MIL-G-62186
19 January 1988
SUPERSEDING
(see 6.6)

MILITARY SPECIFICATION

GENERATOR, ALTERNATING CURRENT (650 AMPERE RECTIFIED), 28 VOLTS DIRECT CURRENT (OIL COOLED)

This specification is approved for use within the US Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers a 28 volt (V) alternating current (ac) direct current (dc), oil cooled generator with integral rectifier, referred to herein as "alternator." The alternator provides regulated output at any engine load up to 500 amperes (A) at any engine speed between 2000 and 2400 revolutions per minute (rpm), and at any load up to 650 A at any speed between 2400 and 8000 rpm, when its field excitation is controlled by a solid-state regulator.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A
FSC 6115

SPECIFICATIONS
FEDERAL

F-F-351	- Filters and Filter Elements, Fluid Pressure: Lubricating Oil, Bypass and Full Flow.
V-F-800	- Fuel Oil, Diesel.

MILITARY

MIL-L-2104	- Lubricating Oil, Internal Combustion Engine, Tactical Service.
MIL-B-11188	- Batteries, Storage: Lead-Acid.
MIL-P-15024	- Plates, Tags and Bands for Identification of Equipment.
MIL-L-21260	- Lubricating Oil, Internal Combustion Engine, Preservative and Break-in.
MIL-L-46167	- Lubricating Oil, Internal Combustion Engine, Arctic.

STANDARDS
MILITARY

MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-130	- Identification Marking of US Military Property.
MIL-STD-454	- Standard General Requirements for Electronic Equipment.
MIL-STD-461	- Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-462	- Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-810C	- Environmental Test Methods and Engineering Guidelines.
MIL-STD-889	- Dissimilar Metals.
MIL-STD-45662	- Electromagnetic Interference Characteristics, Measurement of.

2.1.2 Government drawings. The following Government drawings form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

DRAWINGS
ARMY

10882774	- Cradle.
11655426	- Engine and Transmission Assembly.
11655469	- Generator, AC-DC (Oil Cooled).
11682700	- Engine, Diesel.

11682722	- Coupling.
11684057	- Support.
12354334	- Regulator, Voltage, DC.

(Copies of specifications, standards and drawings required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. Unless otherwise specified (see 6.2 and 6.4), the contractor shall furnish alternators which shall be subjected to first article inspection (see 4.4). First article inspection samples, properly marked with identifying information shall be representative of the units to be furnished to the Government. All subsequent alternators delivered to the Government shall conform to these samples in all of their pertinent physical and performance attributes.

3.2 Materials. Material shall be as specified herein, in applicable specifications, and on applicable drawings. Materials not specifically designated shall be suitable for use in the alternator conforming to the specified requirements (see 4.8.1).

3.2.1 Material compatibility. All materials used in the alternator shall be compatible with fluids per MIL-L-2104, MIL-L-21260, MIL-L-46167, and VV-F-800 (see 4.8.1).

3.2.2 Dissimilar metals. Except where necessary to complete an electrical circuit, contact between dissimilar metals which would encourage galvanic action shall be avoided. Separation of dissimilar metals shall be accomplished by providing insulation between mating surfaces. Dissimilar metals are defined in MIL-STD-889 (see 4.8.1).

3.2.3 External surfaces. All external surfaces shall be corrosion resistant (see 4.8.1).

3.2.4 Fungicidal materials. All nonmetallic materials shall be inherently fungicidal or treated to resist fungus growth except when used for components of potted compounds or otherwise moisture sealed assemblies (see 4.8.1).

3.2.5 Standard parts. Military standard parts shall be used wherever possible (see 4.8.1).

3.2.6 Recycled, virgin and reclaimed materials. There are no requirements for the exclusive use of virgin materials. The use of recycled or reclaimed (recovered) materials is acceptable provided that all other requirements of this specification are met (see 6.3.5).

3.3 Design and construction. The alternator shall conform to dimensions and requirements shown on Drawing 11655469. Further, the alternator shall be in accordance with the recommendations and requirements for MIL-STD-454 (see 4.8.1 and 4.8.2).

3.3.1 Interchangeability. All alternators shall be interchangeable with respect to installation and performance. The alternator, after manufacture or overhaul, shall not require any adjustment at the time of installation. To provide for interchangeability, the assembly fabricated in accordance with this specification shall have external dimensions conforming to the Drawing 11655469. Electrical connectors, mounting dimensions, and location shall conform to the detail requirements of 11655469. Contact designation shall conform to requirements of 11655469 (see 4.8.1 and 4.8.2).

3.3.2 Installation compatibility. The alternator shall fit and perform as specified when installed on an AVDS1790-2C engine (Drawing 11682700) for trial in an M60A1-RISE tank (see 4.8.1 and 4.8.2).

3.3.3 Regulator. The alternator shall function as specified with regulators depicted on Drawing 12354334 (see 4.8.1).

3.3.5 Weight. The weight of the alternator shall be not greater than 100 pounds (lb) (see 4.8.3).

3.4 Performance.

3.4.1 Operating conditions. Unless otherwise specified the alternator shall perform as specified herein under the following conditions (see 4.8.4):

a. Coolant oil

1. For ambient conditions of minus 10 to plus 225 degrees Fahrenheit (°F), oil used shall be in accordance with MIL-L-2104 as follows:

Ambient temperature	Grade of oil
Minus 10 to plus 40°F	10
32 to 90°F	30
60°F or above	50

2. For ambient conditions of minus 25 to 0°F, oil used shall be in accordance with MIL-L-46167.

b. Ambient temperatures:

1. Room ambient 80° F ± 20°F
2. Low temperature ambient -25°F ± 5°F
3. High temperature ambient +225°F ± 5°F

c. Alternator inlet oil temperature range from -25°F ± 5°F to +225°F ± 5°F.

d. Alternator inlet oil temperature range from -.385 psi to 45 psi.

e. Rated output power: 650 ampere @ 28 V dc.

f. AC signal load (L1) 1 k ± 5%; 3W. resistor

g. CT signal load (L2) 40 ± 1%; 3w. resistor.

h. Signal loads (see figure 9): The alternating current (ac signal load at L1 shall be 1 kilo-ohm ± 5% with a 3 watt (W) resistor. Current transformer (ct) signal load at L2 shall be 40 ohms ± 1 percent (%) with a 3 W resistor.

i. Room temperature: 80 ± 20°F.

3.4.2 Overspeed. The alternator shall not be damaged when operated at 10,000 rpm for 1 minute (see 4.8.5).

3.4.3 Maximum field voltage. With the alternator not operating, the alternator's field shall not be damaged by application of maximum potential 22 V dc for thirty minutes (see 4.8.6).

3.4.4 Field resistance. The alternator control field resistance shall be 1.80 ± 0.25 ohms at room ambient temperature (see 4.8.7).

3.4.5 Output power. With the alternator providing output power of 650 A at 28 V dc, the field current shall be not greater than 4.25 A at 2400 rpm, and 3.15 A at 8000 rpm (see 4.4.8).

3.4.6 Ripple voltage. Ripple voltage shall be not greater than 4 V, peak to peak, with output voltage of 28 V dc (see 4.8.9).

3.4.7 Overload output current. The alternator shall not be damaged by an output load of 800 ± 25 A at not less than 23 V dc for 30 seconds. The field current shall be not greater than 4 A (see 4.8.10).

3.4.8 Alternating current (ac) signal. With 20 ± 2 V dc applied to the field terminals, the ac signal level shall be 7.1 ± 0.5 V root mean square (rms) at an alternator speed of 900 rpm, and 8.9 ± 0.5 V rms at a speed of 1100 rpm (see 4.8.11).

3.4.9 Current transformer (ct) signal. The ct signal level shall be 2.8 + 0.2, -0.3 V rms at 650 A load at 8000 rpm (see 4.8.12).

3.4.10 Alternator oil system. The alternator shall be equipped with a self-contained oil pump with a pressure regulator valve. The oil system shall produce a cooling oil flow of not less than 2.35 gallons per minute (gpm), nor greater than 6.0 gpm. The alternator oil pump outlet pressure shall be not greater than the proof pressure (see 4.8.13).

3.4.11 Transient load. The alternator, when subjected to transient loads, shall meet the performance requirements specified on figure 1 (see 4.8.14).

3.4.12 Efficiency. The efficiency of the alternator shall be not less than 65 percent (see 4.8.15).

3.4.13 Proof pressure. The alternator cooling system shall withstand a 200 pounds per square inch (psi) pressure for a period of 5 minutes without evidence of permanent deformation or rupture. The leakage rate shall be not greater than a pressure drop of 10 psi in 1 minute (see 4.8.16).

3.4.14 Endurance. The alternator shall withstand operation for the time specified in table I, with output voltage and speed/load conditions as specified therein. During this time the alternator shall require no servicing or replacement of parts (see 4.8.17).

3.4.14.1 System volts (see table I, normal attitude. System volts shall be applicable at 225°F. Voltage values at lower temperatures shall be in accordance with figure 2.

3.4.14.2 Operating time. At the conclusion of 22 cycles at normal attitude, the alternator shall be operated for 8 hours at condition (a) and 4 hours at condition (b), except with alternator constant load, only; followed by 2 cycles of inclined attitude.

3.4.14.3 Operating conditions. The total time, 3000 hours, shall be run with alternator oil inlet pressures as follows:

1st 600 hours at minus 0.385 ± 0.03 psi.
2nd 600 hours at 45 ± 2 psi.
3rd 600 hours at minus 0.385 ± 0.03 psi.
4th 600 hours at 45 ± 2 psi.
5th 600 hours at minus 0.385 ± 0.03 psi.

3.4.15 External oil leakage. The alternator shall not exhibit oil loss to external surfaces which at any location is greater than a loss of fluid of one drop (see 6.3) per hour (see 4.8.18).

3.4.16 Torsion.

3.4.16.1 Natural frequency. The natural torsional resonant frequency of the rotor and shafting system shall be 100 to 140 hertz (Hz) (see 4.8.19.1).

3.4.16.2 Vibratory torque. The alternator shall withstand a vibratory torque of 3600 inch-pounds double amplitude, maximum positive torque to be not greater than 2100 inch-pounds, at a frequency not greater than 25 Hz or less than 20 Hz for a period producing 12,000 torque reversals (see figure 3 and 4.8.19.2).

3.4.16.3 Torsional application. The alternator shall successfully withstand operation on an engine-transmission assembly (see 6.4) as specified in 4.8.19.3. There shall be no degradation of the system drive train elements or of the engine-transmission assembly performance. The alternator shall subsequently meet 3.4.2 through 3.4.10.

3.5 Environmental. The alternator shall perform as specified herein after meeting the extreme conditions of the military environment (see 4.9).

3.5.1 High temperature. While in an ambient temperature of 225 ± 5°F, the alternator shall meet the performance requirements of 3.4.2 through 3.4.10 (see 4.9.1).

3.5.2 Low temperatures.

3.5.2.1 Cold soak. While in an ambient temperature of minus 25 ± 5°F with an oil inlet pressure of 45 pounds per square inch gage (psig), the alternator shall meet the performance requirements of 3.4.2, 3.4.5, 3.4.8, and 3.4.9. The alternator oil pump outlet pressure shall not exceed the proof pressure (see 4.9.2.1).

3.5.2.2 High viscosity oil. The alternator shall withstand operation in the intended application using grade 10 oil of MIL-L-2104 while at an ambient temperature of minus 10 ± 2°F. This condition represents the highest viscosity oil of the application. There shall be no indications of failure, fractures, distortions, erosion, internal oil leakage, or other evidence of deterioration. External oil leakage shall conform to 3.4.15 (see 4.9.2.2).

