INCH-POUND

MIL-STD-705C
24 April 1989
SUPERSEDING
MIL-STD-705B
26 June 1972

MILITARY STANDARD

GENERATOR SETS, ENGINE DRIVEN
METHODS OF TESTS AND INSTRUCTIONS

AMSC N/A FSC 6115

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DEPARTMENT OF DEFENSE
Washington, DC 20301

Generator Sets, Engine-Driven,
Methods of Tests and Instructions

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Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: USA Belvoir Research, Development, and Engineering Center, ATTN: STRBE-TSE, Fort Belvoir, VA 22060-5606 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FORWARD

This standard is intended to explain, establish and standardize specific methods for measurements associated with the evaluation of electric generators, generator sets and related components. The intended use of this standard is to determine compliance with characteristics represented by procurement documents. In no case is failure criteria established within this document. The specific methods are included herein, while the terminology, instrumentation, general methods of measurement, and informative electrical technology are presented in MIL-HDBK-705, Generator Sets, Electrical Measurements and Instrumentation.

This standard is closely allied with MIL-HDBK-705 and references from one to the other are freely used, particularly from this document to the handbook. Specification writers and equipment inspectors will find the need for both the standard and handbook when working on electric generator equipment. Due to the complexity of the specified requirements needed in procurement documents covering engine driven electric generators and other similar types of electric machinery, the proper use of this standard through referencing the applicable specific test method should greatly simplify the preparation of specifications and help to expedite the purchase and acceptance of the subject equipment. The procurement document requirements paragraph, included as the final paragraph of each test method, gives an indication of the data required to be included in the procurement documents.

CONTENTS

1. SCOPE

1.1 Coverage. This standard covers five series of specific test methods for testing and determining the characteristics of electric generators, generator sets, and associated equipment. This standard establishes methods of test for determining characteristics desired by the Military Departments to insure that electric generators and generator sets comply with Military requirements. Except as indicated in the applicable procurement documents, the test methods now appearing in the various joint-service specifications for testing electric generators and electric generator sets will be superseded by this standard. This standard establishes uniform test methods for the Military services, uniform test equipment and facilities, and uniform procedures for setting up and conducting the various tests. These methods provide for conservation of manpower, materials, equipment, and facilities. This standard does not establish limiting values for the results of the tests nor does it specify the tests required for any specific electric generator or generator set.

1.2 Numbering system. The methods are designated by numbers assigned in accordance with the following system.

1.2.1 Method numbers. The methods included in this standard are numbered in the 300-, 400-, 500-, 600-, and 700-series. (The series are not significant except that the method number assigned is the same as that formerly used in the uncoordinated document MIL-G-10228 which has been in general use as a reference document.)

1.2.2 Decimal system. The decimal system is used to list similar or associated methods in numerical sequence and to provide means for readily identifying main and subparagraphs for purpose of reference.

1.3 Method of reference. Methods of test contained in this standard shall be referenced, when applicable, in the individual procurement documents by specifying this standard and the method number. Equipment specifications will give specific requirements for test and limiting values.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this standard 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.

MIL-HDBK-705 - Generator Sets, Electrical, Measurements, and Instrumentation

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

2.1.2 Other Government documents and publications. The following Government document(s), and publication(s) form a part of this standard to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Standard Atmosphere Tables and Data

(Applications for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

2.2 Other publications. The following document(s) forms a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the non-Government documents which are current on the date of the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

C50 - Rotating Electrical Machinery (Included as a general reference)
40 - Sound Level Meters

Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

2.3 Textbooks. The following textbooks are listed for information and are not to be considered as a part of this standard:

Electrical Engineering Laboratory Experiments, Ricker and Tucker, 4th Ed., McGraw-Hill Book Co.
Electrical Measurement, Harris, 1st Ed., John Wiley and Sons.
Electrical Engineers' Handbook, Pender and Del Mar, Vol. 1, 4th Ed., John Wiley and Sons.
Standard Handbook for Electrical Engineers, Fink and Carroll, 10th Ed., McGraw-Hill Book Co.
Chamber's Technical Dictionary, Tiveney and Hughes, Rev. Ed., The MacMillan Co.

(Non-Government standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this standard 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 standard, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

Custodians:

Army - ME
Navy - YD
Air Force- 80

Preparing activity:

Army - ME

Project No. 6115-0213

Review activities:

Army - CE, TE
Navy - AS

User activities:

Army - AT, ER
Navy - MC
Air Force - 11

METHOD 301.1c

INSULATION RESISTANCE

CAUTION: OBSERVE SAFETY REGULATIONS. The voltages used in this method are dangerous to human life. Contact with the leads or the windings under test may cause severe, and possibly fatal, shock. Arrange the voltage leads so that they are not in a position to be accidentally touched. Keep clear of all energized parts. Always reduce the test voltage to zero and ground the winding under test before making any mechanical or electrical adjustments on the equipment. When grounding windings which have been tested, always connect the connection wire to ground first, and then to the winding. Never perform this test without at least one other person assisting. The generator frame shall be securely grounded to the building ground or earth ground.

301.1.1 General. To assure that the current leakage is kept to a minimum, the insulation resistance must be as high as practicable.

301.1.2 Apparatus. Instrumentation shall be as described and illustrated in MIL-HDBK-705, method 105.1, paragraph 105.1.5.2.

301.1.3 PROCEDURE.

301.1.3.1 Preparation for test.

a. Disconnect the circuit under test from all other circuits. Each circuit of each generator presents an individual problem and no specific instructions can be given here.
b. Disconnect all radio suppression capacitors from the circuit to be tested.
c. In the case where several windings constitute a circuit, all leads of the circuit may be connected together and the resistance measured between this connection and ground.
d. Ground all circuits except the one being tested.
e. When testing a stator element, connect the ground lead from the test apparatus to the generator frame (ground). When testing elements that rotate, connect the test apparatus ground lead to the shaft.
f. Connect the other lead to the circuit under test.

301.1.3.2 Test.

a. Operate the test apparatus in accordance with the manufacturer’s instructions.
b. Record the insulation resistance after one minute of operation (see figure 301.1.I). Also record ambient temperature.
c. Turn off test apparatus. Ground the winding under test and the test lead before disconnecting apparatus leads or touching circuit under test.
d. Remove the leads to the circuit under test and repeat the procedure for all other circuits to be tested.
e. After all circuits are tested, reconnect all circuits to original configuration.

301.1.4 Results. Compare the results with the procurement document requirements.

301.1.5 Procurement document requirements. The following item must be specified in the individual procurement document.

a. Minimum allowable insulation resistance.
b. Circuits to be subjected to this method.

TEST DATA

DESCRIPTION 10 KW, 60 HZ
120 V SINGLE PHASE
GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 21108
REF. MIL-STD-705/301.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

INSULATION RESISTANCE TEST

TEST NO. 1
SHEET 1 OF 1
DATE 1 OCTOBER, 1971
RECORDER [illegible]
PROJ. ENGR. [illegible]
SHIFT LEADER [illegible]
OBSERVER [illegible]

INST →				1701													1076
READ NO ↓	TIME	WINDING		RESISTANCE													AVG AMB TEMP
UNITS	HRS				OHMS												°F
SYM																	
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
123	0931	ROTOR		>	200 M												77
124	0933	STATOR		>	200 M												
125	0938	FIELD		>	200 M												
NOTES																	

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

FIGURE 301.1-I. Typical test record for insulation resistance.

X-4531

METHOD 302.1b

HIGH POTENTIAL TEST

CAUTION: OBSERVE SAFETY REGULATIONS. The voltages used in this method are dangerous to human life. Contact with the leads or the windings under test may cause severe, and possibly fatal, shock. Arrange the voltage leads so that they are not in a position to be accidentally touched. Keep clear of all energized parts. Always reduce the test voltage to zero and ground the w under test before making any mechanical or electrical adjustments on the equipment. When grounding windings which have been tested, always connect the connection wire to ground first, and then to the windings. Never perform this test without at least one other person assisting. The generator frame shall be securely grounded to the building or earth ground.

302.1.1 General. The generator insulation materials must be capable of withstanding, without damage, voltages higher rated for definite periods of time to preclude damage during transient loading and short circuit conditions. This test should be performed after the equipment is completely assembled so that damage to the insulation which might have occurred during manufacture and assembly will be detected.

302.1.2 Apparatus. A variable alternating current, high voltage, current-limited power source shall be required.

302.1.3 Procedure.

302.1.3.1 Preparation for test.

a. Adequately ground the high potential apparatus to a solid electrical ground in accordance with instructions accompanying the apparatus. Also, connect the main frame of the generator set and all windings of the generator, not under test, to the same ground.
b. Unless rectifiers and semiconductors are specifically designed to withstand the specified test voltage they should be removed or disconnected from the circuit along with any radio suppression capacitors prior to conducting the tests.
c. Raise, or remove, brushes from commutator and slip rings, if applicable.
d. Isolate the generator power output windings, the generator field windings, and the exciter armature and field windings if a part of the set. This is accomplished by disconnecting the various windings from the associated control circuits or other connections. Static excitation system feeding the field excitation from the ac generator shall be tested with all rectifiers and capacitors disconnected, unless such rectifiers and capacitors are designed to withstand the specified test voltage.
e. Connect the high voltage lead from the test apparatus to the winding or circuit under test. All other windings and circuits must be securely connected to ground.

302.1.3.2 Test.

a. Turn on the test apparatus in accordance with the manufacturer's instructions, after making sure that the initially applied voltage will not be greater than 600 volts.
b. The test voltage shall then be raised approximately uniformly to the required value. This increase shall be accomplished in not less than 10 seconds nor more than 30 seconds. Unless otherwise specified in the procurement document, the maximum test voltage for power output windings shall be equal to 1,000 volts plus twice the highest rated voltage of the generator. The test voltage for field windings shall be equal to 10 times the exciter ceiling voltage but in no case less than 1,500 volts nor more than 3,500 volts. Record on the data sheet the maximum voltage reached during this method (see figure 302.1-I).

c. Apply the maximum voltage for 1 minute. Record the voltage applied, including any breakdown in insulation observed.
d. After 1 minute the voltage shall be reduced gradually to the voltage initially applied. This reduction shall not be accomplished in less than 5 seconds.
e. Turn off the test apparatus.

CAUTION: Ground the high voltage lead of the test apparatus to make sure that no charge remains on the windings which have been under test.

f. Remove the high voltage lead from the windings and proceed with the tests of the remaining circuits to be tested. Make sure that all the circuits not under test are securely grounded.
g. After test is completed, reconnect all circuits to original configuration.

302.1.4 Results. Compare the results with the procurement document requirements.

302.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Test value of applied voltages, if different than those specified in 302.1.3.2.
b. Windings to be tested, other than those specified in 302.1.3.
c. Definition of insulation breakdown.

TEST DATA

DESCRIPTION 10 KW, 60 HZ
120 V SINGLE PHASE
GENERATOR ONLY
MFGR. ENGENSETS INC
MODEL NO. SF-10.0-MD
SERIAL NO. 1077
REF. MIL STD 705, 302.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE
HIGH POTENTIAL TEST

TEST NO 1
SHEET 1 1
DATE APRIL 13, 1971
RECORDER [illegible]
PROJ. ENGR. [illegible]
SHIFT LEADER [illegible]
OBSERVER [illegible]

INST→								008									1076
READ NO.↓	TIME	WINDINGS						MAXIMUM VOLTAGE APPLIED									AVG AMB TEMP
UNITS	HRS								VOLTS								°F
SYM.																	
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
202	08 05	POWER OUTPUT LEADS							1480								74
203	08 15	FIELD							1500								
204	08 20	EXCITER ARMATURE							1500								
205	08 25	EXCITER FIELD							1500								
NOTES																	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 302.1-I. Typical test record for high potential test.

X-4532

METHOD 401.1b

WINDING RESISTANCE

401.1.1 General. Wingding resistance measurements are commonly used to determine temperature rises; to determine resistance with design data; to compare production models against first article models; and to detect defective windings.

401.1.2 Apparatus. Instrumentation for measuring winding resistances shall be as described and illustrated in MIL-HDBK-705, method 105.1.

401.1.3 Procedure.

401.1.3.1 Preparation for test.

a. Isolate the winding whose resistance is to be measured by disconnecting one end from all other circuits.
b. Winding resistance measurements shall be made by one of the following approved methods: Wheatstone bridge; Kelvin bridge; in potential; or drop-in potential; or comparison. These methods are described in MIL-HDBK-705, method 105.1.
c. Connect the measuring apparatus across the winding in accordance with the apparatus manufacturer's instructions. If the drop-in potential or comparison methods are employed, measure the voltage only on the portion of the circuit to be included in the resistance measurements. Since these measurements are used in comparing one reading against another, care should be taken to measure the voltage at the same location during each measurement of like windings.
d. Cold resistance measurements shall be made with the generator set at approximately the surrounding ambient temperature; that is, the measurements shall be taken after the generator set has been inoperative for a sufficient time (approximately 12 hours) to bring the major generator mass temperature to within 3 deg. C of the ambient temperature.

401.1.3.2 Test. Operate the test apparatus in accordance with the applicable method selected and record the resistance value for the winding(s) under test (see figure 401.1-I). The resistance values shall as a minimum be recorded to four significant digits.

When this test method is used for temperature change determination, speed in taking the measurements is essential (see MIL-HDBK-705, method 110.1). The ambient temperature at which the resistance readings are taken shall also be recorded.

401.1.4 Results. The corrected (see MIL-HDBK-705, method 221.1) values determined by these measurements shall be compared with procurement document or design requirements, or shall be used in other computations.

401.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The minimum and maximum allowable resistance values for each component tested, if applicable.
b. The standard temperature to which these measurements are to be corrected, if applicable.

TEST DATA

DESCRIPTION 10 KW, 60 Hz
120V SINGLE PHASE
GENERATOR ONLY
MFGR ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 21067
REF MIL-STD-705/401.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

WINDING RESISTANCE TEST

TEST NO 32
SHEET 1 OF 1
DATE 15 JANUARY 1971
RECORDER L Wright
PROJ. ENGR. J Pickle
SHIFT LEADER H Salt
OBSERVER L Pepper

INST →		320															1076
READ NO.	TIME	DIAL READING		MULTIPLIER		LEAD RESIS.		WINDING RESIS.			WINDING			WINDING RESIS. CORR TO EDGE			AVG AMB. TEMP
UNITS	HRS					OHMS		OHMS							OHMS		°F
SYM.																	
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
199	10:15	7310		10^{-3}		0.09		7.22			GEN	FIELD			7.08		77
200	10:18	3838		10^{-2}		0.09		38.29			EXC	FIELD			36.73		
201	10:22	1.642		0.05		—		0.0821			T_1 -	T_4			0.0807		
202	10:24	1.642		0.05		—		0.0821			T_2 -	T_5			0.0807		
203	10:26	1.647		0.05		—		0.0824			T_3 -	T_6			0.0810		
204	10:31	1.642		0.05		—		0.0821			T_7	- T_{10}			0.0807		
205	10:33	1.643		0.05		—		0.0821			T_8	- T_{11}			0.0807		
206	10:34	1.647		0.05		—		0.0824			T_9	- T_{12}			0.0810		

NOTES: GENERATOR STABILIZED AT ROOM TEMPERATURE 24 HOUR PRIOR TO MEASUREMENT

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 401-I. Typical test record for winding resistance test.

X-4533

METHOD 410.1b

OPEN CIRCUIT SATURATION CURVE TEST

410.1.1 General. The open circuit saturation curve is used by design engineers in conjunction with the short circuit and zero power factor saturation curves to determine certain performance characteristics of the generator under various load conditions. It is used also in comparison with data obtained fran tests on production models as a check to ascertain that the quality of the iron or the length of the air gap in the production generators has not been changed from that of the first article model.

410.1.2 Apparatus. Instrumentation for measuring terminal voltage, generator speed, exciter field voltage and current (generator field voltage and current, if applicable) shall be as described and illustrated in MIL-HDBK-705. In addition, a prime mover having a steady state speed regulation not greater than +/- 1 percent of rated speed and a separate, variable dc source for excitation shall be required. A voltmeter having an accuracy of +/- 0.5 percent of the reading or better shall be for measuring the terminal voltage.

410.1.3 Procedure.

410.1.3.1 Preparation for test.

a. Mechanically connect the generator to the prim mover and provide the external excitation supply to the generator. Observe correct polarity when connecting the dc supply to field windings.
b. Connect the instrumentation as illustrated in MIL-HDBK-705, method 205.1 for the applicable voltage connection.

410.1.3.2 Test.

a. Start and operate the prime mover such that the generator is operating at rated speed, open-circuited and zero excitation. Read and record all instrumentation.
b. Increase the applied voltage to the field to increase the field current in steps from zero upward to give approximately 20, 40, 60, 80, 90, 95, 100, 105, 110, 120, and 130 percent of rated generator voltage (unless otherwise specified in the procurement document). Read and record all instrumentation at each step. All reading must be taken with rising field current and without interruption (see figure 410.1-I).

NOTE: Should it become necessary to decrease the excitation, the field current must be reduced to zero and then increased to the desired value.

c. When performing this test on three phase machines, reading should be taken of the terminal voltage (line-to-line) of all three phase to check phase balance. These readings should be made under constant conditions of excitation and speed, and with the same voltmeter.

410.1.4 Results. A curve of generator terminal voltage (vertical axis) versus exciter field current (and generator field current, if applicable) (horizontal axis) shall be platted. If the knee of the curve is not well defined, repeat 410.1.3.2 taking additional readings as needed to better establish this portion of the curve. This curve is defined as the open circuit saturation curve (figure 410.1-II). Compare the results with the procurement document requirements.

410.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and frequency(ies) at which this method is to be performed.
b. Maximum value of no load exciter field current, if applicable.
c. Maximum value of no load generator field current, if applicable.

TEST DATA

DESCRIPTION 10KW, 60 Hz 120V, SINGLE PHASE GENERATOR ONLY

MFGR. ENGENSETS, INC.

MODEL NO. SF-10.0-MD

SERIAL NO. 4019

REF. MIL-STD-705/410.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

OPEN CIRCUIT SATURATION CURVE TEST

TEST NO. 3

SHEET 1 OF 1

DATE 3 DECEMBER 1986

RECORDER [illegible]

PROJ. ENGR. [illegible]

SHIFT LEADER [illegible]

OBSERVER [illegible]

INST→		187		183			110	217									1018
READ NO.	TIME	TERMINAL VOLTAGE		FREQUENCY			EXCITER FIELD										AVG AMB TEMP
UNITS	HR		VOLTS		Hz		VOLTS	AMPS									°F
SYM																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
291	08:15		8.2		60.0		0	0									77
292			24.0		60.0		1.2	0.23									
293			48.0		60.0		2.4	0.47									
294			72.0		60.0		3.7	0.73									
295			96.0		60.0		5.0	0.95									
296			108.0		60.0		6.0	1.10									
297			114.0		60.0		6.8	1.25									
298			120.0		60.0		7.5	1.35									
299			128.0		60.0		8.5	1.45									
300			132.0		60.0		10.2	1.55									
301			144.0		60.0		12.1	2.15									
302	08:35		156.0		60.0		15.0	3.22									76

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: EXCITER FIELD CURRENT MEASURED USING A 4AMP-100mV SHUNT N. 1176.

FIGURE 410.1-1. Typical test record for open circuit saturation curve test.

X-4534

Curve Test.]

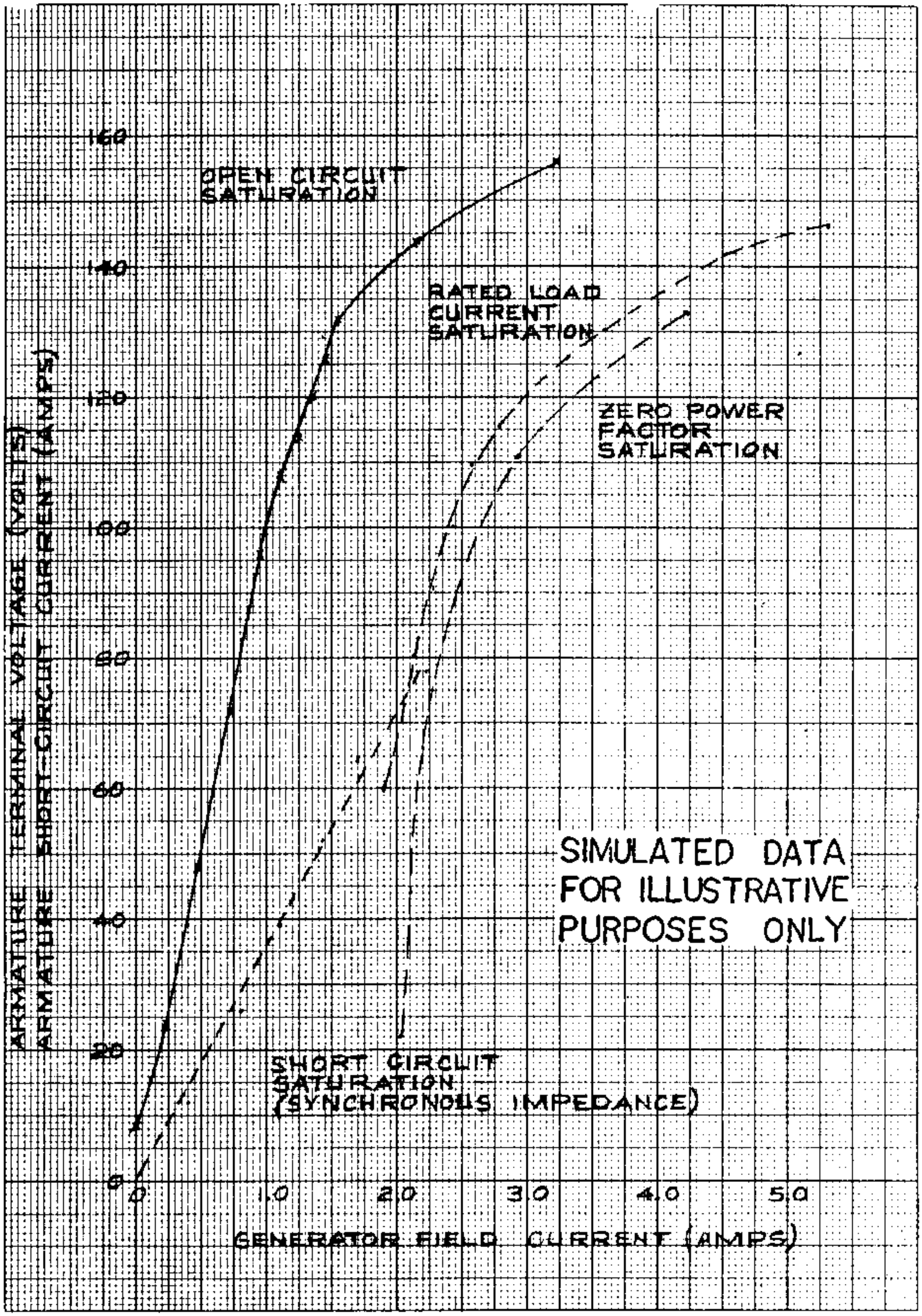


Figure 410.1-II: Family of saturation curves.

X-4535

METHOD 411.1b

SYNCHRONOUS IMPEDANCE CURVE TEST

(SHORT-CIRCUIT SATURATION CURVE)

411.1.1 General. Synchronous impedance curves assist in determining the performance of an alternating current generator during periods of short circuit. This information is needed to properly design protective devices and to assure designers that the air gap, coils and steel meet requirements.

411.1.2 Apparatus. Instrumentation for measuring line current, field voltage and current and generator speed shall be as described and illustrated in MIL-HDBK-705. In addition, a prime mover capable of driving the generator at rated speed with the short-circuit applied and having a speed regulation not greater than +/- 1 percent of rated speed and a separate dc source for excitation shall be required. Instruments for measuring the field and short circuit currents shall have an accuracy of +/- 0.5 percent of reading or better.

411.1.3 Procedure.

411.1.3.1 Preparation for test.

a. Mechanically connect the generator to the prime mover and connect the external excitation supply to the generator.
b. Connect the instrumentation as illustrated in MIL-HDBK-705, method 205.1, for the applicable voltage connection.
c. Apply the short-circuit to the generator terminals through the ammeters.

NOTE: The short-circuit leads shall be as short as possible to reduce heating effects.

411.1.3.2 Test.

a. Start and operate the prime mover such that the generator is operating at rated speed, short-circuited and zero excitation. Read and record all instrumentation.
b. Increase the field current until 100 percent of rated current exists in each phase. Read and record the circuit in all three phases to check current balance. If the current is not balanced within +/- 1 percent of each other, or within the tolerance specified in the procurement document, the cause of the unbalance shall be located and corrected before proceeding with the test.
c. After the phase balance is determined to be satisfactorily within tolerance, increase the field excitation until 150 percent of rated current is present in each phase.

CAUTION: Do not maintain overload current long enough to cause generator overheating.

d. Record all instrument readings.
e. Reduce the field excitation in steps to in 125, 100, 75, 50 and 25 percent of armature current in each phase. Read and record instrument indications at each step. All readings shall be taken without interruption.

411.1.4 Results. A curve of generator armature short-circuit current (vertical axis) versus generator or exciter field current (horizontal axis) shall be plotted. This curve is defined as the synchronous impedance, or short-circuit saturation curve (figure 411.1-II). Compare the results with the requirements of the procurement document.

411.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection(s) and speed(s) at which this method is to be performed.
b. The allowable current variation, if other than as specified herein.

TEST DATA

DESCRIPTION 15 KW, 60 HZ 120/208 V 3-PHASE GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. SF-15.0-MD
SERIAL NO. 1077
REF: MIL-STD-705/411.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

SYNCHRONOUS IMPEDANCE CURVE TEST

TEST NO. 6
SHEET 1 **OF** 1
DATE 8 FEB, 71
RECORDER [illegible]
PROJ ENGR. W Poindexter
SHIFT LEADER C. Fair
OBSERVER VT Smith

INST. →		163				1156	105		377								1076
READ NO. ↓	TIME	LINE CURRENT L1	L2	L3		GENERATOR FIELD			SPEED								AVG AMB TEMP
UNITS	HRS	AMPS	AMPS	AMPS		VOLTS	AMPS			RPM							°F
SYM.		X 20	X 20	X 20													
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
157	11:15	STARTED		DRIVE	MOTOR					1800							77
158	11:20	2.60	2.60	2.60		38.1	1.42			1800							77
159	11:21	3.90	3.90	3.90		45.2	2.21			1800							77
160	11:21	3.25	3.25	3.25		42.3	1.69			1800							77
161	11:22	2.60	2.60	2.60		38.1	1.42			1800							77
162	11:23	1.95	1.95	1.95		29.8	1.11			1800							77
163	11:24	1.30	1.30	1.30		21.8	0.81			1800							77
164	11:25	0.65	0.65	0.65		10.7	0.40			1800							77

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: AC CURRENT MEASURED USING CT # L_1 - 1306; L_2 - 1307; L_3 - 1308
GENERATOR FIELD CURRENT MEASURED USING 3A, 50 mV SHUNT # 1358

FIGURE 411.1-I. Typical test record for synchronous impedance curve test.

X-4536

MIL-STD-705C

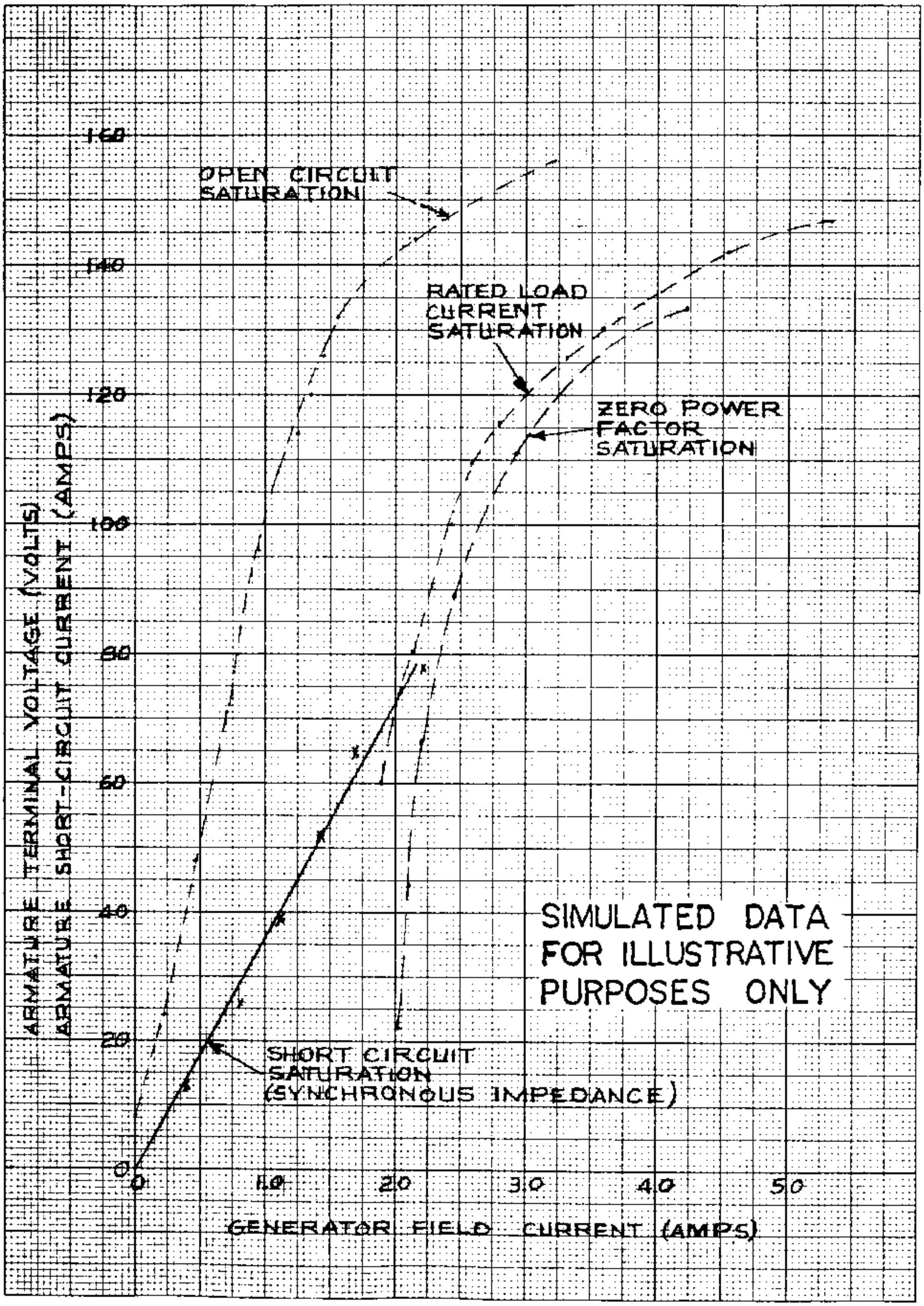


Figure 411.1-II - Family of saturation curves.

X-5437

METHOD 412.1b

ZERO POWER FACTOR SATURATION CURVE TEST

412.1.1 General. The zero power factor saturation curve is used by design engine conjunction with the short-circuit and open-circuit saturation curves to determine certain performance characteristics of the generator under various load conditions. The family of generator saturation curves can be used to approximate the generator field current for any load condition.

412.1.2 Apparatus. Instrumentation for measuring load conditions and generator field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition, a prime mover capable of maintaining constant rated speed of the generator under all load conditions of this method within +/- 1 percent and a source of dc power for generator excitation shall be required. Instruments for measuring the field current and terminal voltage shall have an accuracy of +/- 0.5 percent of reading or better. The power factor meter used shall be capable of indicating power factor to 0.3 lagging.

412.1.3 Procedure.

412.1.3.1 Preparation for test.

a. Mechanically connect the prime mover to the generator and provide the external excitation supply to the generator.
b. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, for the voltage connection and frequency specified in the procurement document.

412.1.3.2 Test.

a. Start and operate the prime mover such that the generator is operating at rated speed with zero excitation. Adjust the low power factor load to minimum reactance.

   NOTE: During all portions of this method the power factor of the load shall not exceed 0.40 and shall not be less than 0.30. Load current on polyphase generators shall be balanced.

b. Increase the field current until the generator is supplying rated load current.
c. Record all instrument readings.
d. Increase the load slightly, then increase the field current until the generator is again supply rated load current. Adjust the excitation of the generator to approximately 20 percent rated voltage while maintaining the load current constant at the rated value.
e. Record all instrument readings.
f. Repeat steps d and e above to obtain at least seven equally spaced steps of terminal voltage up to and including 130 percent of rated voltage (unless otherwise specified in the procurement documents.) All readings shall be taken without interruption.

412.1.4 Results. A curve of terminal voltage (vertical axis) versus generator exciter field current (horizontal axis) shall be plotted. This curve is fined as the zero-power-factor saturation curve (figure 412.1-II). Compare the results with the requirements of the procurement document.

412.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection(s) and speed(s) at which this method is to be performed.
b. The limiting terminal voltage, if other than as specified herein.

TEST DATA

DESCRIPTION 15 KW, 60 HZ
120/208 V 3-PHASE
GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. SF-15.0-MD
SERIAL NO. 1077
REF: MIL-STD-705/411.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

SYNCHRONOUS IMPEDANCE CURVE TEST

TEST NO. 6
SHEET 1 OF 1
DATE 8 FEB, 71
RECORDER FJ Evans
PROJ ENGR. W Poindexter
SHIFT LEADER C. Fair
OBSERVER WT Smith

INST. →		163				1156	105		377								1076
READ NO. ↓	TIME	LINE CURRENT L1	LINE CURRENT L2	LINE CURRENT L3		GENERATOR FIELD			SPEED								AVG AMB TEMP
UNITS	HRS	AMPS	AMPS	AMPS		VOLTS	AMPS			RPM							°F
SYM.		X 20	X 20	X 20													
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
157	11:15	STARTED		DRIVE	MOTOR					1800							77
158	11:20	2.60	2.60	2.60		38.1	1.42			1800							77
159	11:21	3.90	3.90	3.90		45.2	2.21			1800							77
160	11:21	3.25	3.25	3.25		42.3	1.69			1800							77
161	11:22	2.60	2.60	2.60		38.1	1.42			1800							77
162	11:23	1.95	1.95	1.95		29.8	1.11			1800							77
163	11:24	1.30	1.30	1.30		21.8	0.81			1800							77
164	11:25	0.65	0.65	0.65		10.7	0.40			1800							77

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

NOTES: AC CURRENT MEASURED USING CT # L_1 - 1306; L_2 - 1307; L_3 - 1308
GENERATOR FIELD CURRENT MEASURED USING 3A, 50 mV SHUNT # 1358

FIGURE 411.1-I. Typical test record for synchronous impedance curve test.

X-4536

saturation curve test.]

MIL-STD-705C

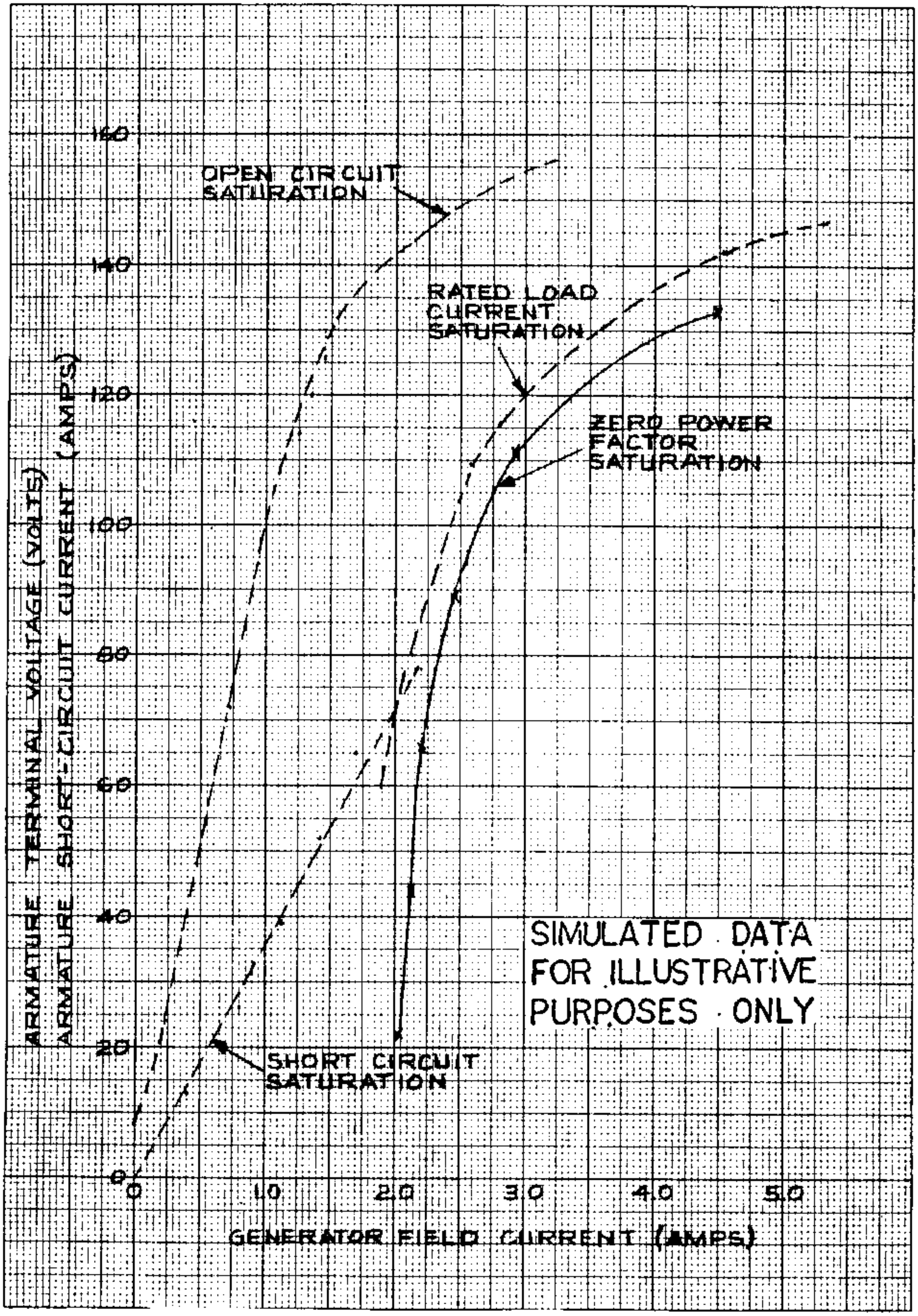


Figure 412.1-II - Family of saturation curves.

X4539

METHOD 413.1b

RATED LOAD CURRENT SATURATION CURVE TEST

413.1.1 General. The rated load current saturation curve is used by design engineers as an aid in determining the field current requirements of the generator. The family of generator saturation curves can be used to approximate the generator field current for any load condition.

413.1.2 Apparatus. Instrumentation for measuring load conditions and field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition, a separate, variable dc source for generator excitation and a prime mover capable of maintaining the generator speed within +/- 1 percent of rated speed under all load conditions of this method shall be required. Instruments for measuring the terminal voltage and field current shall have an accuracy of +/- 0.5 percent of reading or better.

413.1.3 Procedure.

413.1.3.1 Preparation for test.

a. Mechanically connect the generator to the prime mover and provide the external excitation supply to the generator.
b. Connect the load and instrumentation to the generator in accordance with the applicable figure of MIL-HDBK-705, method 205.1, for the voltage connection and frequency specified in the procurement document.

413.1.3.2 Test - ac generators.

a. Start the prime mover and operate the generator at rated frequency, approximately 50 percent of rated voltage, rated load current and rated power factor (0.8 lagging if not otherwise specified).

   NOTE: The load current of polyphase generators shall be balanced.

b. After the conditions of step a above have been reached, record all instrument readings.
c. Reduce the field current to zero using the adjustment on the dc source.
d. Increase the field current in steps fran zero upward while adjusting the load for rated generator output current and rated power factor to vary the terminal voltage to approximately 70, 80, 90, 95, 100, 105, 110, 120, and 130 percent of rated voltage (unless otherwise specified in the procurement document). All readings must be taken with a rising field current. Should it become necessary to decrease the excitation, the field current must be reduced to zero and then increased to the desired value. Then increase the field current to obtain the desired output voltage. Read and record all instrument readings at each step. All reads shall be taken without interruption. Take sufficient additional steps to clearly define the curve (figure 413.1-I).

413.1.3.3 Test - dc generators.

a. Start the prime mover and operate the generator set at rated speed, approximately 20 percent of rated voltage and rated load current.
b. After the conditions of step a above have been reached, record all instrument readings.
c. Reduce the field current to zero using the rheostat on the separate dc source.
d. Increase the field current in steps to obtain 20, 40, 60, 80, 90, 95, 100, 105, 110, 120, and 130 percent of generator rated voltage (unless otherwise specified in the procurement document) while adjusting the load for rated generator output current. All readings must be taken with a rising field current. Should it become necessary to decrease the excitation, the field current must be reduced to zero and then increased to the desired value. Read and record all instrument readings at each step. All readings shall be taken without interruption.

413.1.4 Results. Plot a curve of terminal voltage versus generator or exciter field current (figure 413.1-II) from the data obtained. Compare the results with procurement document.

413.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection(s) and frequency(ies) at which this method is to be performed.
b. The maximum allowable generator or exciter field current.
c. The maximum terminal voltage, if other than as specified herein.

TEST DATA

DESCRIPTION 10 KW, 60 Hz
120 V SINGLE PHASE
GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 21067
REF: MIL-STD-705/413.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

RATED LOAD CURRENT
SATURATION CURVE TEST

TEST NO. 88
SHEET 1 OF 1
DATE FEBRUARY 8, 1971
RECORDER J Wright
PROJ. ENGR. J. Johnson
SHIFT LEADER H Smith
OBSERVER C. Simpson

INST. →		103		206		314		418		66.			138	262			1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY			GENERATOR FIELD				AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW				Hz		VOLTS	AMPS			°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
173	13:16		60.0	2.60	104	0.125	5.0		.80		60.0		26.1	1.87			79
174	13:18	REDUCED FIELD CURRENT TO ZERO															
175	13:20		60.0	2.60	104	0.125	5.0		.80		60.0		26.1	1.87			
176			70.3	2.60	104	0.146	5.85		.80		60.0		27.8	1.98			
177			80.4	2.60	104	0.168	6.7		.80		60.0		28.5	2.13			
178			90.1	2.60	104	0.188	7.5		.80		60.0		30.5	2.27			
179			100.3	2.60	104	0.208	8.35		.80		60.0		32.5	2.42			
180			109.8	2.60	104	0.229	9.15		.80		60.0		34.8	2.68			
181			115.6	2.60	104	0.240	9.6		.80		60.0		37.5	2.79			
182			120.2	2.60	104	0.250	10.0		.80		60.0		40.5	3.00			
183			125.7	2.60	104	0.262	10.5		.80		60.0		43.7	3.31			
184			130.1	2.60	104	0.270	10.8		.80		60.0		47.4	3.58			
185			136.0	2.60	104	0.282	11.3		.80		60.0		51.5	4.02			
186			142.1	2.60	104	0.295	11.8		.80		60.0		55.8	4.53			
187	13:35		146.8	2.60	104	0.305	12.2		.80		60.0		60.3	5.31			79

NOTES: LINE CURRENT MEASURED USING C.T. # 1305
GENERATOR FIELD CURRENT MEASURED USING 10A, 50mV SHUNT # 2071

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 413.1-I. Typical test record for rated load current saturation curve test.

X-4540

curve test.]

MIL-STD-705C

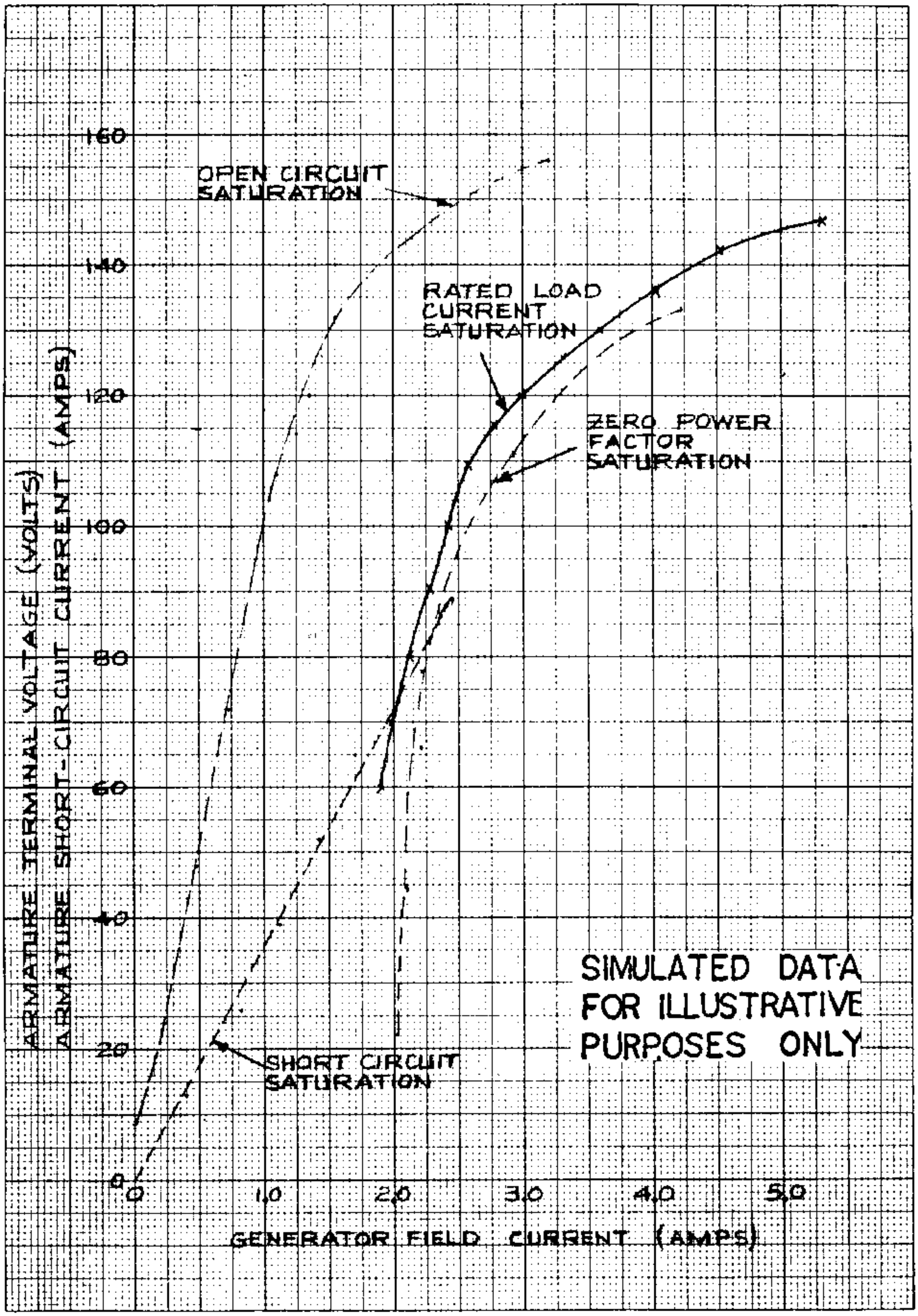


Figure 413.1-II - Family of saturation curves.

X-4541

METHOD 414.1c

ROTATING EXCITER SATURATION CURVE TEST (CONSTANT RESISTIVE LOAD)

414.1.1 General. The saturation curve for a rotating exciter aids the design engineer in determining the suitability of a particular exciter for use with a particular generator.

414.1.2 Apparatus. Instrumentation for measuring exciter output voltage, exciter field current and exciter speed shall be as described and illustrated in MIL-HDBK-705. In addition a prime mover capable of driving the exciter at rated speed with a speed regulation not greater than +/- 1 percent of rated speed, a separate variable dc source for excitation and a resistive load equivalent to the generator field resistance at 75 deg. C shall be required. Instruments for measuring the dc terminal voltage and exciter field current shall have an accuracy of +/- 0.5 percent of reading or better.

414.1.3 Procedure.

414.1.3.1 Preparation for test.

a. Connect the instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1.
b. Connect the resistive load to the output of the exciter. (Slip rings may be necessary if the generator is not so equipped.)

NOTE: In order to obtain zero exciter field current, it may be necessary to open the exciter field circuit. To prevent high voltage hazard to personnel, the exciter field current should be reduced to the minimum possible value before opening the field.

414.1.3.2 Test.

a. On exciters with brushes, check that the brush settings are positioned in accordance with the manufacturer’s recommendation.
b. Start and operate the prime mover such that the exciter is operating at its rated speed. Adjust the exciter field current to obtain nominal exciter voltage. Operate the exciter under these conditions for a 30 minute period. Read and record all instrumentation initially and every 10 minutes thereafter.
c. Reduce the exciter field current to zero. Read and record all instrumentation (see figure 414.1-I).
d. Increase the exciter current in steps to obtain exciter terminal voltages of approximately 20, 40, 60, 80, 90, 95, 100, 105, 110, 120, and 130 percent of nominal exciter voltage. Read and record all instrumentation at each step. All readings shall be taken without interruption.

414.1.4 Results. Plot a curve of exciter terminal voltage versus exciter field current (figure 414.1-II), using the data obtained above. This curve shall be known as "the loaded exciter saturation curve". Compare this curve with the requirements of the applicable generator or the procurement document.

414.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The nominal exciter voltage.
b. Exciter rated speed.
c. Exciter ceiling voltage, if applicable.
d. Generator field resistance or current value.

TEST DATA

DESCRIPTION 15 KW, 60 Hz 120/208 V 3-PHASE EXCITER ONLY	PHILADELPHIA REGION DEFENSE CONTRACT ADMINISTRATION SERVICE	TEST NO. 2 SHEET 1 OF 1 DATE FEBRUARY 8 1971
MFGR ENGENSETS, INC. MODEL NO. T-107 SERIAL NO. 59328 REF. MIL-STD-705/414.1	ROTATING EXCITER SATURATION CURVE TEST	RECORDER PROJ ENGR. SHIFT LEADER OBSERVER

INST. →		312		166		618											1076
READ NO. ↓	TIME	EXCITER VOLTAGE		EXCITER FIELD CURRENT		SPEED											AVG AMB TEMP
UNITS	HRS		VOLTS		AMPS		RPM										°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
188	0910		100.0		2.30		1800	STARTED UNIT									74
189	0920		100.1		2.30		1800	END OF 30 MINUTES OPERATION									75
190	0930		100.1		230		1800										76
191	0940		100.1		2.30		1800										77
192	0942		0		0		1800										78
193	0944		20.0		0.38		1800										
194	0945		40.0		0.78		1800										
195	0946		60.0		1.20		1800										
196	0947		80.0		1.75		1800										
197	0950		90.1		2.03		1800										
198	0951		95.0		2.17		1800										
199	0953		100.0		2.30		1800										
200	0954		105.0		2.48		1800										
201	0958		110.0		2.70		1800										
202	0959		120.1		3.28		1800										
203	1000		130.0		4.25		1800										80

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: EXCITER FIELD CURRENT MEASURED USING A 5A, 100 mV SHUNT NO. 1177
Generator Resistance = 3.31 Ω

FIGURE 414.1-I. Typical test record for rotating exciter saturation curve test.

X-4542

curve test.]

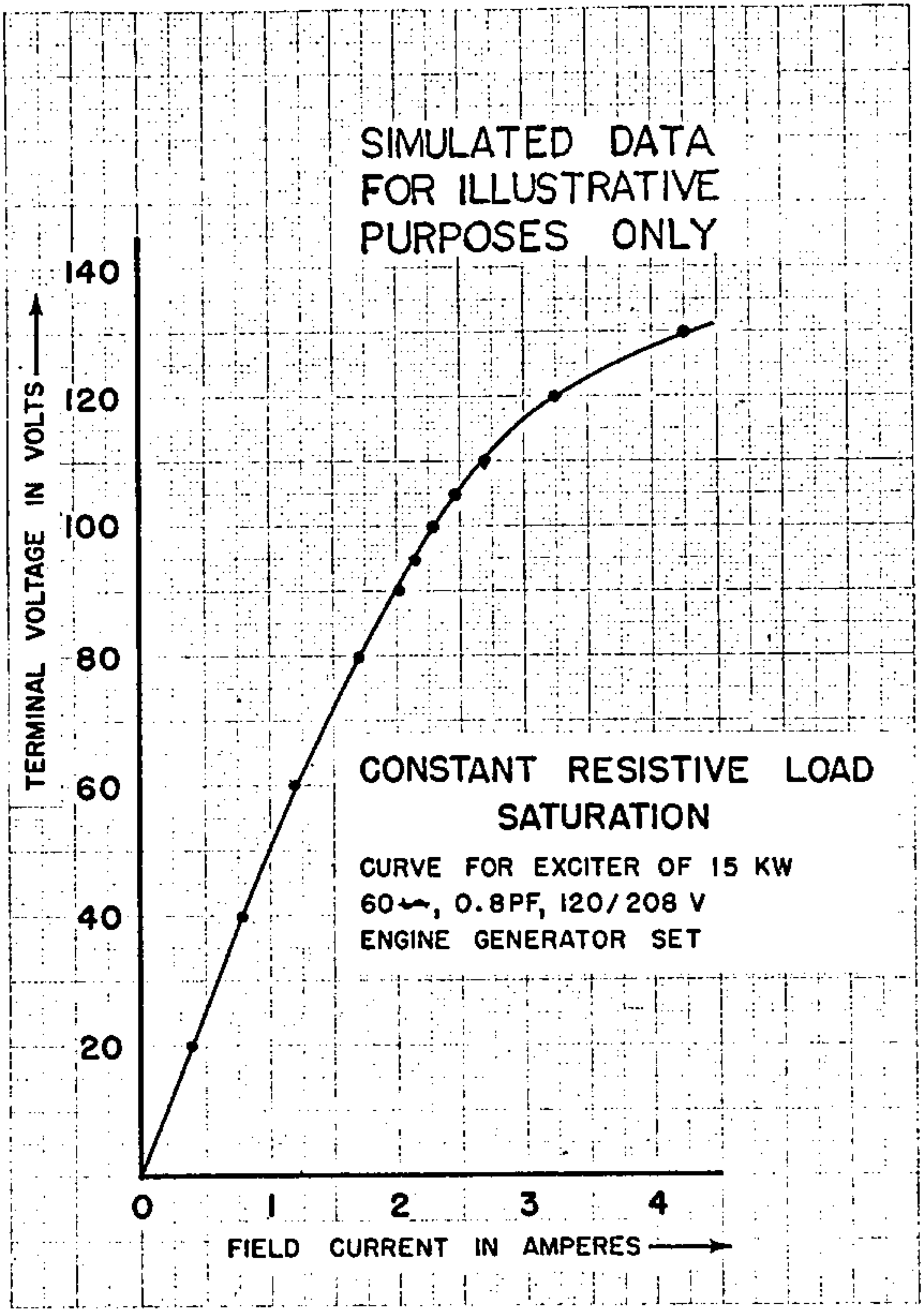


FIGURE 414.1-II. SAMPLE LOADED EXCITER SATURATION CURVE.

X-4543

METHOD 415.0b

SUMMATION OF LOSSES TEST

415.0.1 General. The internal generator losses are inversely related to the efficiency. The efficiency of a generator determines the capacity of the prime mover necessary for proper operation. The summation of losses test all design engineers to investigate the problem of increasing the efficiency of a generator.

415.0.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, set temperatures and prime mover output power shall be as described and illustrated in MIL-HDBK-705. In addition, a prime mover (dynamotor or dc motor) shall be required. If a dc motor is used, a curve of power output (in kW) against input current at a constant input voltage shall be furnished (see figures 415.0-I and 415.0-V). If a calibrated dc motor is used as the prime mover, a constant voltage power supply corresponding to the motor calibration curve shall be used. The dc motor, if used, shall have a horsepower rating of not less than 25 percent nor more than 50 percent of the generator kilowatt rating. A separate variable source of dc power for generator excitation shall be provided. A direct reading torque meter (connected between the prime mover and generator) may be utilized for calculating actual generator input power. Electrical instrumentation used for the following tests shall have an accuracy of +/- 0.5 percent of reading or better.

