MIL-STD-704C
30 DECEMBER 1977
SUPERSESSION DATA
(SEE 6.1)

MILITARY STANDARD

AIRCRAFT ELECTRIC POWER CHARACTERISTICS

FSC MISC

DEPARTMENT OF DEFENSE
Washington, DC 20301

AIRCRAFT ELECTRIC POWER CHARACTERISTICS

MIL-STD-704C

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst, New Jersey 08733 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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TABLES

FIGURES

1. SCOPE

This standard establishes requirements for electric power characteristics on aircraft at the interface between the electric power system and the input to electric utilization equipment. The electric power characteristics covered by this standard are of duration longer than 50 microseconds or frequencies less than 20 kilohertz. Electric power characteristics of less than 50 microseconds or frequencies greater than 20 kilohertz are covered by the Military Specification for Electromagnetic Compatibility Requirements, Systems (MIL-E-6051).

2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on date of invitation for bids, form a part of this standard to the extent specified herein.

SPECIFICATIONS

Military

MIL-E-6051	Electromagnetic Compatibility Requirements, Systems

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the Contracting Officer.)

STANDARDS

Industry

IEEE STD-100-1972	IEEE Standard Dictionary of Electrical and Electronic Terms

2.1.1 Addresses for documents referenced herein, not obtainable from the Government, are as follows:

IEEE	Institute of Electrical & Electronics Engineers, Incorporated 345 East 47th Street New York, New York 10017

3. DEFINITIONS

3.1 Definitions of terms not explicitly treated are as given by IEEE Standard Dictionary of Electrical and Electronic Terms.

3.2 AC voltage. The term ac voltage refers to the gross, root mean square (rms) phase to neutral value unless otherwise designated.

3.3 Crest factor. The crest factor of the ac voltage waveform is defined as the ratio of the peak to rms value.

3.4 Distortion. AC distortion is the rms value of the ac waveform exclusive of the fundamental. AC distortion includes the components resulting from amplitude modulation as well as harmonic and non-harmonic components. In a dc system, distortion is the rms of the superimposed alternating voltage.

3.4.1 Distortion factor. The ac distortion factor is the ratio of the ac distortion to the rms value of the fundamental component. The dc distortion factor is the ratio of the dc distortion to the average dc voltage.

3.4.2 Distortion spectrum. The distortion spectrum quantifies ac distortion and dc distortion in terms of the amplitude of each frequency component. The distortion spectrum includes the components resulting from amplitude and frequency modulation as well as harmonic and non-harmonic components of the ac waveform.

3.5 Emergency operation. The emergency operation is that condition of the electric system whereby a limited electric source, independent of the main generation equipment, is used to power a selected, reduced complement of distribution and utilization equipment.

3.6 Frequency. Frequency is equal to the reciprocal of the alternation period of the fundamental of the ac voltage. The unit of frequency is the number of alternations per second of the ac voltage and is designated hertz (Hz).

3.6.1 Nominal frequency. The nominal frequency is 400 Hz.

3.6.2 Frequency drift. Frequency drift is the slow and random variation of the controlled frequency level within steady state limits due to such influences as environmental effects and aging.

3.6.2.1 Frequency drift rate. The frequency drift rate is the time rate of frequency change due to frequency drift.

3.6.3 Frequency deviation. Frequency deviation is defined as difference between maximum and minimum values of 1/T, where T is the period of one cycle of the fundamental of the phase voltage. The rate at which 1/T values repeat cyclically is called the rate of frequency change.

3.6.4 Frequency transient. The frequency transient is the locus of values defined by the reciprocals of sequential alternation periods of the ac voltage, in instances when the frequency departs from the steady-state value.

3.7 Overvoltage and undervoltage. Overvoltage and undervoltage are those voltages which exceed the combined steady state and transient limits and are terminated by the action of protective devices.

3.8 Protected operation. The protected operation is that condition of the electric system wherein a malfunction or failure in the electric system has taken place and the protective devices of the electric system are operating to remove the malfunction or failure from the remainder of the system.

3.9 Ripple amplitude. The ripple amplitude is the maximum value of the difference between the average and the instantaneous values of a pulsating unidirectional wave. (See 2.1, IEEE Standard.)

3.10 Starting operation. The starting operation is that condition of the electric system during starting of the aircraft propulsion engines.

3.11 Steady state. A steady state condition of the characteristics is one in which the characteristic shows only negligible change throughout an arbitrarily long period of time.

3.12 Transfer operation. The transfer operation is that condition of the electric system which takes place when a transfer is taking place between power sources, including transfers from or to external power sources.

3.13 Utilization equipment. Utilization equipment is that which receives power from the electric power system.

3.13.1 Utilization equipment terminals. Utilization equipment terminals are the terminals through which the electric power system is connected to the utilization equipment. Power interconnections within the utilization equipment or equipment system are excluded.

3.14 Voltage phase difference. The voltage phase difference is the difference in electrical degrees between the fundamental components of any two phase voltages taken at consecutive zero or dc level crossings of their instantaneous values traced in the negative to positive direction.

3.15 Voltage unbalance. Voltage unbalance is defined as the maximum difference among phase voltage magnitudes at the utilization equipment terminals.

4. GENERAL REQUIREMENTS

4.1 Aircraft power system requirements.

4.1.1 Power system performance. The aircraft electric power system shall present the electric power characteristics as specified in this standard at the power input connections of the aircraft electric utilization equipment during all operations of the power system including operations from externally supplied power sources.

4.1.2 Emergency and starting performance disconnect. During aircraft emergency or starting operations the aircraft electric power system shall automatically disconnect all utilization equipment whose specifications do not include requirements for emergency or starting performance, unless the aircraft electric power system provides the full performance characteristics specified herein during the aircraft emergency or starting conditions.

4.2 Aircraft utilization equipment requirements.

4.2.1 Full performance. When supplied electric power characteristics as stated herein for full performance, each utilization equipment shall provide the full performance required by its specification.

4.2.2 Protected and transfer performance. When supplied electric power characteristics as stated herein for protected or transfer performance, each utilization equipment:

a. shall be permitted a degradation or loss of function unless required otherwise by its specification, and

b. shall not produce a damaging or unsafe condition, and

c. shall automatically recover full specified performance when the electric power characteristics are restored to the full performance limits herein.

4.2.3 Emergency and starting performance. When the detail specification for the utilization equipment requires operation during emergency or starting conditions, then the utilization equipment shall provide the full performance required by its detail specification when supplied electric power characteristics as stated herein for emergency or starting performance.

4.2.4 Partial power failure. The failure of one or more phases of ac power or the loss of power to any input terminals of equipment which require ac and dc power shall not result in an unsafe condition.

4.2.5 AC phase power utilization. Loads greater than 0.5 KVA utilizing ac power shall be configured to utilize 3 phase steady state balanced power within the limits of Figure 1. Single phase power shall be used only on a line-to-neutral basis.

5. DETAIL REQUIREMENTS

5.1 Transfer performance characteristics. Under conditions of bus or power source transfers, voltage shall be between zero volts and full performance characteristics for no longer than 50 milliseconds.

5.2 AC power characteristics.

5.2.1 Type system. AC power characteristics are those of a single-phase or three-phase wye-connected neutral or ground return system having a nominal voltage of 115/200 volts and a nominal frequency of 400 Hz. The only alternate standard is a nominal 230/400 volts when specifically authorized. The voltage magnitude limits for the 115/200 volts standard shall apply proprotionally to the 230/400 volts standard. The power characteristics specified herein can take place on each phase independent of other phases unless otherwise stated.

