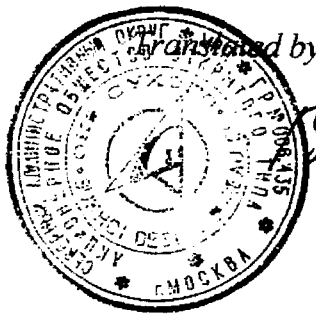
**Official translation**



*Translated by:* Valery S. Kulachkin

11.XII.97

# ELECTRIC POWER SUPPLY SYSTEMS OF AIRCRAFT AND HELICOPTERS

## GENERAL REQUIREMENTS AND NORMS OF QUALITY OF ELECTRIC ENERGY GOST 19705-89

GOST: 19705-89

**ELECTRIC POWER SUPPLY SYSTEMS OF AIRCRAFT AND HELICOPTERS. General Requirements and Norms of Quality of Electric Energy**

**GOST 19705-89**

**Effective Date: January 1, 1990**

**Violation of the Standard is prosecuted in law.**

The present Standard extends to the primary and secondary electric power supply systems of aircraft and helicopters, establishes the requirements for the electric energy quality at steady and transient conditions, as well as for input power devices of the electric loads.

The terms, used in the present Standard, are explained in GOST 19431, GOST 23875 and in Appendix 1 of the present Standard.

## 1. General Requirements

1.1. The electric power supply systems, when operated in compliance with the specifications and fed from the on-board or ground generating systems, shall ensure the electric energy quality at the electric load outputs, which meets the requirements of the present Standard at all operating conditions and at any environmental state.

1.2. The electric power supply system, during normal operation, shall have at least two independent channels or subsystems, except for aircraft and helicopters with one engine, where use may be made of single-channel main electric power supply systems if the electric loads required for safety flight and landing are fed with power from other facilities.

Electrical connection of independent subsystems is permissible.

1.3. The primary and secondary electric power supply systems shall be of two types:

AC, three-phase, constant frequency;

DC.

1.4. If technically justified, the following types of the electric power supply systems may be used:

primary - AC three-phase variable frequency;

secondary - AC single-phase constant frequency;

special.

1.5. The electric power supply systems shall be connected to the aircraft's or helicopter's fuselage by:

power neutral wire - for the three-phase system;

negative wire - for the DC system;

one of the wires - for the single-phase system.

If the aircraft or helicopter structure is current-nonconductive, the neutral, negative, return or common wire may be laid.

1.6. The operation of the primary electric power supply system and associated secondary system shall not depend upon the operation of other electric power supply systems, which are not related to those under discussion.

1.7. The radio noise level produced by the electric power supply systems at the points of connection of the generating system to the distributing system, in decibels, with respect to 1 μV shall not exceed the values given in Table 1.

Table 1

| Frequency range, f, MHz | Radio noise level, dB, maximum |
|---|---|
| From 0.01 to 0.15 inclusive | $90-28.90 \lg \frac{f}{0.01}$ |
| Above 0.15 to 0.50 inclusive | $66-22.97 \lg \frac{f}{0.15}$ |
| Above 0.50 to 6.00 inclusive | $54-12.97 \lg \frac{f}{0.50}$ |
| Above 6.00 to 100.00 inclusive | 40 |

1.8. The electric power supply systems shall be fit for inspection. The characteristics of fitness for inspection shall be defined by GOST 19838.

1.9. The phases of the three-phase electric power supply systems shall be designated: A, B, C.

The voltage in phases shall reach the amplitude values in direct order - A, B, C. The terminals of power sources shall be designated in compliance with the phase sequence.

1.10. The control and protective structure of the sources, their start-up and control equipment, components of the power distribution system and electric loads shall be so that failure of any source, its equipment, component of the distributing system or electric load and their disconnection from the system could not cause deviation of electric energy parameters on the components of the distributing system, which are not directly connected to the faulty source, its equipment or component of the distributing system, beyond the limit values established by the present Standard for the normal operation.

1.11. The requirements for electric energy quality, set up by the present Standard, shall be related to the electric energy at the input terminals of electric loads at all operating modes of the electric power supply system provided that the measurement point or operating conditions of the system is not specified for the specific value of the quality parameter.

The values of the steady voltage shall be taken only for the adjustment points.

## 2. REQUIREMENTS FOR ELECTRIC ENERGY QUALITY

2.1. *Electric Power Supply System, AC, Three-Phase, Constant Frequency*

2.1.1. The AC three-phase electric power supply system with constant frequency shall be three-wire with star connection of phases, with a rated voltage of 115/200 V and rated frequency of 400 Hz. The neutral points of windings of power sources shall be connected to the fuselage of the aircraft or helicopter, which is used as 4th wire in the power distributing system. If the structure of the aircraft or helicopter is current-nonconductive, the neutral wire may be laid.

2.1.2. The basic power parameters are the phase parameters. The linear parameters shall be determined on the basis of the established phase parameters.

2.1.3. Single-phase electric loads shall be distributed between the phases of each channel of the three-phase electric power supply system so that the difference in loads in the maximum and minimum loaded phases does not exceed:

for normal or partial operation - 5 % of the rated power of the channel or 15 % of the power of the source phase;

during emergency operation - 10 % of the rated power of the channel or 30 % of the power of the source phase.

N o t e. In technically justified cases the difference in loads of the maximum and minimum loaded phases, as agreed with the developing agency of the aircraft, may not exceed 10 % of the rated power of the channel in case of normal or partial operation.

2.1.4. The phase shift angle between the voltage vectors of any adjacent phases in case of normal, partial or emergency operation shall be 116-124$^0$.

2.1.5. The steady voltage values shall correspond to those given in Table 2, while the frequency values shall correspond to those indicated in Points 2.1.13, 2.1.17 and load nonuniformity - in Point 2.1.3.

T a b l e 2

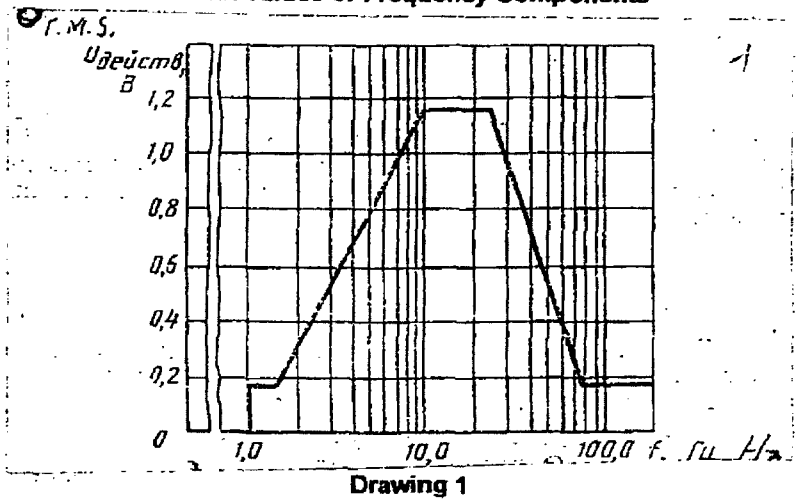
| Points of measurement | Voltage range, V, of any phase when system operates | | | Range of average values of voltage, V, of three phases when system operates | | |
|---|---|---|---|---|---|---|
| | normally or partially | abnormally | in emergency mode | normally or partially | abnormally | in emergency mode |
| Terminals of electric loads | 108-119 | 100-127 | 104-122 | - | - | - |
| At point of adjustment | - | - | - | 114-118 | 105-125 | 112-120 |

2.1.6. The voltage imbalance at phase load nonuniformity (Point 2.1.3) for normal and partial operation of the electric power supply system shall not exceed 3 V. When fed from an emergency power source the imbalance shall not exceed 4 V. At normal or partial operation and phase load nonuniformity of more than 5 % of the system power the voltage imbalance shall not exceed 4 V.

2.1.7. The voltage amplitude modulation coefficient under the steady operating conditions at pulse-intermittent load with cos φ equal to 0.95 and more, the amplitude value of the current intensity of which is in the pulse equal to 7 % of the rated amplitude value of the current intensity of the

channel (source), shall not exceed 1 %. The frequency components of the envelope of the voltage amplitude modulation shall be within the values indicated in Drawing 1 and Table 3.

**Limit Values of Frequency Components**




**Drawing 1**

Table 3

| Name of parameter | Value | | | | | |
|---|---|---|---|---|---|---|
| Voltage, V | 0-0.18 | 0.18 | 1.15 | 1.15 | 0.18 | 0.18 |
| Frequency, Hz | 1.0 | 1.7 | 10.0 | 25.0 | 70.0 | 200.0 |

2.1.8. The voltage non-sinusoidality at steady operating conditions shall be so that the following requirements are met at three-phase full-wave transformer-rectifier load equal to 25 % of the power of the channel (source):

the coefficient of distortion of sinusoidality of the voltage curve is no more than 8 %;

the actual value of any separate highest harmonic of the frequency up to 10 kHz is not in excess of 5 % of the actual value of the first harmonic of the voltage;

the actual value of any highest harmonic of the frequency of 10 kHz and above is not in excess of the value preset by Point 1.7 of the present Standard;

the coefficient of the amplitude value of the voltage is equal to 1.41±0.15;

the constant voltage component is not in excess of ±0.1 V.

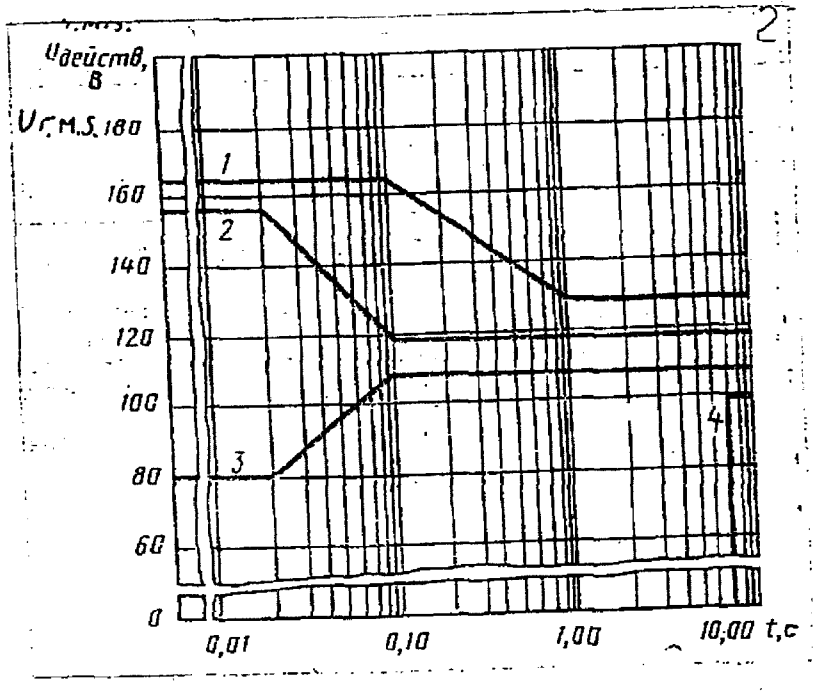
2.1.9. The voltage pulses, coming to the feed bus of the system with the electric loads being disconnected shall be within from minus 70 to 70 V (amplitude value), duration from 0.05 to 5 μs and be applied to the bus voltage at the moment of arrival.