415.0.3 Procedure.

415.0.3.1 Preparation for test.

a. Mechanically connect the generator assembly, including its cooling fan to the prime mover and provide the external excitation supply to the generator.
b. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, for the voltage connection and frequency specified in the procurement document.
c. As applicable, connect the instrumentation necessary to measure the output power of the prime mover. The instrumentation requirements of a shall be connected in accordance with the manufacturer’s instructions; the instrumentation for a calibrated dc motor shall be connected to measure the motor input voltage and current and the field voltage and current similar to that shown in MIL-HDBK-705, method 205.1, figure 205.1.XLI and figure 205.1.XLII.

415.0.3.2 Test.

415.0.3.2.1 Bearing friction and windage loss.

a. Raise the brushes, if applicable, so that they do not touch the slip rings or the commutator.
b. The friction and windage loss is the power input to the machine being tested, with zero excitation.

c. Start and operate the prime mover at rated generator speed until the bearing(s) reach constant temperature so the bearing friction becomes stable.
d. Record the data necessary to compute the output power of the prime mover (motor input power or constant and scale reading).
e. Compute the prime rawer output power in kW. This value represents the bearing friction and windage loss of the generator.

415.0.3.2.2 Brush friction loss.

a. Adjust the brush pressure on all generator brushes to the pressure recommended on the set or in the technical manual.
b. Start and operate the prime mover at rated generator speed until the bearing(s) reach constant temperature so that bearing friction becomes stable.
c. Record the data necessary to compute the output power of the prime mover (motor input power or dynamometer constant and scale reading).
d. Compute the prime mover output power in kW and subtract the prime mover output power found in 415.0.3.2.1e. This difference represents the brush friction loss.

415.0.3.2.3 Brush contact loss.

a. Adjust the brush pressure on all generator brushes to the pressure recommended on the set or in the technical manual.
b. Start and operate the prime mover at rated generator speed until the bearing(s) reach constant temperature so that bearing friction becomes stable. For dc generators, apply a short circuit to the output terminals and adjust the excitation to obtain rated load current. For ac generators adjust the field current to its value at rated load.
c. With a low-range voltmeter (range of approximately 3 volts), read and record the voltage between the brush bracket holder and at least four equally spaced points along the commutator brush span (see figure 415.0-IX).
d. Repeat steps b and c above for all other load conditions specified in the procurement document.
e. For each load condition average the four voltage readings found for that load condition.
f. Compute the brush contact loss by multiplying twice the average voltage found in step e above by the load current under which the average was found.
g. For the summation of losses the brush contact loss shall be taken as the loss found with the generator operating at rated load multiplied by the number of pairs of brushes on the commutator or slip rings.

415.0.3.2.4 Open-circuit core loss (ac generator only).

a. Start and operate the prime mover at rated generator speed, without generator excitation, until the bearing(s) reach constant temperature and friction becomes stable. (Two-hour operation will be sufficient with no more than a 3 deg. C change in the average ambient temperature).

b. Using the external excitation supply raise the terminal voltage from zero to give approximately 20, 40, 60, 80, 90, 100, 105, 110, 120, and 130 percent of rated voltage.
c. Simultaneously read and record the generator field current and voltage, the generator terminal voltage and the data necessary to compute the output power of the prime mover for each step, including the zero step. All readings shall be taken with a rising field current. Should it be necessary to reduce the excitation current it must be reduced to zero and then returned to the desired value (see figure 415.0-VI).
d. From the prime mover output power at each step subtract the bearing friction and windage loss and, if applicable, the brush friction loss to obtain the open circuit core loss for each field current value.
e. Plot a curve of generator open-circuit core loss versus terminal voltage (see figure 415.0-II). The value of open-circuit core loss at rated voltage shall be used in this summation of losses.

415.0.3.2.5 Open-circuit core loss (dc generators only).

a. Start and operate the prime mover at rated generator speed, without generator excitation, until the bearing(s) reach constant temperature and friction become stable. (Two-hour operation will be sufficient with not more than a 3 deg. C change in the average ambient temperature).
b. Using the external excitation supply, raise the terminal voltage from zero to its rated value.
c. Simultaneously read and record the field voltage and current, the generator terminal voltage and the prime mover output power in kW (see figure 415.0-VII).
d. Calculate the internal generator voltages corresponding to 25, 50, 75, and 100 percent of rated load by adding the armature circuit (armature, brushes, commutating field, and series field) voltage drops due to resistance at each of the above load conditions to the rated terminal voltage.
e. Using the external excitation supply raise the terminal voltage to obtain each of the values calculated in step d above.
f. Simultaneously read and record the generator field voltage and current, the generator terminal voltage and the prime mover output power in kW at each step.
g. From the prime mover output at each step subtract the bear friction and windage loss and, if applicable, the brush friction loss to obtain the open circuit core loss for each terminal voltage step.
h. Plot a curve of generator open-circuit core loss versus generator terminal voltage (see figure 415.0-III). The value of open-circuit core loss which corresponds to the calculated internal voltage at rated load shall be used in this summation of losses.

415.0.3.2.6 Armature I^2R Loss.

a. The armature I^2R loss is defined as the product of the square of the armature current under any specified load and the resistance of the armature winding as measured in accordance with MIL-HDBK-705, method 105.1, corrected to 25 deg. C plus the stabilized temperature rise of the armature windings under the same load condition. The following formula for copper windings shall be used to determine the armature resistance:

$$R_c = \frac{R_o(234.5 + T_r)}{234.5 + T_o}$$

Where:

R_c is the corrected resistance.

R_o is the measured resistance.

T_r is the temperature rise in Celsius degrees (C deg.).

T_o is the temperature of the winding at the time R_o is measured in degrees Celsius (deg. C).

b. The armature I^2R loss shall be calculated for rated load current in the armature winding(s) and used in this summation of losses. For a 3-phase machine the loss is the summation of the losses of the individual phase windings.

c. To determine the stabilized armature winding temperature rise perform method 680.1, Temperature Rise Test (Generator Only).

415.0.3.2.7 Field I^2R loss.

a. The field I^2R loss is defined as the product of the square of the field current under any specified load condition and the resistance of the field as measured in accordance with MIL-HDBK-705, method 105.1, corrected to 25 deg. C plus the stabilized temperature rise of the field winding under the same load condition. Use the formula given in 415.0.3.2.6a above to determine the corrected field resistance.

b. The field I^2R loss shall be calculated for rated load field current in the field winding used in the summation.

c. To determine the stabilized field winding temperature rise perform method 680.1, Temperature Rise Test (Generator Only).

415.0.3.2.8 Stray load loss.

a. Short circuit the generator through the load current transformers (or shunt). A wye connected generator shall be shorted line-to-neutral (all phases) while a delta connected generator shall be shorted line-to-line (all phases).
b. Start and operate the prim mover at rated generator speed. Adjust the external excitation supply for approximately 125 percent of rated current (If the phase currents of a multi-phase machine are not approximately balanced, shut down the prim mover and the excitation supply and correct the trouble before proceeding). This test shall be performed with decreasing field current. (During this test, should the field current accidentally be increased, it shall be returned to the value which will cause approximately 125 percent of rated generator current, then reduced to the desired value.)
c. Decrease the excitation to obtain approximately 100, 75, 50, and 25 percent of rated current in the short-circuit ammeters. At each of these steps, including the 125 percent step, read and record the generator output current, the speed of the generator and the prime mover output power in kW (figure 415.0-VIII).
d. From the recorded values of prime mover output power subtract the bearing friction and windage loss, the brush friction loss, brush contact loss, and the armature I^2R loss (which must be calculated for each current step - see 415.0.3.2.6), to obtain the stray load loss.
e. Plot a curve of stray load loss versus armature current (figure 415.0-IV) .
f. The value of stray load loss at the armature current corresponding to rated armature current shall be used in the summation of losses.

415.0.3.2.9 Exciter loss. Connect a "dummy" load consisting of a resistor equal to the field resistance of the generator as defined in 415.0.3.2.7.

415.0.3.2.9.1 Rotating exciter directly coupled to the generator.

a. Start and operate the prime mover at rated generator speed, without generator excitation and with slip ring or commutator brushes raised. Adjust the exciter output voltage and current to the values required to excite the generator at rated load at rated voltage and rated speed.
b. Read and record the prime mover output power in kW, and the output current and voltage of the exciter.
c. From the prime mover output power subtract the field I^2R loss and the bearing friction and windage loss. This value is the exciter loss in kilowatts.

415.0.3.2.9.2 Rotating exciter separately driven.

a. Mechanically connect the exciter to a calibrated motor dynamotor (prime mover).

b. Start and operate the prime mover at the exciter's rated speed. Adjust the exciter output voltage and current to the values required to excite the generator at rated load at rated voltage and rated speed.
c. Read and record the prime mover output power in kW and the output voltage and current of the exciter.
d. From the prime mover output power subtract the field I^2R loss to obtain the exciter loss in kilowatts.

415.0.3.2.9.3 Static exciter.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, for the exciter input power.
b. Using a variable resistor in series with the voltage sensing lines (variable auto transformer for ac generators) adjust the input voltage to vary the excitation voltage and current. Adjust the exciter output voltage and current to the values required to excite the generator at rated load at rated voltage and rated speed.
c. Record all instrument readings.
d. From the kilowattmeter reading of the input power to the exciter, subtract the field I^2R loss to obtain the exciter loss in kilowatts.

415.0.4 Results.

a. Total the following power losses:

1. Bearing friction and windage loss at rated speed.
2. Brush friction loss at rated speed, if applicable.
3. Brush contact loss at rated speed, if applicable.
4. Open-circuit core loss at rated voltage.
5. Armature I^2R loss at rated current.
6. Field I^2R loss at rated load.
7. Stray load loss at rated load.
8. Exciter loss at rated load, if applicable.

b. Substitute the above calculated total in the following formula to determine the efficiency of the generator.

$$\text{Generator efficiency (in percent)} = \frac{\text{Rated kW output X 100}}{\text{Rated kW output + total losses in kW}}$$

c. Compare the generator efficiency found in step b above with the requirements of the procurement document.

415.0.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection and frequency at which this method is to be performed.
b. The minimum allowable generator efficiency.
c. Load conditions at which brush contact loss is to be performed.

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

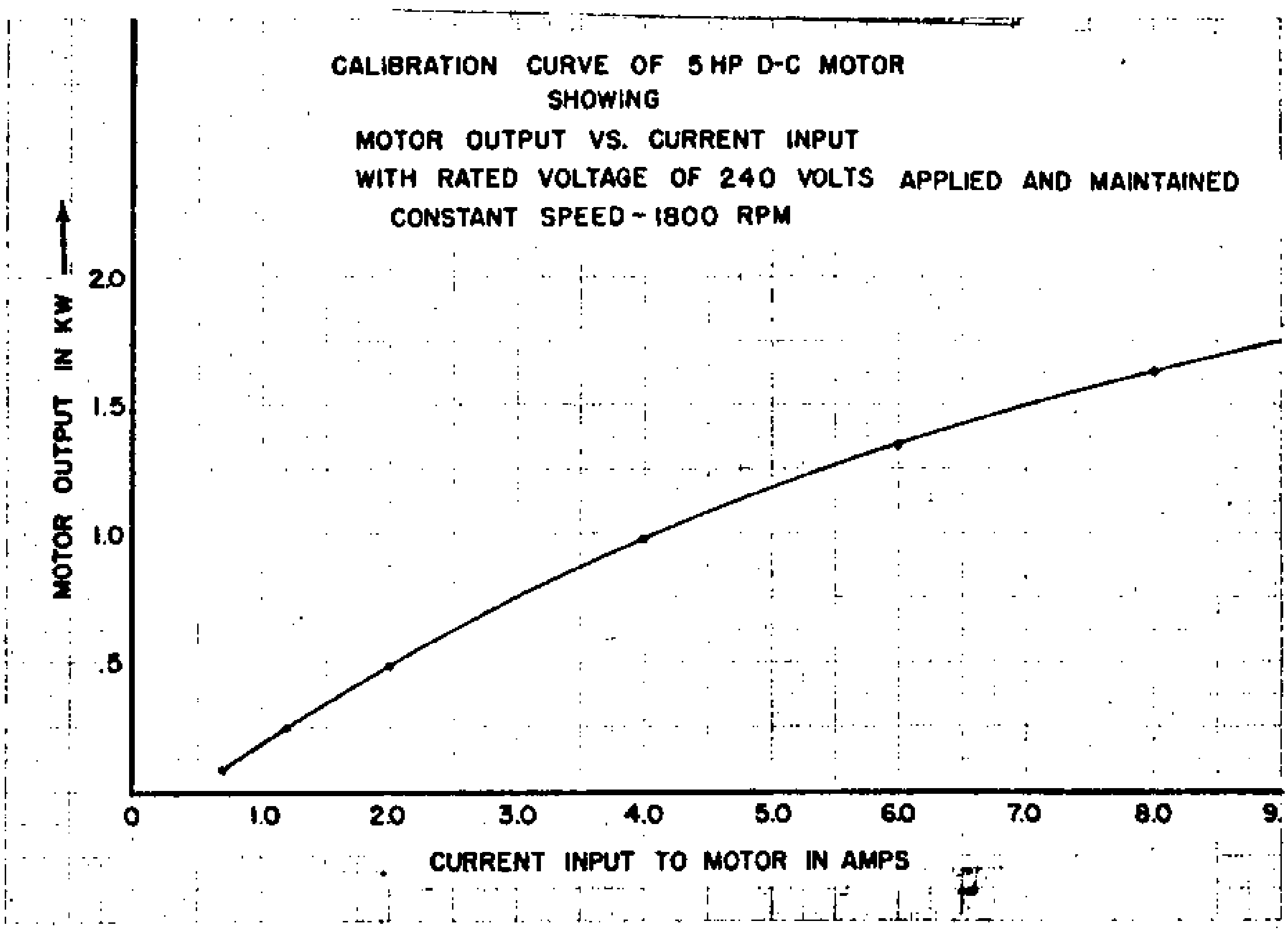


FIGURE 415.0-I TYPICAL PRIME MOVER CALIBRATION CURVE.

X-4544

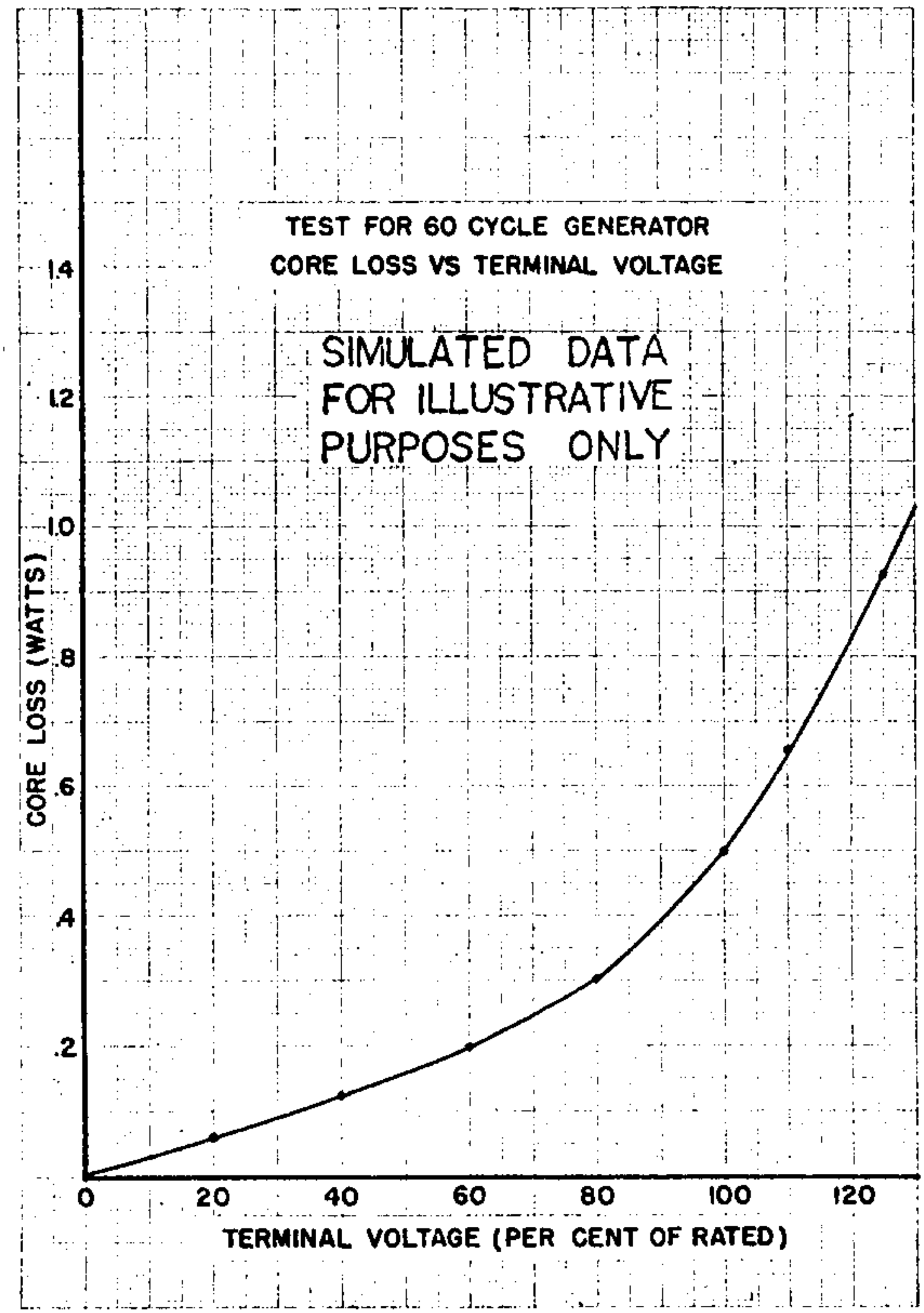


FIGURE 415.0-II TYPICAL OPEN-CIRCUIT CORE LOSS CURVE FOR A-C GENERATOR

X-4545

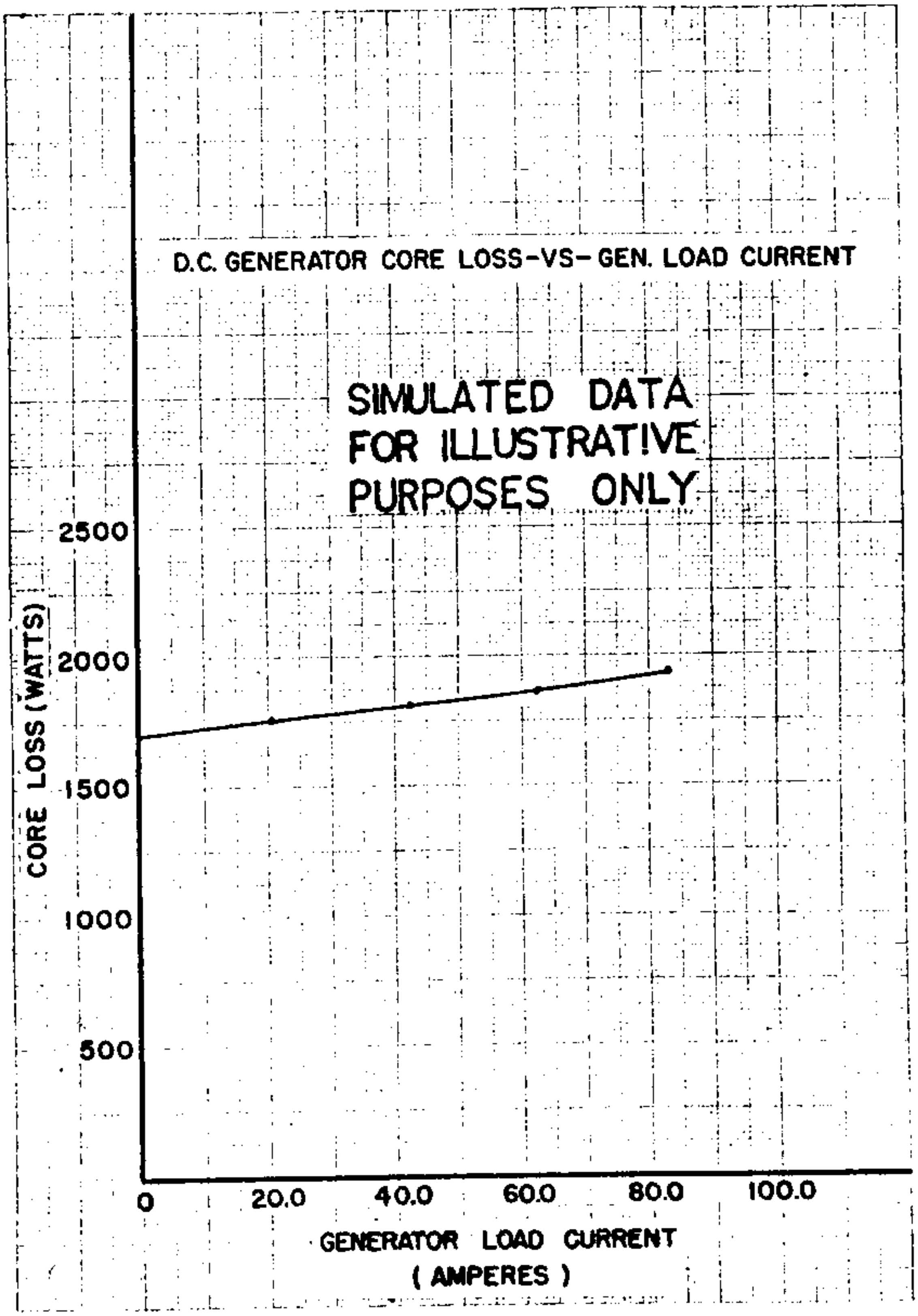


FIGURE 415.0-III TYPICAL OPEN CIRCUIT CORE LOSS CURVE FOR D-C GENERATOR

X-4546

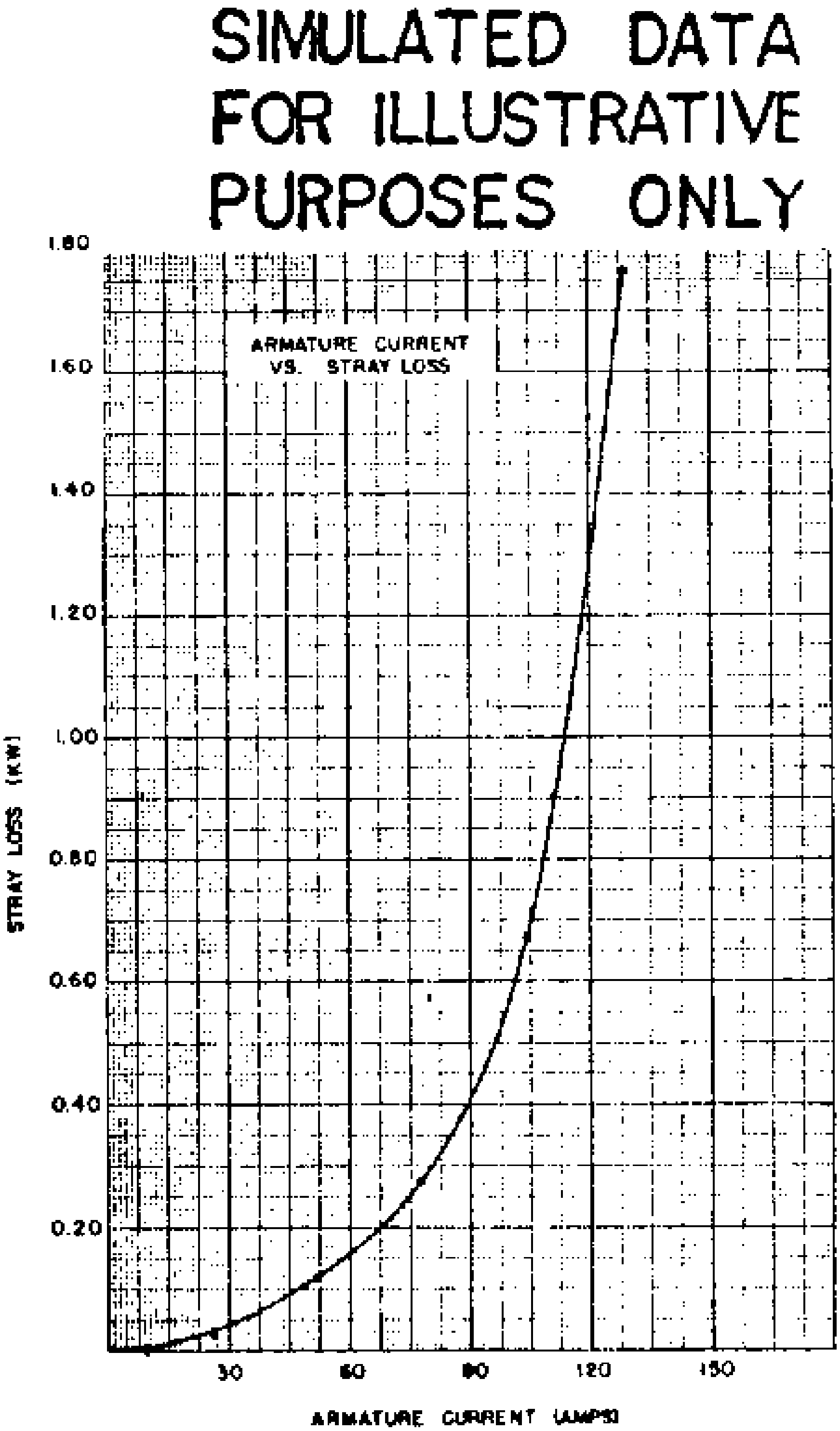


FIGURE 415.0-IV TYPICAL STRAY LOAD LOSS CURVE.

X-4547

TEST DATA

DESCRIPTION 5HP D-C
240 V, SHUNT WOUND
MOTOR ONLY

MFGR. PIRCURMONT INC

MODEL NO. 3776779778 DC

SERIAL NO. 1

REF: MIL-STD-705/415.0

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

SUMMATION OF LOSSES TEST

PRIME MOVER CALIBRATION CURVE

TEST NO. 12

SHEET 1 OF 4

DATE DECEMBER 14, 1970

RECORDER L Wright

PROJ. ENGR. [illegible]

SHIFT LEADER V. Smith

OBSERVER L Lee

INST.		1561	1437	CAL		1176												1076
READ NO.	TIME	PRIME MOVER DC MOTOR		MOTOR OUTPUT		MOTOR SPEED												AVG AMB TEMP
UNITS		AMPS	VOLTS		KW		RPM											°F
SYM.																		
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		17
127	14:00	0.70	240		0.075		3600											75
128	14:02	1.20	240		0.23		3600											
129	14:04	2.00	240		0.49		3600											
130	14:06	4.00	240		0.93		3600											
131	14:08	6.00	240		1.32		3600											
132	14:10	8.00	240		1.63		3600											75

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: DC CURRENT MEASURED USING 10 A, 50 mV SHUNT NO 2108

FIGURE 415.0-V. Portion of a typical test record for summation of losses test.

X-4548

Losses.]

TEST DATA

DESCRIPTION 10 KW, 60 Hz
120 V, SINGLE - PHASE
GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. SF - 10.0 - MD
SERIAL NO. 13067
REF: MIL-STD-705/415.0

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

SUMMATION OF LOSSES TEST
OPEN-CIRCUIT CORE LOSS-AC GENERATOR

TEST NO. 12
SHEET 2 OF 4
DATE 14 DECEMBER, 1970
RECORDER Wright
PROJ. ENGR. [illegible]
SHIFT LEADER Smith
OBSERVER Lee

INST. →		1437	1561	1176		706		1432	1433	FROM CURVE						110	1076
READ NO. ↓	TIME	PRIME MOVER VOLTAGE	PRIME MOVER CURRENT	PRIME MOVER SPEED		GENERATOR TERMINAL VOLTAGE		GENERATOR FIELD		PRIME MOVER OUTPUT		BEARING FRICTION WINDAGE & BRUSH FRICTION LOSSES		CALCULATED CORE LOSS		GEN BEARING	AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	RPM			VOLTS	AMPS	VOLTS		KW		KW		KW	°F	°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
164	15:00	240	1.40	3600			2.0	0	0		.300		.300		—	110	76
165		240	1.65	3600			24.0	0.21	3.50		.370				.070	110	75
166		240	1.87	3600			48.0	0.45	7.52		.450				.150	111	75
167		240	2.25	3600			72.0	0.66	11.0		.550				.250	111	75
168		240	3.20	3600			96.0	0.85	14.2		.770				.470	111	75
169		240	3.95	3600			108.0	1.05	17.5		.920				.620	111	75
170		240	4.40	3600			114.0	1.15	19.2		1.02				.720	111	76
171		240	4.57	3600			120.0	1.30	21.7		1.11				.810	112	76
172		240	5.75	3600			125.0	1.40	23.4		1.28				.980	112	76
173		240	6.75	3600			132.0	1.61	26.9		1.45				1.15	112	76
174		240	8.40	3600			144.0	2.08	34.8		1.68				1.38	112	76
175	16:00	240	10.30	3600			150.0	2.48	41.6		1.90				1.60	112	76

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

NOTES:
PRIME MOVER S/N 1
PRIME MOVER CURRENT MEASURED USING A 20 A, 100 mV SHUNT No. 2108
GENERATOR FIELD CURRENT MEASURED USING A 5 A, 100 mV SHUNT No. 1176

FIGURE 415.0-VI: Portion of a typical test record for summation of losses test.

X-4549

of Losses Test.]

TEST DATA

DESCRIPTION 10KW, 3600 RPM 120 V, DIRECT CURRENT GENERATOR ONLY

MFGR. ENGENSETS, INC

MODEL NO. DC-10.0

SERIAL NO. 307

REF. MIL-STD-705/415.0

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

SUMMATION OF LOSSES TEST

OPEN-CIRCUIT CORE LOSS - DC GENERATOR

TEST NO. 12

SHEET 2 OF 4

DATE 15 DECEMBER, 1970

RECORDER S. Wright

PROJ ENGR. J. James

SHIFT LEADER V. Smith

OBSERVER J. Sue

INST. →		1437	1561	1176		135		CALCULATED		FROM COL. 8						110	1076
READ NO. ↓	TIME	PRIME MOVER VOLTAGE	PRIME MOVER CURRENT	PRIME MOVER SPEED		GENERATOR TERMINAL VOLTAGE		LOAD CURRENT CORRESPONDING TO 1/4 LOAD STEPS		PRIME MOVER OUTPUT		BEARING & BRUSH FRICTION AND WINDAGE LOSS		CALCULATED CORE LOSS		GEN BEARING	AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	RPM			VOLTS *		AMPS		KW		KW		KW	°F	°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
176	09:15	240	11.4	3600			120		0		2.05		.350		1.70	118	77
177		240	11.75	3600			122		20.8		2.10		.350		1.75	118	77
178		240	12.3	3600			123		41.7		2.17		.350		1.82	118	77
179		240	12.7	3600			124		62.5		2.21		.350		1.86	118	77
180		240	13.1	3600			125		83.3		2.27		.350		1.92	118	77

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: * THESE VOLTAGES CORRESPOND TO THE CALCULATED INTERNAL VOLTAGES FOR THE LOAD CURRENTS SHOWN.
PRIME MOVER CURRENT MEASURED USING A 20A 100 mV SHUNT NO. 2108

FIGURE 415.0-VII. Portion of a typical test record for summation of losses test.

X-4550

of Losses Test.]

TEST DATA

DESCRIPTION 10 KW, 60 Hz 120 V, SINGLE - PHASE GENERATOR ONLY

MFGR. ENGENSETS, INC

MODEL NO. SE - 10.0 - MD

SERIAL NO. 13067

REF: MIL-STD-705/415.0

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

SUMMATION OF LOSSES TEST

STRAY LOAD LOSS

TEST NO. 12

SHEET 3 OF 4

DATE 14 DECEMBER, 1970

RECORDER J. Wright

PROJ. ENGR. Know It All

SHIFT LEADER J. Smith

OBSERVER J. Ralph

INST. →		1437	1561	1176		812											1076
READ NO. ↓	TIME	PRIME MOVER VOLTAGE	PRIME MOVER CURRENT	PRIME MOVER SPEED		LOAD CURRENT		I²R LOSSES (CAL)		STRAY LOAD LOSS							AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	RPM		AMPS	AMPS		KW		KW						°F
SYM.						X 40	X 1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
189	1630	240	14.8	3600		3.25	130		1.25		.77						75
190		240	6.87	3600		2.6	104		.798		.675						
191		240	3.55	3600		1.95	78		.576		.275						
192		240	2.15	3600		1.3	52		.384		.118						
193	1638	240	1.17	3600		0.65	26		.192		.03[illegible]						76

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:
PRIME MOVER S/N 1
PRIME MOVER CURRENT MEASURED USING A 20A, 100 mV SHUNT NO. 2108
LOAD CURRENT MEASURED USING C.T. NO. 1305

FIGURE 415.0-VIII. Portion of a typical test record for summation of losses test.

X-4551

of Losses Test.]

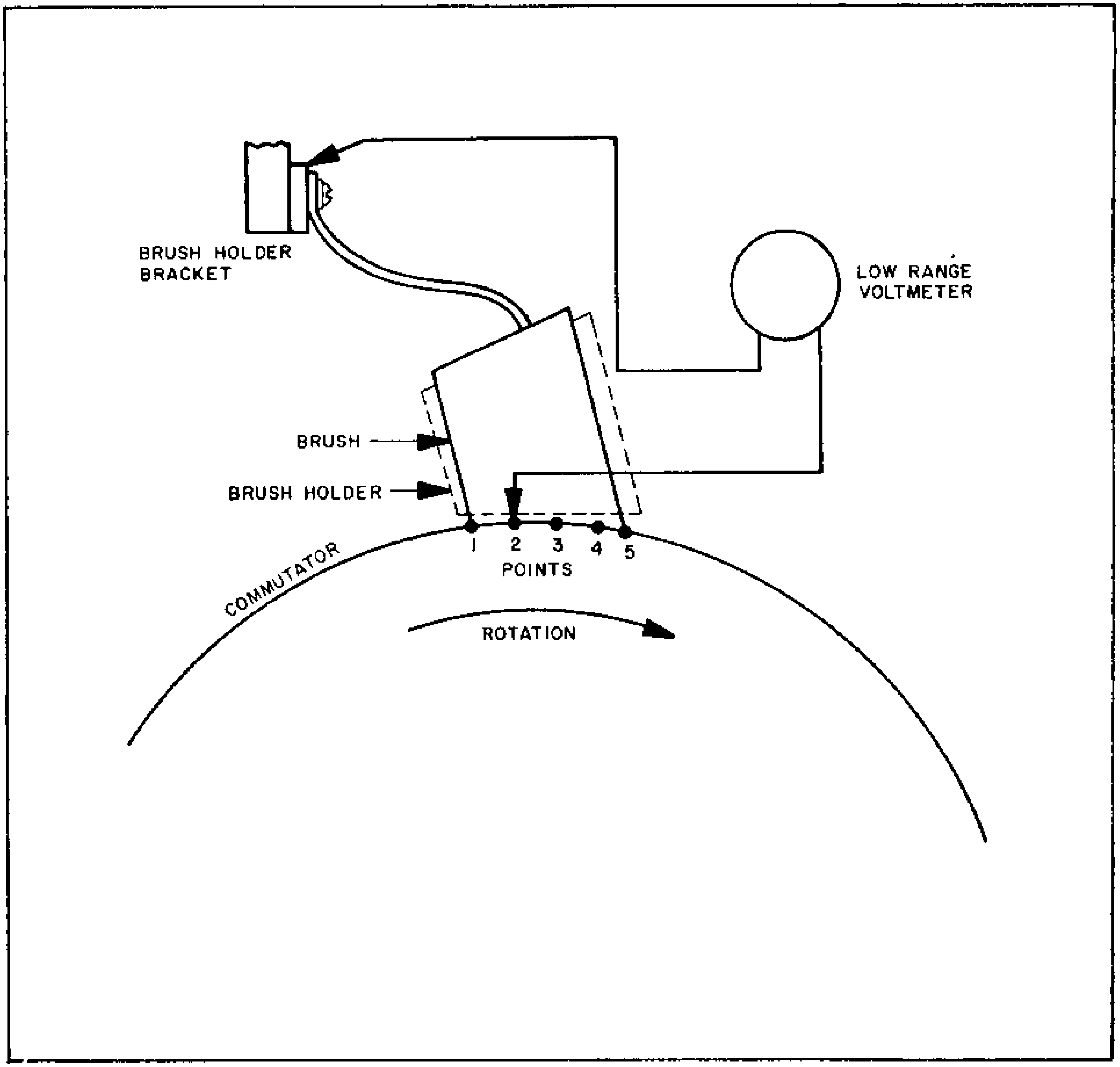


FIGURE 415.0-IX. Method of determining brush contact loss.

X-4552

METHOD 415.1c

GENERATOR POWER INPUT TEST

415.1.1 General. The power required to drive the generator at rated load is important in determining the size of the prime mover and expected operating costs.

415.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, ambient temperature and prime mover output power shall be as described and illustrated in MIL-HDBK-705. In addition, a dynamometer or calibrated electric motor of sufficient output power to drive the generator under test at rated speed and rated load for extended periods of time shall be required. A direct reading torque meter may be connected between the prime mover and the generator for calculating actual generator power input. Electrical instrumentation used for this test shall have an accuracy of +/- 0.5 percent of reading or better.

415.1.3 Procedure.

415.1.3.1 Preparation for test.

a. Mechanically connect the generator assembly, including its cooling fan, to the prime mover.
b. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, for the voltage specified in the procurement document.

415.1.3.2 Test.

a. Start and operate the prime mover such that the generator is operating at rated speed.
b. With the generator under control of its voltage regulator and exciter, apply rated load. Allow the generator to stabilize at rated load, rated voltage and rated frequency. During this period record all instrument readings including ambient temperature at minimum intervals of 10 minutes. If necessary, adjustments to load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment of the load, voltage, or frequency has been made.
c. With the generator stabilized at rated conditions, record all instrument readings including the instrumentation necessary to determine the output power of the prime mover (see figure 415.1-I).
d. Repeat 415.1.3 for any other load condition, voltage connection, frequency, or power factor specified in the procurement document.

415.1.4 Results.

a. Convert the output power of the prime mover to kilowatts. This is the generator power input requirement to produce rated output.
b. Determine the efficiency of the generator by the following formula:

$$\text{Efficiency (in percent)} = \frac{\text{Rated load}}{\text{Input power requirement}} \times 100$$

c. Compare the above results with the procurement document requirements.

415.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable input, or minimum allowable efficiency (in percent) with the generator producing rated output power.
b. Voltage connections(s) and frequency(ies) at which this method is to be performed.
c. Power factor(s) at which this method is to be performed, if applicable.
d. Load condition(s) if other than rated load.

TEST DATA

DESCRIPTION 10KW, 400 HZ 120V, SINGLE-PHASE GENERATOR ONLY

MFGR. ENGENSETS, INC

MODEL NO. HE-10.0-MD

SERIAL NO. 1876

REF: MIL-STD-705/415.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

GENERATOR POWER INPUT TEST

TEST NO. 6

SHEET 1 OF 1

DATE JANUARY 15, 1971

RECORDER S. Wright

PROJ. ENGR. S. Jones

SHIFT LEADER H. Smith

OBSERVER S. See

INST. →		716		308		419		517		556		757	362	1766	CAL	CAL	1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD		INPUT POWER		EFFICIENCY	AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS	HP	KW	%	°F
SYM.				X40	X1	X40	X1										
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
221	0945	STARTED PRIME MOVER - BROUGHT GENERATOR TO RATED SPEED.															77
222	0950	APPLIED RATED LOAD TO GENERATOR															
223	1000		120.0	2.60	104	0.25	10.0		.80		400.0	17.3	0.76	15.90	11.90		77
224	1010		120.5	2.61	104	0.25	10.0		.80		400.7	17.6	0.75	16.00	11.95		78
225	1020		121.0	2.65	106	0.25	10.0		.79		401.5	17.6	0.74	16.10	12.00		77
226	1030	ADJUSTED VOLTAGE AND FREQUENCY TO RATED															
227	1040		120.0	2.60	104	0.25	10.0		.80		400.0	17.8	0.76	16.20	12.05		78
228	1050		120.0	2.60	104	0.25	10.0		.80		400.0	17.8	0.76	16.20	12.05		78
229	1100		120.0	2.60	104	0.25	10.0		.80		400.0	17.8	0.76	16.20	12.05		78
230	1110		120.0	2.60	104	0.25	10.0		.80		400.0	17.8	0.76	16.20	12.05	83	78

$$\text{EFFICIENCY} = \frac{R/L}{\text{INPUT POWER}} \times 100 = \frac{10.0}{12.05} \times 100 = 83\%$$

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:
LINE CURRENT MEASURED USING A C.T. NO. 1042
EXCITER FIELD CURRENT MEASURED USING A 1A, 50mV SHUNT No. 1612

FIGURE 415.1-I. Typical test record for generator power imput test.

X-4553

Test.]

METHOD 416.1b

BRUSH POTENTIAL CURVE TEST

416.1.1 General. The brush potential or contact drop curve is a graphical method for show the difference in potential between the brush and various points on the commutator surface under and in the vicinity of the brush face. Data for brush potential curves are obtained by reading the voltage between the brush and several points on the commutator surface near and under the contact face.

This curve, in conjunction with the recorded armature current, may be used to determine the brush contact loss.

416.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, a low range dc voltmeter (0-3 volts should be sufficient) having an internal resistance of at least 100 times the brush circuit resistance, and a carbon tipped test probe shall be required.

416.1.3 Procedure.

416.1.3.1 Preparation for test.

a. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1 paragraph, 205.1.10 for a voltage connection and speed specified in the procurement document.
b. Connect the low range dc voltmeter as shown in figure 416.1-I to one of the brush holder brackets.

416.1.3.2 Test.

a. Start and operate the generator at rated speed, rated voltage, and rated load.
b. With the low range dc voltmeter, read and record the voltage between the b bracket holder and at least four equally distanced points along the brush span (figure 416.1-I and figure 416.1-II).
c. Repeat paragraph 416.1.3 for any other load condition specified in the procurement document.

416.1.4 Results.

a. Plot a curve of voltage drop across the brush versus distance along the brush span (figure 416.1-III).
b. Compute the brush contact loss by multiplying twice the average voltage across the brush by the current through the brush.
c. Compare these results with the procurement document requirements.

416.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and speed(s) at which this method is to be performed.
b. Load condition(s) at which this method is to be performed if other than as specified herein.
c. Maximum allowable average voltage drop across the brush, if applicable.
d. Maximum allowable brush contact loss, if applicable.

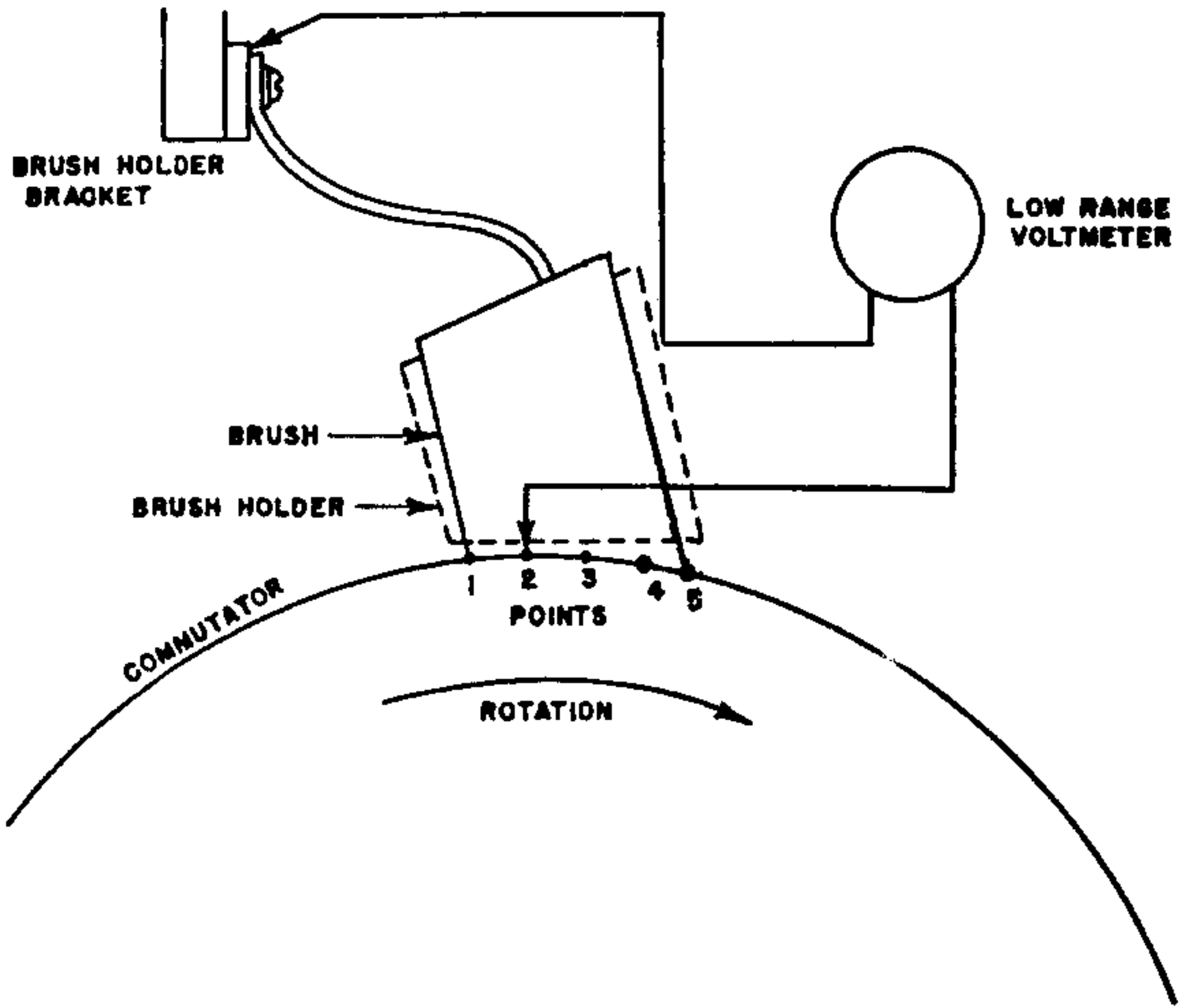


FIGURE 416.1-I METHOD OF DETERMINING BRUSH POTENTIAL CURVE

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

BRUSH POTENTIAL CURVE TEST

DESCRIPTION 15 KW, 1800 RPM
120V DIRECT CURRENT
GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. 59648
SERIAL NO. 3758241
REF: MIL-STD-705/416.1

TEST NO. 12
SHEET 1 OF 1
DATE JANUARY 11, 1971
RECORDER [illegible]
PROJ. ENGR. [illegible]
SHIFT LEADER [illegible]
OBSERVER [illegible]

INST. →		077		218		617			015								16
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		SPEED			PROBE POSITION 1	2	3	4	5				AVG AMB TEMP
UNITS	HRS		VOLTS		AMPS		RPM		VOLTS	VOLTS	VOLTS	VOLTS	VOLTS				°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1310		120.0		125		1800		2	3	4	3	2				77
	1320		120.0		62.5		1800		1	1.5	2	1.5	1				

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: BRUSH CONTACT WIDTH = 1". DIRECTION OF ROTATION CLOCKWISE FACING COMMUTATOR END OF GENERATOR. PROBE POSITIONS 1-5 IN CLOCKWISE DIRECTION: EQUALLY SPACED. POSITIVE (+) BRUSH USED IN TEST.
LINE CURRENT MEASURED USING A 200A, 50mV SHUNT No 1154.

Figure 416.1-II: Typical test record for brush potential curve test.

Test.]

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

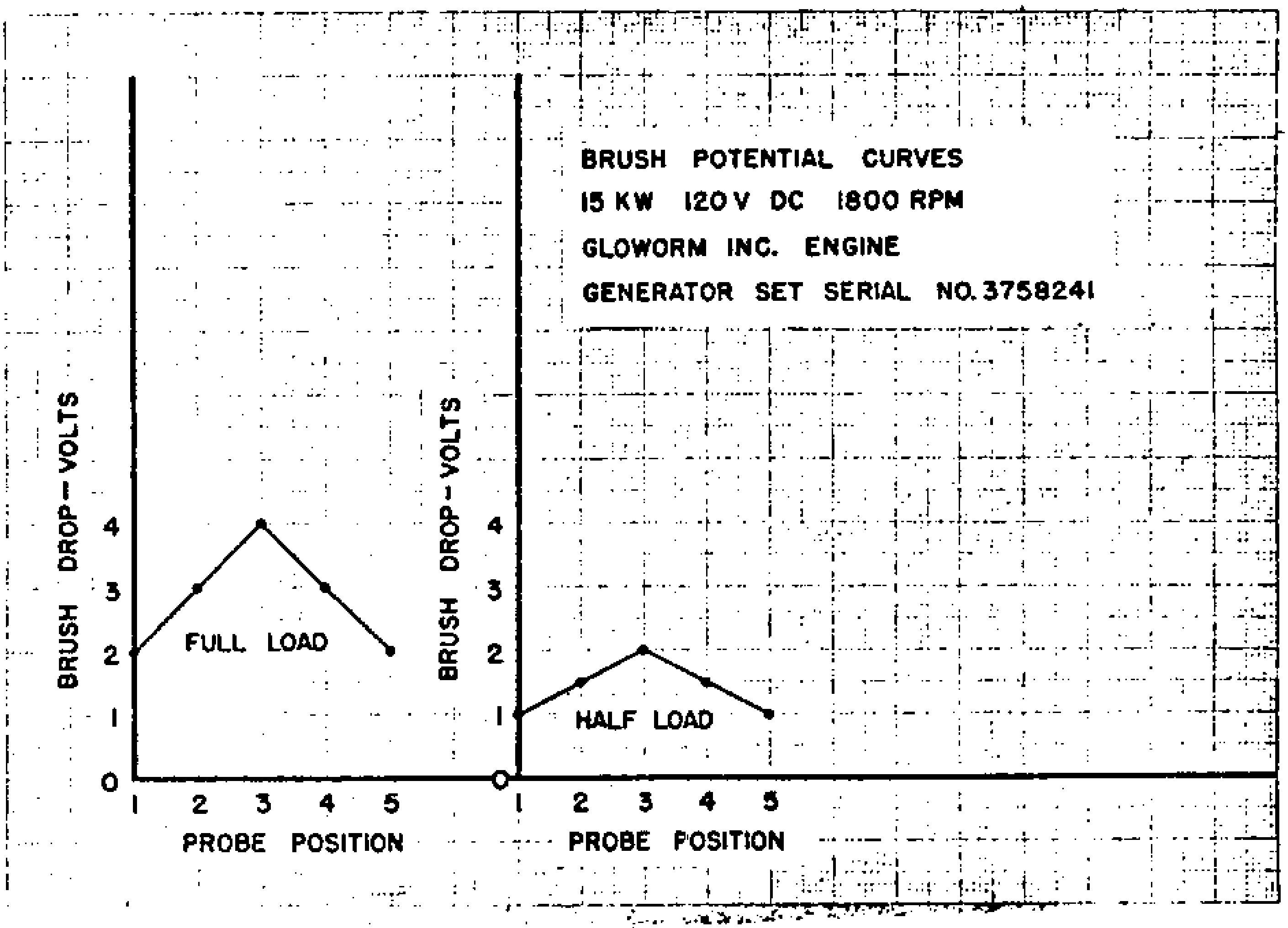


FIGURE 416.1-III SAMPLE BRUSH POTENTIAL CURVE

METHOD 420.1b

SHORT CIRCUIT RATIO TEST

420.1.1 General. short circuit ratio is used by design engineers in the evaluation and comparison of the regulation and stability of generators.

420.1.2 Apparatus. Instrumentation for measuring terminal voltage, generator speed, exciter field voltage and current (generator field voltage and current, if applicable), and line current shall be as described and illustrated in MIL-HDBK-705. In addition, a prime mover having a steady state speed not greater than +/- 1 percent of rated speed and a separate, variable dc source for excitation shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

420.1.3 Procedure.

a. Perform method 410.1, Open Circuit Saturation Curve Test (measure the generator field current.)
b. Perform method 411.1, Synchronous Impedance Curve Test.

420.1.4 Results.

a. From the open circuit saturation curve determine the generator field current required to generate rated open circuit armature terminal voltage. In figure 420.1-I, this value is represented by the distance I_{fgx}.
b. From the synchronous impedance curve (the short circuit saturation curve), determine the generator field current required to produce rated armature short circuit current for a sustained symmetrical short circuit at the generator terminals. In figure 420.1-I, this value is represented by the distance I_{fsi}.
c. Compute the short circuit ratio by dividing the value obtained in step a above, by the value obtained in step b above. This computation is represented

$$SCR = \frac{I_{fgx}}{I_{fsi}}$$

Where: SCR is the short circuit ratio.

d. Compare the calculated short circuit ratio with the procurement document requirements.

420.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The allowable range of short circuit ratio, if applicable.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

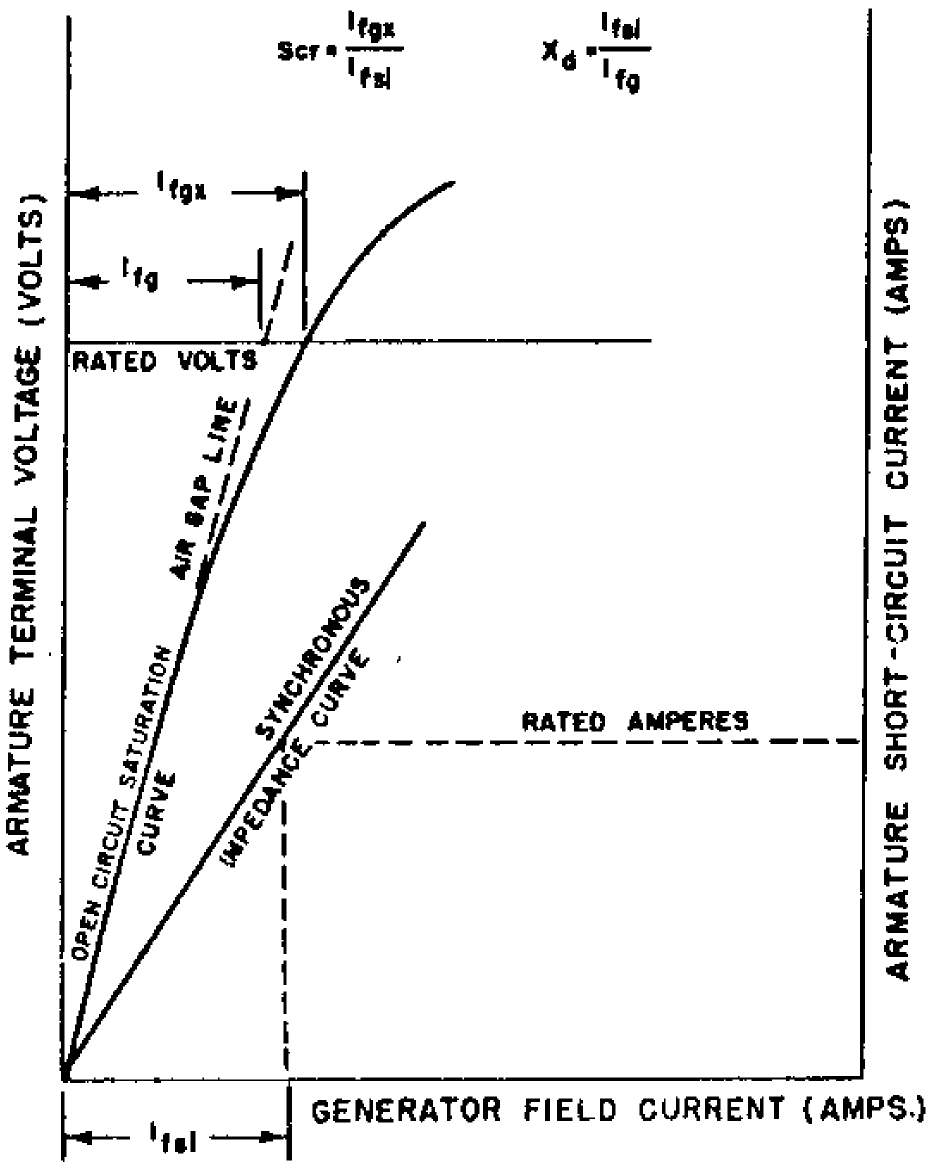


FIGURE 420.1-I SHORT CIRCUIT RATIO AND DIRECT-AXIS SYNCHRONOUS REACTANCE.