5.2.2 Phase sequence. The phase sequence shall be A-B-C corresponding to aircraft wire designations, see Figure 2.

5.2.3 AC full performance characteristics.

5.2.3.1 AC steady state characteristics. The ac steady state characteristics shall be in accordance with Table I.

5.2.3.2 AC transient characteristics.

5.2.3.2.1 AC voltage transients. The ac voltage transients shall be within the limits of Figure 5.

5.2.3.2.2 AC frequency transient.

5.2.3.2.2.1 Transient limits. The ac frequency transients shall be within the limits of Figure 6.

5.2.3.2.2.2 Frequency change rate. The rate of frequency change shall not exceed 500 Hz/seconds for any period greater than 15 milliseconds.

5.2.4 AC protected performance characteristics.

5.2.4.1 AC overvoltage and undervoltage. The ac overvoltage and undervoltage values shall be within the limits of Figure 7.

5.2.4.2 AC overfrequency and underfrequency. The ac overfrequency and underfrequency values shall be within the limits of Figure 8.

5.2.5 AC emergency or starting performance. All electric power characteristics in ac emergency or starting operations shall be the same as for full performance except for steady state voltage and steady state frequency.

5.2.5.1 AC emergency or starting steady state voltage. The ac steady state voltage in the emergency or starting operation shall be within 104 to 122 volts.

5.2.5.2 AC emergency or starting steady state frequency. The ac steady state frequency in the emergency or starting operations shall be within 360 to 440 hertz.

5.3 DC power characteristics.

5.3.1 Type system. DC power characteristics are those of a direct current, two-wire or ground return system having a nominal voltage of 28 volts. The only alternate standard is a nominal 270 volts when specifically authorized.

5.3.2 DC full performance characteristics. The dc full performance characteristics shall be in accordance with Table II.

5.3.3 DC protected performance characteristics.

5.3.3.1 28 volts system. The dc overvoltage and undervoltage values for the 28 volts (nominal) system shall be within the limits of Figure 12.

5.3.3.2 270 volts system. The dc overvoltage and undervoltage values for the 270 volts (nominal) system shall be within the limits of Figure 13.

5.3.4 DC emergency or starting steady state voltage.

5.3.4.1 28 volts (nominal) system. The dc steady state voltage in the emergency or starting operation shall be within 16.0 to 30.0 volts.

5.3.4.2 270 volts (nominal) system. The dc steady state voltage in the emergency or starting operation shall be within 240 to 290 volts.

6. NOTES

The material in this section is not a mandatory part of this standard.

6.1 Supersession data. MIL-STD-704C supersedes MIL-STD-704B dated 17 November 1975, for new system designs. MIL-STD-704A and MIL-STD-704B may be used for existing systems applications or reordered equipment. Users of MIL-STD-704 are reminded that existing applications may require a continued use of MIL-STD-704A dated 9 August 1966, and MIL-STD-704B dated 17 November 1975. MIL-STD-704A and MIL-STD-704B issue with its associated amendments should be retained.

6.2 International Standardization Agreement. Certain provisions of this standard are subject to international standardization agreements: NATO STANAG 3456, NATO STANAG 3516, ASCC Air Standard 12/10, and Air Standard 12/19. When amendment, revision or cancellation of this standard is proposed, that will affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, including departmental offices, if required.

6.3 Changes from the previous issue. Asterisks are normally used to identify changes from the previous issue of a Military document. Because of the extensiveness of this revision, this practice has not been followed in this issue.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Preparing activity:
Navy - AS
(Project No. MISC-0B91)

Table I.

AC Steady State Characteristics (See 5.2.3.1)

Characteristics	Limits
Voltage	108.0 to 118.0 volts
Voltage unbalance	3 volts maximum
Voltage phase difference	116° to 124°
Waveform distortion factor	0.05 maximum
Waveform distortion spectrum	Figure 3
Crest factor	1.31 to 1.51
DC component	+0.10 to -0.10 volts
Frequency	393 to 407 hertz
Frequency deviation	Figure 4
Frequency drift rate	15 hertz per minute maximum

Table II.

DC Full Performance Characteristics (See 5.3.2)

Characteristic	Limits	
	28 volts (nominal) system	270 volts (nominal) system
Steady state voltage	22.0 to 29.0 volts	250 to 280 volts
Distortion factor	0.035 maximum	0.008 maximum
Distortion spectrum	Figure 9	Figure 9
Ripple amplitude	1.5 volts maximum	6.0 volts maximum
Voltage transient	Figure 10	Figure 11

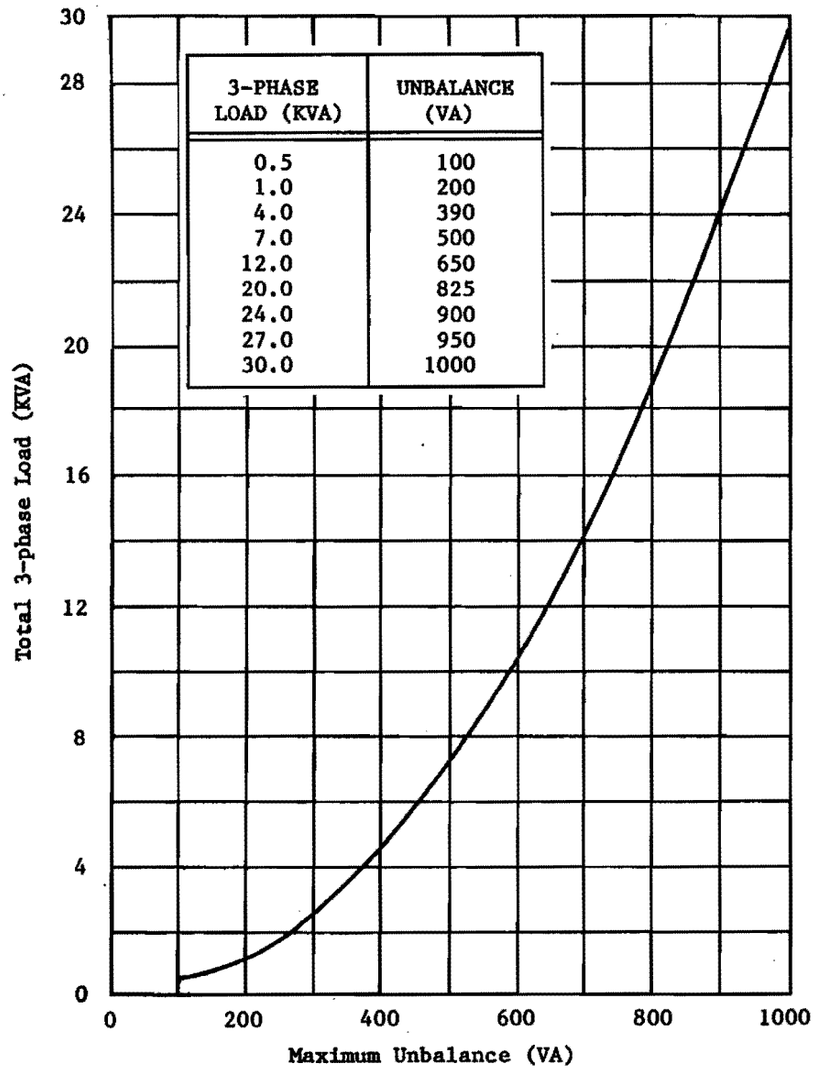


Figure 1. Unbalance Limits for 3-Phase Utilization Equipment (See 4.2.5)

