USING ELECTRICAL POWER

9.1. Military characteristics shall require that the equipment can operate satisfactorily on the appropriate type of power from the table A, with characteristics at the extreme limits of their values as listed in the appropriate STANAG.

9.2. Where alternating current power as given in table A is specified, it is desirable that consuming equipment be capable of operating at either type of electrical power at will.

9.3. Requirements for any additional supply not given in table A should be met by power conditioners within the equipment.

9.4. Where possible, equipment should be able to accept "NATO STANDARD OTAN" class power.

9.5. Equipment using electrical power should not cause distortions of the power supply voltage waveform to the extent of exceeding the tolerances of the power supply, including the achievement of EMC.

9.6. 3-phase equipment should draw a balanced load as far as is practicable.

9.7. Single phase load should not exceed 10 kW when connected to a single phase system.

9.8. In addition to any other form of output connection that may be provided, terminals, of a size and design appropriate to the rated output of the generating set, shall be provided to permit emergency connection, e.g. screw-type terminals.

9.9. Generating sets, conforming to this STANAG, shall have electromagnetic interference suppression and meet susceptibility requirements in accordance with national specifications.

10. REQUIREMENTS FOR OPERATIONAL INSTRUCTIONS

10.1. Abbreviated operational instructions shall be provided with each generating set and affixed to the generating set.

10.2. The operational instructions/manuals shall be bilingual:

- National / English or French
- English / French for Canada, France, United Kingdom, United States

10.3. The content of the operational manuals shall cover the following topics:

- Safety warning and relevant statements
- Set up instructions
- Starting procedures
- Functional checks
- Load connection and operation procedures
- Stopping procedures

11. ELECTRICAL CHARACTERISTICS OF ROTATING 28-VOLT DC GENERATING SET

Definitions of units and methods of measurement

11.1. Definitions are as given in Annex A, together with the associated diagram. Methods of measurement will be in accordance with national specifications.

NATO Standardized characteristics

11.2. The essential characteristics are:

a. rated voltage
b. range of manual voltage setting
c. deviation
d. ripple
e. stability
f. steady-state tolerance band
g. transient

The agreed values for these characteristics are given in the Table at Annex B.

12. ELECTRICAL CHARACTERISTICS OF ROTATING ALTERNATING CURRENT GENERATING SETS

12.1. NATO Standardized characteristics

The essential characteristics are:

a. Rated voltage and manual voltage adjustment range
b. Rated frequency
c. Arrangement of phases
d. Power factor
e. Deviation of voltage and frequency
f. Stability of voltage and frequency
g. Transient of voltage and frequency
h. Modulation of voltage and frequency
i. Harmonics of voltage and frequency

The agreed values for characteristics a. to d. are as given in paragraph 12.4. The agreed values for characteristics e. to i. are given in paragraphs 12.3.

12.2. Terms and test methods

Concerning the NATO standardized characteristics, the applicable terms will be in accordance with ISO 8528, part 1 and part 5.

Test methods, concerning the NATO standardized characteristics will be in accordance with ISO 8528, part 6.

12.3. Operating limit values

For generating sets of 3 kW rated output or less, the operating limit values of the NATO standard characteristics e. to i. from chapter 8 will be in accordance to ISO8528, part 5, performance class G1.

For generating sets of more than 3 kW rated output, the operating limit values of the NATO standard characteristics e. to i. from paragraph 8 will be in accordance to ISO8528, part 5, performance class G2.

12.4. Agreed values

The standard rated voltages referred to rated frequencies are as listed below. Provision shall be made for manual adjustment of the output voltage over the ranges defined below.

Single-phase system (1/N/PE)	3-phase system (3/N/PE)	Frequency	Manual voltage adjustment range
V	V	Hz	%
230	400/230	50	+10/-5
240	416/240	60	+10/-5
120	208/120	60	+10/-5

The standard rated frequencies for AC generating sets shall be 50 or 60 Hz. All sets of more than 10 kW rated output shall be 3-phase and preferably be capable of generating at 50 or 60 Hz at will.

Generating sets shall be terminated so that they shall be connected as follows:

a. For 3-phase supplies the output terminals of the generator shall be connected with access to the neutral (3/N/PE-system). The live conductors shall be marked L1-L2-L3, with the neutral marked N and the terminal for earthing or grounding marked PE. The time sequence of the phase voltages shall be L1-L2-L3-L1-L2.

b. 50 or 60 Hz single phase generating sets shall supply 1/N/PE-systems.

The rated power factor is 0.8 lagging.

13. IMPLEMENTATION OF THE AGREEMENT

This STANDARD is considered to be implemented when a nation has issued the necessary orders/instructions to the forces concerned, putting the procedures detailed in this agreement into effect
This STANDARD is considered to be implemented when signatory countries, by means of appropriate national procedures, have:

a. issued the necessary orders/instructions to the forces concerned, putting the procedures detailed in this agreement into effect.