3.5.3 Shock. The alternator shall withstand a shock pulse of 20 gravity units for 11 milliseconds (ms) (saw tooth wave) (see 4.9.3).

3.5.4 Vibration. The alternator shall withstand exposure to input vibration levels outlined in figures 4, 5 and 6 for a period of 100 minutes in each of the mutually perpendicular axes (see 4.9.4).

3.5.5 Fungus. The alternator shall not be adversely affected by fungi under conditions favorable for their development (see 4.9.5).

3.5.6 Corrosion. The alternator shall resist the effects of a salt atmosphere (see 4.9.6).

3.5.7 Humidity. The alternator shall withstand subjection to a humid environment (see 4.9.7).

3.5.8 Waterproofness. The alternator shall be capable of maintaining of differential pressure of nitrogen at 10 psig. The leakage rate shall be not greater than 3 psig in 2 minutes (see 4.9.8).

TABLE I. Endurance time schedule and conditions.

			Normal attitude						
condition	Time (hours)	Alternator (rpm)	System volts (V)	Alternator constant load (A)	Resistive cyclic load (A)	Total alternator (A)	Load cycles (minutes)	Cyclic load (seconds) on	Cyclic load (seconds) off
a.	1.5	2400	26.50 ± 0.75	320	330	650	90	3	57
b.	7.5	5120	26.50 ± 0.75	320	330	650	450	3	57
c.	14.5	3520	26.50 ± 0.75	320	330	650	870	3	57
d.	0.5	8000	26.50 ± 0.75	650	0	650	0		
	24 hours per cycle								
			Inclined attitude						
e.	9	2400							
f.	9	4000							
g.	9	5000	no. load						
f.	3	6000							
	30 hours per cycle								

3.5.9 Electromagnetic interference. The alternator's broad-band conducted and radiated emissions shall be not greater than the limits of figures 7 and 8 (see 4.9.9).

3.6 Identification marking. The alternator assembly shall be marked in accordance with MIL-STD-130 (see 4.5.2 and 4.8.2).

3.6.1 Nameplate. The alternator assembly shall have a nameplate affixed to the exterior of the alternator frame in a location specified on the drawing. The nameplate shall conform to MIL-P-15024, type A. All nameplates shall include the following information (see 4.5.2 and 4.8.2):

"Generator, Alternating Current, Direct Current (Oil Cooled)",
"28 V dc",
"650 A",
Military part number,
Federal stock number,
Manufacturer's identification (FSCM),
Manufacturer's serial number,
Contract number, and
Date of manufacture.

3.7 Workmanship. The workmanship shall be such as to assure a product free of rust, burrs, and scratches. Solder connections shall conform to requirement 5 of MIL-STD-454. All solder cleaning agents and flux shall be chemically neutralized and removed after soldering. Manufacturing methods shall not cause degradation of the inherent reliability and durability of the alternator (see 4.5.2 and 4.8.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform or witness any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply wih all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

damage. (hot saturated ammonium acetate solution at about 25

4.1.2 Inspection equipment. Unless otherwise specified in the contract (see 6.2), the contractor is responsible for the provision and maintenance of all inspection equipment necessary to assure that supplies and services conform to contract requirements. Inspection equipment must be capable of repetitive measurements to an accuracy of 10% of the measurement tolerance. Calibration of inspection equipment shall be in accordance with MIL-STD-45662.

4.2 Classification of inspection:

a. First article inspection (see 4.4).
   1. Preproduction inspection (see 4.4.1).
   2. Initial production inspection (see 4.4.2).

b. Quality conformance inspections (see 4.5).
   1. Examination (see 4.5.2).
   2. Test (see 4.5.3).

c. Control tests (see 4.6).

4.3 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:

a. Air temperature 80 ± 20°F.
b. Barometric pressure 28.5 + 2.0 - 3.0 inches mercury (Hg).
c. Relative humidity 50 ± 30%.

4.4 First article inspection. First article inspections shall be performed on preproduction or initial production samples as specified herein. Approval of the first article sample by the Government shall not relieve the contractor of the obligation to supply alternators that are fully representative of those inspected as a first article sample. Any changes or deviation of the production units from the first article sample shall be subject to the approval of the contracting officer.

4.4.1 Preproduction inspection. When specified (see 6.2), the preproduction sample shall consist of two alternators. Preproduction inspection shall consist of inspection as specified in table II.

4.4.2 Initial production inspection. Unless otherwise specified (see 6.2), the Government shall select two units, from the first ten alternators produced under the production contract for initial production inspection. Initial production units shall be inspected as specified in table II.

4.4.3 First article inspection failure. Deficiencies found during, or as a result of, the first article inspection shall be cause for rejection of the first article sample until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency. Any deficiency found during, or as a result of, the first article inspection shall be evidence that all items already produced prior to completion of the

first article test are similarly deficient unless contrary evidence satisfactory to the contracting officer is furnished by the contractor. Such deficiencies on all items shall be corrected by the contractor. The Government will not accept products until first article inspection is completed to the satisfaction of the Government.

TABLE II. Classification of inspections.

Title	Requirement	Inspection	First Article Inspections				Quality conformance		Control	
			PPI samples		PPI samples		Examination	Test (100%)	1/50	1/100
			1	2	1	2				
Materials and construction	3.2 thru 3.3.3	4.8.1	X		X				X	
Defects (see table III and 4.8.2)	3.3, 3.3.2 and 3.6 thru 3.7	4.8.2	X		X		X		X	
Weight	3.3.4	4.8.3	X	X	X	X			X	
Overspeed	3.4.2	4.8.5	X	X	X	X		X		
Field voltage	3.4.3	4.8.6	X	X	X	X			X	
Field resistance	3.4.4	4.8.7	X	X	X	X		X		
Output current	3.4.5	4.8.8	X	X	X	X		X		
Ripple voltage	3.4.6	4.8.9	X	X	X	X				
Acceptance		4.8.9.1						X		
Overload output current	3.4.7	4.8.10	X	X	X	X				
Alternating current signal	3.4.8	4.8.11	X	X	X	X		X		
Current transformer signal	3.4.9	4.8.12	X	X	X	X		X		
Acceptance		4.8.12.1					X			
Alternator oil system	3.4.10	4.8.13	X	X	X	X	X	X		
Transient load	3.4.11	4.8.14	X		X					
Efficiency	3.4.12	4.8.15	X		X					
Proof pressure	3.4.13	4.8.16	X	X	X	X			X	
Acceptance		4.8.16.1						X		
Endurance	3.4.14	4.8.17	X							
On vehicle		4.8.17.1	X		X			X		
Control		4.8.17.2							X	
External oil leakage	3.4.15	4.8.18							X	
Torsion	3.4.16	4.8.19								
Natural frequency	3.4.16.1	4.8.19.1	X							
Vibratory torque	3.4.16.2	4.8.19.2	X							
Torsional application	3.4.16.3	4.8.19.3	X							

TABLE II. Classification of inspections (continued).

Title	Requirement	Inspection	First Article Inspections				Quality conformance		Control	
			PPI samples		PPI samples		Examination	Test (100%)	1/50	1/100
			1	2	1	2				
Environmental	3.5	4.9	X		X					
High temperature	3.5.1	4.9.1	X		X					
Control		4.9.1.1								X
Low temperature	3.5.2	4.9.2	X		X					
Cold soak	3.5.2.1	4.9.2.1								X
High viscosity oil	3.5.2.2	4.9.2.2								
Shock	3.5.3	4.9.3	X		X					
Control		4.9.3.1							X	
Vibration	3.5.4	4.9.4	X		X					
Control									X	
Fungus	3.5.5	4.9.5								
Corrosion	3.5.6	4.9.6								
Humidity	3.5.7	4.9.7								
Waterproofness	3.5.8	4.9.8	X	X	X	X				
Electromagnetic	3.5.9	4.9.9				X				

4.5 Quality conformance inspection.

4.5.1 Sampling.

4.5.1.1 Lot formation. An inspection lot shall consist of all the alternators of one type and part number, from an identifiable production period, from one manufacturer, submitted at one time for acceptance.

4.5.1.2 Sampling for examination. Samples for quality conformance examination shall be selected in accordance with general inspection level II of MIL-STD-105. Before sampling may be initiated, the contractor shall establish by examination of at least 20 consecutively produced alternators that the process average percent defective, as defined in MIL-STD-105, is not greater than the specified AQLs.

4.5.2 Examination.

4.5.2.1 Acceptable quality level. Each sample selected in accordance with 4.5.1.2 shall be examined to determine conformance to the following acceptable quality levels (AQL).

Classification	AQL
Major	1.0
Minor	2.5

4.5.2.2 Classification of defects. For examination purposes, defects shall be classified as listed in table III.

TABLE III. Classification of defects.

Category	Defect	Method of examination
Critical	None	
Major	AQL 1.0% Defective	
101	Nonconformance in design and construction (see 3.3).	Visual and SIE 1/
102	Nonconformance in external dimensions affecting interchangeability (see 3.3.1).	SIE 1/
103	Incompatibility of alternator installation in M60 tank (see 3.3.2).	SIE 1/
Minor	AQL 2.5% Defective	
201	Nonconformance in external dimensions not affecting interchangeability (see 3.3.1).	SIE 1/
202	Improper identification marking (see 3.6).	SIE 1/
203	Incorrect information on nameplate (see 3.6.1)	Visual
204	Improper location of nameplate (see 3.6.1).	Visual
205	Faulty workmanship (see 3.7).	Visual

1/ SIE = Standard Inspection Equipment.

4.5.3 Test (100%). Each alternator assembly shall be subjected to the quality conformance tests specified in table II.

4.6 Control tests.

4.6.1 Inspection frequency. One in fifty (1/50) control tests shall be conducted on one alternator from each lot of 50 units consecutively produced or on one alternator every two months, whichever occurs first.

4.6.2 Inspection frequency. Other than one in fifty control tests shall be conducted on one alternator, at the interval specified in table II, from either the first 10 units produced for the interval stipulated or the last 10 units produced from the preceding interval.

4.7 Failure. Failure of any alternator to pass any of the specified quality conformance or control tests shall be cause for the Government to refuse acceptance of the production quantity represented, until action taken by the contractor to correct defects and prevent recurrence has been approved by the Government.

4.8 Methods of inspection.

4.8.1 Materials and construction. Conformance to 3.2 through 3.3.3 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.8.2 Defects. Conformance to 3.3, 3.3.2, and 3.5 through 3.6 shall be determined by examination for the defects listed in table III. Examination shall be visual, tactile, or by measurement with standard inspection equipment.

4.8.3 Weight. To determine conformance to 3.3.4, weigh the alternator without oil in the unit.

4.8.4 Performance conditions. Unless otherwise specified, tests shall be conducted under the following conditions: Performance tests shall be run at room ambient temperature. Oil Inlet temperature to the alternator shall be maintained at 225 ± 5°F. Alternator coolant oil shall be MIL-L-2104 Grade 30. Inlet oil supply pressure (P_3) to be 45 ± 2 psi and the alternator outlet pressure (P_2) not to exceed 5 psi. Performance test shall be conducted with the alternator at a stabilized temperature. The alternator shall be considered to be temperature stabilized when constant conditions of speed and load current current fail to cause a change in alternator oil inlet and outlet differential temperature by more than 2°F during a 10 minute period. The loads shall be resistive and variable to allow 1000 amperes maximum. A set of six batteries type 6 TN per MIL-B-11188 shall be connected in a series parallel combination for a nominal 24 V dc operation.

NOTE: Waterproofness 4.9.8, proof pressure 4.8.16, and overspeed 4.8.5 tests shall be performed prior to other tests.