2.1.10. In case of the normal or partial operation of the electric power supply system and sudden changes of the load from 10 to 160 % of the power of the channel (system) and vice versa the indicated transient voltage shall lie within the limits 2 and 3 indicated in Drawing 2 and Table 4.

The voltage values converted at transient conditions to the reduced transient voltage values are given in Appendix 2.

2.1.11. During normal or partial operation of the electric power supply system the power supply may be interrupted for no longer than 80 ms, after which the reduced transient voltage value after restoration of the power supply shall be within the limits 2 and 3 indicated in Drawing 2 and Table 4.

**Limits 1-4 of AC Reduced Transient Voltage Values**



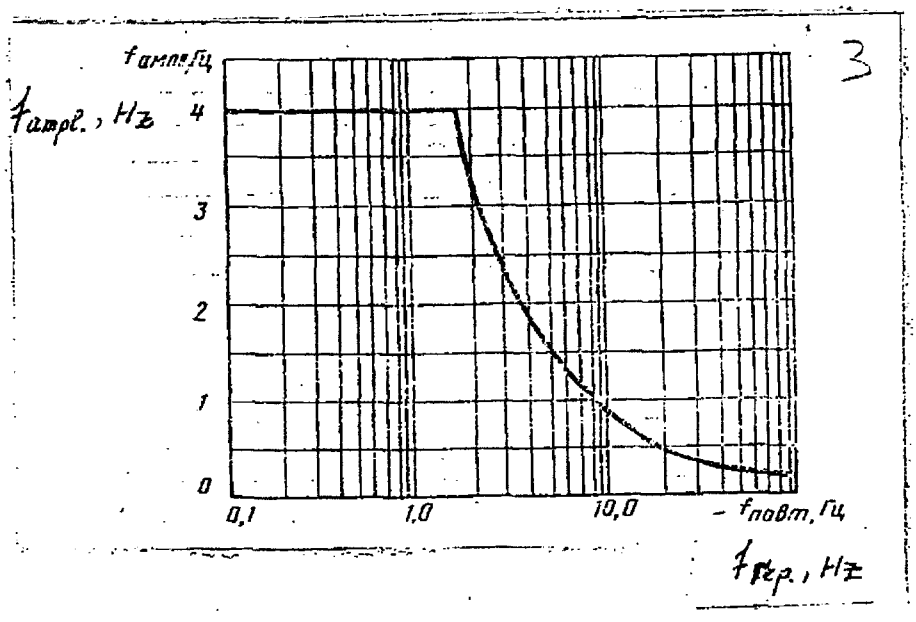

**Drawing 2**

Table 4

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 165 | 155 | 80 | 0 |
| 0.02 | | | | |
| 0.05 | | 137 | 96 | |
| 0.10 | | 119 | 108 | |
| 0.20 | 152 | | | |
| 0.50 | 139 | | | |
| 1.00 | 127 | | | |
| 7.00 | | | | 0-100 |

2.1.12. In case of the abnormal operation of the electric power supply system the values of the reduced transient voltage shall lie within limits 1 and 4 indicated in Drawing 2 and Table 4.

**Limits of Values of Frequencies Components of Frequency Modulation**




**Drawing 3**

2.1.13. In case of the normal or partial operation the AC steady frequency shall be within the range from 380 to 420 Hz, while in case of the emergency operation - within the range from 360 to 440 Hz.

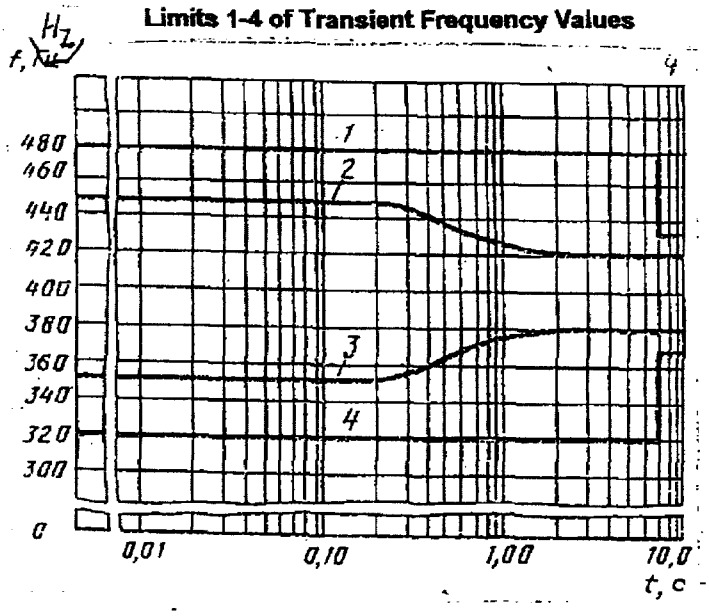
2.1.14. The frequency change rate due to its drift within permissible values of the steady operating conditions shall not exceed 2.5 Hz/s.

2.1.15. The frequency modulation coefficient at steady operation of the electric power supply system shall not exceed 1 % of the rated frequency.

The frequency components of the frequency modulation envelope shall be within the limits presented in Drawing 3.

2.1.16. In case of normal or partial operation of the electric power supply system and sudden changes in load from 10 to 160 % of the power of the channel (system) and vice versa the transient frequency values shall correspond to those indicated in Drawing 4 and Table 5 (limits 2, 3).

**Limits 1-4 of Transient Frequency Values**




**Drawing 4**

Table 5

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 480 | 450 | 350 | 320 |
| 0.10 | | | | |
| 0.15 | | | | |
| 0.30 | | 446 | 354 | |
| 0.50 | | 438 | 362 | |
| 2.00 | | 420 | 380 | |
| 4.00 | | | | |
| 7.00 | 480-430 | | | 320-370 |

In technically justified cases at the steady ground idle conditions of the power plant, as agreed with the Customer, during the normal and partial operation of the electric power supply system the transient processes shall be within limits 2 and 3 indicated in Drawing 4:

pneumatic constant rotational speed drives with the load changing from 0.05 to 1.05 of the rated power;

hydraulic blade drives with the load changing from 0.05 to 0.55 of the rated power.

2.1.17. In case of abnormal operation of the electric power supply system the transient frequency values shall lie within limits 1 and 4 indicated in Drawing 4 and Table 5.

If the frequency changes from 360 Hz towards its decrease, the frequency-to-voltage ratio shall be at least 2.7.

2.1.18. In case of abnormal operation of one of separately operating channels of the electric power supply system, the protection of the respective channel shall send a signal to disconnect the power distributing channel from the faulty source and to connect it to a serviceable source within at least 7 s (if provision is made for such connection).

2.1.19. The average value of the steady voltage of the phases at the points of adjustment may be changed (manually), using the voltage regulator settings from 118 to 114 V.

2.2. *DC Electric Power Supply System*

2.2.1. The DC electric power supply system shall be single-wire with a rated voltage of 27 V. The negative wire of the electric power source shall be connected to the fuselage of the aircraft or helicopter, which is used as the second wire in the power distributing system. If the structure of the aircraft or helicopter is current-nonconductive, the negative wire may be laid.

2.2.2. The steady voltage shall correspond to that given in Table 6.

Table 6

| Point of measurement | Range of voltage, V, when system operates | | |
|---|---|---|---|
| | normally or partially | abnormally | in emergency mode |
| Electric load terminals | 24.0 - 29.4 | 21.0 - 31.5 | 18.0 - 31.0 |
| Adjustment points in system with controllable source | 27.0 - 29.0 | 24.0 - 31.5 | 20.0 - 29.0 |
| Points of connection of uncontrollable rectifying device | 25.4 - 29.4 | 21.0 - 31.5 | 20.0 - 31.0 |

Note. Voltage at the point of connection of the rectifying device may be changed by the setting up to ±0.5 V.

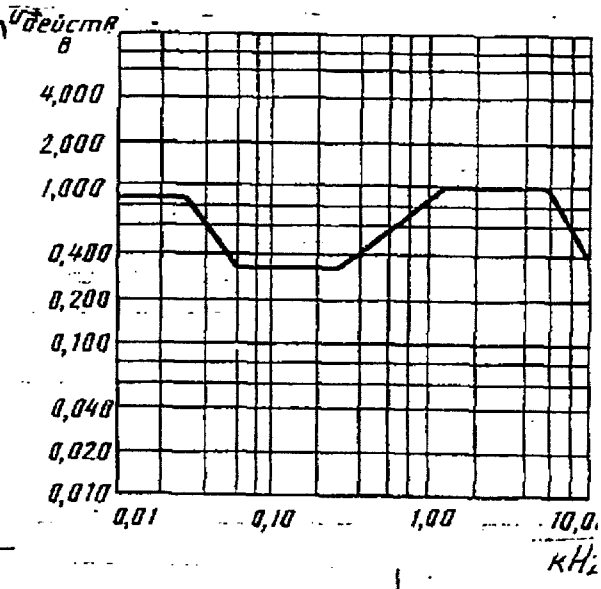
2.2.3. The DC voltage ripples coefficient shall not exceed 7.4 % of the rated value.

The frequency components of the voltage ripples shall be within the limits indicated in Drawing 5 and Table 7 within the frequency range from 0.01 to 10 kHz and correspond to Point 1.7 within the frequency range from 10 kHz and above.

2.2.4. The voltage pulses, coming to the feed bus of the system with electric loads being disconnected shall be within the limits from minus 50 to 50 V (amplitude value), duration from 0.05 to 5 μs and be applied to the bus voltage at the moment of arrival.

2.2.5. In case of normal or partial operation of the electric power supply system fed from the DC generators and sudden change in load from 10 to 160 % of the power of the channel (system) and vice versa the values of the reduced transient voltage shall be within limits 2 and 3 indicated in Drawing 6 and Table 8.