X-4554

METHOD 421.1b

DIRECT-AXIS SYNCHRONOUS REACTANCE TEST

421.1.1 General. The direct-axis synchronous reactance is the ratio determined by dividing the field current during a sustained symmetrical short circuit, at rated frequency required to produce rated armature current, by the value of the field current at the air-gap line of the open circuit saturation curve, at rated voltage and frequency.

NOTE: The definition above is actually that of the per unit direct-axis synchronous impedance. However, this definition is used to a great extent in electrical literature and because the resistance of the machine is so small compared to the reactance, the error in using the impedance value instead of the reactance value is negligible.

421.1.2 Apparatus. Instrumentation for measuring terminal voltage, generator speed, exciter field voltage and current (generator field voltage and current, if applicable), and line current shall be as described and illustrated in MIL-HDBK-705. In addition, a prime mover having a steady state speed not greater than +/- 1 percent of rated speed and a separate, variable dc source for excitation shall be required. Electrical instrumentation used for this test shall have an accuracy of +/- 0.5 percent of reading or better.

412.1.3 Procedure.

a. Perform test method 410.1 (Open Circuit Saturation Curve Test). (Measure the generator field current).
b. Perform test method 411.1(Synchronous Impedance Curve Test).

421.1.4 Results.

a. From the synchronous impedance curve (the short circuit saturation curve), determine the field current required to produce rated armature current for a sustained symmetrical short circuit at the generator terminals. In figure 421.1-I this value is represented by the distance I_{fsi}.
b. From the air-gap line of the open circuit saturation curve (the extended straight line part of the curve, see figure 421.1-I) determine the field current which corresponds to the rated voltage. In figure 421.1-I this value is represented by the distance I_{fg}.
c. Compute the direct-axis synchronous reactance by dividing the value obtained in step a above by the value obtained in step b above. This computation is represented by the following formula:

$$X_d = \frac{I_{fsi}}{I_{fg}}$$

Where: X_d is the direct axis synchronous reactance.

d. Compare the calculated direct-axis synchronous reactance with the procurement document requirements.

421.5. Procurement document requirements. The following items must be specified the individual procurement document:

a. The allowable range of direct-axis synchronous reactance, if applicable.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

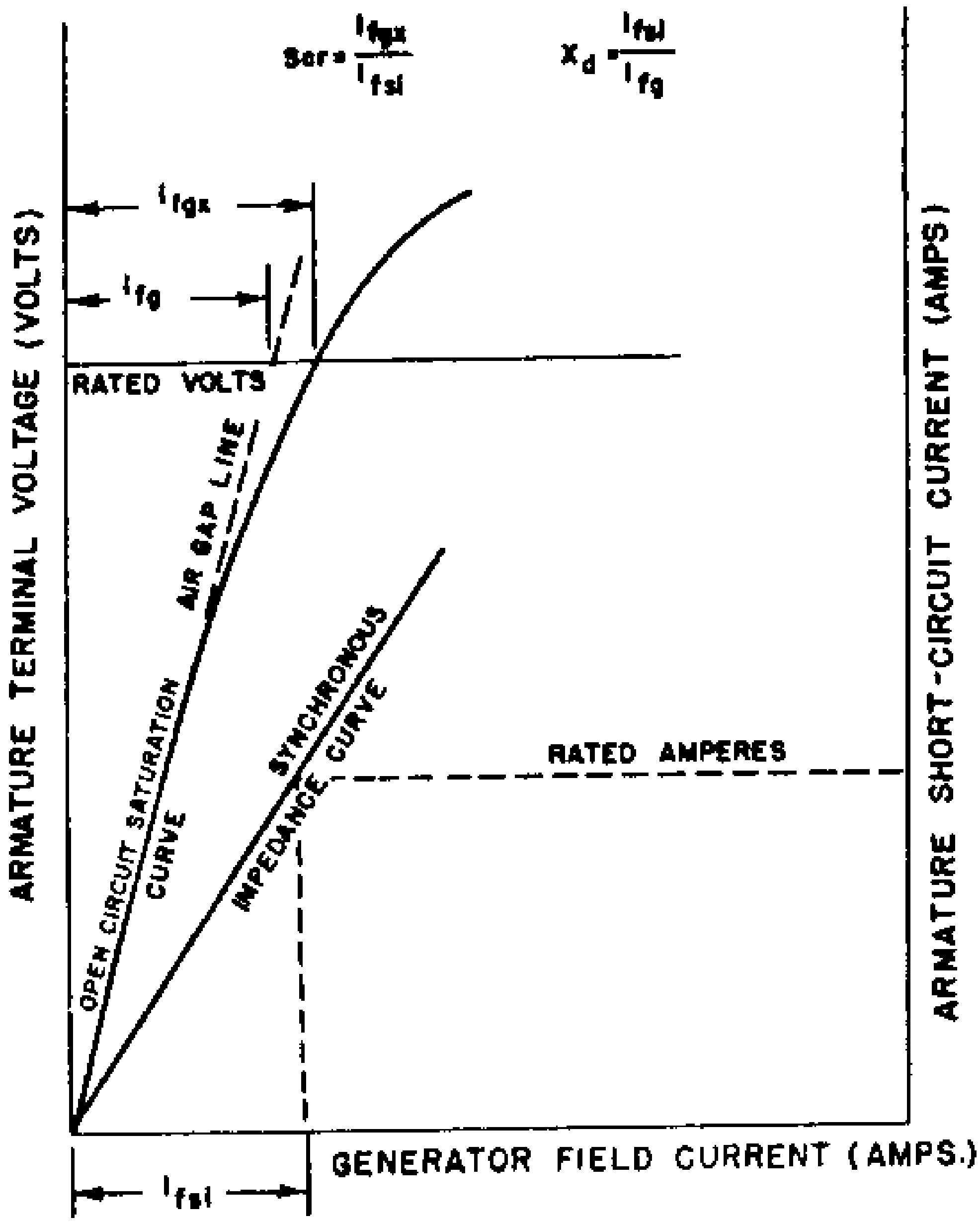


FIGURE 421.1-I SHORT CIRCUT RATIO AND DIRECT-AXIS SYNCHRONOUS REACTANCE.

METHOD 422.1b

NEGATIVE-SEQUENCE REACTANCE AND IMPEDANCE TEST

422.1.1 General. Negative-sequence reactance or impedance is used by design engineers to determine the performance of three-phase wye generators under various load conditions.

422.1.2 Apparatus. Instrumentation for measuring load conditions (wattmeter to be low power factor type), field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, a separate, variable source of dc power for generator excitation, a prime mover, and a shorting switch shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

422.1.3 Procedure.

422.1.3.1 Preparation for test.

a. Mechanically connect the generator to the prime mover and provide the external excitation supply to the generator.
b. Connect the instrumentation and shorting switch in accordance with figure 411.1-I for the voltage connection specified in the procurement document.

422.1.3.2 Test.

a. Start and operate the prime mover such that the generator is at rated speed with no excitation current.
b. Close the shorting switch.
c. Increase the field current until rated current is flowing through the short-circuit.
d. Record all instrument readings (see figure 422.1-II).

422.1.4 Results.

422.1.4.1 Compute the negative-sequence reactance using the following formula:

$$X_2 \text{ (in percent)} = \frac{W I_{RP}}{V_{RP}(1.732) I^2} \times 100$$

Where: X_2 = Negative-sequence reactance
W = Power in watts
V_{RP} = Rated line-to neutral (phase) voltage
I_{RP} = Rated
I = ac Current in amperes

422.1.4.2 Compute the negative-sequence impedance from the data obtained in method using the following formula:

$$Z_{2} \text{ (in percent)} = \frac{EI_{RP}}{1.732IV_{RP}} \times 100$$

Where: Z_{2} = negative-sequence impedance

E = Voltage between the shorted terminals and the third line terminal

V_{VP} = Rated phase voltage

I_{RP} = Rated phase

I = ac current in amperes

422.1.4.3 Compare these results with the procurement document requirements.

422.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection (must be three-phase wye) and frequency at which this method is to be performed.
b. The maximum, minimum or range of allowable negative-sequence reactance, or negative-sequence impedance, if applicable.

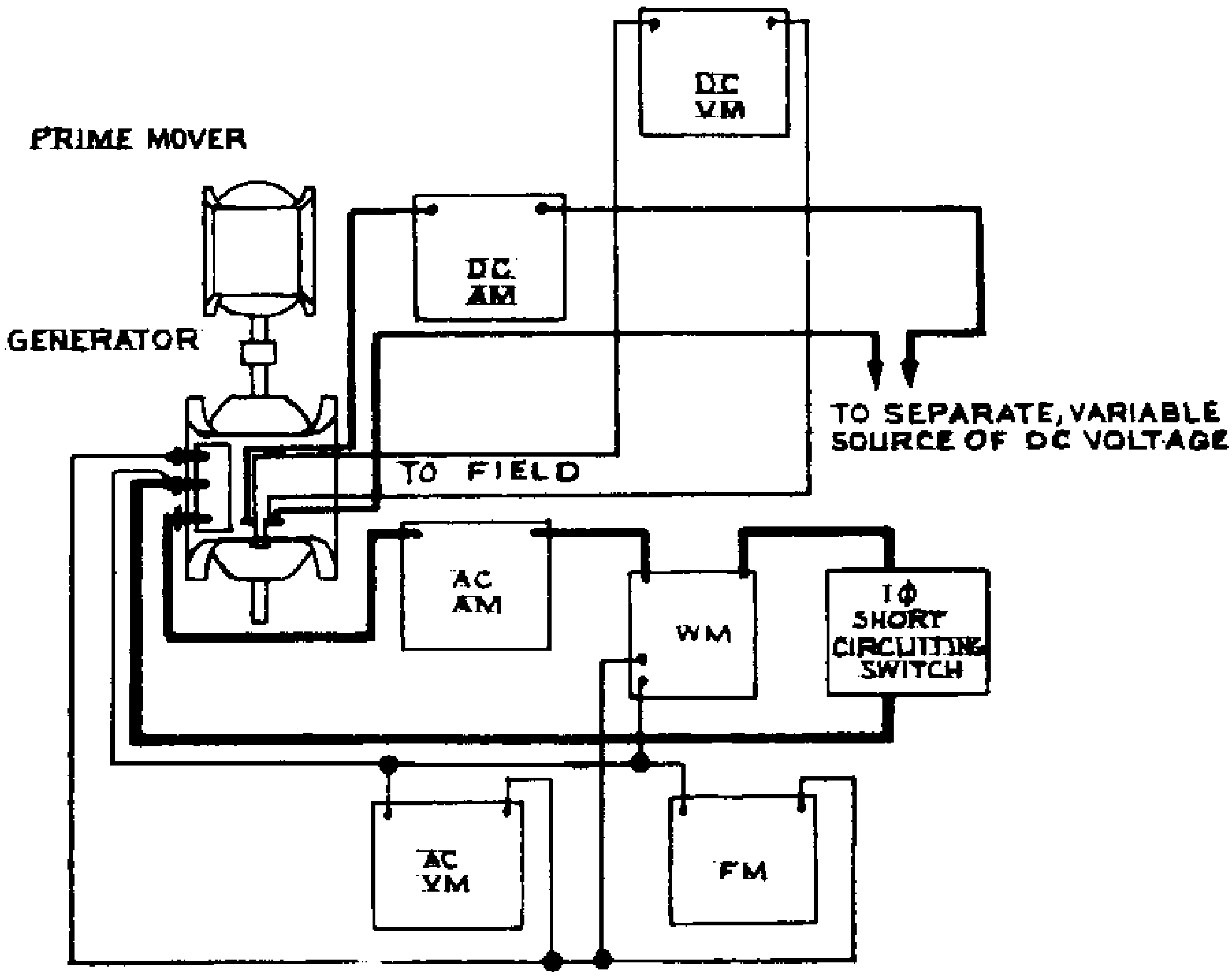


FIGURE 422.1-I APPARATUS HOOK-UP FOR NEGATIVE SEQUENCE REACTANCE AND IMPEDANCE TEST

X-4556

and Impedance Test.]

TEST DATA

DESCRIPTION 10 KW, 60HZ 120/208V, 3-PHASE GENERATOR ONLY

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 16716

REF: MIL-STD-705/422J

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

NEGATIVE SEQUENCE REACTANCE AND IMPEDANCE TEST

TEST NO. 3

SHEET 1 OF 1

DATE JULY 4, 1986

RECORDER Phil Mues

PROJ. ENGR. Jack Daniels

SHIFT LEADER John Walker

OBSERVER L. C. Yall

INST →		329		3233		3767		176	418	761							1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		$T_1 - T_2$ CURRENT		OUTPUT POWER		EXCITER FIELD		SPEED							AVG AMP TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	WATTS	WATTS	VOLTS	AMPS	RPM							°F
SYM			$T_1 - T_2$	X 10	X 1	X 10	X 1										
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
248	11:17		18.2	3.47	34.7	15.0	150	1.7	0.31	3600							74

$$X_2 = \frac{(150)(34.7)(100)}{(120)(1.732)(34.7)^2} = 2.08\%$$

$$Z_2 = \frac{(18.2)(34.7)(100)}{(120)(1.732)(34.7)} = 8.75\%$$

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: $T_1 - T_2$ CURRENT MEASURED USING C.T. NO. 1305
EXCITER FIELD CURRENT MEASURED USING A 1A, 50 mV SHUNT NO. 768

FIGURE 422.1-II. Typical test record for negative sequence reactance and impedance test.

X-4557

Reactance and Impedance Test.]

METHOD 423.1b

ZERO-SEQUENCE REACTANCE TEST

423.1.1 General. Zero-sequence reactance is used by design engineers to determine the performance of three-phase wye connected generators under various load conditions.

423.1.2 Apparatus. Instrumentation for measuring line-to-line voltage, line current, generator speed and field current shall be as described and illustrated in MIL-HDBK-705. In addition a separate, variable source of dc power for generator excitation and a prime mover shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

423.1.3 Procedure.

423.1.3.1 Preparation for test.

a. Mechanically connect the generator to the prime mover and provide the external excitation supply to the generator.
b. Connect the instrumentation in accordance with figure 423.1-I for one "wye" voltage connection and frequency specified in the procurement document.

423.1.3.2 Test.

a. Start and operate the prime mover such that the generator is at rated speed and with zero field current.
b. Adjust the field current such that the ammeter, which short-circuits two generator phases to neutral, indicates a reading equal to three times the rated phase current.
c. Record all instrument readings (see figure 423.1-II).

CAUTION: To prevent serious overheating of the generator, the field current shall be reduced to zero and the generator shut down immediately following the reading of the instruments.

423.1.4 Results.

423.1.4.1 Compute the zero-sequence reactance using the following formula:

$$X_{o} \text{ (in percent)} = \frac{E_{a} I_{RP}}{I_{n} V_{VP}} \times 100$$

Where: X_{o} is the zero-sequence reactance

E_{a} is the armature voltage between the open phase and the short circuit.

I_{RP} is the rated phase current

V_{RP} is the rated phase voltage

I_{n} is the current flowing between the short-circuited phase terminals through the ammeter short-circuiting these terminals to the neutral.

423.1.4.2 Compare the zero-sequence reactance with the procurement document requirements.

423.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection (must be three-phase wye) and frequency at which this method is to be performed.
b. The maximum, minimum or range of allowable zero-sequence reactance, if applicable.

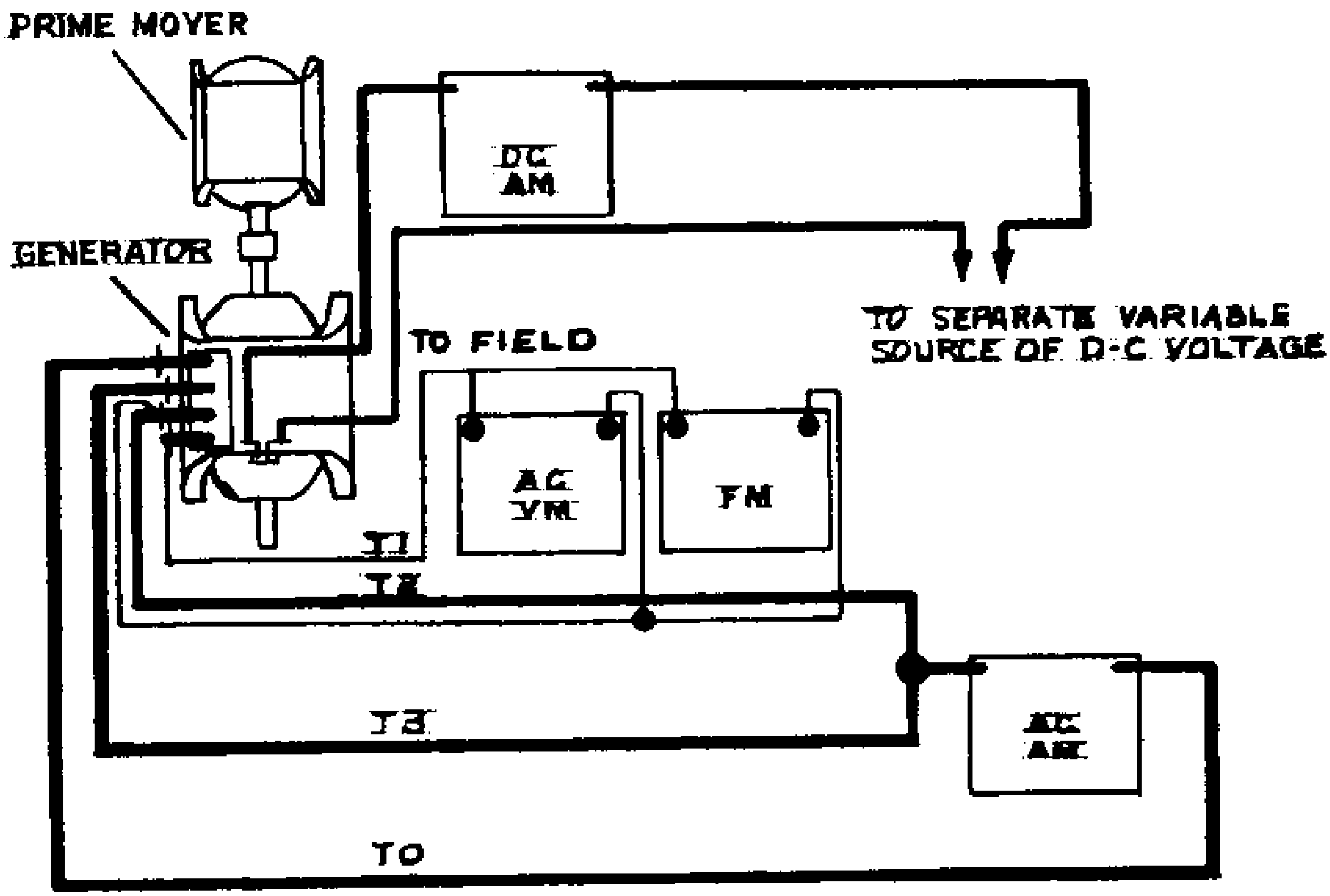


FIGURE 423.1-I APPARATUS HOOK-UP FOR ZERO-SEQUENCE REACTANCE TEST

X-4558

Test.]

TEST DATA

DESCRIPTION 5KW, 60Hz 120/208V, 3-PHASE GENERATOR ONLY
MFGR. ENGENSETS, INC.
MODEL NO SF-5.0-MD
SERIAL NO. 3716
REF: MIL-STD-705/423.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

ZERO SEQUENCE REACTANCE TEST

TEST NO. 12
SHEET 1 OF 1
DATE JANUARY 25, 1971
RECORDER [illegible]
PROJ. ENGR. [illegible]
SHIFT LEADER [illegible]
OBSERVER [illegible]

INST. →		431		5965		8711			5959								
READ NO. ↓	TIME	TERMINAL VOLTAGE		NEUTRAL CURRENT		SPEED		EXCITER FIELD									
UNITS	HRS		VOLTS	AMPS	AMPS		RPM		AMPS								
SYM.				X20	X1												
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
324	08:15		30.0	2.60	52.0		36.00		1.71								

$$X_a = \frac{E_a I_{RP}}{I_N V_{RP}} \times 100 = \frac{30.0 \times 17.3 \times 100}{52 \times 208} = 4.8\%$$

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: NEUTRAL CURRENT MEASURED USING C.T. NO. 1305
EXCITER LEAD CURRENT MEASURED USING 2Ω, 50 MV SHUNT NO. 1041

FIGURE 423.1-II. Typical test record for zero sequence reactance test.

X-4559

Test.]

METHOD 424.1b

QUADRATURE-AXIS SYNCHRONOUS REACTANCE TEST

424.1.1 General. Quadrature-axis synchronous reactance is used by design engineers to determine the performance of generators under various load conditions.

424.1.2 Apparatus. Instrumentation for measuring generator terminal voltage, line current and field voltage shall be as described and illustrated in MIL-HDBK-705. In addition an oscillograph with sufficient galvanometers having a flat frequency response (flat within +/- 5 percent) from dc to 3,000 Hz, a noninductive shunt, a variable voltage ac power supply with sufficient power to deliver rated current to the generator at generator rated frequency, a variable speed prime mover and a tachometer (for generator speed) shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

424.1.3 Procedure.

424.1.3.1 Preparation for test.

a. Mechanically connect the generator to the prime mover.

b. Connect the apparatus in accordance with figure 424.1-I or 424.1-II whichever is applicable.

c. Open circuit the generator field by disconnecting the exciter leads to the field (for brushless machines this method will require slip rings and pilot brushes).

424.1.3.2 Test.

a. Start the prime mover and operate the generator in its normal rotation at rated speed.
b. Apply the variable voltage, ac power supply to the to the generator load terminals at a voltage value well below rated (zero voltage if possible). Slowly increase the applied voltage to the value required to circulate rated current through the generator windings.
c. Record all instrument readings.
d. Adjust the oscillograph elements which record the generator phase voltage trace, the voltage across the open field trace, and the armature current trace to 2-inch amplitudes. Then take an oscillogram for calibration purposes.
e. Gradually reduce the generator speed approximately 5 percent but not more than 5 percent.
f. Take an oscillogram of not less than 5 seconds at sufficient film speed to clearly show the vidual peaks of the voltage and current waves.
g. Gradually increase the generator speed to rated.
h. Record all instrument readings and take another oscillogram for calibration purposes.

CAUTION: Gradually reduce the stator current to zero before the prime mover is brought to rest.

424.1.3.3 Computations. The determination of the quadrature-axis synchronous reactance is made from an interpretation of the oscillogram obtained in 424.1.3.2, step f above when the generator was be driven at a reduced speed. Under these conditions, the quadrature-axis synchronous reactance is in effect when the impedance is at a minimum (i.e., when the ratio of rms armature voltage to rms armature current is at a minimum). The direct-axis synchronous reactance is in effect when the ratio of rms armature voltage to rms armature current is at a maximum.

a. From the oscillogram taken in 424.1.3.2, step f, determine the rms values of line-to-line voltage and the rms values of line current at each peak. Tabulate these values against time in cycles, as shown in the sample tabulation (figure 424.1-V). Each value of line-to-line voltage shall be expressed as a decimal fraction of rated line-to-line voltage. Each value of line current also shall be expressed as a decimal fraction of rated line current (see procedure 4, figure 424.1-III).
b. Divide each value of rms voltage (expressed as a decimal), by the corresponding rms current (expressed as a decimal). These values shall be tabulated and used as a basis for plotting a curve (figures 424.1-V and 424.1-VI).
c. These ratios shall be plotted versus time in cycles (figure 424.1-VI).
d. The approximate per unit direct-axis synchronous reactance is the maximum value of the ratio obtained in step b above.
e. The approximate per unit quadrature-axis synchronous reactance is the minimum value of the ratio obtained in step b above.
f. The ohmic values of direct-axis and quadrature-axis synchronous reactance are the unit values obtained in steps d and e above, multiplied by base ohms. The base ohms are determined by dividing rated phase voltage by rated phase current.

424.1.4 Results. Compare the value of quadrature-axis synchronous reactance obtained in 424.1.3 with the procurement document requirements.

424.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection(s) and frequency(ies) at which this method shall be performed.
b. The maximum, minimum or range of allowable quadrature-axis synchronous reactance, if applicable.

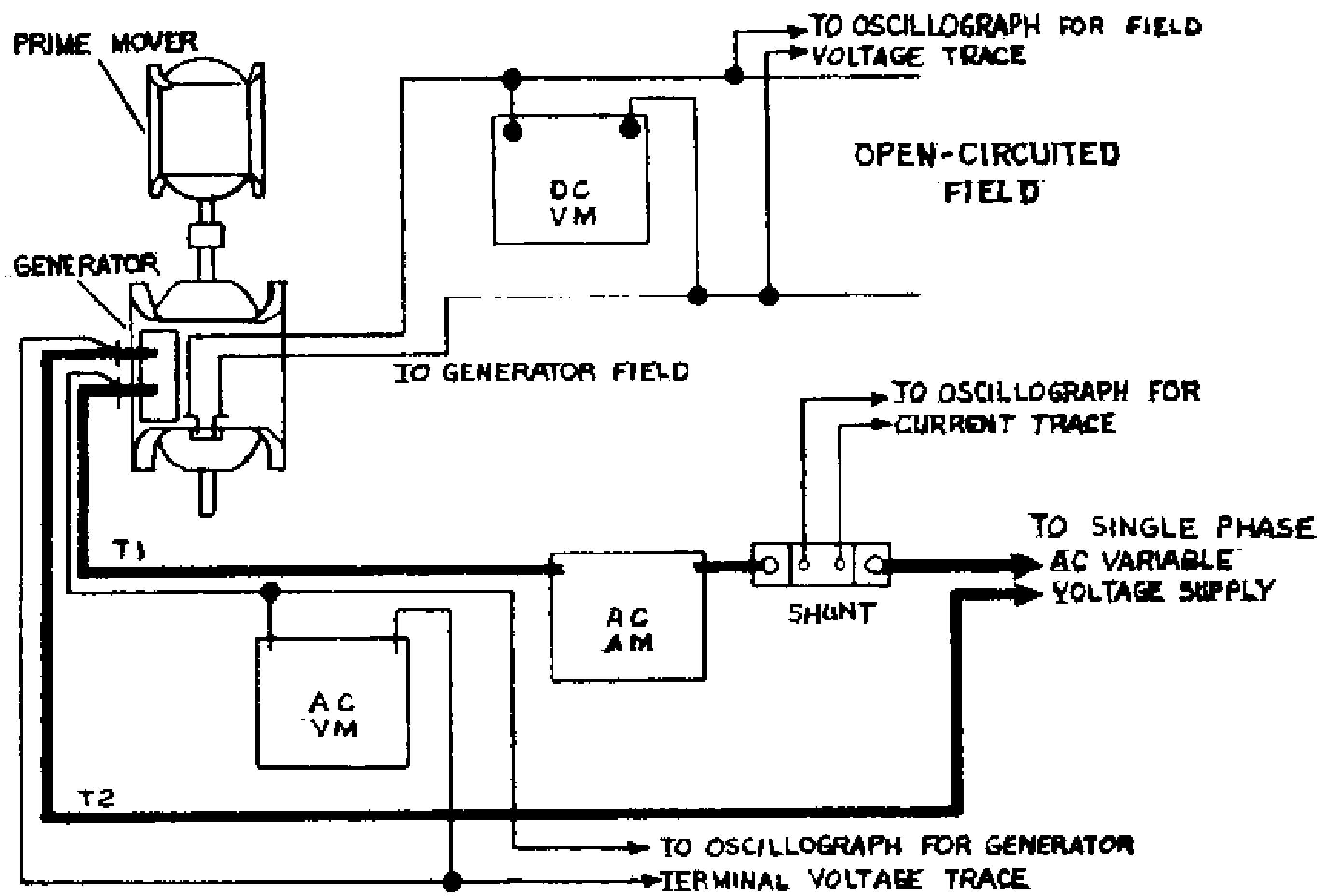


FIGURE 424.1-I APPARATUS HOOKUP FOR DETERMINATION OF QUADRATURE-AXIS SYNCHRONOUS REACTANCE OF SINGLE-PHASE GENERATORS.

X-4560

Axis Synchronous Reactance of Single-Phase Generators.]

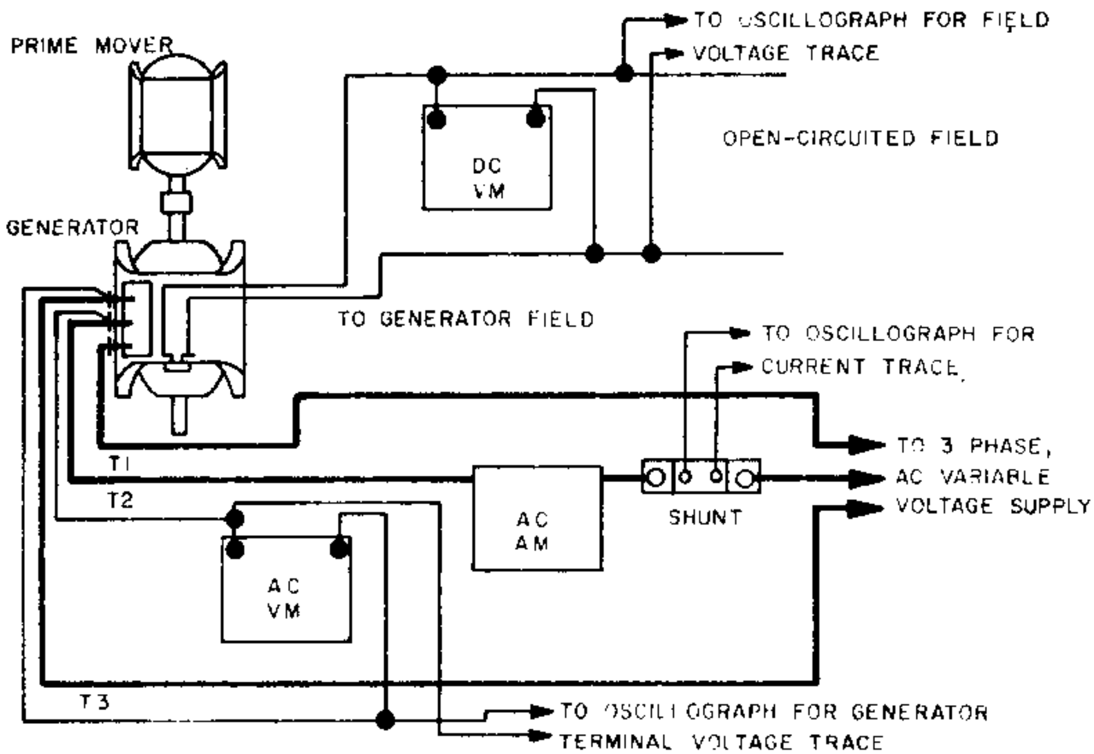
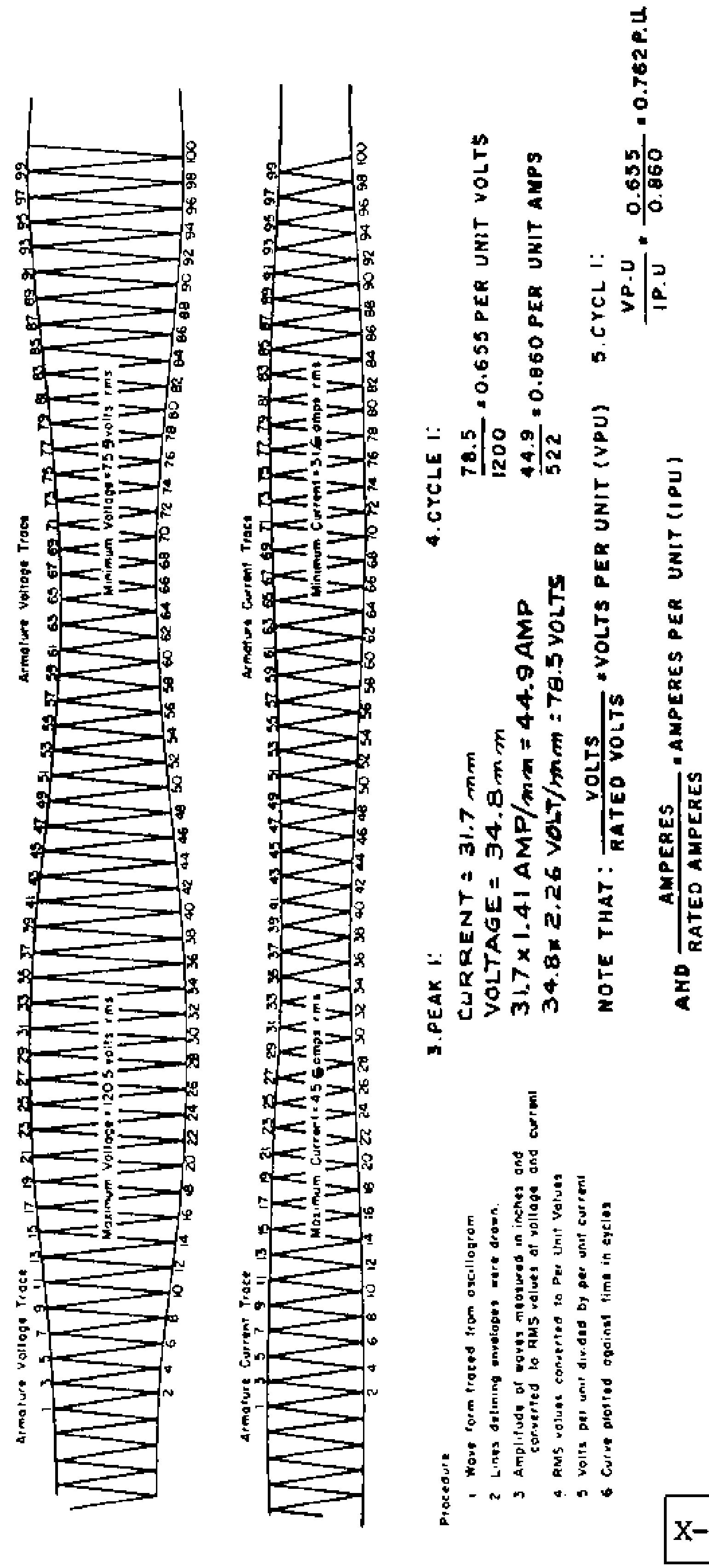


FIGURE 424.1-II. Apparatus hookup for determination of quadrature-axis synchronous reactance of three-phase generators.

X-4561

axis synchronous reactance of three-phase generators.]



X-4562

FIGURE 424.1-III TYPICAL OSCILLOGRAM OBTAINED DURING QUADRATURE-AXIS SYNCHRONOUS REACTANCE TEST.

TEST DATA

DESCRIPTION 5KW, 60HZ
120 V, SINGLE PHASE
GENERATOR ONLY

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

QUADRATURE AXIS SYNCHRONOUS REACTANCE TEST

MFGR. ENGENSETS, INC
MODEL NO. SF-5.0-MD
SERIAL NO. 42968
REF: MIL-STD-705/424.1

TEST NO. 19
SHEET 1 OF 1
DATE FEBRUARY 8, 1971
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. Lee

INST. →		117		216		159		618									1077
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		FIELD VOLTAGE		SPEED									AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS		VOLTS		RPM								°F
SYM.				X20	X1												
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10:00	STARTED		PRIME	MOVER				3600								
	10:10		18.0	2.60	52.0		7.0		3600	EXPOSURE #1							77
	10:12								3420	EXPOSURE #2			10 SEC				
	10:16		18.0	2.60	52.0		7.0		3600	EXPOSURE #3							

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. No 1305

X-4563

Figure 424.1-IV: Typical test record for quadrature axis synchronous reactance test.

Synchronous Reactance Test.]

Tabulated results

Time cycles	Voltage rms volts	Current rms amps	Voltage p u	Current p u	V_{pu}/I_{pu}
1	78.5	44.9	0.655	0.860	0.762
2	80.3	45.0	.667	.869	.768
3	82.6	45.2	.688	.871	.790
4	86.7	45.6	.721	.880	.820
5	91.6	45.4	.763	.877	.870
6	96.0	44.8	.800	.867	.923
7	101.2	44.5	.843	.860	.980
8	105.6	43.8	.880	.846	1.040
9	109.4	42.5	.912	.821	1.110
10	112.6	41.3	.938	.799	1.175
11	115.2	40.0	.960	.773	1.240
12	117.5	38.4	.978	.741	1.320
13	119.6	37.2	.997	.718	1.390
14	120.5	35.7	1.004	.690	1.456
15	120.2	34.3	1.002	.662	1.514
16	120.0	33.4	1.000	.645	1.550
17	118.6	32.9	.988	.636	1.553
18	116.2	32.4	.969	.626	1.547
19	113.0	32.0	.941	.618	1.522
20	108.2	31.6	.901	.610	1.478
21	103.0	32.0	.858	.618	1.390
22	98.6	32.7	.822	.631	1.302
23	94.8	33.8	.790	.653	1.210
24	90.5	34.6	.754	.668	1.127
25	89.3	35.8	.744	.691	1.075
26	85.8	37.2	.715	.718	.996
27	82.0	38.6	.683	.746	.915
28	79.1	39.7	.659	.767	.859
29	77.7	40.6	.648	.785	.827
30	76.5	41.5	.637	.802	.795
31	75.9	42.9	.632	.829	.763
32	76.2	43.6	.634	.841	.753
33	76.2	44.5	.634	.860	.737
34	77.1	44.8	.642	.867	.740
35	78.5	45.2	.654	.871	.750
36	81.5	45.4	.679	.877	.775

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 424.1-V TYPICAL RESULTS TABULATION FOR QUADRATURE-AXIS SYNCHRONOUS REACTANCE TEST.

X-4564

Synchronous Reactance Test.]

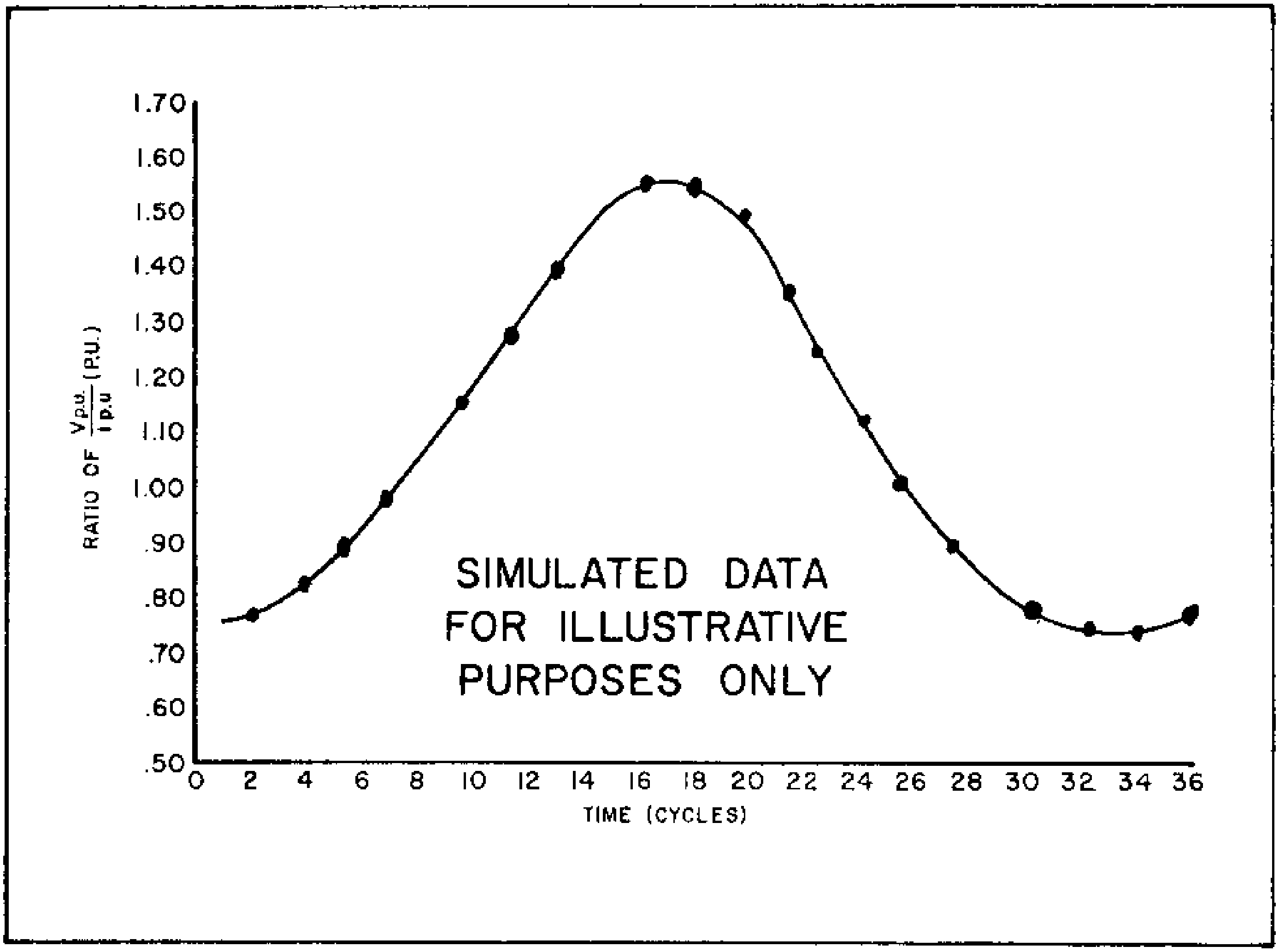


FIGURE 424.1-VI. Reactance versus time curve.

X-4565

METHOD 425.1b

DIRECT-AXIS TRANSIENT REACTANCE TEST

425.1.1 General. The direct-axis transient reactance is used by design engineers to determine the ability of the generator to absorb sudden load applications without having the voltage drop below acceptable levels for using equipment. It gives an indication of the motor starting capabilities of the generator.

425.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition an oscillograph with sufficient galvanometers having a flat frequency response (flat within +/- 5 percent) from dc to 3,000 Hz, a non-inductive shunt, a timing wave source, a short circuiting switch, a separate variable dc source for generator excitation and a prime mover capable of maintaining the generator speed within +/- 1 percent of rated speed under all load conditions of this method shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

425.1.3 Procedure.

425.1.3.1 Preparation for test.

a. Mechanically connect the prime mover to the generator and provide the external excitation supply to the generator.
b. Connect the instrumentation and shorting switch to the generator in accordance with figure 425.1-I for the voltage correction and frequency specified in the procurement document.

   NOTE: Care shall be taken to reduce the impedance of the current-carry leads and contacts to a minimum. The leads shall be as short as possible and the conductors for the various phases as close together as practicable to reduce the inductance. These precautions are especially important when dealing with frequencies above 60 Hz.

c. Operate the generator at rated speed and adjust the field current to produce rated voltage at the generator terminals at no load.
d. Adjust the oscillograph such that the no load voltage trace has a minimum amplitude of 2 inches peak-to-peak. Close the shorting switch and adjust the oscillograph such that the sustained short-circuit current trace has a minimum amplitude of 3/4 inch peak-to-peak.
e. Adjust the speed of the oscillograph film drive such that successive peaks are separated by a minimum of 1/8 inch on the oscillogram.
f. After these adjustments have been made, open the shorting switch.

425.1.3.2 Test.

a. Start and operate the prime mover such that the generator is at rated speed. Adjust the external excitation supply to produce rated voltage at the generator terminals with no load.
b. Record all instrument readings (see figure 425.1-II).
c. Start the oscillograph. Allow sufficient time to record the zero position of the current race, the open circuit voltage, and the timing wave.
d. Close the short-circuiting switch. Allow the oscillograph to record the transient and sustained short-circuit current and voltage.
e. Record all instrument readings when sustained short-circuit conditions are achieved.
f. Repeat steps a thru e two additional times.

NOTE: For a polyphase generator, it is permissible to record oscillographically the short-circuit current in one phase only.

425.1.4 Results.

a. Working directly on the oscillogram, start with the first peak in the current wave following the application of the short-circuit, and number this peak "1" (see figure 424.1-III). Number subsequent peaks consecutively until steady-state conditions occur.
b. Draw a curve through the even numbered peaks and another through the odd numbered peaks. These two curves are called the "envelope".
c. Construct straight lines from each peak to a point on the opposite half of the envelope which is 1/2 the horizontal distance between the preceding and the following peaks on the opposite side of the zero axis.

d. Starting at the first peak that can be identified (either peak no. 1 or peak no. 2), measure (in millimeters or other comparable units) the distance between envelope lines along the lines just constructed. Prepare a table of these distances (see figure 425.1-IV).
e. Measure the perpendicular distance between envelope lines at steady-state and enter this into the table prepared in step d above. Steady-state is determined by the envelope lines (they are parallel at steady-state).
f. Subtract the steady-state distance from each of the other distances to obtain the fourth column of the table.
g. Using semi-log graph paper with the linear axis labeled "peaks" and the log axis labeled "millimeters" (or the unit used in measuring the distances in steps d and e above), plot each of the distances obtained in the fourth column.
h. Draw a smooth curve through the points ignoring obvious measurement errors. This curve is identified as "Curve A" in figure 425.1-V.
i. Extend the straight line portion of "Curve A" to the edge of the paper. This extension is identified as "Curve B" in figure 425.1-V.
j. On the oscillogram measure the distance along the zero axis between the "t = 0" line (the point at which the short circuit was applied) and the line drawn from the no. 2 peak. Enter this distance on the work sheet. In the example, the distance was found to be 7.0 millimeters.

k. Measure the distance along the zero axis between the lines drawn from no. 2 and no. 4 peaks. Enter this distance on the work sheet. In the example, the distance was found to be 11.5 millimeters.

l. Divide the measurement obtained in j by the measurement obtained in k to obtain the ratio between the two distances. In the example, this ratio is 0.61.

m. On the graph, plot a point to the left of the no. 2 peak position, representing the ratio obtained in step 1 multiplied by the distance between 2 and 0 on the semi-log paper. In figure 425.1-V this distance is 6.1 squares to the left of the no. 2 peak position. Draw a perpendicular line through this point and extending through "Curve B". This line represents t = 0.

n. Determine the reading at the point where "Curve b" intersects the t = 0 line. In the example, this reading is 18.5 millimeters. This value is substituted for $i_t = 0$ in the following formula:

$$X'_d = \frac{I_{RATED}}{(I_{t=0} + i_{ss})\,\dfrac{I_{ss}}{i_{ss}}}$$

i_{ss} is the distance perpendicular to the zero axis of the oscillogram between peaks at steady-state. In the example, i_{ss}=25 millimeters.

I_{SS} is the ammeter reading obtained from the data sheet. In the example, I_{ss}=64.5 amperes.

I_{RATED} is the rated current of the generator phase under test. In the example, I_{RATED}= 17.34 amperes.

X'_d is the direct axis transient reactance. In the example, X'_d = 0.154 per unit or 15.4 percent.

o. Repeat 425.1.3.3 for each oscillogram taken in 425.1.3.2. The value of the direct axis transient reactance shall be the average of the several computed values.

p. Compare the computed value of the direct axis transient reactance with the procurement document requirements.

425.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and frequency(ies) at which this method is to be performed.

b. Maximum allowable direct axis transient reactance (X'_d), at rated voltage expressed in per unit or percent.

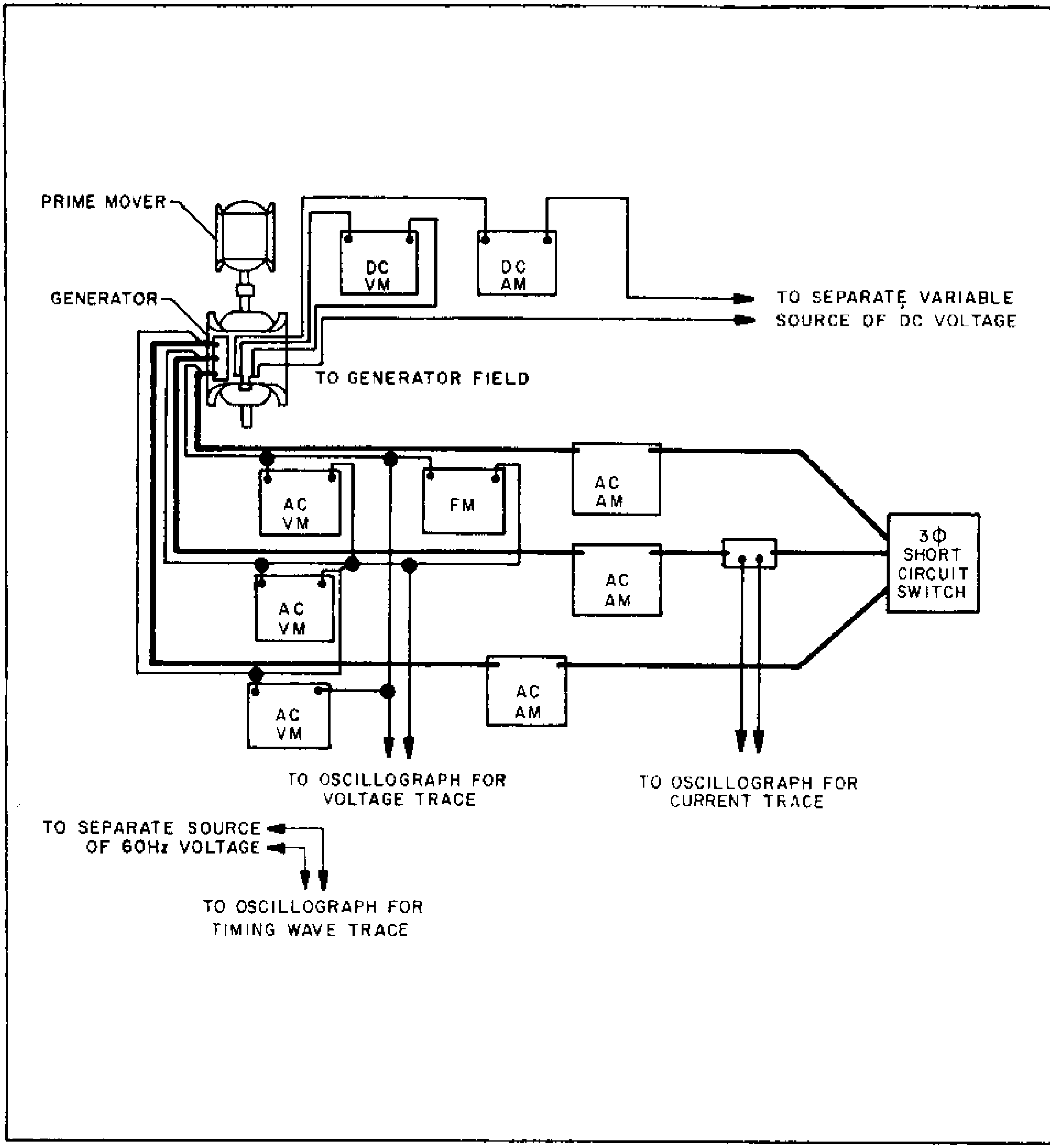


FIGURE 425.1-I. Typical apparatus hookup for direct-axis transient reactance test.

X-4566

TEST DATA

DESCRIPTION 3 KW, 400 Hz
120/208 V 3-PHASE
GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. HF-3.0-MD
SERIAL NO. 1667
REF: MIL-STD-705/425.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

DIRECT AXIS TRANSIENT REACTANCE TEST

TEST NO. 16
SHEET 1 OF 1
DATE DECEMBER 28, 1970
RECORDER D. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER [illegible]
OBSERVER D. Se.

INST. →			117				337				511			131	381		1076
READ NO. ↓	TIME		TERMINAL VOLTAGE				LINE CURRENT				FREQUENCY			EXCITER FIELD			AVG AMB TEMP
			L1-L2	L2-L3	L3-L1		L1	L2	L3								
UNITS	HRS		VOLTS	VOLTS	VOLTS		AMPS	AMPS	AMPS			Hz		VOLTS	AMPS		°F
SYM.							X 20	X 20	X 20								
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0830		205	206	206		0	0	0			418		22.1	.23		73
			0	0	0		3.21	3.22	3.20					22.1	.23		
	0900		208	208	208		0	0	0			416		22.3	.25		72
			0	0	0		3.22	3.22	3.22					22.3	.25		
	0930		208	208	208		0	0	0			417		22.3	.25		73
			0	0	0		3.22	3.22	3.22					22.3	.25		

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. L1 - #1306; L2 - #1307; L3 - #1308
EXCITER FIELD CURRENT MEASURED USING A 0.5A, 50 mV SHUNT NO. 1674

FIGURE 425.1-II. Typical test record for direct axis transient reactance test.

X-4567

Reactance Test.]

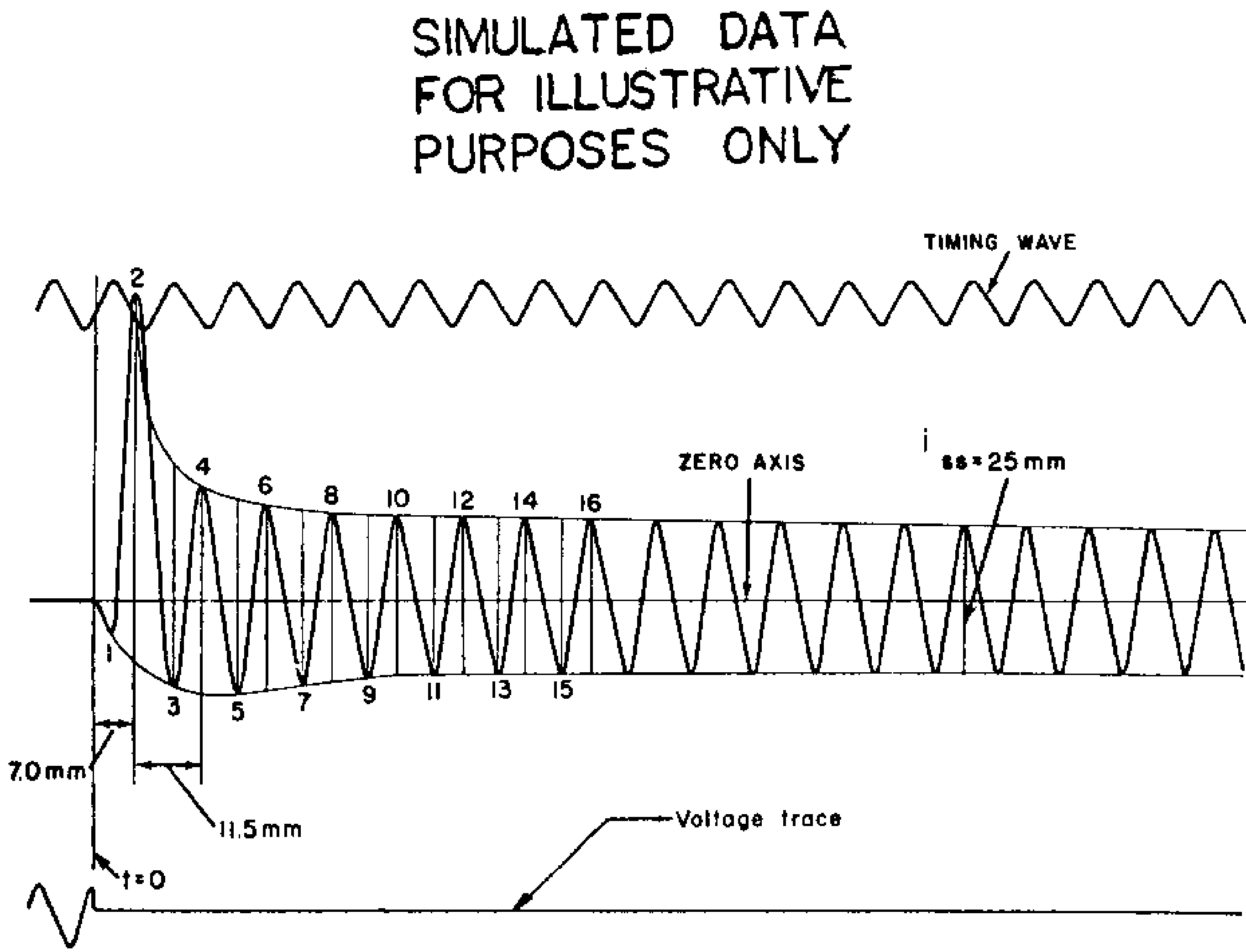


FIGURE 425.1–III. *Sample oscillogram for direct-axis transient reactance test.*

X–4568

Reactance Test.]