4.8.5 Overspeed. To determine conformance to 3.4.2, operate the alternator at 10 000 rpm with open field for a period of 1 minute (see figure 9 and 3.4.15).

4.8.6 Field voltage. To determine conformance to 3.4.3, with the alternator not operating, apply a field supply voltage of 22 V dc (Ef) to the alternator field pin, A-to-C, at the J2 connector for 30 minutes (see figure 9 and 3.4.15).

4.8.7 Field resistance. To determine conformance to 3.4.4, measure the alternator field resistance between terminals A and C on the J2 connector with the power supply disconnected (see figure 9 and 3.4.15).

4.8.8 Output current. To determine conformance to 3.4.5, the alternator shall operate with output power of 650 A (IA) at 28 V dc (ea). The field current (If) shall be measured (see figure 9).

4.8.9 Ripple voltage. To determine conformance to 3.4.6, connect the alternator into a test circuit such as is shown in figure 10 and measure ripple voltage at ES at the following conditions. Verify that the ripple voltage is not greater than 4 V for each condition.

rpm	Load (amperes)	Regulated volts	Ripple volts (+peak -peak)	Ripple volts (peak to peak)
3000	50	28 ± 0.5		
3000	650	28 ± 0.5		
8000	50	28 ± 0.5		
8000	650	28 ± 0.5		

4.8.9.1 Acceptance. With the alternator connected as shown in figure 10, the following readings shall be recorded at 8000 rpm and 650 A as follows:

rpm	Load (A)	Regulated V	Ripple V (+peak -peak)	Ripple V (peak to peak)
8000	650	28 ± 0.5		

4.8.10 Overload output current. To determine conformance to 3.4.7, operate the alternator at 5000 rpm with output power of 800 ± 25 A (IA) at not less than 23 V dc (EA) for 30 seconds. Measure the field current (IF). At the conclusion and prior to further testing, cool the alternator for 5 minutes by operating at 5000 rpm with battery load only (see figure 9 and 3.4.15).

4.8.11 Alternating current (ac) signal. To determine conformance to 3.4.8, apply 20 ± 2 V dc to the alternator field at pin C-to-pin A at the J2 connector and measure the ac signal voltage (EAC) at pin A-to-pin C at the J1 connector, at alternator speed of 900 rpm and 1100 rpm (see figure 9 and 3.4.15).

4.8.12 Current transformer (ct) signal. To determine conformance to 3.4.9, operate the alternator at 8000 rpm with a power output of 650 A (IA) and 28 V dc (EA). Measure the ct signal (Ect) at the J1 connector from pin B to pin C (see figure 9).

4.8.12.1 Acceptance. Operate the alternator as in 4.8.12, and measure the ct signal at the J2 connector from pin B to pin C (see 3.4.15).

4.8.13 Alternator oil system. To determine conformance to 3.4.10, with no electrical load, and with alternator speed, alternator outlet pressure (P2), and oil inlet pressure (P3) as follows, measure oil flow (F1) and pump outlet pressure (P1) (see figure 9 and 3.4.15).

Test	Alternator speed (rpm)	Alternator outlet pressure (P2)	Alternator oil inlet pressure (P3)
1	2000 and 8000	5 psi maximum	minus 0.385 ± 0.03 psi
2	2000 and 8000	5 psi maximum	45 ± 2 psi

4.8.14 Transient load. To determine conformance to 3.4.11, record voltage (EA) and current (IA) on an oscillograph tape. While connected in a test circuit as in figure 10, subject the alternator to ten motor load applications and removals at 2400 rpm and 8000 rpm, and at each speed per figure 1. Oscillograph galvanometer response from 0 to 2000 Hz shall be flat within ± 5.0 percent.

4.8.15 Efficiency. To determine conformance to 3.4.12, with the alternator speed at 8000 rpm, the output current at 650 A, the output voltage at 28 V dc (measured at the alternator terminals), the inlet oil temperature at 225°F, and the temperature at room ambient (see 3.4.1); connect the alternator as shown on figure 9, and obtain the efficiency by use of a suitable test stand. Calculate the efficiency as follows:

$$\text{Efficiency } (\eta) = \frac{0.001341 \times EA \times IA \times 100}{SHP}$$

n = Efficiency at terminals in percent.
EA = Alternator terminal voltage.
IA = Alternator current in A.
SHP = Shaft horsepower input to alternator measured by a dynamometer or by test stand calibration.

4.8.16 Proof pressure. To determine conformance to 3.4.13, cap and seal the oil inlet port of the alternator. Connect a regulated supply of dry nitrogen to the oil outlet port. Pressurize to 200 psi for 5 minutes. With the nitrogen supply turned off, verify that the pressure drop is not greater than 10 psi in 1 minute.

4.8.16.1 Acceptance. With the oil inlet capped and sealed, connect a regulated supply of dry nitrogen to the oil outlet port. Pressurize to 150 psi, and shut off the supply. Verify that the pressure drop is not greater than 10 psi in 1 minute.

4.8.17 Endurance. To determine conformance to 3.4.14, subject the alternator to 3000 hours of operation per table I (five 600-hour cycles) at constant and cyclic loads, in accordance with the following conditions:

a. Oil shall be per MIL-L-2104.
b. Oil shall be contaminated with soft C-2A per F-F-351, according to table V.

TABLE V. Oil contamination.

Test hours	Oil contamination
At start of 600-hour cycle	Provide 3.2 g 1/ of C-2A per 5 gal 2/ of new MIL-L-2104 oil in oil system.
At 200 hours	Add 3.2 g of C-2A per 5 gal of used oil already in system.
At 400 hours	Add 3.2 g of C-2A per 5 gal of used oil. Total contamination now 9.6 g C-2A per 5 gal oil.
At 600 hours	Drain used oil and grit out of system. Thoroughly flush oil and grit from system with solvent. Use air to dry system thoroughly. Refill system per "start" for next 600-hour period, if required.

1/ Gram (g)
2/ Gallon (gal)

c. Total internal oil leakage shall be no greater than 1500 cubic centimeters (cc).
d. Internal oil leakage during any 600-hour cycle shall be no greater than 400 cc.
e. External oil leakage shall not be greater than one drop (see 6.3) per hour exhibited by alternator.
f. Ambient temperature shall be 225 ± 5°F, except as specified in (g).
g. Inclined operation shall be at room temperature, with alternator motor driven at no load and not excited during the last 60 hours of each 600-hour cycle, and with alternator drive end tilted down 45° from horizontal for 30 hours and tilted up 45° from horizontal for 30 hours.

Perform 4.8.5 through 4.8.15 before and after 4.8.17.

4.8.17.1 Record readings. The following readings shall be recorded at the beginning and end of each speed change:

a. Oil leakage at drain ports shown on drawing 11655469.
b. Oil temperature [in (T1) and out (T2)].
c. Oil flow (F1) (gpm).
d. Pump discharge pressure (P1), back pressure (P2), and inlet pressure (P3).
e. Time.
f. Amount of external oil leakage.

4.8.17.2 Operation. Install the alternator on the engine-transmission assembly provided by the Government acquiring agency (see 6.2 and 6.4). Operate the engine-transmission assembly to provide alternator performance per table I, running through a, b, c, and d in sequence, twice, for a total

of 48 endurance hours. Visually inspect the alternator for indications of failures, fractures, distortions, erosion, external oil leakage (see 3.4.15), or other evidence of deterioration.

4.8.17.3 Control (100 hours). Operate the production alternator for 100 hours per table I, consisting of four cycles of a through d, followed by 2 hours at a and 2 hours at b. Total internal oil leakage shall be not greater than 200 cc. The internal leakage shall be not greater than an average rate of 0.50 cc per hour from the eightieth hour to the one-hundredth hour for a total internal leakage of 10 cc during the last 20 hours. External oil leakage shall be not greater than one drop (see 6.3) per hour.

4.8.17.3.1 Other conditions. Use uncontaminated MIL-L-2104 oil. Ensure that inlet oil is at 225 ± 5°F and the alternator is at room temperature. Run the cycles with alternator oil and inlet port pressures as follows:

25 cycles at minus 0.385 ± 0.03 psi,
25 cycles at 45 ± 2 psi,
25 cycles at minus 0.385 ± 0.03 psi, and
25 cycles at 45 ± 2 psi.

4.8.18 External oil leakage. Conformance to 3.4.15 shall be determined by exercising the alternator and by qualitative observation sufficient to demonstrate that specified characteristics and features are present and functional.

4.8.19 Torsion.

4.8.19.1 Natural frequency. To determine conformance to 3.4.16.1, support the alternator and drive shaft system in the normal bearings. Rigidly attach the rotor and shafting at the driven end to a reaction flywheel having a mass moment of inertia not less than 20 times that of the alternator rotating system. Excite the rotor and shafting system in a torsional manner. Determine the natural torsional resonant frequency.

4.8.19.2 Vibratory torque. To determine conformance to 3.4.16.2, attach the alternator to an engine-transmission assembly, and drive the alternator to obtain a vibratory torque of ± 2100 inch-pounds (or 3600 inch-pounds double amplitude). With positive torque not greater than 2100 inch-pounds, drive the alternator at a frequency of 20 to 25 Hz for a period which produces 12 000 torque reversals. Record on suitable oscillographic equipment the torque input to and reversals at the alternator drive shaft. The oscillograph galvanometer response shall be flat within 5 percent from 0 to 2000 Hz.

4.8.19.3 Torsional application. To determine conformance to 3.4.16.3, operate the alternator on an engine-transmission assembly for 4 cycles of 48 hours each per items a, b, c, and d of table I (at room temperature), for a total of 192 hours; during which time there shall be no failure, parts replacement or servicing, or loss of oil greater than one drop (see 6.3). Subject the alternator to 4.5.8 through 4.8.13. Subsequently, visually inspect the alternator for indications of failures, fractures, distortions,

erosion, external oil leakage greater than one drop (see 6.3), or other evidence of deterioration; and the engine-transmission assembly for evidence for deterioration of the drive train elements.

4.9 Environmental. Unless otherwise specified, environmental tests shall be performed at standard ambient conditions of 4.3.

4.9.1 High temperature test. To determine conformance to 3.5.1, the alternator oil circuits shall be filled with MIL-L-2104, grade 50. The unit shall be subjected to a high temperature test in accordance with procedure II, method 501 of MIL-STD-810 except that 36 hours of storage at 225°F shall be substituted for steps 1, 2, 3, 4, 5 and 6 and that the hot operational test of steps 7 and 8 be performed at standard ambient operating test of steps 9, 10 and 11 shall be performed at standand ambient conditions. While stabilized at the 225°F operational temperature, the unit shall be subject to the tests specified in:

4.8.5	Overspeed
4.8.8	Output power
4.8.11	AC signal
4.8.12	CT signal
4.8.13	Oil system

The same tests are to be repeated at the ambient operating test.

4.9.2 Low temperature test.

4.9.2.1 Cold soak test. To determine conformance to 3.5.2.1, the alternator oil circuits shall be filled with MIL-L-46167 prior to start of cold soak test. The alternator shall be subjected to a low temperature storage test at -65°F ± 5°F for 12 hours. At the conclusion of the -65°F cold soak test, the alternator and its oil supply will be temperature stabilized at -25°F ± 5°F. Conduct a low temperature operation test at -25°F temperature, in accordance with procedure 1, method 502, of MIL-STD-810. While stablilized at the -25°F temperature, and with 45 psig oil pump inlet pressure, the unit shall be subjected to the test specified in:

4.8.5	Overspeed
4.8.8	Output power
4.8.11	AC signal
4.8.12	CT signal

The alternator oil pump outlet pressure shall not exceed the proof pressure.