**Limits of Values of Frequency Components of 27 V**

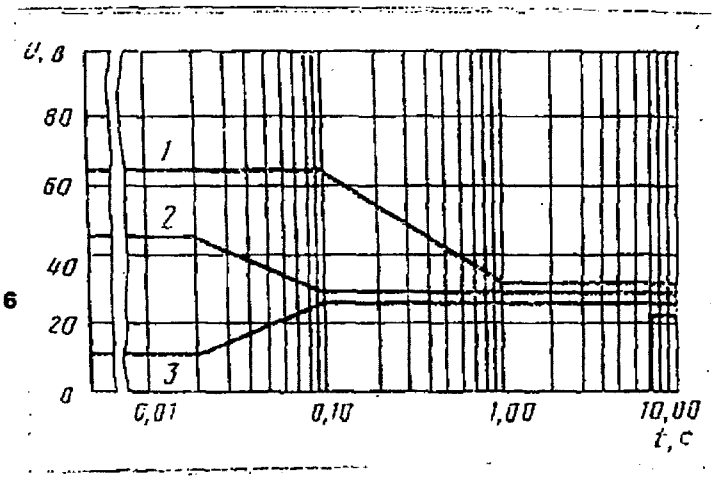



**Drawing 5**

| Name of parameter | Value | | | | | | |
|---|---|---|---|---|---|---|---|
| Voltage, V | 0.900 | 0.900 | 0.320 | 0.320 | 1.000 | 1.000 | 0.32 |
| Frequency, kHz | 0.010 | 0.025 | 0.060 | 0.25 | 1.700 | 6.000 | 10.000 |

2.2.6. In case of normal or partial operation of the electric power supply system fed from the DC generators the power supply may be interrupted for no longer than 80 μs, after which the values of the reduced transient voltage during restoration of the power supply shall be within limits 2 and 3 indicated in Drawing 6 and Table 8.

**Limits 1-4 of Values of DC Reduced Transient Voltage in Systems Fed from Generators**




**Drawing 6**

Table 8

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 65.0 | 45.0 | 13 | 0 |
| 0.02 | | | | |
| 0.05 | | 36.0 | 20 | |
| 0.10 | | 29.4 | 24 | |
| 0.20 | 53.5 | | | |
| 0.50 | 41.0 | | | |
| 1.00 | 31,5 | | | |
| 7.00 | | | | 0-21 |

2.2.7. In case of abnormal operation of the electric power supply system fed from DC generators the values of the reduced transient voltage shall be within limits 1 and 4 indicated in Drawing 6 and Table 8.

2.2.8. In case of normal or partial operation of the electric power supply system fed from rectifying devices the values of the reduced transient voltage shall be within limits 2 and 3 indicated in Drawing 7 and Table 9.

2.2.9. In case of normal or partial operation of the electric power supply system fed from rectifying devices the power supply may be interrupted for no longer than 80 μs, after which the values of the reduced transient voltage during restoration of the power supply shall be within limits 2 and 3 indicated in Drawing 7 and Table 9.

2.2.10. In case of abnormal operation of the electric power supply system fed from rectifying devices the values of the reduced transient voltage shall be within limits 1 and 4 indicated in Drawing 7 and Table 9.

2.2.11. When starting the aviation engines and on-board auxiliary power plants from the ground or on-board power sources the voltage at distributing buses of the electric power supply systems may reduce too 10 V for no longer than 1 s and up to 14 V for no longer than 5 s followed by restoration of the voltage to the value of at least 15 V within 40 s, maximum. Characteristics, serviceability and operating conditions of electric loads, which shall operate or remain switched on during the start-up of the aviation engines or auxiliary power plant, shall be indicated in the standard technical documentation.

2.2.12. In case of abnormal operation of one of separately operating channels of the electric power supply system the protection of the respective channel shall send a signal to disconnect the power distributing channel from the faulty source and to connect it to the serviceable one within no longer than 7 s (if provision is made for such connection).

2.3. *Secondary Electric Power Supply System, AC Single-Phase, Constant Frequency*

2.3.1. The AC single-phase constant frequency power supply system shall be single-wire with a rated voltage of 115 V and rated frequency of 400 Hz. One of the terminals of the electric power source shall be connected to the fuselage of the aircraft or helicopter, which is used as the second wire in the power distributing system. If the structure of the aircraft or helicopter is current-nonconductive, the return or common wire may be laid.

**Limits of Values of Reduced Transient Voltage in DC Systems Fed by Rectifying Devices from DC Constant Frequency Generators**

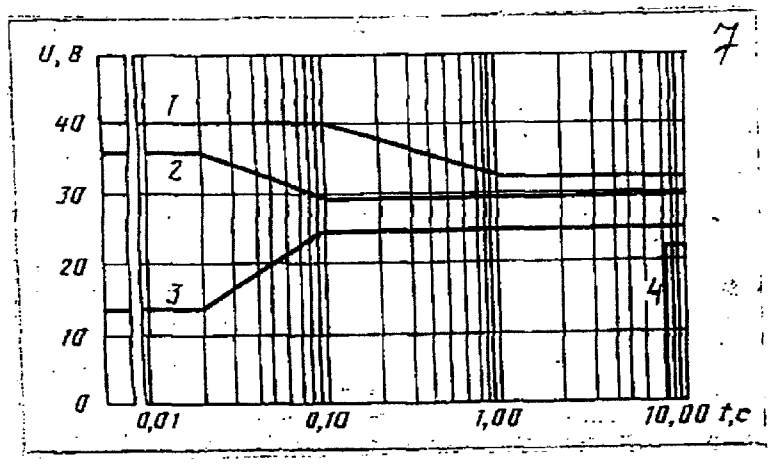



Table 9

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 40.0 | 37.0 | 13.0 | 0 |
| 0.02 | | | | |
| 0.05 | | 32.0 | 19.5 | |
| 0.10 | | 29.4 | 24.0 | |
| 0.20 | 37.5 | | | |
| 0.50 | 33.5 | | | |
| 1.00 | 31.5 | | | |
| 7.00 | | | | 0-21 |

2.3.2. The AC single-phase constant frequency power supply system shall meet the requirements of Points 2.1.7, 2.1.9-2.1.17.

2.3.3. The steady voltage shall correspond to that indicated in Table 10.

2.3.4. The voltage non-sinusoidality at the steady operating conditions shall be so that:

the coefficient of the distortion of sinusoidality of the voltage curve does not exceed 8 %;

the actual value of any separate highest harmonic of the frequency up to 10 kHz does not exceed 5 % of the actual value of the first harmonic of the voltage;

the actual value of any highest harmonic of the frequency of 10 kHz and above does not exceed the value given in Point 1.7;

the coefficient of the voltage amplitude value is equal to 1.41±0.15;

the constant component of the voltage does not exceed ±0.1 V.

Table 10

| Point of measurement | Range of voltage, V, when system operates | | |
|---|---|---|---|
| | normally or partially | abnormally | in emergency mode |
| Terminals of electric loads | 108-119 | 100-127 | 104-122 |
| Point of adjustment | 115-119 | 105-125 | 112-120 |

2.4. *Electric Power Supply System, AC Three-Phase, Variable Frequency*

2.4.1. The AC three-phase variable frequency power supply system shall be three-wire with star connection of phases, rated voltage of 115/200 V and frequency, which is within the limits from 320 to 640 Hz. The neutral points of windings of the electric power sources shall be connected to the fuselage of the aircraft or helicopter, which is used as the 4th wire in the power distributing system. If the structure of the aircraft or helicopter is current-nonconductive, the neutral wire may be laid.

2.4.2. The AC three-phase variable frequency power supply system shall meet the requirements of Points 2.1.2-2.1.8, 2.1.18.

2.4.3. The reduced transient voltage and voltage pulses at the frequency from 320 to 420 Hz shall meet the requirements of Points 2.1.9-2.1.12.

2.4.4. The upper limits of the reduced transient voltage at the frequency of more than 420 Hz shall be equal to upper limits 1 and 2 established in Points 2.1.10-2.1.12, multiplied by the f/420 ratio. The lower limits of the reduced transient voltage at the frequency of less than 380 Hz and voltage pulses beyond the frequency range from 380 to 420 Hz shall be equal to lower limits 3 and 4 and to the pulses given in Points 2.1.9-2.1.12.

2.5. *Special Secondary Electric Power Supply Systems*

2.5.1. The special secondary electric power supply systems shall be made as the AC single-phase systems with constant frequency, rated voltage of 27 and 6 V and rated frequency of 400 Hz.

2.5.2. The secondary special electric power supply systems shall be used to feed electric loads, which are a part of the illumination engineering equipment. The steady deviation of the voltage in the systems shall not exceed ±10 % of the rated voltage.

2.5.3. The secondary special electric power supply systems shall meet the requirements of Points 2.1.7, 2.1.9, 2.1.11, 2.1.13-2.1.17.

The permissible values of the reduced transient voltage shall be within the limits given in Points 2.1.10 and 2.1.12, multiplied by the 27/115 or 6/115 ratio depending upon the rated voltage value of the system.

## 3. BASIC REQUIREMENTS FOR ELECTRIC LOADS

3.1. The electric loads are divided into three categories as to the purpose:

the loads of the first category are used to ensure completion of the flight and safety landing.

In case of failure of the primary sources the electric loads shall draw the current from the emergency sources:

on the aircraft, which are not equipped with auxiliary power plants or generators driven from the drop-out turbine - till completion of the flight and safety landing;

on the aircraft, which are equipped with auxiliary power plants or generators driven from the drop-out turbine - in the process of safety descent to the height of start-up of the auxiliary power plant (turbine) and its start-up;

the loads of the secondary category are used for safety continuation of the flight, performance of the task and landing;

the loads of the third category, the failure of which does not affect the flight safety.

3.2. In case of the normal or partial operation of the electric power supply system the electric loads of all categories shall ensure their output characteristics if the electric energy quality at their input terminals meets the requirements of the present Standard. The operation of a load, as agreed with the Customer, may be stopped for the time of interruption of the power supply and transient process in case of the normal or partial operation of the electric power supply system (switching over of buses) with the faulty signal not removed.

3.3. In case of the abnormal operation of the electric power supply system the following requirements shall be met:

the output characteristics of the electric loads of the first and second categories shall meet the requirements of the standard technical documentation for these loads for power supply conditions in case of abnormal operation of the electric power supply system;

during abnormal operation of the electric power supply system the operation of the electric loads of the third and second categories may be stopped, the standard technical documentation for which does not contain requirements for the output characteristics of the power supply in case of abnormal operation of the electric power supply system, but this fact shall not affect their characteristics during the subsequent operation under normal power supply conditions;

the electric loads of all categories after restoration of the normal or partial operation or the electric loads of the first category after changeover to the emergency operation of the electric power supply system shall automatically and completely restore their characteristics (except for the cases when the serviceability of the load is restored manually, which is specified by the standard technical documentation);

the electric loads of all categories shall not be sources of emergency situations or dangerous operating conditions of the units and systems of the aircraft or helicopter.