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

PEAK NO.	LENGTH MM	iSS LENGTH MM	COL (2) - COL (3)
(1)	(2)	(3)	(4)
1		25	
2	63.5	25	38.5
3	40.5	25	15.5
4	35	25	10
5	33	25	8
6	31.5	25	6.5
7	30	25	5
8	29.5	25	4.5
9	28.5	25	3.5
10	28	25	3
11	27.4	25	2.4
12	27	25	2
13	26.5	25	1.5
14	26.5	25	1.5
15	26.5	25	1.5
16	26.5	25	1.5

$$x'_d = \frac{I_{rated}}{(i_{t=0} + i_{ss})\frac{I_{ss}}{i_{ss}}}$$

t=0 to peak 2 = 7.0 mm

peak 2 to peak 4 = 11.5 mm

$$\frac{7}{11.5} = 0.61$$

$i_{t=0}$ = 18.5 mm

i_{ss} = 25 mm

I_{ss} = 64.5 amperes

I_{rated} = 17.34 amperes

THEREFORE

$$x'_d = \frac{17.34}{(18.5 + 25)\ \frac{64.5}{25}}$$

$$x'_d = \frac{17.34}{43.5\left(\frac{64.5}{25}\right)}$$

$$x'_d = \frac{17.34}{43.5\,(2.58)}$$

$$x'_d = \frac{17.34}{112.23}$$

x'_d = 0.154 or 15.4% reactance

FIGURE 425.1-IV. *Sample worksheet for direct-axis transient reactance test.*

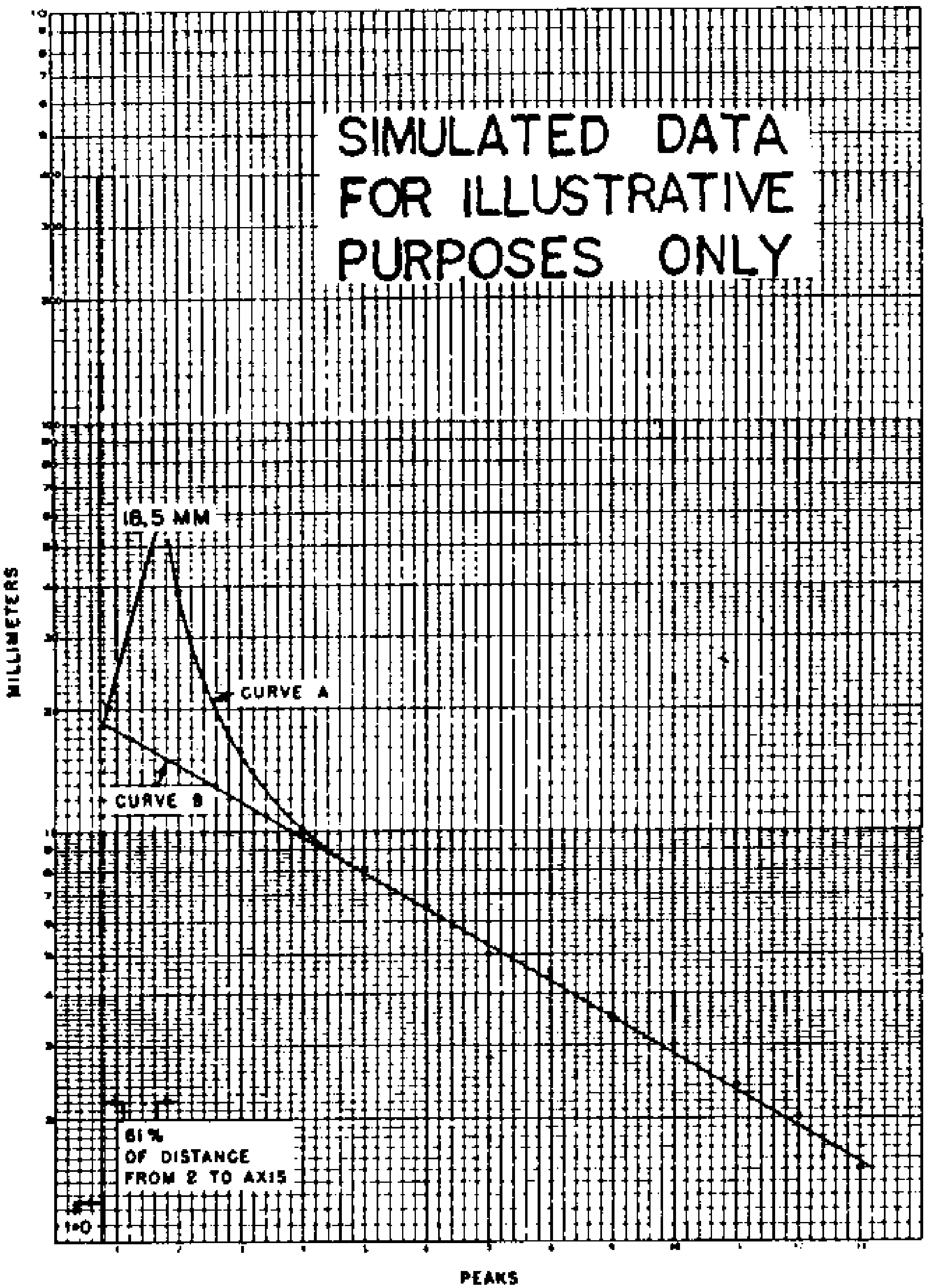


FIGURE 425.1–V. *Sample curve used in the determination of direct-axis transient reactance.*

X-4570

METHOD 426.1b

DIRECT-AXIS SUBTRANSIENT REACTANCE TEST

426.1.1 General. The direct-axis subtransient reactance is used by design engineers to determine the necessary interrupting capacity of the set circuit interrupter.

426.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition an oscilloscope with sufficient galvanometers having a flat frequency response (flat within +/- 5 percent) from dc to 3,000 Hz, a non-inductive shunt, a timing wave source, a short circuiting switch, a separate, variable dc source for generator excitation and a prime mover capable of maintaining the generator speed within +/- 1 percent of rated speed under all load conditions of this method shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

426.1.3 Procedure.

a. Perform method 425.1, Direct-Axis Transient Reactance Test.

b. On the same graph as plotted for method 425.1, plot an additional line as shown in figure 426.1-I. The procedure for plotting this line is as follows:

   1. Ascertain the scale distance between the straight line (Curve "B") and the curved line (Curve "A") for at least three peak positions.
   2. Plot these distances on the respective peak lines. In the example, Curve "A" is 24 mm from Curve "B" on the No. 2 peak perpendicular. Similarly, at the 2.6 peak, the scale distance between the two curves is 7.5 mm. At the No. 3 peak, the distance is 3.5 mm.
   3. Draw a straight line through these points. In the example, this line is identified as Curve "C".

c. Read the value in mm (or the unit used in measuring the distances in step b above) where the Curve "C" crosses the t = 0 line. In the example, this crossing is at 264 mm.

d. Using the following formula compute the direct-axis subtransient reactance, X_d.

$$X''_d \text{ (in percent)} = \frac{I_{RATED}}{(i'_{t=0}\ i_{t=0} + i_{ss})\ \dfrac{I_{ss}}{i_{ss}}} \times 100$$

Where: $i'_{t=0}$ is the point where Curve "C" crosses the t=O line (in the example $i'_{t=0}$=264 mm).

$i_{t=0}$ is the point where Curve "B" crosses the t=0 line.

i_{ss} is the distance perpendicular to the zero axis of the oscillogram between peaks at steady-state.

I_{ss} is the ammeter reading obtained from the data sheet taken in method 425.1.

I_{RATED} is the rated current of the generator under test.

e. The above procedure shall be applied to the short-circuit current in all phases of a polyphase generator when they have been recorded oscillographically, or to the three individual oscillograms taken on one phase. The value of X''_{d} for the generator shall be the average of the several computed values.

426.1.4 Results. Compare the average value of the subtransient reactance (X''_{d}) with the procurement document requirements.

426.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum, minimum or range of allowable values of the direct-axis subtransient reactance (X''_{d}), at rated voltage, expressed as a percent.
b. Voltage connection(s) and frequency(ies) at which this method is to be performed.

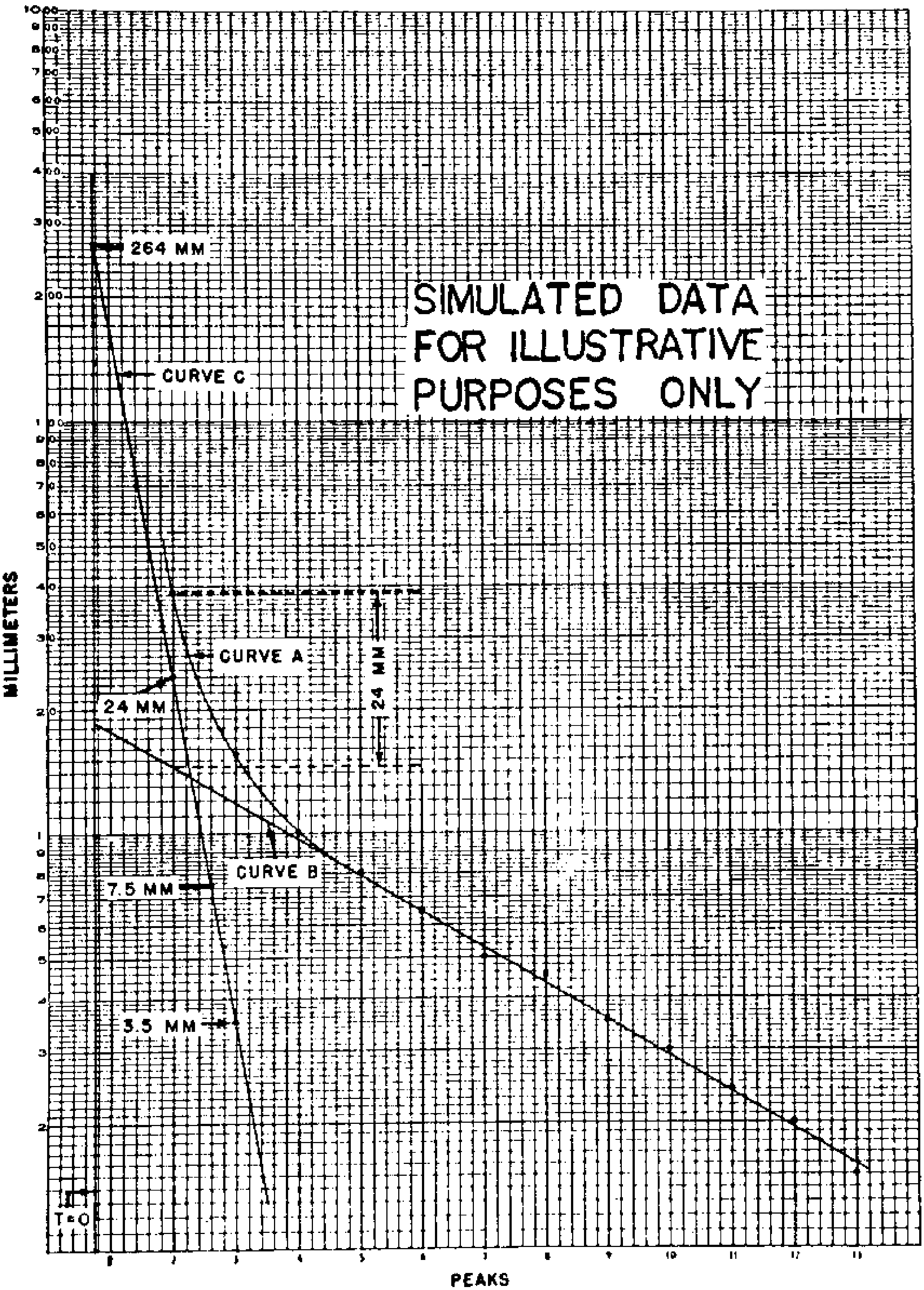


FIGURE 426.1-I. *Sample curve u ·l in the determination of direct-axis subtransient reactance.*

X-4571

METHOD 427.1b

DIRECT-AXIS TRANSIENT SHORT-CIRCUIT TIME CONSTANT TEST

427.1.1 General. The direct-axis transient short-circuit time constant is used by design engineers to aid in the determination of the performance of a generator under various load conditions.

427.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition an oscilloscope with sufficient galvanometers having a flat frequency response (flat within +/- 5 percent) from dc to 3,000 Hz, a non-inductive shunt, a timing wave source, a short circuiting switch, a separate, variable dc source for generator excitation and a prime mover capable of maintaining the generator speed within +/- 1 percent of rated speed under all load conditions of this method shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

427.1.3 Procedure.

a. Perform method 425.1, Direct-Axis Transient Reactance Test.
b. On the same graph as plotted for method 425.1:

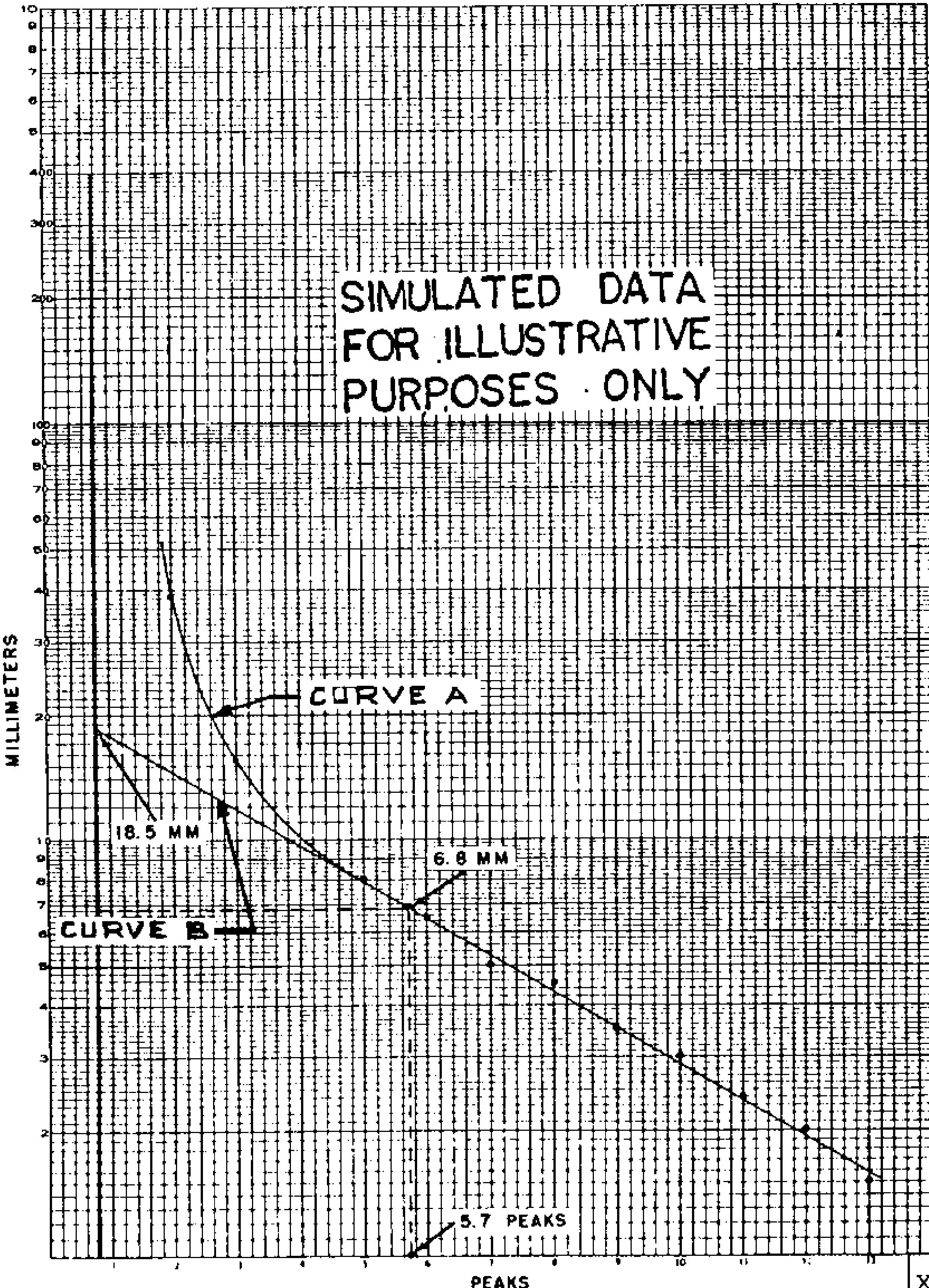
   1. Determine the point at which Curve "B" crosses the t = 0 line. In the example; this has been previously determined to be 18.5 mm.
   2. Multiply the quantity obtained in step 1 above by 0.368. In example: 18.5 x 0.368 = 6.8 mm.
   3. Find the point of Curve "B" at which the quantity obtained in step 2 above is located.
   4. Determine the peak at this point. In the example, this is 5.7 peaks (figure 427.1-I).
   5. Subtract "1.0" from the number obtained in step 4 above. In example: 5.7 - 1.0 = 4.7.
   6. To the number obtained in step 5 above, add the time (peaks) from t = 0 to t = 1. In the example, this time is 0.2 peaks. 4.7 + 0.2 = 4.9 peaks.
   7. Multiply the number of peaks obtained in step 6 above by the time interval between peaks, which is "1" divided by twice the frequency. In the example, the frequency is 60 Hz. The computation, then becomes $4.9 \times \frac{1}{120} = 0.041$ second. This represents the direct-axis transient short-circuit time constant.

c. Repeat step b above for each of the three graphs plotted for method 425.1. The value for the direct-axis transient short-circuit time constant shall be taken as the average of the several computed values.

427.1.4 Results. Compare the average value of the direct-axis transient short-circuit time constant with the procurement document requirements.

427.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The allowable range of direct-axis transient short-circuit time constant in seconds, if applicable.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.



X-4572

FIGURE 427.1-1. *Sample curve used in the determination of direct-axis transient short-circuit time constant.*

METHOD 428.1b

DIRECT-AXIS SUBTRANSIENT SHORT-CIRCUIT TIME CONSTANT TEST

428.1.1 General. The direct-axis subtransient short-circuit time constant is used by design engineers to aid in the determination of the performance of a generator under various load conditions.

428.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition an oscilloscope with sufficient galvanometers having a flat frequency response (flat within +/- 5 percent) from dc to 3,000 HZ, a non-inductive shunt, a timing wave source, a short circuiting switch, a separate, variable dc source for generator excitation and a prime mover capable of maintaining the generator speed within +/- 1 percent of rated speed under all load conditions of this method shall be required. Electrical instrumentation for this test shall have an a percent of reading or better.

428.1.3 Procedure.

a. Perform method 426.1, Direct-Axis Subtransient Reactance Test.
b. On the same graph as plotted for method 426.1:

1. Determine the point at which Curve "C" crosses the t = 0 line. In the example, this has been previously determined to be 264 mm.
2. Multiply the quantity obtained in step 1 above by 0.368. In the example: 264 x 0.368 = 97.15.
3. Find the point on Curve "C" at which the quantity obtained in step 2 above is located.
4. Determine the peak at this point. In the example, this is 1.3 peaks (figure 428.2-I).
5. Subtract "1.0" from the number obtained in step 4 above. In the example, 1.3 - 1.0 = 0.3.
6. To the number obtained in step 5 above, add the time (peaks) from t = 0 to t = 1. In the example, this time is 0.2 peak. 0.3 + 0.2 = 0.5 peak.
7. Multiply the number of peaks obtained in step 6 above by the time interval between peaks, which is "1" divided by twice the frequency. In the example, the frequency is 60 Hz. The computation, then, becomes $0.5 \times \frac{1}{120} = 0.004$ second. This represents the direct-axis subtransient short-circuit time constant.

c. Repeat step b above for each of the three graphs plotted for method 426.1. The value for the direct-axis subtransient short-circuit time constant shall be taken as the average of the several computed values.

428.1.4 Results. Compare the average value of the direct-axis subtransient short-circuit time constant with the procurement document requirements.

428.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The allowable range of direct-axis subtransient short-circuit time constant in seconds, if applicable.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.

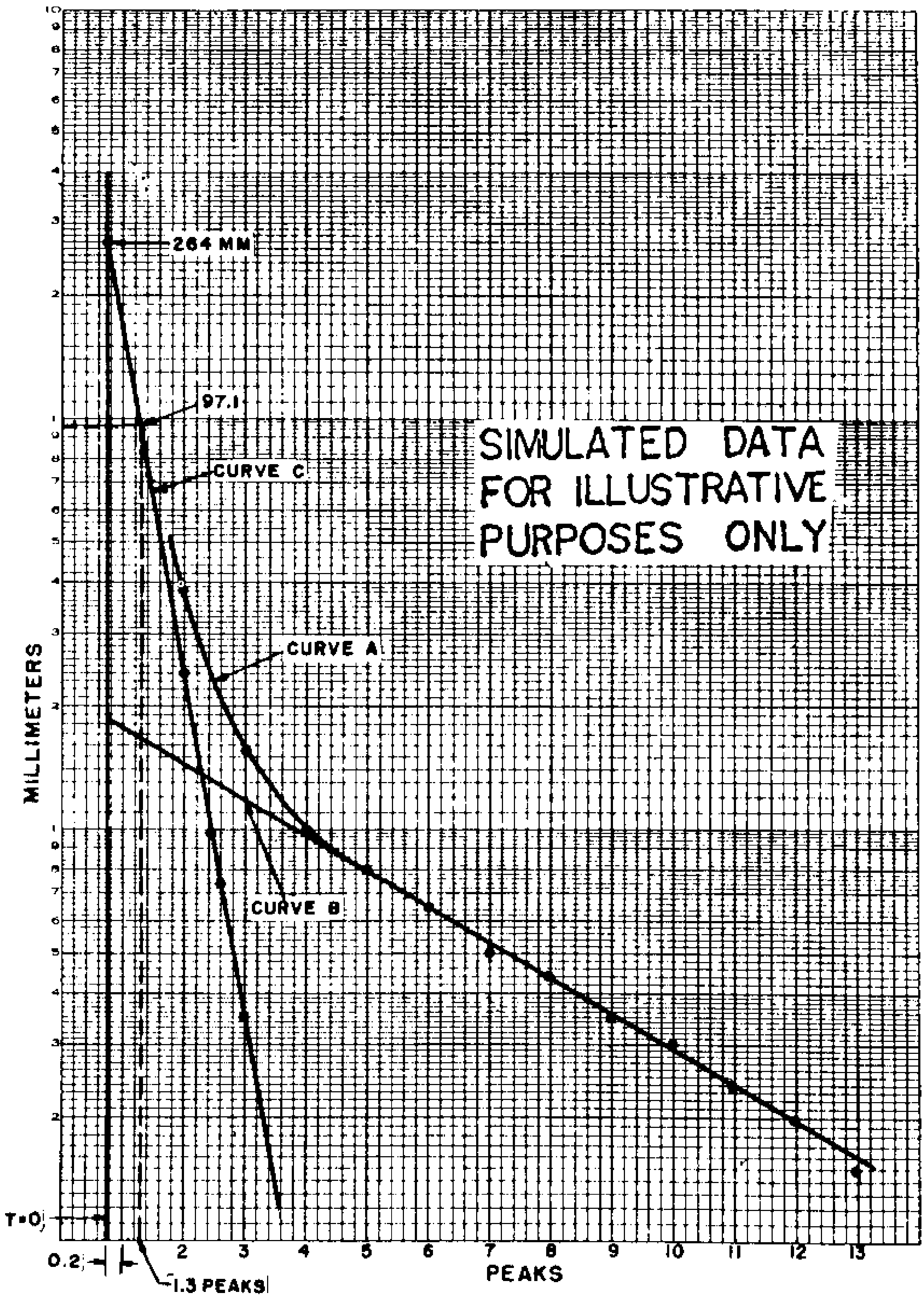


FIGURE 428.1-I. *Sample curve used in the determination of direct-axis subtransient short-circuit time constant.*

METHOD 430.1a

DIRECT-AXIS TRANSIENT OPEN-CIRCUIT CONSTANT TEST

430.1.1 General. The direct-axis transient open-circuit time constant is used by design engineers to aid in the determination of the performance of a generator under various load conditions.

430.1.2 Apparatus. Instrumentation for measuring terminal voltage, generator speed, and field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition a short circuiting switch, for the generator field; a oscillograph with sufficient galvanometers (3,000 Hz response); and a prime mover shall be required.

430.1.3 Procedure.

430.1.3.1 Preparation for test.

a. Mechanically connect the generator to the prime mover and provide the external excitation supply to the generator through a resistor of sufficient size to prevent injury to the supply circuit when the field is short circuited.
b. Connect the instrumentation and field shorting switch in accordance with figure 430.1-I for a voltage connection and frequency specified in the procurement document.

430.1.3.2 Test.

a. Start and operate the prime mover such that the generator is at rated voltage, rated speed and no load.
b. Adjust the amplitude of the generator terminal voltage trace to at least 2 inches.
c. Adjust the amplitude of the generator field voltage trace to at least 3/4 inch and set up a field voltage zero trace.
d. Set up a timing line trace.
e. Adjust oscillograph film speed to give at least 1/8 inch separation between successive peaks.
f. Start the oscillograph, with the generator operating at rated voltage, rated speed and no load, and operate for at least 1/4-second to record the initial steady-state traces of the terminal voltage and field voltage. Record all instrument readings (see figure 430.1-II).
g. Close the field short-circuiting switch and keep the oscillograph in operation until the generator voltage decays to its residual value. Record this value on the data sheet.

430.1.4 Results.

430.1.4.1

a. Draw a voltage envelope on the oscillogram. Construct a perpendicular at t = 0 (a typical curve is in figure 430.1-III).
b. Measure the height of the initial envelope (steady-state before shorting field).
c. Measure the height of the final envelope (steady-state after shorting field).
d. Subtract final measurement from initial measurement and multiply by 0.368.
e. To the value obtained in step d above add the measurement taken in step c above.
f. Slide the scale along the curve until the envelope height is the value obtained in step e above. At this point construct a perpendicular to the timing wave.
g. From the point of the timing wave obtained in step f above, determine length of time away from t = 0. This is the direct-axis transient open circuit time constant.

430.1.4.2 Compare the results with the procurement document requirements.

430.1.5. Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable direct-axis transient open-circuit time constant in seconds.
b. Voltage connection(s) and frequency(ies) at which this method is to be performed.

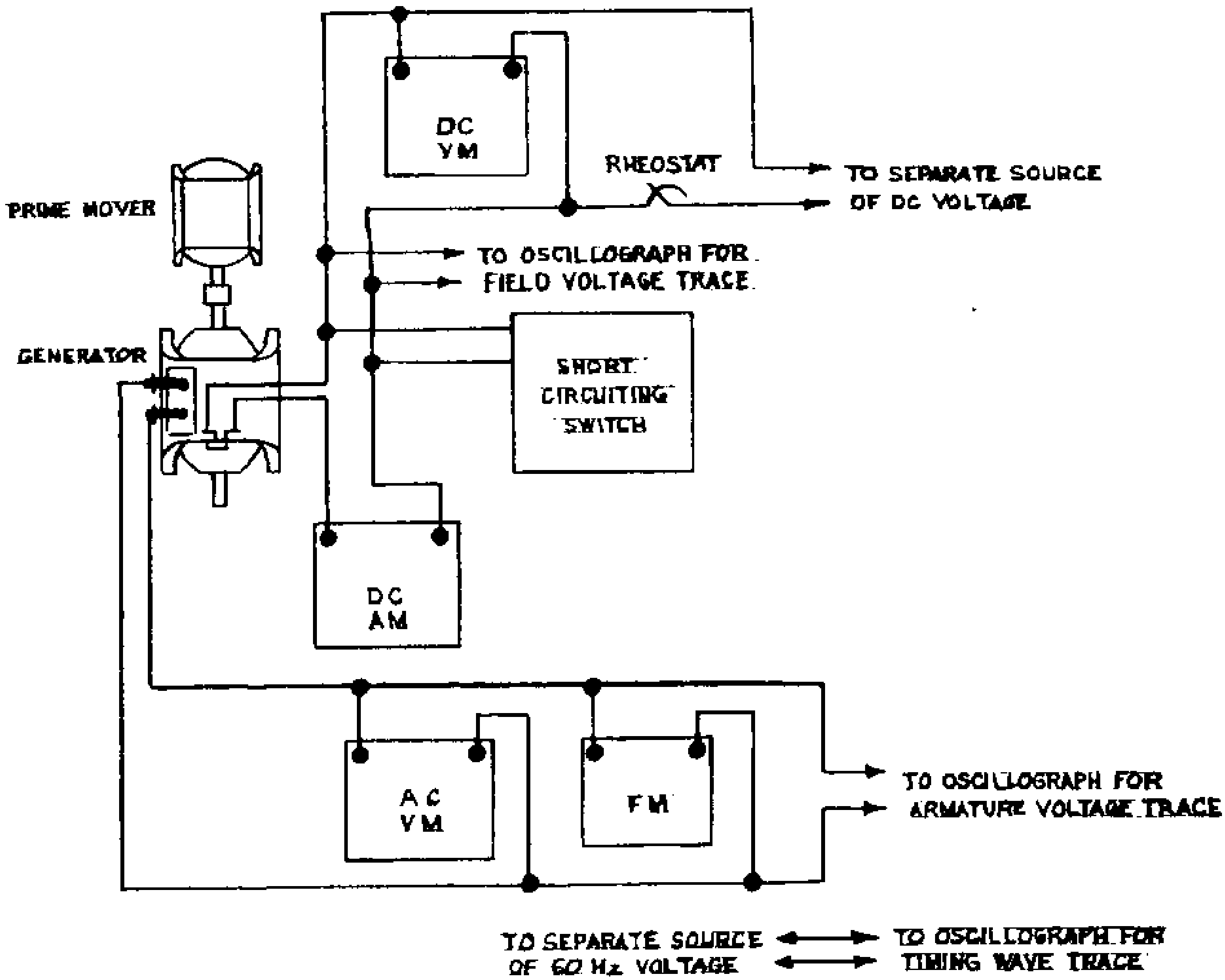


FIGURE 430.1-I. TYPICAL APPARATUS HOOKUP FOR DIRECT-AXIS TRANSIENT OPEN-CIRCUIT TIME CONSTANT TEST.

X-4574

Open-Circuit Time Constant Test.]

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

DESCRIPTION 10KW, 60HZ
120V, SINGLE PHASE
GENERATOR ONLY
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 10717
REF: MIL-STD-705/430.1

DIRECT AXIS TRANSIENT OPEN CIRCUIT
TIME CONSTANT TEST

TEST NO. 11
SHEET 1 OF 1
DATE FEBRUARY 1, 1971
RECORDER J. Wright
PROJ. ENGR J. Jones
SHIFT LEADER H. Smith
OBSERVER L. Lee

INST. →		107		612			118	306									1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		FREQUENCY			GENERATOR FIELD										AVG AMB TEMP
UNITS	HRS		VOLTS		Hz		VOLTS	AMPS									°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	07:15		120.0		60.0		0.28	9.5	BEFORE SHORTING								84
			21.2		—		0	0	AFTER SHORTING								
		FROM O-GRAPH - DIRECT AXIS TRANSIENT OPEN-CIRCUIT TIME CONSTANT = 0.70 SEC															

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

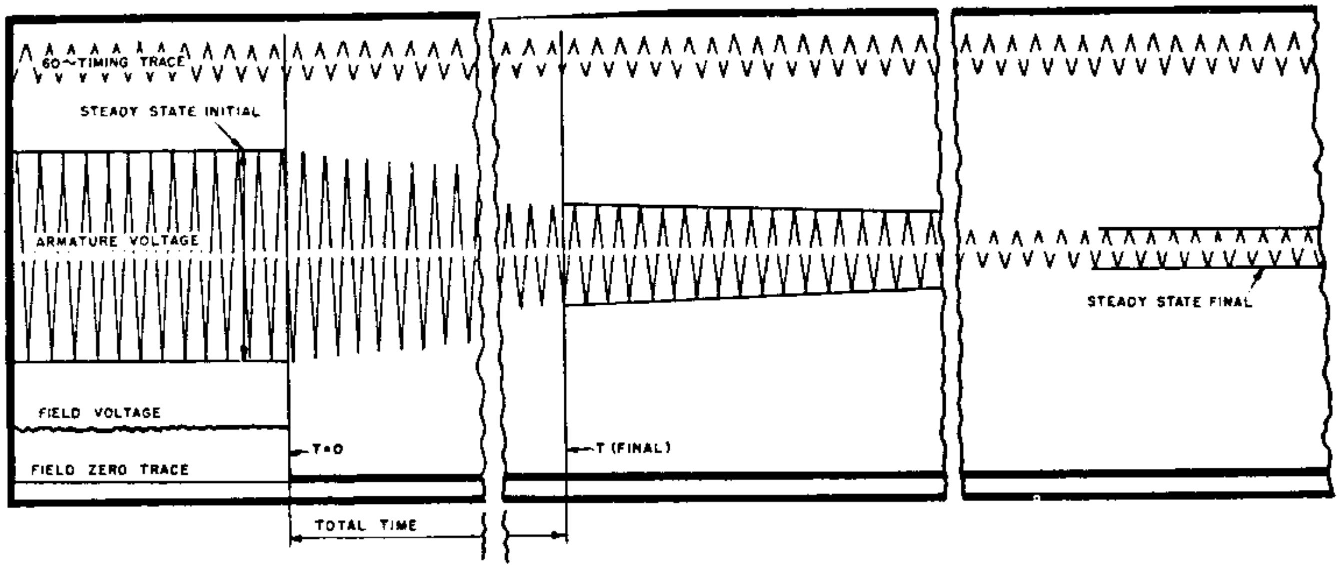
NOTES: GENERATOR FIELD CURRENT MEASURED USING 10 A, 50 mV SHUNT No 2110

X-4575

Figure 430.1-II: Typical test record for direct axis open circuit time constant test.

Time Constant Test.]

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY



CALCULATION

ITEM	UNIT
A. ERECT PERPENDICULAR T=0	
B. STEADY STATE INITIAL	44.0
C. STEADY STATE FINAL	7.8
D. B-C	44.0-7.8=36.2
E. DX 0.368	36.2 X 0.368=13.3
F. C+E	7.8+13.3=21.1

CALCULATION

ITEM	UNIT
G. SLIDE SCALE ALONG ENVELOPE UNTIL WIDTH IS THE VALUE FOUND IN F. ABOVE. ERECT PERPENDICULAR TO TIMING WAVE	
H. COMPUTE TOTAL TIME FROM TIMING TRACE	$\frac{42\ \text{CYCLES}}{60}$ = 0.70 SECONDS

FIGURE 430.1-III. TYPICAL OSCILLOGRAM, DIRECT-AXIS TRANSIENT OPEN-CIRCUIT TIME CONSTANT TEST.

X-4576

Open-Circuit Time Constant Test.]

METHOD 432.1b

SHORT-CIRCUIT TIME CONSTANT OF ARMATURE WINDING TEST

432.1.1 General. The short-circuit time constant of armature winding is used by design engineers as a criterion for the requirements of auxiliary equipment intended to protect the load and generator from extreme conditions.

432.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition an oscilloscope with sufficient galvanometers having a flat frequency response (flat within +/- 5 percent) from dc to 3,000 Hz, a non-inductive shunt, a timing wave source, a short circuiting switch, a separate, variable dc source for generator excitation and a prime mover capable of maintain the generator speed within +1 percent of rated speed under all load conditions of this method shall be required. Electrical instrumentation for this test shall have an accuracy of +/- 0.5 percent of reading or better.

432.1.3 Procedure.

a. Perform method 425.1, Direct-Axis Transient Reactance Test.
b. On an oscillogram obtained in step a above (see figure 432.1-I), beginning at the number two peak, determine the distance in millimeters between the zero axis and each current envelope line, at each peak, as far as steady-state. Tabulate these distances.
c. Determine the difference between the values obtained at each peak and tabulate these differences. The table shall contain four columns: column 1 shall contain the peak number; column 2 shall contain the distance between the zero axis and the upper envelope line; column 3 shall contain the distance between the zero axis and the lower envelope line; and column 4 shall contain the differences between the values in column 3 and 4.
d. Plot a curve on semilogarithmic paper of the asymmetrical component versus peak number. Plot the asymmetrical component values on the logarithmic axis and the peak numbers on the linear axis. This curve shall be added to the graph obtained in step a above and extended to cross the t = 0 line. The curve is shown in figure 432.1-II, and is labeled "D".
e. Determine the point at which the curve crosses the t = 0 line. In the example shown in figure 432.1-II, this value is 27.
f. Multiply the quantity obtained in step e above by 0.368. In the example: 27 x 0.368 = 9.9.
g. Find the point on the curve at which the value obtained in step f above falls.
h. Determine the peak value at the point determined in step g above. In the example, this point is 2.2 peaks.
i. Subtract "1.0" from the peak value obtained in step g above. In the example: 2.2 - 1.0 = 1.2.

j. To the value obtained in step i above, add the peak value from t = 0 to t = 1. In the example, this time is 0.2 peak. Therefore: 1.2 + 0.2 = 1.4.

k. Multiply the peak value obtained in step j above by the time interval between peaks, which is "1.0" divided by twice the frequency. In the example, the frequency is 60 Hz. The short-circuit time constant for armature winding in the example is $1.4 \times \frac{1}{120} = 0.01167$ seconds.

l. Repeat steps b thru k above for each oscillogram taken during step a above. The short-circuit time constant for armature winding shall be taken as the average of the several values.

432.1.4 Results. Compare the short-circuit time constant of armature winding with the procurement document requirements.

432.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The maximum allowable short-circuit time constant for armature winding, if applicable.

b. The voltage connection(s) and frequency(ies) at which this method is to be performed.

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

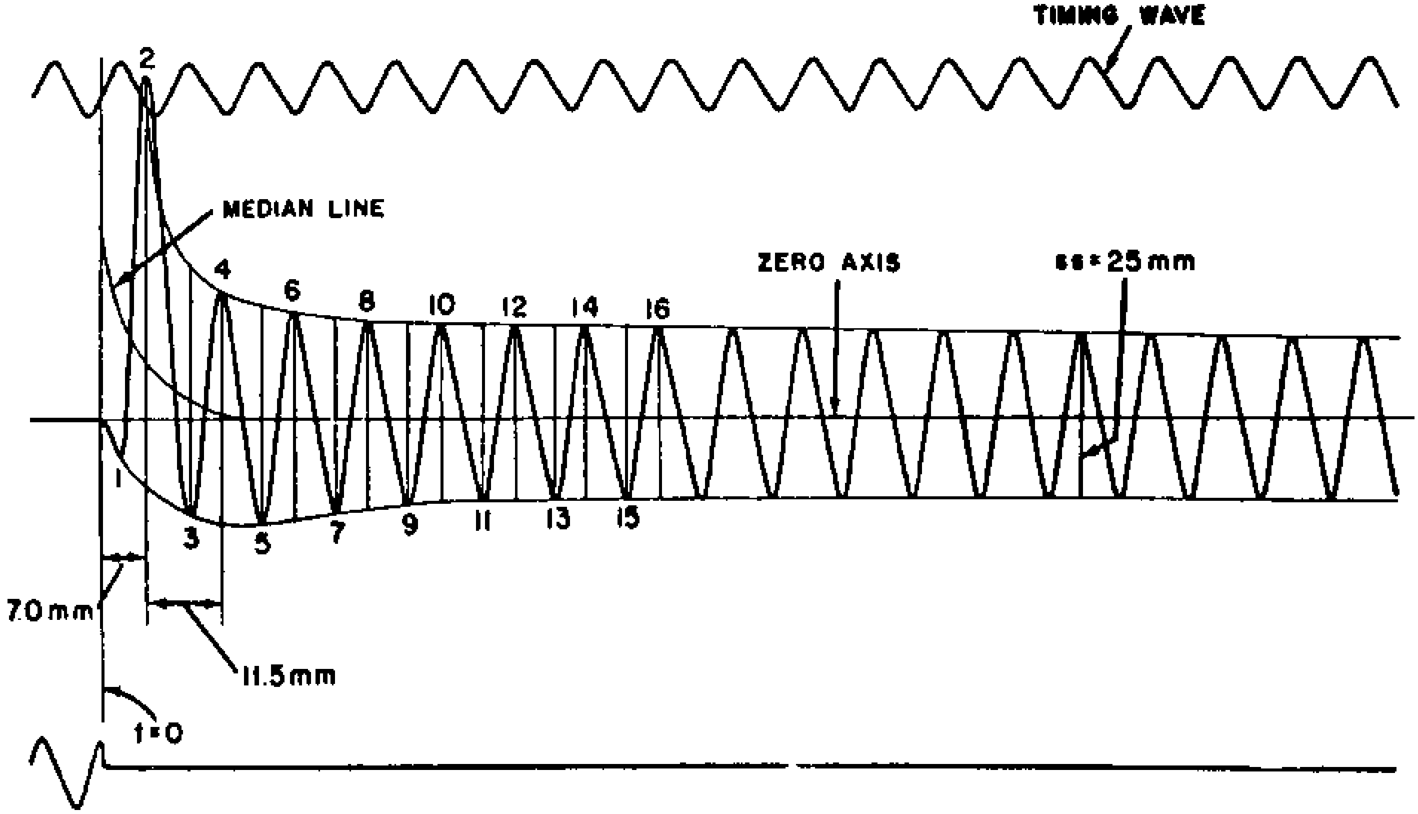


FIGURE 432.1-I SAMPLE OSCILLOGRAM, SHOWING MEDIAN LINE.

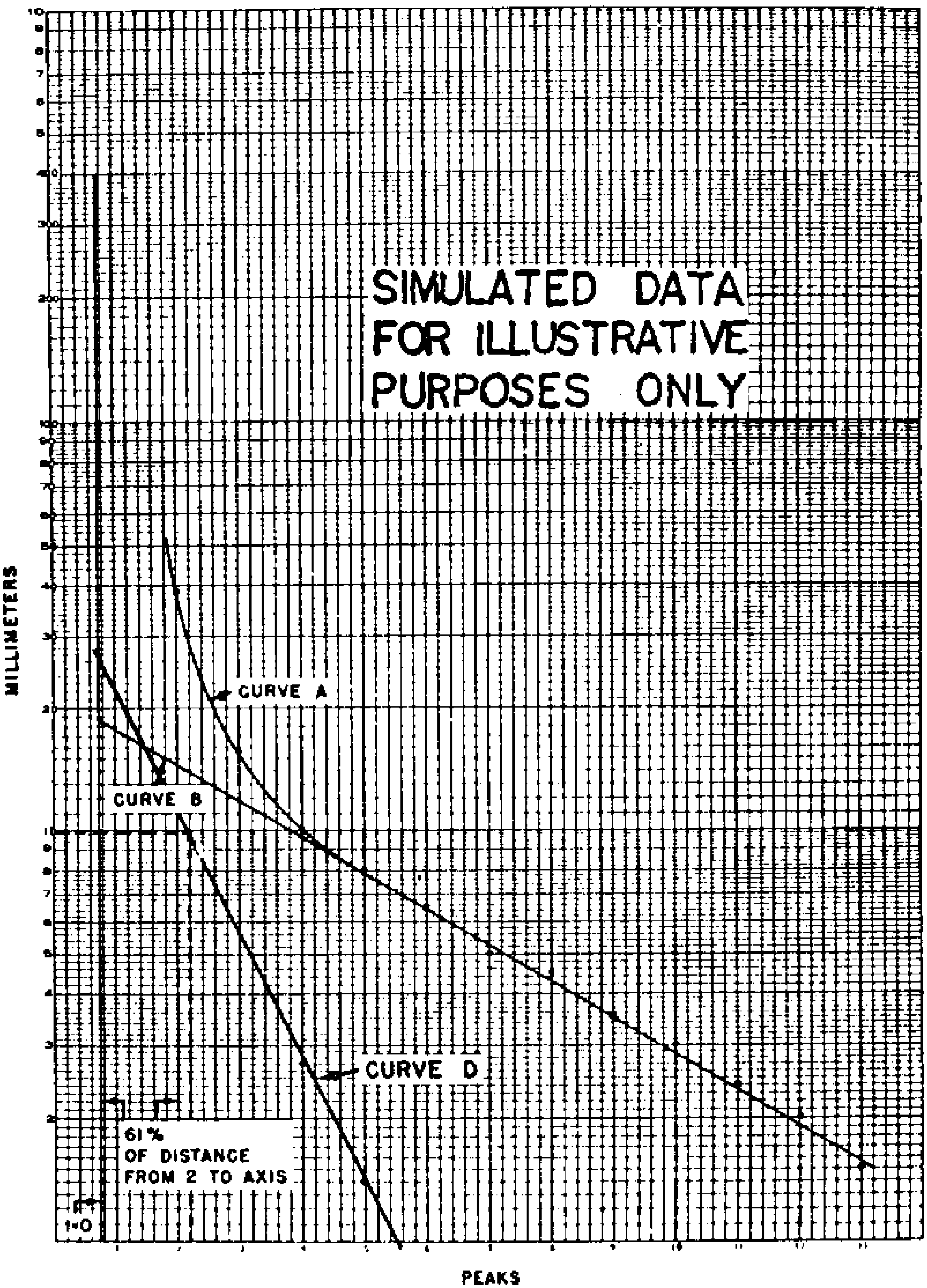


FIGURE 432.1-II SAMPLE CURVE USED IN DETERMINING THE SHORT-CIRCUIT TIME CONSTANT OF ARMATURE WINDING.

X-4578

METHOD 503.1c

START AND STOP TEST

503.1.1 General. The adequacy of the starting and operating instructions on the set is essential to safe operation of the generator set. Any abnormal start and stop conditions may endanger personnel or equipment.

503.1.2 Apparatus. A stopwatch shall be required.

503.1.3. Using the items provided as part of the generator set, perform the following operations:

a. Start the generator set by following the operating instructions on the set. Use the stopwatch to determine the time required to start the set. The start time is defined as the period of time from initiating start procedures until the generator set has achieved rated voltage and frequency (speed) without the further use of starting aids.
b. Operate the set at rated voltage, rated frequency (speed), and no load for 5 minutes with the circuit interrupter closed.
c. Stop the set by following the operating instructions on the set. Use the stopwatch to determine the time required to stop the set. A set is considered to have stopped when all rotating members are at zero rpm, with the exception of the turbocharger, if used.
d. Repeat steps a thru c two additional times.
e. Repeat steps a thru d utilizing any alternate starting methods provided for in the operator’s manual or set design (e.g. rope start) but not including remote starting.

503.1.4 Results. The data sheet shall indicate how the set performed during this test, including the time to start, the operating time, the voltage and operating speed during each period of operation, and the and time of set shutdown. Compare these results with the procurement document requirements.

503.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection and frequency at which this method is to be performed.
b. Time limit to start the set.
c. Time limit to stop the set, if applicable.

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

START AND STOP TEST

DESCRIPTION 10 KW, 60 HZ 120V SINGLE PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 21067

REF: MIL-STD-705/503.1

TEST NO. 6

SHEET 1 OF 2

DATE 23 DECEMBER, 1970

RECORDER D. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER [illegible]

INST. →		
READ NO. ↓	TIME	
UNITS	HRS	
SYM.		
COL.	1	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
	09:10	STARTED SET IN 15 SEC USING NORMAL START PROCEDURE. CLOSED CIRCUIT BREAKER. SET OPERATING AT 120V & 60HZ
	09:15	SHUTDOWN SET. SET SLOWED BUT CONTINUED TO RUN ERRATICALLY FOR 48 SEC.
	09:17	STARTED SET IN 10 SEC USING NORMAL START PROCEDURE. CLOSED CIRCUIT BREAKER. SET OPERATING AT 120V & 60HZ
	09:22	SHUTDOWN SET. SET SLOWED BUT CONTINUED TO RUN ERRATICALLY FOR 36 SEC.
	09:25	STARTED SET IN 5 SEC USING NORMAL START PROCEDURE. CLOSED CIRCUIT BREAKER SET OPERATING AT 120V & 60HZ
	09:30	SHUTDOWN SET IN 5 SEC - NO ERRATIC OPERATION NOTICED
	09:35	STARTED SET IN 9 SEC USING EMERGENCY START PROCEDURE. CLOSED CIRCUIT BREAKER SET OPERATING AT 120V & 60HZ
	09:40	SHUTDOWN SET IN 3 SEC - NO ERRATIC OPERATION
	09:41	STARTED SET IN 7 SEC USING EMERGENCY START PROCEDURE. CLOSED CIRCUIT BREAKER SET OPERATING AT 120V & 60HZ
	09:46	SHUTDOWN SET IN 3 SEC - NO ERRATIC OPERATION
NOTES:		

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 503.1-I. Portion of a Typical Test Record for Start and Stop Test.

X-4579

Stop Test.]

METHOD 503.2c

START AND STOP TEST
(REMOTE CONTROL)

503.2.1 General. The adequacy of the remote control starting and operating instructions on the set is essential to safe operation of the generator set. Any abnormal start and stop conditions may endanger personnel or equipment.

503.2.2 Apparatus. A remote-control station consisting of two momentary-contact, pushbutton switches connected to a 3-conductor, number 16 AWG, 150-foot cable as shown in figure 503.2-I and a stop watch shall be required.

503.2.3 Procedure.

503.2.3.1 Preparation for test. Connect the remote-control station as shown in figure 503.2-I.

503.2.3.2 Test.

a. Start the generator set by following the remote-control operating instructions on the set or in the technical manual. Use the stopwatch to determine the time required to start the set. The start time is defined as the period of time from initiating start procedures until the generator set has achieved rated voltage and frequency (speed) without the further use of starting aids.
b. Operate the set at rated voltage, rated frequency, and no load for 5 minutes.
c. Stop the set by following the operating instructions on the set or in the technical manual. Use the stopwatch to determine the time required to stop the set. A set is considered to have stopped when all the rotating are at zero rpm, with the exception of the turbocharger, if used.
d. Repeat steps a thru c above two additional time.
e. With the remote-local selector switch in the "off" or "local" position attempt to start the set from the remote-control station. Record whether the set started.

503.2.4 Results. The data sheet shall indicate how the set performed during this test, including the time to start, the operating time, the voltage and operating speed during each period of operation, the manner and time of set started from the remote station with the remote-local selector switch in the "off" or "local" position. Compare these results with the procurement document requirements.

503.2.5. Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection and frequency at which this method is to be performed.
b. The time limit for remote starting, if different than the time limit for starting at the set.
c. The time limit for remote stopping, if applicable.

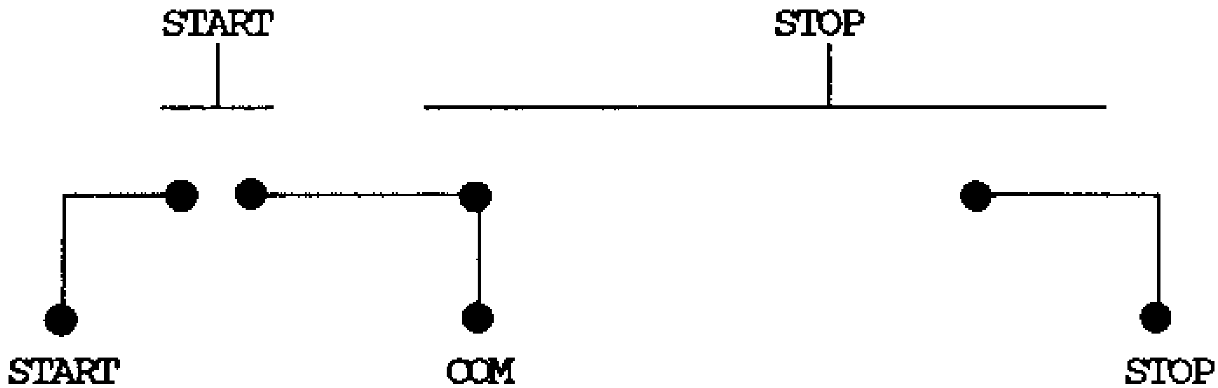


FIGURE 503.2-I. Connection diagram for remote control station.

Method 503.2c

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

START AND STOP TEST

(REMOTE CONTROL)

DESCRIPTION 10 KW 60 HZ 120V, SINGLE PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 21067

REF: MIL-STD-705/503.2

TEST NO. 7

SHEET 1 OF 1

DATE 23 DECEMBER, 1970

RECORDER [illegible]

PROJ. ENGR. [illegible]

SHIFT LEADER [illegible]

OBSERVER [illegible]

INST. →		
READ NO. ↓	TIME	
UNITS	HRS	
SYM.		
COL	1	2–17
	10:15	STARTED SET IN 8 SEC USING REMOTE START PROCEDURE. SET OPERATING AT 120V, 60HZ.
	10:20	SHUTDOWN SET IN 3 SEC USING REMOTE STOP PROCEDURE
	10:22	STARTED SET IN 6 SEC USING REMOTE START PROCEDURE. SET OPERATING AT 120V, 60HZ
	10:27	SHUTDOWN SET IN 3 SEC USING REMOTE STOP PROCEDURE
	10:30	STARTED SET IN 7 SEC USING REMOTE START PROCEDURE. SET OPERATING AT 120V, 60HZ.
	10:35	SHUTDOWN SET IN 3 SEC USING REMOTE STOP PROCEDURE.
	10:38	PUT "REMOTE-LOCAL" SWITCH IN "LOCAL" - ATTEMPTED TO START SET USING REMOTE SWITCH. SET CRANKED BUT WOULD NOT START AFTER 30 SEC OF CRANKING.

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

Figure 503.2-II. Typical Test Record for Start and Stop Test (Remote Control).

X-4580

(Remote Control).

METHOD 503.3a

START AND STOP TEST (REMOTE CUBICLE)

503.3.1 General. The remote cubicle must be capable of starting, operating, and monitoring the set from distances up to 500 feet.

503.3.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

503.3.3 Procedure.

503.3.3.1 Preparation for test.

a. Remove the control cubicle from the set and connect the cubicle to the set with a 500 foot cable in accordance with instructions on the set or in the technical manual, unless otherwise specified in the procurement document.
b. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.

503.3.3.2 Test.

a. Start and operate the generator set using the remote cubicle at rated voltage, rated frequency and rated load.
b. Perform method 511. 1, Regulator Range Test.
c. Perform method 511.2, Frequency Adjustment Range Test.
d. Perform method 513.2, Indicating Instrument Test (Electrical).
e. Perform any additional method(s) specified in the procurement document.
f. Repeat steps a thru e above at any other voltage connection and frequency specified in the procurement document.
g. Shut down the set using the remote cubicle.