4.9.2.2 High viscosity oil test. To determine conformance to 3.5.2.2, to an engine-transmission assembly (see 6.2d) and operated at no electrical load with 10 wt MIL-L-2104 lubricating oil to circulate oil throughout the alternator. The test system shall then be cold soaked at -10°F for 24 hours. The engine shall be started while at -10°F using standard procedures and shall remain at idle rpm until engine oil pressure stabilizes. The engine shall then be immediately accelerated to maximum.

4.9.3 Shock. To determine conformance to 3.5.3, mount the alternator on a shock test machine, utilizing the alternator mounting brackets and simulating the actual installation as far as is practical. Subject the alternator to sawtooh shock pulses of 20 gravity units for a duration of 11, + 2 milliseconds (ms) in accordance with MIL-STD-810C, method 516.1, procedure 1. At the conclusion, examine the alternator for damage.

4.9.3.1 Control. Perform as in 4.9.3, except subject the alternator to shock pulses of 15 gravity units.

4.9.4 Vibration. To determine conformance to 3.5.4, mount the alternator as in intended use. Vibrate the alternator along each axis according to figures 4, 5, and 6, using vibrating equipment capable of providing the amplitude and frequencies specified therein. The vibration axis shall be oriented per figure 10. Cycling time in each axis shall be 100 minutes. Each sweep shall be 5 to 500 to 5 Hertz (Hz) in 15 minutes. Resonent frequencies of the alternator shall be determined and a sinusoidal resonence search shall be conducted for the four most severe resonent frequencies of the alternator. The test sample shall be subjected to dwell time at the most severe resonence in accordance with the applicable figure. The frequency of applied vibration shall be swept over the specified range in accordance with figure 12. The sweep time of figure 12 is that of an ascending plus a descending time. At the conclusion, confirm that there is no internal or external oil leakage or other damage resultant from the vibration test.

4.9.4.1 Control. Perform as in 4.9.4, except the dwell time at each resonance shall be 5 minutes.

4.9.5 Fungus. To determine conformance to 3.5.5, seal all installation openings and install the alternator in a fungus chamber. Subject the alternator to method 508 of MIL-STD-810 for 28 days. Incubate samples under cyclic temperature and humidity conditions to include 20 hours of relative humidity at 95 $\pm$ 5% at an air temperature of 86 $\pm$ 2°F followed by 4 hours of 100 percent relative humidity at 77 $\pm$ 2°F.

4.9.6 Corrosion. To determine conformance to 3.5.6, seal all installation openings, and subject the alternator to method 509.1 of MIL-STD-810C for four test cycles (192 hours).

4.9.7 Humidity. To determine conformance to 3.5.7, seal all installation openings, and place the alternator in a test chamber. Perform the following:

a. Operate the alternator under standard ambient conditions.
b. Dry the alternator at 129°F for 24 hours.
c. Condition the alternator at 73°F and 50 $\pm$ 10% relative humidity for 24 hours.
d. Record data for determining satisfactory operation of the alternator as specified herein.

NOTE: The alternator may be readjusted or realigned, as necessary, to meet requirements. No further realignment or readjustment shall be permitted throughout this period, other than with accessible controls employed for operation of the alternator. No repair or replacement of parts shall be permitted. Equipment shall be operated only when specified procedures are being performed.

e. Raise the internal chamber temperature to 86°F and the relative humidity to 94 ± 4%.
f. Subject the alternator to five continous 48-hour cycles in accordance with figure 13.
g. On completion of the test cycles, remove the alternator from the chamber to room ambient conditions. With MIL-L-2104 grade 30 oil at 225 ± 5°F oil temperature, perform 4.8.4.4 without delay. Return the alternator, all installation openings sealed, to the chamber. Raise the chamber to 73 ± 5°F and 50 ± 10% relative humidity, and condition for 24 hours.
h. Remove the alternator to room ambient conditions. With MIL-L-2104 grade oil at 225 ± 5°F oil inlet temperature, perform 4.8.4.4 without delay.

4.9.8 Waterproofness. To determine conformance to 3.5.8, seal all installation openings, and pressurize the alternator inside a storage container of approximately 1 cubic foot to 10 psig of nitrogen. With the nitrogen supply shut off, Verify that the leakage rate shall not exceed 3 psig in 2 minutes.

4.9.9 Electromagnetic interference. To determine conformance to 3.5.9, perform tests methods RE02 and CE04 of MIL-STD-462. Operate the alternator at 5000 rpm. Measure broadband radiated emission with a 500 A load. Broadband conducted emission shall be measured with a balanced 650 A split load having the current probe on a 50 A load lead. Conduct this with the regulator (Drawing 11668583) interconnected (see figures 7, 8, and 10).

5. PACKAGING

5.1 Preservation, packaging, packing, and marking. Preservation, packaging, packing, and marking for the desired level of protection shall be in accordance with the applicable packaging requirements specified by the contracting authority (see 6.2).

6. NOTES

6.1 Intended use. The alternator is intended for use in the electrical generating systems of the M60 tanks, consisting of an alternator-rectifier, referred to herein as "alternator," and a solid-state voltage regulator.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. If first article samples are not required (see 3.1).
c. If inspection conditions shall be other than as specified (see 3.4.1 and 4.3).

d. If responsibility for inspection shall be other than as specified (see 4.1).
e. If responsibility for inspection equipment shall be other than as specified (see 4.1.1).
f. If preproduction inspection is required (see 4.4.1).
g. If initial production inspection is not required (see 4.4.2).
h. Selection of applicable level and packaging requirements (see 5.1).

6.3 Definitions.

6.3.1 Fully charge battery. For the purposes of this specification, a fully charged battery is defined as a battery having current consumption of not greater than 4 A and 28 V at room temperature (90 ± 10°F).

6.3.2 Load current. For the purposes of this specification, load current is defined as that current from generator to batteries and resistive load, and controlled by the regulator (see figure 10).

6.3.3 Drop. Drop is defined as a volume of fluid equal to 0.5 cc.

6.3.4 Temperature stabilized. For the purposes of this specification, a temperature stabilized alternator is defined as a situation when constant conditions of speed and load current fail to cause a change in alternator oil inlet and outlet differential temperature by more than 2°F during a 10-minute period.

6.3.5 Recovered materials. "Recovered materials" means materials that have been collected or recovered from solid waste (see 6.3.6).

6.3.6 Solid waste. "Solid waste" means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Clean Water Act, (33 U.S.C. 1342 et seq.), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) (Source: Federal Acquisition Regulations, section 23.402).

6.4 Engine-transmission assembly. When required, the engine-transmission assembly (Drawing 11655426) will be furnished by the Government contracting authority, at a site it will designate (see 3.1 and 4.8.17.2).

6.5 Recycled materials. The use of recycled materials which meet the requirements of the applicable material specifications without jeopardizing the intended use of the item shall be encouraged (see 3.2).

6.6 Subject term (key word) listing.

Generator, alternating current (650 ampere rectified).
Alternator, 650 ampere, 28 V DC.
Oil cooled alternator, 650 ampere, 28 V DC.

6.7 Supersession data. This military specification supersedes purchase description MIL-P-62186, dated 23 March 1981.

REQUIREMENTS:

1. MAXIMUM RECOVERY TIME:
   (A-C) 0.500 SECOND
   (D-F) 0.700 SECOND
   (G-H-K) 0.700 SECOND
   (G-J-K) 0.700 SECOND
2. ALTERNATOR OUTPUT CURVE SHALL BE WITHIN ENVELOPE DEFINED BY CURVES X AND Y.
3. VOLTAGE RESPONSE LIMITS:
   A. UNDERSHOOT POINT B NOT LESS THAN 20 V
   B. OVERSHOOT POINT E NOT MORE THAN 32 V
   C. UNDERSHOOT POINT K NOT LESS THAN 250 A

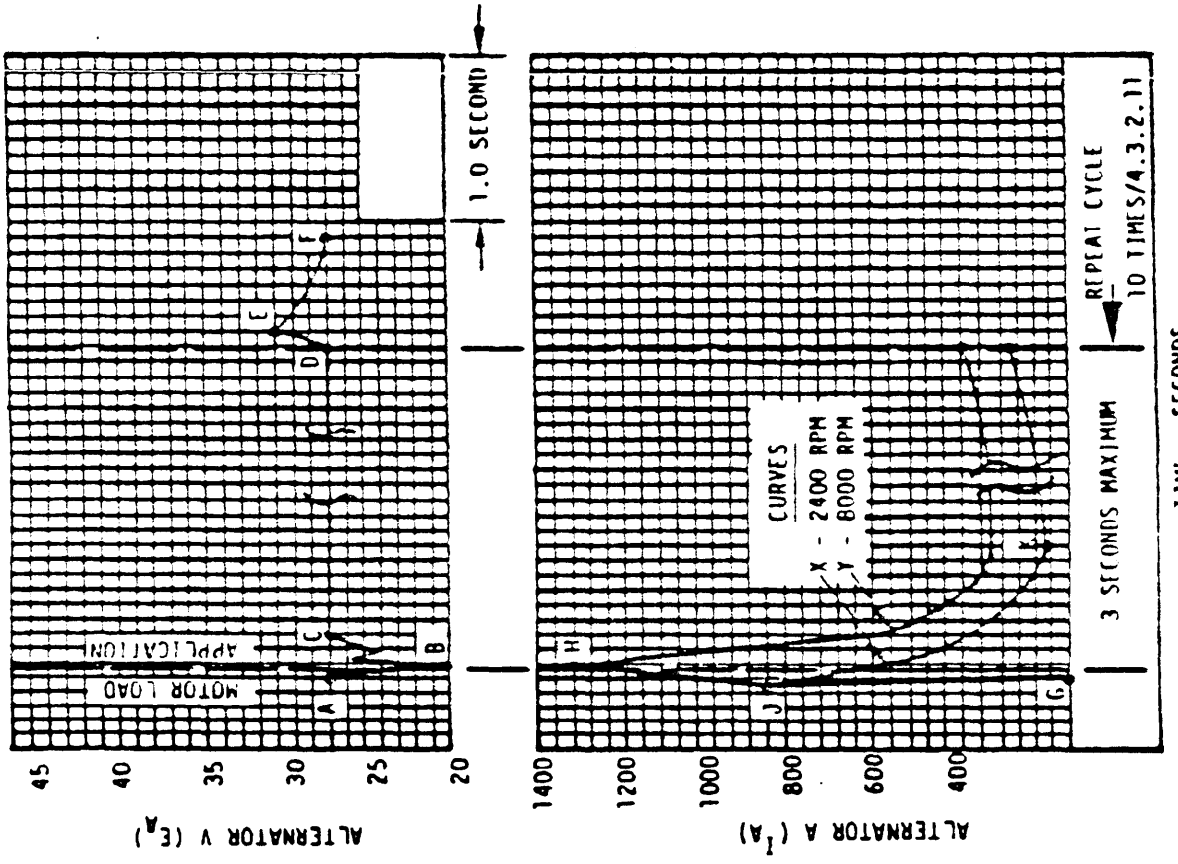


FIGURE 1. Transient loading - oil cooled alternator.