3.4. In case of the emergency operation of the electric power supply system fed from an emergency power supply source:

the electric loads of the first and second categories, for which the emergency operation is stipulated by the standard technical documentation, shall ensure their characteristics specified in the technical documentation;

after restoration of the normal power supply characteristics the loads of all categories shall completely restore their characteristics;

the electric loads of all categories shall not be sources of emergency situations or dangerous operating conditions of the units and systems of the aircraft or helicopter.

3.5. The electric loads shall not cause deviation of the power supply characteristics at the input terminals, which are beyond the values given in the present Standard.

The starting current of an electric load of more than 200 W in power (except for head-lamps) shall not exceed 5 $I_{rated}$ within no longer than 0.1 s.

Change in load of the electric loads shall not produce in the electric power supply system the modulation, pulsation, nonsinusoidal voltage, as well as transient voltage and frequency, exceeding the values or being beyond the limits indicated in Points 2.1.7, 2.1.8, 2.1.10, 2.1.15, 2.1.16, 2.2.3 and 2.2.5.

3.6. The AC electric loads of more than 50 VA in power shall have no input power circuits with half-wave rectification. The coefficient of distortion of sinusoidality of the curve of the current consumed by electric loads of 500 VA in power and more shall not exceed 35 %.

The constant component of the current intensity of the AC load shall not exceed 2 % of its rated value.

**Limit of Values of Load Nonuniformity of Different Phases of Three-Phase Loads**

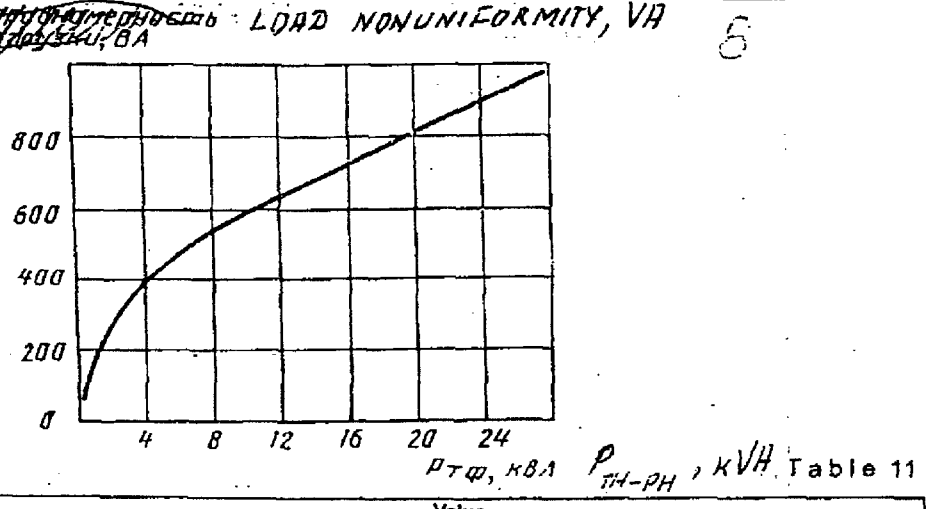


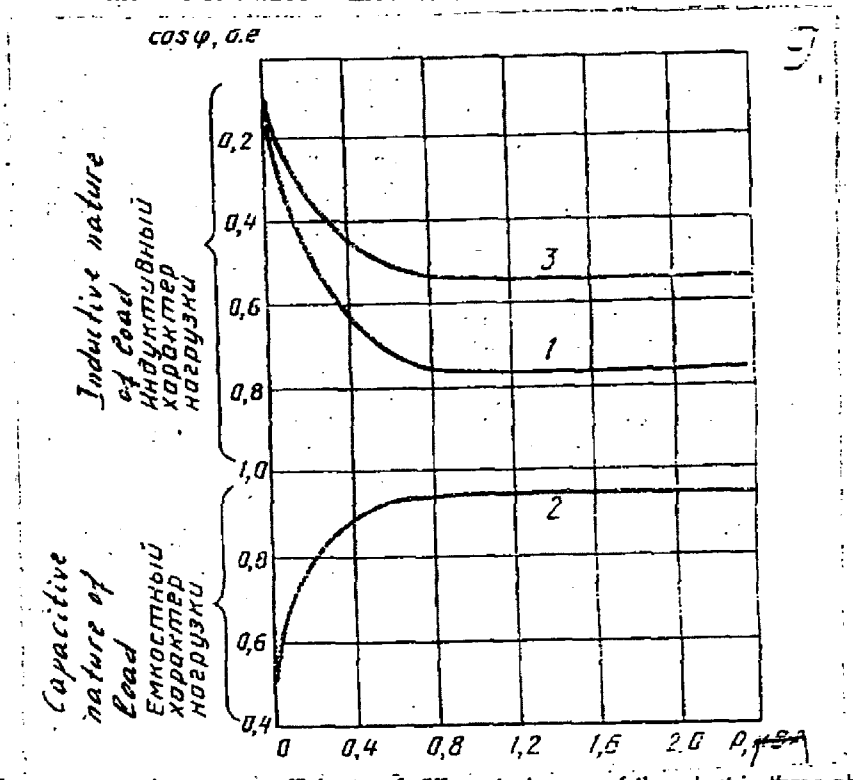

Table 11

| Name of parameter | Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Load nonuniformity, VA | 100 | 200 | 400 | 500 | 650 | 825 | 900 | 950 | 1000 |
| Three-phase power, kVA | 0.5 | 1.0 | 4.0 | 7.0 | 12.0 | 20.0 | 24.0 | 27.0 | 30.0 |

3.7. The electric loads (except for those, operating only in the mode of starting up the engine or auxiliary power plant) shall not produce the pulse-intermittent load, the amplitude value of the current intensity of which exceeds 2 A in the primary electric power supply system. Use of electric loads, which produce pulse-intermittent loads of higher power, shall be agreed with the developing agency of the aircraft or helicopter electric power supply system and with the Customer.

3.8. The AC electric loads of 500 VA in power and more shall be rated for three-phase power, except for the head-lamps, for which use may be made of the single-phase AC with a power up to 1200 VA.

**Limits 1-3 of Values of Electric Load Power Coefficient**




3.9. The power and power coefficients of different phases of the electric three-phase load, except for electric thermal anti-icing systems, shall be close to each other in values. The difference in the maximum and minimum power of the phases shall be less than the values presented in Drawing 8 and Table 11, while the minimum power coefficient at the load in each phase close to the rated one shall be equal at least to the values given in Drawing 9 (limits 1 and 2). In technically justified cases use may be made of asynchronous motors, the minimum power coefficients of which shall be equal at least to the values given for limit 3 in Drawing 9.

3.10. At the rated voltage the power consumed by different electric loads of one type indicated in the technical documentation shall not differ from the rated value by more than 10 %. This requirement does not extend to electric loads, the rated power of which is less than 50 VA or 50 W.

3.11. In case of failure of one or several phases of the three-phase power supply or one of types of the power supply when an electric load consumes simultaneously AC and DC the

requirements for the characteristics of the electric load shall not be imposed (if such a requirements is not specified in the technical documentation for the given electric load). The defective load shall not affect the operation of other electric loads or be the cause of the emergency situation aboard the aircraft or helicopter and shall restore its characteristics after restoration of the normal power supply.

3.12. The electric loads of the first category shall be rated for DC power supply.

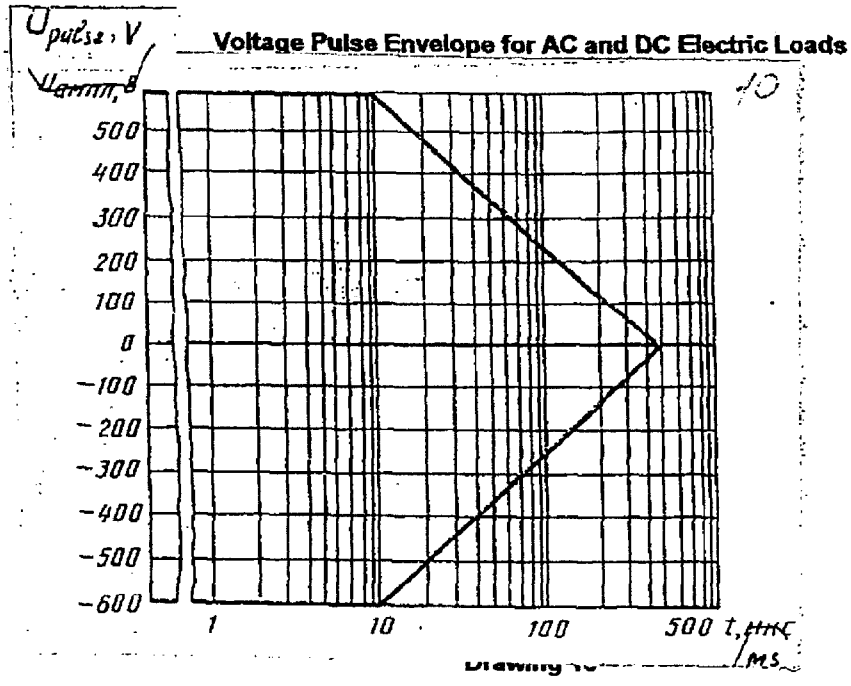
The electric loads of the second and third categories shall be rated for AC power supply, the electric load cut-in circuits may be fed with DC.

3.13. If the normal operation of the electric load requires the power with other parameters or deviations less than established by the present Standard, the generation or conversion of the power or provision of smaller tolerance shall be effected by the devices, which are not included into the electric power supply system and worked out by the developing agency of the electric load as agreed with the developing agency of the aircraft or helicopter.

3.14. All power supply terminals (direct and return) of the electric load shall be connected to the independent contacts of the connector. To exclude interruption in power supply provision shall be made in the electric load for separate terminals for connection to independent channels of the electric power supply system.

Diode decoupling may be used for electric loads of 100 W in power and less.

3.15. The voltage pulses, produced at the moment the circuit gets open at the contacts of the switching devices on the side of the electric loads being switched off, shall not exceed the values presented in Drawing 10.




Drawing 10

The internal resistance of the electric load, which generates the voltage pulses, shall be at least 50 ohms.

3.16. Recommendations for check of the electric loads for correspondence to the requirements of the present Standard at the steady operating conditions and transient processes in the electric power supply system are given in Appendix 3.

3.17. The permissible norms of the electric energy quality at the terminals of electric loads designed for installation aboard the aircraft or helicopter, which are elaborated before January 1, 1983, are given in Appendix 4.

