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AERONAUTICAL DESIGN STANDARD

INTERFACE STANDARD

AIRCRAFT ELECTRICAL POWER CHARACTERISTICS

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AERONAUTICAL DESIGN STANDARD
AIRCRAFT ELECTRICAL POWER CHARACTERISTICS

UNITED STATES ARMY AVIATION AND MISSILE COMMAND
AVIATION ENGINEERING DIRECTORATE
REDSTONE ARSENAL, ALABAMA

FUNCTIONAL DIVISION:

David B. Cripps
Chief, Mission Equipment Division

SUBMITTED BY:

Dr. William D. Lewis
Acting Director of Aviation Engineering

APPROVED BY:

KENNETH E. DULANEY
AMCOM and PEO, Aviation
Standards Executive

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Acting Director, Aviation Engineering Dr. William D. Lewis	✓		5/17/06
AMCOM and PEO, Aviation Standards Executive Kenneth E. Dulaney	✓		5/23/06

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1. SCOPE.

1.1 Introduction. The characteristics of Army helicopter electrical power have been governed by MIL-STD-704, which is a DoD interface standard that establishes the requirements and characteristics of aircraft electric power provided at the input terminals of electrical electronic utilization equipment. As new helicopters have emerged over the years, different versions of MIL-STD-704 have been applied to different type/model/series aircraft according to the latest version at the time of procurement. Some of the electrical characteristics specified by the different versions of MIL-STD-704 have remained fairly constant, while others have changed significantly. Table I describes the various versions of MIL-STD-704 that were cited in contractual documents for those aircraft. It should be noted that the quality of individual aircraft electrical power may be better than (or worse than) that required by the specified version of MIL-STD-704. There is generally no contractual obligation to maintain the "better than" state, and testing usually only documents whether the aircraft meets the requirements. It typically does not measure the actual performance. Unless deviations from MIL-STD-704 are reflected in appropriate contractual documents, it is not included here. (In the case of fixed-wing aircraft, the Army has normally bought these aircraft off-the-shelf with the electrical power characteristics of the basic aircraft being governed by RTCA/DO-160. In some instances, modifications to the aircraft have been required as a result of the addition of military hardware designed for MIL-STD-704 electrical power.)

1.2 Purpose. The primary purpose of this standard is to provide the requisite information to promote compatibility between aircraft electrical power, external electrical power, and the airborne equipment that uses that power, with MIL-STD-704 serving as the governing document. Accordingly, the content of past versions of MIL-STD-704 is presented here to enable comparisons of the detailed requirements. To ensure that an individual piece of equipment will work satisfactorily in multiple types of aircraft, a worst-case set of electrical interface criteria should be developed from the applicable versions of MIL-STD-704 and subsequently imposed as an interface requirement for that equipment to ensure compatibility with the various types of aircraft being addressed.

1.3 Scope. The development of numerous combinations of worst-case characteristics is considered to be beyond the scope of this document; however, the required information is presented to enable development of an appropriate set of worst-case criteria. Table V provides an example of a set of worst-case criteria for 28 volts DC; i.e., it represents the worst-case requirements of revisions A through E of MIL-STD-704. At the time this standard was developed, the (then) latest approved version of MIL-STD-704 (revision E) was used as the starting point for this ADS, and where earlier versions differ, that information is also provided to enable side-by-side comparisons, as well as development of worst-case criteria. The various versions of MIL-STD-704 that are included are Revisions A through F. The requirements and some of the textual content of Revision F have also been included as its release was pending at the time this standard was being written; consequently, it includes some information that has not been included in previous versions, such as reference to test methods and procedures for determining compliance with these requirements. Information included in this

document and derived from (peculiar to) the released version of MIL-STD-704F is clearly identified as such.

2. APPLICABLE DOCUMENTS.

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government Documents.

2.2.1 Government specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-704	6 Oct 59	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-704A	9 Aug 66	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-704A NOT 1	7 Feb 68	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-704A NOT 2	5 May 70	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-704B	17 Nov 75	Aircraft Electric Power Characteristics
MIL-STD-704C	30 Dec 77	Aircraft Electric Power Characteristics
MIL-STD-704D	30 Sep 80	Aircraft Electric Power Characteristics
MIL-STD-704D NOT 1	31 Mar 88	Aircraft Electric Power Characteristics
MIL-STD-704E	1May 91	Aircraft Electric Power Characteristics
MIL-STD-704F	12 Mar 04	Aircraft Electric Power Characteristics

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-704		Guidance for Test Procedures for Demonstration of Utilization Equipment Compliance to Aircraft Electrical Power Characteristics

Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA, 19111-5094.)

2.2.2 Other government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ADS-37A-PRF	28 May 96	Electromagnetic Environmental Effects (E^3) Performance and Verification Requirements
RTCA/DO-160	29 Jul 97	Environmental Conditions and Test Procedures for Airborne Equipment
USD (AT) SD-2		(Under Secretary of Defense) Buying Commercial and Non-Developmental Items: A Handbook

Copies of these documents are available through the United States Army Aviation and Missile Command, Aviation Engineering Directorate, Redstone Arsenal, Alabama.

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS.

3.1 Abbreviations/Acronyms

AC	Alternating Current
ADS	Aeronautical Design Standard
AHSS	Abnormal High Steady State
ALSS	Abnormal Low Steady State
COTS	Commercial Off-The-Shelf
DC	Direct Current
EHSS	Emergency High Steady State
ELSS	Emergency Low Steady State
Hz	Hertz
KVA	Kilo-Volt-Amperes
max	maximum
NATO	North Atlantic Treaty Organization
NHSS	Normal High Steady State
NLSS	Normal Low Steady State
OUSD (AT)	Office of the Under Secretary of Defense for Acquisition & Technology
PoR	Point Of Regulation
RMS	Root-Mean-Square
RTCA	Requirements and Technical Concepts for Aviation
SAE	Society of Automotive Engineers
STANAGS	Standardization Agreements

3.2 Abnormal operation. Abnormal operation occurs when a malfunction or failure in the electric system has taken place and the protective devices of the system are operating to remove the malfunction or failure from the remainder of the system before the limits for abnormal operation are exceeded. The power source may operate in a degraded mode on a continuous basis, where the power characteristics supplied to the utilization equipment exceed normal operation limits but remain within the limits for abnormal operation.

3.3 AC voltage. AC voltage is the RMS phase-to-neutral value for each half cycle. Steady state AC voltage is the time average of the RMS voltage over a period not to exceed one second. Peak AC voltage is the maximum absolute value of the instantaneous voltage.

3.4 Aircraft electric power systems. An aircraft electric power system consists of a main power source, emergency power source, power conversion equipment, control and protection devices, and an interconnection network (wires, cables, connectors, etc.). The main power is generally derived from aircraft generators driven by the aircraft propulsion engines. Emergency power is generally derived from

batteries, independent auxiliary power units, and ram air or hydraulically driven generators.

3.5 Crest factor. The crest factor is the absolute value of the ratio of the peak to the RMS value for each half cycle of the voltage waveform measured over a one-second period under steady state conditions.

3.6 DC component of the AC voltage. The DC component of the AC voltage is the average value of the voltage.

3.7 DC voltage. Steady state DC voltage is the time average of the instantaneous DC voltage over a period not to exceed one second.

3.8 Distortion. AC distortion is the RMS value of the AC waveform exclusive of the fundamental. In a DC system, DC distortion is the RMS value of the alternating voltage component on the DC voltage.

3.9 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 DC steady state voltage.

3.10 Distortion spectrum. The distortion spectrum quantifies AC or 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 waveform.

3.11 Electric starting operation. Electric starting operation is a specialized case of normal electric system operating conditions where the normal voltage limits may be exceeded due to the high electric demand. The voltage limits for normal operation may be exceeded during the following starting conditions:

- An electric start of the propulsion engine.
- A battery start of an auxiliary power unit.

3.12 Emergency operation. Emergency operation occurs following the loss of the main generating equipment when a limited electric source, independent of the main system, is used to power a reduced complement of distribution and utilization equipment selected to maintain flight and personnel safety.

3.13 External power source. The external power source refers to the ground or shipboard power source used to provide power to the aircraft's electrical distribution system.

3.14 Frequency. Frequency is the reciprocal of the period of the AC voltage. The unit of frequency is designated the Hertz (Hz). Steady state frequency is the time average of the frequency over a period not to exceed one second.

3.15 Frequency modulation. Frequency modulation is the difference between the maximum and minimum frequency values that occur in a one-minute period during steady state operating conditions. Frequency modulation is a measure (in Hz) of the stability of the power source's frequency regulation.

3.16 Load unbalance. Load unbalance for a three-phase load is the difference between the highest and lowest phase loads.

3.17 Normal operation. Normal operation occurs when the system is operating as intended in the absence of any fault or malfunction that degrades performance beyond established requirements. It includes all system functions required for aircraft operation except during the electric starting of propulsion engines and the battery start of an auxiliary power unit. Normal operation includes switching of utilization equipment, prime mover speed changes, synchronizing and paralleling of power sources, and operation from external power sources. Although transfer operation as defined herein is a normal function, it is treated separately in this standard because of the power interruption that it may produce. Conducted switching spikes, which are excursions of the instantaneous voltage not exceeding 50 microseconds, are to be considered normal operation characteristics.

3.18 Over-frequency and under-frequency. Over-frequency and under-frequency are those frequencies that exceed the transient limits for normal operation and are limited by the action of protective devices.

3.19 Over-voltage and under-voltage. Over-voltage and under-voltage are those voltages that exceed the transient limits for normal operation and are limited by the action of protective devices.

3.20 Point of regulation. The PoR is that point at which a power source senses and regulates the system voltage. The PoR is defined as being at the input terminals of the line contactor connecting the power system to the load bus.

3.21 Ripple. Ripple is the variation of voltage about the steady state DC voltage during steady state electric system operation. Sources of ripple may include, but are not limited to, voltage regulation instability of the DC power source, commutation/rectification within the DC power source, and load variations within utilization equipment. Ripple amplitude is the maximum absolute value of the difference between the steady state and the instantaneous DC voltage.

3.22 Steady state. Steady state is the condition in which the characteristics remain within the limits for normal-operation steady state characteristics throughout an arbitrarily long period of time. Steady state conditions may include lesser transients.

3.23 Transfer operation. A transfer operation occurs when the electric system transfers between power sources, including transfers from or to external power sources.

3.24 Transient. A transient is a changing value of a characteristic that usually occurs as a result of normal disturbances, such as electric load change and engine speed change. A transient may also occur as a result of a momentary power interruption or an abnormal disturbance such as fault clearing. Transients that do not exceed the steady state limits are defined as lesser transients. Transients that exceed the steady state limits but remain within the specified normal transient limits are defined as normal transients. Transients that exceed normal transient limits as a result of an abnormal disturbance and eventually return to steady state limits are defined as abnormal transients.

3.25 Utilization equipment. Utilization equipment is that equipment that receives power from the electric power system.

3.26 Utilization equipment terminals. Utilization equipment terminals provide the interface with the electric power system. Power interconnections within the utilization equipment or equipment system are excluded.

3.27 Voltage modulation. Voltage modulation is the variation of AC voltage during steady state AC electric system operation. Sources of voltage modulation may include, but are not limited to, voltage regulation instability of the AC power source, generator speed variations, and load variations within utilization equipment. Voltage modulation amplitude is the difference between the maximum and minimum AC voltage values that occur in a one-second period during steady state operating conditions.

3.28 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-crossings traced in the negative to positive direction.

3.29 Voltage unbalance. Voltage unbalance is the maximum difference between RMS phase-voltage amplitudes at the utilization equipment terminals.

4. GENERAL REQUIREMENTS

4.1 Power compatibility. Utilization equipment shall be compatible with the power characteristics of the aircraft in which the equipment will be installed. Table I provides information as to which version of MIL-STD-704 shall apply to each of various Army aircraft, which dictates which set of power characteristics specified herein shall apply to the utilization equipment. In the event utilization equipment must operate in more than one aircraft type/model, the worst-case power characteristics shall be developed from the information provided herein for those aircraft. Utilization equipment shall not require electric power of better quality than specified herein. Utilization equipment shall also be compatible with the applicable aircraft specification

requirements for control of electromagnetic interference and voltage spikes induced by other utilization equipment, lightning, electromagnetic pulses, and power bus switching. (Electromagnetic interference and voltage spikes are covered by ADS-37A-PRF and not this standard.)

4.2 Operation. When supplied with electric power having characteristics specified herein, aircraft utilization equipment shall provide the level of performance required by its detail specification for each operating condition. Operation of utilization equipment shall not cause the power characteristics at its terminals to exceed the limits specified herein. Utilization equipment operation under any electric system operating condition shall not have an adverse effect on or cause malfunction of the electric system.

4.2.1 Normal operation. Utilization equipment shall provide the level of performance specified in its detail specification.

4.2.2 Abnormal operation. Detail specifications for utilization equipment may require a level of performance during abnormal operation. Utilization equipment that is permitted a degradation or loss of performance during abnormal operation shall not suffer damage or cause an unsafe condition, and shall automatically resume specified performance when normal operating characteristics are restored.

4.2.3 Transfer operation. Utilization equipment may not be required to operate under the transfer condition unless a level of performance is specified by its detail specification. Utilization equipment shall automatically resume specified performance when normal operating characteristics are resumed.

4.2.4 Emergency operation. Utilization equipment shall provide the level of performance specified in its detail specification when such performance is essential for flight or safety.

4.2.5 Starting operation. Utilization equipment shall provide the level of performance specified in its detail specification when such performance is essential during the starting operation.

4.3 Power failure. The loss of power (AC or DC) or the loss of one or more phases of AC power to any utilization equipment terminal shall not result in an unsafe condition or damage to utilization equipment.

4.4 AC power utilization. Utilization equipment that requires more than 0.5 KVA of AC power shall be configured to utilize three-phase steady state balanced power. Load unbalance of individual utilization equipment shall be within the limits of Figure 1. The load unbalance of utilization equipment whose total load is greater than 30 KVA shall be no greater than 3.33 percent of its total three-phase load. Single-phase AC power shall be used only on a line-to-neutral basis. AC power shall not be half-wave rectified.

4.5 Pulsed load design issues (derived from MIL-STD-704F). Pulsed loads are a potential cause of unacceptable voltage modulation. Hence, large pulsed loads may require excess power source capacity or dedicated power sources to protect other aircraft equipment. The utilization equipment shall not introduce excessive pulse loading in order to minimize current modulation.

4.6 Non-linear loads and effects (derived from MIL-STD-704F). Utilization equipment shall not introduce excessive current distortion such that other equipment is affected.

4.7 Grounding (derived from MIL-STD-704F). All electrical power input terminals, including AC neutral and DC negative terminals, shall be electrically isolated from case ground. The equipment chassis shall not be used for power returns.

4.8 Inrush current (newly added). For AC loads over 3 KVA, the maximum inrush current shall not exceed 300 percent of rated current.

4.9 Power factor (derived from MIL-STD-704F). The power factor of AC equipment >500 VA shall be between 0.85 lagging and unity when operating at 50 percent or more of its rated load current in steady state condition. AC equipment shall not have a leading power factor when operating at more than 100 VA.

4.10 Polarity or phase reversal (derived from MIL-STD-704F). Three-phase AC equipment shall not be damaged by reversal of input phase sequence. Single-phase AC equipment shall not be damaged by reversal of line and neutral connections. DC equipment shall not be damaged by reversal of positive and negative connections. Employing a positive physical means to prevent phase or polarity reversal shall also fulfill this requirement.

4.11 Multiple input terminals (derived from MIL-STD-704F). Equipment having multiple input terminals for connection to more than one power source shall isolate the inputs from each other so that one power source cannot supply power to another. AC inputs shall not be paralleled. DC inputs shall be protected with blocking diodes if they are paralleled.

4.12 Test Requirements. Equipment testing shall be required to demonstrate utilization equipment compatibility with the electric power characteristics of this standard. Utilization equipment test requirements shall be in accordance with the equipment detail specification. A set of test methods and procedures for determining whether utilization equipment is compatible with the electric power characteristics of this standard are available and are discussed in MIL-HDBK-704. Aircraft integration testing prior to fielding of the utilization equipment shall also be required to allow detection of possible incompatibility with aircraft power in a controlled test environment .

5. DETAILED REQUIREMENTS Utilization equipment may encounter, and thus shall be compatible with, the following aircraft electrical power characteristics.

5.1 Transfer operation characteristics. Under conditions of bus or power source transfers, voltage and frequency shall not vary between zero and normal operating limits for longer than 50 milliseconds. The occurrence of a normal transient upon completion of the transfer shall be acceptable.

5.2 AC power characteristics.

5.2.1 Type system. AC power characteristics are those of a single-phase or three-phase Y-connected grounded neutral system having a nominal voltage of 115/200 volts. The waveform is a sine wave having a nominal frequency of 400 Hz. The only alternative standard is a nominal 230/400 volts when specifically authorized by the procuring activity. The voltage amplitude limits for the 115/200 volts standard shall apply proportionally to the 230/400 volts standard. The power characteristics specified herein shall apply to each phase.

5.2.2 Phase sequence. The phase sequence shall be A-B-C, and aircraft wiring and equipment terminals shall be marked accordingly. Generator terminals shall be marked T_1-T_2-T_3 corresponding to A-B-C, respectively. The phase sequence shall be counterclockwise (positive) as shown in Figure 2.

5.2.3 Normal operation. Normal operation characteristics shall be in accordance with Tables II.a-II.j and II.r.

5.2.4 Abnormal operation. Abnormal operation characteristics shall be in accordance with Tables II.k-II.m and II.o-II.q.

5.2.5 Emergency operation. Emergency operation characteristics shall be the same as normal operation except as noted in Table II.n.

5.3 DC power characteristics.

5.3.1 Type systems. DC power characteristics are those of a two-wire or negative-ground-return system having a nominal voltage of 28 volts or 270 volts.

5.3.2 28-volts DC system.

5.3.2.1 Normal operation. Normal operation characteristics shall be in accordance with Tables III.a-III.e and III.l.

5.3.2.2 Abnormal operation. Abnormal operation characteristics shall be within the limits of Tables III.f, III.g, III.j, and III.k.