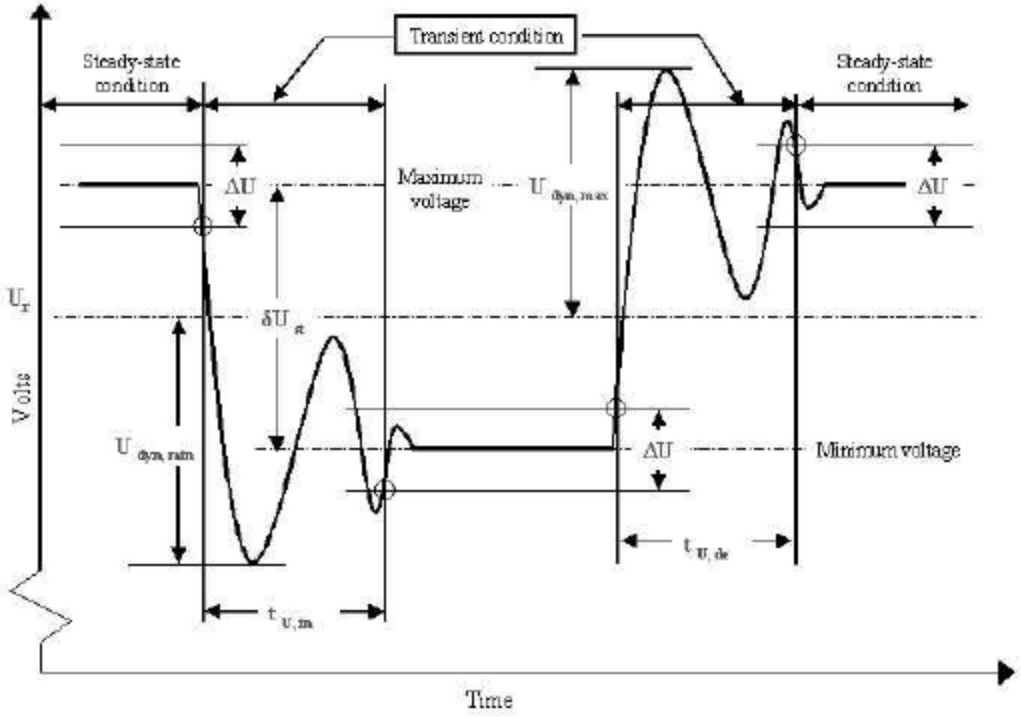
b. ensured that all persons responsible for the design and construction of electrical generating sets for military equipment are informed of the existence of the NATO standard characteristics defined in this STANDARD; and

c. prohibited the introduction, or the use in new equipment designs, of features which would render them incompatible, from the aspect of electrical characteristics or means of connection, with other equipment conforming to the NATO standard characteristics covered by this STANDARD.

ANNEX A: DEFINITIONS

Term	Definition
Rated VOLTAGE*	The Line-to-line voltage at the terminals of the electrical generator at rated output. The rated voltage is within the range of deviation
RANGE of setting*	The range of maximum possible upward and downward adjustment of voltage at the generator terminals, for all loads between no-load and rated output.
STEADY STATE CONDITIONS	Conditions which prevail at any constant load and any constant temperature when only non-cyclic, inherent or natural changes occur.
DEVIATION*	The difference from any constant setting of the voltage under steady-state conditions for all power between no-load and rated output. This difference is expressed as a percentage of the rated voltage. The range of deviation must include the rated voltage.
TRANSIENT	The sudden change of a characteristic which goes beyond the steady state limits and returns to the steady state limits within a specified time (the recovery time), measured from the initiation of the disturbance as shown in the attached diagram
SPIKE	A very short oscillatory variation from the steady state condition or transient level of a characteristic decaying to half peak value in less than 50 micro-seconds.
RIPPLE	The cyclic variation about the average voltage under steady state conditions. The value from the upper limit to the lower limit of the cyclic variation is called the "peak-to-peak ripple value" and is normally expressed as a percentage of the rated voltage
STABILITY	The ability of the generating set to maintain its voltage within the specified limits under steady state conditions over a specified period. Measurements are made of the maximum and minimum values and the difference is expressed as a percentage of the rated voltage.
Steady–state tolerance band*	Agreed band about the steady-state voltage that the voltage reaches within a given regulating period after a specified sudden increase or decrease of load.

* Definition according to ISO 8528



Ur : Rated voltage

δUst: Steady-state voltage deviation

ΔU: Steady-state voltage tolerance band

Udyn, min: Minimum voltage which occurs on a sudden change from no-load to full load. The required maximum variation relates to the rated voltage.

tU,in: Time interval from the point at which a load change from a lower to a higher load is initiated until the point when the voltage returns to and remains within the specified steady-state voltage tolerance band

Udyn, max: Maximum voltage which occurs on a sudden change from full load to no-load . The required maximum variation relates to the rated voltage.

tU,de: Time interval from the point at which a load change from a higher to a lower load is initiated until the point when the voltage returns to and remains within the specified steady-state voltage tolerance band

ANNEX B: AGREED VALUES FOR CHARACTERISTICS

Symbol	Term	Value
	range of manual voltage setting	+ 15% / - 5%
ΔU_{st}	Steady-state voltage deviation (max)	4%
ΔU	Steady-state voltage tolerance band	2%
	Ripple (Max), peak to peak	7%
$U_{dyn, min}$	Variation (Max) caused by application of a load	30%
$tU_{,in}$	Recovery time (max) following application of a load	1 sec
$U_{dyn, max}$	Variation (Max) caused by removal of a load	40%
$tU_{,de}$	Recovery time (Max) following removal of a load	0.5 sec

Note:
Measurements are made at the generating set output terminals and with no buffer batteries present.

AEP-4133(A)(1)