503.3.4 Results. Compare the results with the procurement document requirements.

503.3.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and frequency(ies) at which this method is to be performed.
b. Length of cable to the remote cubicle, if other than as specified herein.
c. Any methods to be performed not specified herein.
d. Maximum and minimum voltages between which the generator set shall perform.
e. The maximum allowable voltage regulation (droop).
f. Maximum frequency adjustment(s).

g. Minimum frequency adjustment(s).
h. The accuracy of each instrument contained in the cubicle.
i. Standard instrument calibration requirements, if different than those by MIL-HDBK-705.

TEST DATA

DESCRIPTION 15KW, 60Hz 120/208Y, 3-PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 13
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 1
MODEL NO. SF-15.0-MD	START AND STOP TEST	DATE 18 NOVEMBER, 1971
SERIAL NO. 1186	(REMOTE CUBICLE)	RECORDER L Wright
REF: MIL-STD-705/503.3		PROJ. ENGR. B Jones
		SHIFT LEADER H Smith
		OBSERVER L Lee

INST. →																	
READ NO. ↓	TIME																
UNITS	HRS																
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10:00	STARTED SET - APPLIED RATED LOAD															
	10:10	PERFORMED METHOD 511.1															
	10:30	PERFORMED METHOD 511.2															
	10:50	PERFORMED METHOD 513.2															
	11:20	SHUT DOWN SET - FROM REMOTE CUBICLE.															
NOTES:																	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 503.3-I Portion of a typical test record for start and stop test (remote cubicle).

X-4581

Stop Test.]

METHOD 504.2a

TORSIOGRAPHING TEST

504.2.1 General. Torsional vibration means the repeated twisting of a shaft, back and forth, about its axis.

If the shaft of an engine is twisted and then released, it will vibrate back and forth at a number of vibrations per second (natural frequency) which will be determined by the stiffness of the shaft and the type of weights attached to various parts of the shaft. If the shaft is left alone, these vibrations will gradually die out, but if a vibrating force is applied which rises and falls at a time rate close to the natural frequency, torsional vibration will build up and may eventually destroy the shaft. Therefore, since the turning effort of an engine varies during each revolution, it is possible to run the engine at a speed at which the frequency of the turning effort variations coincides with the natural frequency of the shaft system, thus cause torsional vibrations to build up.

Torsional vibration is different from other forms of vibration in that there may be no visible or audible indications that dangerous vibrations are present. Furthermore, an engine-generator set with dangerous torsional vibrations may not show any defects during inspection, yet shaft failure may occur after many hours of operation. It is necessary to use special instrumentation (see figures 504.2-I and 504.2-II) and compare the instrument readings with certain calculated values in order to make sure the engine-generator set is not subjected to injurious torsional vibrations. The instrumentation used shall not require attachment of masses of such a magnitude to the shaft that they appreciably affect the characteristics of the system.

The instrumentation used in torsional vibration studies is designed to measure changes in speed, not speed itself, and the frequency of these changes in speed. This can be done either mechanically or electrically.

504.2.2 Apparatus. Load instrumentation shall be as described and illustrated in MIL-HDBK-705. In addition, a suitable torsiograph instrument (see figures 504.2-I and 504.2-II or equivalent) shall be required.

504.2.3 Procedure.

504.2.3.1 Preparation for test.

a. Obtain the contractor’s mathematical analyses, indicating probable compliance with the limits of the equipment specification. The mathematical analyses shall include:

   1. A description of the system relating information pertinent to analyses such as operating speed range and identification plate data.
   2. A mass-elastic assembly drawing, showing the arrangement of the units in the generator set and dimensions of shafting, including minimum diameters (or section moduli) of all shafting in the system.

3. A labeled line diagram of the mass elastic system indicating values of masses, stiffness, equivalent lengths, and equivalent diameters including basic assumptions where applicable. See figure 504.2-III.
4. Sample calculations showing procedure used to obtain relative stress.
5. Holtzer tables for the natural frequencies of all significant modes of vibration. Table shall include calculation of equivalent stresses in each shaft length for a one degree deflection (twist) at mass no. 1.

b. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10.
c. Install the torsiograph instrument on one end of the shaft of the generator set per the instrument manufacturer’s instructions.

504.2.3.2 Test.

a. Start and operate the set at rated voltage, rated frequency (speed) and rated load. Record all instrument readings including the torsiograph output.
b. Reduce the load to zero and record all instrument readings.
c. Repeat steps a and b above for the maximum and minimum frequencies specified in the procurement document.
d. Repeat steps a and c above for any other load condition specified in the procurement document.
e. Repeat steps a thru d above for any other rated frequency specified in the procurement document.

504.2.4 Results.

a. Recalculate the Holtzer table(s) supplied by the contractor to insure that no mathematical errors exist (see figure 504.2-IV).
b. Reduce the data taken from the torsiograph instrumentation per the manufacturer’s instructions to determine both the frequency of vibration and the amount of twist in degrees for each condition specified in the procurement document.
c. Using the frequency of the torsional vibration found in step b above determine the applicable Holtzer table to use, e.g., use the first mode Holtzer table for any vibrational frequency below the first mode natural frequency; use the second mode Holtzer table for any vibrational frequency above the first mode natural frequency but below the second mode natural frequency, etc.
d. From the applicable Holtzer table determine the maximum shaft stress for a one degree deflection at mass no. 1. This will be the largest number in the summation column.
e. To determine the actual shaft stress multiply the maximum shaft stress by the actual deflection at mass no. 1 as found in step b above.
f. Repeat steps c thru e above for each load and frequency condition specified in the procurement document.
g. Tabulate the data and results into a table. See figure 504.2-V.
h. Have this data analyzed by a competent impartial agency.

504.2.5 Procurement document requirements. The following details must be specified in the individual procurement document.

a. Rated frequency (ies) at which this test shall be performed.
b. Maximum and minimum frequencies between which specified torsional stresses shall not be exceeded, in percent of rated frequency.
c. Load conditions at which this test shall be performed if other than rated load and no load.
d. Maximum allowable torsional stress in the shaft in pounds per square inch.

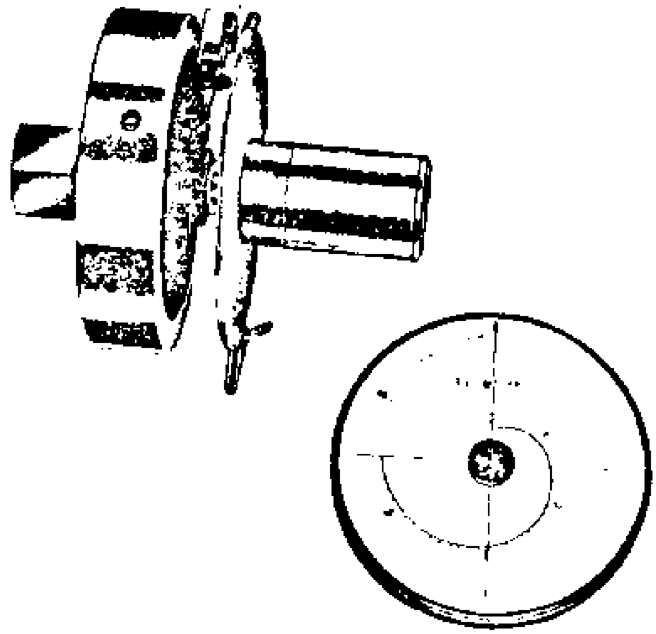


FIGURE 504.2-I REPRESENTATIVE MECHANICAL TORSIOGRAPH

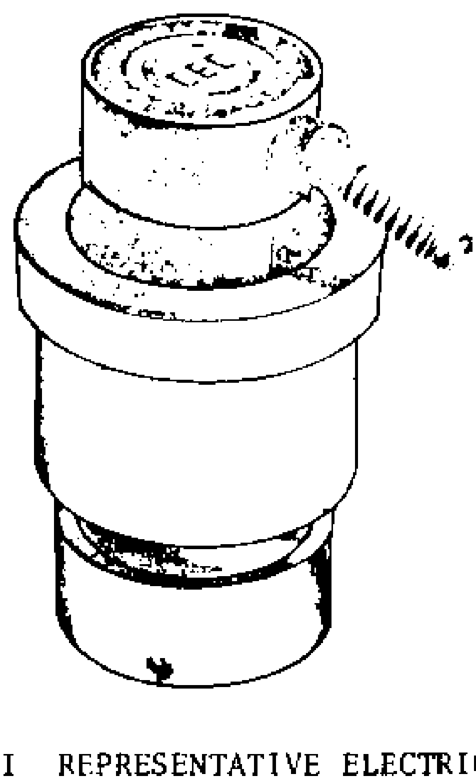


FIGURE 504.2-II REPRESENTATIVE ELECTRICAL TORSIOGRAPH

X-4582

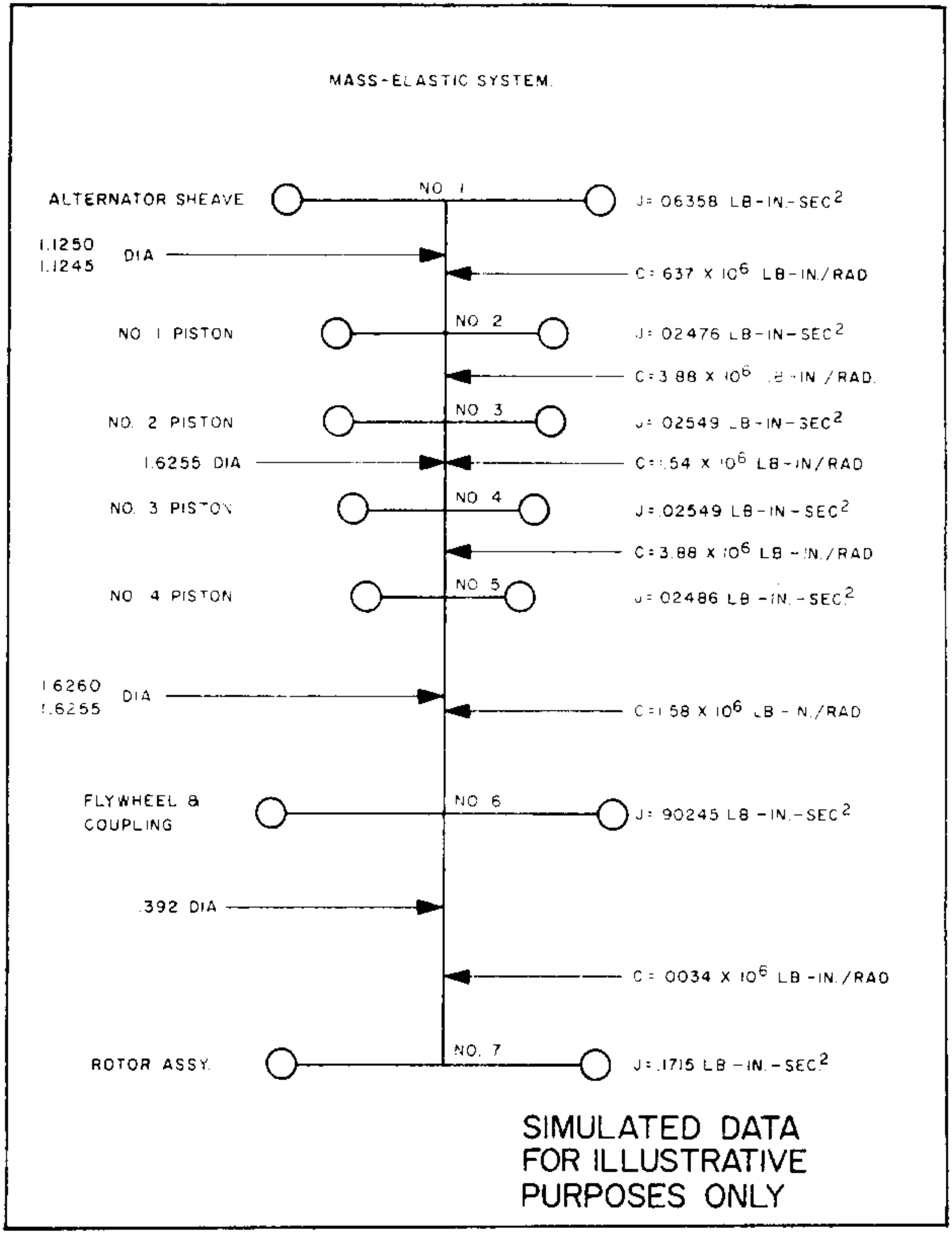


FIGURE 504.2-III. Typical mass-elastic system.

X-4583

HOLTZER TABLE

$w^2 = 4.147567463 \times 10^6$
$w = 2.036557749 \times 10^3$
$f = 324.1285066$ Hz

STATION	J	$Jw^2/10^6$	β	$Jw^2\beta/10^6$	$\Sigma Jw^2\beta/10^6$	$C/10^6$	$\Sigma Jw^2\beta/C$
1	0.06358	0.2637023393	1.0000000000	0.2637023393	0.2637023393	0.637	0.4139754149
2	0.02476	0.1026937704	0.5860245851	0.0601810742	0.3238834135	3.88	0.834751066
3	0.02549	0.1057214946	0.5025494785	0.0531302820	0.3770136955	1.54	0.2448140880
4	0.02549	0.1057214946	0.2577353905	0.0272481707	0.4042618662	3.88	0.1041912026
5	0.02486	0.1031085271	0.1535441879	0.0158317151	0.4200935813	1.58	0.2658820135
6	0.90245	3.742972257	-0.1123378256	-0.4204773646	-0.0003837833	0.0034	-0.1128774412
7	0.17150	0.7113078199	+0.0005396156	+0.0003838328	+0.0000000495	--	--

= 1.0000000000 at Sta. 1

β = (Sta. 1β - Sta. 1 $\Sigma Jw^2\beta/c$) at Sta. 2
etc.

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

FIGURE 504.2-IV TYPICAL HOLTZER TABLE

X-4584

RESULTS

ENGINE SPEED RPM	LOAD %	VIBRATION PERIOD ms X 1/3	VIBRATION FREQUENCY Hz (CAL)	VIBRATION w RAD/SEC (CAL)	VIBRATION LEVEL V(P-P)	ANGULAR DISPLACEMENT DEGREE (CAL)	TORSIONAL STRESS PSI (CAL)
3200	0	10.2	294	1848	1.2	0.0361	595
3200	100	10.2	294	1848	1.7	0.0512	843
3300	0	10.2	294	1848	0.84	0.0254	419
3300	100	9.9	303	1903	1.7	0.0496	818
3400	0	10.8	278	1745	1.0	0.0318	524
3400	100	10.2	294	1848	1.9	0.0572	943
3500	0	10.2	294	1848	1.8	0.0541	892
3500	100	9.9	303	1903	2.6	0.0758	1249
3600	0	9.6	311	1952	1.7	0.0483	796
3600	100	9.5	316	1985	2.2	0.0616	1015
3700	0	9.9	303	1903	1.3	0.0380	626
3700	100	9.9	303	1903	1.9	0.0554	913
3800	0	10.4	288	1808	1.4	0.0431	710
3800	100	9.9	303	1903	1.9	0.0554	913
3900	0	11.1	270	1695	1.5	0.0492	811
3900	100	9.9	303	1903	2.6	0.0758	1249
4000	0	9.9	303	1903	1.6	0.0467	770
4000	100	11.2	268	1682	2.3	0.0758	1249

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

FIGURE 504.2-V TYPICAL RESULTS TABULATION

X-4585

METHOD 505.1b

OVERSPEED TEST

(SET)

505.1.1 General. Since possible surging speeds during operation may injure personnel or destroy the equipment, there must be assurance that rotating parts are in balance.

505.1.2 Apparatus. A frequency meter or tachometer, as described and illustrated in MIL-HDBK-705, method 104.1 or 109.1, shall be required.

505.1.3 Procedure.

505.1.3.1 Preparation for test.

a. Connect the frequency meter or tachometer as described and illustrated in MIL-HDBK-705, method 205.1, paragraph 205.1.9, or utilize the tachometer in accordance with the manufacturer’s instructions.
b. Disconnect, or otherwise render inoperative, any overspeed protection devices, if necessary.

505.1.3.2 Test.

a. Start and operate the set at rated voltage, rated frequency (speed) and at no load.
b. By operating the throttle lever, or by any other satisfactory means, bring the speed up slowly from rated speed to the overspeed specified in the procurement document.
c. With the generator operating without load, adjust the terminal voltage, if possible, to approximately rated value. The voltmeter on the set control panel is adequate to indicate the voltage for this method.
d. Maintain the overspeed for the specified time duration and record the time of overspeed operation.
e. Record any evidence of excessive noise or increased vibration.
f. After completion of this test, reconnect any overspeed protection devices, if necessary.

505.1.4 Results. Any evidence of excessive noise or increased vibration shall require disassembly and inspection to determine the cause.

505.1.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. The overspeed at which this method is to be performed.
b. The time duration that the set is required to operate at the overspeed condition.

TEST DATA

DESCRIPTION 15KW, 60HZ
120/208 V, 3-PHASE
GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-15.0-MD

SERIAL NO. 16037

REF: MIL-STD-705/505.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

OVERSPEED TEST
(SET)

TEST NO. 36

SHEET 1 OF 1

DATE 28 SEPT, 1970

RECORDER J. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER J. Lee

INST. →		SET			3686												
READ NO. ↓	TIME	OUTPUT VOLTAGE			SPEED												
UNITS	HRS	VOLTS	VOLTS	VOLTS	RPM												
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0923	STARTED UNIT															
	0923	120	120	119	1800												
	0924	120	120	115	2350												
	0930					UNIT VIBRATING EXCESSIVELY											
	0939	120	120	115	2350												

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: REMOVAL OF THE GENERATOR ASSEMBLY REVEALED ROTOR BALANCE WEIGHT THROWN OFF.

Figure 505.1-I: Typical test record for overspeed test.

X-4586

METHOD 505.2b

OVERSPEED PROTECTIVE DEVICE TEST

505.2.1 General. To assure that adequate protection is afforded the generator set against overspeeding, the overspeed protective device must operate properly.

505.2.2 Apparatus. A frequency meter or tachometer as described and illustrated in MIL-HDBK-705, method 104.1 or 109.1 shall be required.

505.2.3 Procedure.

505.2.3.1 Preparation for test. Connect the frequency meter in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.9, or utilize the tachometer in accordance with the manufacturer's instructions. If the set is provided with an electronic governor or throttle stops, it may be necessary to deactivate these devices.

505.2.3.2 Test.

a. Start and operate the generator set at rated speed (frequency), rated voltage and no load.
b. Slowly increase the engine speed until the overspeed protective device actuates. Record the speed of the generator set at this point, and the malfunction indicator light indication, if applicable.

CAUTION: Do not operate the set in excess of 125 percent of rated speed or as otherwise limited in the procurement document.

c. If the set is equipped with a manual reset provision for the overspeed protective device, attempt to start the set. Record if starting is achieved. If the set did not start, reset the overspeed protective device.

d. Repeat steps a thru c above two additional times.

505.2.4 Results. The speed at which the overspeed protective device actuated shall be compared with the limits specified in the procurement document.

505.2.5 Procurement document requirements. The following details must be specified in the individual procurement document:

a. Speed conditions at which the overspeed protective device shall actuate.
b. Overspeed malfunction indicator requirements, if applicable.
c. Manual reset requirements, if applicable.

TEST DATA

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE
OVERSPEED PROTECTIVE DEVICE TEST

DESCRIPTION 15KW, 60Hz 120/208V 3-PHASE GENERATOR SET
MFGR. ENGENSETS, INC.
MODEL NO. SF-15.0-MD
SERIAL NO. 1716
REF: MIL-STD-705/505.2

TEST NO. 24
SHEET 1 OF 1
DATE JAN 15, 1971
RECORDER L. Wright
PROJ. ENGR. L. Jones
SHIFT LEADER R. Smith
OBSERVER L. Lee

INST. →					316	
READ NO. ↓	TIME				FREQUENCY	
UNITS					Hz	
SYM.						
COL.	1	2	3	4	5	6 7 8 9 10 11 12 13 14 15 16 17
	14:10	STARTED SET			60.0	
	14:15				67.2	OVERSPEED PROTECTIVE DEVICE ACTUATED
	14:20	ATTEMPTED TO RESTART SET - IT WOULD NOT CRANK - RESET OVERSPEED SWITCH.				
	14:25	STARTED SET			60.0	
	14:28				67.0	OVERSPEED PROTECTIVE DEVICE ACTUATED.
	14:30	ATTEMPTED TO RESTART SET - IT WOULD NOT CRANK - RESET OVERSPEED SWITCH.				
	14:35	STARTED SET			60.0	
	14:40				67.1	OVERSPEED PROTECTIVE DEVICE ACTUATED
	14:42	ATTEMPTED TO RESTART SET - IT WOULD NOT CRANK - RESET OVERSPEED SWITCH				

NOTES:

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 505.2-I: Typical test record for overspeed protective device test.

X-4587

Device Test.]

METHOD 505.3c

OVERSPEED TEST

(GENERATOR ONLY)

505.3.1 General. Unbalanced rotating assemblies during possible surging speeds may injure personnel, or damage or destroy the equipment; there be assurance that rotating parts are properly balanced.

505.3.2 Apparatus. A voltmeter and frequency meter or tachometer as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 or 109.1 shall be required. A variable speed prime mover capable of driving the generator at the specified overspeed at no load, and an external dc source for excitation shall also be required.

505.3.3 Procedure.

505.3.3.1 Preparation for test.

a. Mechanically connect the generator to the prime mover and connect the external excitation supply to the generator.
b. Connect the voltmeter to any suitable terminals of the generator as described and illustrated in MIL-HDBK-705, method 205.1, paragraph 205.1.4.
c. Connect the frequency meter as described and illustrated in MIL-HDBK-705, method 205.1, paragraph 205.1.9, or utilize the tachometer in accordance with the manufacturer's instructions.

505.3.3.2 Test.

a. Start and operate the prime mover so that the generator is operating at rated frequency (speed), and adjust the external excitation supply to produce rated voltage.
b. By operating the prime mover controls, increase the speed of the generator slowly from rated to the specified overspeed.
c. With the generator operating without load, adjust the coil voltage to approximately rated voltage, if necessary.
d. Maintain the overspeed condition for 15 minutes or for the time interval specified in the procurement document. Record any indications of increased vibration or noise.
e. Stope the prime mover and generator, and visually inspect the generator for evidence of destruction, injury or noticeable change to any part.

505.3.4 Results. Any evidence of increased noise or vibration or any evidence of destruction, injury or noticeable change in any part after shutdown shall be recorded on the data sheet.

505.3.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The speed at which this method shall be performed.
b. The time duration that the generator is required to operate at the condition, if other than 15 minutes.

TEST DATA

DESCRIPTION 15 KW 60HZ 120V SINGLE PHASE GENERATOR ONLY

MFGR. ENGENSETS, INC.

MODEL NO. SF-15.0-MD

SERIAL NO. 16037-G

REF: MIL-STD-705/505.3

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

OVERSPEED TEST

(GENERATOR ONLY)

TEST NO. 3

SHEET 1 OF 1

DATE 26 OCTOBER 1970

RECORDER L. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER [illegible]

INST. →		107		316													
READ NO. ↓	TIME	TERMINAL VOLTAGE		FREQUENCY													
UNITS	HRS		VOLTS		HZ												
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10:15		120.0		60.0												
	10:17		120.0		75.0												
	10:32		120.0		75.0												

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: NO NOTICEABLE INCREASE IN VIBRATION LEVELS DURING TEST
NO EVIDENCE OF DAMAGE AFTER TEST

Figure 505.3-I: Typical test record for overspeed test (generator only).

X-4588

(generator only).]

METHOD 506.1b

UNDERSPEED PROTECTIVE DEVICE TEST

506.1.1 General. The underspeed protective device protects both the generator and the load against a speed (frequency) that is below acceptable limits. Operating a generator set at a speed that is below design limits can cause excessive field currents, inability to carry rated load, and damage to frequency sensitive loads such as motors, motor operated equipment, and transformers.

506.1.2 Apparatus. Load instrumentation shall be as described and illustrated in MIL-HDBK-705.

506.1.3 Procedure.

506.1.3.1 Preparation for test. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.

506.1.3.2 Test.

a. Start and operate the set at rated voltage and rated speed at no load.
b. Close the circuit interrupter.
c. Slowly decrease the speed from rated, recording the speed at which the underspeed protective device causes the circuit interrupter to open. (See figure 506.1-I). If the set is equipped with a low frequency (speed) malfunction indicator, record its indication.
d. Return the speed to rated and apply rated load.
e. Slowly decrease the speed from rated and record the speed at which the underspeed protective device causes the circuit interrupter to open. If the set is equipped with a low frequency (speed) malfunction indicator, record its indication.
f. Attempt to reclose the circuit interrupter with the set at this underspeed condition and record if circuit interrupter actuation was possible.
g. If the generator set is equipped with an electrical type underspeed protective device repeat steps a thru f above with the set operating at the maximum and minimum specified voltage operating range limits.
h. Repeat steps a thru g above for any other rated speed specified in the procurement document.

506.1.4 Results. The underspeed protective device actuation shall be compared with the requirements specified in the procurement document.

506.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage connection(s) at which this method shall be performed.
b. The speed at which the underspeed protective device shall actuate for each frequency condition.
c. The frequency(ies) at which this method shall be performed.
d. The voltage operating limits, if applicable.
e. Circuit interrupter non-closure requirements at underspeed conditions.
f. Malfunction indicator requirements, if applicable.

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

UNDERSPEED PROTECTIVE DEVICE TEST

DESCRIPTION 15 KW, 60 Hz 120V, SINGLE-PHASE GENERATOR SET
MFGR. ENGENSETS, INC.
MODEL NO. SF-15.0-MD
SERIAL NO. 11718
REF: MIL-STD-705/506.1

TEST NO. 61
SHEET 1 OF 1
DATE JAN 15, 1971
RECORDER L Wright
PROJ. ENGR. J Jones
SHIFT LEADER B Smith
OBSERVER L Doe

INST. →		377	153		217		706	208		1076
READ NO. ↓	TIME	TERM VOLT.	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ		AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	Hz		°F
SYM.			X40	X1	X40	X1				
COL.	1	2	3	4	5	6	7	8	9 10 11 12 13 14 15 16	17
	0912	STARTED SET								
	0912	180.0	0	0	0	0	—	60.0	CIRCUIT INTERRUPTER CLOSED	73
	0913							56.3	UNDERSPEED PROTECTIVE DEVICE ACTUATED	
									LOW FREQ. LIGHT ON	
	0914							60.0	RETURNED SPEED TO RATED AND CLOSED	
									CIRCUIT INTERRUPTER.	
	0916	APPLIED RATED LOAD								
	0917	120.0	3.9	156	.375	15.0	0.80	60.0		74
	0918							56.4	UNDERSPEED PROTECTIVE DEVICE ACTUATED	
									LOW FREQ LIGHT ON	
	0920							56.4	COULD NOT RECLOSE CIRCUIT INTERRUPTER	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. No. 1038

Figure 506.1-I: Typical test record for underspeed protective device test.

-2-

X-4589

Device Test.]

METHOD 507.1d

PHASE SEQUENCE TEST
(ROTATION)

507.1.1 General. Unless the phase sequence (rotation) of the load terminals of a three-phase generator set is correct, serious damage or injury could be done to connected equipment and to personnel as a result of reversed motor rotation or excessive current surges.

507.1.2 Apparatus. A phase sequence (rotation) indicator as described and illustrated in MIL-HDBK-705, method 116.1 or a three-phase motor whose direction of operation in relation to phase sequence is known shall be required.

507.1.3 Procedure.

a. Connect the generator set load terminals to the applicable test apparatus for one of the set three-phase voltage connections. Recheck the connections to insure that L_1, T_2, and L_3 of the generator set are connected to L_1, T_2, and L_3 of the test apparatus respectively.
b. Start and operate the generator set at rated voltage and frequency. The set indicating instruments shall be sufficient indication of voltage and frequency.
c. Close the circuit interrupter and determine the direction of phase sequence (rotation) by observing the indicator, or by noting the direction of rotation if a three-phase motor is used. Record results (see figure 507.1-I).
d. Check the phase sequence (rotation) of the power output of each receptacle on the generator set by connecting the applicable test apparatus to that receptacle and repeating steps a thru c above.
e. Repeat steps a thru d above for all other three-phase voltage output connections of the generator set.

507.1.4 Results. The phase sequence (rotation) as indicated by the test shall be checked against the set wiring diagram and the requirements of the procurement document.

507.1.5 Procurement document requirements. The following detail must be specified in the procurement document:

a. Phase sequence (rotation).

TEST DATA

DESCRIPTION 10 KW, 60 Hz 120/208V OR 120V 3-PHASE, GEN SET

MFGR. ENGENSETS, INC

MODEL NO. SE-10.0-MD

SERIAL NO. 21067

REF: MIL-STD-705/507.1

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

PHASE SEQUENCE
(ROTATION)

TEST NO. 62

SHEET 1 OF 1

DATE 24 AUGUST 1970

RECORDER [illegible]

PROJ. ENGR. [illegible]

SHIFT LEADER [illegible]

OBSERVER [illegible]

INST. →		PHASE INDICATOR #1376															
READ NO. ↓	TIME																
UNITS																	
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10:15	120/208 V WYE				PHASE SEQUENCE				L_1-L_2-L_3							
	10:45	120 V DELTA			PHASE SEQUENCE				L_1-L_2-L_3								

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

NOTES:

SMEFB Form 28
16 Sep 69

FIGURE 507.1-I TYPICAL TEST RECORD FOR PHASE SEQUENCE TEST

X-4590

MIL-STD-705C

METHOD 508.1d

PHASE BALANCE TEST

(VOLTAGE)

508.1.1 General. Polyphase electrical equipment may not operate properly or may be damaged if the phase voltages of a polyphase generator differ greatly from each other. Also, large differences between the phase voltages of a polyphase generator may be an indication that the generator set has been improperly manufactured or damaged.

508.1.2 Apparatus. A frequency meter (or tachometer) as described and illustrated in MIL-HDBK-705, method 104.1 (or 109.2) and a rms indicating ac voltmeter having an accuracy of +/- 0.1 percent of the reading (or better) shall be required to perform both procedures. If load is required in procedure I, instrumentation for measuring load conditions shall be described and illustrated in MIL-HDBK-705. A means of separately exciting the generator will be required if 508.1.3.2, procedure II, is performed.

508.1.3 Procedure.

508.1.3.1 Procedure I. (Generator with Exciter and Voltage Regulator)

508.1.3.1.1 Preparation for test.

a. Connect the generator set for one of the voltage connections and frequencies specified in the procurement document.
b. Connect the frequency meter to the generator output.
c. The same voltmeter shall be used to measure all ac output voltages.

508.1.3.1.2 Test.

a. Start and operate the generator set at no load.
b. Adjust a regulated phase voltage (line-to-neutral) to rated voltage.
c. Read and record the generator frequency, all line-to-neutral voltages, and all line-to-line voltages.
d. Repeat steps a thru c above at each of the other voltage connections and frequencies specified in the procurement.
e. If additional load conditions, other than no load, are specified in the procurement document, repeat steps a thru d above for all specified load conditions maintaining balanced loads (both resistive and reactive).

508.1.3.2 Procedure II. (Generator with separate excitation).

508.1.3.2.1 Preparation for test.

a. Completely isolate the generator windings (armature coils and field winding).
b. Connect the frequency meter to one of the armature coils of the generator.

c. Provide separate excitation for the generator. For generators with static exciters, excite the generator field; for brushless generators, energize the exciter field.

508.1.3.2.2 Test.

a. Start and operate the generator at one of its rated frequencies (speeds) and at no load.
b. Adjust the excitation so that any one of the coil voltages is at rated value.
c. Read and record the generator frequency (speed) and the voltage of each armature coil (see figure 508.1-I).
d. Repeat steps a thru c above for any other specified frequency.

508.1.4 Results.

508.1.4.1 Generator with exciter and voltage regulator: (procedure I).

a. From the data obtained in 508.1.3.1.2, determine the maximum and minimum line-to-neutral voltages for one voltage, frequency and load condition.
b. Line-to-neutral voltage unbalance, in percent, is the difference between the maximum voltage (V max) and minimum voltage (V min) determined in step a above divided by the rated line-to-neutral voltage (V rated) (at the voltage connection used) and multiplied by 100.

$$\text{Voltage Unbalance (L-N), in percent} = \frac{\text{V max} - \text{V min x 100}}{\text{V rated}}$$

c. Repeat steps a and b above substituting line-to-line voltages for line-to-neutral voltages.
d. Repeat steps a thru c above for each voltage connection, frequency and load condition.
e. Compare the results of steps b thru d above with the requirements of the procurement document.

508.1.4.2 Generator with separate excitation: (Procedure II)

a. Determine from the data obtained in 508.1.3.2.2, the maximum and minimum coil voltages.
b. The voltage unbalance is the difference between the maximum armature coil voltage (V max) and minimum armature coil voltage (V min). To express this in percent divide this difference by rated armature coil voltage (V rated) and multiply by 100.

$$\text{Voltage Unbalance (Coil), in percent} = \frac{\text{V max} - \text{V min x 100}}{\text{V rated}}$$

c. Repeat steps a and b above for any other specified frequency.
d. Compare the results of steps b and c above with the requirements of procurement document.

508.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Requirement as to whether the procedure of 508.1.3.1 or 508.1.3.2 or both shall be performed.

508.1.5.1 Procedure I.

a. Maximum allowable line-to-neutral voltage unbalance, in percent of rated line-to-neutral voltage.
b. Maximum allowable individual line-to-line voltage unbalance, in percent of rated line-to-line voltage, if required.
c. Load conditions if other than no load at which this method is to be performed.
d. Voltage connection(s) and frequency(ies) at which this method is to be performed.

508.1.5.2 Procedure II.

a. Maximum allowable individual armature coil voltage unbalance in percent of rated armature coil voltage or maximum allowable voltage difference between armature coils.
b. Frequency(ies) at which this method is to be performed.

TEST DATA

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

PHASE BALANCE
(VOLTAGE)

DESCRIPTION 10KW, 60HZ 120/208V - 3-PHASE WYE GEN SET
MFGR. ENGENSGTS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 4097
REF: MIL-STD-705/508.1

TEST NO. 7
SHEET 1 OF 1
DATE 2 NOV., 1970
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. See

INST. →		1306			1307				312								916
READ NO.	TIME	TERM. VOLTAGE			TERM. VOLTAGE				FREQUENCY		VOLTAGE UNBAL. L-N	VOLTAGE UNBAL. L-L					AVG AMB TEMP
		L_1-L_0	L_2-L_0	L_3-L_0	L_1-L_2	L_2-L_3	L_3-L_1										
UNITS		VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS			HZ	%	%					°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0815	START GEN.		SET													
	0820	120.0	120.1	119.9	207.8	208.0	208.1			60.0	0.17	0.14					
	0830	120.0	120.1	119.9	207.8	208.0	208.1			60.0	0.17	0.14					
	0835	120.0	120.1	119.9	207.8	208.0	208.1			60.0	0.17	0.14					

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

SMEFB Form 28
16 Sep 69

FIGURE 508.1-I TYPICAL TEST RECORD FOR PHASE BALANCE (VOLTAGE) TEST (PROCEDURE I)

X-4591

Test (Procedure I).]

METHOD 509.1b

CIRCULATING CURRENT TEST

509.1.1 General. Excessive circulating current will shorten the useful life of the generator.

509.1.2 Apparatus. Instrumentation for measuring voltage, current and frequency shall be as described and illustrated in MIL-HDBK-705.

509.1.3 Procedure.

509.1.3.1 Preparation for test.

a. Connect the voltage and frequency instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 to measure all line-to-line and line-to-neutral voltages.
b. Connect the necessary ammeters, for the applicable voltage and winding configuration, in accordance with figure 509.1-I.

509.1.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency, frequency, and at no load.
b. Record all instrument readings (see figure 509.1-II).

509.1.4 Results. Compare the results with the procurement document requirements.

509.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and frequency(ies) at which this method is to be performed.
b. Allowable circulating currents.

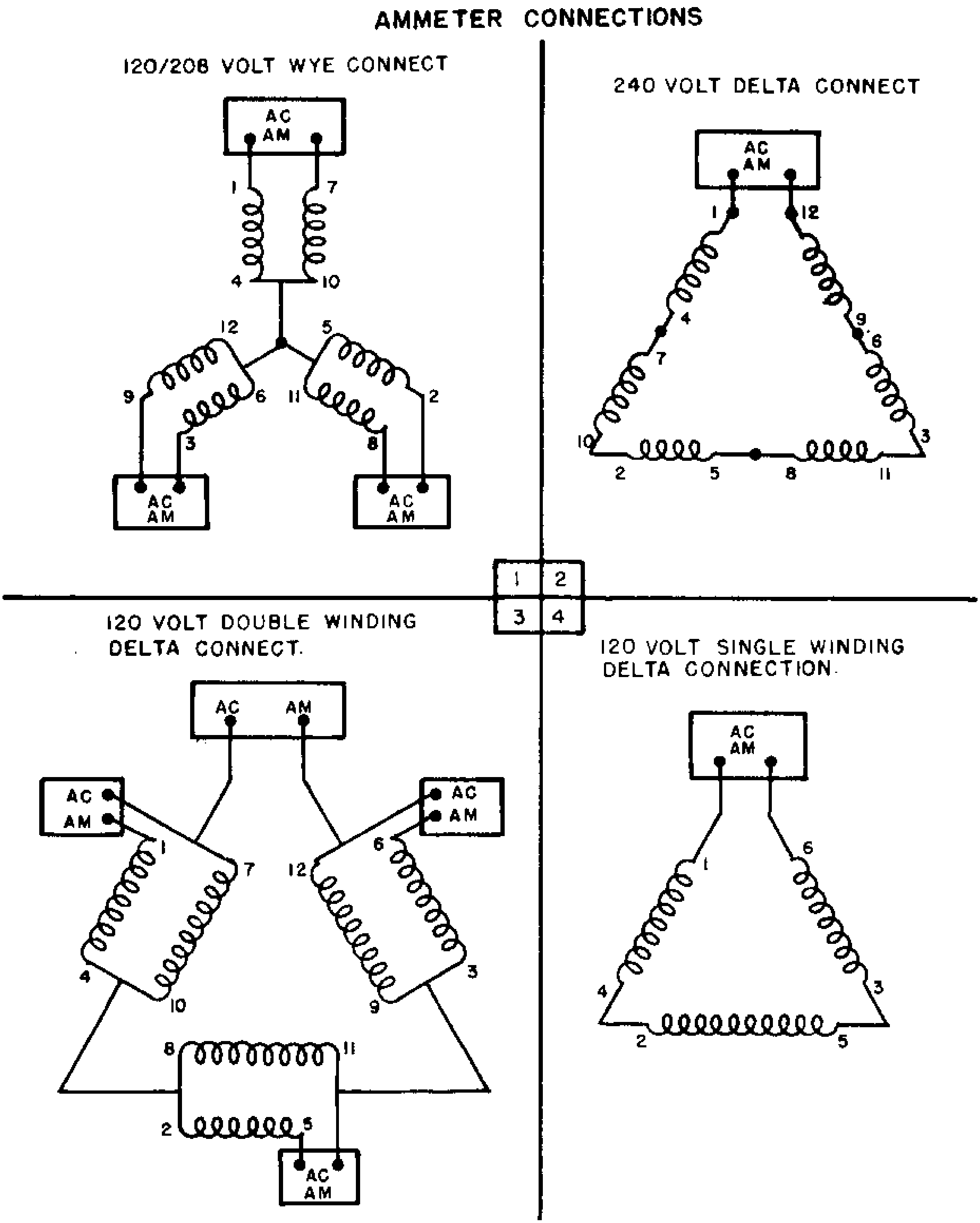


FIGURE 509.1–I. *Apparatus hookup for circulating current test.*

TEST DATA

DESCRIPTION 3KW 60HZ 120V 3-PHASE-DELTA GENERATOR SET
MFGR. ENGENSETS, INC
MODEL NO. SF-3.0-MD
SERIAL NO. 10779
REF: MIL-STD-705/509.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE
CIRCULATING CURRENT TEST

TEST NO. 12
SHEET 1 OF 1
DATE APRIL 13, 1971
RECORDER J Wright
PROJ. ENGR. J Jones
SHIFT LEADER H Smith
OBSERVER W. Cox

INST. →		107			211		487										1076
READ NO. ↓	TIME	TERMINAL VOLTAGE L_1-L_2	L_2-L_3	L_3-L_1	CIRCULATING CURRENT		FREQUENCY										AVG AMB TEMP
UNITS	HRS	VOLTS	VOLTS	VOLTS		AMPS		Hz									°F
SYM.						X1											
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:10	STAR	TED	SET													
	09:15	120.0	119.8	120.2		1.78		60.0									77

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

FIGURE 509.1-II. Typical test record for circulating current test.

X-4594

Test.]

METHOD 510.1d

RHEOSTAT RANGE TEST

510.1.1 General. The manual field or manual control rheostat provided with the generator set must have adjustment capable of varying the excitation to compensate for the inherent voltage regulation of the generator. It must also be capable of proven an operating voltage other than rated voltage for special types of equipment and it must be capable of compensating for voltage drop on the distribution system.

510.1.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705. Electrical instrumentation used for this test shall have an accuracy of +/- 0.5 percent of reading or better.

510.1.3 Procedure.

510.1.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Render the voltage regulator inoperative by positioning the "manual-automatic voltage regulation selector switch"at the "MANUAL" position.

510.1.3.2 Test.

510.1.3.2.1 No load.

a. Start and operate the generator set at rated speed.
b. Adjust the manual field rheostat such that the terminal voltage is at the minimum specified voltage at no load. Record all instrument readings.
c. Adjust the manual field rheostat such that the terminal voltage is at the specified voltage at no load. Record all instrument readings.

510.1.3.2.2 Rated load.

a. With the generator set operating at no load adjust the manual field rheostat such that the terminal voltage is at the minimum specified voltage.
b. Increase the load, adjust the voltage, speed and load until the set is operating at rated load, rated speed and at the minimum specified voltage. Record all instrument readings (see figure 510.1-I).

   NOTE: At this point the set will be carrying greater than rated current.

c. Reduce the voltage to the minimum possible value using the manual field rheostat. Next, remove the load.

d. With the generator operating at no load, adjust the manual field rheostat such that the terminal voltage is at the maximum specified voltage.

e. Increase the load, adjust the voltage, speed and load until the set is operating at rated load, rated speed and at the maximum specified voltage. Record all instrument readings.

NOTE: At this point the set will be carrying less than rated current.

f. Reduce the voltage to the minimum possible value using the manual field rheostat. Next remove the load.

CAUTION: The voltage be reduced prior to removing the load to avoid possible voltages that will damage the set and the apparatus.

510.1.4 Results. Compare the recorded results with the procurement document requirements.

510.1.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. The voltage connection(s) and frequency(ies) at which this method is to be performed.

b. The maximum and minimum voltages for each voltage connection and frequency.

TEST DATA

DESCRIPTION 100KW, 60HZ 120/208V, 3-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-100.0-MD

SERIAL NO. 116

REF: MIL-STD-705/510.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

RHEOSTAT RANGE TEST

TEST NO. 6

SHEET 1 OF 1

DATE FEBRUARY 16, 1971

RECORDER L. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER L. See

INST. →		107						218			456				319	676	1076
READ NO. ↓	TIME	TERMINAL VOLTAGE						LINE CURRENT			OUTPUT POWER				POWER FACTOR	FREQ	AVG AMB TEMP
		L_1-L_0	L_2-L_0	L_3-L_0	L_1-L_2	L_2-L_3	L_3-L_1	L_1	L_2	L_3	L_1	L_2	L_3	TOTAL			
UNITS	HRS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	KW	KW	KW	—	HZ	°F
SYM.								X80	X80	X80	X80	X80	X80	X1			
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0810	STARTED SET															
	0812	114.0	114.0	114.0	198.0	198.0	198.0	0	0	0	0	0	0	0	—	60.0	77
	0815	126.0	126.0	126.0	218.0	218.0	218.0	0	0	0	0	0	0	0	—	60.0	77
	0830	114.0	114.0	114.0	198.0	198.0	198.0	4.66	4.66	4.66	.416	.416	.416	100.0	.80	60.0	78
	0850	124.0	124.0	124.0	215.0	215.0	215.0	4.19	4.19	4.19	.416	.416	.416	100.0	.80	60.0	78
		VOLTAGE ADJUST RHEOSTAT AT MAXIMUM															

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. L_1 - No 1376; L_2 - 1377; L_3 - 1378

Figure 510.1-II Typical test record for rheostat range test.

METHOD 511.1d

REGULATOR RANGE TEST

511.1.1 General. The voltage adjust device associated with the voltage regulator provided with the generator set must have adjustment capable of varying the regulated voltage throughout the limits and under the various load conditions and temperature ranges without causing the voltage droop of the set to exceed specification limits. The voltage adjust device also must be capable in some cases of providing an operating voltage other than rated voltage for special types of equipment and to compensate for external line drop.

NOTE: The Regulator Range Test is required by the Indicating Instrument Test (method 513.1). If method 513.1 is to be performed, a separate regulator range test is not required.

511.1.2 Apparatus. Instrumentation for measuring load conditions, ambient temperature, and the generator field (or exciter field) voltage and current shall be as described and illustrated in MIL-HDBK-705. Electrical instrumentation used for this test shall have an accuracy of +/- 0.5 percent of reading or better.

511.1.3 Procedure.

511.1.3.1 Preparation for the test.

a. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
b. By-pass the circuit interrupter, if necessary, except on sets equipped with overvoltage and undervoltage protection devices.

511.1.3.2 Test.

a. Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustment.

Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made. If this test is performed immediately following another test which has established stabilization values, stabilization will be considered valid once all the previously established values and operating parameters are obtained. (Initial stabilization readings therefore must include all values needed for subsequent testing).

NOTE: Operation of the set must not be interrupted between this test and the test that established stabilization values.

b. No further adjustments shall be made to any set control for the remainder of this test except the control panel voltage adjust device.
c. Record all instrument readings (figure 511.1-I).
d. Remove load.
e. Record all instrument readings (after transients have subsided).
f. Adjust the terminal voltage to the maximum specified value.
g. Record all instrument readings.

NOTE: At voltages above rated values, the generator will be supplying less than rated current; and at voltages below rated values, the generator will be supplying greater than rated current. Caution should be taken to avoid damage to instrumentation and load banks.

h. Apply rated load (rated kW at rated power factor).
i. Record all instrument readings (after transients have subsided).
j. Remove load and adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device. (The voltage adjust device should be at the mechanical stop or end of rotation).
k. Record all instrument readings (after transients have subsided).
l. Apply rated load.
m. Record all instrument readings (after transients have subsided).
n. Adjust voltage to the minimum specified value at rated load.
o. Record all instrument readings (after transients have subsided).
p. Remove load.
q. Record all instrument readings (after transients have subsided).
r. Adjust voltage to the minimum attainable value or the value just prior to activation of the undervoltage protection device. (The device should be at the mechanical stop or end of rotation).
s. Record all instrument readings (after transients have subsided).
t. Repeat steps a thru s above for any other voltage connection(s) and frequency(ies) specified in the procurement document.

511.1.4 Results. The data sheets shall indicate the voltage regulation as a percent of rated voltage within the specified limits at the minimum and maximum specified voltages and the regulation as a percent of rated voltage at the extremes, the maximum and minimum voltages attainable and the actuation of the protection devices (if applicable). Compare these results with the procurement document requirements.

511.1.4.1 Sample calculations. Voltage regulation (droop) expressed in percent, is defined for the purposes of this method as the no-load value minus the rated load value divided by the rated load value.

$$\text{Percent Regulation} = \frac{(\text{No-Load Voltage}) - (\text{Rated-Load Voltage})}{(\text{Rated-Load Voltage})} \times 100$$

511.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum and minimum voltages between which the generator set shall perform.
b. The maximum allowable regulation (droop).
c. The voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Load conditions at which this method is to be performed, if other than those specified herein.
e. Minimum and maximum voltage adjustments, if applicable.

TEST DATA

DESCRIPTION 10KW, 60HZ
120V, SINGLE-PHASE
GEN SET
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 21067
REF: MIL-STD-705/511.1

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

REGULATOR RANGE TEST

TEST NO. 9
SHEET 1 OF 1
DATE 7 DECEMBER, 1970
RECORDER
PROJ. ENGR.
SHIFT LEADER
OBSERVER

INST. →			377		153			217			706		809		342	115	912
READ NO. ↓	TIME		TERM. VOLTAGE		LINE CURRENT			POWER OUTPUT			POWER FACTOR		FREQ	VOLT REG.	EXCITER FIELD		AVG. AMB TEMP
UNITS	HRS		VOLTS		AMPS	AMPS		KW	KW		—		HZ	%	VOLTS	AMPS	°F
SYM.					X40	X1		X40	X1							X.02	
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	2013		120.0		2.60	104.0		0.250	10.0		0.80		60.1		8.1	48.2	76
2			121.6		0	0		0	0		—		61.2	1.33	3.1	19.0	
3			126.0		0	0		0	0		—		61.2		3.4	20.0	
4			124.3		2.51	120.4		0.250	10.0		0.80		60.8	1.37	8.5	50.0	
5			137.8		0	0		0	0		—		62.0		4.5	26.0	
6			135.2		2.31	92.4		0.250	10.0		0.80		60.8	1.42	10.0	58.0	
7			114.0		2.74	109.6		0.250	10.0		0.80		60.0		8.1	48.0	
8			115.5		0	0		0	0		—		61.8	1.31	3.0	16.0	
9			107.1		0	0		0	0		—		61.8		2.3	13.0	77

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: EXCITER FIELD MEASURED USING 2 AMPERE 50 mV SHUNT # 1076
CT # 1136

SMEFB Form 28
16 Sep 69

FIG. 511.1-I. PORTION OF A TYPICAL TEST RECORD FOR REGULATOR RANGE TEST.

Range Test.]

METHOD 511.2c

FREQUENCY ADJUSTMENT RANGE TEST

511.2.1 General. It is necessary that the frequency of a generator set be adjustable to provide rated frequency at various load conditions as required in certain applications and to synchronize two or more generators for parallel operation.

511.2.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

511.2.3 Procedure.

511.2.3.1 Preparation for test. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10.

511.2.3.2 Test.

a. Start and operate the generator set at one of the voltage connections and frequencies specified in the procurement document and allow it to stabilize at rated load, rated voltage and rated frequency. During this period, readings of the load and field instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to voltage and frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency shall be noted on the data sheet at the time of adjustment. Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current reading of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last load, voltage or frequency adjustment has been made. If this test is performed immediately following another test which has established stabilization values, stabilization will be considered valid once all the previously established values and operating parameters are obtained. (Initial stabilization readings therefore include all values needed for subsequent testing).

   NOTE: Operation of the set must not be interrupted between this test and the test that established stabilization values.

b. No further adjusts shall be made to any set control for the remainder of this test except for the control panel frequency adjust device.
c. For each of the conditions in the following steps allow approximately 2 minutes between each adjustment and the subsequent instrument readings.
d. Adjust the generator set frequency for the specified maximum frequency at rated load. Read and record all instrument readings.
e. Adjust the generator set frequency for the specified minimum frequency at rated load. Read and record all instrument readings.
f. Reduce the load to zero.
g. Slowly adjust the generator set frequency control for the maximum attainable frequency. Read and record all instrument readings. During this adjustment carefully observe the frequency meter and record the frequency at which the overspeed device alarms and actuates, if so equipped. (Note: Maximum attainable frequency adjustments are not applicable to generator sets that utilize a threaded shaft and lock nut(s) or other mechanical means as a method of operator speed adjustment.)
h. Slowly adjust the generator set frequency control for the minimum attainable frequency. Read and record all instrument readings. On sets with protection devices, read and record all readings just prior to point of actuation if the underfrequency or underspeed protection device actuates. Record on the data sheet whether the protection device actuated. (Note: Minimum attainable frequency adjustments are not applicable to generator sets that utilize a threaded shaft and lock nut(s) or other mechanical means as a method of operator speed adjustment.)
i. Repeat 511.2.3.1 and 511.2.3.2 a thru h for each frequency specified in the procurement document.

511.2.4 Results. The data sheet shall show the maximum and minimum frequencies attained at rated load, the maximum and minimum attainable frequencies at no load and actuation of the protection devices (if applicable). Compare these results with the requirements of the procurement document.

511.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum frequency adjustment(s).
b. Minimum frequency adjustment(s).
c. Generator set voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Load conditions at which this method is to be performed if other than those specified herein.
e. Protective device actuation requirements.

TEST DATA

DESCRIPTION 10KW ENG-GEN SET, 120V, 1Ø, 0.8 pf 60Hz GEN SET

MFGR. ENGENSET, INC.

MODEL NO. SF-10.0-MD

SERIAL NO. 4097

REF: MIL-STD-705A/TS11.2b

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

FREQUENCY ADJUSTMENT RANGE

TEST NO. 10

SHEET 1 OF 1

DATE 8 JULY, 1970

RECORDER J. Katten

PROJ. ENGR. M. J. Fox

SHIFT LEADER David Brenner

OBSERVER Y. ... Kho

INST. →			377		153			217			809		706		342	118	918
READ NO. ↓	TIME		TERM VOLT		LINE CURRENT			POWER OUTPUT			FREQ		POWER FACTOR		EXCITER FIELD		AVG. AMB TEMP
UNITS			VOLTS		AMPS	AMPS		KW	KW		HZ				VOLTS	AMPS	°F
SYM.					X40	X1		X40	X1		X1		X1		X1	X.02	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
101	0900	STARTED UNIT APPLIED RATED LOAD															
102	0910		120.0		2.60	104.0		0.250	10.0		60.2		0.80		7.6	48.0	76
103	0920		120.4		2.62	105.0		0.251	10.04		60.3		0.796		7.8	48.4	77
104	0930		120.4		2.62	105.0		0.251	10.04		60.3		0.796		7.9	48.4	77
105	ADJUSTED LOAD, VOLTAGE, AND FREQUENCY TO RATED																
106	0940		120.0		2.60	104.0		0.250	10.0		60.0		0.80		8.0	48.2	78
107	0950		120.0		2.60	104.0		0.250	10.0		60.0		0.80		8.1	48.2	78
108	1000		120.0		2.60	104.0		0.250	10.0		60.0		0.80		8.1	48.2	78
109	1010		120.0		2.60	104.0		0.250	10.0		60.0		0.80		8.1	48.2	77
110	1020		120.0		2.60	104.0		0.250	10.0		60.0		0.80		8.1	48.2	77
111	1025		120.0		2.60	104.0		0.250	10.0		[illegible]		0.80		7.6	46.3	77
112	1030		120.0		2.60	104.0		0.250	10.0		[illegible]		0.80		8.4	51.[illegible]	77
	1035	DROPPED LOAD AND SHUT UNIT DOWN															

NOTES: NO MECHANICAL STOPS ON THIS UNIT - STEPS (g) AND (h) OMITTED

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 511.2-I. Typical test record for frequency adjustment range.

X-4596

Range.]

METHOD 512.1d

CIRCUIT INTERRUPTER TEST
(SHORT CIRCUIT)

512.1.1 General. A circuit interrupter is connected between the generator voltage reconnection system and the generator set output terminals to disconnect the generator output from the load and also to protect the generator from a short circuit. The circuit interrupter is operated from a current sensor either internal or external to the interrupter.

512.1.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a non-inductive shunt, a short-circuiting switch, an oscilloscope with galvanometer matching networks as described and illustrated in MIL-HDBK-705, method 106.1, paragraph 106.1.3 and galvanometers having a flat frequency response (flat within plus or minus five percent) from dc to 3,000 hertz will be required.

512.1.3 Procedure.

512.1.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
b. Connect the shunt, galvanometer matching network, oscillograph, and short-circuiting switch as illustrated in figure 512.1-I.