5.3.2.3 Emergency operation. The DC steady state voltage in emergency operation shall be within the limits of Table III.h.

5.3.2.4 Electric starting. The DC voltage in electric starting operation shall be within the limits of Table III.i. Electric starting of an auxiliary power unit (other than battery starts) is a normal operating function and shall not be included under this condition.

5.3.3 270-volts DC system.

5.3.3.1 Normal operation. Normal operation characteristics shall be in accordance with Tables IV.a-IV.e and IV.l.

5.3.3.2 Abnormal operation. Abnormal operation characteristics shall be within the limits of Tables IV.f, IV.g, IV.j and IV.k.

5.3.3.3 Emergency operation. The DC steady state voltage in emergency operation shall be within the limits of Table IV.h.

5.3.3.4 Electric starting. The DC voltage in electric starting operation shall be within the limits of Table IV.i. Electric starting of an auxiliary power unit (other than battery starts) is a normal operating function and shall not be included under this condition.

6. NOTES.

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

6.1 Intended use (derived from MIL-STD-704F). The intent of this document is to define the electric power quality requirements for utilization equipment used in DoD aircraft; however, the document may also be used for utilization equipment used in commercial aircraft or other types of vehicles. Other industry standards, such as SAE AS1212 and ISO 1540, also define aircraft electric power quality requirements; however, these documents are generally not appropriate for use with military aircraft. They do not address all the areas of concern with military aircraft electric power quality, and often require wider limits compared to this document due to the differences in the types and sizes of aircraft covered. In addition, the documents do not always take into account legacy DoD aircraft electrical power systems or legacy DoD utilization equipment. The power characteristics requirements of this document also apply to commercial and non-developmental utilization equipment purchased in compliance with OUSD (AT) SD-2. If such equipment does not fully comply with the power characteristics requirements of this standard, the effect of equipment noncompliance on the electrical power quality and on the equipment capability to perform its intended function in DoD aircraft should be evaluated.

6.2 Considerations (derived from MIL-STD-704F). Each element of the aircraft electrical power system is qualified and purchased to its own specification requirements document. The requirements of this standard are less severe than the output power requirements of the typical electrical power source, taking into account the degradation of electrical power quality that can occur between a power source and the input electrical power terminals of utilization equipment. The combined effects of the electrical power distribution system and the control and protection system, and the interactions between electrical power sources and utilization equipment may cause degradation of electrical power quality. The following military specifications are currently active for typical power sources:

- MIL-DTL-6162, Generators and Starter-Generators, Electrical Direct Current, Nominal 30 Volts, Aircraft General Specification for
- MIL-G-21480, Generator system, 400 Hz Alternating Current, Aircraft General Specification for
- MIL-C-7115, Converters, Aircraft, General Specification for
- MIL-PRF-24021, Electric Power Monitors, External, Aircraft
- MIL-E-85583, Electric Power Generating Channel, Variable Input Speed, Alternating Current, 400 Hz, Aircraft; General Specification for
- SAE AS4361, Minimum Performance Standards for Aerospace Electric Power Converters
- SAE AS8023, Minimum Performance Standards for Airborne Static Electric Power Inverters

6.3 Application of this standard in utilization equipment specifications. Utilization equipment specifications should include a statement that "This equipment shall utilize electric power in accordance with ADS-68-IS and shall be in accordance with the utilization equipment requirements of ADS-68-IS." The equipment specification should also specify the type of electric power to be utilized and the detailed performance required during normal, abnormal, emergency, starting, transfer, and power failure operation of the electric system. The electric power characteristics specified therein are minimum requirements for utilization equipment. Therefore, specifications for utilization equipment that require greater operating margins should include specific electric power characteristic operating ranges that exceed those stated herein. Utilization equipment specifications should never specify operating ranges that are narrower than those specified herein, nor waive compatibility with the electric power characteristics specified herein, since that could result in failure of the equipment to perform as required. Utilization equipment specifications should also include requirements that reduce the likelihood of the equipment having an adverse effect on the electric power characteristics provided by the electric system. High inrush current,

low lagging power factor, high peak-power to average-power ratio, high current ripple amplitude, and current distortion are some characteristics of utilization equipment that can adversely affect the electric system by degrading electric power characteristics or increasing capacity requirements. Minimizing these undesirable utilization equipment characteristics involves tradeoffs with weight, cost, and reliability that are specific to each type of equipment and should be addressed in the utilization equipment specification.

6.4 Other alternative AC standards. For the first time, MIL-STD-704 addresses two additional alternative standards that may be used when specifically authorized by the procuring activity, namely, a nominal 115/200-volt variable-frequency system (360-800 Hz), and a nominal 115/200 volt 60-Hz system for COTS equipment only. Use of 60-Hz equipment is to be minimized. Standards for these alternative systems are not addressed here, but they are addressed in MIL-STD-704F.

6.5 Precedence. Continuous reproduction of the figures in the various versions of MIL-STD-704 and this standard may result in the distortion of the curves. Tables and equations on the figures take precedence.

6.6 Guidance and lessons learned (derived from MIL-STD-704F).

6.6.1 Compatibility and testing. Historically, users of MIL-STD-704 interpret or view the electrical power quality characteristics limits in that document as they would those of a typical power source/generator. This interpretation is incorrect. An aircraft electrical system is composed of a variety of power components (generation, conversion, inversion, control, power distribution, and power management and protection devices) that provide power to aircraft buses and utilization equipment terminals. Each component and subsystem is designed and tested to its individual equipment specification, which often requires tighter performance than does MIL-STD-704 (or this standard) to compensate for the effects of loads, as well as the associated feeder/line voltage drops therein. Therefore, the limits specified here are minimum requirements for specifying that utilization equipment is compatible with aircraft electrical power. To ensure utilization equipment is compatible with aircraft power, system testing similar to that outlined in MIL-HDBK-704-1 through -8 should be performed. For information and access to the Government's MIL-STD-704 compatibility test laboratory and test methods, contact the following:

Naval Air Systems Command
Attn: MIL-STD-704 Laboratory
Electrical Power Systems Division (AIR-4.4.4)
48298 Shaw Road, Bldg. 1461
Patuxent River, MD 20670

Web site: http://ppe.navair.navy.mil

TABLE I. Applicable versions of MIL-STD-704

Aircraft Type/Model/Series	Applicable Standard
RAH-66	MIL-STD-704E (Note 1)
AH-64A	MIL-STD-704A, Notice 2 (Cat. B) (Note 2)
AH-64D	MIL-STD-704D, Notice 1 (Note 3)
UH-60A/L/EH-60A	MIL-STD-704A, Notice 2 (Cat. B) (Note 4)
MH-60K	MIL-STD-704A, Notice 2 (Cat. B) (Note 5)
MH-60L	
HH-60L (UH-60Q)	MIL-STD-704A, Notice 2 (Note 6)
UH-60M (AC Power)	MIL-STD-704A, Notice 2 (Cat. B) (Note 7)
UH-60M (DC Power)	MIL-STD-704E (Note 7)
CH-47D/F, MH-47E	MIL-STD-704A, Notice 1 (Cat. B) (Note 8)
MH-47D	MIL-STD-704A, Notice 1 (Cat. B) (Note 9)
MH-47G	MIL-STD-704A, Notice 1 (Cat. B)(Note 13)
OH-58A	
OH-58C	MIL-STD-704 (Note 10)
OH-58D	MIL-STD-704C (Note 11)
A/MH-6J	(Note 12)
A/MH-6 (MELB)	(Note 12)
UH-1/UH-1V	
AH-F	

Notes:

1 Reference 2000-310-901-4, RAH-66 Production Performance Weapon System Specification (PWSS).

2 Reference DRC-S-H10000B, System Specification for AH-64A Advanced Attack Helicopter.

3 Reference DRC-S-H20000B, System Specification for the AH-64 Longbow Apache Attack Helicopter.

4 Reference DARCOM-CP-2222-S1000K, Prime Item Development Specification (PIDS) UH-60L Black Hawk Aircraft.

5 Reference SES-700114, Prime Item Development Specification (PIDS) MH-60K Special Operations Aircraft.

6 Same as for the UH-60A/L since the electrical power generating system had not changed.

Notes: (cont'd)

7 Reference AVNS-PRF-10002A, System Specification UH-60M Black Hawk Utility Helicopter. MIL-STD-704E applies to the DC system supplying aircraft avionics.

8 Reference 145-PJ-8103-1, Prime Item Development Specification for the Model CH-47D and MH-47E Helicopters. According to Appendix IV, the electrical system of the MH-47E is unchanged from that of the CH-47D, and, according to Appendix V, the electrical system of the CH-47F is unchanged from that of the CH-47D.

9 Same as for the CH-47D since the electrical power generating system had not changed.

10 Reference 206-947-203, System Specification for OH-58C Kiowa.

11 Reference 406-947-500A, System Specification for OH-58D Kiowa Warrior, except the allowable normal frequency range was changed to 400 $\pm$ 20 Hz.

12 These aircraft are derived from commercial aircraft MDHI MD-530, which were probably designed to commercial standards such as DO-160 for electrical power quality. Both of these configurations were recently tested to military standards for electrical power quality, which should provide references relative to particular versions of MIL-STD-704. This information will be included at a later date as the information becomes available.

13 Reference 791-PJ-8103-1A, MH-47G Chinook Prime Item Development Specification.

TABLE II. MIL-STD-704 limits for AC electrical power

a. Normal limits for steady state voltage, voltage unbalance, and frequency

Normal Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Voltage NLSS	108 V	108 V	108 V	108 V	108 V	108 V
Voltage NHSS	118 V	118 V	118 V	118 V	118 V	118 V
Voltage Unbalance	3.0V	3.0V	3.0V	3.0V	3.0V	3.0V
Frequency NLSS	380 Hz	395 Hz (380 Helicopters)	393 Hz	393 Hz	393 Hz	393 Hz
Frequency NHSS	420 Hz	405 Hz (420 Helicopters)	407 Hz	407 Hz	407 Hz	407 Hz

b. Normal limits for three-phase voltage phase difference

Limit	704A*	704B	704C	704D	704E	704F
Voltage Phase Difference	116^{o} to 124^{o}	118^{o} to 122^{o}	116^{o} to 124^{o}	116^{o} to 124^{o}	116^{o} to 124^{o}	116^{o} to 124^{o}

c. Normal limits for voltage modulation

Limit	704A*	704B	704C	704D	704E	704F
Voltage Modulation	3.5 V Peak-to-Valley Figure 1 MIL-STD-704A	Sideband 0.62 Vrms over the range 400 ± 60 Hz	N/A	N/A	2.5 Vrms max	2.5 Vrms max

d. Normal limits for frequency modulation

Limit	704A*	704B	704C	704D	704E	704F
Frequency Modulation	± 4 Hz (Para. 5.1.5.3)	± 5 Hz Figure 3 MIL-STD-704B	± 5 Hz Figure 4 MIL-STD-704C	± 5 Hz Figure 4 MIL-STD-704D	4 Hz	4 Hz
Figure Comparison		- same -				

e. Normal limits for voltage distortion spectrum

Limit	704A*	704B	704C	704D	704E	704F
Voltage Distortion Spectrum	Individual Harmonic ≤ 5%	Figure 2 MIL-STD-704B	Figure 3 MIL-STD-704C	Figure 3 MIL-STD-704D	Figure 3 MIL-STD-704E	Figure 7 MIL-STD-704F
Figure Comparison		- same -				

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE II. MIL-STD-704 limits for AC electrical power - Continued

f. Normal limits for total voltage distortion

Limit	704A*	704B	704C	704D	704E	704F
Voltage Distortion Factor	0.08	0.05	0.05	0.05	0.05	0.05

g. Normal limits for direct current component of AC voltage

Limit	704A*	704B	704C	704D	704E	704F
DC Voltage Component of the AC Voltage	N/A	± 0.10 V	± 0.10 V	± 0.10 V	± 0.10 V	± 0.10 V

h. Limits for normal voltage transients

Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Normal Voltage Transients	Figure 3 MIL-STD-704A Locus of Equivalent Step Function Curves 2 and 3	Figure 4 MIL-STD-704B	Figure 5 MIL-STD-704C	Figure 5 MIL-STD-704D	Figure 4 MIL-STD-704E	Figure 3 MIL-STD-704F
Figure Comparison		- same -				

i. Limits for normal frequency transients

Limit	704A*	704B	704C	704D	704E	704F
Normal Frequency Transients	Figure 5 MIL-STD-704A Locus of Equivalent Step Function Curves 2 and 3	Para. 5.1.3 MIL-STD-704B	Figure 6 MIL-STD-704C	Figure 6 MIL-STD-704D	Figure 5 MIL-STD-704E	Figure 5 MIL-STD-704F
Figure Comparison			- same -			
Normal Maximum df/dt	250 Hz/sec	N/A	N/A	N/A	N/A	N/A

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE II. MIL-STD-704 limits for AC electrical power - Continued

j. Normal power transfer limits

Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Power Interrupt	50 msec	50 msec	50 msec	50 msec	50 msec	50 msec
Voltage NLSS	108 V	108 V	108 V	108 V	108 V	108 V
Voltage NHSS	118 V	118 V	118 V	118 V	118 V	118 V

k. Abnormal limits for steady state voltage and frequency

Abnormal Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Voltage ALSS	102 V	100 V	100 V	100 V	100 V	100 V
Voltage AHSS	124 V	125 V	125 V	125 V	125 V	125 V
Frequency ALSS	370 Hz	375 Hz	380 Hz	375 Hz	380 Hz	380 Hz
Frequency AHSS	430 Hz	425 Hz	420 Hz	425 Hz	420 Hz	420 Hz

l. Limits for abnormal voltage transients

Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Abnormal Voltage Transients	Figure 3 MIL-STD-704A Locus of Equiv. Step Function Curves 1&4	Figure 5 MIL-STD-704B	Figure 7 MIL-STD-704C	Figure 7 MIL-STD-704D	Figure 6 MIL-STD-704E	Figure 4 MIL-STD-704F
Figure Comparison		- same -				

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE II. MIL-STD-704 limits for AC electrical power – Continued

m. Limits for abnormal frequency transients

Limit	704A*	704B	704C	704D	704E	704F
Normal Frequency Transients	Figure 5 MIL-STD-704A Locus of Equiv. Step Function Curves 1&4	Para. 5.1.5 MIL-STD-704B	Figure 8 MIL-STD-704C	Figure 8 MIL-STD-704D	Figure 7 MIL-STD-704E	Figure 6 MIL-STD-704F
Figure Comparison		- same as 704D -		- same as 704B -	-same-	
Abn Max df/dt	500 Hz/sec	500 Hz/sec	500 Hz/sec	N/A	N/A	N/A

n. Emergency limits for steady state voltage and frequency

Emergency Limit	704A* (Cat. B)	704B	704C (or starting)	704D	704E	704F
Voltage ELSS	104 V	102 V	104 V	104 V	108 V	108 V
Voltage EHSS	122 V	124 V	122 V	122 V	118 V	118 V
Frequency ELSS	360 Hz	360 Hz	360 Hz	360 Hz	393 Hz	393 Hz
Frequency EHSS	440 Hz	440 Hz	440 Hz	440 Hz	407 Hz	407 Hz

o. Abnormal power failure limits (three phase)

Limit	704A*	704B	704C	704D	704E	704F
Power Failure	7 sec Figure 3 Curve 4 MIL-STD-704A	7 sec Figure 5 MIL-STD-704B	7 sec Figure 7 MIL-STD-704C	7 sec Figure 7 MIL-STD-704D	7 sec Figure 6 MIL-STD-704E	7 sec Figure 4 MIL-STD-704F
Figure Comparison		- same -				

p. Abnormal power failure limits (single & two phase)

Limit	704A*	704B	704C	704D	704E	704F
Single Phase and Two Phase Power Failure	7 sec and indefinitely Figure 3 Curve 4 MIL-STD-704A	7 sec and indefinitely Figure 5 MIL-STD-704B	7 sec and indefinitely Figure 7 MIL-STD-704C	7 sec and indefinitely Figure 7 MIL-STD-704D	7 sec and indefinitely Figure 6 MIL-STD-704E	7 sec and indefinitely Figure 4 MIL-STD-704F
Figure Comparison		- same -				

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE II. MIL-STD-704 limits for AC electrical power – Continued

q. Abnormal phase sequence reversal requirements

Limit	704A*	704B	704C	704D	704E	704F
Phase Reversal	N/A	N/A	N/A	N/A	N/A	Phase Sequence Reversal Does Not Cause Damage

r. Normal limits for crest factor

Limit	704A*	704B	704C	704D	704E	704F
Crest Factor	1.41±0.15	1.41±0.10	1.41±0.10	1.41±0.10	1.41±0.10	1.41±0.10

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE III. MIL-STD-704 limits for 28 VDC electrical power

a. Normal limits for steady state voltage

Normal Limit	704A* (Cat B)	704B	704C	704D	704E	704F
Voltage NLSS	24 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc
Voltage NHSS	28.5 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc

b. Normal limits for voltage distortion spectrum

Limit	704A*	704B	704C	704D	704E	704F
Voltage Distortion Spectrum	Figure 7 MIL-STD-704A	Figure 6 MIL-STD-704B	Figure 9 MIL-STD-704C	Figure 9 MIL-STD-704D	Figure 8 MIL-STD-704E	Figure 15 MIL-STD-704F
Figure Comparison		- same -			- same -	

c. Normal limits for ripple DC voltage distortion

Limit	704A*	704B	704C	704D	704E	704F
Voltage Ripple	2 Volts Peak to Mean & Figure 7 MIL-STD-704A	1.5 Volts Peak to Average & Figure 6 MIL-STD-704B	1.5 Volts Peak to Average & Figure 9 MIL-STD-704C	1.5 Volts Peak to Average & Figure 9 MIL-STD-704D	1.5 Volts Peak to Average & Figure 8 MIL-STD-704E	1.5 Volts Peak to Average & Figure 15 MIL-STD-704F
Figure Comparison		- same -			- same -	

d. Limits for normal voltage transients

Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Normal Voltage Transients	Fig 9 MIL-STD-704A Locus of Equiv. Step Function Curves 2&3	Figure 7 MIL-STD-704B	Figure 10 MIL-STD-704C	Figure 10 MIL-STD-704D	Figure 9 MIL-STD-704E	Figure 13 MIL-STD-704F
Figure Comparison		- same -				