3.18. The permissible norms of the electric energy quality at the terminals of electric loads designed for installation aboard the aircraft or helicopter, which are elaborated before January 1, 1990, are given in Appendix 5.

**APPENDIX 1**

**Reference**

## EXPLANATION OF TERMS USED IN THE PRESENT STANDARD

Table 12

| Term | Explanation |
|---|---|
| 1. Electric power supply system of aircraft or helicopter. Electric power supply system | Combination of the power generating or conversion and distributing systems.<br>N o t e. The electric power supply system may have several channels (as to the number of sources or converters of one type of the power), which may operate in parallel (with electric coupling of power circuits with each other) or separately (without electric coupling) |
| 2. Channel of electric power supply system | A part of the system, which includes the electric energy source and storage batteries for the DC channel, its control and protective equipment, a part of the power distributing system connected to the said source. |
| 3. Power generating system. Generating system | Combination of power sources or converters (generators, converters of the kind of current and voltage value, storage batteries), devices for stabilization of their voltage and frequency, parallel operation devices, protective, control and checking devices, which produce electric energy and maintain its characteristics within preset limits at the points of adjustment under all operating conditions of the system. |
| 4. Power distributing system. Distributing system | Combination of devices used to transmit the electric energy from the generating system to the switch gear and from switch gear to the electric loads.<br>N o t e. The power distributing system maintains at the terminals of the electric loads the electric energy characteristics within the preset limits (if at the points of adjustment they are within the limits preset for the generating system), makes required switchings, backs up the power supply of electric loads and protects the distributing system against damage. |
| 5. Primary electric power supply system | The system, generators of which are placed in rotary motion by the cruise engines of the aircraft, by the main rotor gearbox of the helicopter or by the auxiliary power plant. |
| 6. Secondary electric power supply system | The system fed by converting devices from the primary system |
| 7. Power of the system | The sum of the rated power of its sources, generating the electric energy of one type. |

Table 12, continued

| Term | Explanation |
|---|---|
| 8. Normal operation of electric power supply system. Normal operation | Operating conditions, at which all components of the electric power supply system operate normally, which provide all electric loads with power, and at which the operations required for performance of the flight at all its stages are performed.<br>N o t e. Examples of operations performed during the said operating conditions are switching-on and switching-off of electric loads, change of engine revolutions, switchover and synchronization of buses, cut-in of generators for parallel work. Such operations may be performed at any time when preparing the aircraft for flight, during take-off, during landing and taxying without limitation in number of operations. |
| 9. Partial operation of electric power supply system | The operating conditions in flight, at which the electric power supply system is not capable of giving the required power, due to which a part of electric loads are cut off and the remaining electric loads continue drawing power from the remaining serviceable power supply sources fitted on the cruise engines or/and the auxiliary power plant. |
| 10. Emergency operation of electric power supply system. Emergency operation | Operating conditions in flight with faulty or disconnected primary power supply sources fitted on the cruise engines and auxiliary power plant when changing over to power supply from the emergency power supply sources. |
| 11. Abnormal operation of electric power supply source. Abnormal operation | Operating conditions at sudden loss or worsening of the control of electric power supply system.<br>N o t e. Abnormal operation is uncommon occasional phenomenon, which occurs due to failure of a part of power supply sources or control equipment, short circuit in the system. Such operation may be in flight, in the process of preparation or may never occur during the entire service life of the aircraft. Short-time abnormal operation is stopped upon restoration of the normal operation, changeover to emergency operation or to long-time abnormal operation |
| 12. Steady operating conditions of electric power supply system. Steady operating conditions | Operating conditions, at which the electric energy characteristics vary slightly within arbitrary period of time.<br>N o t e. Steady operating conditions of the system occur at constant load or at accidental smooth, step or pulse-intermittent loads, the amplitude value of the current of which in the pulse is not in excess of 7 % of the rated amplitude value of the current of the channel (source), change in rotational speed of aviation engines is not in excess of 1 % per 1 s or fluctuation of this speed is not in excess of 0.2 % of the rated value with a period of more than 0.33 s. |

Table 12, continued

| Term | Explanation |
|---|---|
| 13. Normal long-time load | The load, having inductive nature and being within the limits of 10-100 % of the channel power at power coefficient 0.8-1.0 or 10-30 % of the channel power at power coefficient 0.5-1.0. The time of action of the load exceeds the time, within which the sources fitted aboard the given aircraft (helicopter) admit of one and one half overload. |
| 14. Normal short-time load | The load, having inductive nature and being within the limits of 100-150 % of the channel power at the power coefficient of 0.8-1.0.<br>The time of action of the load is equal to or less than the time, within which the sources fitted aboard the given aircraft (helicopter) admit of one and one half overload. |
| 15. Pulse-intermittent load | The load, which changes periodically smoothly or by steps at equal time intervals with a frequency of 0.5-400 Hz and period-to-duration ratio of more than 1. |
| 16. Voltage pulse | Change in voltage with respect to the steady value or its transient deviation, occurring in circuits of electric loads when disconnecting the electric loads with inductive nature of the load.<br>N o t e. The voltage pulse generated by the electric load being disconnected may be of oscillating type with very high frequency and may consist of a number of pulses in the open load circuit. |
| 17. Frequency drift | Slow random change in controllable frequency level within tolerances for the steady operating conditions of the electric power supply system, which occurs under influence of the environment upon the equipment of the system and due to wear-out of generator drives. |
| 18. Point of adjustment | Place of connection of measuring circuits of voltage regulators.<br>When connecting the ground power supply source to the on-board electric mains the adjustment point of the ground controllable source is the on-board ground supply connector. |
| 19. Point of connection | Place of connection of the source of the secondary electric power supply system. |
| 20. Emergency power supply source.<br>Emergency source | Power supply source, which does not depend upon the operation of primary sources fitted on the cruise engines, auxiliary power plant, main-rotor gearbox of the helicopter.<br>N o t e. The emergency source shall be used in flight with primary sources being faulty or/and disconnected to supply power to the limited number of electric loads (of the first category).<br>Examples of emergency sources are storage battery, converter fed from the storage battery, wind motor generator |

Table 12, continued

| Term | Explanation |
|---|---|
| 21. Power supply interruption | Time interval, which exceeds 1 ms, within which the voltage and/or frequency at the steady and/or transient operating conditions is beyond the limits permissible for normal operation of the electric power supply system |

**APPENDIX 2**

**Reference**

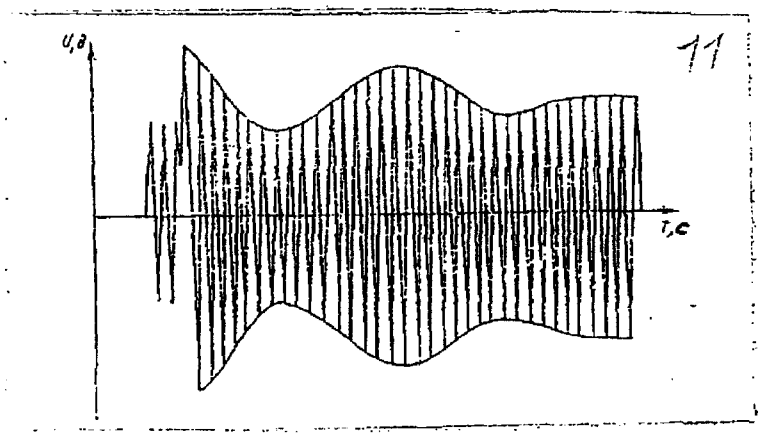
## VOLTAGE CONVERSION AT TRANSIENT CONDITIONS

### 1. Conversion of Voltage Curve at Transient Conditions to Equivalent Characteristic

1.1. *General Provisions for Conversion of Voltage at Transient Conditions*

1.1.1. The curve of the transient voltage is converted to the equivalent characteristic separately at the increase or decrease of the voltage. For conversion of the curve of the transient AC voltage to the equivalent characteristic it is necessary to draw the envelope of the transient AC voltage as shown in Drawings 11 and 12. In this case the values of the transient AC voltage for the envelope shall be decrease by $\sqrt{2}$ times.

**Change in AC Voltage at Transient Conditions**



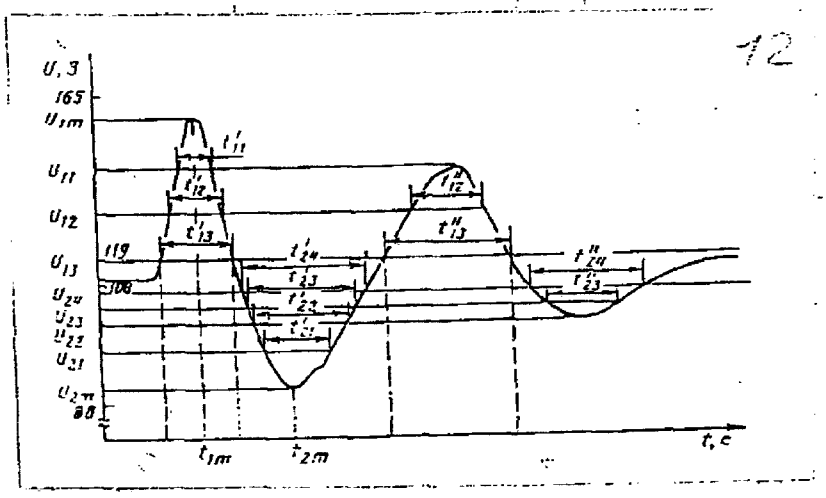

**Drawing 11**

For the DC voltage it is necessary to draw the transient voltage curve as shown in Drawing 13, obtained directly from decoding of the oscillographic record (without decrease by $\sqrt{2}$ times). The maximum permissible voltage values of the steady conditions are applied to the obtained charts:

108 and 119 V - for AC voltage (Drawing 12);

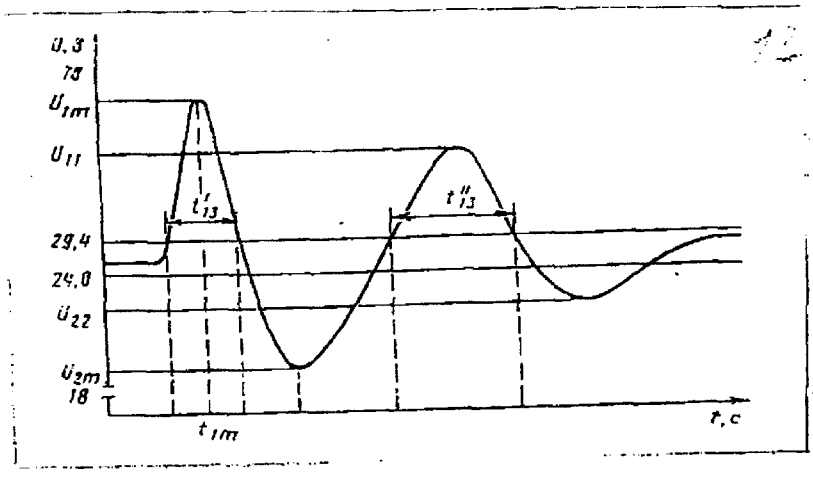
24 and 29.4 V - for DC voltage (Drawing 13).