512.1.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency and rated load.
b. Set the oscillograph time marker to a minimum of 0.01 seconds or use a 60 hertz timing trace.

    1. For ac generators set the chart speed such that the individual peaks of the current waveform are clearly visible and adjust the peak-to-peak rated current amplitude to a minimum of 0.5 inch (or approximately 12 millimeters).
    2. For dc generators set the chart speed such that the timing markers or timing trace is clearly visible and adjust the no load-rated load trace excursion to at least 0.5 inch (or approximately 12 millimeters).

c. Prior to closing the short-circuiting switch, record a portion of the steady state load current for calibration. With the same load conditions record all instrument readings.
d. With the oscillograph still recording the steady state current, close the short-circuiting switch.

CAUTION: If the circuit interrupter fails to operate within the specified time, remove the short circuit to prevent damage. Note the failure to operate on the data sheet.

e. If the generator set contains a short-circuit malfunction indicator, check and record its indication.
f. Should the generator set control circuitry contain a specified time delay to prevent the circuit interrupter from operating on short duration faults, the circuitry shall be checked as follows:

    1. Open the short-circuiting switch and reapply rated load.
    2. Operate the oscillograph as in b above.
    3. Momentarily close and open the short-circuiting switch, being certain that the switch is not closed for a period of time equal to or greater than the specified time delay.
    4. Record on the data sheet if the circuit interrupter operated and the indication of the malfunction indicator (if applicable).

g. Repeat steps a thru f above for each possible short circuit condition ($L_1 - L_0$, $L_2 - L_3$, $L_1 - L_2 - L_3$, etc.). Allow the generator set to cool at rated load for a minimum of 15 minutes between short circuits.
h. Repeat steps a thru g above for each voltage connection and frequency specified in the procurement document.

512.1.4 Results.

a. From the oscillograms taken in 512.1.3.2d, determine the time between the indicated closure of the short-circuiting switch and the opening of the circuit interrupter (see figure 512.1-II).
b. Calculate the short-circuit current using the peak-to-peak amplitudes of the current trace and the steady state water reading prior to application of the short circuit load (see figure 512.1-II).
c. For sets having a time delay, use the oscillograms taken in 512.1.3.2f and determine if the circuit interrupter actuated upon application of the momentary short circuit load.
d. Tabulate the above results and the malfunction indicator indication for each line correction at each voltage connection and frequency and compare the results with the procurement document requirements (see figure 512.1-III).

512.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The time for the circuit interrupter to operate after the short-circuit load is applied.
b. The current value, in percent of rated current, at which the circuit interrupter shall operate, if necessary.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Short circuit conditions ($L_1 - L_2$, $L_1 - L_2 - L_3$, etc.) if other than as specified herein.
e. Short-circuit malfunction indicator requirements.
f. Circuit interrupter delay time, if applicable.

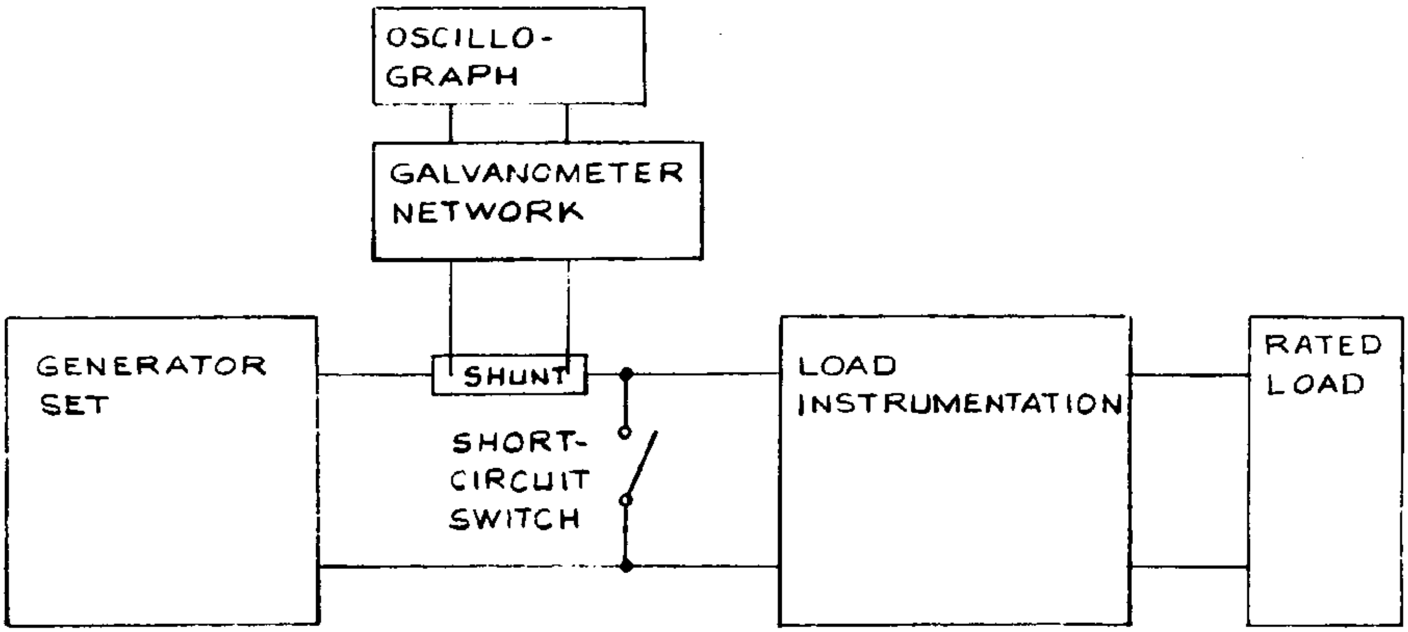
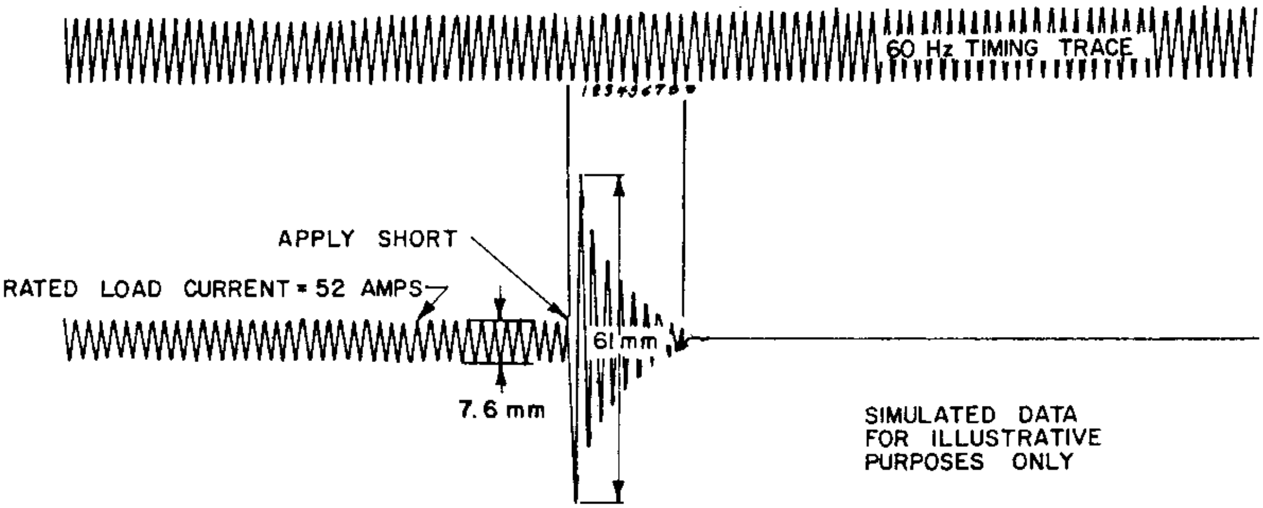


FIGURE 512.1-I APPARATUS CONNECTION FOR CIRCUIT INTERRUPTER (SHORT-CIRCUIT) TEST.

X-4597

(Short-Circuit) Test.]



CIRCUIT INTERRUPTER OPERATED IN 9.0 CYCLES OR 9 CYCLES X $16.7 \frac{\text{MS}}{\text{CYCLE}}$ = 150 MILLISECONDS

SHORT CIRCUIT LOAD CURRENT = $\frac{61\text{mm}}{7.6\text{mm}}$ X 52 AMPS = 417 AMPS

Figure 512.1-II. Portion of an oscillogram showing circuit interrupter operation and calculations.

X-4598

Interrupter Operation and Calculations.]

TEST DATA

DESCRIPTION 5 kW, 60 Hz
240 V - SINGLE - PHASE
120 V - SINGLE - PHASE
120 V - DELTA
120/208 V WYE GEN. SET

MFGR. ENGENSETS, INC

MODEL NO. SF-5.0-MD

SERIAL NO. 751430

REF: MIL-STD-705/512.1

U.S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

CIRCUIT INTERRUPTER TEST
(SHORT CIRCUIT)

TEST NO. 37
SHEET 1 OF 1
DATE 10/12/70
RECORDER J. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER R. Smith
OBSERVER J. Lee

INST. →		2313			6710			6901			338	510				1377	
READ NO. ↓	TIME	TERMINAL VOLTAGE L_1-N	L_2-N	L_3-N	LINE CURRENT L_1	L_2	L_3	OUTPUT POWER L_1-N	L_2-N	L_3-N	POWER FACTOR	FREQ	SHORT CIRCUIT CONN.	PEAK CURRENT	TRIP TIME	O-GRAM NO.	AVG AMB TEMP
UNITS	HRS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	KW	KW	—	HZ		AMPS	SEC		°F
SYM.					X20	X5	X5	X20	X5	X5				X1			
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		120 V	SINGLE PHASE CONNECTION														
1	13:10	120.0			2.60			0.25			.80	60.0	L_1-L_2	310	.076	1	73
	CHANGED TO 120/202V WYE CONNECTION																
					X5			X5									
2	14:30	120.0	120.0	120.0	3.47	3.47	3.47	0.33	0.33	0.33	.80	60.0	L_1-N	97	.170	2	74
3	14:40	120.0	120.0	120.0	3.47	3.47	3.47	0.33	0.33	0.33	.80	60.0	L_2-N	106	.163	3	73
4	14:52	120.0	120.0	120.0	3.47	3.47	3.47	0.33	0.33	0.33	.80	60.0	L_3-N	99	.171	4	73
5	14:59	120.0	120.0	120.0	3.47	3.47	3.47	0.33	0.33	0.33	.80	60.0	L_1-L_2	175	.131	5	73
6	15:10	120.0	120.0	120.0	3.47	3.47	3.47	0.33	0.33	0.33	.80	60.0	L_2-L_3	181	.126	6	73
7	15:20	120.0	120.0	120.0	3.47	3.47	3.47	0.33	0.33	0.33	.80	60.0	L_3-L_1	178	.127	7	73
8	15:35	120.0	120.0	120.0	3.47	3.47	3.47	0.33	0.33	0.33	.80	60.0	L_1-L_2-L_3	167	.125	8	74
	CHANGED TO 240 V SINGLE PHASE																
					X10			X10									
9	16:10	240.0			2.60			0.25			.80	60.0	L_1-L_2	153	.137	9	73
	CHANGED TO 120 V DELTA																
		L_1-L_2	L_2-L_3	L_3-L_1	X10												
10	16:40	120.0	120.0	120.0	3.00	3.00	3.00	0.167	0.167	0.167	.80	60.0	L_1-L_2	182	.131	10	73
11	16:45	120.0	120.0	120.0	[illegible]	3.00	3.00	0.167	0.167	0.167	.80	60.0	L_2-L_3	177	.140	11	73
12	16:50	120.0	120.0	120.0	[illegible]	3.00	3.00	0.167	0.167	0.167	.80	60.0	L_3-L_1	198	.126	12	73

NOTES:
SHUNT #1377 — L_1 CT # 6752
O-GRAPH #1068 — L_2 CT # 6753
GALVO #1068-3 — L_3 CT # 6754

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 512.1-III. Typical test record for circuit interrupter (short-circuit) test.

X-4599

(Short-Circuit) Test.]

METHOD 512.2d

CIRCUIT INTERRUPTER TEST
(OVERLOAD CURRENT)

512.2.1 General. A circuit interrupter is connected between the generator voltage reconnection system and the generator output terminals to disconnect the generator output from the load and to protect the generator from a sustained overload current. The circuit interrupter is operated from a current sensor either internal or external to the interrupter.

512.2.2 Apparatus. Instrumentation for measuring load conditions and field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition, a stopwatch, an oscillograph with galvanometer matching network, a non-inductive shunt as described and illustrated in MIL-HDBK-705, method 106.1, paragraph 106.1.3, and galvanometers having a flat frequency response (within +/- 5 percent) from dc to 3000 Hz will be required.

512.2.3 Procedure.

512.2.3.1 Preparation for test. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10, for one voltage connection and frequency specified in the procurement document.

512.2.3.2 Test.

CAUTION: If the circuit interrupter fails to operate within the time specified in the procurement document at any time during the performance of this method, manually open the circuit interrupter. Record on the data sheet failure of the interrupter to operate and the total elapsed time the overload was on the set.

a. Start and operate the generator set at rated voltage, rated frequency and rated load.
b. Allow the generator set to stabilize at rated load, voltage and frequency. During this period, readings of the load and field instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustment to the load, voltage or frequency shall be noted on the data sheet. Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last load, voltage, or frequency adjustment has been made.

c. In one continuous operation, increase the load current to the overload current value specified in the procurement document (the increase in current may be accomplished by any practical means, e.g. reactively). Note: The frequency shall be maintained at rated conditions, the load current shall be balanced equally among the phases. Simultaneously the load current increase, start the stopwatch.
d. Record all load instrumentation and the time, in seconds, required for the circuit interrupter to operate (see figure 512.2-I).
e. If the generator set contains an overload malfunction indicator, check and record its indication.
f. Allow the generator set to cool at rated load for a minimum of 15 minutes.
g. Repeat steps c thru f except that the load current is increased to the overload current value in Phase A only. Phases B and C remain at the rated load current value of wye connections or equally share the increase for delta connections. (This step is not applicable for 2 wire single phase or dc sets.)
h. Repeat step g except that the load is increased to the overload current value in phase B only. Phases A and C remain at the rated load value of current.
i. Repeat step g except that the load is increased to the overload current value in phase C only. Phases A and B remain at the rated load value of current.
j. If the procurement document requires circuit interrupter operation at overload currents other than that used in c thru i above, repeat a thru i above for the specified overload current(s).
k. Repeat a thru i above for each voltage connection and frequency specified in the procurement document.
l. If the procurement document requires that the circuit interrupter not trip at a specified load above 100 percent of rated load, load the generator set to the value specified and operate at this load for a two hour period.

512.2.4 Results. The data sheets shall show, as a minimum, whether or not the circuit interrupter operated, the time(s) required for the interrupter to operate, the indication of the malfunction indicator, the overload load conditions) and the stabilization data. Compare the time(s) required for the circuit interrupter to operate with the procurement document requirements.

512.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The time(s), in seconds, for the circuit interrupter to operate after the overloads) is (are) applied.
b. The percent overload trip current(s) at which this method is to be performed.
c. The percent overload hold current(s) at which this method is to be performed, if applicable.
d. Voltage connections) and frequency(ies) at which this method is to be performed.
e. Overload malfunction indicator requirements.

TEST DATA

DESCRIPTION 10KW, 60Hz 120V SINGLE-PHASE GEN SET

MFGR. ENGENSETS, INC.

MODEL NO. SF-10.0-MD

SERIAL NO. 27016

REF: MIL-STD-705/512.2C

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

CIRCUIT INTERRUPTER TEST
(OVERLOAD CURRENT)

TEST NO. 38

SHEET 1 OF 1

DATE 7 DECEMBER, 1970

RECORDER L. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. See

INST. →		107		1177		916		514		577		138	1110				177
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD		TRIP TIME			AVG AMB TEMP
UNITS			VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS		SEC		°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:30	STARTED		SET													
	08:40		120.0	2.60	104	0.25	10.0		.80		60.0	7.8	1.35				75
	08:50		120.0	2.62	105	0.255	10.08		.81		60.2	7.9	1.36				76
	09:00		120.8	2.73	108	0.260	10.40		.81		60.3	8.1	1.36				76
	09:00	ADJUSTED VOLTAGE, FREQUENCY AND LOAD TO RATED.															
	09:10		120.0	2.60	104	0.25	10.0		.80		60.0	7.9	1.35				75
	09:20		120.0	2.60	104	0.25	10.0		.80		60.0	7.9	1.35				75
	09:30		120.0	2.60	104	0.25	10.0		.80		60.0	7.9	1.35				75
	09:40		120.0	2.60	104	0.25	10.0		.80		60.0	7.9	1.35				75
	09:42	APPLIED OVERLOAD CURRENT 130% OF RATED															
			120.0	3.37	135	0.26	10.4		.66		60.0	9.2	1.53		177.3		77

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: C.T. # 1151

SMEFB Form 28
16 Sep 69

FIGURE 512.2-I TYPICAL TEST RECORD FOR CIRCUIT INTERRUPTER TEST (OVERLOAD CURRENT)

-2-

X-4600

(Overload Current).

METHOD 512.3d

CIRCUIT INTERRUPTER TEST

(OVERVOLTAGE AND UNDERVOLTAGE)

512.3.1 General. To protect the load from generator malfunction (e.g. overvoltage or undervoltage) a circuit interrupter is connected between the generator voltage reconnection system and the generator output terminals. A voltage sensing circuit operates the circuit interrupter if an overvoltage or undervoltage condition occurs and thus protects the load from a generator malfunction.

512.3.2 Apparatus. Instrumentation for measuring voltage and frequency shall be as described and illustrated in MIL-HDBK-705. Resistor(s), galvanometer matching networks, and oscillograph (as described and illustrated in MIL-HDBK-705, method 106.1, paragraph 106.1.3) and galvanometers having a minimum flat frequency response (flat within +/- 5 percent) from dc to 3,000 Hertz and the voltage divider transformer network (figure 512.3-I) will be required.

512.3.3 Procedure.

512.3.3.1 Procedure I. (Overvoltage)

512.3.3.1.1 Preparation for test.

a. Locate and disconnect the input circuit to the input terminals of the overvoltage protective sensing circuit and connect the apparatus as illustrated in figure 512.3-I for the voltage connection and frequency specified in the procurement document.
b. Connect the frequency meter to the output terminals of the generator set.

512.3.3.1.2 Test.

a. Start and operate the set at rated frequency and no load.
b. Close the switch (see figure 512.3-I) and use resistance, R1 to adjust the voltage to the overvoltage value specified in the procurement document (Voltmeter Number 1). If the set has provisions for shutdown or removal of excitation from the generator upon an overvoltage condition, it will be necessary to temporarily deactivate this provision to permit adjustment of the overvoltage value. This may be done by activation of the "protective by-pass" (Battle Short) switch, if provided. Do not deactivate the circuit interrupter trip circuitry.
c. Open the switch, reset the overvoltage circuit and adjust the resistance, R2, until the Voltmeter Number 2 reads rated voltage.
d. Repeat steps b and c to assure that the specified overvoltage and rated voltage settings are correct.

e. Set the oscillograph chart speed such that the individual waveform peaks are clearly visible. Set the timing lines to a minimum of 0.01 seconds per line or use a 60 Hertz timing trace. Adjust the trace peak-to-peak amplitude to a minimum of one inch (or 25 millimeters).
f. Read and record both voltmeter readings.
g. With the oscillograph recording and the circuit interrupter closed, close the switch. (See figure 512.3-I).
h. Reactivate the shutdown provision if used.
i. If the generator set contains an overvoltage malfunction indicator, check and record its indication.
j. If set shutdown or removal of generator excitation is required, record whether or not the shutdown or generator excitation removal occurred.
k. Open the switch, reset the overvoltage circuit if necessary, restart the set if required, and close the circuit interrupter.
l. Repeat steps e thru k above two additional times.

512.3.3.2 Procedure II. (Undervoltage)

512.3.3.2.1 Preparation for test.

a. Locate the input terminals of the undervoltage sensing circuit and connect the apparatus as illustrated in figure 512.3-I.
b. Repeat step b of 512.3.3.1.1.

512.3.3.2.2 Test.

a. Start and operate the set at rated frequency and no load.
b. Close the switch (see figure 512.3-I) and use the resistance, R1, to adjust the voltage to the rated value.
c. Open the switch and adjust the resistance, R2, until Voltmeter Number 2 reads the undervoltage value specified in the procurement document. If the set has provisions for shutdown or removal of excitation from the generator upon an undervoltage condition, it will be necessary to temporarily deactivate this provision for this adjustment. Do not deactivate the circuit interrupter trip circuitry. When two or more undervoltage values are specified, this test shall be repeated for each undervoltage value. In addition, if the procurement document specifies a voltage bandwidth in which the undervoltage protection device shall not operate instantaneously, operation within this bandwidth shall also be checked.
d. Repeat steps b and c above to assure that the specified undervoltage and rated voltage settings are correct.
e. Set the oscillograph chart speed such that the individual waveform peaks are clearly visible. Set the timing lines to a minimum of 0.01 seconds per line or use a 60 Hertz timing trace. With the switch open, adjust the trace peak-to-peak amplitude to a minimum of one inch (or 25 millimeters).
f. With the set operating and the circuit interrupter and the switch open, read and record both voltmeter readings (see figure 512.3-II).
g. Close the switch and circuit interrupter.
h. Reactivate the set shutdown provision if used.
i. With the oscillograph recording, open the switch.

j. After allowing sufficient time for the circuit interrupter to operate, check and record the indication of the undervoltage malfunction indicator if the set contains one.
k. If set shutdown or removal of generator excitation is required, record whether or not the shutdown or generator excitation removal occurred.
l. Close the switch, reset the undervoltage circuit if necessary, restart the set if required, and close the circuit interrupter.
m. Repeat steps e thru l above two additional times.
n. If the undervoltage protection circuitry contains a time delay to prevent undervoltage condition, the circuitry shall be checked as follows:

    1. With the oscillograph operating, momentarily open and close the switch making sure that the switch is not closed for a period of time equal to or longer than the specified delay time.
    2. Record on the data sheet if the circuit interrupter operated and the indication of the malfunction indicator (if applicable).

o. If more than one undervoltage value is specified in the procurement document, repeat 512.3.3.2.1 and 512.3.3.2.2 for each value specified.

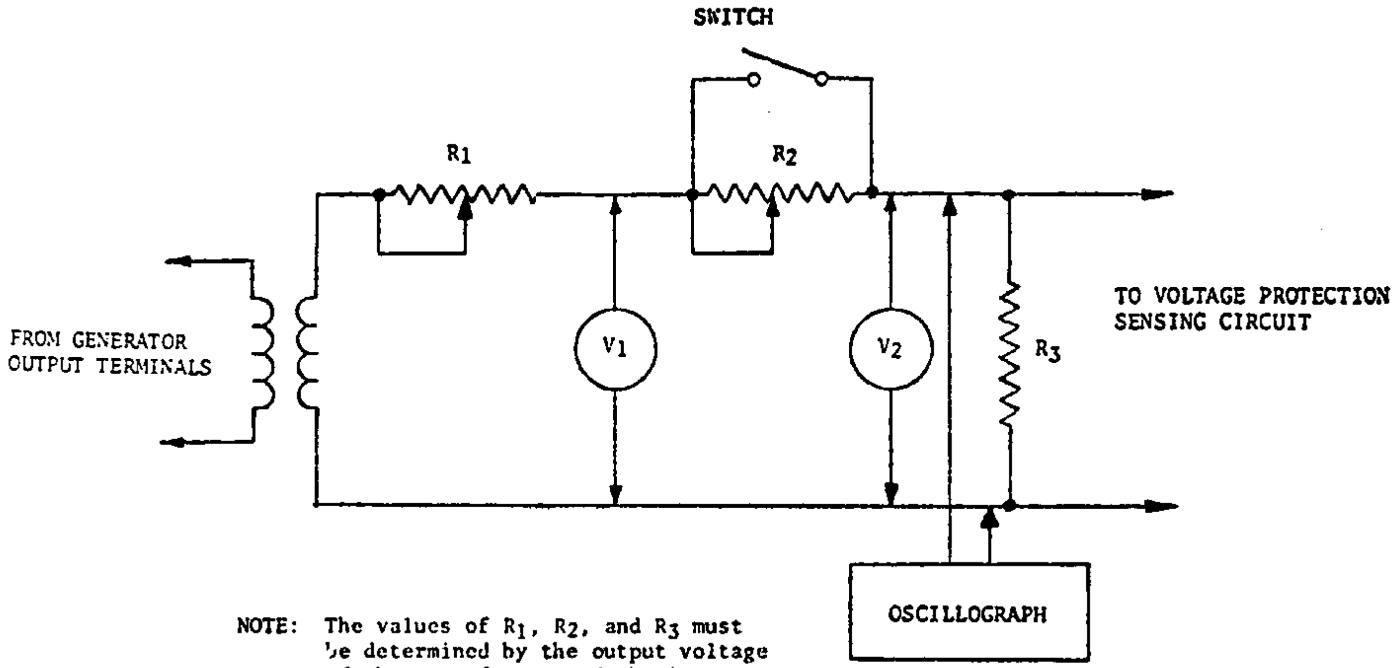
512.3.3.3 Repeat procedure. Repeat 512.3.3.1 and 512.3.3.2 at each of the voltage connections and frequencies specified in the procurement document.

512.3.4 Results.

a. From the oscillograms made in 512.3.3 determine and tabulate the time between the application of the overvoltage and operation of the circuit interrupter for each application of overvoltage.
b. From the oscillograms made in 512.3.3 determine and tabulate the time between the application of the undervoltage and operation of the circuit interrupter for each application of undervoltage.
c. For sets having a time delay, use the oscillograms taken in 512.3.3.2.2n1 and determine if the circuit interrupter actuated upon application of a momentary undervoltage.
d. Compare these results with the requirements of the procurement document.

512.3.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The value of overvoltage in volts and time in seconds required for the circuit interrupter to operate after application of the overvoltage.
b. The value(s) of undervoltage in volts and time(s) in seconds required for the circuit interrupter to operate after application of the undervoltage.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Overvoltage and undervoltage malfunction indicator requirements.
e. Conditions of set shutdown or removal of generator excitation as applicable.
f. Circuit interrupter delay time if applicable.



NOTE: The values of R_1, R_2, and R_3 must be determined by the output voltage of the transformer and the input impedance of the voltage protection sensing circuit.

FIGURE 512.3-I APPARATUS CONNECTION FOR CIRCUIT INTERRUPTER TEST (OVERVOLTAGE AND UNDERVOLTAGE)

X-4601

Test.]

TEST DATA

DESCRIPTION 60KW, 60HZ 120/208, 240/416 V 0.8 PF GEN SET MFGR. ENGENSETS, INC MODEL NO. SF-60.0-MD/ELED SERIAL NO. 4097 REF: MIL-STD-705A/512.3	U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER FORT BELVOIR, VIRGINIA CIRCUIT INTERRUPTER TEST (OVERVOLTAGE AND UNDERVOLTAGE)	TEST NO. 5 SHEET 1 OF 1 DATE JULY 31, 1970 RECORDER J. Jones PROJ. ENGR. R. C. Smith SHIFT LEADER M. Munn OBSERVER L. See

INST. →		139	421	1035		
READ NO. ↓	TIME	VOLTAGE		FREQ	REMARKS	AVG AMB TEMP
UNITS	HRS	VOLTS	VOLTS	HZ		°F
SYM.		#1	#2			
COL.	1	2	3	4	5–16	17
1	0900	148.0	120.0	60.0	CIRCUIT INTERRUPTER OPENED, SET SHUT DOWN O.V. LIGHT ON	73
2	0905	148.0	120.0	60.0	SAME AS READING No 1	
3	0910	148.0	120.0	60.0	SAME AS READING No 1	
4	0930	120.0	102.0	60.0	CIRCUIT INTERRUPTER OPENED, U.V LIGHT ON	75
5	0935	120.0	102.0	60.0	SAME AS READING No 4	
6	0940	120.0	102.0	60.0	SAME AS READING No 4	

NOTES: OVER AND UNDERVOLTAGE PROTECTION DEVICES CONNECTED TO COIL T9-T12

SMEFB Form 28
16 Sep 69

FIGURE 512.3-II. TYPICAL TEST RECORD FOR CIRCUIT INTERRUPTER TEST (OVERVOLTAGE AND UNDERVOLTAGE)

X-4602

Test.]

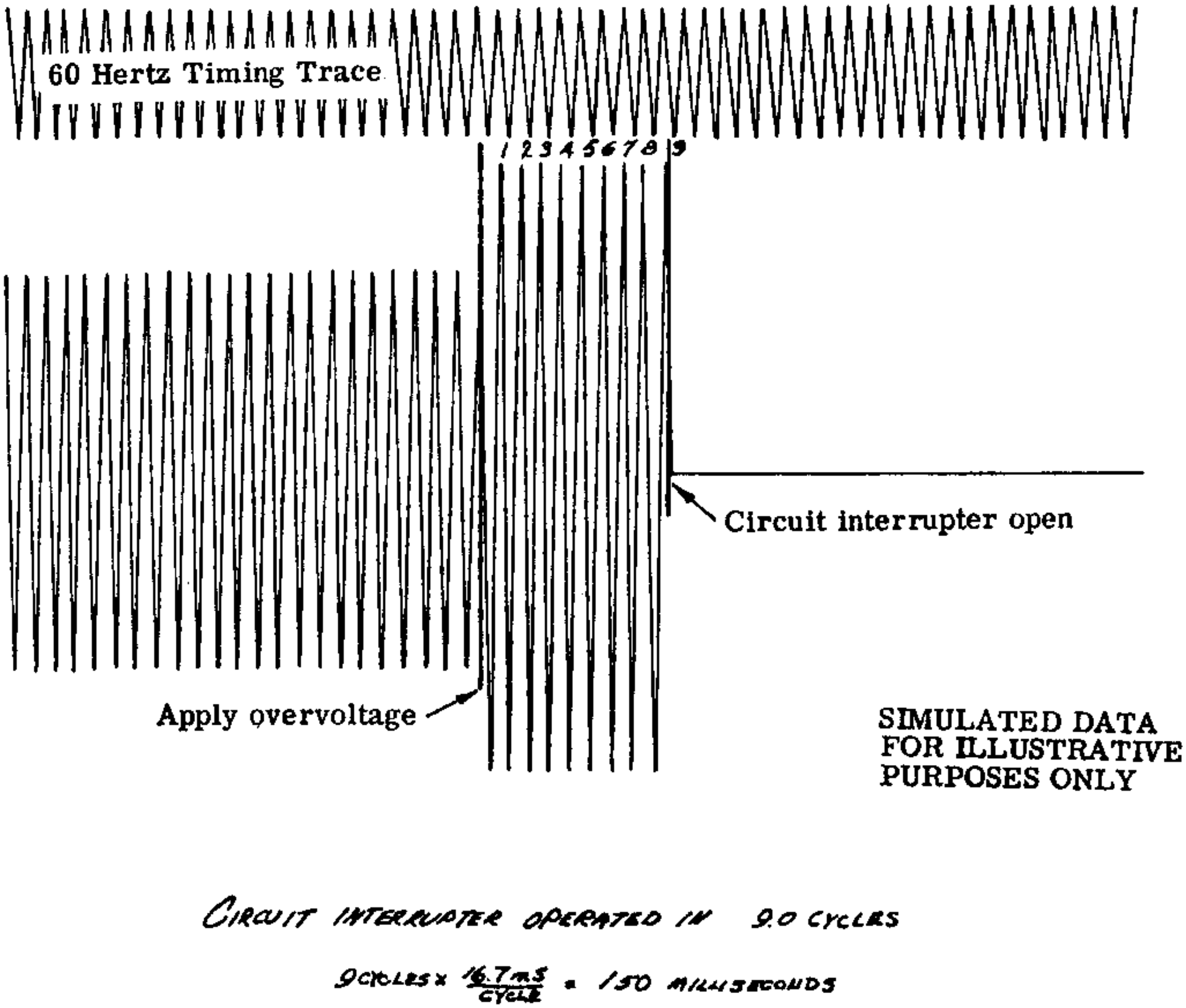


FIGURE 512.3-III. Portion of an oscillogram showing circuit interrupter operation upon application of an overvoltage.

X-4603

Interrupter Operation Upon Application of an Overvoltage.]

METHOD 513.1d

INDICATING INSTRUMENT TEST

(ELECTRICAL)

513.1.1 General. Accurate set instrumentation is necessary for determination of proper operation of the generator set and to prevent set overload or connected equipment problems.

513.1.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705. Electrical instrumentation used for this test shall have an accuracy of +/- 0.5 percent of reading or better.

513.1.3 Procedure.

513.1.3.1 Preparation for test.

a. Connect the load instrumentation as illustrated in the applicable figure in MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the applicable voltage connection and frequency.
b. Set the mechanical zero, if possible, on the applicable set instruments. The set instruments shall not be readjusted once the test is in progress.

NOTE: During this method the set instruments should be set at the desired value and the actual value read from the standard instruments.

513.1.3.2 Test.

a. Start and operate the set at no load and rated frequency.
b. Record all set and standard instrument readings concurrently.
c. Reduce the frequency (if a frequency adjust device is provided) to obtain a panel frequency indication at the extreme low end of the meter operating range (the lowest major scale division for the frequency condition tested) or to a value just prior to the activation of the under frequency protective device (if an under frequency protective device is provided).
d. Record all set and standard instrument readings concurrently, (see figures 513.1-I and 513.1-II).
e. Increase the frequency to obtain a set frequency indication at the extreme high end of the meter operating range (the highest major scale division for the frequency condition tested) or to a value just prior to the activation of the overspeed protective device.
f. Record all set and standard instrument readings concurrently.
g. Reduce the voltage (if a voltage adjust device is provided) to obtain a panel voltage indication at the extreme low end of the meter operating range (the lowest major scale division for the voltage condition tested) or to a value just prior to the activation of the undervoltage protective device (if an undervoltage protective device is provided).

h. Record all set and standard instrument readings concurrently.
i. Increase the voltage to obtain a set voltage indication at the extreme high end of the meter operating range (the highest major scale division for the voltage condition tested) or to a value just prior to the activation of the overvoltage protective device.
j. Record all set and standard instrument readings concurrently.
k. Repeat a thru j except at 25 percent rated load.
l. Repeat a thru j except at 50 percent rated load.
m. Repeat a thru j except at 75 percent rated load.
n. Repeat a thru j except at 100 percent rated load.
o. Perform test method 511.1 Regulator Range Test.
p. Repeat a thru o for any other rated frequency.
q. Repeat a thru p for all other rated line-to-line or line-to-neutral voltages.

513.1.4 Results.

a. Compute the accuracy for each set instrument at each condition given in paragraph 513.1.3 above, using the following equation.

$$\text{Accuracy} = \frac{\text{(Set Instrument - Standard) X 100}}{\text{(Set Instrument Full-Scale Value}}$$

b. Tabulate the results of step a above for each set instrument.
c. Compare these results with the requirements of the procurement document.

513.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The accuracy of each set instrument.
b. Standard instrument calibration requirements if different than those required by MIL-HDBK-705.
c. Maximum and minimum voltages between which the generator set shall perform.
d. The maximum allowable regulation.

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120V SINGLE PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 4087

REF: MIL-STD-705/513.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

INDICATING INSTRUMENT TEST (ELECTRICAL)

MASTER INSTRUMENTS

TEST NO. 26

SHEET 1 OF 2

DATE NOVEMBER 2, 1970

RECORDER [illegible]

PROJ. ENGR. [illegible]

SHIFT LEADER [illegible]

OBSERVER [illegible]

INST. →		106		217		308		1517									1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		FREQUENCY									AVG. AMB. TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		HZ								°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:10	STARTED		SET													77
	09:12		121.0	0	0	0	0		60.2								
	09:15		121.0	0	0	0	0		54.9								
	09:20		121.0	0	0	0	0		65.4								
	09:25		121.0	0.625	25	0.063	2.52		60.2								
	09:30		121.0	0.625	25	0.063	2.52		54.9								
	09:35		121.0	0.625	25	0.063	2.52		65.4								
	09:40		121.0	1.33	52.6	0.126	5.04		60.2								
	09:45		121.0	1.33	52.6	0.126	5.04		54.9								
	09:50		121.0	1.33	52.6	0.126	5.04		65.4								
	09:55		121.0	1.95	78	0.188	7.52		60.2								
	10:00		121.0	1.95	78	0.188	7.52		54.9								
	10:05		121.0	1.95	78	0.188	7.52		65.4								
	10:10		121.0	2.63	105	0.252	10.08		60.2								
	10:15		121.0	2.63	105	0.252	10.08		54.9								
	10:20		121.0	2.63	105	0.252	10.08		65.4								
	10:30	PERFORMED		METHOD		511.1, R											

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. # 1305

Figure 513.1-I - Portion of a typical test record for indicating instrument test.

X-4604

Instrument Test.]

TEST DATA

DESCRIPTION 10KW, 60HZ 120V SINGLE PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 26
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 2 OF 2
MODEL NO. SF-10.0-MD	INDICATING INSTRUMENT TEST (ELECTRICAL)	DATE NOVEMBER 2, 1970
SERIAL NO. 4087		RECORDER [illegible]
REF: MIL-STD-705/513.1	SET INSTRUMENTS	PROJ. ENGR. [illegible]
		SHIFT LEADER [illegible]
		OBSERVER [illegible]

INST. →																	
READ NO. ↓	TIME	VOLTAGE				PERCENT LOAD CURRENT				FREQUENCY							
UNITS	HRS	VOLTS		%		%		%		HZ		%					
SYM.				ERROR				ERROR				ERROR					
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:12	120		0.83		0		0		60.0		0.3					
	09:15	120		0.83		0		0		55		0.2					
	09:20	120		0.83		0		0		65		0.7					
	09:25	120		0.83		25		4.0		60		0.3					
	09:30	120		0.63		25		4.0		55		0.2					
	09:35	120		0.83		25		4.0		65		0.7					
	09:40	120		0.83		50		1.2		60		0.3					
	09:45	120		0.83		50		1.2		55		0.2					
	09:50	120		0.83		50		1.2		65		0.7					
	09:55	120		0.83		75		0		60		0.3					
	10:00	120		0.83		75		0		55		0.2					
	10:05	120		0.83		75		0		65		0.7					
	10:10	120		0.83		100		0.95		60		0.3					
	10:15	120		0.93		100		0.95		55		0.2					
	10:20	120		0.63		100		0.96		65		0.7					

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

Figure 513.1-II - Portion of a typical test record for indicating instrument test.

X-4605

Instrument Test.]

METHOD 513.2a

INDICATING INSTRUMENT TEST

(PRODUCTION SETS)
(ELECTRICAL)

513.2.1 General. Accurate set instrumentation is necessary for determination of proper operation of the generator set and to prevent set overload or connected equipment problems.

513.2.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

513.2.3 Procedure.

513.2.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure in MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency.
b. Set the mechanical zero if possible on the applicable set instruments. The set instruments may not be readjusted once the test is in progress.

NOTE: During this method the set instruments shall be set at the desired value and the actual value read from the standard instruments.

513.2.3.2 Test.

a. Start and operate the set at no load and at rated frequency.
b. Record all set and standard instrument readings concurrently for each instrument selector switch position (see figures 513.2-I and 513.2-II).
c. Reduce the frequency (if a frequency adjust device is provided) to obtain a set frequency indication at the extreme low end of the instrument's operating range (the lowest major scale division for the frequency condition tested) or to a value just prior to the actuation of the underfrequency protection device (if an unfrequency protection device is provided).
d. Record all set and standard instrument readings concurrently.
e. Increase the frequency to obtain a set frequency indication at the extreme high end of the instrument's operating range (the hit major scale division for the frequency condition tested) or to a value just prior to the actuation of the overspeed protection device.
f. Record all set and standard instrument readings concurrently.
g. Reduce the voltage (if a voltage adjust device is provided) to obtain a panel voltage indication at the extreme low end of the meter operating range (the lowest major scale division for the voltage condition tested) or to a value just prior to the activation of the undervoltage protective device (if an undervoltage protective device is provided).
h. Record all set and standard instrument readings concurrently.

i. Increase the voltage to obtain a set voltage indication at the extreme high end of the meter operating range (the highest major scale division for the voltage condition tested) or to a value just prior to the activation of the overvoltage protective device.
j. Record all set and standard instrument readings concurrently.
k. Repeat a and b except at 25 percent of rated load.
l. Repeat a and b except at 50 percent of rated load.
m. Repeat a and b except at 75 percent of rated load.
n. Repeat a and b except at 100 percent of rated load.
o. Repeat a, b, and n for any other rated frequency.
p. Repeat a, b, n ar-d o for all other rated line-to-line or line-to-neutral voltages.

512.2.4 Results.

a. Compute the accuracy for each set instrument at each condition given in 513.2.3 above, using the following equation:

$$\text{Accuracy} = \frac{(\text{Set Instrument - Standard}) \times 100}{(\text{Set Instrument Full-Scale Value})}$$

b. Tabulate the results of step a above for each set instrument.
c. Compare these results with the requirements of the procurement document.

513.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The accuracy of each set instrument.
b. Standard instrument calibration requirements if different than those required by MIL-HDBK-705.

TEST DATA

DESCRIPTION 10KW, 60Hz
120V SINGLE-PHASE
GEN SET.
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 4087
REF: MIL-STD-705/513.2

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

PANEL INSTRUMENT TEST
(ELECTRICAL)
MASTER INSTRUMENTS

TEST NO. 26
SHEET 1 OF 1
DATE 2 NOV, 1970
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. Lee

INST. →		106		217		308		1517										
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		FREQUENCY										
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		Hz									
SYM.				X40		X1												
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	09:10	STARTED SET																
2	09:12		120.0	0	0	0	0		60.0									
3	09:15		120.0	0	0	0	0		55.0									
4	09:20		120.0	0	0	0	0		69.8									
5	09:25		120.0	.65	26.0	.0625	2.5		60.0									
6	09:30		120.0	.65	26.0	.0625	2.5		55.0									
7	09:35		120.0	.65	26.0	.0625	2.5		65.0									
8	09:40		120.0	1.30	52.0	.1250	5.0		60.0									
9	09:45		120.0	1.30	52.0	.1250	5.0		55.0									
10	09:50		120.0	1.30	52.0	.1250	5.0		65.0									
11	09:55		120.0	1.95	78.0	.1875	7.5		60.0									
12	10:00		120.0	1.95	78.0	.1875	7.5		55.0									
13	10:05		120.0	1.95	78.0	.1875	7.5		65.0									
14	10:10		120.0	2.60	104	.2500	10.0		60.0									
15	10:15		120.0	2.60	104	.2500	10.0		55.0									
16	10:20		120.0	2.60	104	.2500	10.0		65.0									

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: C.T. No 1304

SMEFB Form 28
16 Sep 69

513.2-I TYPICAL TEST RECORD FOR PANEL INSTRUMENT TEST (ELECTRICAL)

X-4606

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120 V SINGLE-PHASE GEN SET

MFGR. ENGENSETS, INC.

MODEL NO. SF-10.0-MD

SERIAL NO. 4087

REF: MIL-STD-705/513.2

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

PANEL INSTRUMENT TEST (ELECTRICAL)

PANEL INSTRUMENTS

TEST NO. 26

SHEET 1 OF 1

DATE 2 NOV, 1970

RECORDER J. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER J. See

INST. →																	
READ NO. ↓		TERMINAL VOLTAGE			LOAD CURRENT			FREQUENCY									
UNITS		VOLTS		%	%		%	HZ		%							
SYM				ERROR			ERROR			ERROR							
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:12	121		0.83	0		0	60.0		0							
	09:15	121		0.83	0		0	55.0		0							
	09:20	121		0.83	0		0	65.0		0							
	09:25	121		0.83	24		4.0	60.0		0							
	09:30	121		0.83	24		4.0	55.0		0							
	09:35	121		0.83	24		4.0	65.0		0							
	09:40	121		0.83	51		2.0	60.0		0							
	09:45	121		0.83	51		2.0	55.0		0							
	09:50	121		0.83	50		0	65.0		0							
	09:55	121		0.83	75		0	60.0		0							
	10:00	121		0.83	75		0	55.0		0							
	10:05	121		0.83	74		1.25	65.0		0							
	10:10	121		0.83	101		1.0	60.0		0							
	10:15	121		0.83	101		1.0	55.0		0							
	10:20	121		0.83	100		0	65.0		0							

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

SMEFB Form 28
16 Sep 69

513.2-II TYPICAL TEST RECORD FOR PANEL INSTRUMENT TEST (ELECTRICAL)

-2-

X-4607

METHOD 515.1b

LOW OIL PRESSURE PROTECTIVE DEVICE TEST

515.1.1 General. Since generator sets frequently operate unattended for long periods, the engine is usually equipped with a low oil pressure protective device. This device shuts down the engine when the oil pressure drops below the safe limit.

515.1.2 Apparatus. The following equipment shall be required to perform this test.

Oil pressure gage (+/- 1 percent accuracy)
Flexible oil line (or copper tubing)
Regulating valves
Brass fittings

515.1.3 Procedure.

515.1.3.1 Preparation for test. With the set not operating remove the protective device tap from the engine block and reconnect as shown in figure 515.1-II with the protective device and oil pressure gage in approximately the same horizontal plane as the protective device tap located on the engine.

515.1.3.2 Test.

a. With the bleeder valve closed and the shut-off valve in the oil pressure line open, start and operate the set at rated speed (use the set instrumentation) and at no load.
b. Open the bleeder valve slightly to purge air from the system.
c. Close the bleeder valve and record the oil pressure as indicated on the external gage.
d. Almost completely close the shut-off valve.
e. Slowly open the bleeder valve until the low oil pressure protective device shuts down the engine. Record the reading of the oil pressure gage at the point of set shutdown (see figure 515.1-I).
f. Record operation of the malfunction indicator, if so equipped.

515.1.4 Results. Compare the value of shutdown pressure with that given in the procurement document.

515.1.5 Procurement document requirements. The following items be specified in the individual procurement document:

a. Oil pressure at which the engine must shut down.
b. Low oil pressure malfunction indicator requirements, if applicable.

TEST DATA

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

LOW OIL PRESSURE PROTECTIVE DEVICE TEST

DESCRIPTION 10 KW, 60 Hz
120 V. SINGLE-PHASE
GEN SET
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 27016
REF: MIL-STD-705/515.1

TEST NO. 39
SHEET 1 OF 1
DATE 7 DECEMBER, 1970
RECORDER J. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. See

INST. →		SET		11377													
READ NO. ↓	TIME	FREQUENCY		OIL PRESSURE AT SHUT DOWN													
UNITS	HRS.		Hz		PSIG												
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	11:15	STARTED SET															
	11:20		60.0		15.7	SET SHUT DOWN											
	11:25																

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

SMEFB Form 28
16 Sep 69

FIGURE 515-1-I TYPICAL TEST RECORD FOR LOW OIL PRESSURE PROTECTIVE DEVICE TEST.

X-4608

Protective Device Test.]

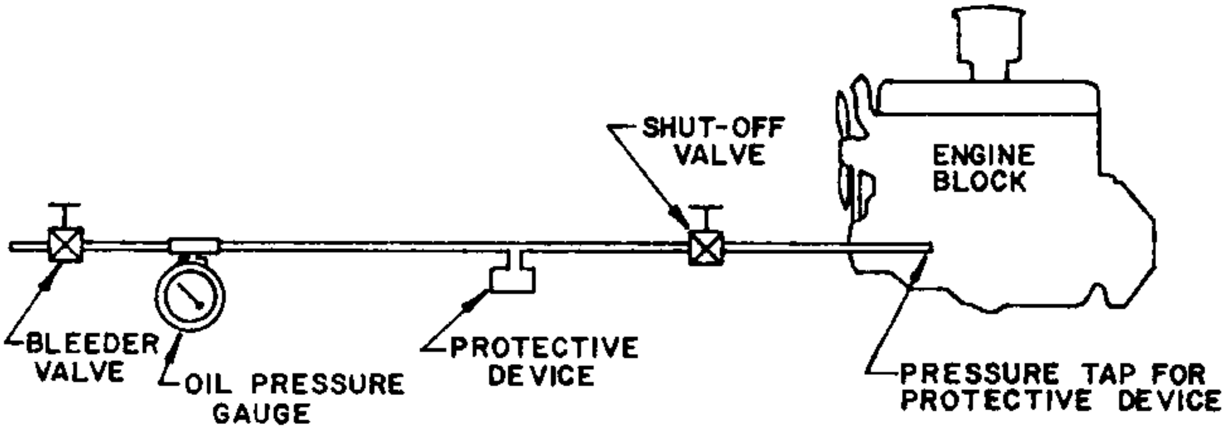


FIGURE 515.1-II. Apparatus hookup for low oil pressure protèctive device test.

X-4609

Device Test.]

METHOD 515.2b

OVERTEMPERATURE PROTECTIVE DEVICE TEST

515.2.1 General. The overtemperature device must be capable of protecting the engine in the set against overheating for any reason.

515.2.2 Apparatus. Instrumentation for measuring load conditions and set and ambient temperatures shall be as described and illustrated in MIL-HDBK-705.

515.2.3 Procedure.

515.2.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10.
b. Install a thermocouple to measure the same temperature as seen by the protective device sensor. Record the position of the thermocouple.

515.2.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency (speed), and rated load.
b. Block the cooling air to the generator set by any suitable means.
c. Continuously monitor the temperature seen by the thermocouple installed in paragraph 515.2.3.1b above. Record the temperature at which the overtemperature protective device actuates (see figure 515.2-I). Record the temperature at which the warning alarm device actuates, if applicable.

CAUTION: If the engine fails to shut down when the temperature exceeds the maximum trip value specified in the procurement document, the test shall be immediately discontinued.

d. Record the operation of the malfunction indicator, if applicable.

515.2.4 Results. Compare the results with the procurement document requirements.

515.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Range of temperature or maximum temperature in which the overtemperature protective device shall actuate.
b. Overtemperature malfunction indicator requirements, if applicable.
c. Range of temperature in which the warning alarm device shall actuate, if applicable.

TEST DATA

DESCRIPTION 15KW, 60HZ 120/208V, 3-PHASE GENERATOR SET

MFGR. ENGENSETS, INC.

MODEL NO. SF-15.0-MD

SERIAL NO. 10778

REF: MIL-STD-705/515.2

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

OVERTEMPERATURE PROTECTIVE DEVICE TEST

TEST NO. 76

SHEET 1 OF 1

DATE MARCH 31, 1971

RECORDER J. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER J. Lee

INST. →		1076															
READ NO. ↓	TIME	COOLANT TEMPERATURE															
UNITS	HRS		°F														
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:10			STARTED SET													
	08:15			BLOCKED ENGINE COOLING AIR													
	08:28		199	WARNING ALARM SOUNDED													
	08:33		208	ENGINE SHUT DOWN - OVERTEMPERATURE LIGHT "ON"													

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

Figure 515.2-I Typical test record for overtemperature protective device test.

X-4610

Device Test.]

METHOD 515.5a

LOW FUEL PROTECTIVE DEVICE TEST

515.5.1 General. The low fuel protective device is designed to prevent evacuation and loss of prime in the fuel system.

515.5.2 Apparatus. Load instrumentation (as described and illustrated in MIL-HDBK-705), a continuity indicating device, and a stopwatch shall be required.

515.5.3 Procedure.

515.5.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
b. Level the generator set.
c. Fill the day tank using the set fuel pump(s) until the fuel valve operates.
d. Disconnect the fuel lines to the set from the set fuel tank and any auxiliary fuel tank(s).
e. Bypass the low fuel protective device.
f. Connect the continuity indicating device across the shut down terminals of the low fuel protective device.

515.5.3.2 Test.

a. Start and operate the set at rated load, voltage and frequency, simultaneously start the stopwatch.
b. Note the exact time the low fuel protective device actuates.
c. Continue to operate the generator set at rated load, voltage and frequency until the procurement document requirements are met.
d. Measure and record the length of the set operating time at rated load prior to the actuation of the low fuel protective device and the length of time the set was allowed to operate at rated load after the actuation of the fuel protective device (see figure 515.5-I).
e. After the engine stops, reconnect the low fuel protective device and record operation of the malfunction indicator, if so equipped (see figure 515.5-I).

515.5.4 Results. Compare the times recorded with the minimum times of operation specified in the procurement document.

515.5.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The minimum time of set operation on the day tank before the low fuel protective device actuates, if applicable.
b. The minimum time of set operation after the low fuel protective device actuates.

c. The voltage connection and frequency at which this method is to be performed.
d. The load condition at which this method is to be performed, if other than as specified herein.
e. Low fuel malfunction indicator requirements, if applicable.

TEST DATA

DESCRIPTION 15 KW, 60 Hz
120 V, SINGLE-PHASE
GEN SET
MFGR. ENGENSETS, INC
MODEL NO. SE-15.0-MD
SERIAL NO. 1377
REF: MIL-STD-705/515.5

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

LOW FUEL PROTECTIVE DEVICE TEST.

TEST NO. 39
SHEET 1 OF 1
DATE 7 DECEMBER, 1970
RECORDER S. Wright
PROJ. ENGR. [illegible]
SHIFT LEADER H. Smith
OBSERVER L. See

INST. →		108		209		310		411		512								613
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		POWER OUTPUT		POWER FACTOR		FREQUENCY		SET OPERATING TIME					
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—			MIN	SEC				
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	12:45	STARTED UNIT, APPLIED RATED LOAD															
	12:47		120.0	3.90	156	.375	15.0		.80		60.0						
	12:58	LOW FUEL PROTECTIVE DEVICE ACTUATED										13	10				
	13:00	SHUT SET DOWN										15	13				

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

SMEFB Form 28
16 Sep 69

FIGURE 515.5-I TYPICAL TEST RECORD FOR LOW FUEL PROTECTIVE DEVICE TEST

X-4611

Test.]

METHOD 516.1a

CONTROLS, DIRECTION OF ROTATION

516.1.1 General. The direction of rotation of the controls must be standard for generator sets to assure proper use by operating personnel.

516.1.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705.

516.1.3 Procedure.

516.1.3.1 Preparation for test. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.

516.1.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency, and a load condition specified in the procurement document with the "unit-parallel" switch in the "unit" position, if applicable.
b. Vary the voltage adjusting control. Record the effect of clockwise rotation on the output voltage (see figure 516.1-I).
c. Vary the frequency adjusting control. Record the effect of clockwise rotation of the frequency.
d. Vary the frequency droop control, if applicable. Record the effect of clockwise rotation of the control.
e. Vary the cross-current compensating control. Record the effect of clockwise rotation of the control.
f. Repeat steps b thru e above at any other specified load condition.
g. Repeat steps b thru f with the "unit-parallel" switch in the "parallel" position, if applicable.

516.1.4 Results. Compare the results with the procurement document requirements.

516.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Direction of rotation of each control and the effect on the set.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.
c. Load condition(s) at which this method is to be performed.

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

CONTROLS, DIRECTION OF ROTATION TEST

DESCRIPTION 10KW, 60HZ 120V, SINGLE-PHASE GENERATOR SET
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 10776
REF: MIL-STD-705/516.1

TEST NO. 28
SHEET 1 OF 1
DATE APRIL 13, 1971
RECORDER J. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. Lee

INST. →		171		407													
READ NO. ↓	TIME	TERMINAL VOLTAGE		FREQUENCY													
UNITS	HRS		VOLTS		Hz												
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	11:15	STARTED		SET													
	11:17		120.0		60.0												
	11:18	CLOCKWISE ROTATION OF VOLTAGE CONTROL KNOB INCREASED VOLTAGE															
		COUNTERCLOCKWISE ROTATION DECREASED VOLTAGE															

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

NOTES: NO OTHER CONTROLS ON FRONT PANEL

Figure 516.1-I Typical test record for controls, direction of rotation test.

X-4612

Rotation Test.]