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE III. MIL-STD-704 limits for 28 VDC electrical power - Continued

e. Normal power transfer limits

Limit	704A*	704B	704C	704D	704E	704F
Power Interrupt	50 msec	50 msec	50 msec	50 msec	50 msec	50 msec
Voltage NLSS	24 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc
Voltage NHSS	28.5 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc

f. Abnormal limits for steady state voltage

Abnormal Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Voltage ALSS	22.5 Vdc	20.0 Vdc	20.0 Vdc	20.0 Vdc	20.0 Vdc	20.0 Vdc
Voltage AHSS	30.0 Vdc	31.5 Vdc	31.5 Vdc	31.5 Vdc	31.5 Vdc	31.5 Vdc

g. Limits for abnormal voltage transients

Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Abnormal Voltage Transients	Figure 9 MIL-STD-704A Locus of Equivalent Step Function Curves 1 and 4	Figure 8 MIL-STD-704B	Figure 12 MIL-STD-704C	Figure 12 MIL-STD-704D	Figure 11 MIL-STD-704E	Figure 14 MIL-STD-704F
Figure Comparison		- same -			- same -	

h. Emergency limits for steady state voltage

Emergency Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Voltage ELSS	16.0 Vdc	18.0 Vdc	16.0 Vdc	16.0 Vdc	18.0 Vdc	16.0 Vdc
Voltage EHSS	24.0 Vdc	29.0 Vdc	30.0 Vdc	29.0 Vdc	29.0 Vdc	29.0 Vdc

i. Limits for starting voltage transients

Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Starting Voltage Transients	16.0 Vdc to 28.5 Vdc	N/A	16.0 Vdc to 30.0 Vdc	12.0 Vdc to 29.0 Vdc	12.0 Vdc to 29.0 Vdc	12.0 Vdc to 29.0 Vdc

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE III. MIL-STD-704 limits for 28 VDC electrical power - Continued

j. Abnormal power failure limits

Limit	704A* (Cat. B)	704B	704C	704D	704E	704F
Power Failure	7 sec Figure 9 Curve 4 MIL-STD-704A	5 sec Figure 8 MIL-STD-704B	5 sec Figure 12 MIL-STD-704C	7 sec Figure 12 MIL-STD-704D	7 sec Figure 11 MIL-STD-704E	7 sec Figure 14 MIL-STD-704F
Figure Comparison		- same -			-same-	

k. Abnormal polarity reversal requirement

Limit	704A*	704B	704C	704D	704E	704F
Polarity Reversal	N/A	N/A	N/A	N/A	N/A	Polarity Reversal Does not Cause Damage

l. Normal limits for voltage distortion factor

Limit	704A*	704B	704C	704D	704E	704F
Voltage Distortion Factor	N/A	0.02	0.035	0.035	0.035	0.035

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE IV. MIL-STD-704 limits for 270 VDC electrical power

a. Normal limits for steady state voltage

Normal Limit	704A*	704B	704C	704D	704E	704F
Voltage NLSS	N/A	250 Vdc	250 Vdc	250 Vdc	250 Vdc	250 Vdc
Voltage NHSS	N/A	280 Vdc	280 Vdc	280 Vdc	280 Vdc	280 Vdc

b. Normal limits for voltage distortion spectrum

Limit	704A*	704B	704C	704D	704E	704F
Voltage Distortion Spectrum	N/A	Figure 6 MIL-STD-704B	Figure 9 MIL-STD-704C	Figure 9 MIL-STD-704D	Figure 13 MIL-STD-704E	Figure 18 MIL-STD-704F
Figure Comparison		- same -			- same -	

c. Normal limits for ripple DC voltage distortion

Limit	704A*	704B	704C	704D	704E	704F
Voltage Ripple	N/A	6 Volts Peak to Average And Figure 6 MIL-STD-704B	6 Volts Peak to Average And Figure 9 MIL-STD-704C	6 Volts Peak to Average And Figure 9 MIL-STD-704D	6 Volts Peak to Average And Figure 13 MIL-STD-704E	6 Volts Peak to Average And Figure 18 MIL-STD-704F
Figure Comparison		- same -			- same -	

d. Limits for normal voltage transients

Limit	704A*	704B	704C	704D	704E	704F
Normal Voltage Transients	N/A	Figure 9 MIL-STD-704B	Figure 11 MIL-STD-704C	Figure 11 MIL-STD-704D	Figure 10 MIL-STD-704E	Figure 16 MIL-STD-704F
Figure Comparison		- same -			-same -	

e. Normal power transfer limits

Limit	704A*	704B	704C	704D	704E	704F
Power Interrupt	N/A	50 msec	50 msec	50 msec	50 msec	50 msec
Voltage NLSS	N/A	250 Vdc	250 Vdc	250 Vdc	250 Vdc	250 Vdc
Voltage NHSS	N/A	280 Vdc	280 Vdc	280 Vdc	280 Vdc	280 Vdc

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE IV. MIL-STD-704 limits for 270 VDC electrical power - Continued

f. Abnormal limits for steady state voltage

Abnormal Limit	704A*	704B	704C	704D	704E	704F
Voltage ALSS	N/A	245 Vdc	245 Vdc	245 Vdc	240 Vdc	240 Vdc
Voltage AHSS	N/A	285 Vdc	285 Vdc	285 Vdc	290 Vdc	290 Vdc

g. Limits for abnormal voltage transients

Limit	704A*	704B	704C	704D	704E	704F
Abnormal Voltage Transients	N/A	Figure 10 MIL-STD-704B	Figure 13 MIL-STD-704C	Figure 13 MIL-STD-704D	Figure 12 MIL-STD-704E	Figure 17 MIL-STD-704F
Figure Comparison		- same -			- same -	

h. Emergency limits for steady state voltage

Emergency Limit	704A*	704B	704C	704D	704E	704F
Voltage ELSS	N/A	240 Vdc	240 Vdc	240 Vdc	250 Vdc	250 Vdc
Voltage EHSS	N/A	290 Vdc	290 Vdc	290 Vdc	280 Vdc	280 Vdc

i. Limits for starting voltage transients

Limit	704A*	704B	704C	704D	704E	704F
Starting Voltage Transients	N/A	N/A	240 Vdc to 290 Vdc	N/A	N/A	N/A

j. Abnormal power failure limits

Limit	704A*	704B	704C	704D	704E	704F
Power Failure	N/A	7 sec Figure 10 MIL-STD-704B	7 sec Figure 13 MIL-STD-704C	7 sec Figure 13 MIL-STD-704D	7 sec Figure 12 MIL-STD-704E	7 sec Figure 17 MIL-STD-704F
Figure Comparison		- same -			- same -	

* MIL-STD-704A column applies to both Notices 1 and 2.

TABLE IV. MIL-STD-704 limits for 270 VDC electrical power - Continued

k. Abnormal polarity reversal requirement

Limit	704A*	704B	704C	704D	704E	704F
Polarity Reversal	N/A	N/A	N/A	N/A	N/A	Polarity Reversal Does not Cause Damage

l. Normal limits for voltage distortion factor

Limit	704A*	704B	704C	704D	704E	704F
Voltage Distortion Factor	N/A	0.03	0.008	0.008	0.015	0.015

* MIL-STD-704A column applies to both Notices 1 & 2.

TABLE V. Worst-case MIL-STD-704 limits for 28 VDC electrical power (revisions A through E)

a. Normal limits for steady state voltage

Voltage NLSS	22 Vdc
Voltage NHSS	29 Vdc

b. Normal limits for voltage distortion spectrum

Voltage Distortion Spectrum	Use the larger of the two voltage values shown for each frequency in Figure 3 of this ADS

c. Normal limits for ripple DC voltage distortion

Voltage Ripple	2 Volts Peak to Average And Figure 3 of this ADS

d. Limits for normal voltage transients

Normal Voltage Transients	Figure 9 of MIL-STD-704A* (Cat. B) Locus of Equivalent Step Function Curves 2 and 3, except steady-state values are changed to 29 and 22 volts, respectively

e. Normal power transfer limits

Power Interrupt	50 msec
Voltage NLSS	22 Vdc
Voltage NHSS	29 Vdc

f. Abnormal limits for steady state voltage

Voltage ALSS	20.0 Vdc
Voltage AHSS	31.5 Vdc

g. Limits for abnormal voltage transients

Abnormal Voltage Transients	Figure 9 MIL-STD-704A* (Cat. B) Locus of Equivalent Step Function Curves 1 and 4, except steady-state values are changed to 31.5 and 20 volts, respectively

* References to MIL-STD-704A apply to both Notices 1 and 2.

TABLE V. Worst-case MIL-STD-704 limits for 28 VDC electrical power (revisions A through E) - Continued

h. Emergency limits for steady state voltage

Voltage ELSS	16.0 Vdc
Voltage EHSS	30.0 Vdc

i. Limits for starting voltage transients

Starting Voltage Transients	12.0 Vdc to 30.0 Vdc

j. Abnormal power failure limits

Power Failure	7 sec Figure 11 of MIL-STD-704E

k. Abnormal polarity reversal requirement

Polarity Reversal	N/A

l. Normal limits for voltage distortion factor

Voltage Distortion Factor	0.035

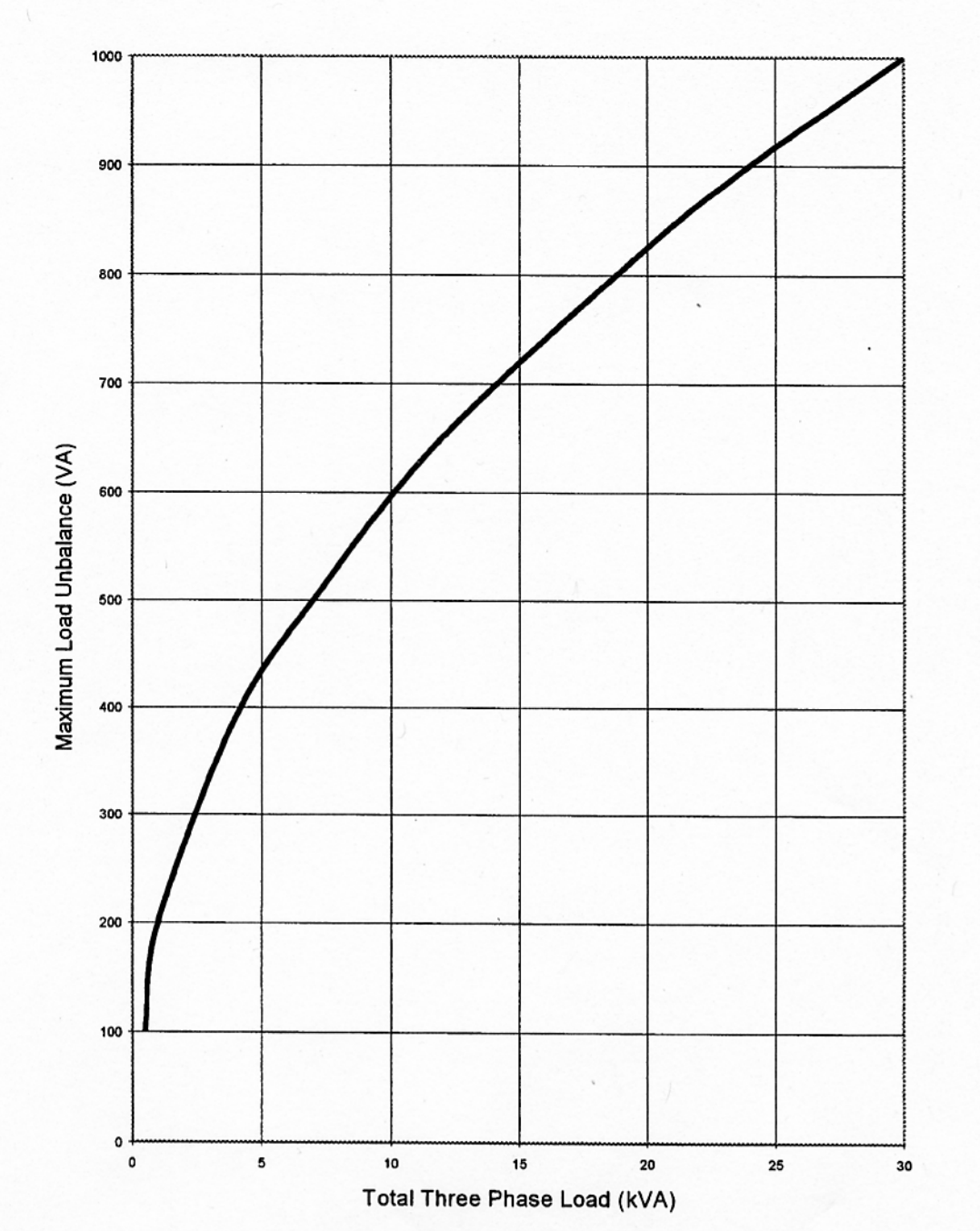


Figure 1. Load unbalance limits for three-phase utilization equipment

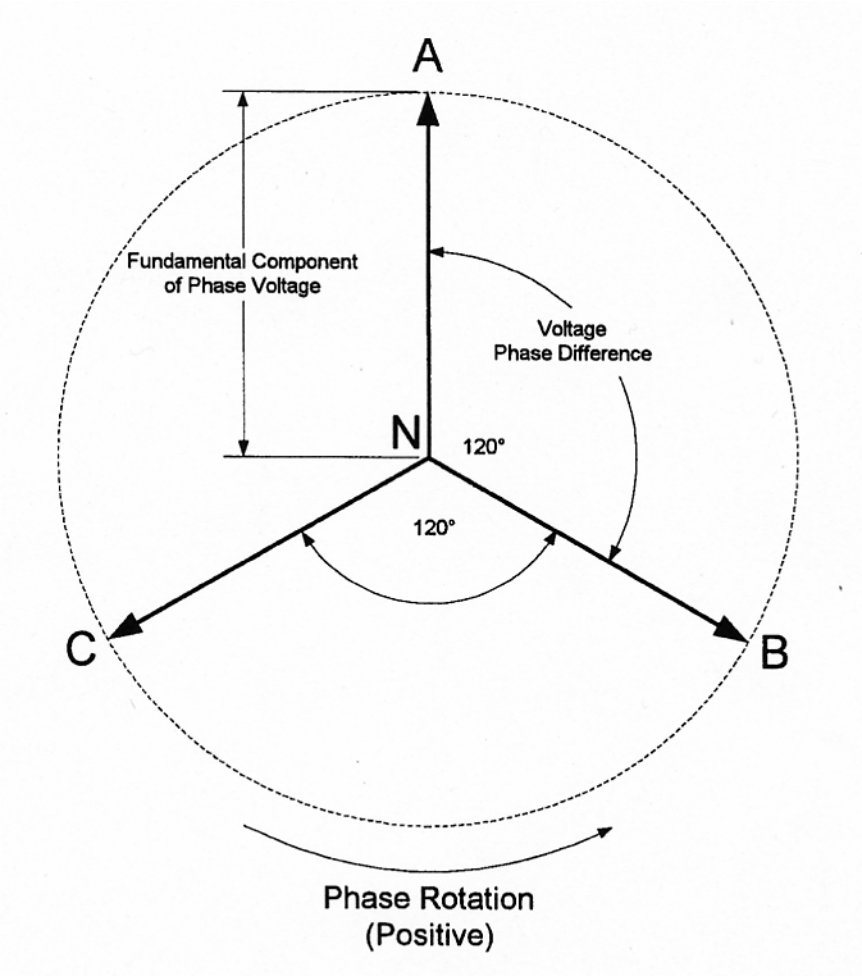


Figure 2. Phasor diagram showing required phase sequence relationship

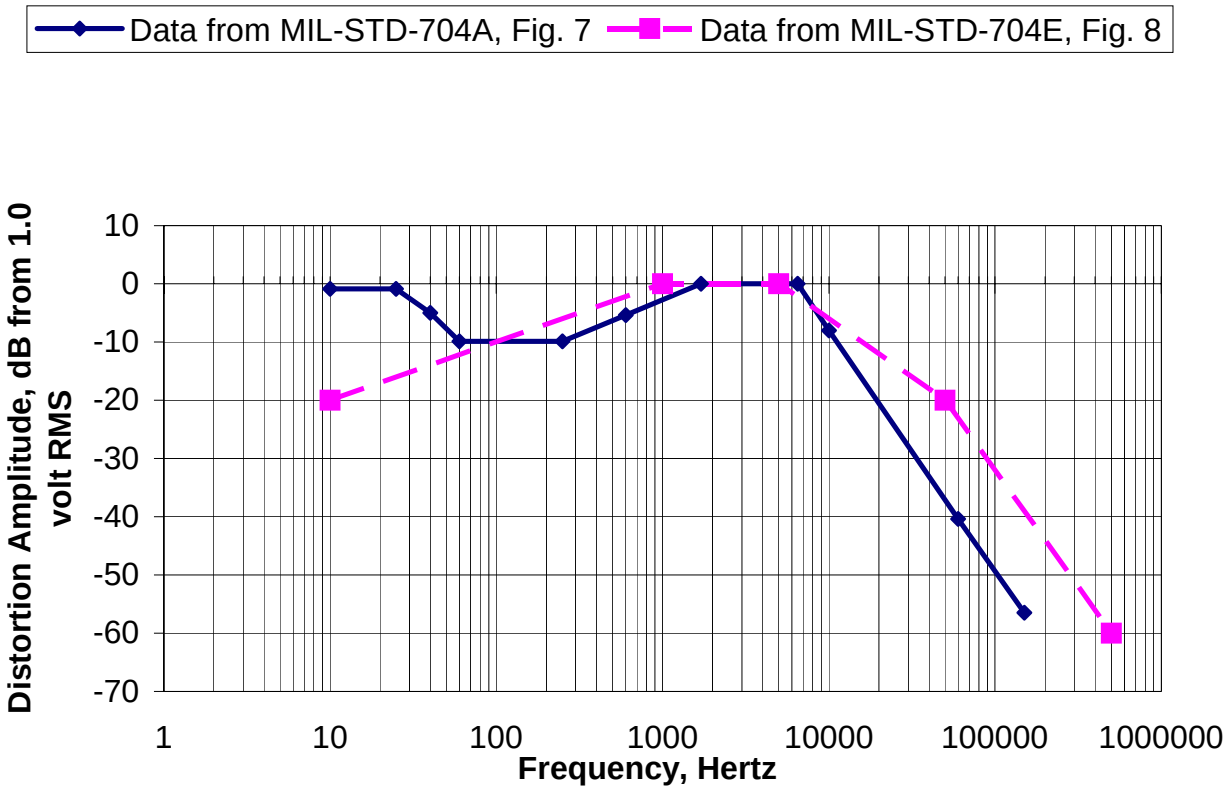


FIGURE 3. Maximum distortion spectrum for 28 volts DC system

APPENDIX A

COPIES OF MIL-STD-704 FIGURES AND TEXT REFERENCED IN TABLES II THROUGH V

A.1 SCOPE

A.1.1. Scope. This appendix provides copies of figures from the various versions of MIL-STD-704 that are referenced in Tables II through V for the convenience of the user of this ADS. Where figures are identified in the table as being the same, only one of the figures is provided here. The source of each figure is provided in its header.