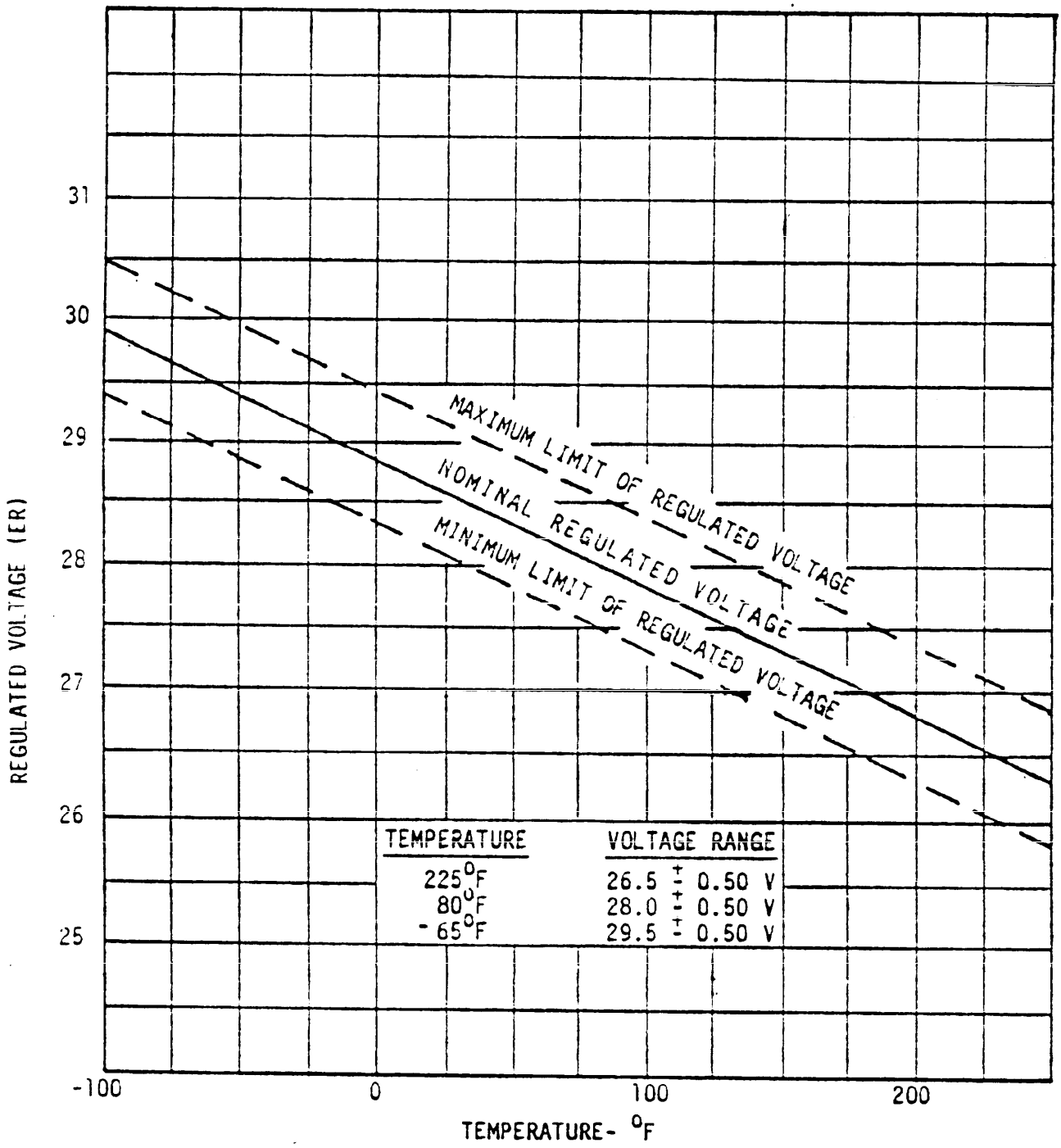
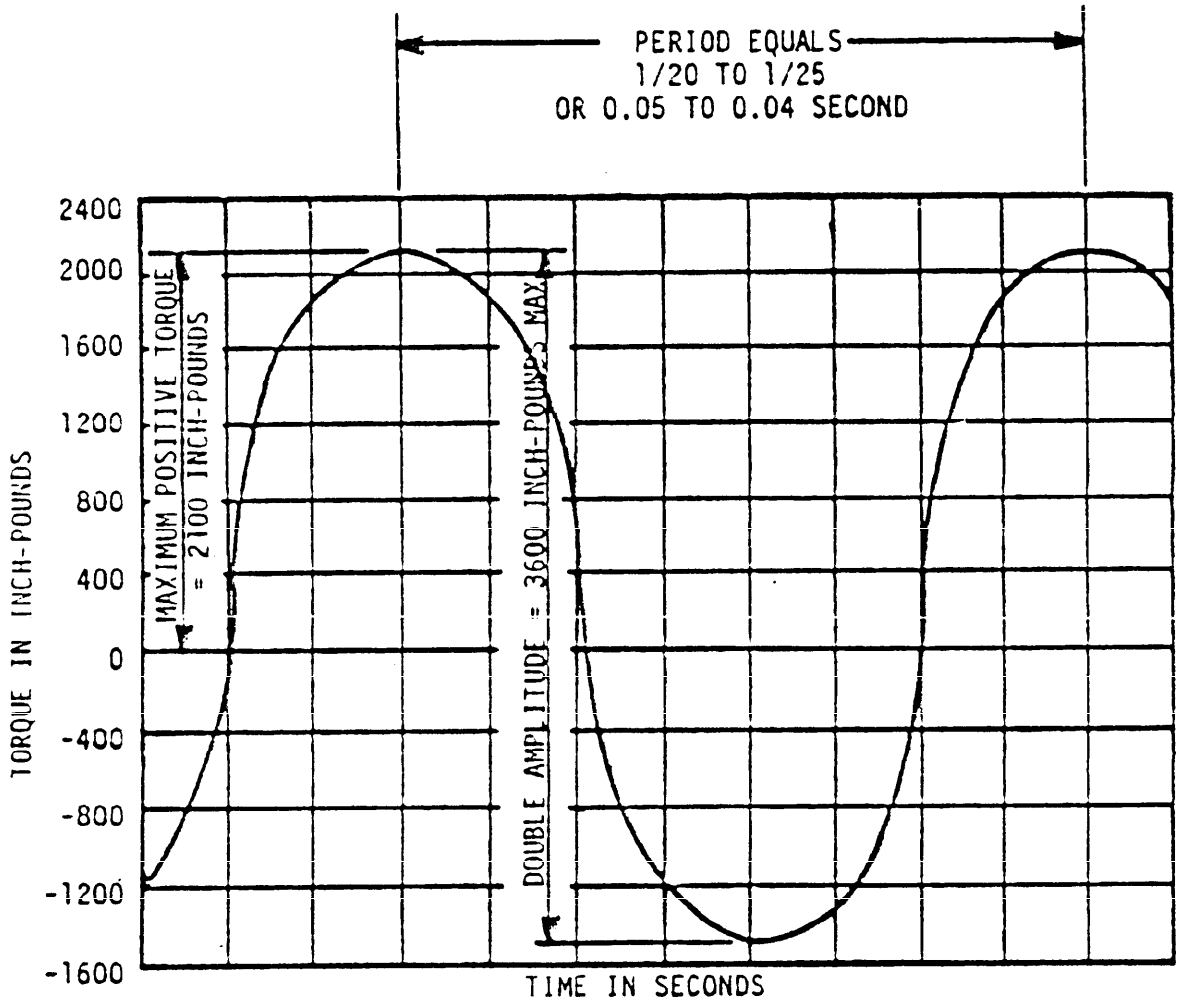


FIGURE 2. Temperature compensation.



NOTE:

FREQUENCY EQUALS 20 TO 25 HZ FOR THESE LIMITS.

FIGURE 3. Alternator torsional vibration torque requirements.

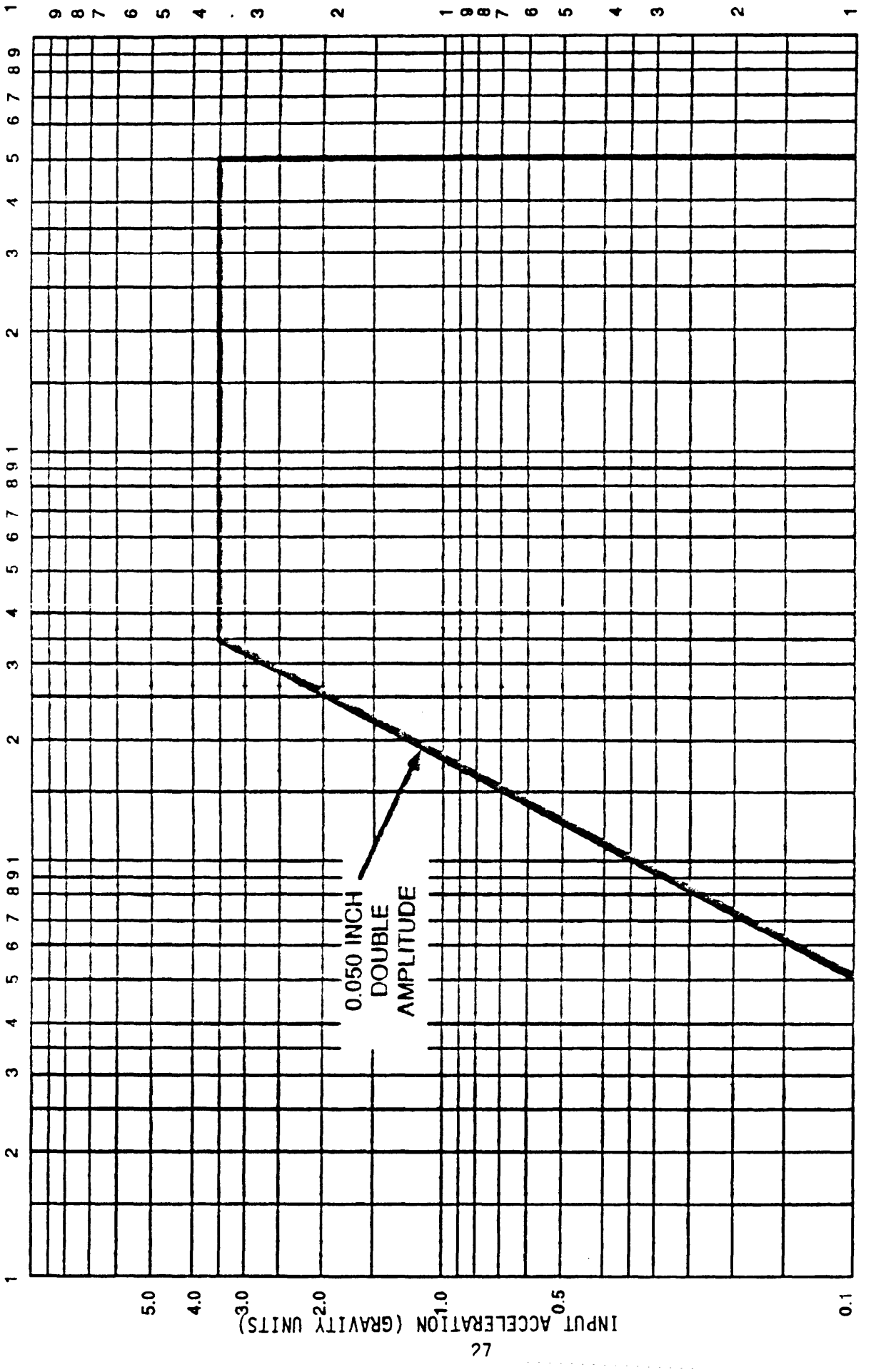


FIGURE 4. Vibration input (vertical) oil cooled alternator.