**Envelope of Transient AC Voltage at Transient Conditions**




**Drawing 12**

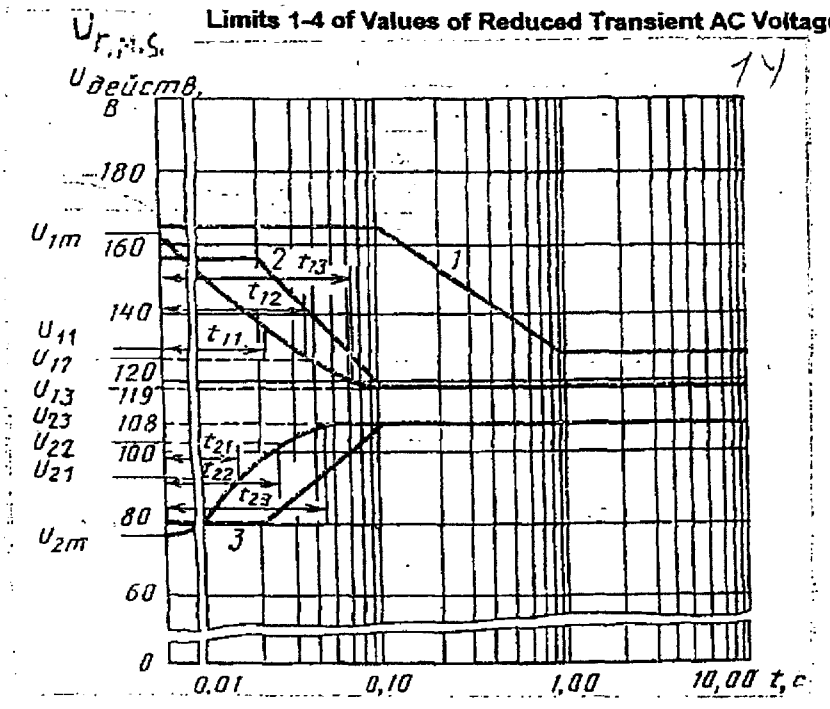
**Change in DC Voltage at Transient Conditions**




**Drawing 13**

1.2. *Conversion of Increased Transient Voltage*

1.2.1. Determine the greatest transient voltage (increase in voltage) $U_{1m}$ in compliance with Drawings 12, 13 and plot it on the ordinates as shown in Drawing 14.




**Drawing 14**

1.2.2. Draw several lines parallel to the abscissa through points $U_{11}$, $U_{12}$, $U_{13}$, etc. in compliance with Drawings 12, 13 between the horizontal line, which corresponds to the maximum permissible voltage of 119 V AC or 29.4 V DC for the steady normal operation and the greatest transient increase in voltage $U_{1m}$.

Number of points $U_{1i}$ shall be selected so as to construct the equivalent curve in compliance with Drawing 14 with acceptable accuracy. In this case, one of lines $U_{1i}$, for example, line $U_{11}$, in compliance with Drawing 12, shall be drawn through the maximum value of the increase in voltage of the second period if the transient process is of oscillating type.

1.2.3. Applied to Drawing 14 are the points with coordinates:

$$U_{1i},\ t_{1i} = t_{1i}' + t_{1i}''$$

Specifically, for $U_{11}$ $t_{1i} = t_{1i}'$ since $t_{1i}'' = 0$;

For $U_{12}$ $t_{12} = t_{12}' + t_{12}''$, etc. (refer to Drawings 12, 14).

1.2.4. The obtained points - $U_{1m}$, $t_{1m} = 0$, $U_{11}$, $t_{11}$, $U_{12}$ - shall be connected with smooth curve in compliance with drawing 14.

1.3. *Conversion of Reduced Transient Voltage*

1.3.1. Determine the least transient voltage (decrease in voltage) $U_{2m}$ in compliance with Drawing 12 and plot it in Drawing 14 on the ordinates.

1.3.2. Draw several lines parallel to the abscissa through points $U_{2i}$, $U_{21}$, $U_{22}$, $U_{23}$ etc. in compliance with Drawings 12, 13 between the horizontal line, which corresponds to the maximum permissible reduced voltage of 108 V AC or 24 V DC and the line, which corresponds to the greatest value of reduced transient voltage $U_{2m}$. Number of points $U_{2i}$ shall be selected so as to construct the equivalent curve in compliance with Drawing 14 with acceptable accuracy. In this case, one of lines $U_{2i}$, for example, line $U_{22}$, in compliance with Drawing 12, shall be taken equal to the minimum value of the voltage of the second period if the transient process is of oscillating period.

1.3.3. Applied to Drawing 14 are the points with coordinates:

$$U_{2i}, t_{2i} = t_{2i}' + t_{2i}''$$

Specifically, for $U_{21}$ $t_{21} = t_{21}'$ since $t_{21}'' = 0$;

For $U_{23}$ $t_{23} = t_{23}' + t_{23}''$, etc.

**2. Estimation of Admissibility of Transient Voltage**

2.1. The transient voltage will meet the requirements of the present Standard if its equivalent curves will not intersect the boundaries of the respective maximum permissible values of these characteristics (for example, limits 2 and 3 for the normal operating conditions on Drawing 12 of the present Standard) and will be within these limits. The transient process indicated in Drawing 11, the equivalent curves of which are presented in Drawing 14, meets the requirements of the present Standard for abnormal operating conditions and fails to meet the requirements of the Standard for normal operating conditions.

2.2. Estimation of increase and decrease in DC transient voltage shall be made in a similar way. But instead of the AC voltage envelope, as shown in Drawing 12, use shall be made of the DC transient voltage in compliance with Drawing 13.

**APPENDIX 3**

**Recommended**

## RECOMMENDATIONS FOR CHECK OF ELECTRIC LOADS FOR CORRESPONDENCE TO REQUIREMENTS OF THE PRESENT STANDARD

**1. Check of Electric Loads for Influence of Voltage and Frequency of 115/200 V, 400 Hz**

1.1. Check of electric loads for influence of the voltage and frequency at steady operating conditions of the electric power supply system shall be made in compliance with Table 13.

Table 13

**Test Cycles for Alternating Voltage**

| Cycle No. | U, V | f, Hz | t, min | U, V | f, Hz | t, min | U, V | f, Hz | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st operating conditions | | | 2nd operating conditions | | | 3rd operating conditions | | | |
| 1 | 115 | 400 | 10 | 108 | 400 | 10 | 119 | 400 | 10 | 1 |
| 2 | | 380 | | | 380 | | | 380 | | |
| 3 | | 420 | | | 420 | | | 420 | | |
| 4 | | 360 | | 104 | 360 | | 122 | 360 | | |
| 5 | | 440 | | | 440 | | | 440 | | |
| 6 | | 370 | | 100 | 370 | 30 | 127 | 370 | 30 | |
| 7 | | 430 | | | 430 | | | 430 | | |
| 8 | 75 | 380 | | 50 | 380 | 10 | 25 | 380 | 10 | |

Nos of the test cycles stand for:

1, 2, 3 - normal operation of the electric power supply system

4, 5 - emergency operation of the electric power supply system;

6, 7, 8 - abnormal operation of the electric power supply system.

1.2. An electric load for influence of the transient voltage in case of the normal operation of the electric power supply system shall be checked at the frequency of 380 Hz in compliance with Table 14.

1.3. An electric load for influence of the transient voltage in case of the abnormal operation of the electric power supply system shall be checked at the frequency of 370 Hz in compliance with Table 15.

Table 14

**Test Cycles Equivalent To Normal Values of AC Transient Voltage at Frequency of 380 Hz**

| Cycle No. | U, V | t, min | U, V | t, min | U, V | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|
| | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| 1 | 115 | 10 | 155 | 0.10 | 115 | 10 | 3 |
| 2 | | | 0 | 0.08 | | | |
| 3 | | | 80 | 0.10 | | | |

Table 15

**Test Cycles Equivalent To Abnormal Values of AC Transient Voltage at Frequency of 380 Hz**

| Cycle No. | U, V | t, min | U, V | t, min | U, V | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|
| | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| 1 | 115 | 10 | 165 | 0.2 | 115 | 10 | 1 |
| 2 | | | 155 | 0.5 | | | |
| 3 | | | 140 | 1.0 | | | |
| 4 | | | 0 | 7.0 | | | |

Table 16

**Test Cycles Equivalent to Normal (Cycles 1 and 2) and Abnormal (Cycles 3 and 4) Frequency Values at Transient Operating Conditions**

| Cycle No. | U, V | f, Hz | t, min | f, Hz | t, min | f, Hz | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|---|
| | | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| 1 | 108 | 400 | 10 | 450 | 2.0 | 400 | 10 | 3 |
| 2 | 119 | | | 350 | | | | |
| 3 | 108 | | | 480 | 7.0 | | | 1 |
| 4 | 119 | | | 320 | | | | |

1.4. Check of the electric load for influence of the transient frequency shall be made in compliance with Table 16.

Nos of the test cycles stand for:

1, 2 - normal operation of the electric power supply system;

3, 4 - abnormal operation of the electric power supply system.

2. Check of Electric Loads for Influence of 27 V DC Voltage

2.1. Electric loads shall be checked for influence of the DC voltage at the steady operation of the electric power supply system in compliance with Table 17.

Table 17

**Test Cycles for DC Voltage**

| Operating conditions | Cycle No. | U, V | t, min | U, V | t, min | U, V | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|---|
| | | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| Normal | 1 | 27 | 10 | 24.0 | 10 | 29.4 | 10 | 1 |
| Emergency | 2 | | | 18.0 | | 31.0 | | |
| Abnormal | 3 | | | 31.5 | 30 | 21.0 | 30 | |
| | 4 | 15 | | 10.0 | 10 | 5.0 | 10 | |

Table 18

**Test Cycles Equivalent to Normal Values of DC Transient Voltage in Systems Fed from DC Generators**

| Cycle No. | U, V | t, min | U, V | t, s | U, V | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|
| | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| 1 | 27 | 10 | 45 | 0.10 | 27 | 10 | 3 |
| 2 | | | 0 | 0.08 | | | |
| 3 | | | 13 | 0.10 | | | |

Nos of the test cycles stand for:

1 - normal operation of the electric power supply system;

2 - emergency operation of the electric power supply system;

3, 4 - abnormal operation of the electric power supply system.