A.2 Referenced Texts. The following texts referenced in the aforementioned tables are also provided:

A.2.1 Paragraph 5.1.5.3 of MIL-STD-704A. "Modulation rate. Rates of frequency change owing to frequency modulation shall be not greater than 25 cps per second."

A.2.2 Paragraph 5.1.3 of MIL-STD-704B. "Frequency transient limits (frequency surge). The frequency transient shall be within 400±25Hz, returning to within 400±20 Hz in one second, to within 400±10Hz in 5 seconds, and to within 400±5Hz in 15 seconds. The rate of frequency change shall not exceed 500Hz/second for any period greater than 15 milliseconds."

A.2.3 Paragraph 5.1.5 of MIL-STD-704B. "Out-of-tolerance frequency (over- and under-frequency). The frequency limits shall not exceed 400±25Hz for more than 5 seconds, or for an interval specifically authorized, but in no instance be allowed to exceed 480Hz. Interruptions following this interval shall be as specified in 4.2. (See also 5.1.3.)" The pertinent portion of paragraph 4.2 of MIL-STD-704B is "Interruptions resulting from out-of-tolerance frequency….may be followed by bus transfer, or by power restoration delays as determined by the particular application."

MIL-STD-704A

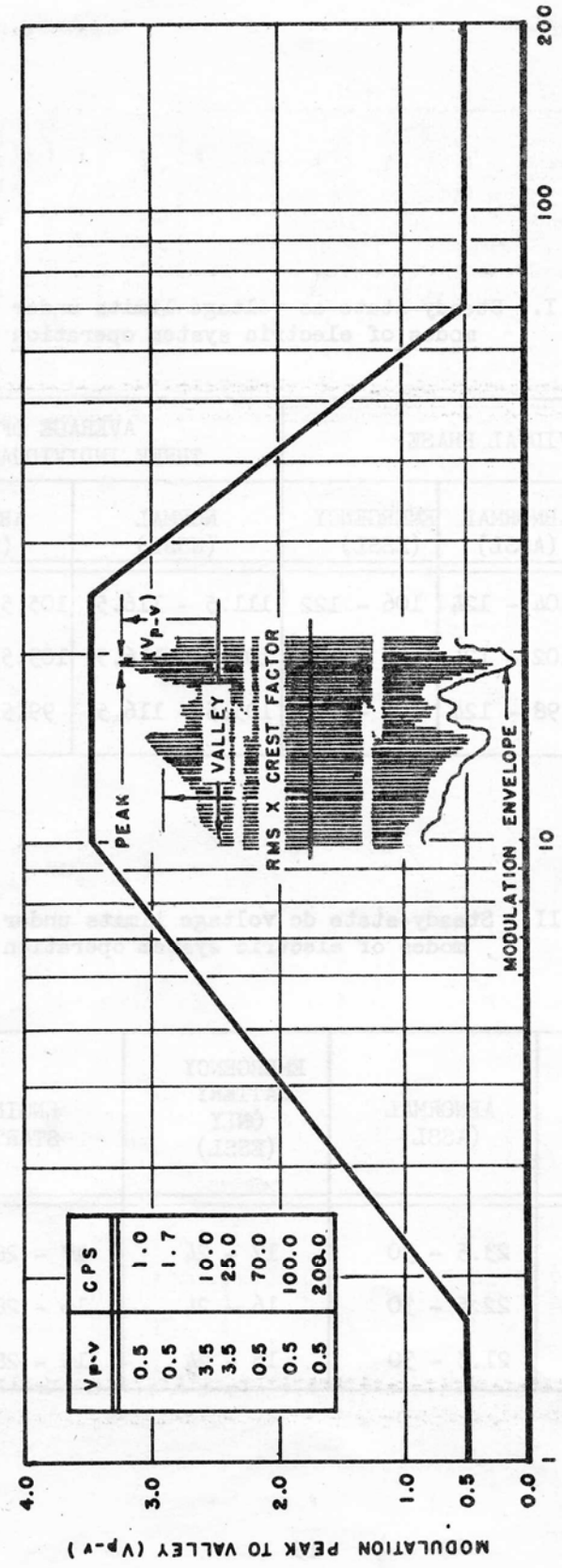


FIGURE 1. Frequency characteristics of ac voltage modulation envelope

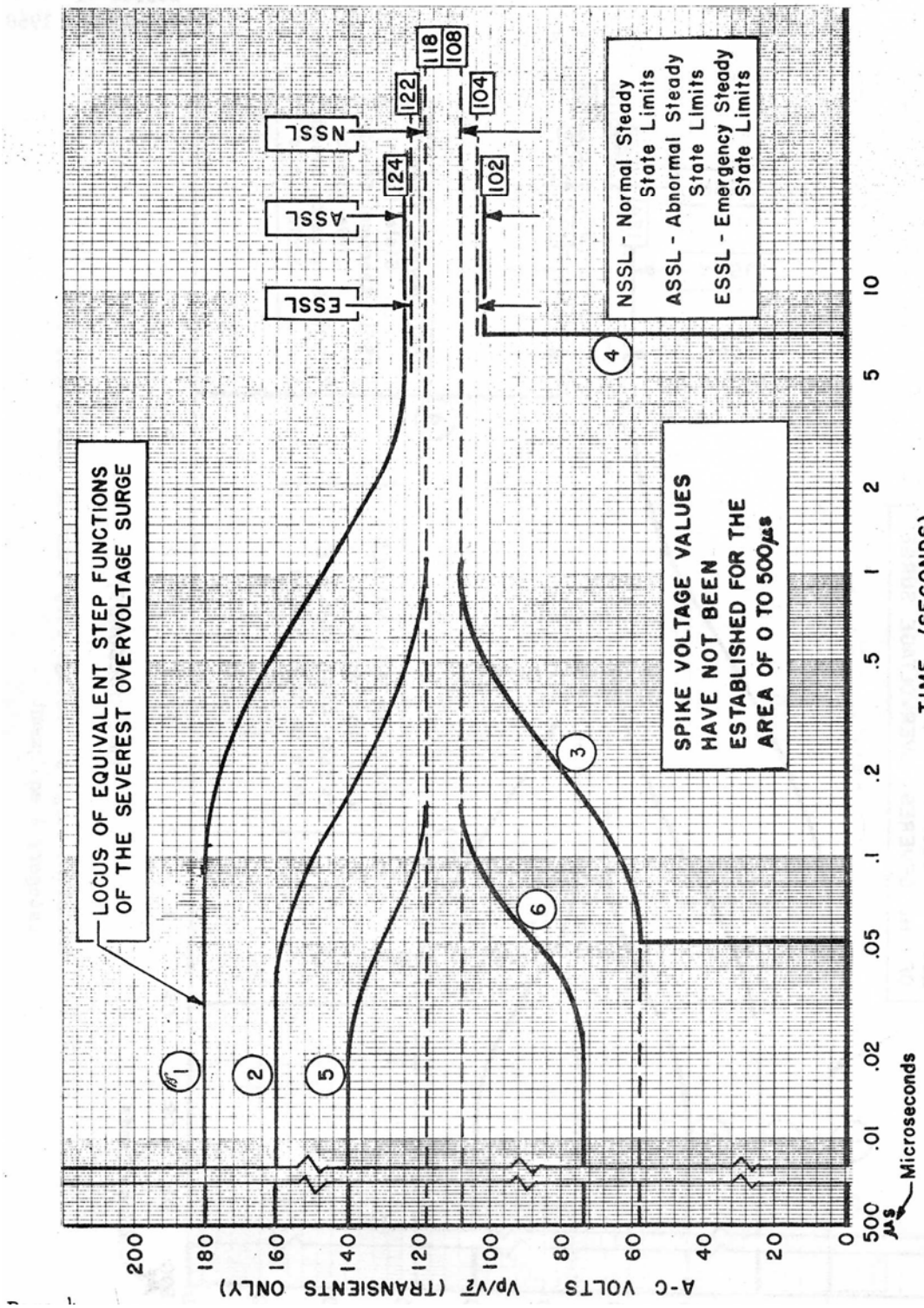


FIGURE 3. Transient surge ac voltage step function loci limits for category B equipment