METHOD 516.2a

REVERSE POWER PROTECTIVE DEVICE TEST

516.2.1 General. To assure that adequate protection is afforded the generator set from drawing excessive power from a connected "bus", the reverse power protective device must operate properly.

516.2.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature of the "system" to which the set under test is paralleled shall be as described and illustrated in MIL-HDBK-705. In addition, a generator set of equal rating as the set under test shall also be required.

516.2.3 Procedure.

516.2.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document to the set acting as the "bus" (set No. 2) to which the set under test (set No. 1) shall be paralleled.
b. Connect the voltage and frequency sensing instruments to the line side of the circuit interrupter of set No. 2 in accordance with the applicable figure(s) of MIL-HDBK-705, method 205.1, paragraphs 205.1.4 and 205.1.9 for the same voltage connection and frequency used in step a above.
c. Connect the output terminals of set No. 2 to the output terminals of set No. 1 with the correct phase relationship (L_1 - L_1; L_2 - L_2; L_3 - L_3; L_0 - L_0).

516.2.3.2 Test.

a. Start and operate set No. 2 at rated voltage, rated frequency and 75 percent of rated load. Allow the set to operate in this manner for 15 minutes and then record all instrument readings. These readings are the base for the reverse power test.
b. Start and operate set No. 1 at rated voltage, rated frequency, and at no load.
c. Parallel set No. 1 with set No. 2 in accordance with the instructions on the sets or in the technical manuals.
d. Slowly reduce the setting of the frequency adjust device on set No. 1 until the reverse power protective device removes set No. 1 from the "bus" (in this case, set No. 2). Read and record the load instrumentation wattmeter(s) at the point just prior to the actuation of the reverse power protection device.
e. Record the operation of the malfunction indicator, if so equipped.
f. Repeat steps c thru e above two additional times.
g. Repeat 516.2.3 for each voltage connection and frequency specified in the procurement document.

516.2.4 Results.

a. Average the wattmeter readings taken during each trial of 516.2.3.2d above. Subtract the wattmeter reading(s) taken in step a of 516.2.3.2 above from the average. This value is the reverse power necessary to activate the reverse power protective device.
b. Compare the value(s) obtained in step a above with the requirements of the operation of the reverse power protective device as specified in the procurement document.

516.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The maximum allowable reverse power at which the reverse power protective device shall actuate.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.
c. Reverse power malfunction indicator requirements, if applicable.

TEST DATA

DESCRIPTION 15 KW, 60 HZ 120/208 V 3-PHASE GENERATOR SET

MFGR. ENGENSETS INC

MODEL NO. SF-15.0-MD

SERIAL NO. 16039 (SET NO. 1)

REF: MIL-STD-705/516.2

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

REVERSE POWER PROTECTIVE DEVICE

TEST NO. 16

SHEET 1 OF 1

DATE FEBRUARY 8, 1971

RECORDER J. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER J. Lee

INST. →		116			3035	3036	3037		317	318	319		516	717			1076
READ NO. ↓	TIME	BUS VOLTAGE			SYSTEM CURRENT			TOTAL CURRENT	SYSTEM POWER L_1-N	L_2-N	L_3-N	TOTAL SYSTEM POWER	POWER FACTOR	FREQ			AVG AMB TEMP
UNITS	HRS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	AMPS	KW	KW	KW	KW	—	Hz			°F
SYM.		L_1-N	L_2-N	L_3-N	X20	X20	X20	X1	X20	X20	X20	X1					
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1400	STARTED SET NO. 2 - APPLIED 75% RATED LOAD															75
	1415	120.0	120.0	120.0	1.95	1.95	1.95	117	0.188	0.188	0.188	11.2	0.80	60.0			75
	1420	STARTED SET NO. 1 - PARALLELED WITH SET NO. 2															
	1422	REDUCED GOVERNOR SETTING UNTIL SET							0.200	0.200	0.200	12.0	0.37	60.0			75
		NO. 1 CIRCUIT BREAKER OPENED - REVERSE POWER MALFUNCTION INDICATOR LIGTH ON															
	1425	120.0	120.0	120.0	1.95	1.95	1.95	117	0.188	0.188	0.188	11.2	0.80	60.0			75
	1430	PARALLELED SET NO. 1 WITH SET NO. 2															
	1433	REDUCED GOVERNOR SETTING UNTIL SET							0.200	0.200	0.200	12.0	0.37	60.0			75
		NO. 1 CIRCUIT BREAKER OPENED - REVERSE POWER MALFUNCTION INDICATOR LIGTH ON															
	1435	120.0	120.0	120.0	1.95	1.95	1.95	117	0.188	0.188	0.188	11.2	0.80	60.0			75
	1440	PARALLELED SET NO. 1 WITH SET NO. 2															
	1443	REDUCED GOVERNOR SETTING UNTIL SET							0.200	0.200	0.200	12.0	0.37	60.0			75
		NO. 1 CIRCUIT BREAKER OPENED - REVERSE POWER MALFUNCTION INDICATOR LIGTH ON															
	1445	SHUTDOWN BOTH SETS															
							AVERAGE SYSTEM POWER 11.2 KW										
							AVERAGE C/B OPEN POWER 12.0 KW										
		REVERSE POWER REQUIRED TO ACTUATE REVERSE POWER PROTECTIVE DEVICE ON SET NO. 1 = 0.8 KW															

NOTES: SYSTEM CURRENT MEASURED USING CURRENT TRANSFORMERS NO. 1305 - L_1, 1306 - L_2, 1307 - L_3

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 516.2-I. Typical test record for reverse power protective device test

X-4613

Device Test.]

METHOD 516.5a

REVERSE BATTERY POLARITY TEST

516.5.1 General. Batteries are items that are normally installed in the field since they are shipped dry and mist be activated before use in the generator set. Little control is available aver the installation of the set batteries or the connection of slave batteries, therefore it is important that a mistake in the battery connections will not cause damage to the generator set.

516.5.2 Apparatus. A slave battery cable and slave batteries of the proper voltage and size to start the set shall be required.

516.5.3 Procedure.

a. With the set batteries installed in their normal operating position in accordance with the instructions on the set or in the technical manual, start and operate the generator set at rated voltage, rated frequency (speed) and no load for a period of 5 minutes. The set instruments will be sufficient to indicate voltage and frequency.
b. After the 5 minute operation, shut the set down. Reverse the polarity of the set batteries and attempt to start the set following the instructions on the set or in the technical manual. Record the results of the starting attempt on the data sheet (see figure 516.5-I).
c. Open the control panel and visually check for damage to any component. Record observations on the data sheet. Replace fuse, if applicable.
d. Record operation of reverse polarity malfunction indicator, if so equipped.
e. Correct the polarity of the set batteries and attempt to start the set in accordance with the instructions on the set on the data sheet.
f. If the generator set is equipped with a battery slave receptacle, disconnect the set batteries and using a slave cable and slave batteries, repeat steps a thru d above.
g. Perform any other checks as specified in the procurement document.

516.5.4 Results. Compare the operation or non-operation of the generator set with the requirements of the procurement document.

516.5.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The requirements of the reverse battery polarity protection.
b. Any additional checks on the battery polarity other than those specified in 516.5.3.
c. Reverse polarity malfunction indicator requirements, if applicable.

TEST DATA

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE
REVERSE BATTERY POLARITY TEST

DESCRIPTION 15 KW, 60 HZ 120 V, SINGLE-PHASE - GENERATOR SET
MFGR. ENGENSETS, INC
MODEL NO. SE-15.0-MD
SERIAL NO. 1077
REF: MIL-STD-705/516.5

TEST NO. 29
SHEET 1 OF 1
DATE FEBRUARY 9, 1971
RECORDER J Wright
PROJ. ENGR. J Jones
SHIFT LEADER H Smith
OBSERVER L Lee

INST. →			1076
READ NO. ↓	TIME		AVG AMB TEMP
UNITS	HRS		°F
SYM.			
COL.	1	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	17
	09:15	STARTED SET WITH BATTERIES CONNECTED IN ACCORDANCE WITH SET SCHEMATIC - SET OPERATING AT NO LOAD.	73
	09:20	SHUTDOWN SET.	
	09:30	ATTEMPTED TO START SET WITH BATTERY POLARITY OPPOSITE THAT SHOWN ON SET SCHEMATIC. SET DID NOT CRANK - NO VISUAL FAILURES NOTED.	
	09:40	STARTED SET WITH BATTERIES CONNECTED IN ACCORDANCE WITH SET SCHEMATIC	
	09:42	SHUTDOWN SET.	
	10:00	STARTED SET WITH SLAVE BATTERIES CONNECTED IN ACCORDANCE WITH SET SCHEMATIC - SET OPERATING AT NO LOAD.	
	10:06	SHUTDOWN SET.	
	10:08	ATTEMPTED TO START SET WITH SLAVE BATTERIES - POLARITY OPPOSITE THAT SHOWN ON SET SCHEMATIC. SET DID NOT CRANK. NO VISUAL FAILURES NOTED.	
	10:10	STARTED SET WITH SLAVE BATTERIES CONNECTED IN ACCORDANCE WITH SET SCHEMATIC	
NOTES:			

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 516.5-I - Typical test record for reverse battery polarity test.

X-4614

Test.]

METHOD 521.1a

PARALLELING AID DEVICE TEST

521.1.1 General. The paralleling aid device is designed to prevent the paralleling of a generator set with another generator set or operating system unless the voltage and phase relations are within certain limits to prevent damage to either the generator set or the system.

521.1.2 Apparatus. Instrumentation for measuring load conditions of the generator set acting as the system, and voltage and frequency of the generator set to be paralleled, shall be as described and illustrated in MIL-HDBK-705. In addition, a synchroscope or phase relationship indicating equipment as described and illustrated in MIL-HDBK-705, method 117.1, to detect the phase relationship between the system and the generator set, shall be required.

521.1.3 Procedure. The generator set acting as the "system" shall be designated as set No. 1. The generator set with the paralleling aid device under test shall be designated as set No. 2.

521.1.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 to set No. 1 for a voltage connection and frequency specified in the procurement document.
b. Connect the voltage and frequency sensing instruments to the line side of the circuit interrupter of set No. 2 in accordance with the applicable figure(s) of MIL-HDBK-705, method 205.1, paragraphs 205.1.4 and 205.1.9 for the same voltage connection and frequency used in step a above.
c. Connect the output terminals of set No. 2 to the output terminals of set No. 1 with the correct phase relationship (L_1 - L_1; L_2 - L_2; L_3 - L_3; L_0 - L_0).
d. Connect the synchroscope, or phase relation indicating equipment, in accordance with the manufacturer’s instructions in such a manner that the same phase voltage of each set (No. 1 and No. 2) is sensed and the phase difference, in degrees, can be readily determined.

521.1.3.2 Test.

a. Start and operate set No. 1 at rated voltage, rated frequency and rated load.
b. Start and operate set No. 2 with the frequency difference between the two sets within the limits specified in the procurement document for the paralleling aid device to activate and with the voltage 10 percent below the voltage of set No. 1.
c. With the operator selector switch of set No. 2 in the "Parallel Operation" position, slowly raise the voltage of set No. 2. Record the voltage of both sets and the phase difference in degrees at the time the sets are paralleled.
d. Repeat steps b and c above with the operator selector switch in the "Single Unit Operation" position and the circuit interrupter control switch held in the "closed" position.

e. Repeat steps b and c above except that the voltage of set No. 2 shall be 10 percent above the voltage of set No. 1 and the voltage of set No. 2 shall be slowly lowered.
f. Repeat step e above with the operator selector switch in the "Single Unit 10 operation" position and the circuit interrupter control switch held in the "closed" position.
g. Operate set No. 2 such that the voltage difference between the two sets is within the limits specified in the procurement document for the paralleling aid device to activate and the frequency is 2.5 percent below the frequency of set No. 1.
h. With the operator selector switch of set No. 2 in the "Parallel Operation" position, slowly raise the frequency of set No. 2. Record the frequency of both sets and the phase difference in degrees just prior to the time the sets are paralleled.
i. Repeat steps g and h above with the operator selector switch in the "Single Unit Operation" position and the circuit interrupter control switch held in the "closed" position.
j. Repeat steps g and h above except that the frequency of set No. 2 shall be 2.5 percent above the frequency of set No. 1 and the voltage of set No. 2 shall be slowly lowered.
k. Repeat step j above with the operator selector switch in the "Single Unit Operation" position and the circuit interrupter control switch held in the "closed" position.
l. Shut down set No. 1. With set No. 2 operator selector switch in the "Parallel Operation" position, record the operation of set No. 2’s circuit interrupter.
m. Repeat steps a thru 1 above for any other voltage connection(s) and frequency(ies) specified in the procurement document.

521.1.4 Results. Compare the parallel and device activation readings with the limits as specified in the procurement document.

521.1.5 Procurement document requirements. The following item must be specified in the individual procurement document:

a. Voltage tolerance in percent of rated voltage beyond which the paralleling aid device must not permit paralleling.
b. Frequency tolerance in percent of rated frequency beyond which the paralleling aid device must not permit paralleling.
c. Phase angle tolerance in degrees beyond which the paralleling aid device must not permit paralleling.
d. Voltage connection(s) and frequency(ies) at which this method shall be performed.

TEST DATA

DESCRIPTION 15 KW, [illegible]
120/208 V 3-PHASE
GENERATOR SET
MFGR. ENGENSETS INC
MODEL NO SE-15.0-MD
SERIAL NO. 2177
REF MIL-STD-705/521.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

PARALLELING AID DEVICE TEST

TEST NO. 14
SHEET 1 OF 1
DATE 5 NOV, 1971
RECORDER [illegible]
PROJ. ENGR [illegible]
SHIFT LEADER [illegible]
OBSERVER [illegible]

INST →		117		601				119		218		312		406		612	1001
READ NO. ↓	TIME	SET					SYSTEM										PHASE DIFF
		TERM VOLTAGE		FREQUENCY			TERM VOLTAGE		LINE CURRENT		OUTPUT	POWER	POWER FACTOR		FREQUENCY		
UNITS	HRS		VOLTS		HZ			VOLTS	AMPS	AMPS	KW	KW		—		HZ	DEG
SYM									X 20	X 1	X 20	X 1					
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:30	STARTED SYSTEM APPLIED RATED LOAD															
	08:3[illegible]	STARTED SET															
	08:3[illegible]		108		60.0			120	2.6	52	.25	5.0		0.80		60.0	0
	08:35		112	SET PARALLELED WITH SYSTEM.													0
	08:40	OPENED SET CIRCUIT INTERRUPTER															
	08:41		108		60.0			1[illegible]	[illegible]	[illegible]	.25	5.0		0.80		60.0	0
	08:42	ATTEMPTED TO CLOSE CIRCUIT INTERRUPTER WITH UNIT-PARALLEL SWITCH IN THE UNIT															
		POSITION - SET WOULD NOT PARALLEL.															
	08:45		132		60.0			120	2.6	52	.25	5.0		0.80		60.0	0
	08:47		129		60.0		SET PARALLELED WITH SYSTEM.										0
	08:5[illegible]	OPENED SET CIRCUIT INTERRUPTER															
	08:51		132		60.0			120	2.[illegible]	52	.25	5.0		0.80		60.0	0
	08:53	ATTEMPTED TO CLOSE CIRCUIT INTERRUPTER WITH UNIT-PARALLEL SWITCH IN THE															
		UNIT POSITION - SET WOULD NOT PARALLEL															
	09:00		120		58.5			120	2.6	52	.25	5.0		0.80		60.0	-
	09:02		120		60.0			120	2.6	5[illegible]	.25	5.0		0.80		60.0	0
		SET PARALLELED WITH SYSTEM.															
	09:05	OPENED SET CIRCUIT INTERRUPTER															

NOTES: C.T. FOR LINE CURRENT TJ. 1305, 1306, 1307
LOAD WAS BALANCED ON THE SYSTEM THE READINGS SHOWN
FOR VOLTS, AMPS, KW, POWER FACTOR WERE FROM PHASE 1 ONLY

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 521.1-I. Portion of a typical test record for paralleling aid device test.

X-4615

Aid Device Test.]

METHOD 601.1d

VOLTAGE WAVEFORM TEST

(OSCILLOGRAPHIC)

601.1.1 General. Voltage waveform is the value of voltage as a function of time. A graphic representation of a voltage waveform may be obtained using an oscillograph.

Generally, the voltage waveform produced by alternating-current generators is approximately sinusoidal; however, since the design of generators varies, the voltage waveform also varies or deviates differently for each generator design. The term deviation factor is used to describe the maximum deviation of a generator voltage waveform fran that of a true sine wave. The deviation factor of a wave is defined as the ratio of the maximum difference between corresponding ordinates of the wave and the equivalent true sine wave to the peak value of the equivalent true sine wave when the two waves are superposed in such a manner as to make this maxima difference as small as possible.

Since some equipment powered by a generator set may not function properly if the voltage waveform deviates too much from a true sine wave, it is important that the deviation factor be maintained within practical limits.

601.1.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, an oscillograph as described and illustrated in MIL-HDBK-705, method 106.1, graph 106.1.3, having chart speeds of a minimum of 240 inches per second for 60 Hz or 1600 inches per second for 400 Hz (unless otherwise specified in the procurement document), galvanometers having a minimum flat frequency response (flat within plus or minus 5 percent) from dc to 3000 Hz and galvanometer matching networks utilizing noninductive-resistive components will also be required.

601.1.3 Procedure.

601.1.3.1 Preparation for test. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10, the oscillograph manufacturer's instructions, and the instructions given in this method for one voltage connection and frequency specified in the procurement document.

601.1.3.2 Test.

a. In the following steps, the galvanometer and matching network shall be connected directly to the generator set output terminals.
b. Connect the galvanometer and matching network to one of the line connections (L_1 - L_2, L_1 - l_0, etc.) specified in the procurement document.
c. Start and operate the generator set at one of the load conditions specified in the procurement document.
d. Adjust the peak-to-peak amplitude of the voltage trace to a minimum of 4 inches (approximately 10 centimeters).

e. Adjust the oscillograph chart speed such that the per cycle time base of the voltage trace is a minimum of 4 inches (approximately 10 centimeters).
f. After the conditions of steps d and e above have been obtained, take an oscillogram of the voltage waveform.
g. Read and record the load instrumentation, line connection and oscillogram number (see figure 601.1-I).
h. Repeat steps b thru g above for each of the other line connections specified in the procurement document.
i. Repeat steps b thru h above for each of the other voltage connections, procurement document.

6.1.1.4 Results.

a. The equivalent sine wave shall be determined by the following method (see figures 601.1-II.and 601.1-III):

    1. Construct the zero potential line of the voltage trace midway between the positive and negative peaks, being careful to use the center of the trace width.
    2. Using one complete cycle of the trace, divide the zero potential line into at least 36 equal parts beginning and ending at the points where the trace crosses the zero potential line.
    3. Construct line (ordinates) perpendicular to the zero potential line at each of the points established in step 2 above.
    4. Measure the length of each ordinate from the zero potential line to the center of the trace width, to the nearest millimeter.
    5. Square each measured ordinate and sum the squares. Divide this sum by the total number of equal parts.
    6. Take the square root of the value obtained in step 5 above and multiply this value by the square root of 2.
    7. Using the value obtained in step 6 above as the peak value of the equivalent sine wave, calculate the lengths of the remaining ordinates using the sine of the electrical degree angles at each of the remaining points established in step 2 above.
    8. Construct the equivalent sine wave with a time base equal to the complete cycle of the generator voltage waveform trace used in step 2 above. This construction must be on a separate sheet of paper in order to proceed with part b below.

b. Comparison of waves:

    1. Superpose the complete cycle used in 601.1.4a.2 over the equivalent sine wave constructed in 601.1.4a.8 so that the maximum vertical difference between the two traces is as small as possible. Accomplish this by shifting one trace with respect to the other, keeping the zero potential lines of the two traces superposed.
    2. Determine, to the nearest 0.25 millimeter, the maximum vertical difference between the two traces.
    3. Divide the result of step 2 above by the peak value obtained in 601.4a.6, then multiply by 100. This is the deviation factor of the generator waveform, in percent.

c. Compare the deviation factor determined in 601.1.4b.3 above with the requirement of the procurement document.

601.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable deviation factor.
b. Load conditions at which this method is to be performed.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Line connections ($L_1 - L_2$, $L_1 - L_0$, etc.) for which this method is to be performed.

TEST DATA

DESCRIPTION 10 KW, 60 Hz
120/208 Volts
3-PHASE C.B.P.F. GEN SET
MFGR. [illegible] INC
MODEL NO. SF-10.0-MD/SIED
SERIAL NO. 21067
REF: MIL-STD-705/601.1

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

VOLTAGE WAVEFORM
(OSCILLOGRAPHIC)

TEST NO. 40
SHEET 1 OF 1
DATE AUG 5, 1970
RECORDER [illegible]
PROJ. ENGR. [illegible]
SHIFT LEADER
OBSERVER [illegible]

INST. →			495	317	425				465	010							
READ NO. ↓	TIME	LINE CONN.	TERM VOLT.	LINE CURR.	OUTPUT POWER				POWER FACTOR	FREQ	PIC No						
UNITS	HRS		VOLTS	AMPS	KW	KW	KW	KW		Hz							
SYM.				X10	X10	X10	X10	X1									
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1300	L1-L2	208	3.5	0.33	0.33	0.34	10.0	0.90	60.0	1						
		L2-L3	208	3.5	0.33	0.33	0.33	9.9	0.90	60.0	2						
		L3-L1	208	3.5	0.33	0.33	0.34	10.0	0.80	60.0	3						
		L1-L0	120	3.5	0.33	0.33	0.34	10.0	0.80	60.0	4						
		L2-L0	120	3.5	0.33	0.33	0.34	10.0	0.80	60.0	5						
		L3-L0	120	[illegible]	0.33	0.33	0.34	10.0	[illegible]	60.0	6						
		L1-L2	[illegible]	2.8	0.33	0.33	0.34	10.0	1.0	[illegible]	7						
		L2-L3	[illegible]	2.8	0.33	0.33	0.34	10.0	1.0	60.0	8						
		L3-L1	[illegible]	2.8	0.33	[illegible]	0.34	10.0	1.0	[illegible]	[illegible]						
		L1-L0	120	2.8	0.33	0.33	[illegible]	10.0	1.0	[illegible]	[illegible]						
		L2-L0	120	2.8	[illegible]	0.33	[illegible]	10.0	1.0	60.0	11						
		L3-L0	120	2.8	0.33	[illegible]	0.34	10.0	1.0	60.0	12						
		L1-L2	208	0	0	0	0	[illegible]	—	60.0	[illegible]						
		L2-L3	[illegible]	0	0	0	0	[illegible]	—	60.0	14						
		L3-L1	[illegible]	0	0	0	[illegible]	[illegible]	—	60.0	[illegible]						
		L1-L0	120	0	0	[illegible]	[illegible]	[illegible]	—	60.0	[illegible]						
		L2-L0	120	0	0	0	[illegible]	[illegible]	—	[illegible]	[illegible]						
		L3-L0	120	0	0	0	[illegible]	0	—	60.0	[illegible]						

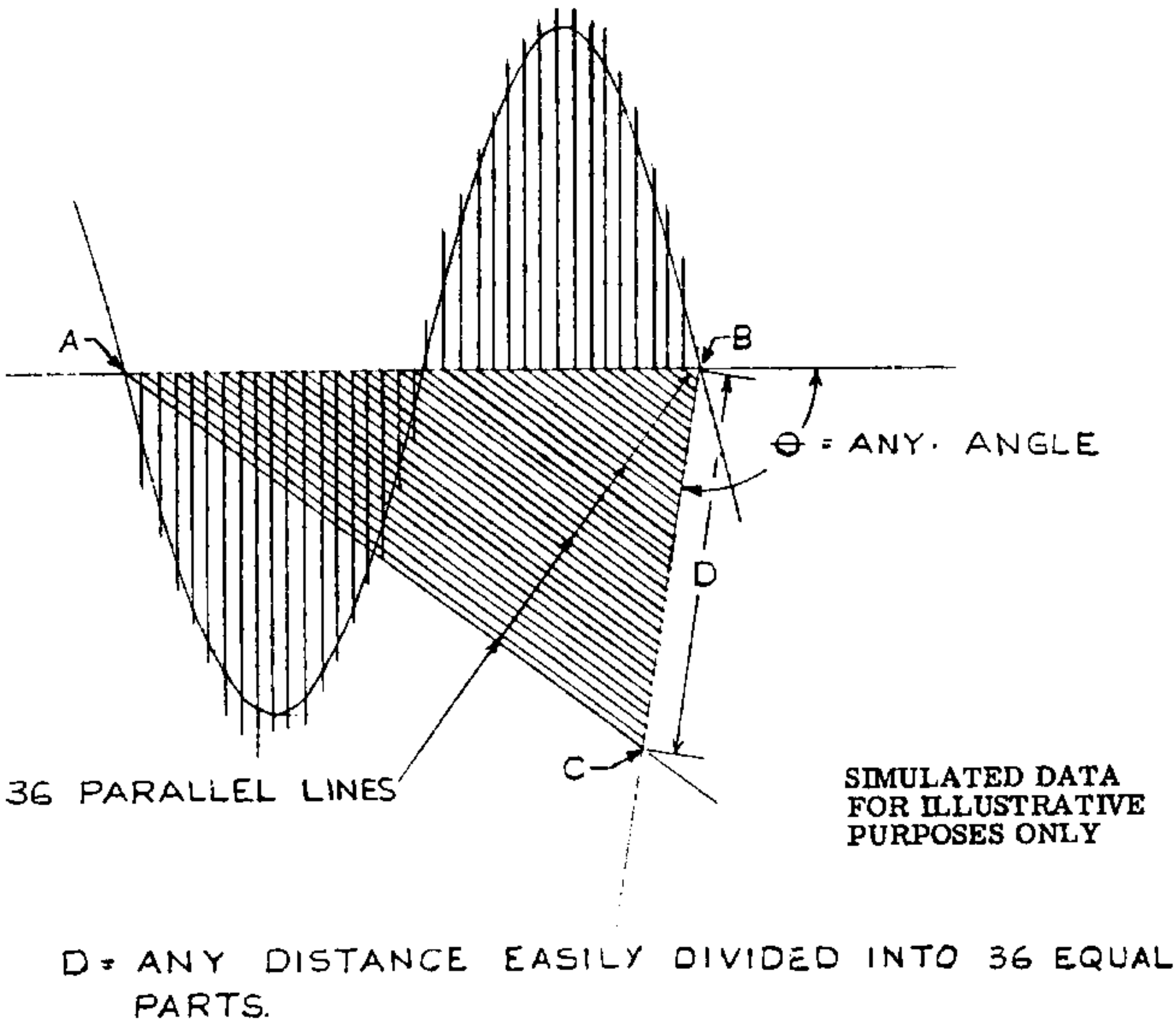
NOTES: CT# 1151

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

SMEFB Form 28
16 Sep 69

FIGURE 601.1-I TYPICAL TEST RECORD FOR VOLTAGE WAVEFORM (OSCILLOGRAPHIC)

-2- -16,608—Ft Belvoir



NOTES:

1. (A) is the intersection of the zero potential line with the voltage trace and shall be the start of the complete cycle.

2. (B) is the second intersection of the zero potential line with the voltage trace counting from (A) and shall be the end of the complete cycle.

3. (C) is 36 equal distances from (B) along any line starting at (B).

4. Line A-C is the direction of the 36 parallel lines dividing the zero potential line into 36 equal parts. These lines start at each of the 36 equal divisions of line B-C.

FIGURE 601.1-II. TYPICAL OSCILLOGRAM OF A VOLTAGE WAVEFORM (NOT TO SCALE)

ORDINATE NO.	ORDINATE LENGTH (mm)	ORDINATE SQUARED $(mm)^2$	ANGLE ELECTRICAL DEGREES	SINE OF ANGLE	ORDINATE LENGTH EQUIV. SINE WAVE
0	0	0	0	0	0
1	10	100	10	0.174	9
2	20	400	20	0.342	18
3	29	841	30	0.500	26
4	35	1225	40	0.643	34
5	41	1681	50	0.766	40
6	45	2025	60	0.866	45
7	49	2401	70	0.940	49
8	51	2601	80	0.985	51.5
9	52	2704	90	1.000	52
10	51	2601	100	0.985	51.5
11	50	2500	110	0.940	49
12	46	2116	120	0.866	45
13	42	1764	130	0.766	40
14	37	1369	140	0.643	34
15	30	900	150	0.500	26
16	23	529	160	0.342	18
17	15	225	170	0.174	9
18	6	36	180	0	0
19	- 2	4	190	-0.174	- 9
20	-12	144	200	-0.342	-18
21	-21	441	210	-0.500	-26
22	-31	961	220	-0.643	-34
23	-37	1369	230	-0.766	-40
24	-42	1764	240	-0.866	-45
25	-47	2209	250	-0.940	-49
26	-50	2500	260	-0.985	-51.5
27	-52	2704	270	-1.000	-52
28	-51	2601	280	-0.985	-51.5
29	-50	2500	290	-0.940	-49
30	-46	2116	300	-0.866	-45
31	-41	1681	310	-0.766	-40
32	-35	1225	320	-0.643	-34
33	-26	676	330	-0.500	-26
34	-19	361	340	-0.342	-18
35	-10	100	350	-0.174	- 9
36	0	0	360	0	0
	TOTAL	49,374			

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$$\text{Peak Value of Equiv. Sine Wave} = \sqrt{\frac{49,374}{36}} \times \sqrt{2}$$

$$= 52 \text{ mm}$$

Typical Equivalent Sine Wave Ordinate Calculation:
Ordinate at 10 Degrees = Sine 10° x 52 (Peak value of equiv. sine wave)
= 0.174 x 52 = 9 mm

FIGURE 601.1-III SAMPLE CALCULATION OF EQUIVALENT SINE WAVE

METHOD 601.4b

VOLTAGE WAVEFORM TEST

(HARMONIC ANALYSIS)

601.4.1 General. The voltage waveform of a generator set may be analyzed by determining the magnitude of the specific frequency components, other than the fundamental, contained in the waveform. The method of analysis is called harmonic analysis. A harmonic is defined as a frequency component whose frequency is an integral multiple of the fundamental frequency of the waveform.

601.4.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a waveform analyzer and oscilloscope (with camera) as described and illustrated in MIL-HDBK-705, method 106.1 (unless otherwise specified in the procurement document) will also be required.

601.4.3 Procedure.

601.4.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure in MIL-HDBK-705, method 205.1, paragraph 205.1.10 for a voltage connection and frequency specified in the procurement document.
b. Connect the waveform analyzer and oscilloscope signal inputs directly to the generator set output terminals, for one of the line connections (L_1 - L_2, L_1 - L_0, etc.) specified in the procurement document.

NOTE: If the generator set output voltage magnitude will be greater than the voltage input ratings of either the waveform analyzer or oscilloscope, use a voltage divider of noninductive-resistive components to lower the input voltage such that it is compatible with the signal input voltage ratings of the waveform analyzer or oscilloscope. For the oscilloscope, a probe may be used but care must be exercised to insure that it is properly adjusted in accordance with the manufacturer’s instructions.

601.4.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency, and at one of the load conditions specified in the procurement document.
b. Operate the waveform analyzer in accordance with the manufacturer’s instructions and read and record, as a percentage of the fundamental, the magnitude of each harmonic in excess of 0.05 percent. On preproduction generator sets, read and record all the harmonics thru the 50th, fractional order harmonics and slot harmonics. Scan the frequencies thru 50 kHz, noting and recording any harmonics greater than 0.05 percent. On production generator sets, read and record the harmonics thru the 20th.

NOTE: The calibration of the waveform analyzer must be checked, using the internal calibrator, before proceed to the next condition (e.g. load condition, line connection, etc.).

c. Adjust the voltage trace on the oscilloscope screen such that the complete cycle of the voltage covers approximately both the full vertical and full horizontal dimensions of the graduated portion of the viewing screen. The oscilloscope controls need not be in their calibrated position unless measurements of discontinuities in the waveform are desired.
d. With the oscilloscope adjusted as in step c above, take a photograph of the voltage waveform.
e. Repeat 601.4.3 for each of the other load conditions, line connections, voltage conditions and frequencies specified in the procurement document.

601.4.4 Results. The data sheet (see figure 601.4-I) shall show in addition to the load instrumentation readings, the values of the harmonics in percent of the fundamental for each line connection, load condition, voltage connection and frequency. Compare these results with the procurement document requirements.

601.4.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable value of a single harmonic, in percent of the fundamental.
b. Line connection(s) at which this method is to be performed.
c. Load conditions(s) at which this method is to be performed.
d. Voltage connection(s) and frequency(ies) at which this method is to be performed.
e. Discontinuities in the voltage waveform allowed, if any.

TEST DATA

DESCRIPTION 10KW 60Hz
120/208 V 3-PHASE
0.8 P.F. GEN SET
MFGR. ENGENSETS, INC.
MODEL NO. SF-10.0-MD/SIEP
SERIAL NO. 21067
REF: MIL-STD-705A/601.4

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

VOLTAGE WAVEFORM
(HARMONIC ANALYSIS)

TEST NO. 15
SHEET 1 OF 4
DATE AUGUST 5, 1970
RECORDER D. Wright
PROJ. ENGR. M.E. Doo
SHIFT LEADER L.E.T. Go
OBSERVER D.C. Too

INST. →			995	317	425				965	010	792						
READ NO. ↓	TIME	LINE CONN	TERM VOLT	LINE CURR	OUTPUT POWER				POWER FACTOR	FREQ	HARMONIC						
											FUND.	2ND	3RD	4TH	5TH	6TH	7TH
UNITS			VOLTS	AMPS	L_1	L_2	L_3	KW		Hz	%	%	%	%	%	%	%
SYM.				X10	X10	X10	X10	X1									
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1300	L_1-L_2	208	3.4	.33	.33	.34	10.0	.80	60.0	100	0.10	1.30	0.08	0.72	0.06	0.43
		L_2-L_3	208	3.4	.33	.33	.34	10.0	.80	60.0	100	0.11	1.27	0.06	0.71	0.05	0.43
		L_3-L_1	208	3.5	.33	33	.34	10.0	.80	60.0	100	0.11	1.29	0.07	0.70	0.06	0.42
		L_1-L_0	120	3.4	.33	.33	.34	10.0	.80	60.0	100	0.09	1.75	0.13	0.92	0.09	0.27
		L_2-L_0	120	3.4	.33	.33	.34	10.0	.80	60.0	100	0.10	1.72	0.11	0.84	0.06	0.24
		L_3-L_0	120	3.5	.33	.33	.34	10.0	.80	60.0	100	0.09	1.75	0.12	0.91	0.08	0.26
		L_1-L_2	208	2.8	.33	.33	.34	10.0	1.0	60.0	100	0.07	1.10	0.06	0.65	—	0.39
		L_2-L_3	208	2.9	.33	.33	.34	10.0	1.0	60.0	100	0.06	1.15	0.07	0.69	—	0.37
		L_3-L_1	208	2.8	.33	.33	.34	10.0	1.0	60.0	100	0.07	1.13	0.05	0.62	—	0.38
		L_1-L_0	120	2.8	.33	.33	.34	10.0	1.0	60.0	100	0.08	1.52	0.09	0.86	0.05	0.09
		L_2-L_0	120	2.8	.33	.33	.34	10.0	1.0	60.0	100	0.07	1.97	0.07	0.84	—	0.08
		L_3-L_0	120	2.8	.33	.33	.34	10.0	1.0	60.0	100	0.08	1.51	0.08	0.85	0.06	0.10
		L_1-L_2	208	0	0	0	0	0	—	60.0	100	—	2.11	—	0.30	—	0.18
		L_2-L_3	208	0	0	0	0	0	—	60.0	100	—	2.33	—	0.28	—	0.16
		L_3-L_1	208	0	0	0	0	0	—	60.0	100	—	2.16	—	0.29	—	0.15
		L_1-L_0	120	0	0	0	0	0	—	60.0	100	—	2.30	—	0.41	—	0.06
		L_2-L_0	120	0	0	0	0	0	—	60.0	100	—	2.28	—	0.43	—	0.07
		L_3-L_0	120	0	0	0	0	0	—	60.0	100	—	2.26	—	0.40	—	0.07

NOTES:

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

X-4618

SMEFB Form 28
16 Sep 69

FIGURE 601.4-I. PORTION OF A TYPICAL TEST RECORD FOR VOLTAGE WAVEFORM (HARMONIC ANALYSIS)

Waveform.]

METHOD 601.5

VOLTAGE WAVEFORM TEST (DEVIATION FACTOR)

601.5.1 General. Voltage waveform is the value of voltage as a function of time. The deviation factor of a wave is the ratio of the maximum difference between corresponding ordinates of the wave and of the equivalent sine wave to the maximum ordinate of the equivalent sine wave when the waves are superposed in such a way as to make this maximum difference as small as possible. Since some equipment powered by a generator set may not function properly if the voltage waveform deviates too much from a true sine wave, the deviation factor must be maintained within practical limits.

601.5.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a data acquisition instrument or system capable of digitizing, storing, and displaying one cycle of the voltage waveform in any x-y format will also be required. Data acquisition instruments are described in MIL-HDBK-705, method 106.1. Also a noninductive voltage divider may be required to reduce the generator line voltage to a voltage compatible with the instrumentation input.

601.5.3 Procedure.

601.5.3.1 Preparation of test. Connect the load and instrumentation in accordance with the applicable figure of method 205.1, MIL-HDBK-705, the data acquisition instrument manufacturer’s instructions, and the instructions contained herein for one voltage connection and frequency specified in the procurement document.

601.5.3.2 Test.

601.5.3.2.1 Waveform acquisition.

CAUTION: Some digital equipment may have single-ended inputs; that is, one input load is connected to the chassis ground. This chassis ground is electrically the same as "House Power" ground and the engine generators utilized during this test may have their neutral tied to earth ground. This condition presents no problem for phase-to-neutral (L-N) voltage waveform measurements. For phase-to-phase ($L_1 - L_2$, $L_1 - L_0$, etc.) measurements however, it may be necessary to "float" the instrument (Lift the chassis ground). A phase-to-phase non-inductive voltage divider may be used to reduce the signal voltage to the instrument.

a. Connect the voltage waveform deviation measurement system to one of the line connections ($L_1 - L_2$, $L_1 - L_0$, etc.) specified in the procurement document.
b. Start and operate the generator set at one of the load conditions specified in the procurement document. Read and record load instrumentation, line connection and voltage connection on the data sheet. (See figure 601.1-I).

d. Store the sampled waveform in memory.
e. Record the voltage waveform in an x-y format. A photograph of an oscilloscope display of each sample waveform or an x-y presentation shall be supplied for record purpose.
f. From the stored digital waveform data, analyze the waveform for deviation from a true sine wave. If the data acquisition system has the capability of storing the data on magnetic tape, the waveform analysis may be performed after all waveform samples are obtained.
g. Repeat steps a through f for each of the other line connections, load conditions, voltage outputs, and frequencies specified in the procurement document. Once the waveform is digitized, the waveform deviation should be processed by calculator or computer on a numerical basis.

601.5.3.2.2 Waveform analysis. The mathematical data reduction techniques described herein require the accurate shifting of the theoretical sine wave in 0.25 degree increments. Therefore, the shifting operation should be performed on a numerical basis utilizing a computer or a programmable calculator.

a. From the recorded waveform, establish the zero potential line midway between the positive and negative peaks of the voltage waveform.
b. Divide the zero potential line into at least 36 parts for 1 complete waveform.
c. Determine the voltage waveform amplitude at each of these points.
d. Square each value in step c and sum the squares. Divide this sum by the total number of sample points used in step b.
e. Take the square root of the value obtained in step d and multiply this value by the square root of two.
f. Using the value obtained in step e as the peak value of the equivalent sine wave, calculate the lengths of the remaining ordinates using the sine of the electrical degree angles at each of the remaining points established in step b above.
g. Compare sample waveform actual values versus theoretical values.
h. Determine the maximum difference at each ordinate.
i. Divide the results of step h above by the peak value obtained in step e above. This is a deviation factor.
j. Shift the ordinates established in step f above by a maximum of +/- 0.25 degrees steps. Recalculate the amplitude of these ordinates.
k. Repeat steps h, i, and j until the deviation factor is minimized. This is the deviation factor of the generator in percent. Record the deviation factor on the data sheet.
l. Compare the minimum deviation factor determined in step k above with the requirements of the procurement document.

601.5.4 Results. The data required from this test shall include:

a. Data sheet showing line connection, load instrument readings, frequency etc. (figure 601.1-I).
b. x-y presentation of each sample generator waveform for each line connection, load condition, voltage connection and frequency specified in the procurement document.
c. Maximum deviation in percent from a true sine wave.

d. An equipment list showing all load measuring equipment, data acquisition system components, and data analysis equipment utilized.
e. Data analysis program utilized. For example, if a computer based data reduction system is used, the computer program listing shall be supplied.

601.5.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable deviation factor.
b. Load conditions at which this method is to be performed.
c. Voltage(s) connections and frequency(ies) at which this method is to be performed.
d. Line connections ($L_1 - L_2$, $L_1 - L_0$, etc.) for which this method is to be performed.

ITEM	TEST AND EVALUATION DIVISION	TEST NO. 601.1
GENERATOR SET	U.S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER	SHEET 1 OF 1
120V. 10. 0.8PF	FORT BELVOIR, VIRGINIA 22060	DATE 5 AUG 80
MFGR. ACE MFG. CO.		JOB NO. XXXX
MODEL NO. MEP-003A	VOLTAGE WAVEFORM TEST	RECORDER R. E. Corder
SERIAL NO. XX0001	(DEVIATION FACTOR)	OBSERVER Pat E. Melt
REF: MIL-STD-705/601.1		

INST. →			495	317	425	465	010	216									
READ NO. ↓	TIME	LINE CONN	TERM V	LINE I	PWR	P.F.	FREQ	X-Y		MAX DEV							AMB TEMP
UNITS	HRS		VOLTS	AMPS	KW	%	HZ			%							°C
SYM.				X40	X40												
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	0900	L1-L3	120.0	2.60	2.50	80	60.0	1		2.31							21
2	0930	L1-L3	120.0	0	0	-	60.0	2		1.20							21
3	1000	L1-L3	120.0	2.08	2.50	1.0	60.0	3		1.72							21
4	1030	L1-L3	120.0	1.04	1.25	1.0	60.0	4		1.51							21
5	1100	L1-L3	120.0	1.30	1.25	0.8	60.0	5		2.21							21
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES.
CURRENT TRANSFORMER RATIO 200/5 SN: 1151
WAVEFORM INSTRUMENT/SYSTEM DESCRIPTION

FIGURE 601.5-I Typical test record for voltage waveform.

X-4616

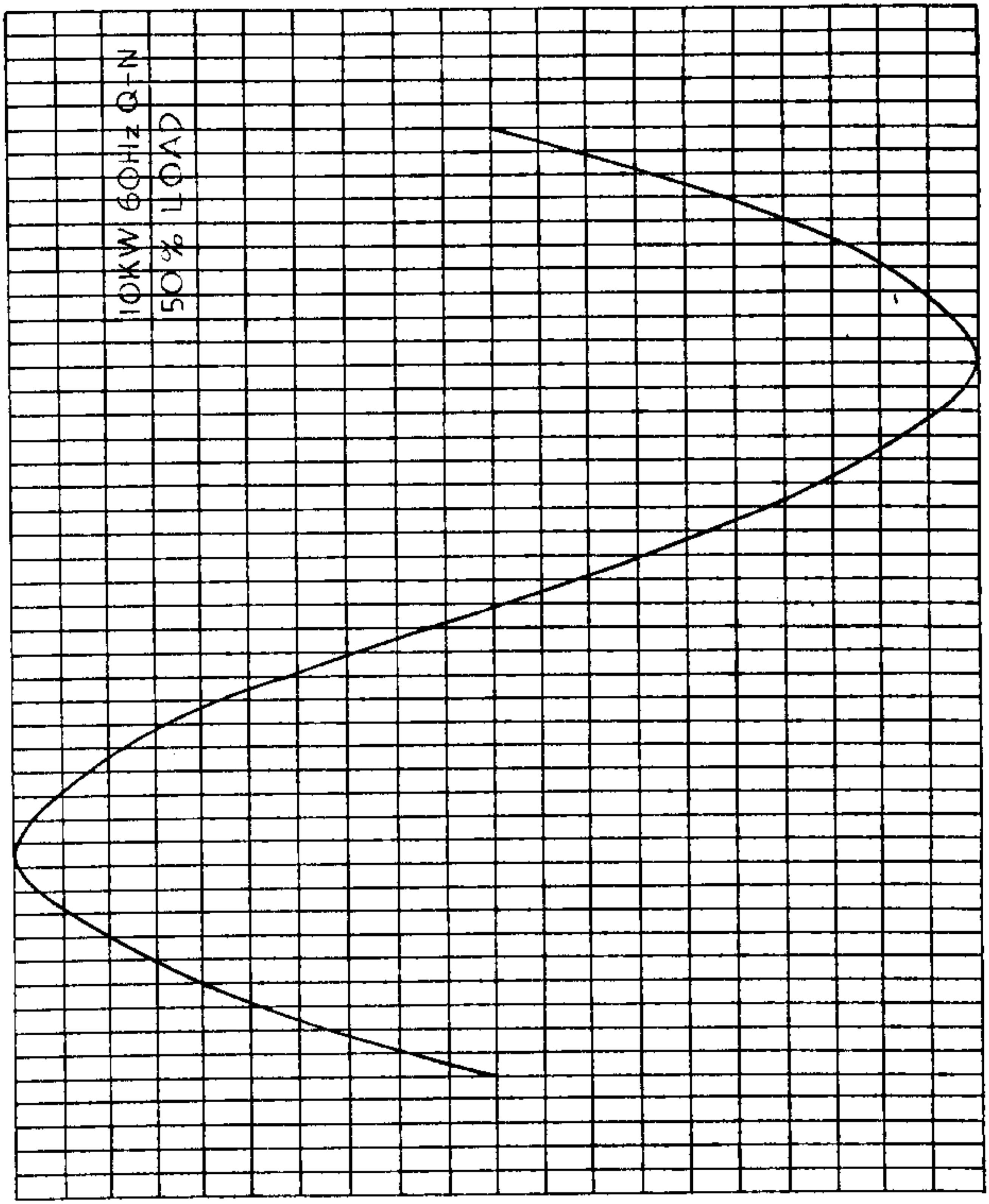


FIGURE 601.5-II. Typical x-y graph of voltage waveform.

X-4617

METHOD 602.1b

VOLTAGE MODULATION TEST

602.1.1 General. If the peak value of a voltage wave is not constant but varies with time, the wave is considered to be voltage modulated. In many cases, the rate at which the peak value varies is so rapid or the magnitude of variation so small that the modulation cannot be detected by observation of a voltmeter. Voltage modulation can affect the operation of the generator set as well as some types of electrical equipment.

602.1.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a fast writing oscilloscope having a flat bandwidth of dc to 5 MHz, minimum, and single sweep features (Tektronix Model 556, or equal) equipped with a centimeter marked graticule and an oscilloscope camera will be required. The circuit illustrated in figure 602.1-I will also be required. The two zener diodes CR 1 and CR 2 are a matched pair with nominal rating of 170 volts; zener voltage of the two diodes shall be determined by test and shall not differ by more than 0.3 volts. A continuously variable autotransformer and isolation transformers will be needed. The continuously variable autotransformer shall be selected such that the following will apply:

a. There will be negligible saturation of the magnetic circuits. To achieve this requirement, the autotransformer rated input voltage shall be at least 125 percent of the maximum voltage which will be applied to its input terminals during this test.
b. The distortion of the output shall not be more than 0.5 percent higher than at the input.
c. The winding resistance will be not greater than 50 ohms.

The same requirements shall apply for the isolation transformers at the input voltages indicated in figure 602.1-II.

602.1.3 Procedure.

602.1.3.1 Preparation for test.

a. Connect the load apparatus in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10.
b. Operate the set at rated frequency and voltage at no load.
c. Connect the specific voltage(s) to be tested to the modulation test box as shown in figure 602.1-II. The voltmeter shown shall be a rms indicating meter in accordance with MIL-HDBK-705, method 101.1.
d. Compensate the oscilloscope probe in accordance with the manufacturer’s instructions.
e. Verify the accuracy and frequency response of the oscilloscope by inserting a square wave signal of known value into the probe. Check all calibrated ranges to be used in this test.

602.1.3.2 Test.

a. With rated voltage at the generator output and with the oscilloscope vertical gain control set to measure at least 2.0 volts/cm, adjust the autotransformer such that the zener voltage is exceeded slightly and a display is seen on the screen of the oscilloscope. Adjust the horizontal sweep until approximately six voltage peaks per centimeter appear. Adjust the autotransformer output voltage until the smallest voltage peaks are a minimum of 0.5 volts above or below zero voltage. This minimum voltage level must be maintained for all of the readings. Increase the scope vertical gain (using the calibrated positions of the gain selector switch) to the maximum possible without causing any peak to go off the screen. Adjust vertical position of the display, if necessary, to help obtain this condition. The display will then be similar to figure 602.1-III.

b. Take a picture of the oscilloscope display with the oscilloscope in its single sweep mode. Record the reading of the voltmeter at the input to the test circuit, the oscilloscope gain and sweep calibration, the probe multiplier, and the load instrumentation.

c. Repeat a and b above, for each of the conditions specified in the procurement document.

602.1.4 Results.

a. Examine the positive peaks on each oscilloscope picture and determine from the centimeter graticule scale the difference in deflection of the highest and lowest peaks; convert this deflection to volts by multiplying by the volts/cm calibration of the oscilloscope vertical gain selector (taking into account the probe multiplier); designated as Vp. Calculate voltage modulation as follows:

$$\text{Percent modulation} = \frac{VP}{V\sqrt{2}} \times 100$$

Where V is the reading of voltmeter shown in figure 602.1-II.

b. Repeat 602.1.4.a for the negative peaks on the picture.

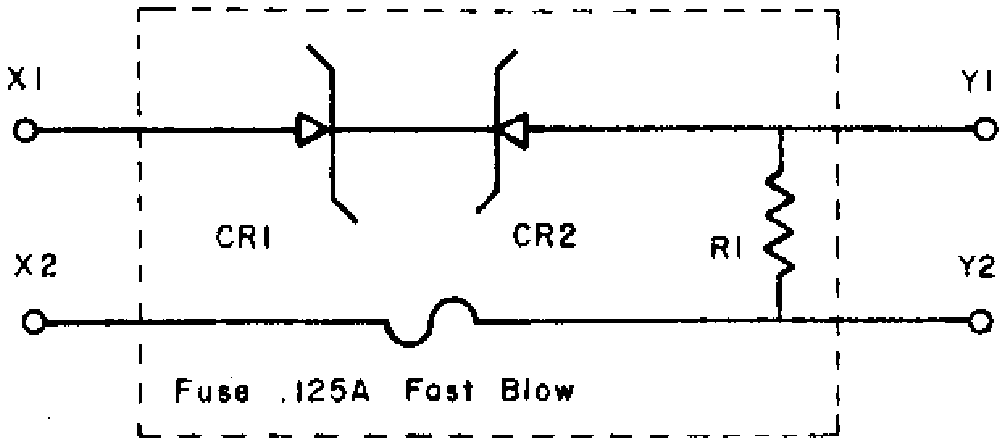
c. Select the larger of the values obtained from 602.1.4.a and b. This larger value is the voltage modulation for the particular conditions tested.

d. Determine on each oscilloscope picture if any repetitive pattern is present in the positive or negative peak pattern and the number of positive or negative peaks between the repetition if it exists. Divide this number into the frequency meter reading at the time the picture was taken. This value is the frequency of the modulation in the picture examined.

e. Compare the results with procurement document requirements.

602.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Allowable voltage modulation.
b. Frequency limitations (if any) on modulation.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Load conditions at which this method is to be performed.
e. Individual generator coils to be tested, if required.



R1 = 5000 OHMS ±5%, 5 WATTS

CR1 = CR2 = 1N5385B OR EQUAL; V_{Zt} = 170, I_{Zt} = 8 ma,

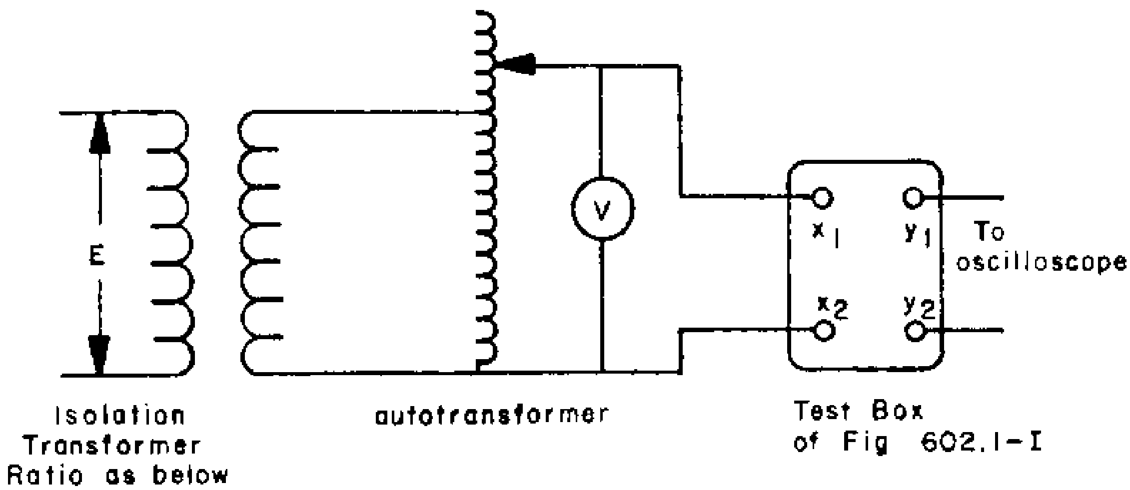
$Z_{Zt} \leqq$ 380 OHMS

NOTE: ALL TERMINALS ISOLATED FROM ENCLOSURE.

FIGURE 602.1-I. Schematic diagram of the voltage modulation test box.

X-4619

Box.]



E = GENERATOR LINE TO LINE, LINE TO NEUTRAL OR COIL OUTPUT

V = VOLTMETER

E	ISOLATION TRANSFORMER RATIO
120	1:1
208-240	2:1
416	4:1
2400	20:1
4160	40:1

FIGURE 602.1-II. Voltage modulation test connection diagram.