2.2. The electric load shall be checked for influence of the transient voltage during normal operation of the electric power supply system fed from generators in compliance with Table 18.

2.3. The electric load shall be checked for influence of the transient voltage during abnormal operation of the electric power supply system fed from generators in compliance with Table 19.

Table 19

**Test Cycles Equivalent to Abnormal Values of DC Transient Voltage in Systems Fed from DC Generators**

| Cycle No. | U, V | t, min | U, V | t, s | U, V | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|
| | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| 1 | 27 | 10 | 65.0 | 0.2 | 27 | 10 | 1 |
| 2 | | | 53.5 | 0.5 | | | |
| 3 | | | 41.0 | 1.0 | | | |
| 4 | | | 0 | 7.0 | | | |

2.4. The electric load shall be checked for influence of the transient voltage during normal operation of the electric power supply system fed by rectifying devices in compliance with Table 20.

Table 20

**Test Cycles Equivalent to Normal Values of DC Transient Voltage in Systems Fed by Rectifying Devices from DC Generators at Constant Frequency**

| Cycle No. | U, V | t, min | U, V | t, s | U, V | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|
| | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| 1 | 27 | 10 | 37 | 0.10 | 27 | 10 | 3 |
| 2 | | | 0 | 0.08 | | | |
| 3 | | | 13 | 0.10 | | | |

2.5. The electric load shall be checked for influence of the transient voltage during abnormal operation of the electric power supply system fed by rectifying devices in compliance with Table 21.

Table 21

**Test Cycles Equivalent to Abnormal Values of DC Transient Voltage in Systems Fed by Rectifying Devices from DC Generators at Constant Frequency**

| Cycle No. | U, V | t, min | U, V | t, s | U, V | t, min | Number of cycles |
|---|---|---|---|---|---|---|---|
| | 1st operating conditions | | 2nd operating conditions | | 3rd operating conditions | | |
| 1 | 27 | 10 | 40 | 0.2 | 27 | 10 | 1 |
| 2 | | | 37 | 0.5 | | | |
| 3 | | | 34 | 1.0 | | | |
| 4 | | | 0 | 7.0 | | | |

**APPENDIX 4**

**Obligatory**

## PERMISSIBLE NORMS OF ELECTRIC ENERGY QUALITY AT TERMINALS OF ELECTRIC LOADS DESIGNED FOR INSTALLATION ABOARD AIRCRAFT OR HELICOPTERS, WORKED OUT BEFORE JANUARY 1, 1983

### 1. 115/200 V 400 Hz AC Electric Loads

1.1. The voltage of any phase at electric load terminals shall correspond to the following values:

from 108 to 120 V - during normal or partial operation of the electric power supply system;

from 104 to 125 V - during emergency operation of the electric power supply system;

from 94 to 132 V - during abnormal operation of the electric power supply system.

1.2. The difference in values of the phase voltage (imbalance) at the terminals of three-phase electric loads shall not exceed:

4 V - for the normal or partial operation of the electric power supply system;

6 V - for the emergency operation of the electric power supply system.

1.3. Non-sinusoidality of the voltage at the steady normal or partial operation of the electric power supply system shall be so that:

the coefficient of distortion of non-sinusoidality of the voltage curve does not exceed 8 %;

the actual value of any individual highest harmonic does not exceed 5 % of the actual value of the main harmonic of the voltage;

the amplitude coefficient is equal to 1.41±0.15.

1.4. The reduced transient voltage at electric load terminals shall correspond to the limits given in Drawing 15 and Table 22:

*limits: 2 and 3 - during normal or partial operation of the electric power supply system;*

limits: 1 and 4 - during abnormal operation of the electric power supply system.

### 2. 27 V DC Electric Loads

2.1. The voltage at electric load terminals at the steady operating conditions shall correspond to the following values:

from 24.0 to 29.4 V - during normal or partial operation of the electric power supply system;

from 18.0 to 31.0 V - during emergency operation of the electric power supply system;

from 21.0 too 33.0 V - during abnormal operation of the electric power supply system.

2.2. The DC voltage ripples coefficient at the electric load terminals shall not exceed 7.4 % of the rated value.

The frequency components of the voltage ripples shall correspond to the values given in Drawing 16 and Table 23.

2.3. The reduced transient voltage at electric load terminals shall correspond to the limits given in Drawing 17 and Table 24:

limits 2 and 3 - during normal or partial operation of the electric power supply system fed from generators;

limits 1 and 4 - during abnormal operation of the electric power supply system fed from generators.

2.4. The reduced transient voltage at electric load terminals shall correspond to the limits given in Drawing 18 and Table 25:

**Limits 1-4 of Permissible Values of Stepped Characteristic**

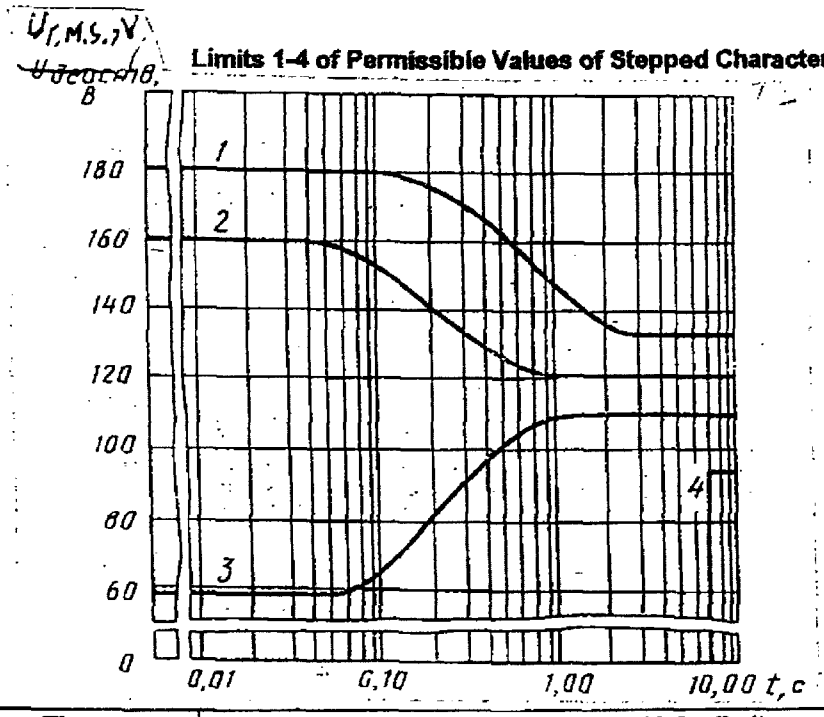
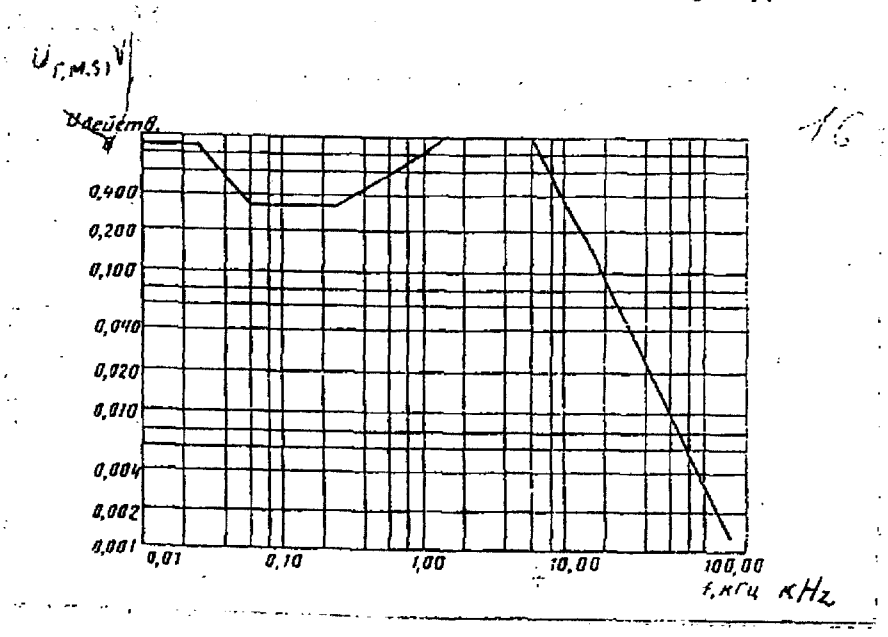



Table 22

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 180 | 160 | 58 | 0 |
| 0.02 | | | | |
| 0.05 | | | | |
| 0.10 | | 150 | 65 | |
| 0.20 | 175 | 140 | 80 | |
| 0.50 | 162 | 124 | 102 | |
| 1.00 | 148 | 120 | 108 | |
| 3.00 | 132 | | | |
| 7.00 | | | | 0-94 |

**Limit Values of Frequency Components of 27 V DC Voltage Ripples**




**Drawing 16**

Table 23

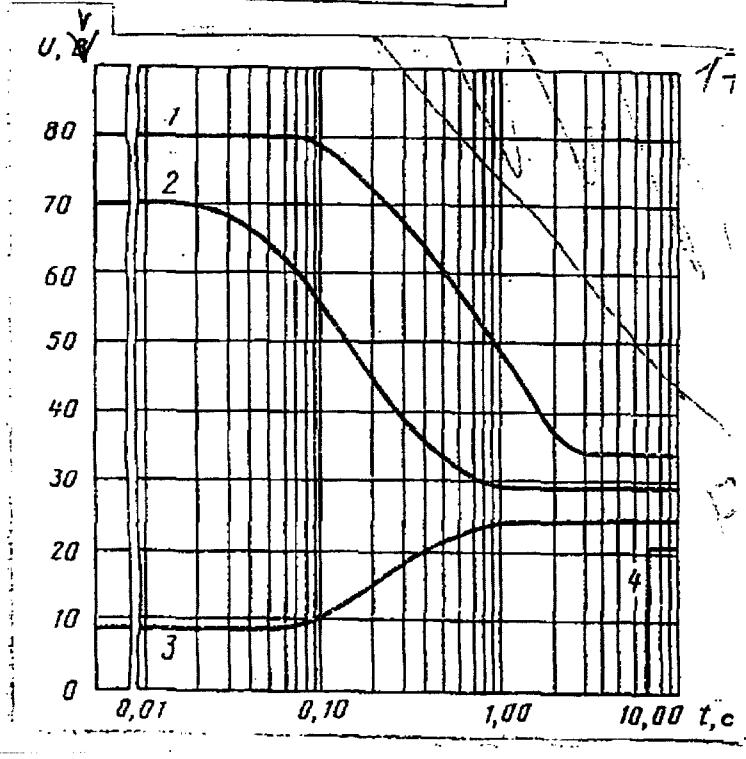
| Name of parameter | Value | | | | | | |
|---|---|---|---|---|---|---|---|
| Voltage, V | 0.9000 | 0.9000 | 0.3200 | 0.3200 | 1.0000 | 1.0000 | 0.0015 |
| Frequency, kHz | 0.010 | 0.025 | 0.060 | 0.250 | 1.700 | 6.500 | 150.000 |