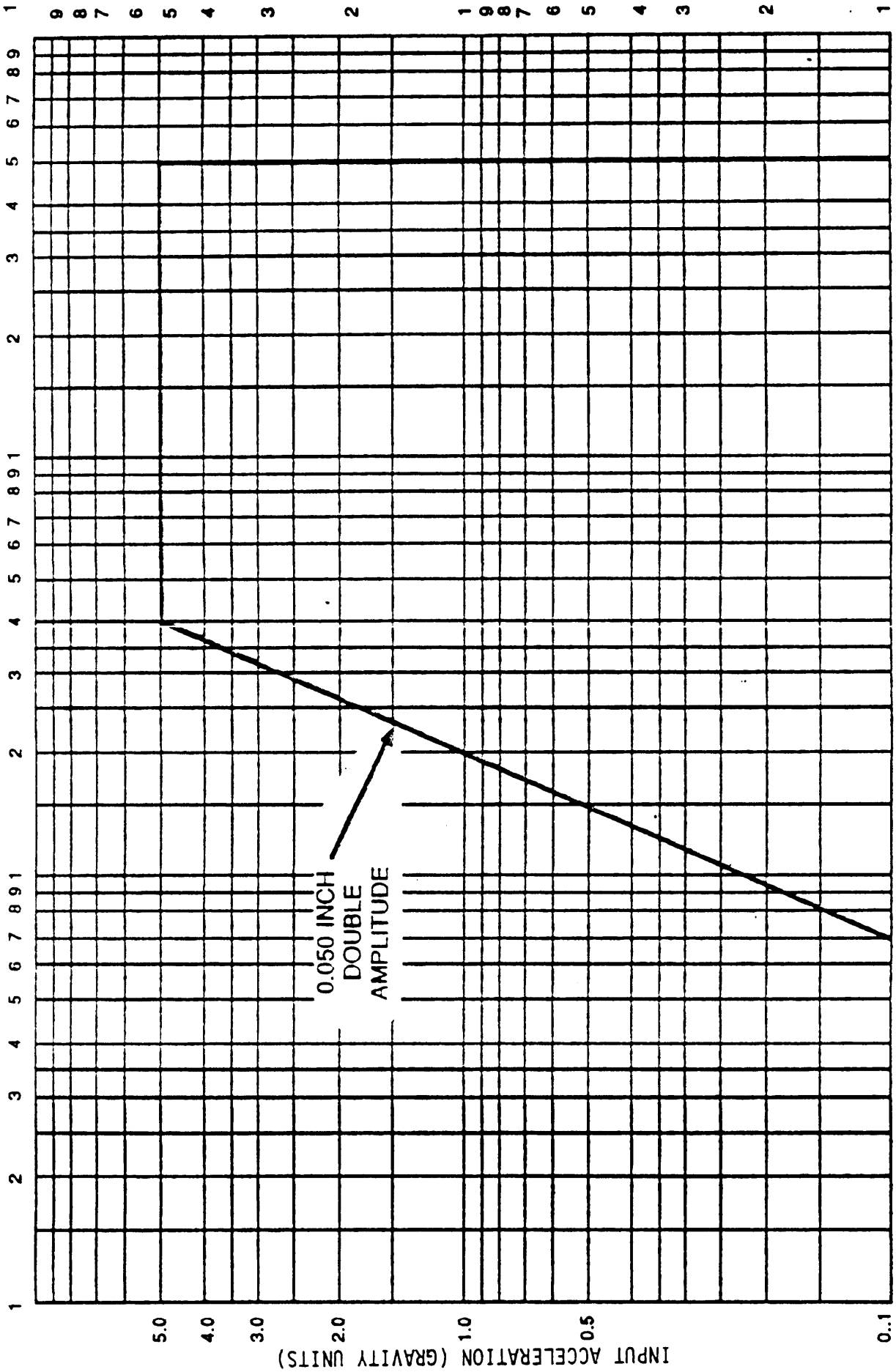


FIGURE 5. Vibration input (longitudinal) oil cooled alternator.

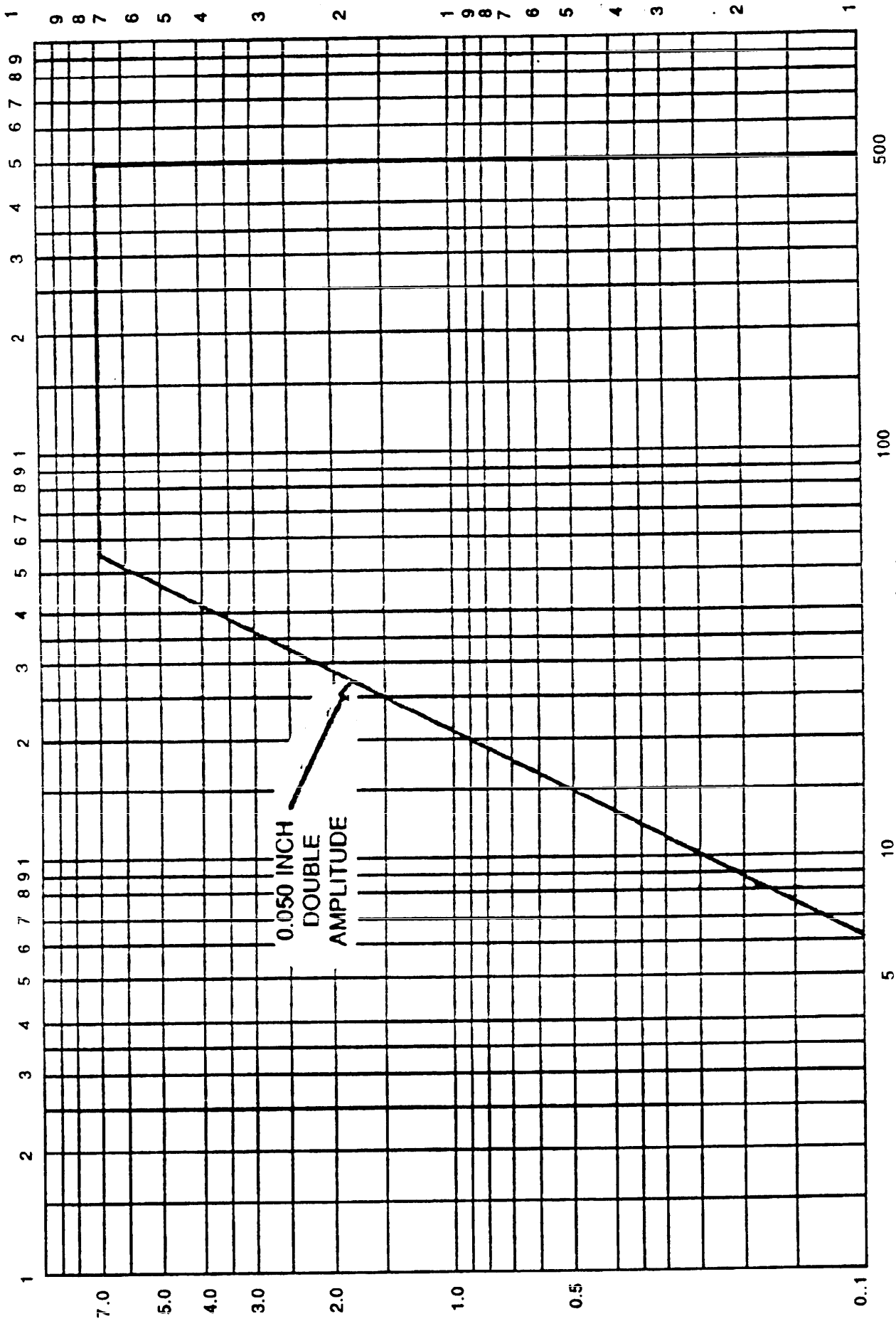


FIGURE 6. Vibration input (horizontal) oil cooled alternator.

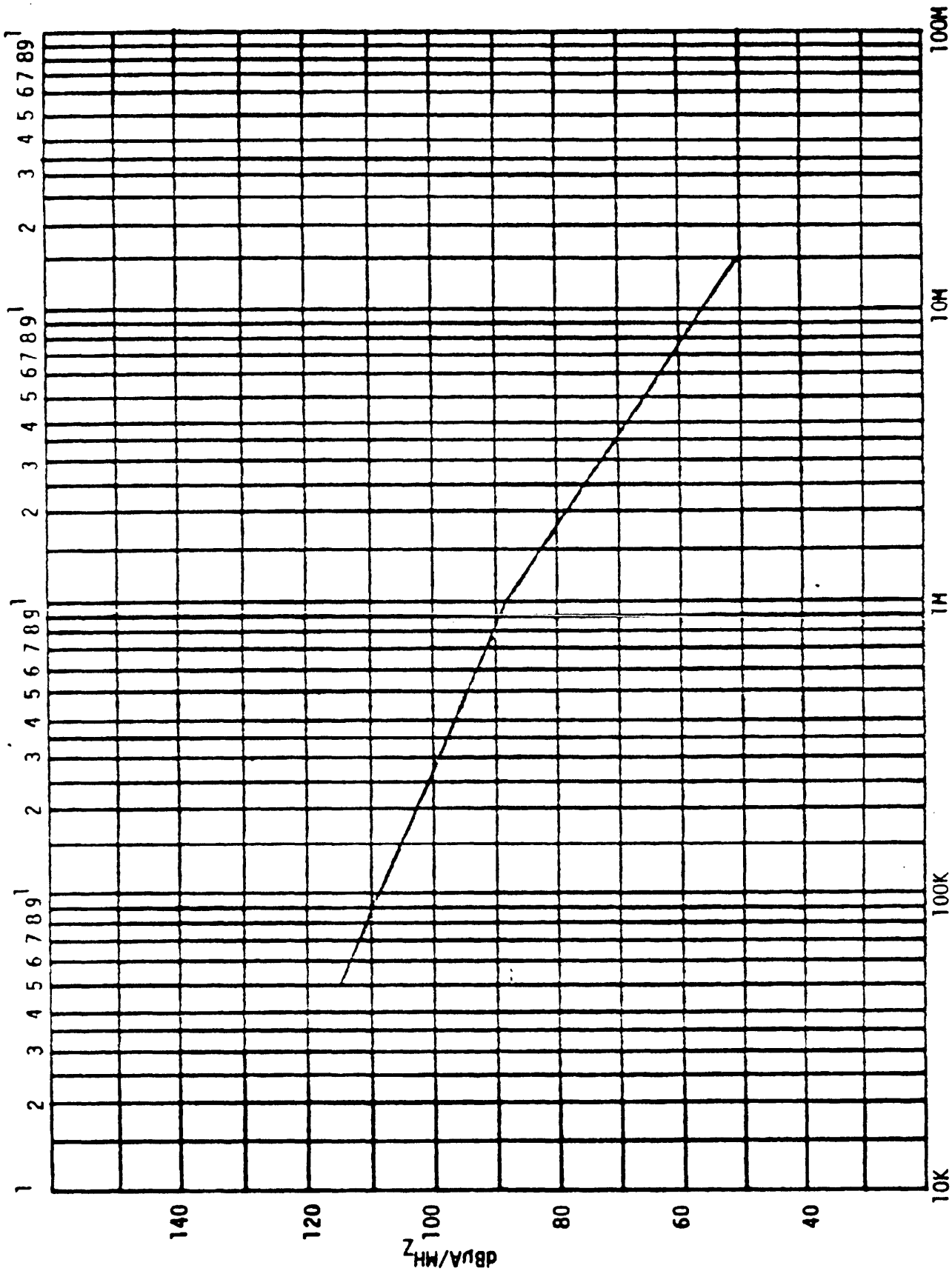


FIGURE 7. Broadband emission limits (conducted EMI).