MIL-STD-704A

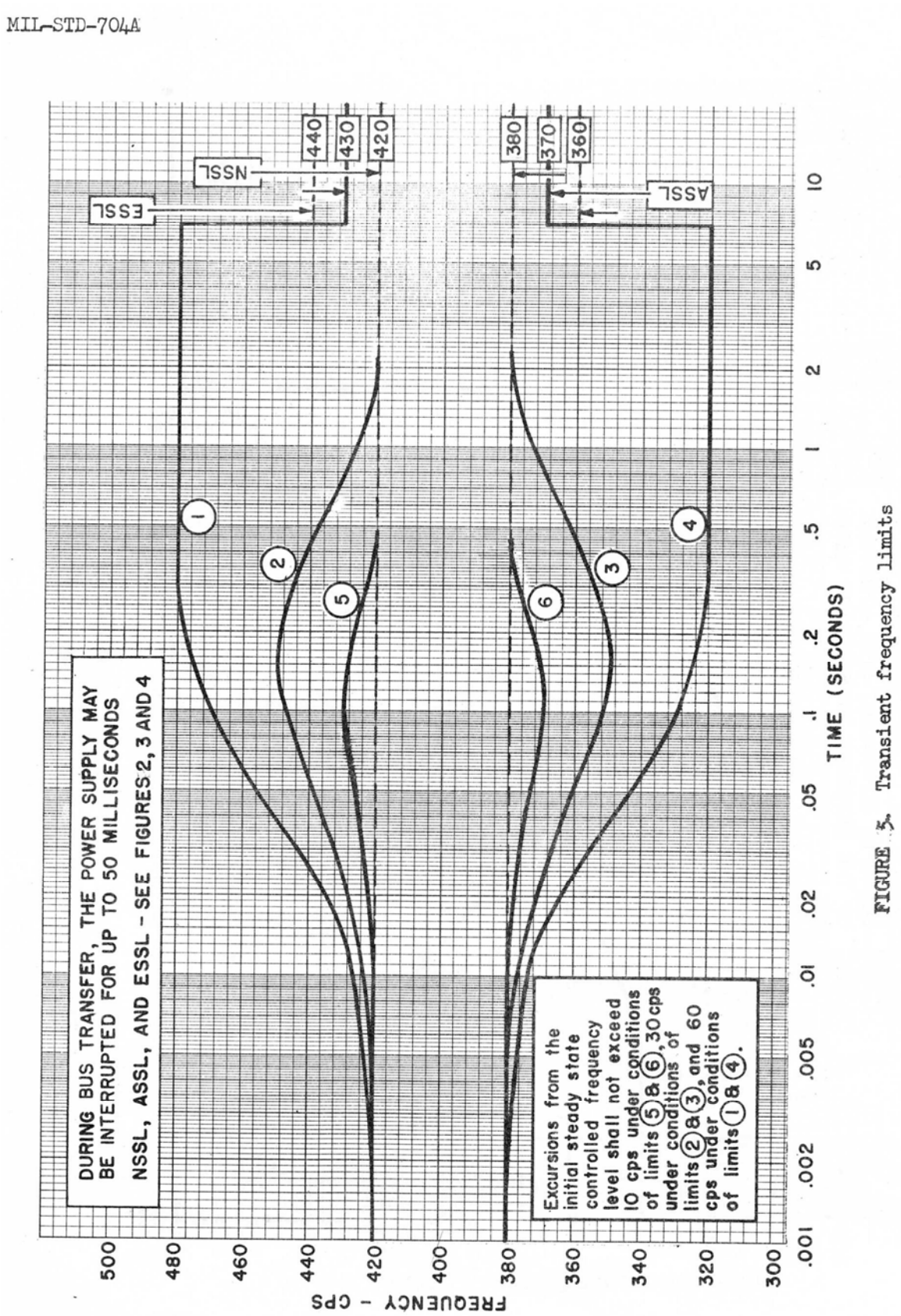


FIGURE 3. Transient frequency limits

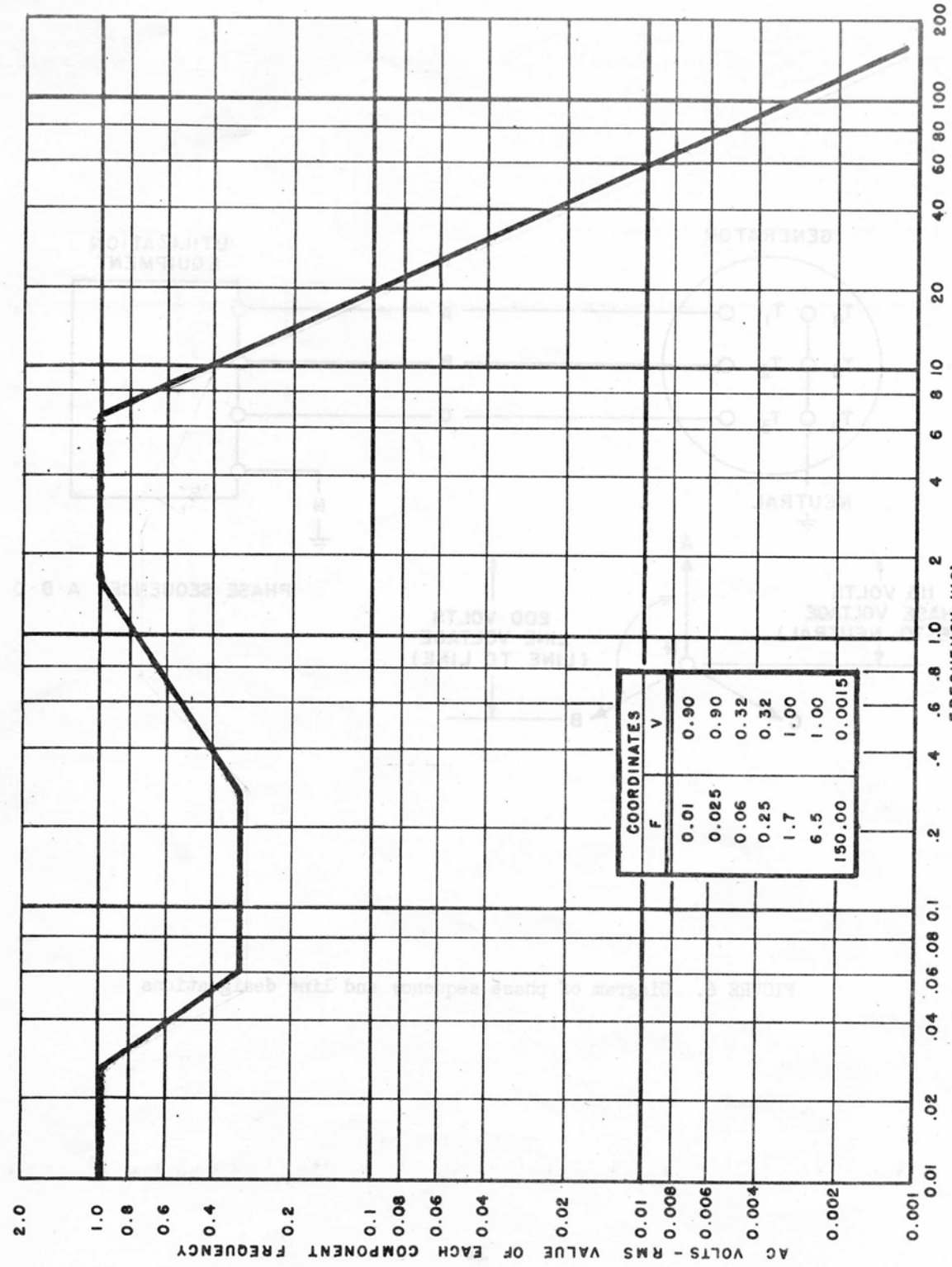


FIGURE 7. Frequency characteristics of ripple in 28 volt dc electric systems

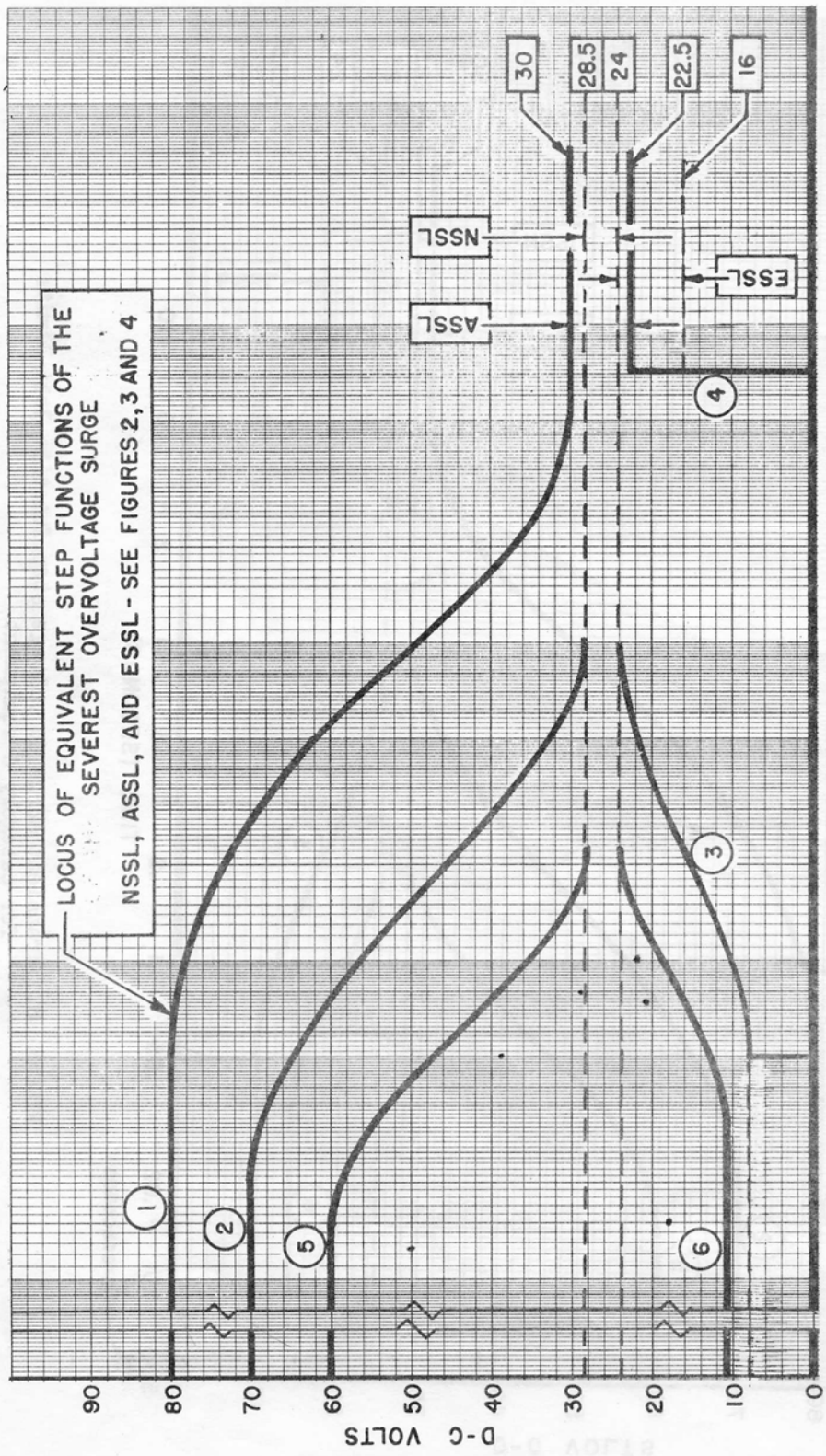
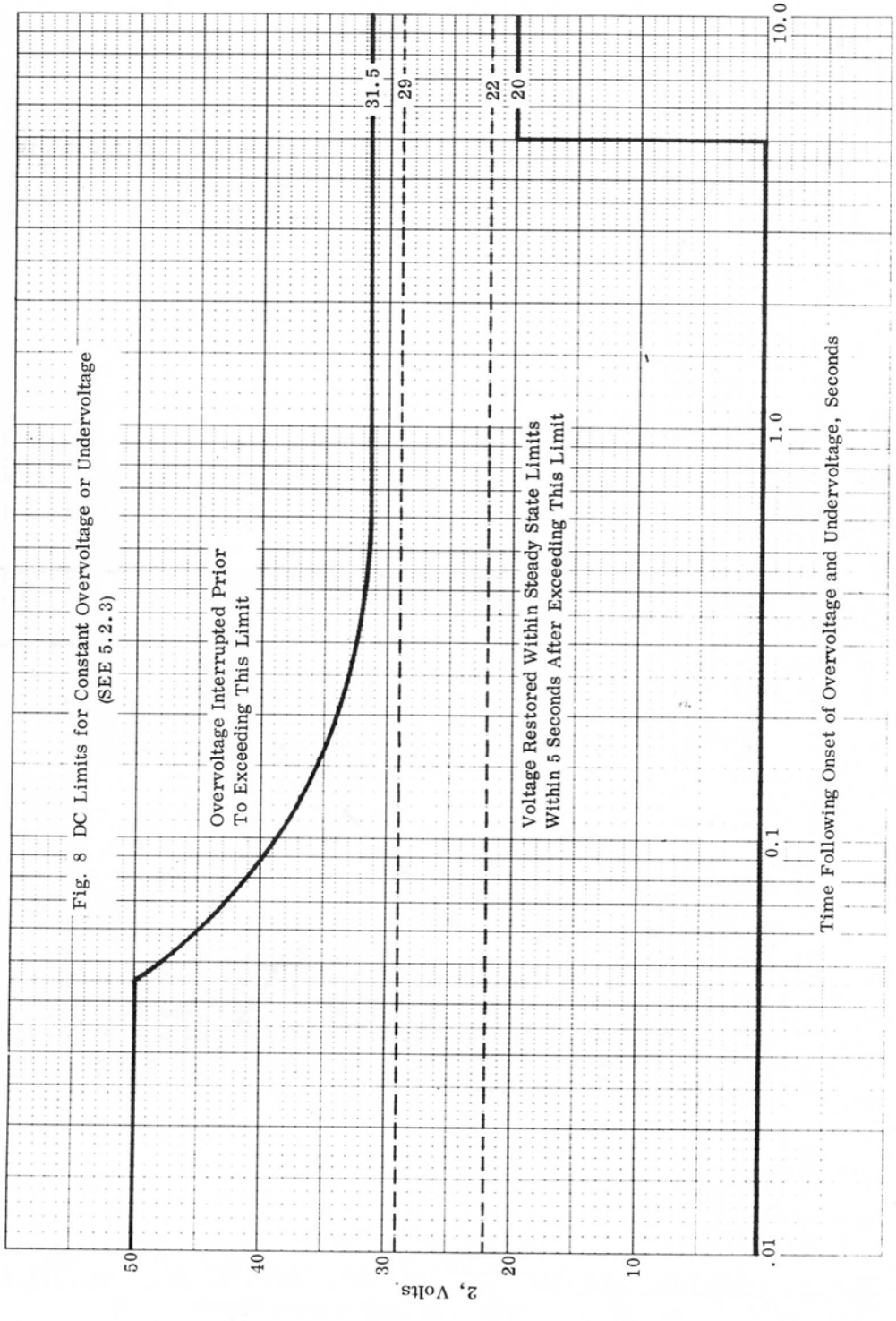


FIGURE 9. Transient surge dc voltage step function loci limits for category B equipment



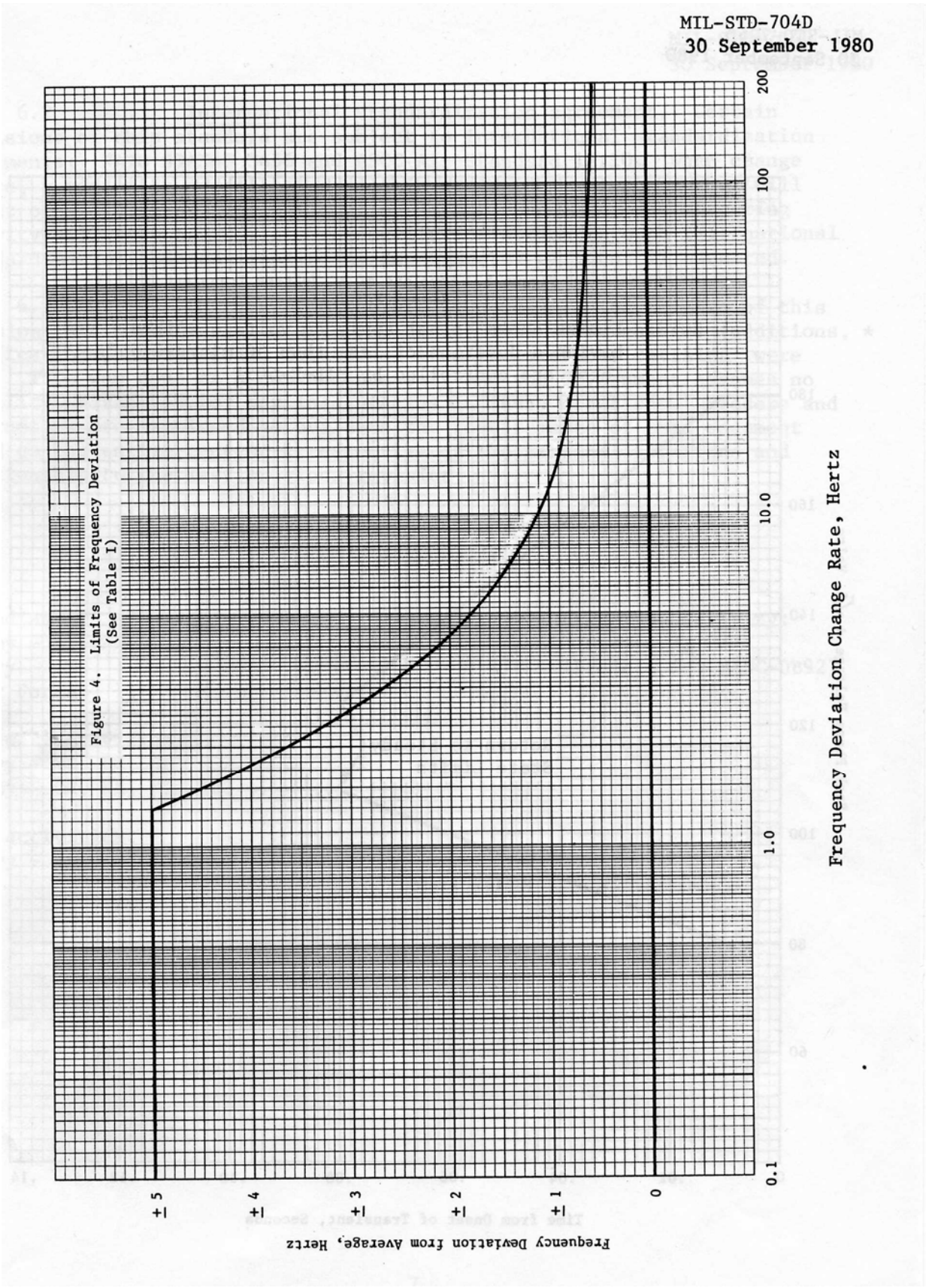


Figure 4. Limits of Frequency Deviation (See Table I)

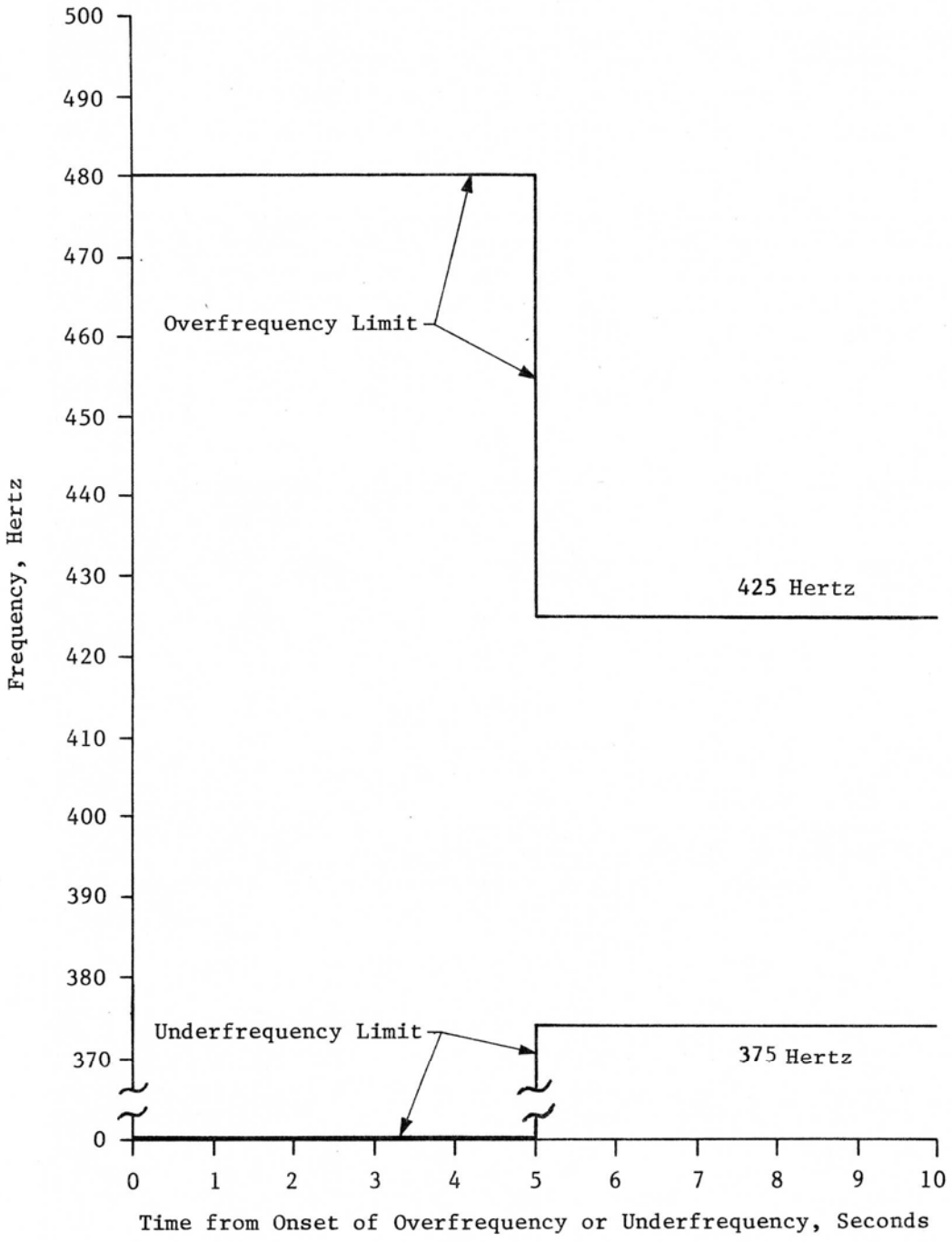
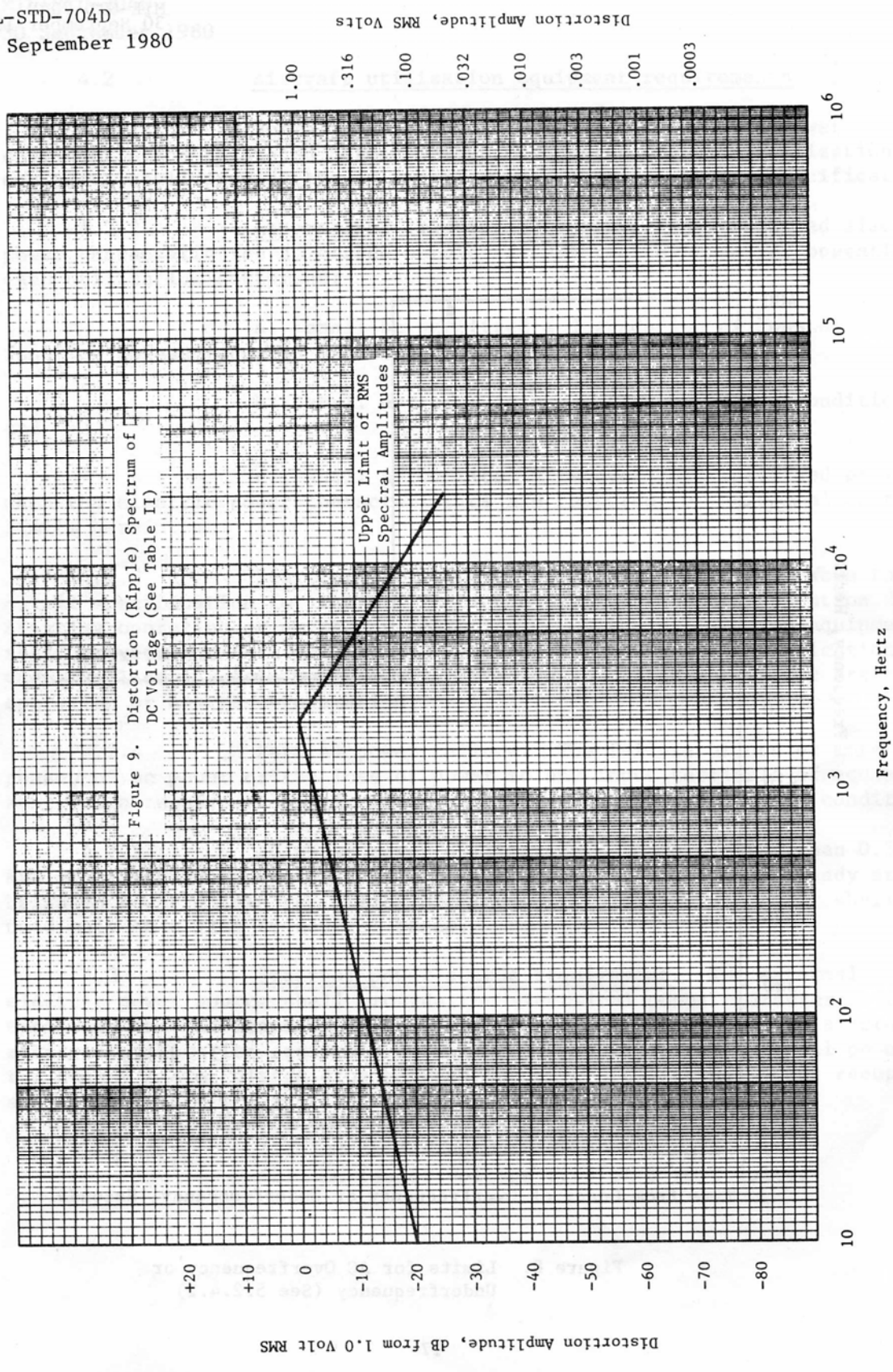


Figure 8. Limits for AC Overfrequency or Underfrequency (See 5.2.4.2)