## Limits 1-4 of Values of DC Reduced Transient Voltage in Systems Fed from Generators

~~Drawing 17~~

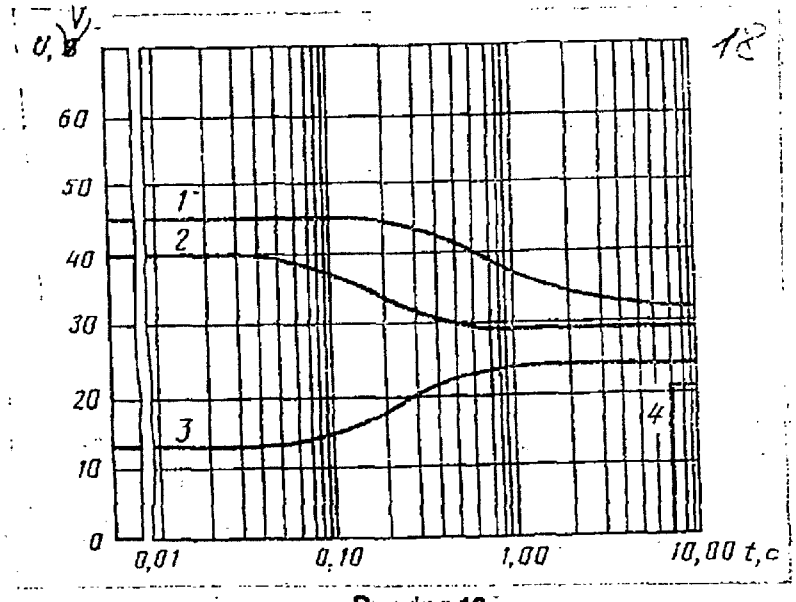
Table 24

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 80 | 70.0 | 8 | 0 |
| 0.02 | | | | |
| 0.05 | | 64.0 | | |
| 0.10 | 78 | 55.0 | 10 | |
| 0.20 | 73 | 45.5 | 15 | |
| 0.50 | 62 | 33.0 | 22 | |
| 1.00 | 49 | 29.4 | 24 | |
| 3.00 | 33 | | | |
| 7.00 | | | | 0-21 |




Drawing 17

**Limits 1-4 of Permissible Values of Stepped Characteristic of DC Transient Voltage in Systems Fed by Rectifying Devices from DC Generators at Constant Frequency**




**Drawing 18**

Table 25

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 45.0 | 40.0 | 13.0 | 0 |
| 0.02 | 45.0 | 40.0 | 13.0 | 0 |
| 0.05 | 45.0 | 39.0 | 13.5 | 0 |
| 0.10 | 45.0 | 37.0 | 15.3 | 0 |
| 0.20 | 44.0 | 33.5 | 18.5 | 0 |
| 0.50 | 40.5 | 30.0 | 22.5 | 0 |
| 1.00 | 37.0 | 29.0 | 24.0 | 0 |
| 3.00 | 33.0 | 29.0 | 24.0 | 0 |
| 7.00 | 32.0 | 29.0 | 24.0 | 0-21 |

Limits 2 and 3 - during normal or partial operation of the electric power supply system fed by *rectifying devices;*

Limits 1 and 4 - during abnormal operation of the electric power supply system fed by *rectifying devices*

**APPENDIX 5**
**Obligatory**

## PERMISSIBLE NORMS OF ELECTRIC ENERGY QUALITY AT TERMINALS OF ELECTRIC LOADS DESIGNED FOR INSTALLATION ABOARD AIRCRAFT OR HELICOPTERS, WORKED OUT BEFORE JANUARY 1, 1990

### 1. 115/200 V 400 Hz AC Electric Loads

1.1. The voltage of any phase at electric load terminals shall correspond to the following values:

from 108 to 119 V - during normal or partial operation of the electric power supply system;

from 102 to 124 V - during emergency operation of the electric power supply system;

from 97 to 134 V - during abnormal operation of the electric power supply system.

1.2. Non-sinusoidality of the voltage at the steady normal or partial operation of the electric power supply system shall be so that:

the coefficient of distortion of non-sinusoidality of the voltage curve does not exceed 8 %;

the actual value of any individual highest harmonic does not exceed 5 % of the actual value of the main harmonic of the voltage;

the amplitude coefficient is equal to 1.41±0.15.

1.3. The reduced transient voltage at electric load terminals shall correspond to the limits given in Drawing 19 and Table 26:

limits: 2 and 3 - during normal or partial operation of the electric power supply system;

limits: 1 and 4 - during abnormal operation of the electric power supply system.

### 2. 27 V DC Electric Loads

2.1. The voltage at electric load terminals at the steady operating conditions shall correspond to the following values:

from 24.0 to 29.4 V - during normal or partial operation of the electric power supply system;

from 18.0 to 31.0 V - during emergency operation of the electric power supply system;

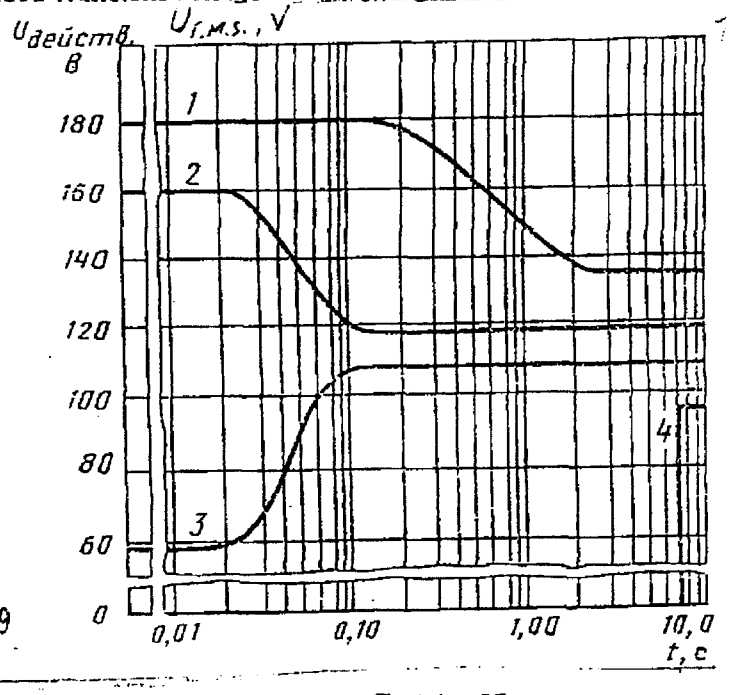
from 21.0 too 33.0 V - during abnormal operation of the electric power supply system.

2.2. The DC voltage ripples coefficient at the electric load terminals shall not exceed 7.4 % of the rated value.

The frequency components of the voltage ripples shall correspond to the values given in Drawing 16 and Table 23.

2.3. Reduced transient voltage at electric load terminals shall correspond to the limits given in Drawing 20 and Table 27:

**Limits 1-4 of Values of AC Reduced Transient Voltage**

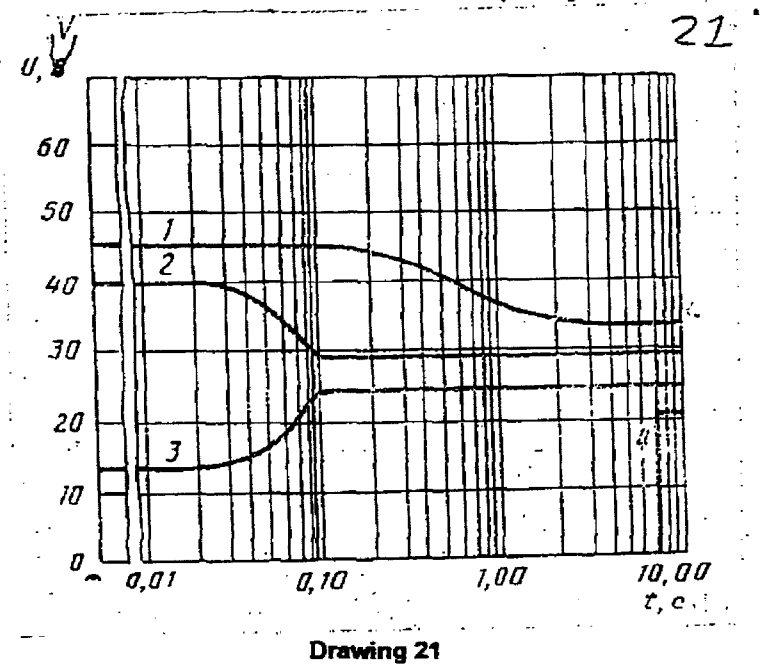



Drawing 19

Table 25

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 180 | 160 | 58 | 0 |
| 0.02 | | | | |
| 0.05 | | 139 | 86 | |
| 0.10 | | 119 | 108 | |
| 0.20 | 175 | | | |
| 0.50 | 162 | | | |
| 1.00 | 148 | | | |
| 3.00 | 134 | | | |
| 7.00 | | | | 0-97 |

**Limits of Values of DC Reduced Transient Voltage in Systems Fed by Rectifying Devices from AC Generators at Constant Frequency**




**Drawing 21**

Table 28

| Time, s | Voltage, V, for limit | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.01 | 45.0 | 40.0 | 13 | 0 |
| 0.02 | | | | |
| 0.05 | | 37.0 | 17.0 | |
| 0.08 | | 31.0 | 22.5 | |
| 0.10 | | 29.4 | 24.0 | |
| 0.20 | 44.0 | | | |
| 0.50 | 40.5 | | | |
| 1.00 | 37.0 | | | |
| 3.00 | 33.0 | | | |
| 7.00 | | | | 0-21 |

limits 2 and 3 - during normal or partial operation of the electric power supply system fed from generators;

limits 1 and 4 - during abnormal operation of the electric power supply system fed from generators.

2.4. The reduced transient voltage at electric load terminals shall correspond to the limits given in Drawing 21 and Table 28:

limits 2 and 3 - during normal or partial operation of the electric power supply system fed by rectifying devices;

limits 1 and 4 - during abnormal operation of the electric power supply system fed by rectifying devices.