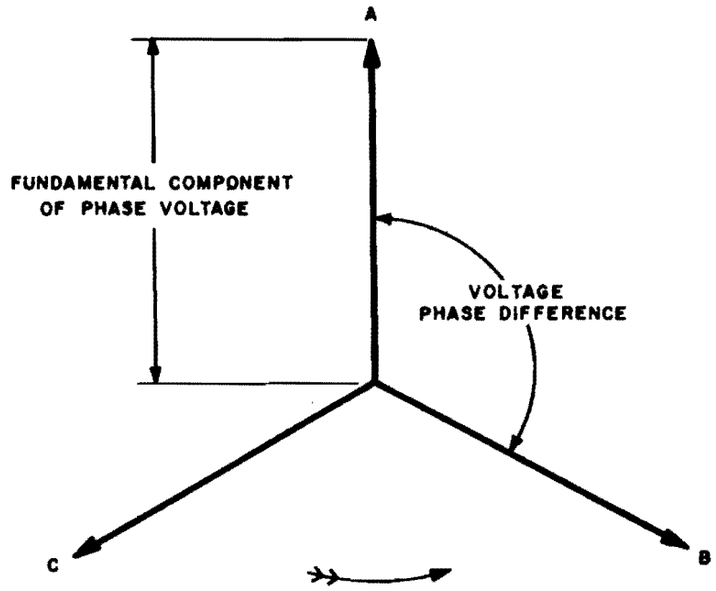


Figure 2. Phasor Diagram Showing Required Phase Sequence Relationship (See 5.2.2)

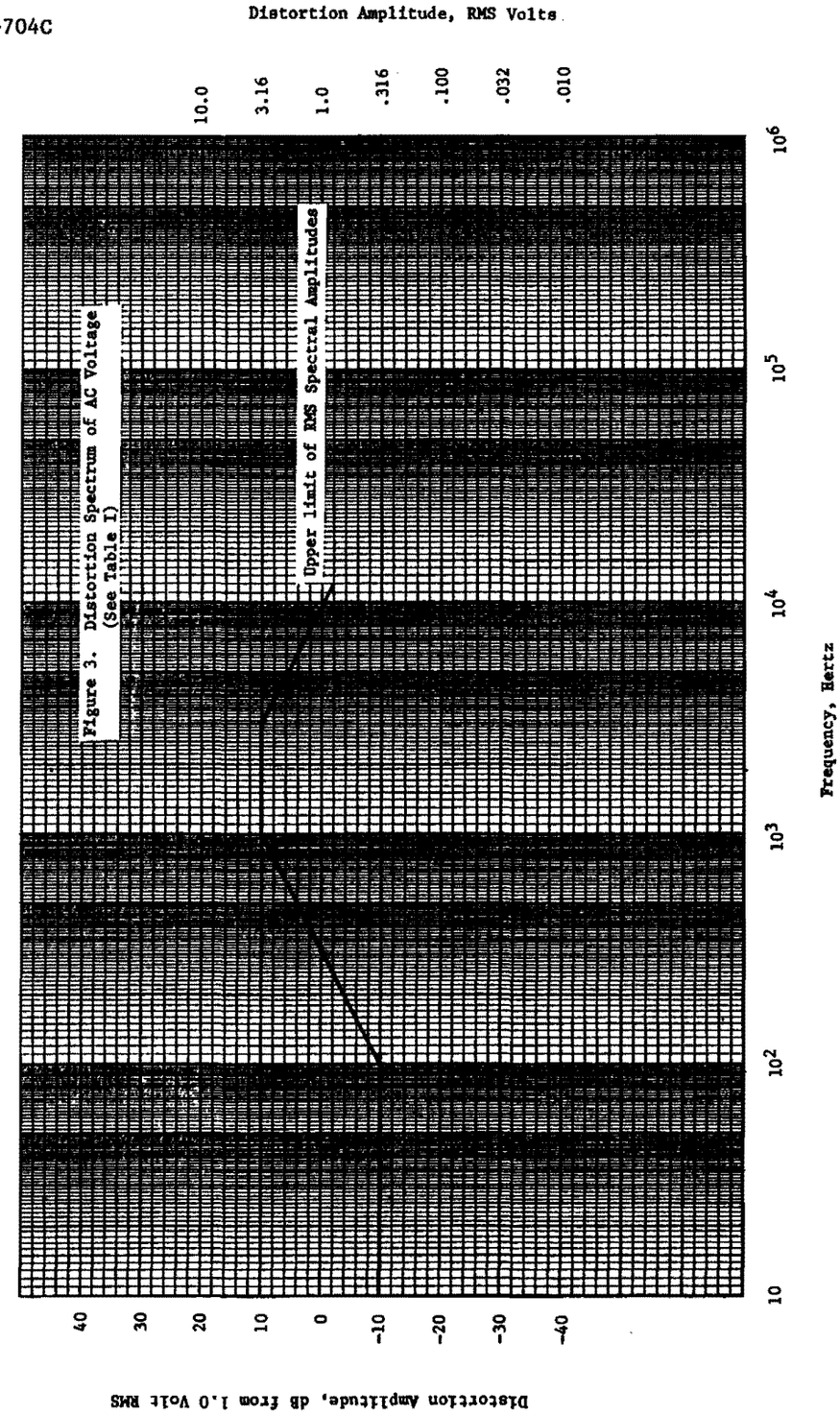


Figure 3. Distortion Spectrum of AC Voltage (See Table I)