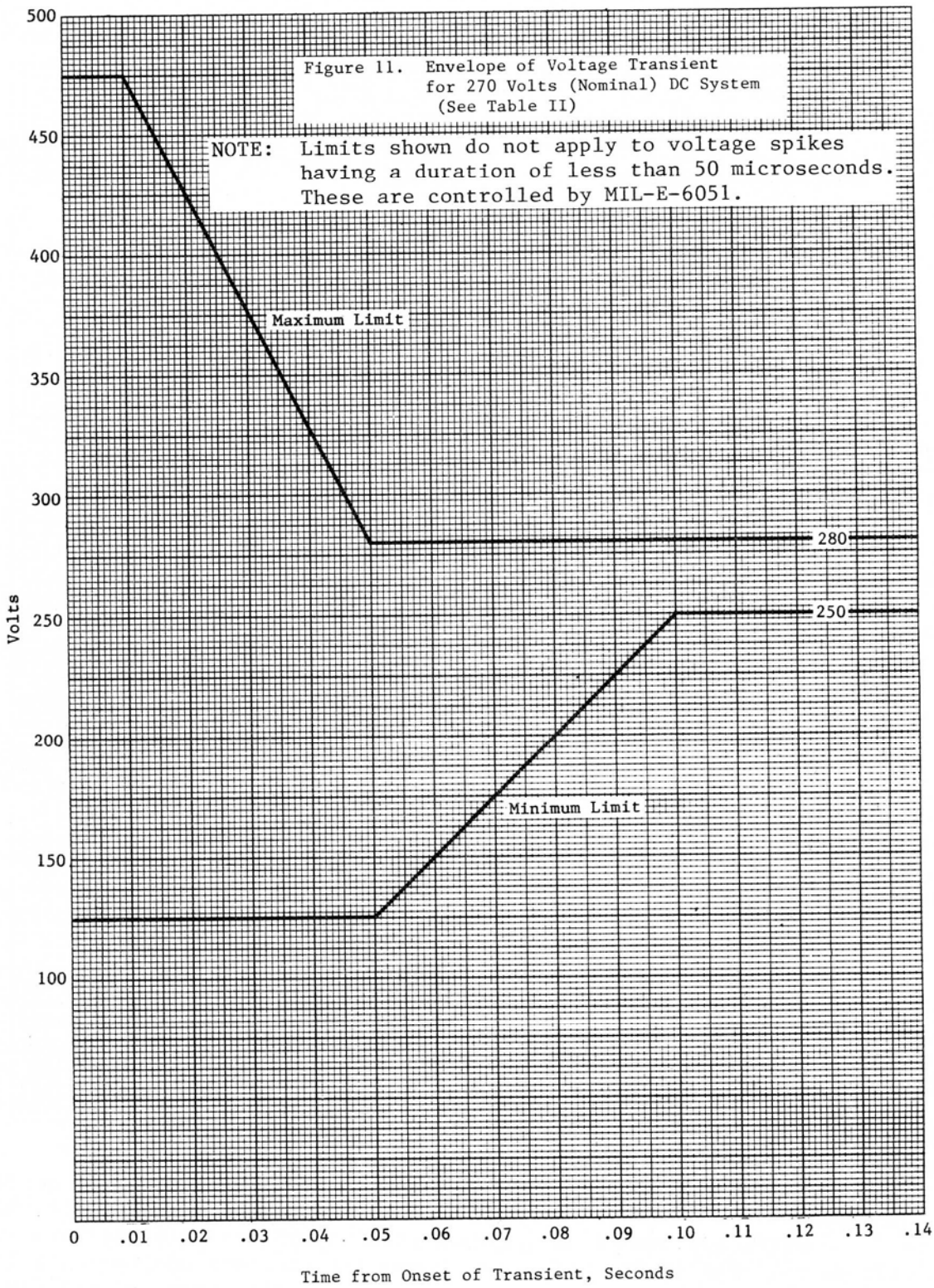


Figure 11. Envelope of Voltage Transient for 270 Volts (Nominal) DC System (See Table II)

NOTE: Limits shown do not apply to voltage spikes having a duration of less than 50 microseconds. These are controlled by MIL-E-6051.

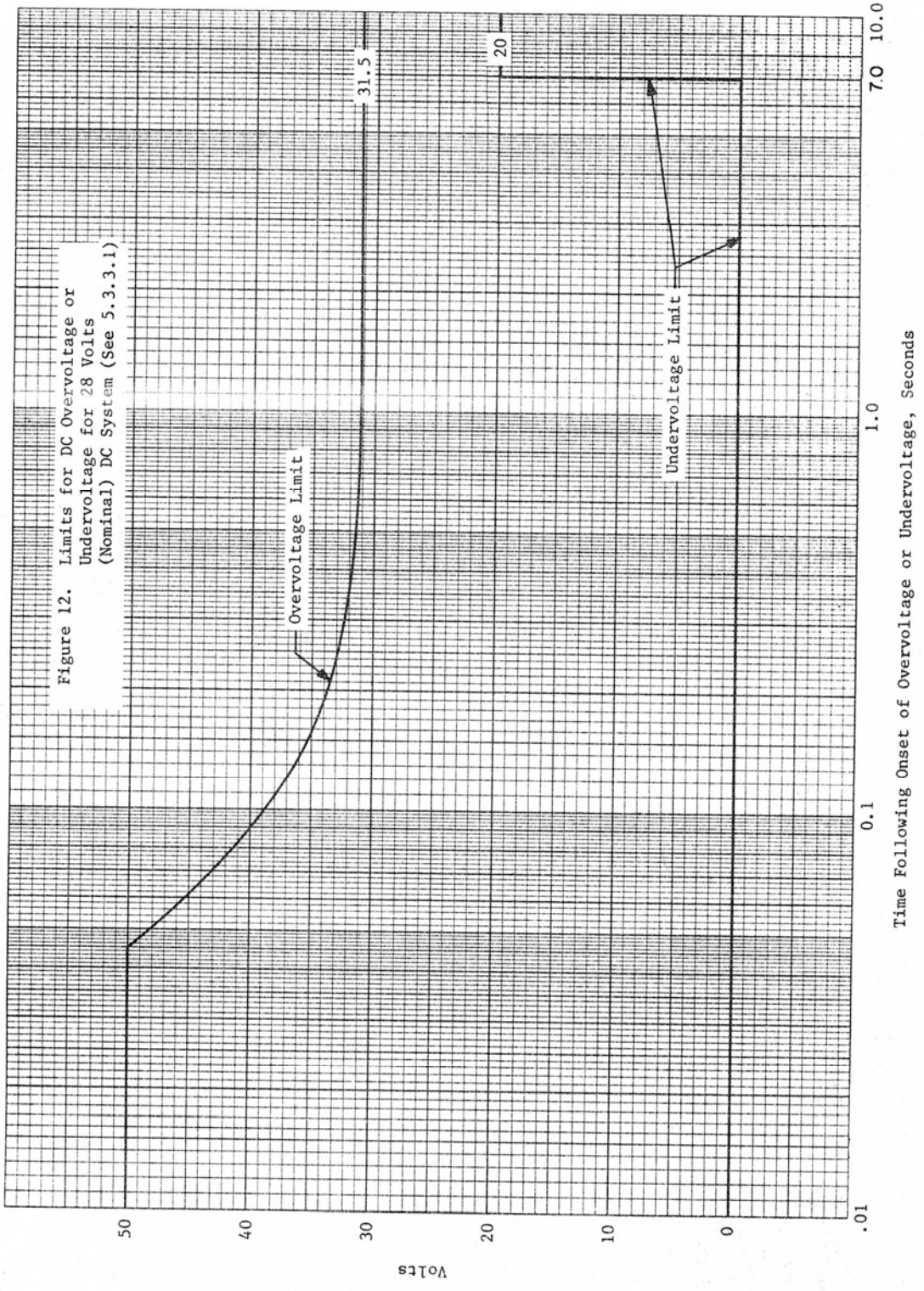


Figure 12. Limits for DC Overvoltage or Undervoltage for 28 Volts (Nominal) DC System (See 5.3.3.1)

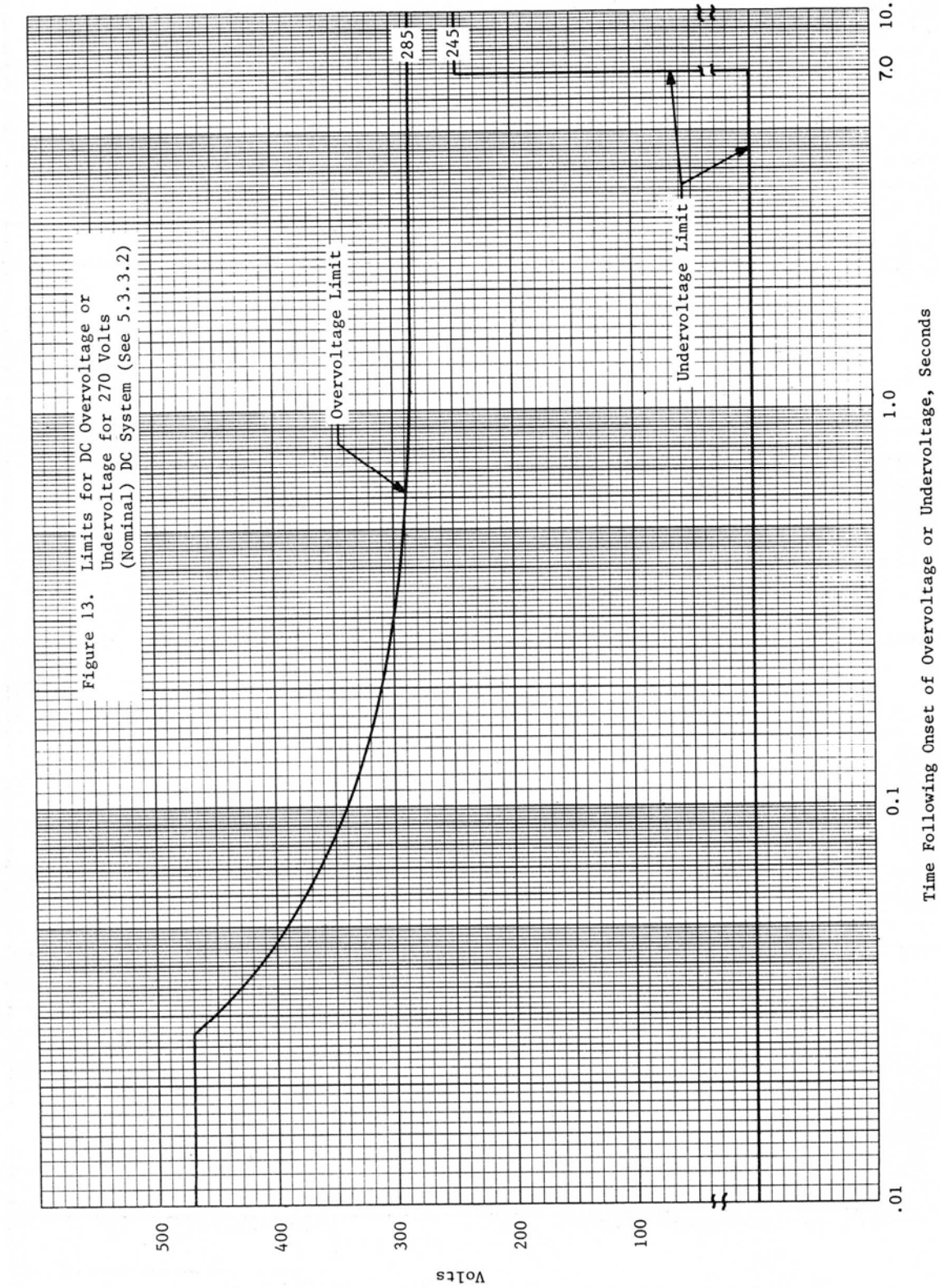


Figure 13. Limits for DC Overvoltage or Undervoltage for 270 Volts (Nominal) DC System (See 5.3.3.2)

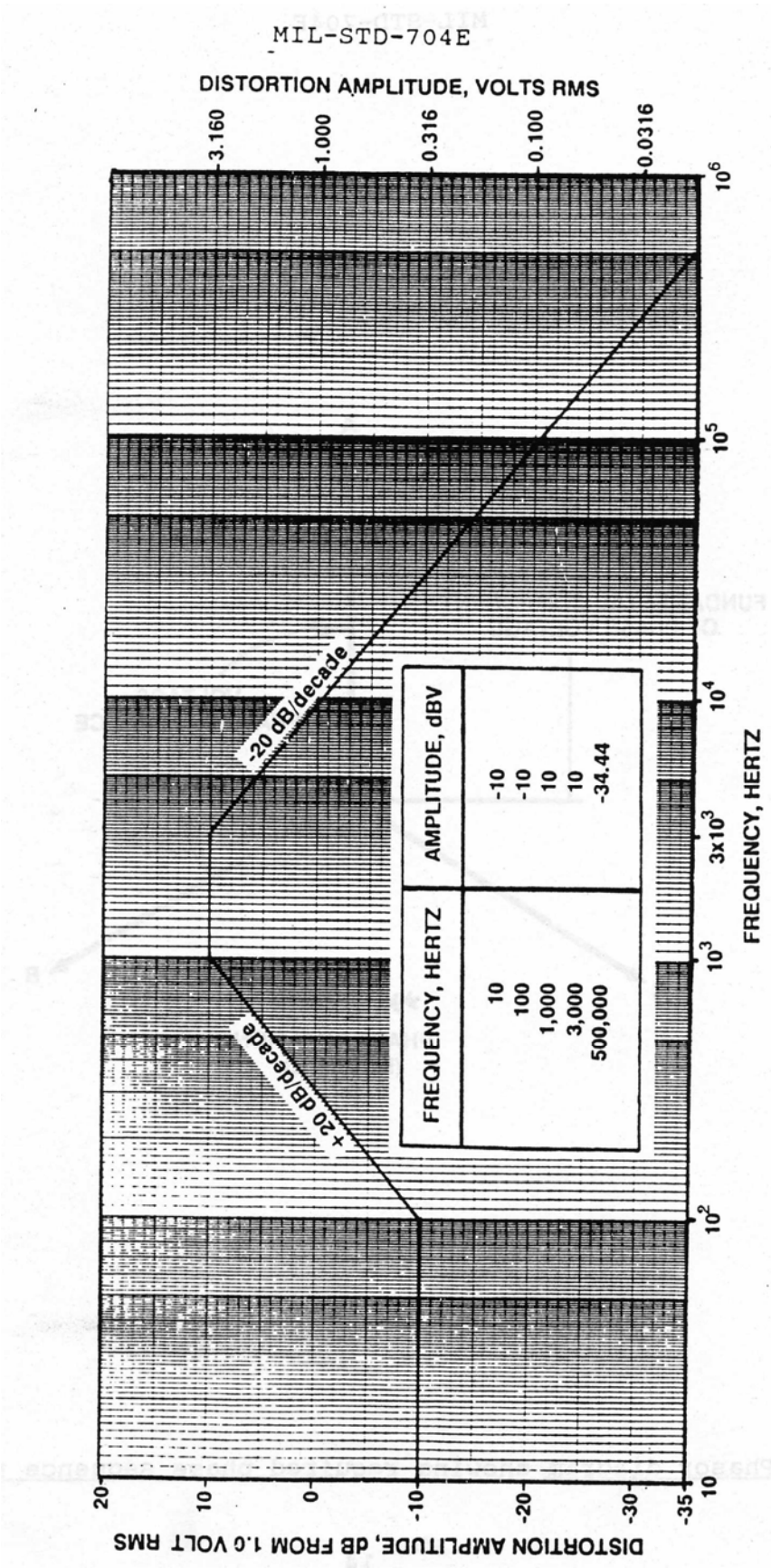


FIGURE 3. Maximum distortion spectrum of AC voltage.

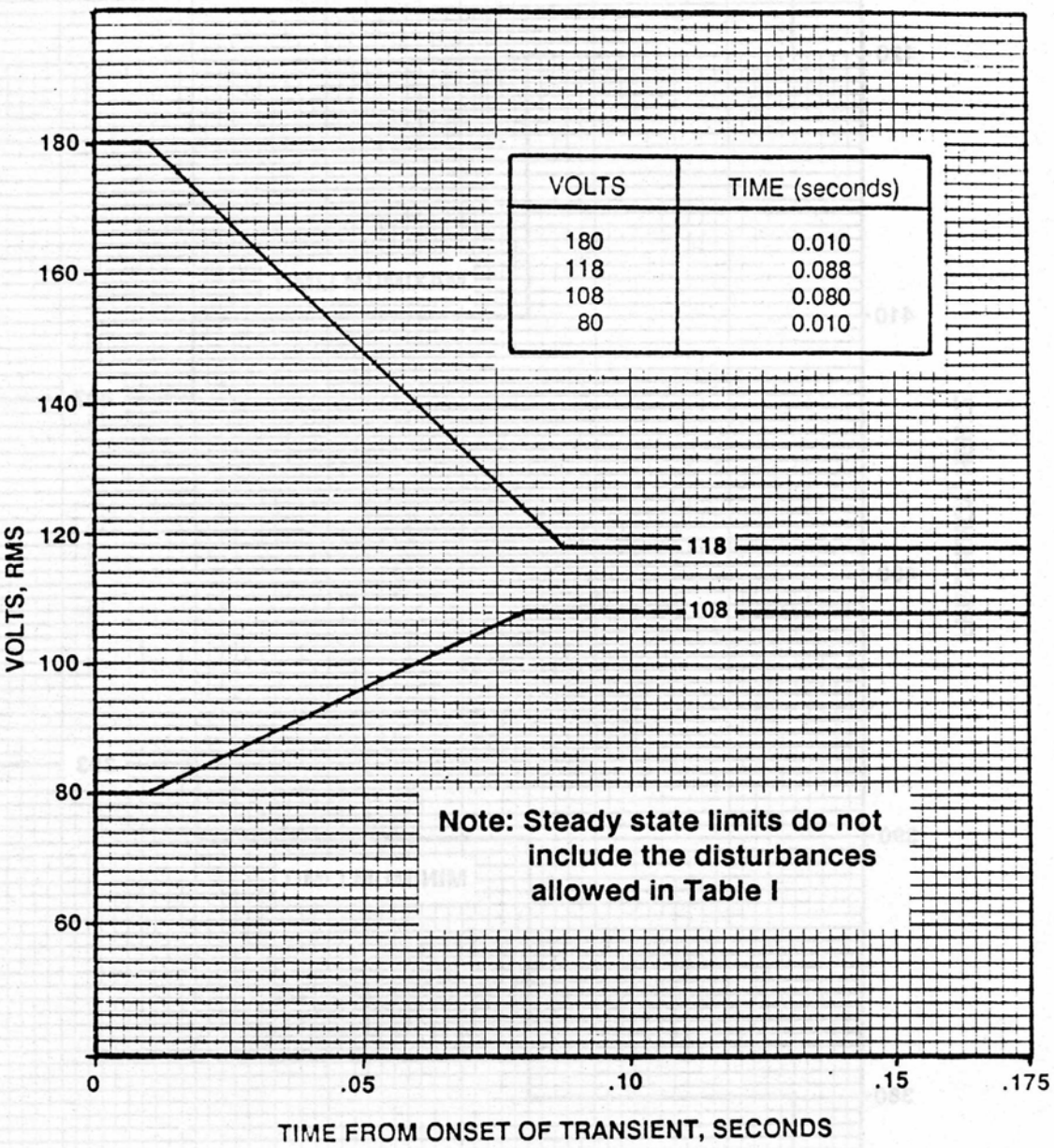


FIGURE 4. Envelope of normal AC voltage transient.