6.3 Adhesion. The page lucky assembly shall be mounted

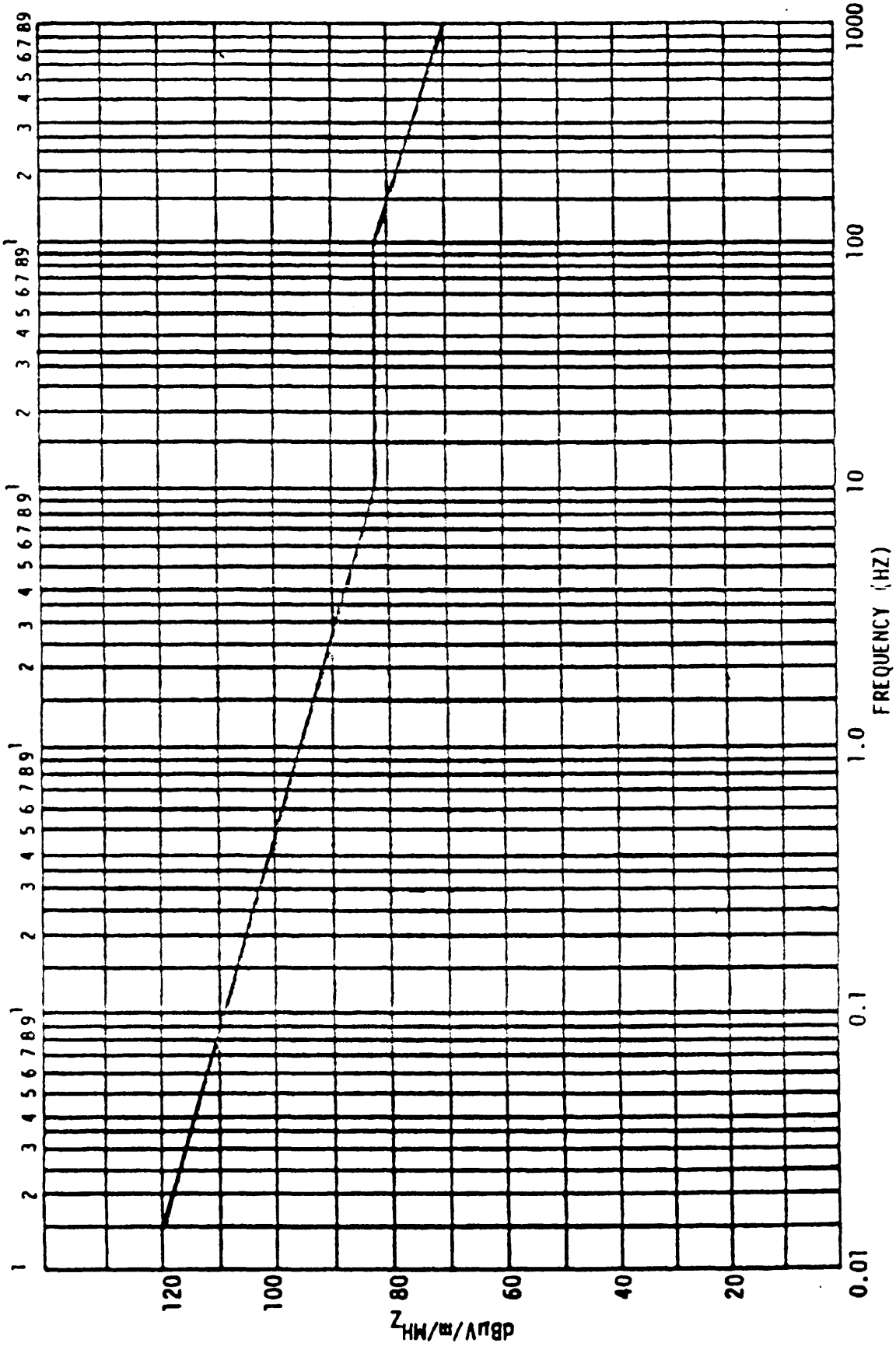


FIGURE 8. Broadband emission limits (radiated EMI).

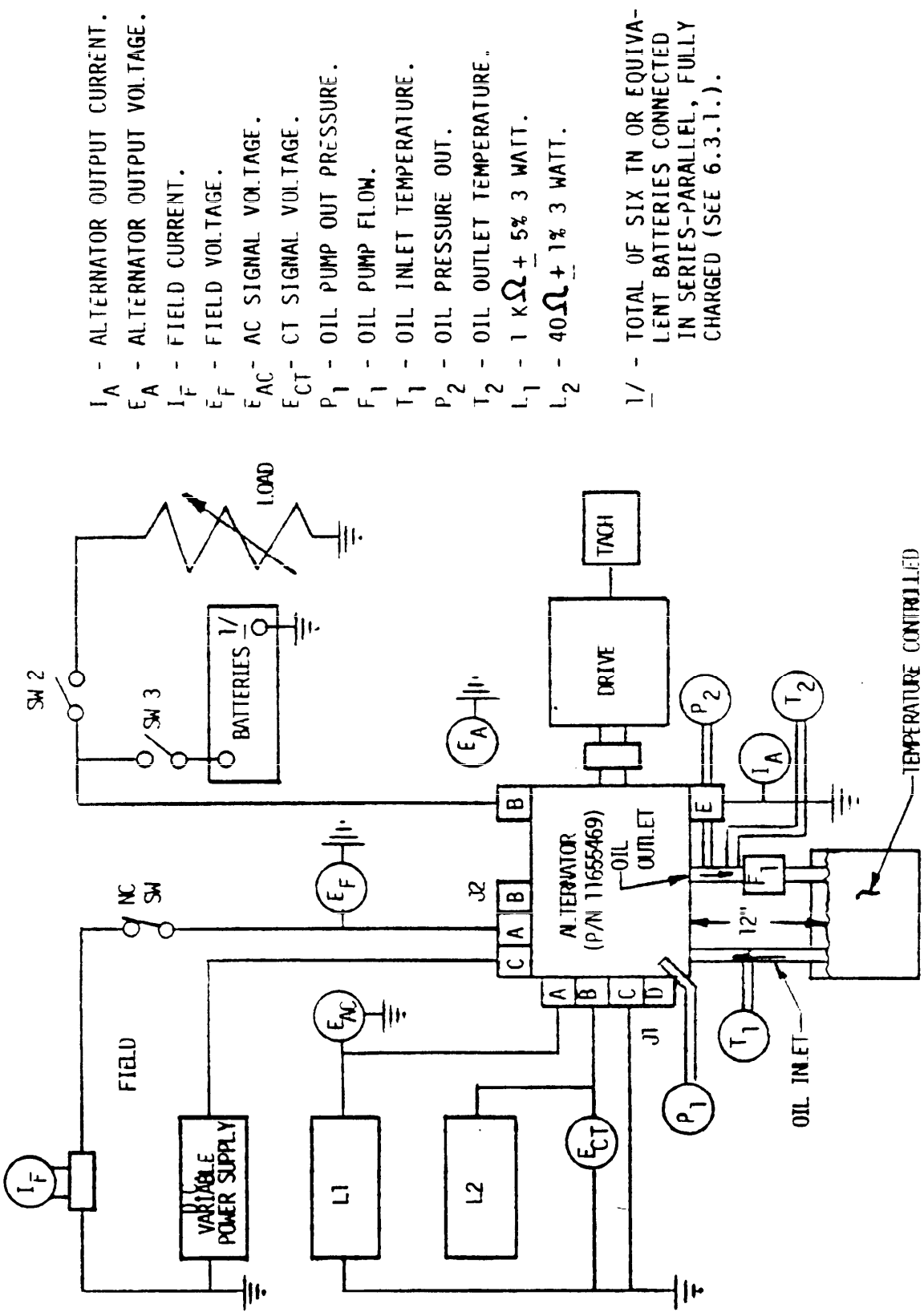
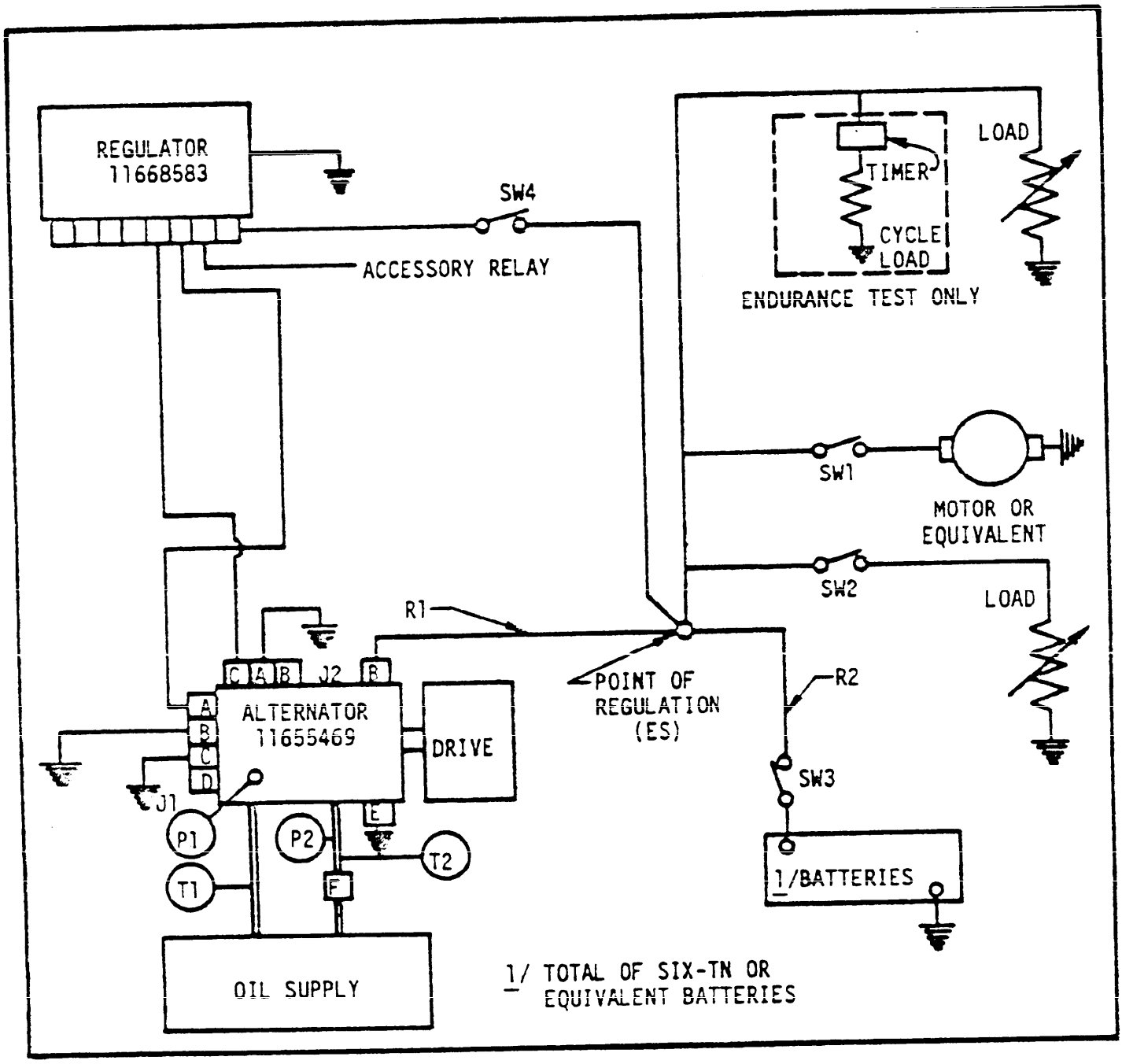