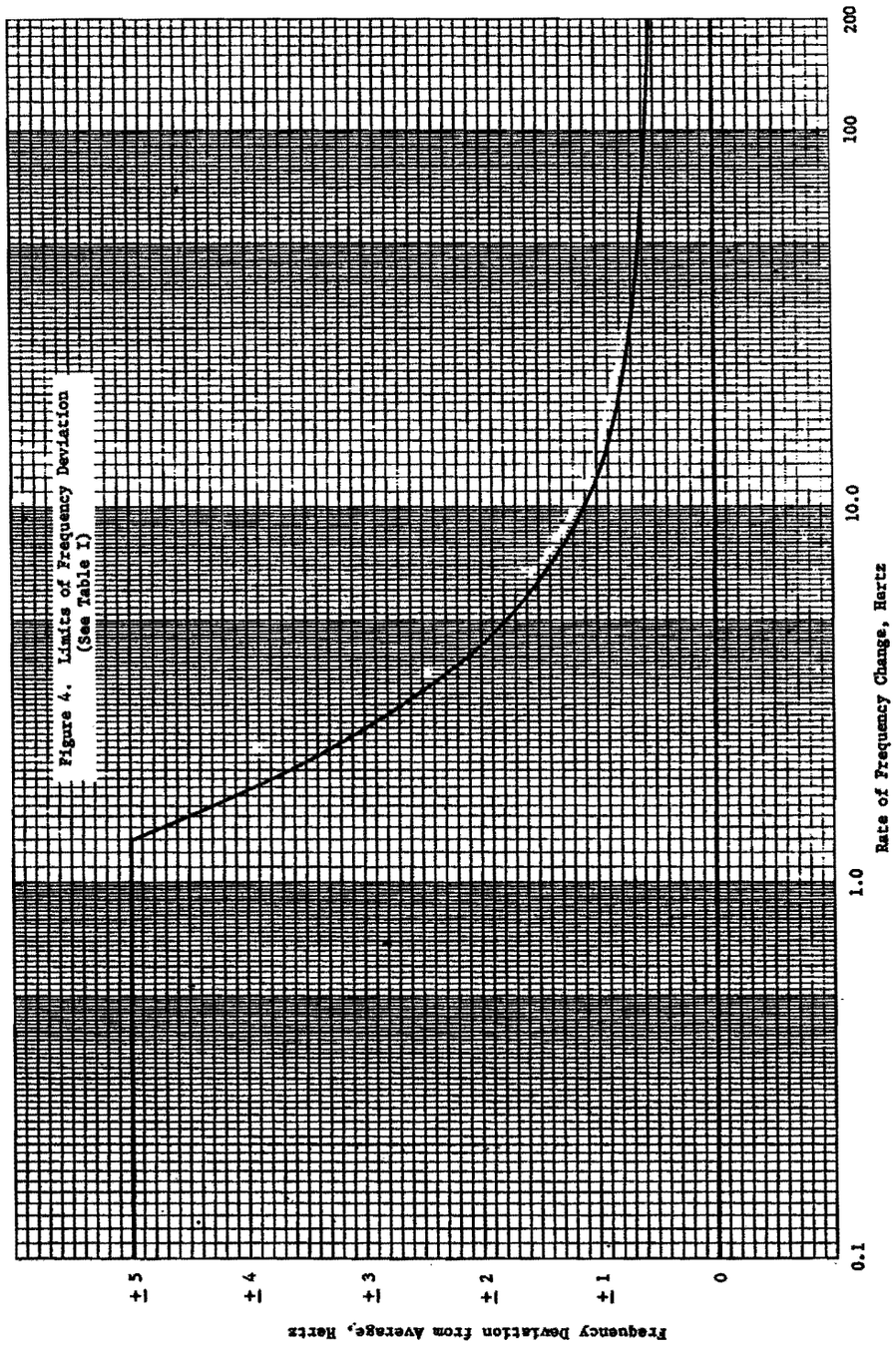


Figure 4. Limits of Frequency Deviation (See Table I)

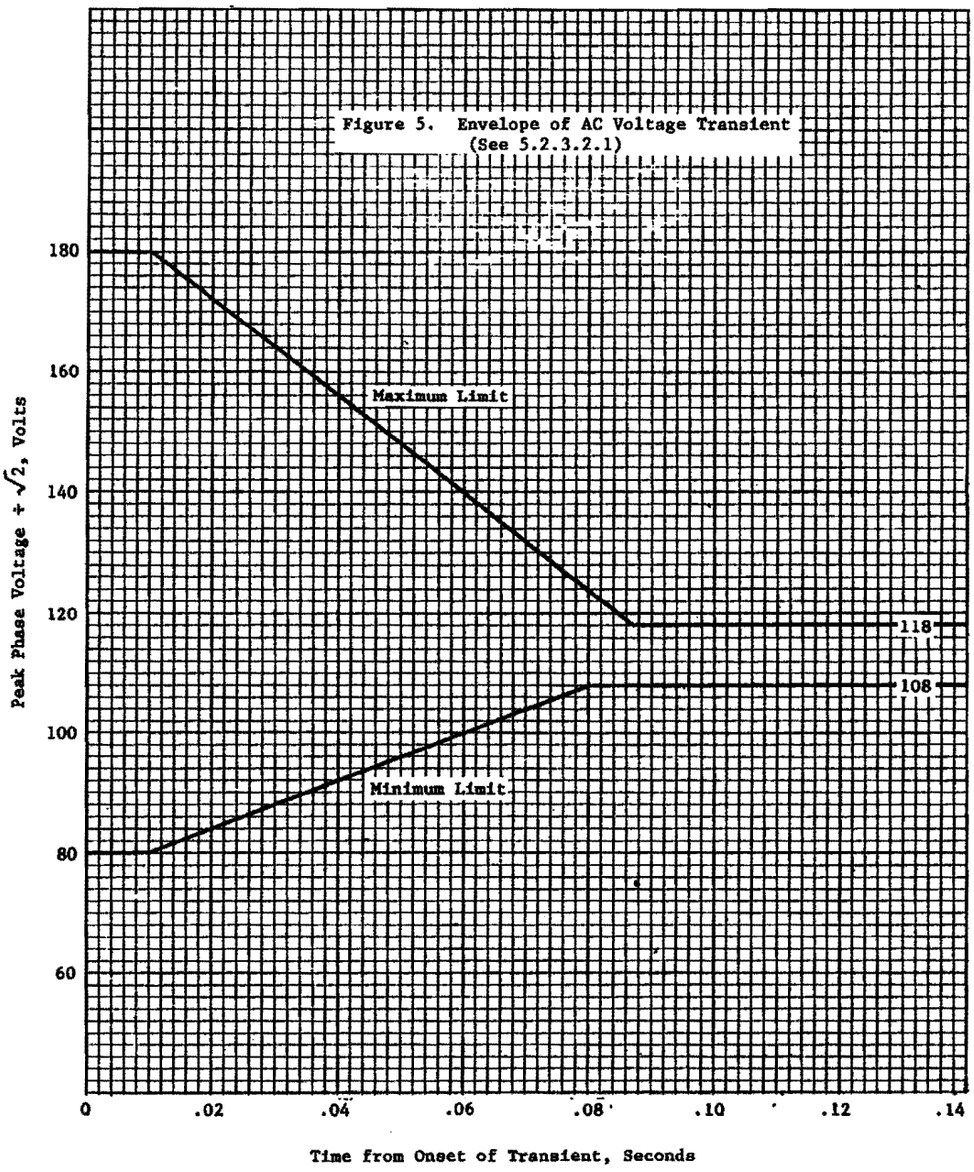


Figure 5. Envelope of AC Voltage Transient
(See 5.2.3.2.1)