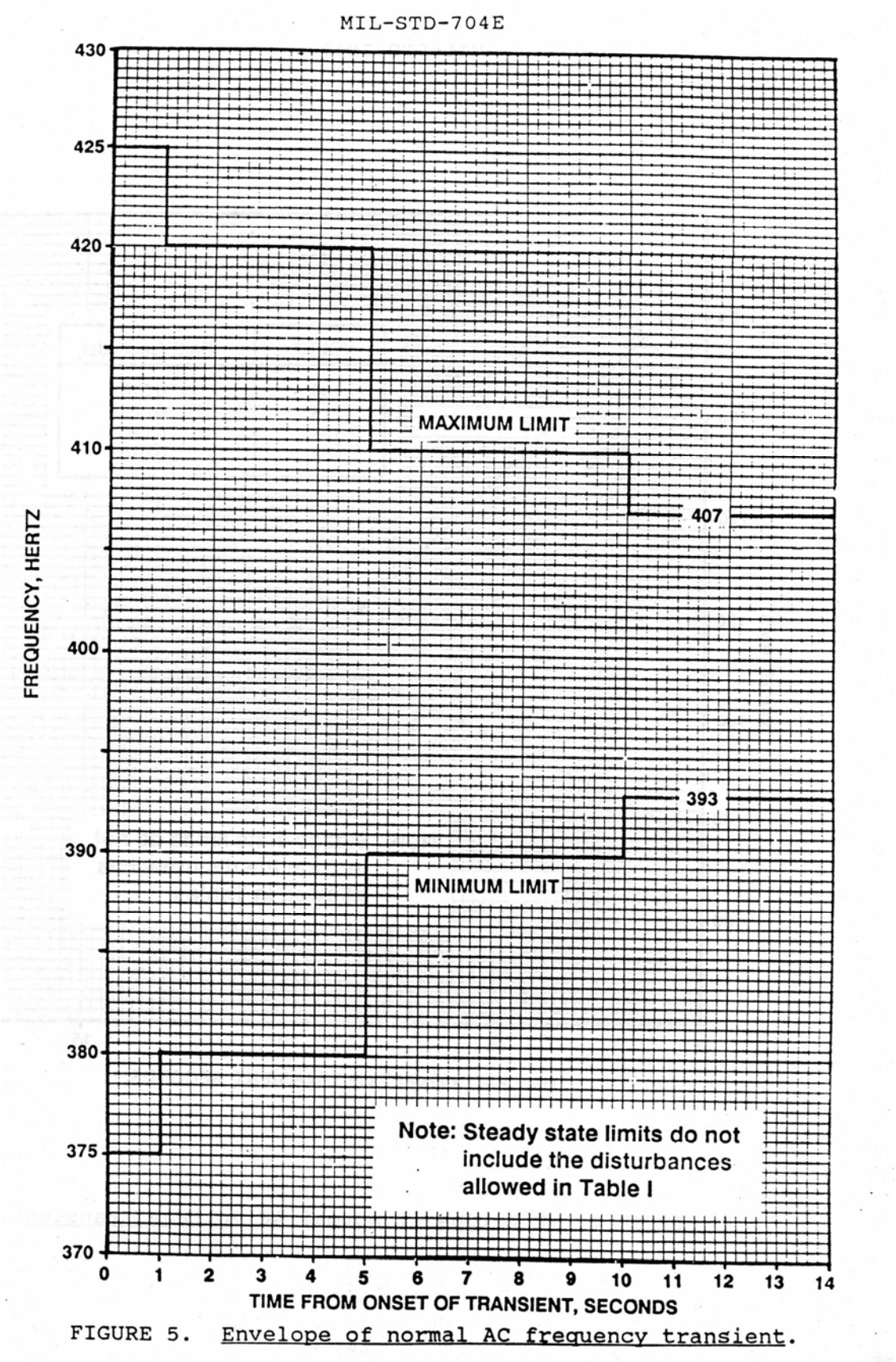


FIGURE 5. Envelope of normal AC frequency transient.

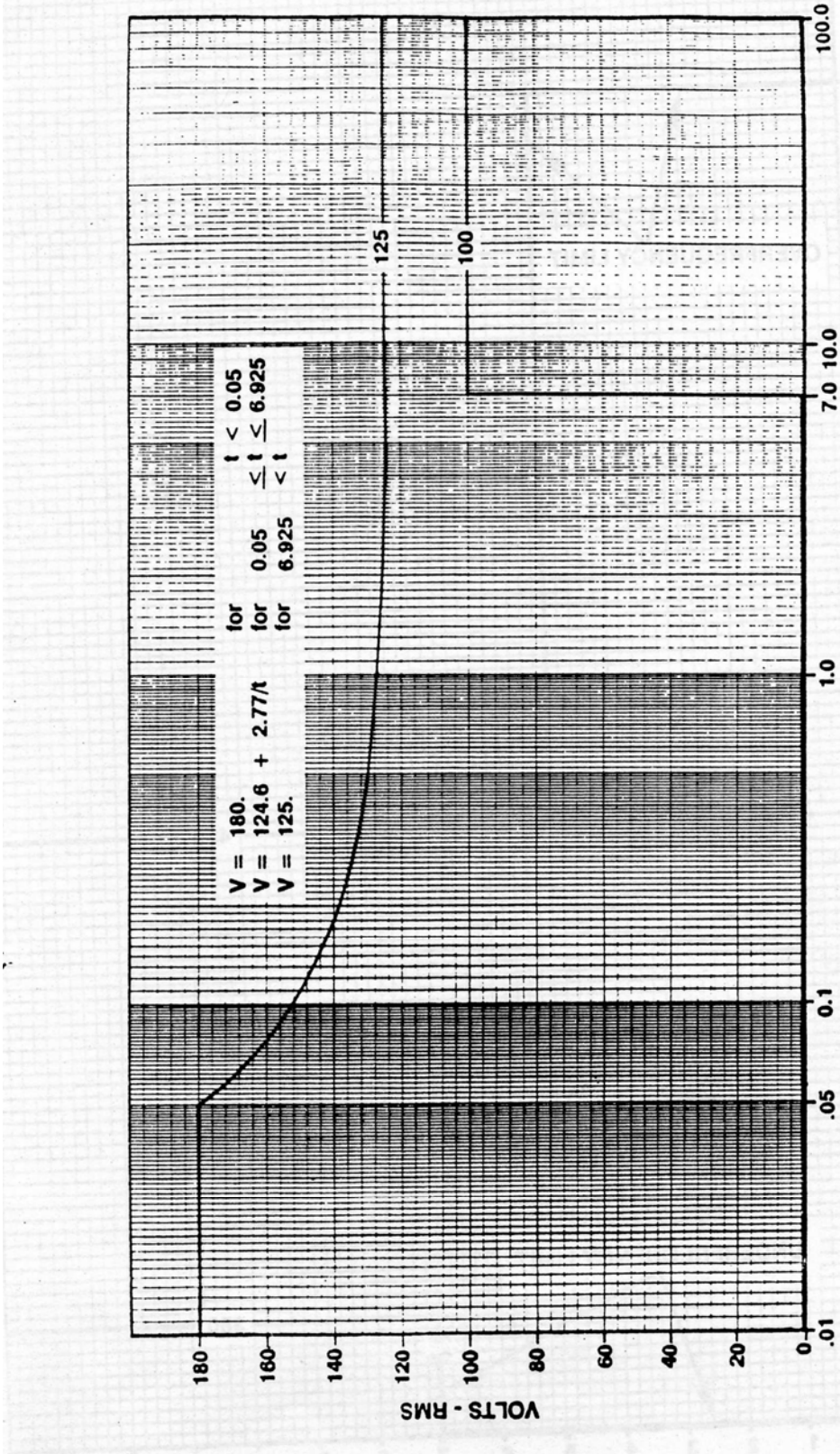


FIGURE 6. Limits for AC overvoltage or undervoltage.

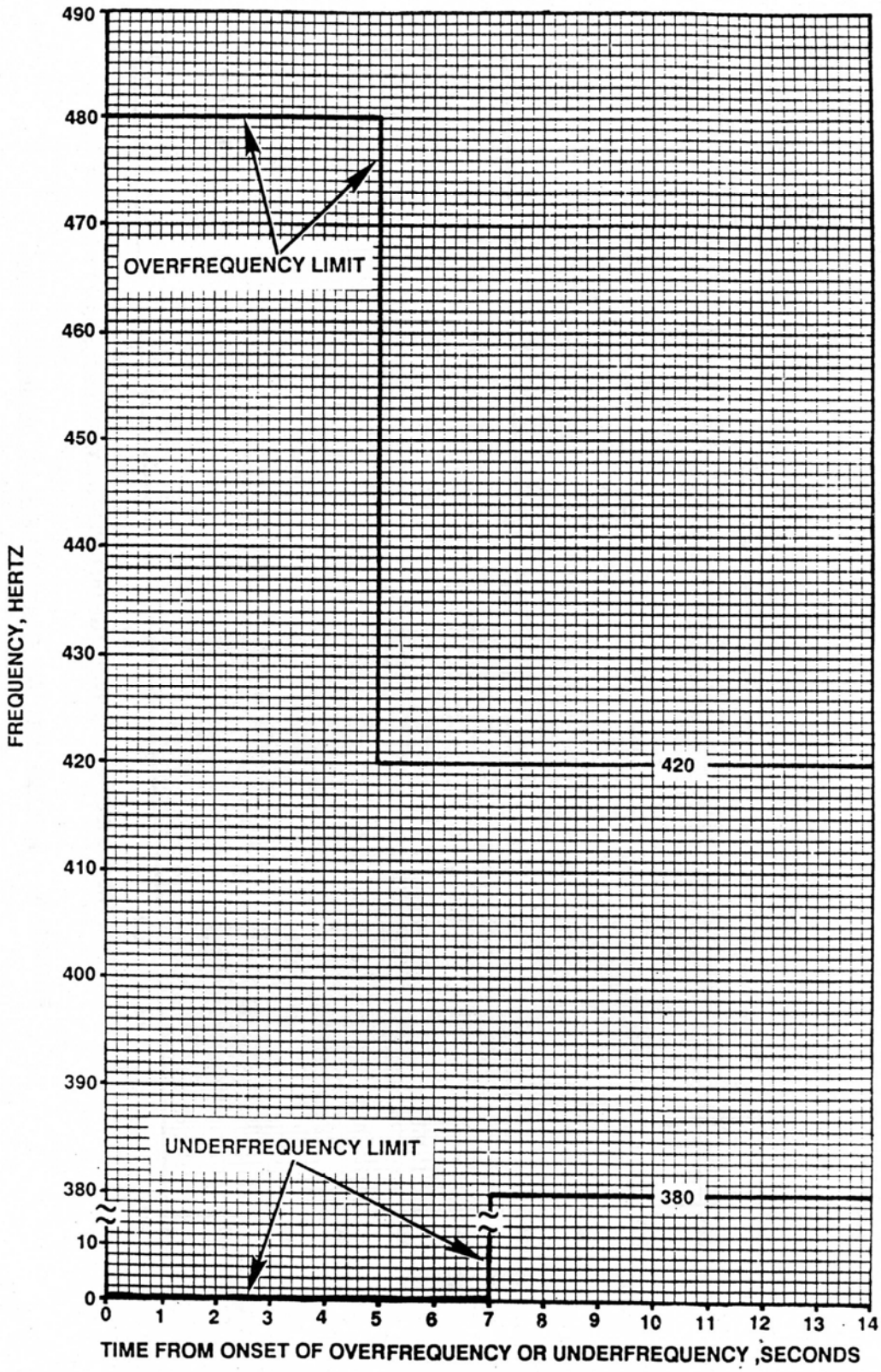


FIGURE 7. Limits for AC overfrequency or underfrequency.

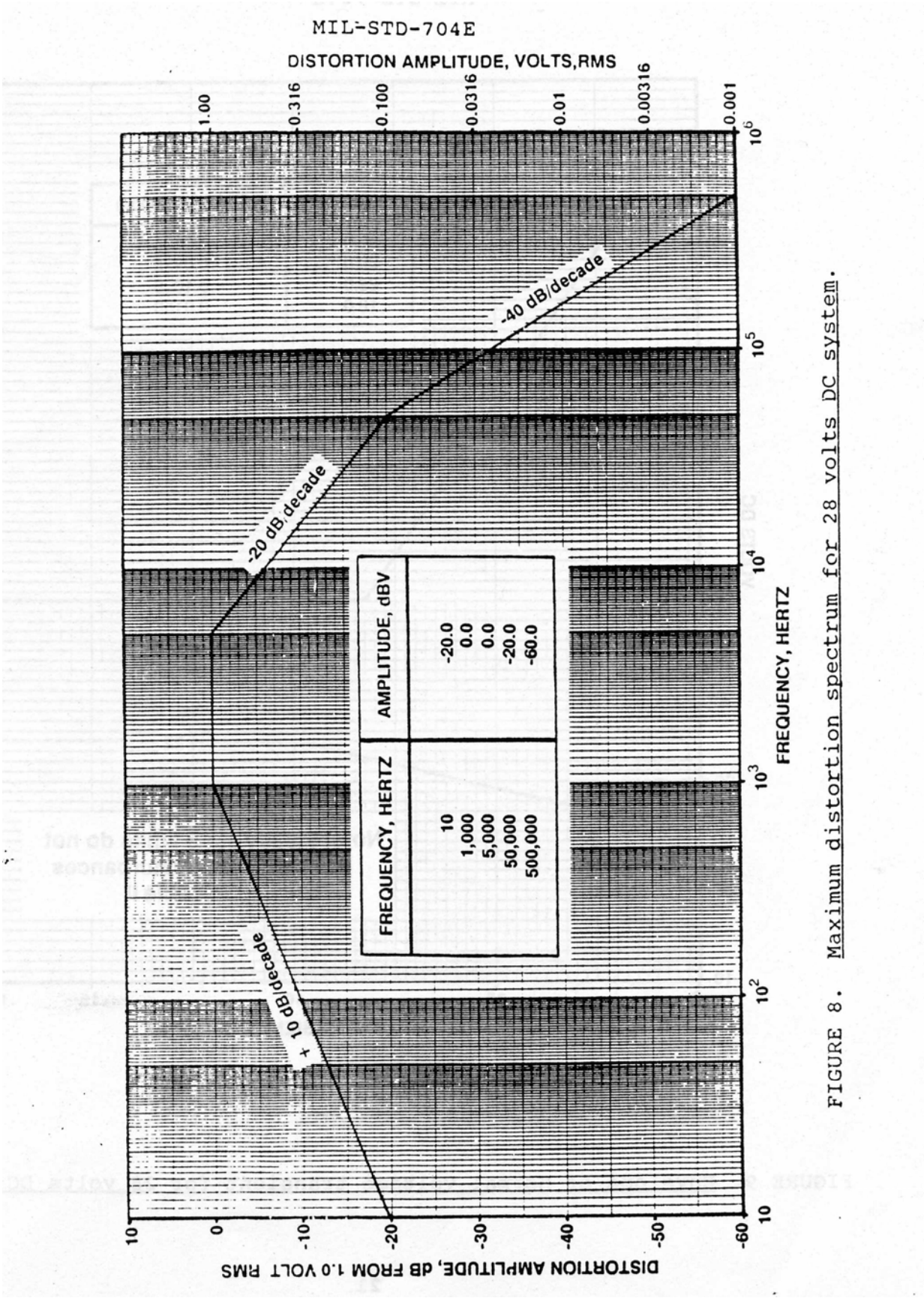


FIGURE 8. Maximum distortion spectrum for 28 volts DC system.