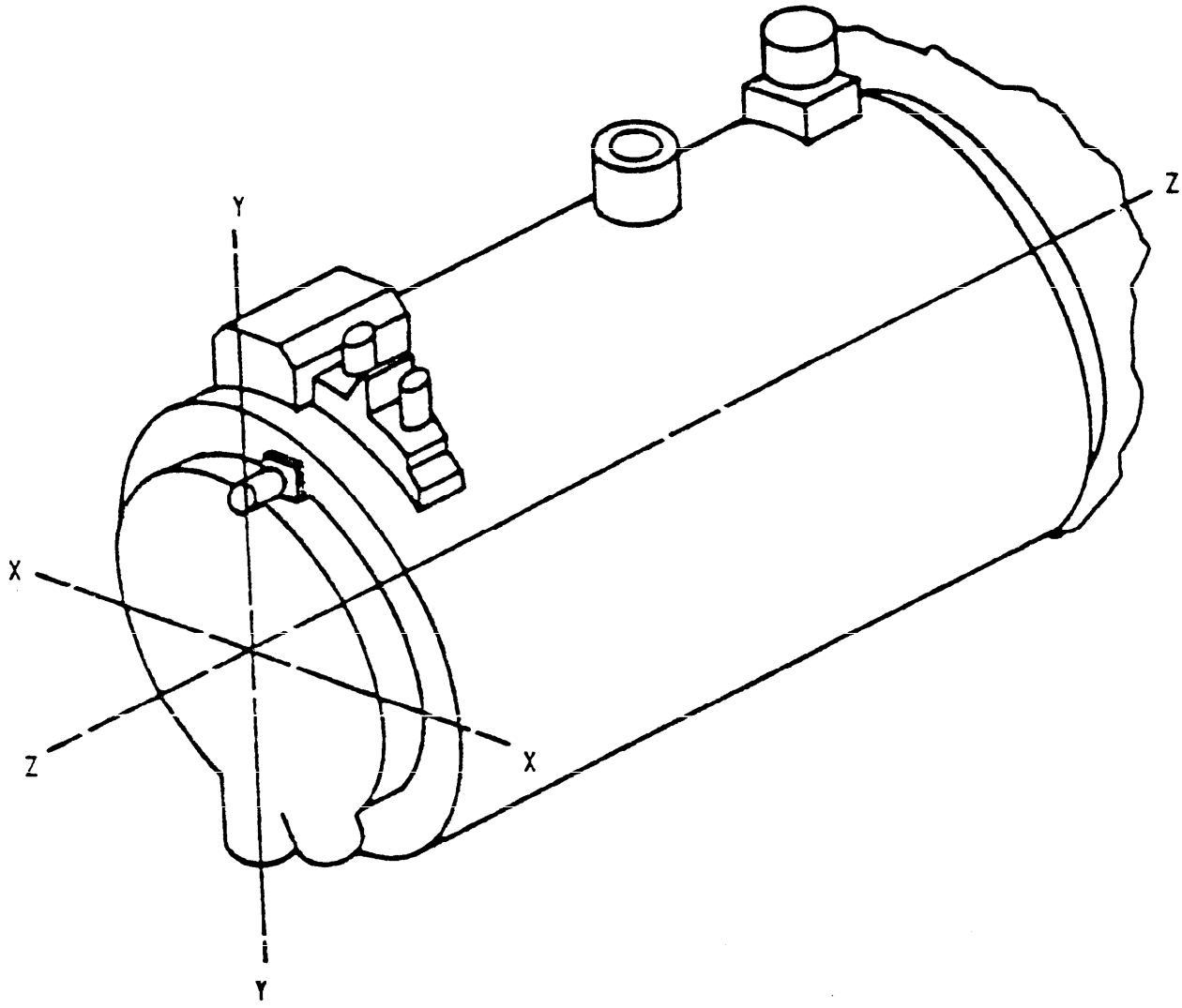
FIGURE 9. Oil cooled alternator test circuit.



R1 - RESISTANCE EQUIVALENT TO 2 PARALLEL COPPER CABLES. #00 GAGE, 17.5 FEET LONG.

R2 - RESISTANCE EQUIVALENT TO 2 PARALLEL COPPER CABLES. #00 GAGE, 30 INCHES LONG.

FIGURE 10. Oil cooled alternator test circuit with regulator.



X - HORIZONTAL
Y - VERTICAL
Z - LONGITUDINAL

FIGURE 11. Orientation of vibration axes for 11655469 alternator.

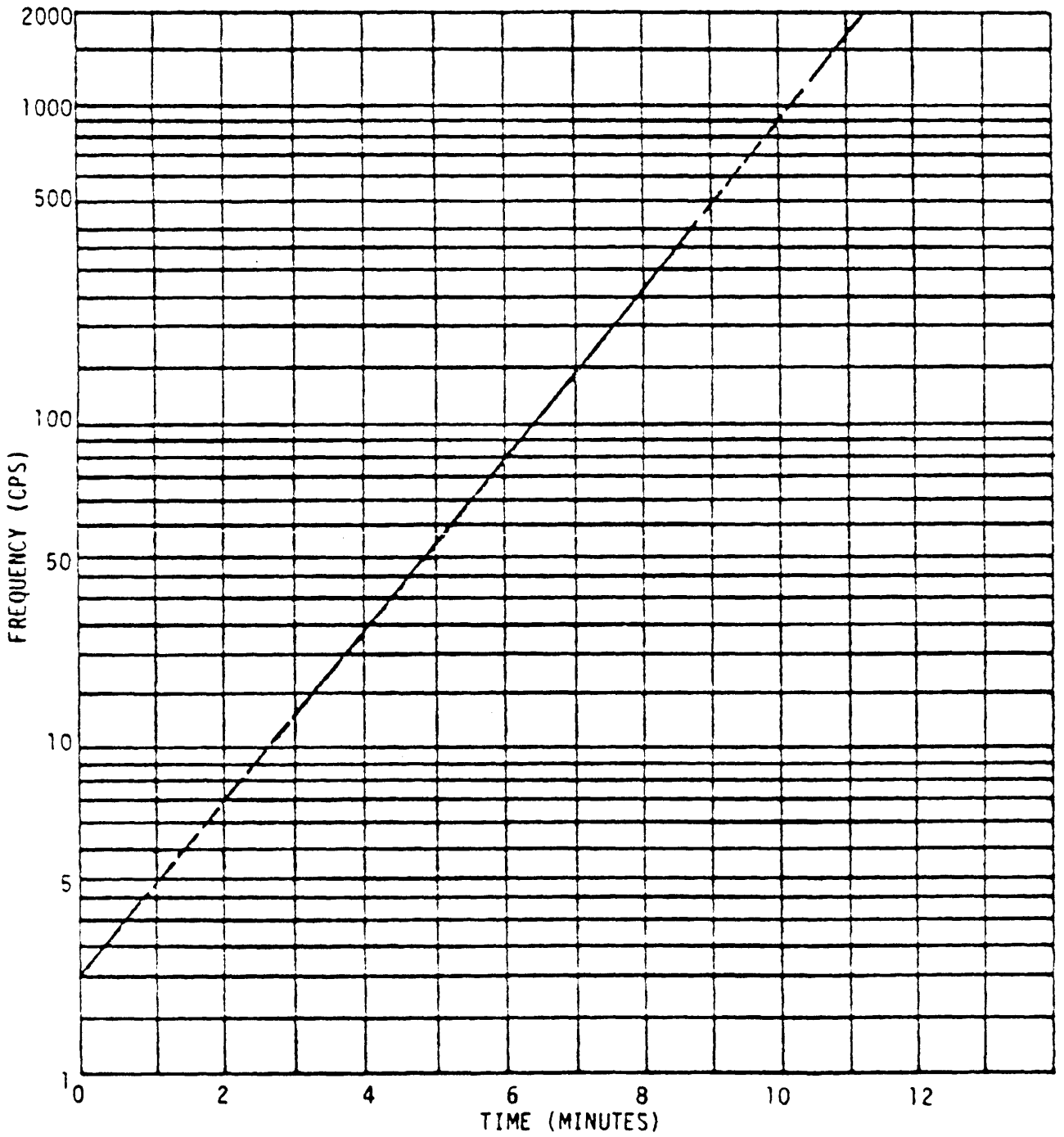
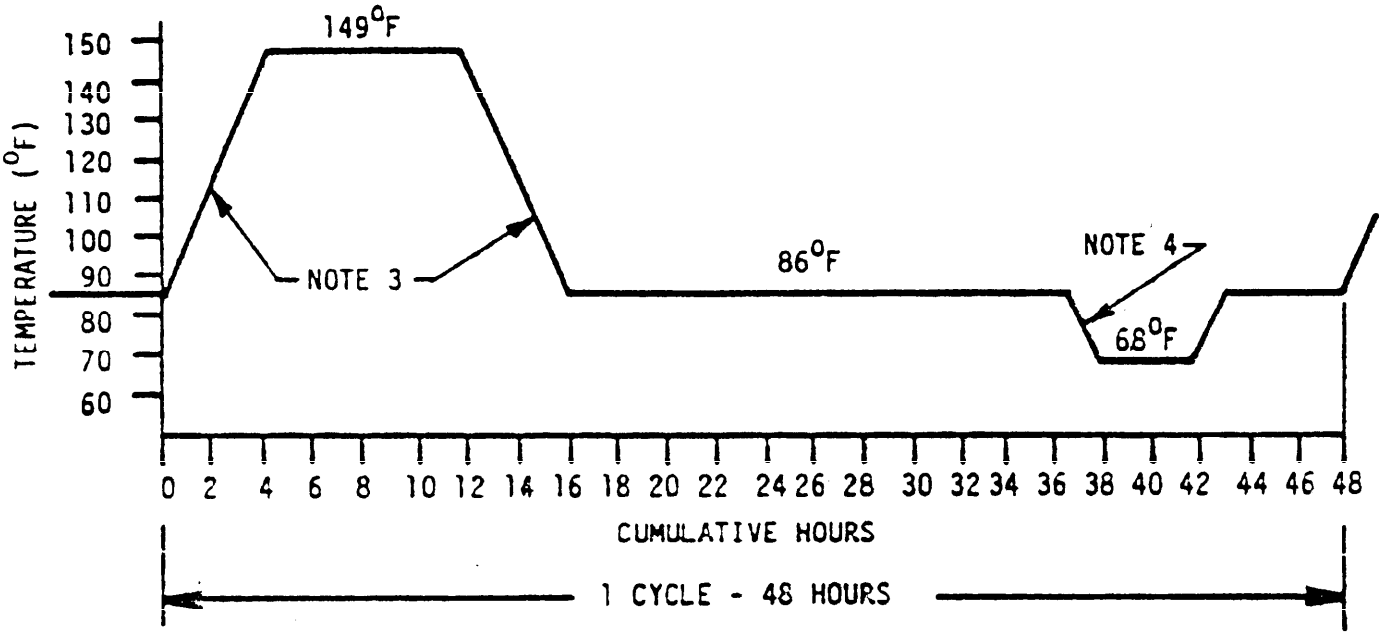


FIGURE 12. Logarithmic sweep.



NOTES:

1. TOLERANCE DURING TEMPERATURE CHANGE SHALL NOT BE GREATER THAN 5°F.
2. RELETIVE HUMIDITY SHALL BE MAINTAINED AT 94 + 4% AT ALL TIMES, EXCEPT
3. THAT DURING THE DESCENDING TEMPERATURE PERIOD, THE RELETIVE HUMIDITY MAY BE PERMITTED TO DROP AS LOW AS 85%.
3. RATE OF TEMPERATURE CHANGE BETWEEN 86° AND 149°F SHALL NOT BE LESS THAN 14.4°F PER HOUR.
4. THE TEMPERATURE INCREASE IN THIS PORTION OF THE CURVE SHALL NOT BE LESS THAN 18°F.

FIGURE 13. Humidity cycle.

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Navy - YD
Air Force - 99

Preparing activity:
Army - AT

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FSC 6115

DOCUMENT IDENTIFIER AND TITLE MIL-G-62186;Generator,Alternating Current (650 Ampere Rectified),28 Volts Direct Current(Oil Cooled)

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

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