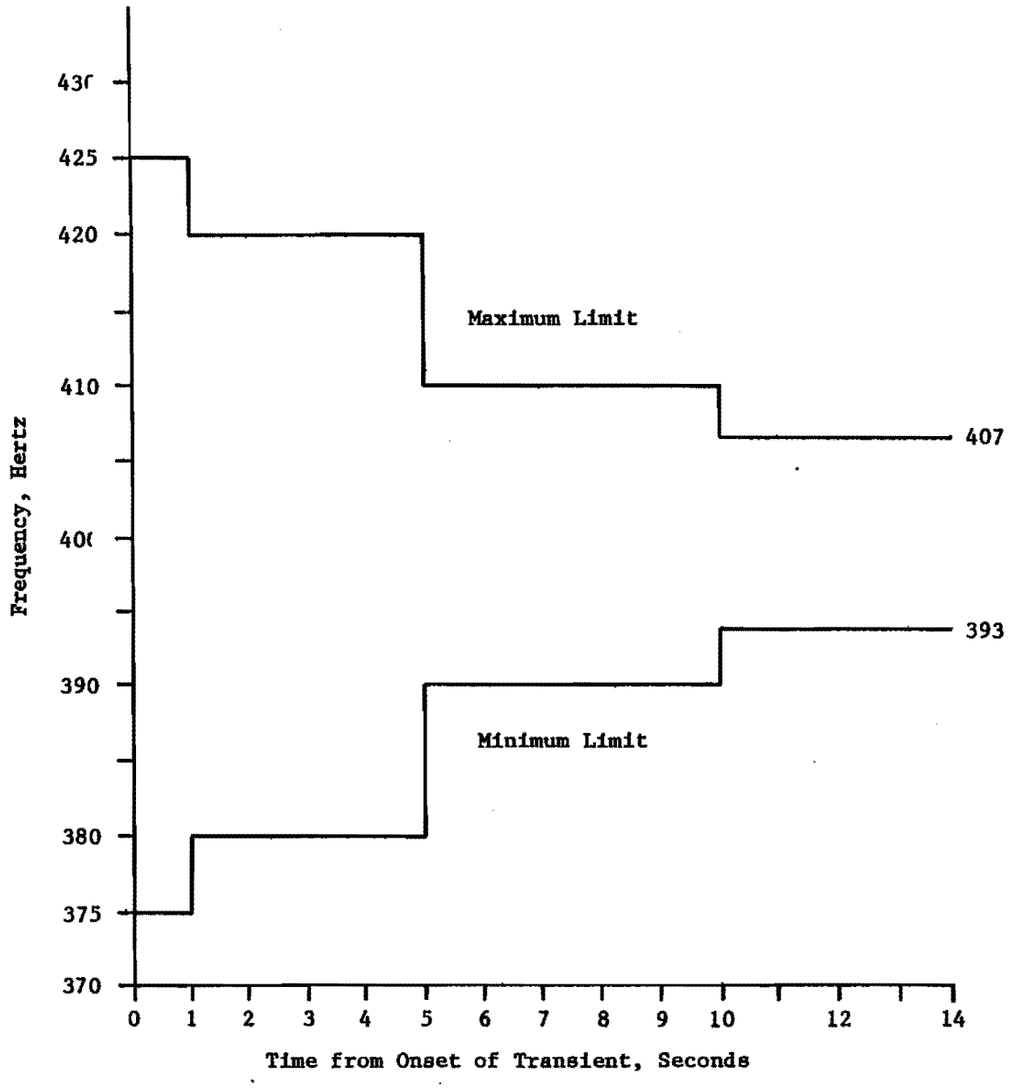
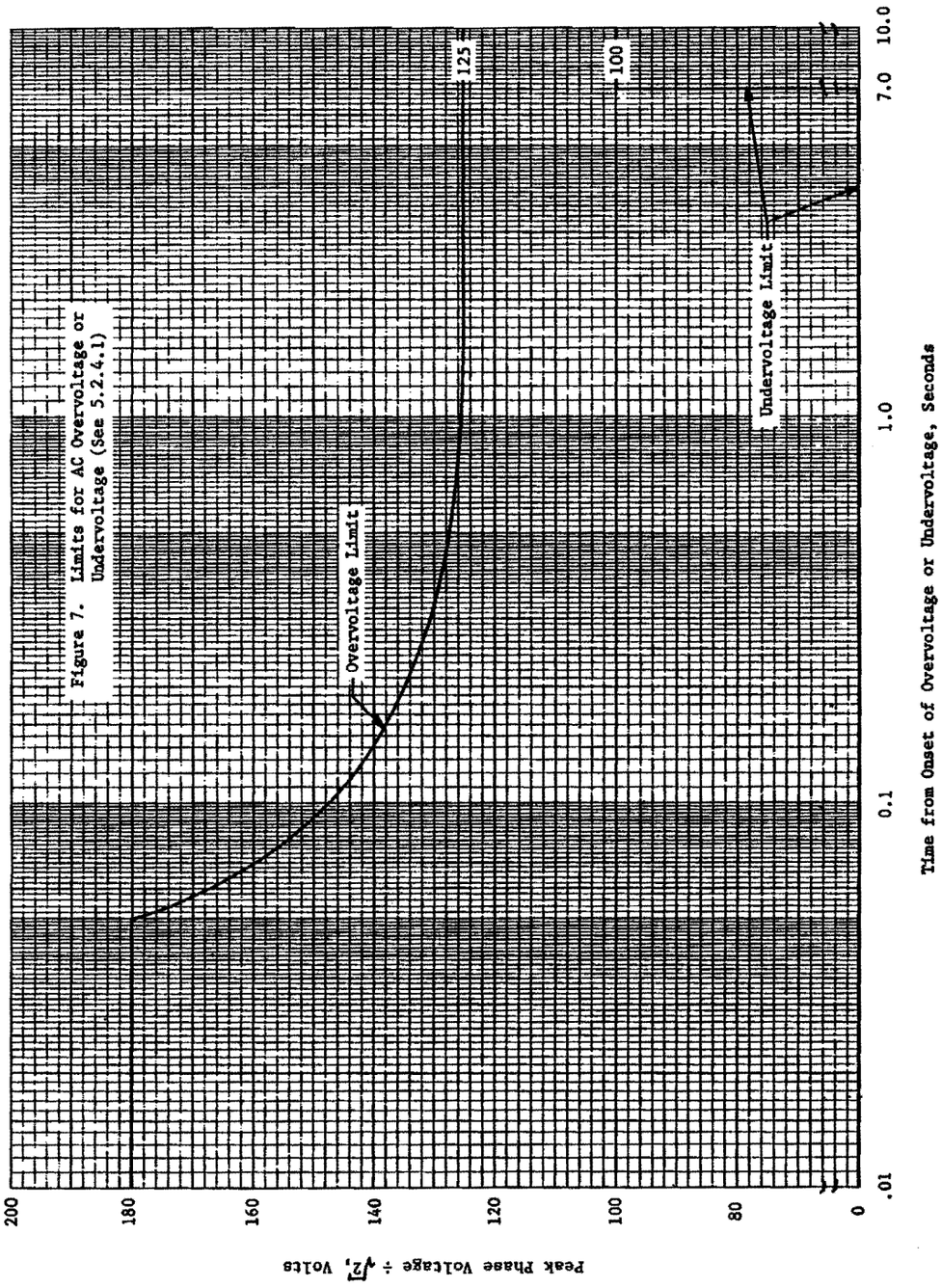


Figure 6. Envelope of AC Frequency Transient
(See 5.2.3.2.2.1)