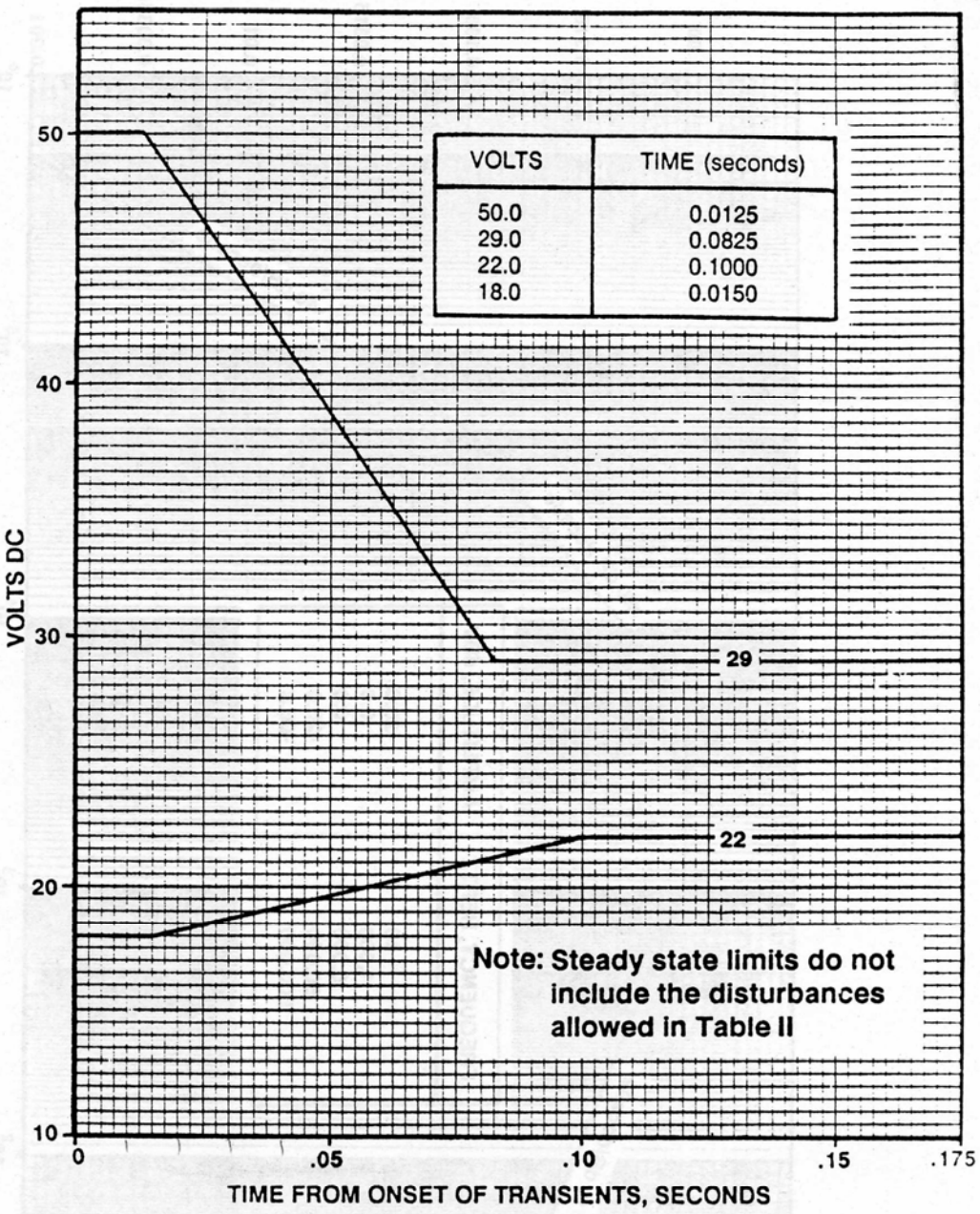


FIGURE 9. Envelope of normal voltage transient for 28 volts DC s

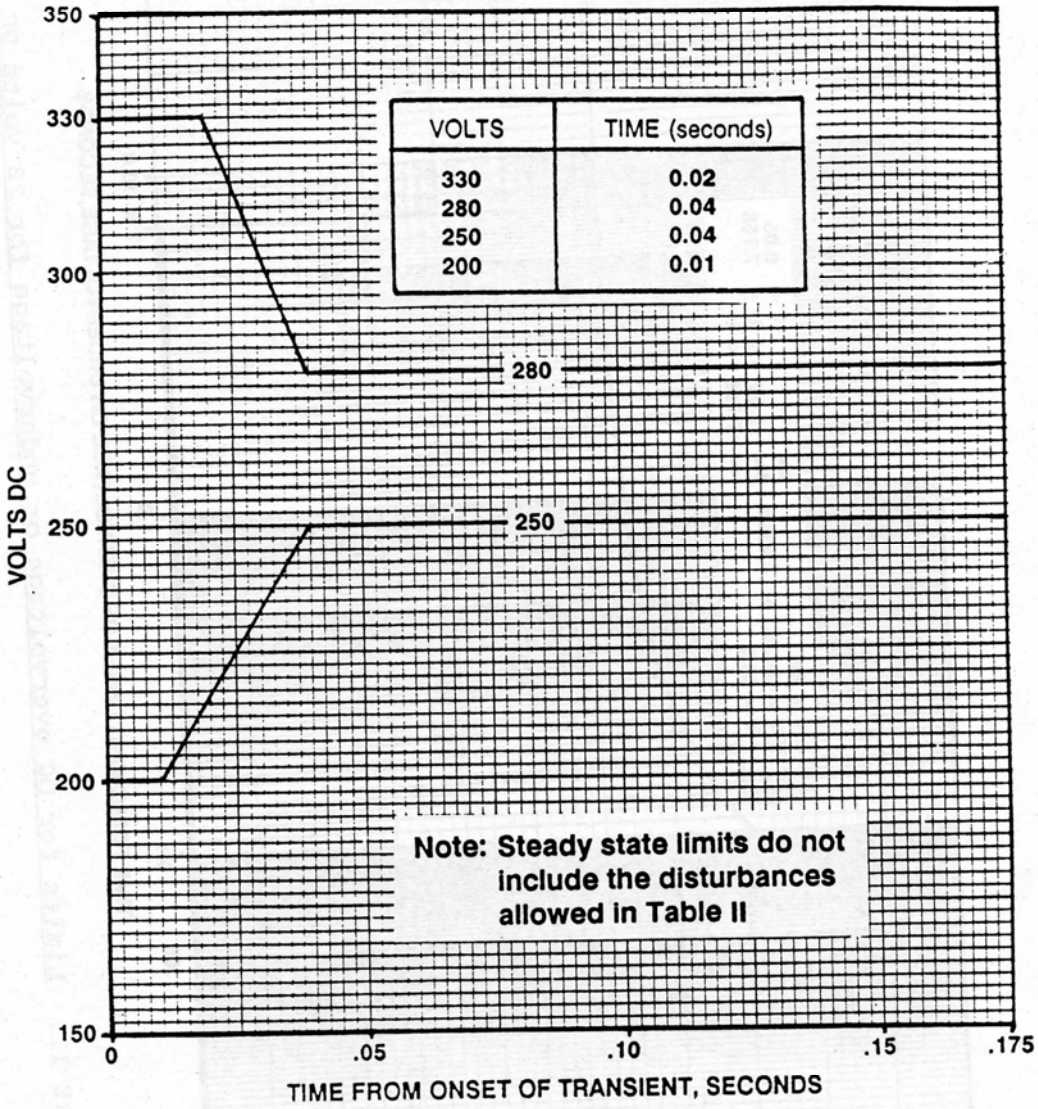


FIGURE 10. Envelope of normal voltage transient for 270 volts DC syst

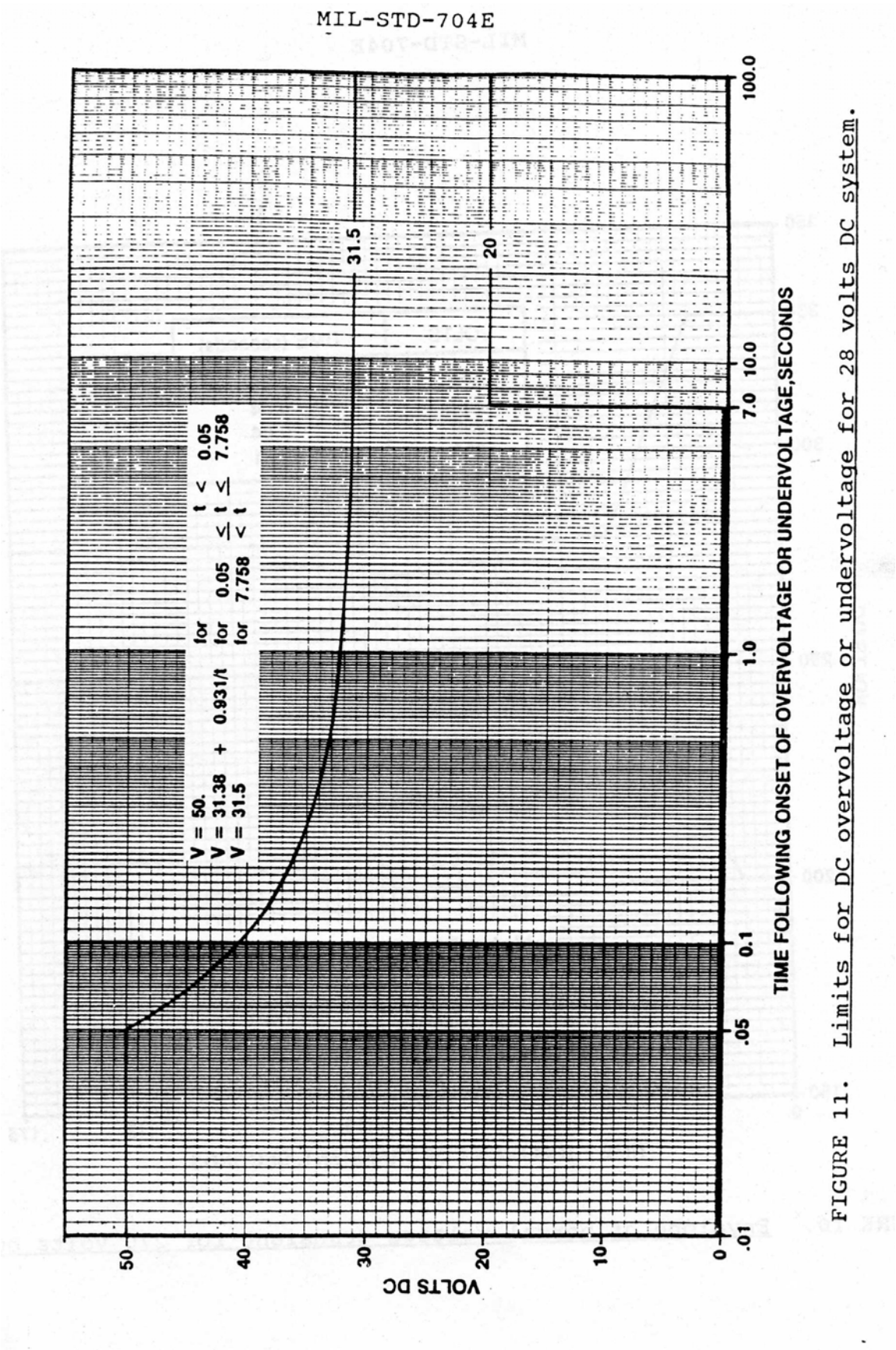


FIGURE 11. Limits for DC overvoltage or undervoltage for 28 volts DC system.

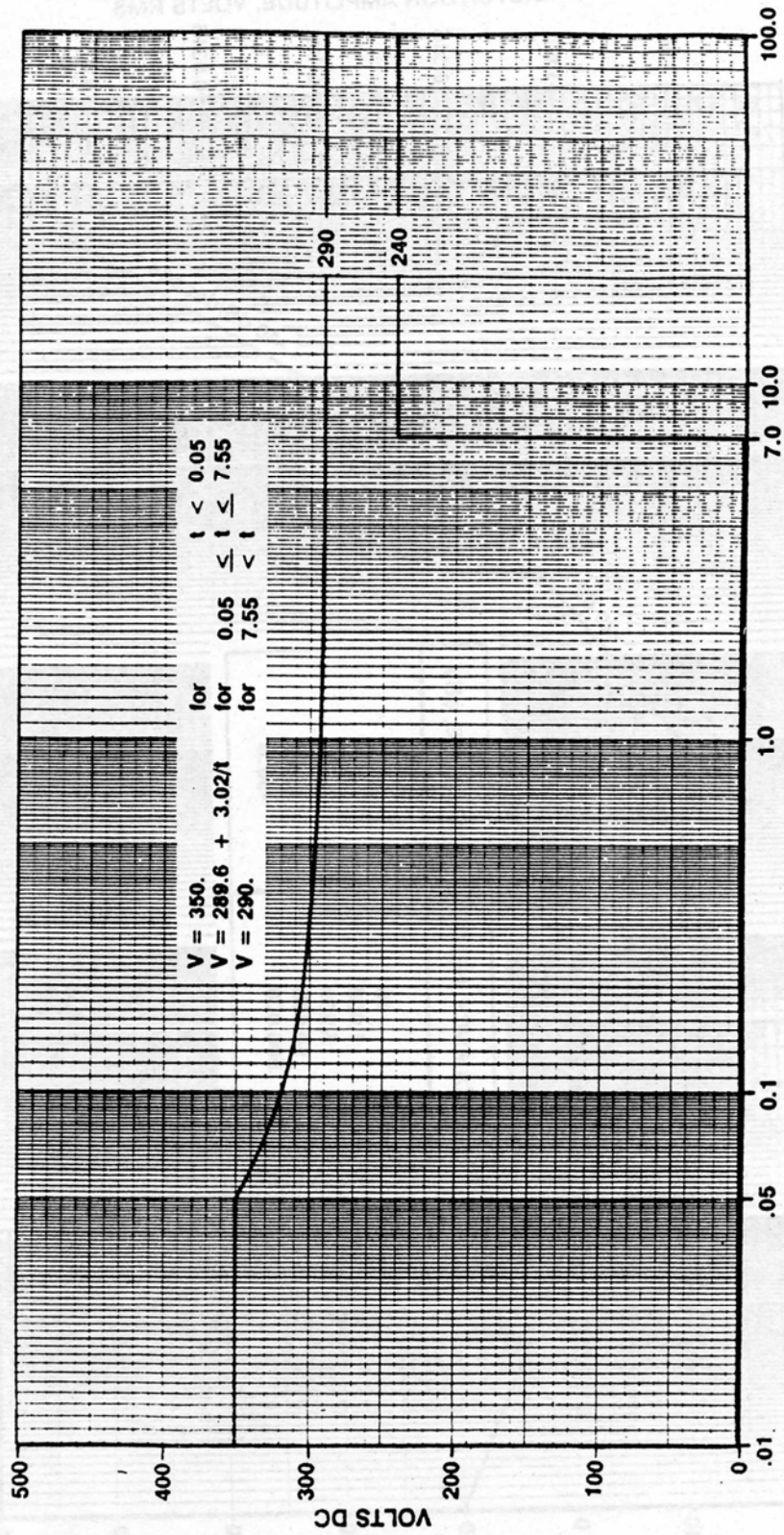


FIGURE 12. Limits for DC overvoltage or undervoltage for 270 volts DC system.

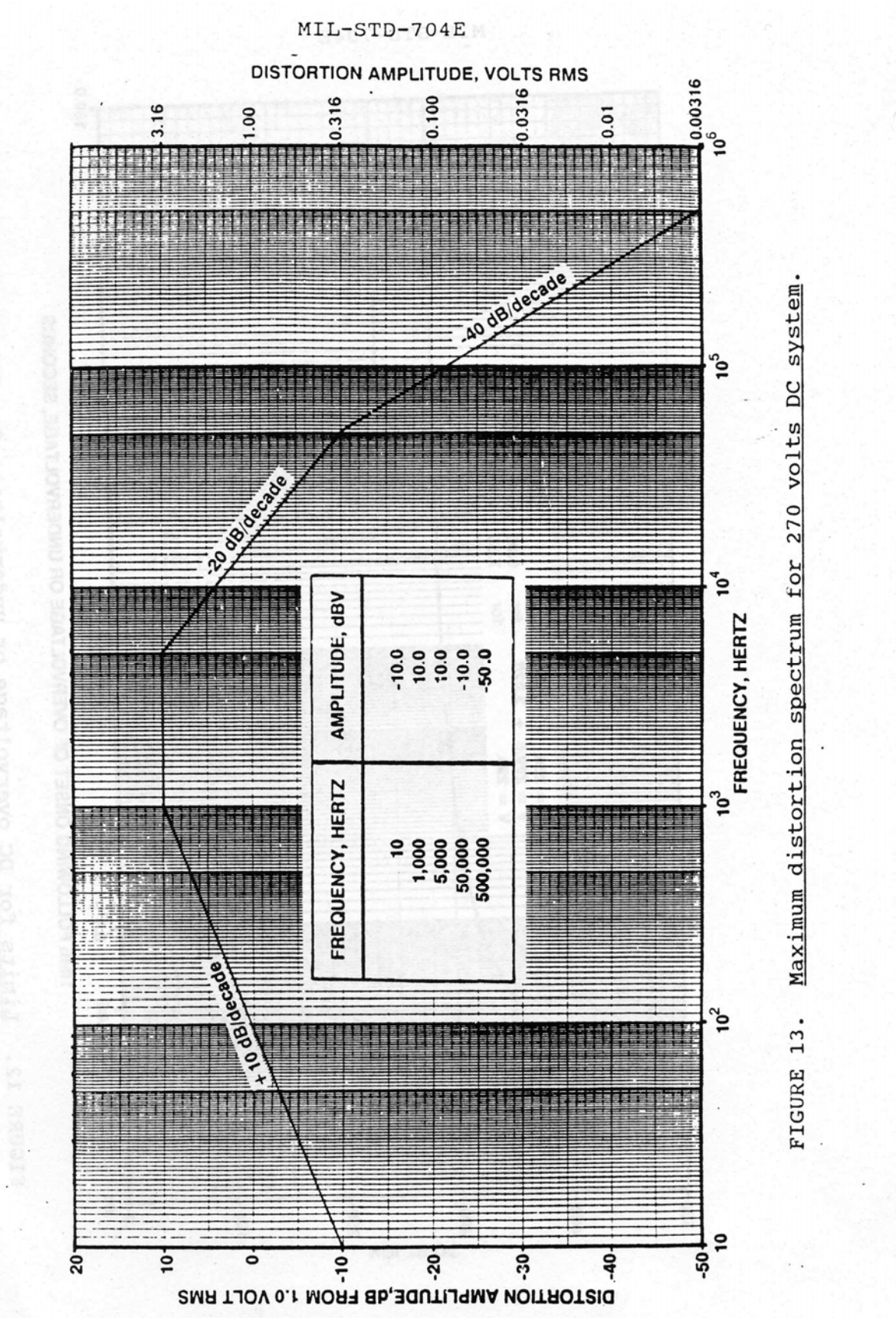


FIGURE 13. Maximum distortion spectrum for 270 volts DC system.