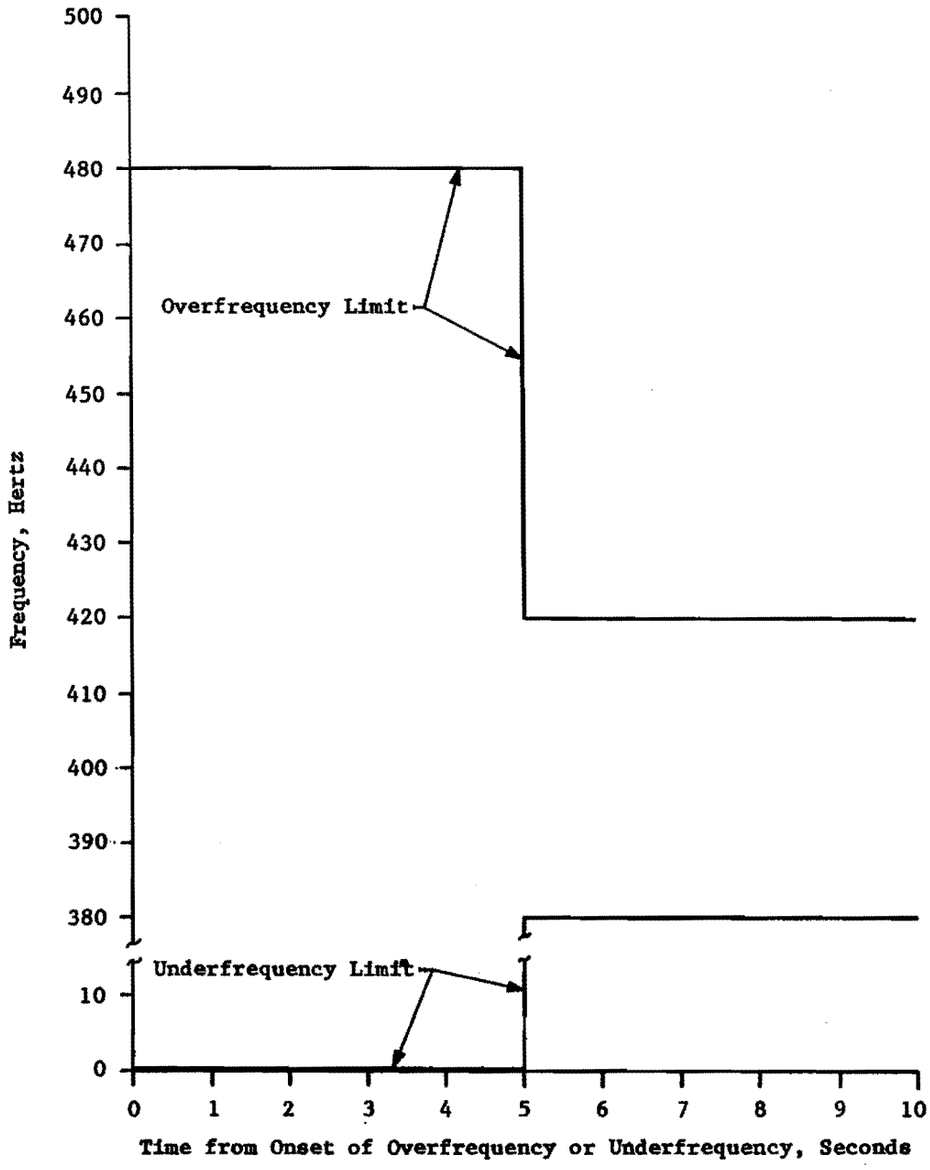


Figure 8. Limits for AC Overfrequency or Underfrequency (See 5.2.4.2)

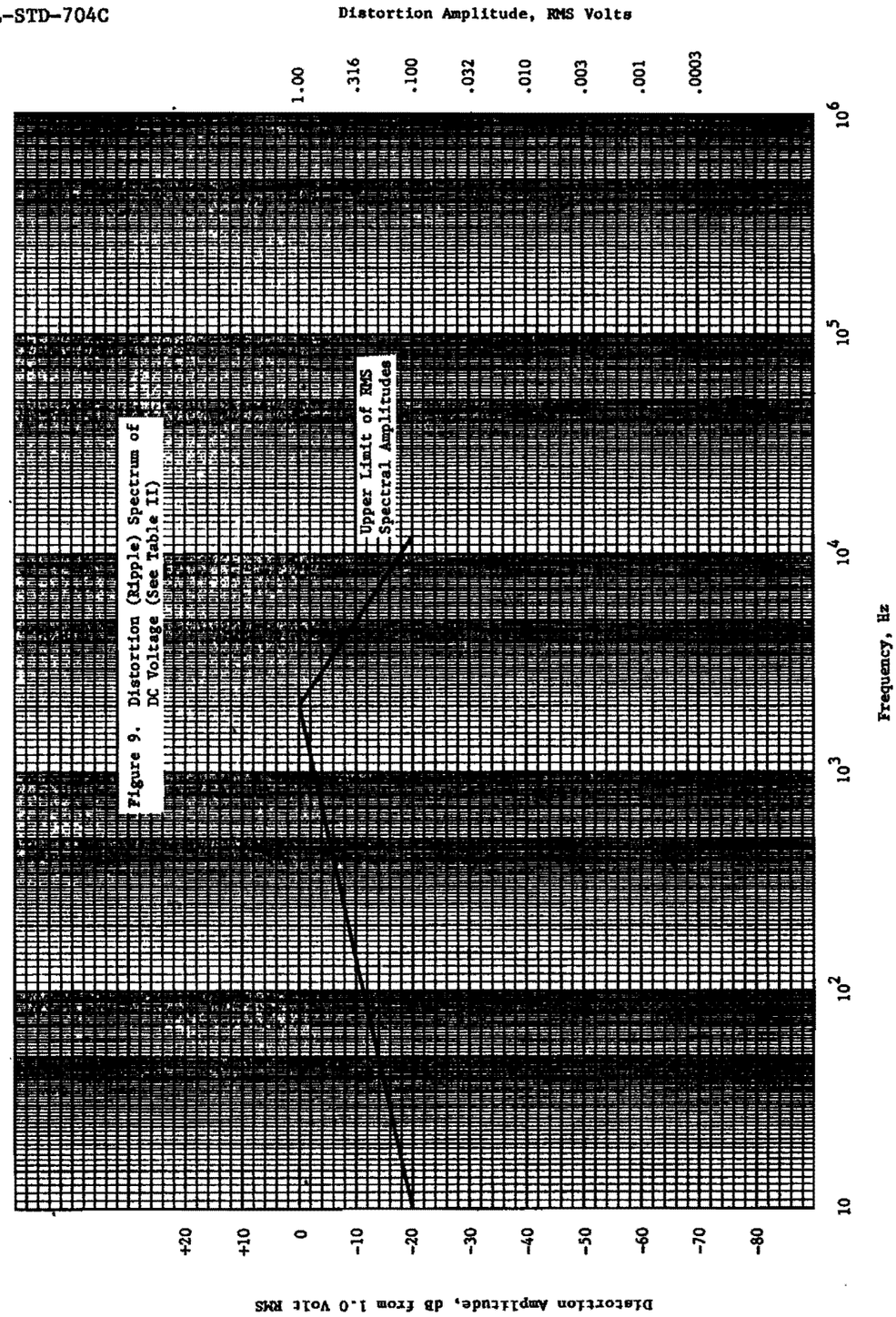


Figure 9. Distortion (Ripple) Spectrum of DC Voltage (See Table II)

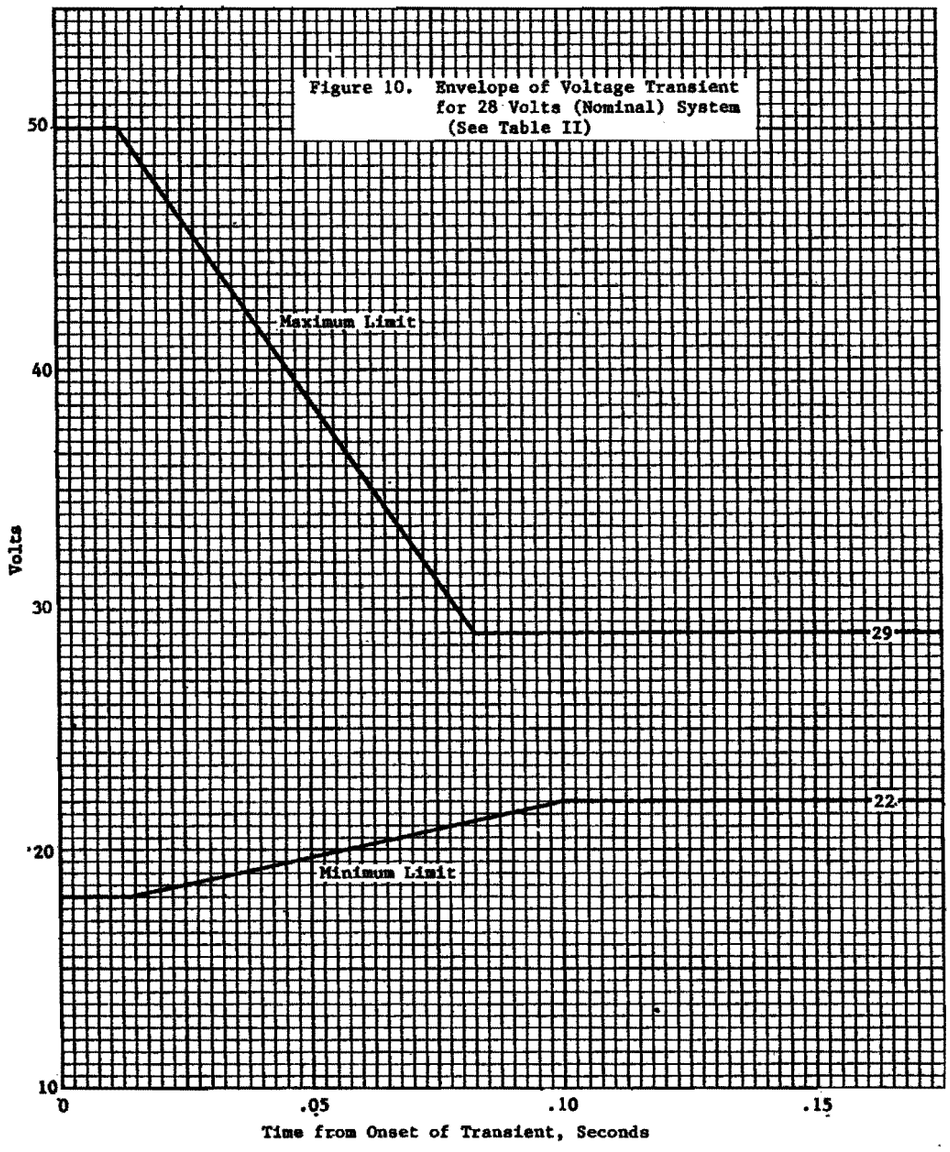


Figure 10. Envelope of Voltage Transient for 28 Volts (Nominal) System (See Table II)

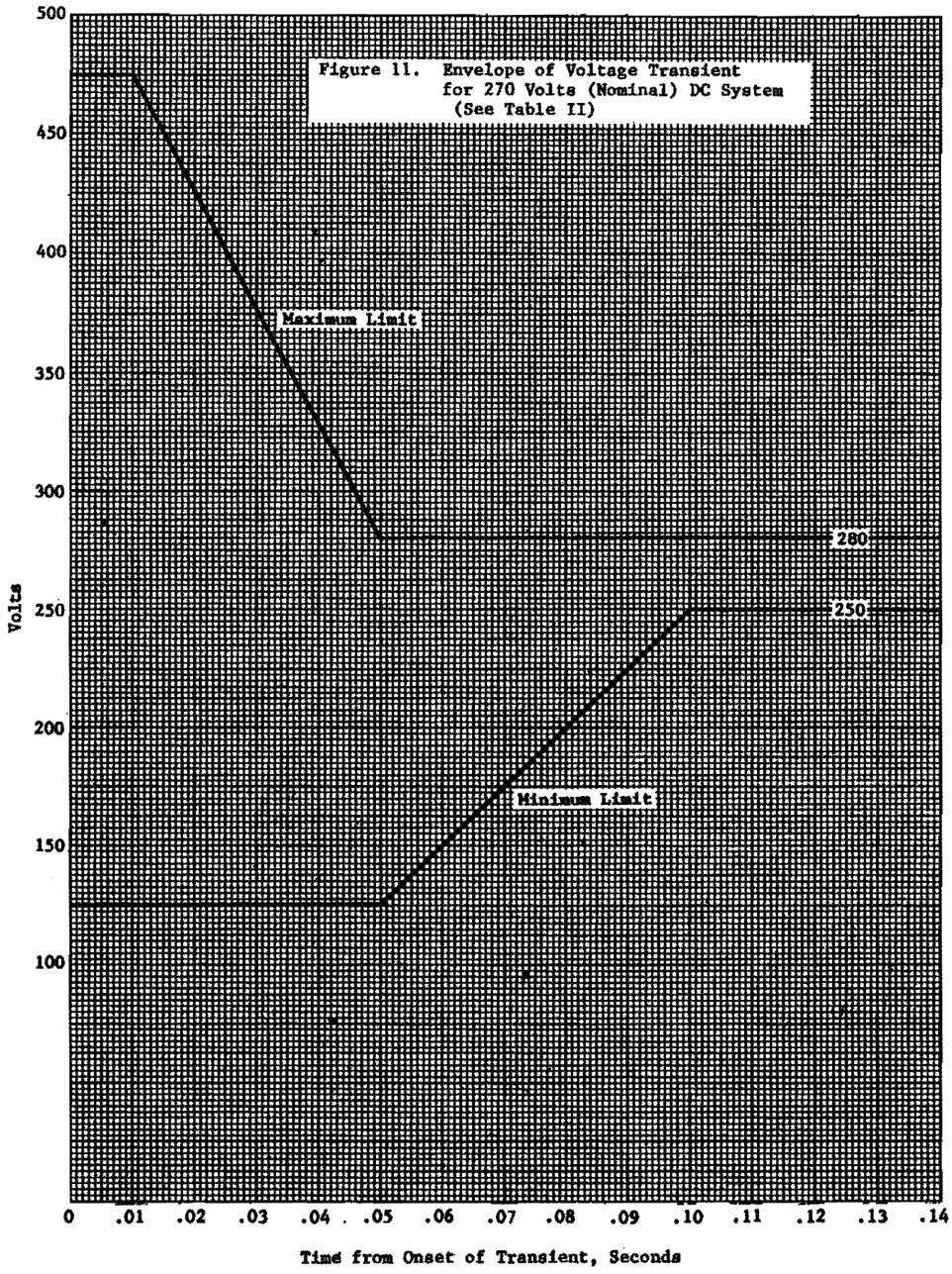


Figure 11. Envelope of Voltage Transient for 270 Volts (Nominal) DC System (See Table II)

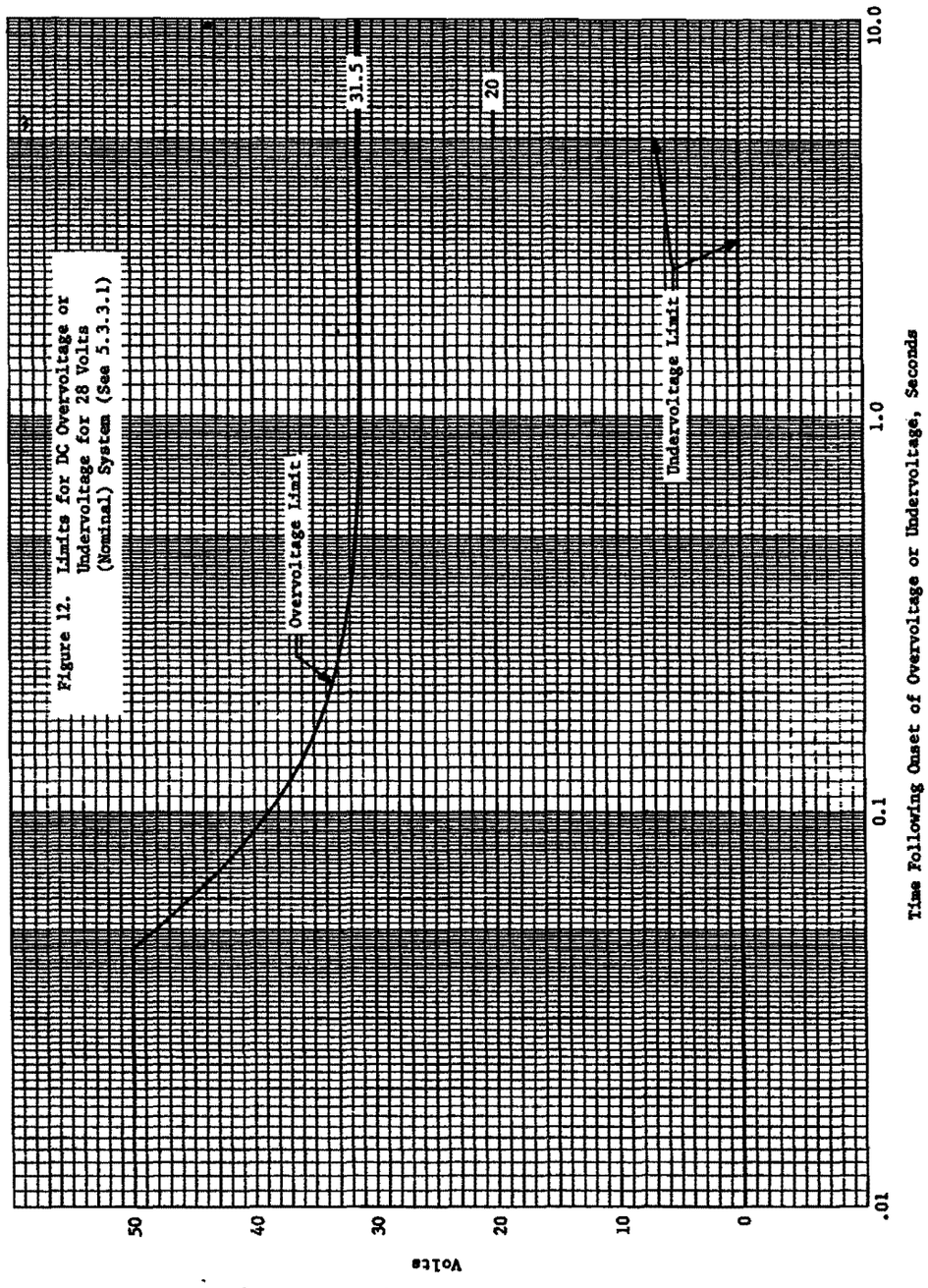


Figure 12. Limits for DC Overvoltage or Undervoltage for 28 Volts (Nominal) System (See 5.3.3.1)

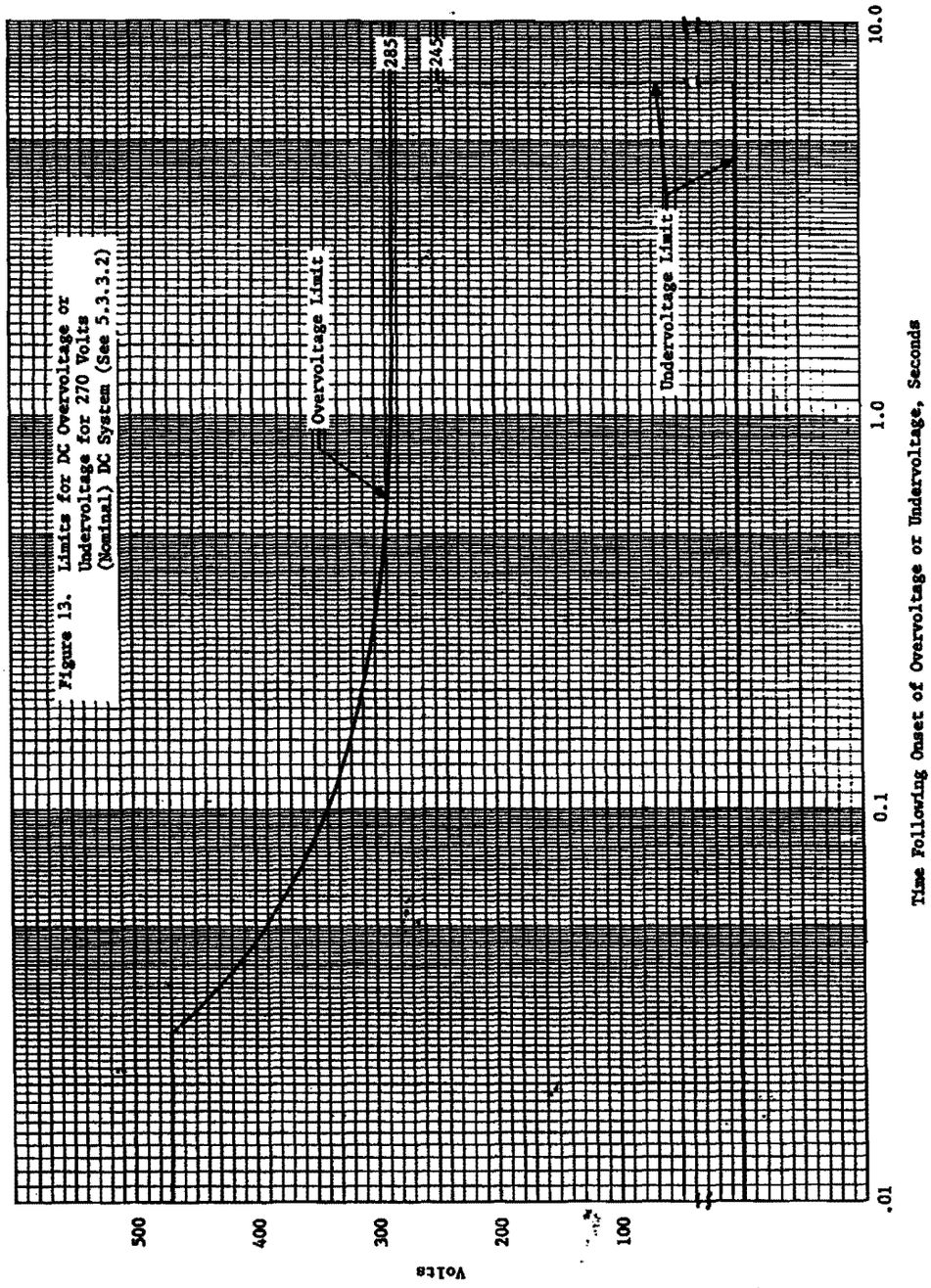


Figure 13. Limits for DC Overvoltage or Undervoltage for 270 Volts (Nominal) DC System (See 5.3.3.2)