X-4620

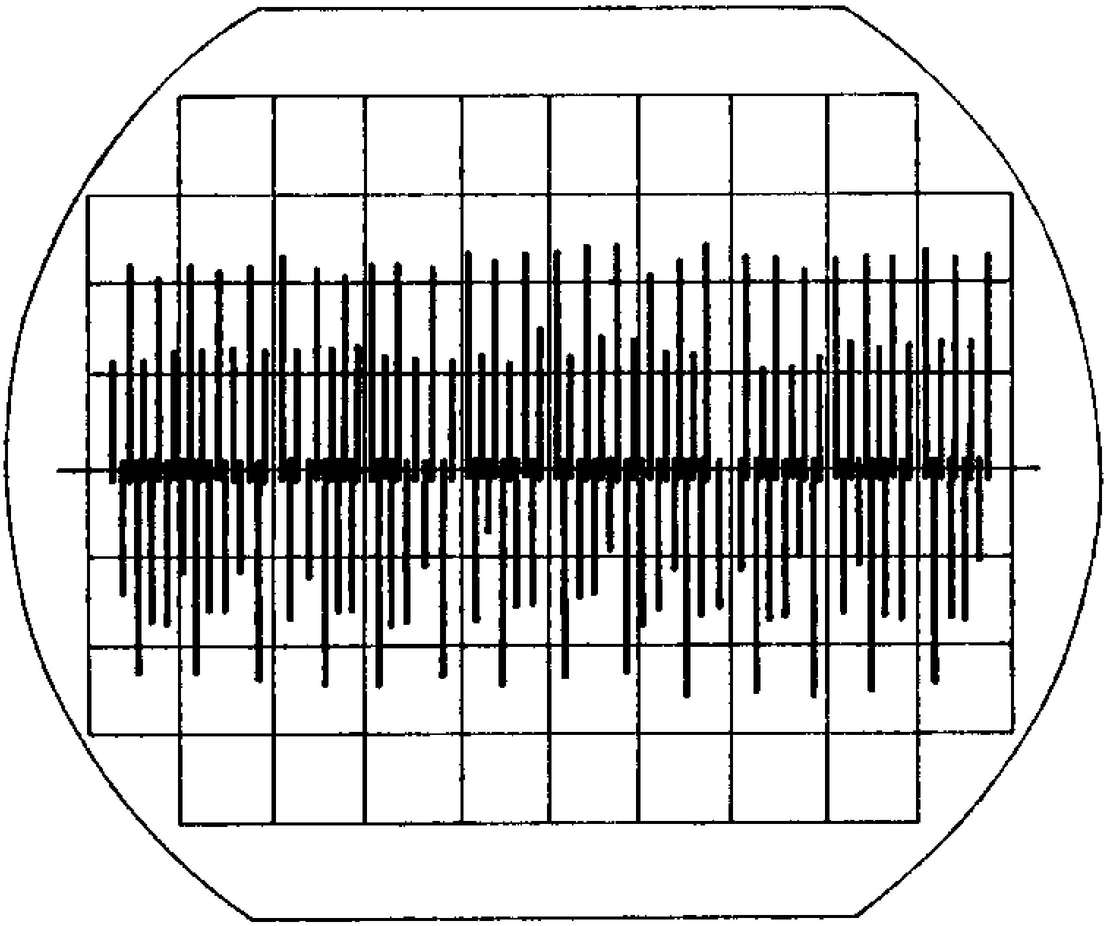


FIGURE 602.1-III. Typical oscilloscope display.

X-4621

METHOD 608.1b

FREQUENCY AND VOLTAGE REGULATION, STABILITY AND TRANSIENT RESPONSE TEST (SHORT TERM)

608.1.1 General. The frequency regulation (sometimes referred to as droop) of a generator set is the maximum difference between the no load value of frequency and the value at any load up to and including rated load. This difference is expressed as a percentage of the rated frequency of the generator set. The voltage regulation is expressed similarly except that the rms value of voltage is used. Frequency stability describes the tendency of the frequency to remain at a constant value at a constant load. Generally, the instantaneous value of frequency is not constant but varies randomly above and below a mean value. Stability may be described as either short-term or long-term depending upon the length of time that the frequency is observed. Another term, bandwidth, describes the limits of these variations. Bandwidth is expressed as a percentage of the rated frequency of the generator set. Voltage stability is described similarly.

Frequency transient response describes the reaction of the frequency to a sudden change in some condition; such as, a load change on a generator set. This response consists of the amount of excursion beyond the mean of the new operating band, and the recovery time. The recovery time is the interval begin at the point where the frequency leaves the original prescribed operating band and ending at the point where it enters and remains within the new prescribed operating band. The amount of surge is expressed as a percentage of the rated frequency of the generator set. The recovery time is expressed in seconds. The voltage transient response is described similarly.

608.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) shall be described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document).

608.1.3 Procedure.

608.1.3.1 Preparation for test.

a. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10, for one voltage connection and frequency specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the recording meter(s) from the commercial utility).
b. Set the recording meter chart speed(s) to a minimum of 6 inches per hour. The following items shall be recorded on both data sheets and recording chart(s):

1. The date
2. The serial number(s) of the recording meter(s)
3. Generator set identification
4. The recording chart speed(s)
5. The data reading number

(Refer to figures 608.1-I, 608.1-II, and 608.1-III)

c. Place all instrumentation referred to in 608.1.2 in operation.

608.1.3.2 Test.

a. Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period operate the recording meter(s) at a chart speed of not less than 6 inches per hour, and record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to load, voltage or frequency controls shall be recorded on both the data sheet and the recording chart(s) at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made. Refer to figure 608.1-I. If this test is performed immediately following another test which has established stabilization values, stabilization will be considered valid once all the previously established values and operating parameters are obtained (initial stabilization readings therefore must include all values needed for subsequent testing). NOTE: operation of the set must not be interrupted between this test and the test that established stabilization values.
b. After stabilization has occurred, drop the load to no load and reapply rated load a number of times (three should be sufficient) to assure that the no load and rated load voltage and frequency values are repeatable and that the frequency and voltage regulation is within the limits specified in the procurement document. If any adjustments are necessary, paragraph a above must be repeated. Reapply rated load.
c. The recording meter chart speed(s) shall be 12 inches per minute throughout the remainder of this test. At each of the following load conditions (one step) operate the set for a minimum of 40 seconds (or the short-term stability period plus the allowable recovery time as

specified in the procurement document). During each load condition read and record all instrument readings except thermal instrumentation (for three-phase sets it is not necessary to record line-to-line voltages). Each load condition shall be applied to the generator set in one step at the end of the short-term stability period for the previous load condition. The load conditions are:

1. Rated load
2. No load
3. Rated load
4. No load
5. Rated load
6. No load
7. Adjust load to 3/4 load and check for the accuracy of the load until the load is equal to 3/4 load. No adjustments to either voltage or frequency shall be made. Drop the load to no load and hold for 40 seconds.
8. 3/4 rated load
9. No load
10. 3/4 rated load
11. No load
12. 3/4 rated load
13. No load
14. Repeat step 7 except at 1/2 load.
15. 1/2 rated load
16. No load
17. 1/2 rated load
18. No load
19. 1/2 rated load
20. No load
21. Repeat step 7 except at 1/4 load.
22. 1/4 rated load
23. No load
24. 1/4 rated load
25. No load
26. 1/4 rated load
27. No load
28. Repeat step 7 except at rated load.
29. Rated load
30. No load
31. Rated load
32. No load
33. Rated load
34. No load

d. Repeat steps a thru c for any other voltage connection(s) and frequency(ies) specified in the procurement document.

608.1.4 Results.

608.1.4.1 Prepare a chart similar to figure 608.1-V giving for each load change the momentary overshoot or undershoot and the recovery time. For each constant load, give the maximum voltage variation.

a. Referring to figure 608.1-IV, begin by determining the observed B and steady state D voltage bandwidths.

   1. Mark numerically the stabilizations occurring after each load change, starting with the stabilization obtained before the first load change.
   2. Determine the observed voltage bandwidth B by marking the maximum trace excursion and minimum trace excursion in the stabilized portion. Draw two lines parallel to the axis of chart movement, one each passim through these maximum and minimum trace excursions respectively.
   3. Draw a line C parallel to and equidistant from the edges of the observed voltage bandwidth, determined in step 2 above.
   4. Using the rated voltage of the generator and given procurement document requirements, calculate the steady state voltage bandwidth D. Draw this steady state voltage bandwidth as two parallel lines, parallel to and equidistant from the median C at the observed voltage bandwidth.

b. To determine the maximum voltage variation at constant load:

   1. One-half the observed voltage bandwidth B is the plus or minus value of voltage deviation at constant load.
   2. Divide each of the values obtained in step 1 by the rated voltage of the generator and multiply by 100 to convert to percentage.

c. To determine the maximum overshoot and undershoot at each load step, and express this as a percentage of its rated voltage, proceed as follows:

   1. From the meter recording charts, determine the maximum amount that the voltage trace goes beyond the line C of the observed voltage band following the load change (see figure 608.1-IV for illustration of overshoot and undershoot).
   2. Divide the result obtained in step 1 by the rated voltage (as given on the generator nameplate), then multiply by 100 to convert to percentage.

      CAUTION: Do not use the constant operating voltage at each load as the divisor in the computation. Use only the rated voltage of the generator.

d. To determine the time required to restore stable voltage conditions after each load change (recovery time):

1. The prescribed steady state voltage bandwidth, extended to the point at which the voltage trace leaves the prescribed steady state band, shall be considered as the time at which the transient conditions begin. The point at which the voltage trace enters and remains within the prescribed band after a load change shall be considered as the point at which stabilization begins.
2. Measure the distance (in inches) on the chart from the point where the voltage trace leaves the prescribed steady state band to the point where it reenters and remains within the prescribed voltage band for the next load condition.
3. Divide this distance by chart speed (in inches per second). This will give the voltage recovery time, in seconds.

e. Determine the voltage regulation for all load changes (e.g. rated load to no load, 1/2 rated load to no load, no load to 1/4 load, etc.) as follows:

1. Using the indicating voltmeter readings subtract the load value of voltage from the no load value for each load changes (e.g. step 1 to step 2). (For voltage regulators utilizing single-phase voltage sensing, the value of voltage in the sensed phase only shall be used in the above calculations. For voltage regulators utilizing multi-phase voltage sensing, the average value of the sensed voltage shall be used.)
2. Convert each of the values obtained in step 1 above to a percentage of rated by dividing by the rated voltage and multiplying by 100. This is the voltage regulation expressed in percent.

608.1.4.2 Repeat 608.1.4.1 substituting frequency for voltage.

608.1.4.3 Compare the results tabulated in 608.1.4.1 and 608.1.4.2 with the requirements of the procurement document.

608.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Frequency

1. Maximum allowable short-term stability bandwidth or deviation in percent of rated frequency.
2. Maximum allowable recovery time.
3. Maximum allowable overshoot and undershoot.
4. Frequency(ies) at which this method is to be performed.
5. Maximum allowable regulation.

b. Voltage

1. Maximum allowable short-term stability bandwidth or deviation in percent of rated voltage.
2. Maximum allowable recovery time.
3. Maximum allowable overshoot and undershoot, if applicable.
4. Voltage connection(s) at which this method is to be performed.
5. Maximum allowable regulation.

TEST DATA

DESCRIPTION 10KW, 60HZ 120 VOLT, SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC.

MODEL NO. SF-10.0-MD

SERIAL NO. 21067

REF: MIL-STD-705/608.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

FREQUENCY AND VOLTAGE REGULATION, STABILITY AND TRANSIENT RESPONSE TEST (SHORT TERM)

TEST NO. 4

SHEET 1 OF 1

DATE 24 JULY, 1970

RECORDER L. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		201		113		476		194		819		342	118				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD					AVG AMB TEMP
UNITS			VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS				°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:50	STARTED UNIT - APPLIED RATED LOAD															
	09:10		120.0	2.60	104	.250	10.0		.80		60.0	7.0	.91				80
	09:20		120.0	2.60	104	.250	10.0		.80		60.0	8.5	1.08				82
	09:30		120.0	2.60	104	.250	10.0		.80		60.0	8.6	1.08				82
	09:40		120.0	2.60	104	.250	10.0		.80		60.0	8.6	1.08				82
	09:50		120.0	2.60	104	.250	10.0		.80		60.0	8.7	1.08				83
	10:00		120.0	2.60	104	.250	10.0		.80		60.0	8.8	1.08				84
	10:10		120.0	2.60	104	.250	10.0		.80		60.0	8.8	1.08				84
	10:20		120.0	2.60	104	.250	10.0		.80		60.0	8.8	1.08				84
	10:30		120.0	2.60	104	.250	10.0		.80		60.0	8.8	1.08				84
	10:33	STARTED TEST															
	10:59	COMPLETED TEST - SHUTDOWN SET															

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: VOLTAGE AND FREQUENCY RECORDER No 1176 CHART SPEED 12"/HR
LINE CURRENT MEASURED USING C.T. No 1377
EXCITER FIELD CURRENT MEASURED USING 2A, 50mV SHUNT No 1286

Figure 608.1-I: Typical test record for stabilization for frequency and voltage regulation, stability and transient response test.

-2-

X-4622

Frequency and Voltage.]

TEST DATA

DESCRIPTION 10KW, 60Hz 120VOLTS, SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SE-10,0-MQ

SERIAL NO. 21067

REF: MIL-STD-705/608.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

FREQUENCY AND VOLTAGE REGULATION, STABILITY AND TRANSIENT RESPONSE TEST (SHORT-TERM)

TEST NO. 4

SHEET 1 OF 1

DATE 24 JULY 1970

RECORDER D. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER D. Doe

INST. →			201	113	476		194	819			201	113	476		194	819	1076
READ NO.	TIME	LOAD	TERM VOLTAGE	LINE CURRENT	OUTPUT POWER		POWER FACTOR	FREQ		LOAD	TERM VOLTAGE	LINE CURRENT	OUTPUT POWER		POWER FACTOR	FREQ	AVG AMB TEMP
UNITS	HRS	%	VOLTS	AMPS	KW	KW	—	HZ		%	VOLTS	AMPS	KW	KW	—	HZ	°F
SYM.				X40	X40	X1						X40	X40	X1			
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10:33	100	120.0	2.60	.250	10.0	.80	60.0		50	121.0	1.30	.125	5.0	.80	61.0	84
		0	121.3	0	0	0	—	61.8		0	121.8	0	0	0	—	61.8	
		100	120.0	2.60	.250	10.0	.80	60.0		50	121.0	1.30	.125	5.0	.80	61.0	
		0	121.8	0	0	0	—	61.8		0	121.8	0	0	0	—	61.8	
		100	120.0	2.60	.250	10.0	.80	60.0		25	121.5	.65	.063	2.5	.80	61.5	
		0	121.8	0	0	0	—	61.8		0	121.8	0	0	0	—	61.8	
		100	120.0	2.60	.250	10.0	.80	60.0		25	121.5	.65	.063	2.5	.80	61.5	
		0	121.8	0	0	0	—	61.8		0	121.8	0	0	0	—	61.8	
		75	120.5	1.95	.187	7.5	.80	60.5		25	121.5	.65	.063	2.5	.80	61.5	
		0	121.8	0	0	0	—	61.8		0	121.8	0	0	0	—	61.8	
		75	120.5	1.95	.187	7.5	.80	60.5		100	120.0	2.60	.250	10.0	.80	60.0	
		0	121.8	0	0	0	—	61.8		0	121.8	0	0	0	—	61.8	
		75	120.5	1.95	.187	7.5	.80	60.5		100	120.0	2.60	.250	10.0	.80	60.0	
		0	121.8	0	0	0	—	61.8		0	121.3	0	0	0	—	61.8	
		50	121.0	1.30	.125	5.0	.80	61.0		100	121.0	2.60	.250	10.0	.80	60.0	
		0	121.8	0	0	0	—	61.8		0	121.8	0	0	0	—	61.8	

NOTES: VOLTAGE AND FREQUENCY RECORDER No 1176 CHART SPEED 12"/MIN
LINE CURRENT MEASURED USING C.T. No 1377

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 608.1-II: Portion of a typical test record for frequency and voltage regulation, stability and transient response test.

-2-

X-4623

and Voltage Regulation.]

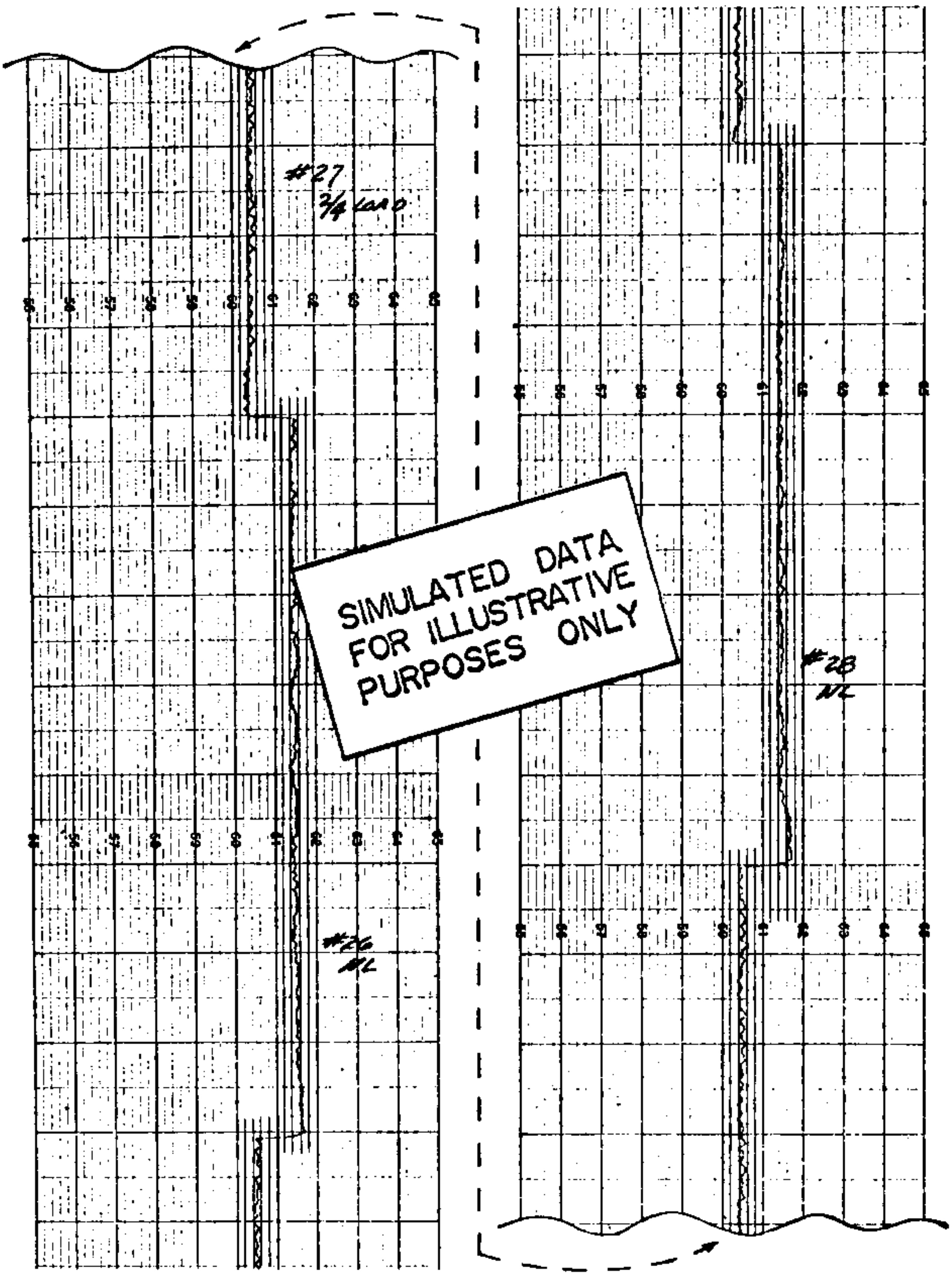
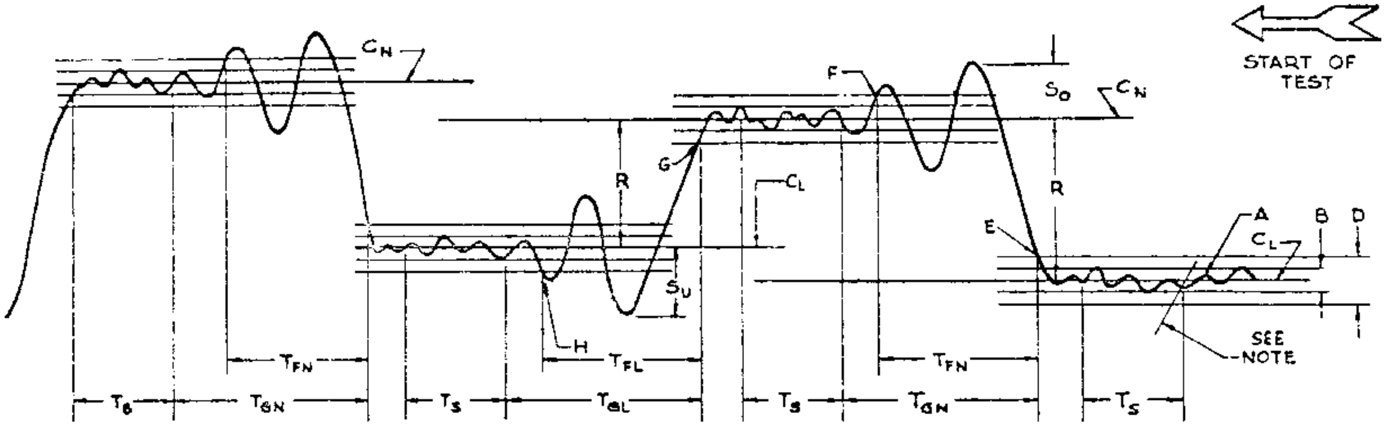


FIGURE 608.1 - III. PORTION OF A FREQUENCY RECORDING CHART SHOWING LOAD CHANGES.

X4624



Trace and definitions apply to either voltage or frequency.

NOTE: Chart marked at start of test.

A Actual instrument trace of function.

B Observed steady state band (two lines parallel to the axis of chart movement, one each passing through the center points of maximum and minimum trace excursion respectively during the short-term stability sample period, T_S).

C Mean of observed band

C_L Mean value at selected load.

C_N Mean value at no load.

D Prescribed steady state band.

E Point at which trace initially leaves prescribed load band under condition of decrease in load.

F Point at which trace enters and remains within prescribed no load band.

G Point at which trace initially leaves prescribed no load band.

H Point at which trace enters and remains within prescribed load band.

R Regulation between any two loads.

S Surge after a load change.

S_O Overshoot.

S_U Undershoot.

T_{FL} Observed recovery time, no load to load.

T_{FN} Observed recovery time, load to no load.

T_G Maximum allowable recovery time.

T_{GL} Maximum allowable recovery time-No load to load.

T_{GN} Maximum allowable recovery time-Load to no load.

T_S Prescribed short-term sample time for determining stability.

FIGURE 608.1 - IV. DIAGRAMMATIC REPRESENTATION OF REGULATION, STABILITY AND TRANSIENT RESPONSE TERMS.

X-4625

Stability and Transient Response Terms.]

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120 VOLTS, SINGLE-PHASE GENERATOR SET

MFGR ENGENSETS INC.

MODEL NO. SF-10.0-MO

SERIAL NO. 21067

REF: MIL-STD-705/608.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

FREQUENCY AND VOLTAGE REGULATION, STABILITY AND TRANSIENT RESPONSE TEST (SHORT TERM)

TEST NO. 4

SHEET 1 OF 3

DATE SEPT 3, 1970

RECORDER Charles Manson

PROJ. ENGR. L. H. Oswald

SHIFT LEADER [illegible]

OBSERVER Steve Wonder

INST. →		VOLTAGE							REGULATION		FREQUENCY						
READ NO.	LOAD STEP	MAX VOLT EXCURSION		EXCURSION AS % RATED		REC TIME	VARIATION		VOLT	FREQ	MAX FREQ EXCURSION		EXCURSION AS % RATED		REC TIME	VARIATION	
UNITS		VOLTS	VOLTS	%	%	SEC	VOLT	%	%	%	HZ	HZ	%	%	SEC	HZ	%
SYN.		DROP	ADD	DROP	ADD						DROP	ADD	DROP	ADD			
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1						0.20	0.17								0.22	0.37
	1-2	14.0		11.7		0.60			1.50	3.0	2.6		4.3		1.15		
	2						0.20	0.17								0.12	0.20
	2-3		11.0		9.2	0.45			1.50	3.0		2.4		4.0	0.70		
	3						0.20	0.17								0.12	0.20
	3-4	14.0		11.7		0.60			1.50	3.0	2.4		4.0		0.50		
	4						0.50	0.42								0.22	0.37
	4-5		11.0		9.2	0.30			1.25	3.0		2.8		4.7	0.60		
	5						0	0								0.15	0.26
	5-6	14.0		11.7		0.50			1.25	3.0	2.4		4.0		0.80		
	6						0.50	0.42								0.22	0.37
	6-7		11.0		9.2	0.35			1.33	3.0		2.4		4.0	0.65		
	7						0.20	0.17								0.15	0.25
	7-8	14.0		11.7		0.60			1.33	3.0	2.5		4.2		0.85		
	8						0.50	0.42								0.20	0.33
	8-9		8.0		6.7	0.25			0.84	2.17		2.1		3.5	0.50		
	9						0.20	0.17								0.15	0.25
	9-10	11.0		9.2		0.45			0.84	2.17	1.7		2.8		0.50		

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 608.1-V. Portion of a typical tabulation of results for frequency and voltage regulation, stability and transient response test.

X-4626

Frequency and Voltage Regulation.]

METHOD 608.2a

FREQUENCY AND VOLTAGE STABILITY TEST

(LONG-TERM)

608.2.1 General. The generator-regulator-exciter combination must be capable of maintaining constant voltage and the engine-governor combination must be capable of maintaining constant speed for constant loads over long periods of time. Frequency stability describes the tendency of the frequency to remain at a constant value at a constant load. Generally, the instantaneous value of frequency is not constant but varies randomly above and below a mean value. Stability may be described as either short-term or long-term stability depending upon the length of time that the frequency is observed. Another term, bandwidth, describes the limits of these variation. Bandwidth is expressed as a percentage of rated frequency of the generator set. Voltage stability is described similarly.

608.2.2 Apparatus. Instrumentation for measuring load conditions, field temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) shall be as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 unless otherwise specified in the procurement document.

608.2.3 Procedure.

608.2.3.1 Preparation for test.

a. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the applicable voltage connection and frequency. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the recording meter(s) from the commercial utility.)
b. The following items shall be recorded on both the data sheets and the recording chart(s):

    1. The date
    2. The serial number(s) of the recording meter(s)
    3. Generator set identification
    4. Recording chart speed(s)
    5. Data reading number

608.2.3.2 Test.

a. Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period operate the recording meter(s) at a chart speed of not less than 6 inches per hour, and record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjusts to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to load, voltage or frequency controls shall be recorded on both the data sheet and the record chart(s) at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

b. After step a above, no further adjustments my be made to the voltage or frequency controls or control systems for the remainder of this test.
c. Determine the short-term stability prior to the start of the long-term rated load test by operating the recording meter(s) at a chart speed of 12 inches per minute for 40 seconds. During this 40 second period, record all instrument readings. At the end of the 40 second period reduce the recording meter(s) chart speed to 12 inches per hour and continue to record, proceed with the test at rated load for a 4 hour period. During this period record all instrument readings at maximum intervals of 30 minutes.
d. Immediately after the long-term stability period, step c, reduce the load to zero and allow the set to stabilize at no load. During this period record all instrument readings including ambient temperature at minimum intervals of 10 minutes. No adjustments to the set shall be made before, during, or following this stabilization period. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value.
e. Immediately after the set has stabilized at no load repeat step c above except at no load.
f. Immediately after the no load stability period operate the recording meter chart speed at 12 inches per minute and in one step apply the following load conditions to the generator set. Each load condition shall last for a minimum of 40 seconds. No adjustments to the set shall be made before or during this portion of the method.

   1. Rated load
   2. No load
   3. Rated load
   4. No load
   5. Rated load
   6. No load

g. Repeat 608.2.3 for each voltage connection and frequency specified in the procurement document.

608.2.4 Results.

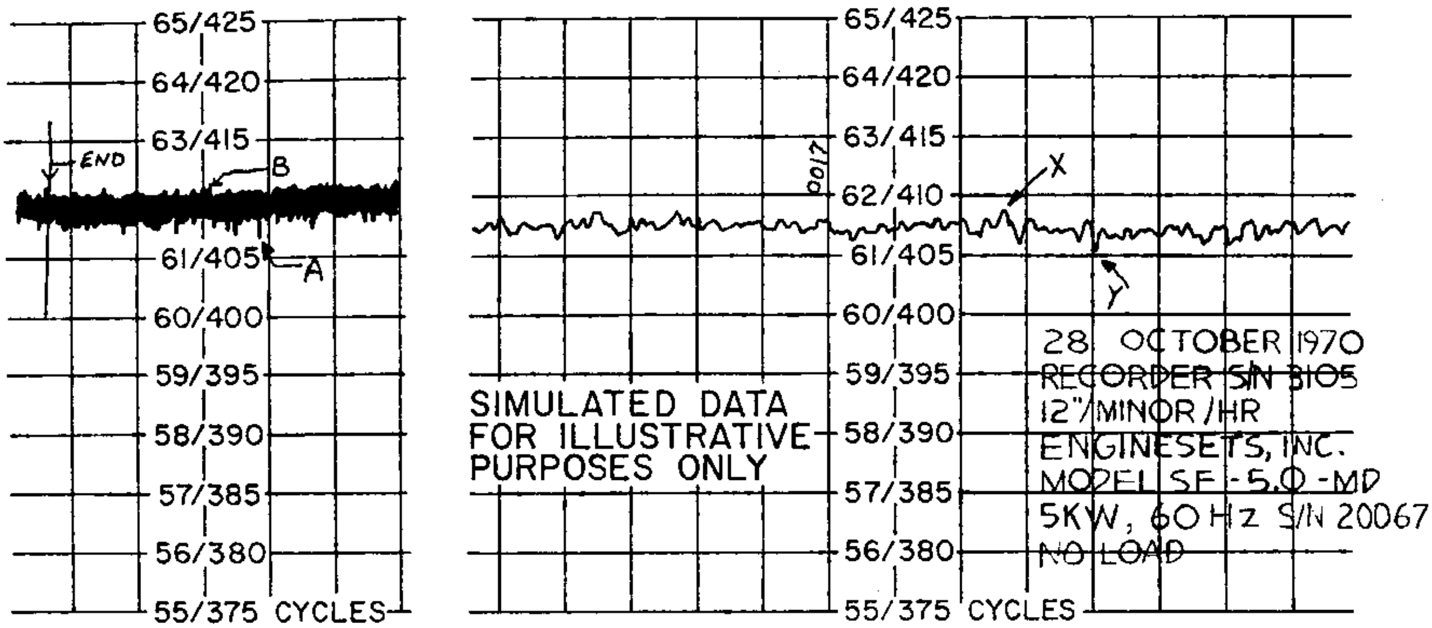
a. Determine the long-term rated load voltage stability as follows (see figure 608.2-I):

   1. Using the rated load short-term voltage stability trace run prior to the long-term rated load voltage stability test, determine the maximum and minimum trace excursions. The maximum trace excursion is the point of maximum voltage during the 40 second period prior to the start of the long-term stability test and the minimum trace excursion is the point of minimum voltage during the same time period.
   2. Calculate the middle of the observed steady state band by adding the values obtained in step 1 above and divided by 2.
   3. Draw the center line of the observed steady state band on the chart at the value determined in step 2 above.
   4. Construct the prescribed steady state by drawing two line parallel to and equidistant from the center line of the observed band. Extend this band the entire length of the long-term steady state stability test.

b. Repeat step a for the long-term rated load frequency stability chart.
c. Repeat step a for the long-term no load voltage stability chart.
d. Repeat step a for the long-term no load frequency stability
e. Analyze the recording chart data taken in 608.2.3.2f in accordance with method 608.1, paragraph 608.1.4.
f. The tabulation sheet shall contain for each trace the observed maximum and minimum excursions during the short-term steady state stability period, and the observed maximum and minimum excursions during the long-term steady state stability tests.
g. Compare the tabulated results with the requirements of the procurement document.

608.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable long-term voltage stability bandwidth or deviation in percent of rated voltage.
b. Maximum allowable long-term frequency stability bandwidth or deviation in percent of rated frequency.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Length of time for the long term stability runs, if other than four (4) hours at rated load and 4 hours at no load.



X — MAXIMUM TRACE EXCURSION, SHORT-TERM, STEADY-STATE STABILITY.
Y — MINIMUM TRACE EXCURSION, SHORT-TERM, STEADY-STATE STABILITY.
A — MINIMUM TRACE EXCURSION, LONG-TERM, STEADY-STATE STABILITY.
B — MAXIMUM TRACE EXCURSION, LONG-TERM, STEADY-STATE STABILITY.

FIGURE 608.2-I. Portion of a four hour long-term stability run.

X-4627

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120V, SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SE-10.0-MD

SERIAL NO. 21026

REF: MIL-STD-705/608.2

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

FREQUENCY AND VOLTAGE STABILITY TEST (LONG-TERM)

TEST NO. 11

SHEET 1 OF 1

DATE JULY 28, 1970

RECORDER L. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. See

INST. →		201		113		476		819		194		342	118				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD					AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS				°F
SYM.				X40	X1	X40	X1						X.02				
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0800	STARTED SET - APPLIED RATED LOAD															
	0810	120.0		2.63	105	0.252	10.1		.80		60.0	7.0	45.5				73
	0820	120.2		2.65	106	0.254	10.2		.80		59.6	8.5	64.0				74
	0830	ADJUSTED LOAD, VOLTAGE AND FREQUENCY TO RATED VALUES															
	0840	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	54.0				75
	0850	120.0		2.60	104	0.260	10.0		.80		60.0	8.5	54.0				75
	0900	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	54.0				74
	0910	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	54.0				75
	0910	UNIT STABLE - START RATED LOAD STABILITY TEST.															
	0911	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	54.0				75
	0926	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	54.0				75
	0941	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	59.0				75
	0956	120.0		2.60	104	0.250	10.0		.80		60.1	8.5	54.0				75
	1011	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	54.0				75
	1026	120.0		2.60	104	0.250	10.0		.80		60.0	8.5	54.0				74
	1041	120.0		2.60	104	0.250	10.0		.80		59.9	8.5	54.0				73
	1056	120.1		2.60	104	0.250	10.0		.80		60.0	8.5	54.1				73
	1111	120.1		2.60	104	0.250	10.0		.80		60.0	8.5	54.1				73
	1126	120.1		2.60	104	0.250	10.0		.80		60.0	8.5	54.1				73

NOTES: RECORDING METER No 038, CHART SPEED = 12"/HR
LINE CURRENT MEASURED USING C.T. No 1377

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 608.2-II: Portion of a typical test record for frequency and voltage stability (long term).

-2-

X-4628

and Voltage Stability.]

METHOD 610.1b

VOLTAGE AND FREQUENCY DROOP

610.1.1 General. In a generator set in which the generator is equipped with a voltage regulator, the voltage regulator must be capable of maintaining a terminal voltage that falls within specified limits throughout the load range of the generator. The engine governor also must be capable of maintaining speed within the specified range, under the same conditions. Terminal voltage and speed will vary as load is applied but shall not vary more than the specified limits.

610.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient illustrated in MIL-HDBK-705.

610.1.3 Procedure.

610.1.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10.
b. Disconnect or otherwise render inoperative the cross current compensator, if provided.

610.1.3.2 Test.

a. Start and operate the generator set and allow the set to stabilize at rated load, voltage and frequency. During this period record all instrument readings including ambient temperature at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On sets utilizing a droop-type frequency control system as the prime speed control, the frequency and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet at the tim of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recordings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made.
b. After temperatures have stabilized, apply and drop the load a number of times (three should be sufficient) to insure that the voltage regulator and engine governor return the terminal voltage and frequency to their rated values at rated load.

c. Reapply rated load. Adjust the voltage regulator and engine governor to obtain rated values of terminal voltage and frequency. After governor adjustments, the frequency regulation shall be checked for compliance with the requirements of the procurement document.

   NOTE: No further adjustments shall be made to the voltage regulator or engine governor.

d. Starting at rated load, rated voltage, and rated frequency, reduce the load to no load in one step and record all instrument readings.
e. Gradually increase the load at rated power factor in approximately 10 percent steps, recording all instrument readings at each load step until the load reaches the specified overload condition. Then gradually decrease the load in approximately 10 percent steps until no load is reached recording all instrument readings at each step.
f. On ac generator sets repeat step e above with a unity power factor load.

610.1.4 Results.

a. Plot voltage-droop and frequency-droop curves. The voltage-droop curve shall be plotted with the vertical axis as the "terminal voltage" and the horizontal axis as the total kilowatt load. The frequency-droop curve shall be plotted with the vertical axis as the "frequency" and the horizontal axis as the total kilowatt load.
b. Compare these results with the requirements of the procurement document.

610.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum voltage droop allowed.
b. Maximum frequency droop allowed.
c. Maximum overload condition at which this method shall be performed.
d. Short-term frequency stability requirement.
e. Maximum frequency regulation allowed.

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120 V, SINGLE PHASE GENERATOR SET

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

VOLTAGE AND FREQUENCY DROOP TEST

MFGR. ENGENSETS, INC.

MODEL NO. SF-10.0-MD

SERIAL NO. 4087

REF: MIL-STD-705/610.1

TEST NO. 17

SHEET 1 OF 1

DATE FEBRUARY 9, 1971

RECORDER Wright

PROJ. ENGR. [illegible]

SHIFT LEADER [illegible] Smith

OBSERVER [illegible]

INST. →		1077		963		212		1308		1328		1016	1068				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD					AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS				°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	14:10	STABILIZATION COMPLETE															
	14:12		122.2	0	0	0	0		—		61.6	18.2	0.85				77
	14:15		122.0	0.26	10.2	0.025	1.0		0.80		61.4	18.6	0.87				
	14:20		121.5	0.51	20.4	0.050	2.0		0.80		61.3	19.2	0.89				
	14:25		121.5	0.77	30.8	0.075	3.0		0.80		61.1	19.6	0.92				
	14:30		121.3	1.03	41.2	0.100	4.0		0.80		61.0	19.8	0.96				
	14:35		121.1	1.29	51.7	0.125	5.0		0.80		60.8	20.0	1.00				
	14:40		120.8	1.55	62.0	0.150	6.0		0.80		60.6	20.5	1.05				
	14:45		120.6	1.81	72.5	0.175	7.0		0.80		60.4	21.0	1.15				
	14:50		120.4	2.07	83.0	0.200	8.0		0.80		60.3	21.5	1.20				
	14:55		120.2	2.33	93.3	0.225	9.0		0.80		60.1	22.0	1.25				
	15:00		120.0	2.60	104.0	0.250	10.0		0.80		60.0	23.0	1.35				77

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING CURRENT TRANSFORMER No 1305
EXCITER FIELD CURRENT MEASURED USING 2A, 50 mV SHUNT No 712

Figure 610.1-I - Typical test record for voltage and frequency droop test.

X-4629

Droop Test.]

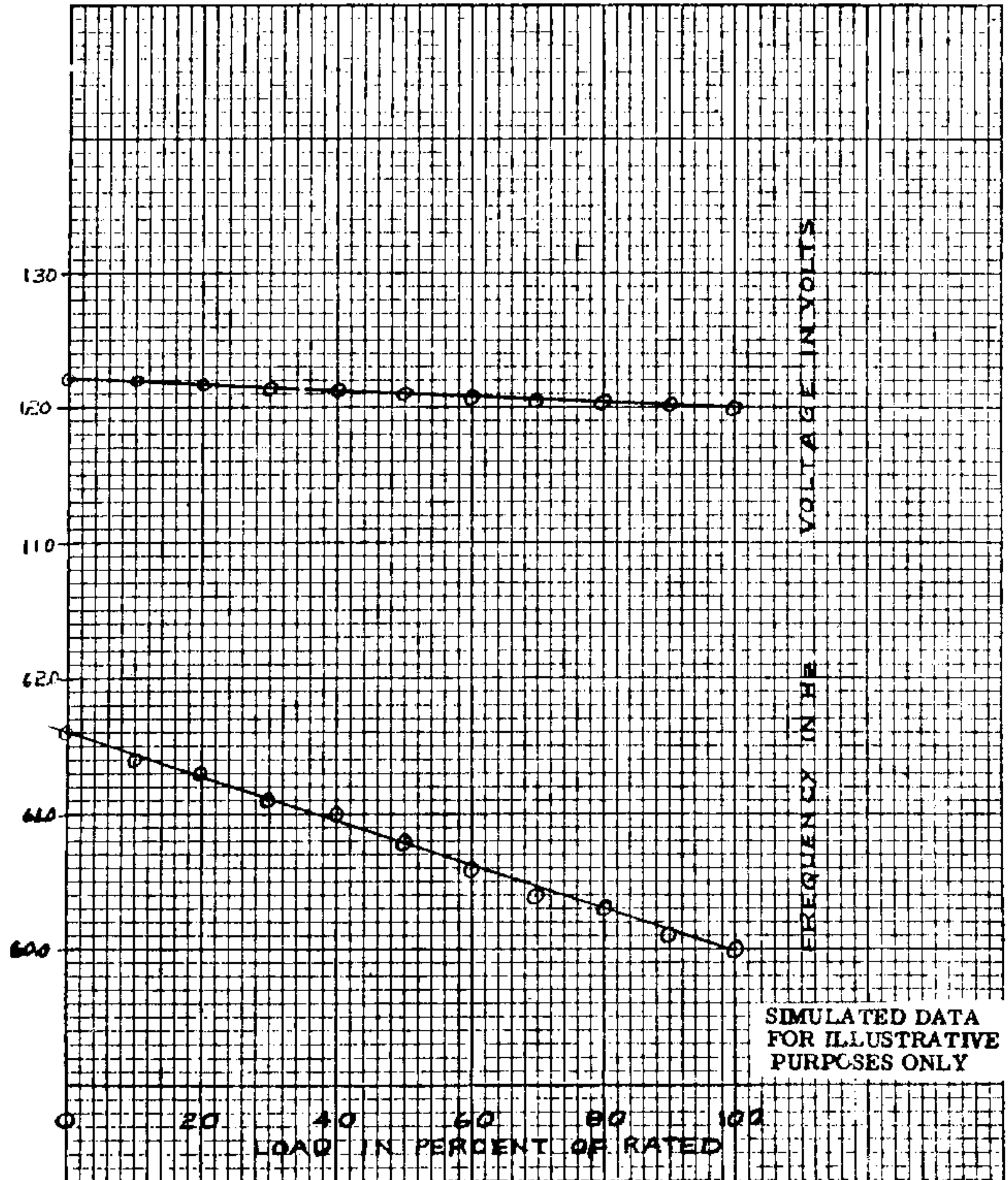


FIGURE 610.1-II VOLTAGE AND FREQUENCY DROOP CURVES FOR INCREASING LOAD.

X-4630

METHOD 611.1b

INHERENT VOLTAGE DROOP TEST

611.1.1 General. The inherent voltage droop of the generator is used by design engineers as an aid in the selection of a suitable voltage regulator and as a check to compare production generators with the preproduction generator.

611.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, a variable dc source for external excitation shall be required.

611.1.3 Procedure.

611.1.3.1 Preparation for test.

a. Provide the external excitation supply to the generator (disconnect the voltage regulator, if applicable).
b. Connect the load and field instrumentation in accordance with the applicable figure MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and speed specified in the procurement document.

CAUTION: When operating the generator under manual voltage control, care must be exercised in going from rated load to no load. The terminal voltage may rise to as much as 150 percent of rated terminal voltage and exceed the voltage ratings of test instruments connected in the circuit.

611.1.3.2 Test.

a. Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated speed. During this period record all instrument readings at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and speed may be made to maintain rated load at rated voltage and speed. Adjustments to the voltage and speed shall be limited to those adjustments available to the operator, specifically adjusts to the voltage or speed adjust devices. On sets utilizing a droop type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and speed control system shall be made unless permitted by the procurement document. Adjustments to load, voltage or speed controls shall be recorded on the data sheet at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or speed has been made.

b. After stabilization has occurred apply and drop rated load several times (3 should be sufficient) to assure that the no load and rated load voltage and speed values are repeatable and that the speed regulation is within the limits specified in the procurement document. If any adjustments are necessary step a above must be repeated.
c. Adjust the excitation voltage, if necessary, to obtain the rated terminal voltage at rated load. No further adjustments of the field rheostat shall be made during the test except as permitted under certain conditions of no load, as described in e below.
d. Starting with rated load (or specified overload) operation, reduce the load gradually to no load and record the instrument readings at approximately each 10 percent of rated load value (see figure 611.1-I).
e. At no load operation, adjust the terminal voltage to its rated value.
f. Gradually increase the load to rated current (or specified overload current) operation and record instrument readings at approximately each 10 percent of rated current value.

611.1.4 Results.

a. Plot voltage droop curves. The vertical axis shall be "terminal voltage", and the horizontal axis shall be "load current". For each of these curves, the maximum deviation from rated voltage shall be noted (see figure 611.1-II).
b. Compare the maximum deviation from rated voltage with the procurement document requirements.

611.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Allowable inherent voltage droop.
b. Voltage connection(s) and speed(s) at which this method is to be performed.
c. Maximum overload current, if applicable.

TEST DATA

DESCRIPTION 15KW, DC 120V, 3600RPM GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. DC-15.0

SERIAL NO. 0001

REF: MIL-STD-705/611.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

INHERENT VOLTAGE DROOP TEST

TEST NO. 12

SHEET 1 OF 1

DATE MARCH 22, 1971

RECORDER J. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		103		212		CAL		617		112	316						1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		SPEED		EXCITER FIELD							AVG AMB TEMP
UNITS	HRS		VOLTS		AMPS		KW		RPM	VOLTS	AMPS						°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0810	STARTED		SET	APPLIED		RATED	LOAD									
	0830		120.0		125		15.0		3600	15.6	1.81						71
	0840		120.0		125		15.0		3600	15.6	1.81						71
	0850		120.0		125		15.0		3600	15.6	1.81						71
	0900		120.0		125		15.0		3600	15.6	1.81						71
	0900	DROPPED AND APPLIED RATED LOAD SEVERAL TIMES															
	0910		120.0		125		15.0		3600	15.6	1.81						71
			121.7		113		13.5		3600	15.6	1.81						72
			123.2		100		12.0		3600	15.6	1.81						72
			125.0		87		10.5		3600	15.6	1.81						72
			126.1		75		9.0		3600	15.6	1.81						72
			127.2		62		7.5		3600	15.6	1.81						72
			128.0		50		6.0		3600	15.6	1.81						72
			128.6		38		4.5		3625	15.6	1.81						72
			128.8		25		3.0		3650	15.6	1.81						72
			129.0		13		1.5		3650	15.6	1.81						72
	0925		129.0		0		0		3675	15.6	1.81						72

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING A 200A, 50 mV SHUNT No. 1723

Figure 611.1-I Typical test record for inherent voltage droop test.

X-4631

Test.]

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

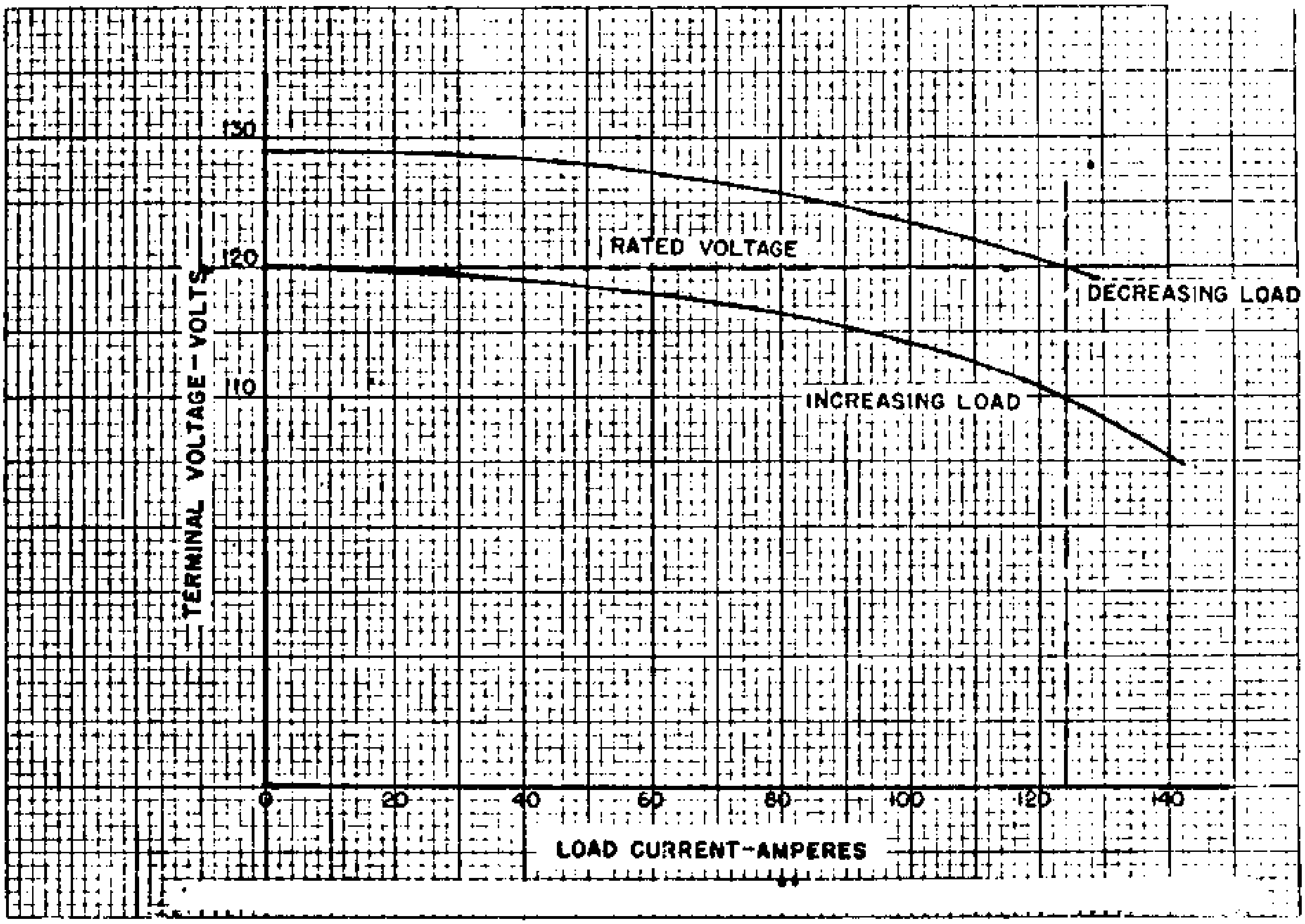


FIGURE 611.1-II. TYPICAL CURVE FOR INHERENT VOLTAGE DROOP TEST

X-4632

METHOD 614.1b

VOLTAGE AND FREQUENCY REGULATION TEST

(FOR GENERATOR SETS)

614.1.1 General. The frequency regulation (sometimes referred to as droop) of a generator set is the maximum difference between the no load value of frequency and the value at any load up to and including rated load. This difference is expressed as a percentage of the rated load frequency of the generator set. The voltage regulation is expressed similarly except that the rms value of voltage is used. Frequency stability describes the tendency of the frequency to remain at a constant value at a constant load. Generally, the instantaneous value of frequency is not constant but varies randomly above and below a mean value. Stability may be described as either short-term or long-term depending upon the length of time that the frequency is observed. Another term, bandwidth, describes the limits of these variations. Bandwidth is expressed as a percentage of the rated frequency of the generator set. Voltage stability is described similarly.

614.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature illustrated in MIL-HDBK-705.

614.1.3 Procedure.

614.1.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Disconnect or otherwise render inoperative the cross current compensation circuits, if provided.

614.1.3.2 Test.

a. Start and operate the generator set at rated voltage. Adjust the engine governor so that the frequency regulation is within the specified limits.
b. Operate the generator set and allow the set to stabilize at rated load, voltage and frequency. During this period record all instrument readings including ambient temperature at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On sets utilizing a droop-type frequency control system as the prime speed control, the frequency and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control system shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustment.

Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made.

c. Starting with the rated load, voltage and frequency record all instrument readings. Then, reduce the load to zero in one step.
d. Record all instrument readings. Then, reapply rated load in one step.
e. Repeat steps c and d above two additional times.
f. Repeat 614.1.3 above, for ac sets only, using a rated kilowatt and unity power factor load.

614.1.3.3 Repeat procedure. Repeat 614.1.3 for all other voltage connections and frequencies specified in the procurement document.

614.1.4 Results.

614.1.4.1 Voltage regulation.

a. Obtain the average of the no-load and rated-load voltages individually. Do this for both line-to-line and line-to-neutral voltages.

Sample Computations
From data sheet - Figure 614.1-I

Rated Load

	Reading No. 116	Reading No. 118	Reading No. 120
$L_1 - L_2$ (volts)	208	208	208
$L_2 - L_3$ (volts)	208	208	208
$L_1 - L_3$ (volts)	208	208	208
Total	624	624	624

Average of three trials =

$$\frac{624 + 624 + 624}{9} = 208 = V_{r1}$$

	Reading No. 116	Reading No. 118	Reading No. 120
$L_1 - L_0$ (volts)	120.4	120.4	120.4
$L_2 - L_0$ (volts)	120.1	120.0	120.0
$L_3 - L_0$ (volts)	120.2	120.2	120.2
Total	360.7	360.6	360.6

Average of three trials =

$$\frac{360.7 + 360.6 + 360.6}{9} = 120.2 = V_{r1}$$

No Load

	Reading No. 117	Reading No. 119	Reading No. 121
$L_1 - L_2$ (volts)	210	211	212
$L_2 - L_3$ (volts)	210	211	212
$L_3 - L_1$ (volts)	210	211	212
Total	630	633	636

Average of three trials =

$$\frac{630 + 633 + 636}{9} = 211 = V_{n1}$$

$L_1 - L_0$ (volts)	121.4	121.8	122.2
$L_2 - L_0$ (volts)	121.4	121.6	122.2
$L_3 - L_0$ (volts)	121.6	122.0	122.4
Total	364.4	365.4	366.8

Average of three trials =

$$\frac{364.4 + 365.4 + 366.8}{9} = 121.8 = V_{n1}$$

b. Substitute the average values of the three trials in the following formula:

$$\text{Voltage regulation (in percent)} = \frac{V_{n1} - V_{r1}}{V_{r1}} \times 100$$

Where: V_{n1} is the average voltage at no load.

V_{r1} is the average voltage at rated load.

Sample Computation Line-to-Line

Average voltage regulation =

$$\frac{211 - 208}{208} \times 100 = \frac{3}{208} \times 100 = 1.44\%$$

Sample Computation Line-to-Line

Average voltage regulation =

$$\frac{121.8 - 120.2}{120.2} \times 100 = \frac{1.6}{120.2} = 1.33\%$$

614.1.4.2 Frequency (speed) regulation.

a. Obtain the average of the no-load speeds individually. On ac generator sets, frequency may be used instead of speed.

Sample Computation

Reading No.	Frequency
116	399.4
118	400.0
120	400.0

$$\text{Average of three trials} = \frac{1199.4}{3} = 399.8 = X_{r1}$$

Reading No.	Frequency
117	408.5
119	408.0
121	408.0

$$\text{Average of three trials} = \underline{1224.5} = 408.2 = X_{n1}{}_{3}$$

b. Substitute the average values in the following formula:

Frequency (speed) regulation (in percent) =

$$\frac{X_{n1} - X_{r1}}{X_{r1}} \times 100$$

Where X_{n1} is the average frequency (speed) at no load

X_{r1} is the average frequency (speed) at rated load

Sample Computation

Average frequency (speed) regulation =

$$\frac{408.2 - 399.8}{399.8} \times 100 = \frac{8.4}{399.8} \times 100 = 2.10\%$$

614.1.4.3 Compare the results of the computations with the values given in the procurement document.

614.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Allowable voltage regulation.
b. Allowable frequency regulation.
c. The voltage connection(s) and frequency(ies) at which this method shall be performed.

TEST DATA

DESCRIPTION 30KW, 400Hz 120/208V 3-PHASE GENERATOR SET

MFGR. ENGENSETS, INC.

MODEL NO. HE-30.0-MD

SERIAL NO. RA-8038

REF: MIL-STD-705/614.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

VOLTAGE AND FREQUENCY REGULATION

TEST NO. 12

SHEET 1 OF 1

DATE FEBRUARY 9, 1971

RECORDER J. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER [illegible]

INST. →		1756						1532			314			196	1315	1406	1076
READ NO. ↓	TIME	TERMINAL VOLTAGE						LINE CURRENT			OUTPUT POWER			FREQ	EXCITER FIELD		AVG AMB TEMP
		L1-L2	L2-L3	L3-L1	L1-L0	L2-L0	L3-L0	L1	L2	L3	L1	L2	L3				
UNITS	HRS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	KW	KW	HZ	VOLTS	AMPS	°F
SYM.								X40	X40	X40	X40	X40	X40				
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:00	STARTED UNIT - REGULATION OK - APPLIED RATED LOAD															74
110	09:10	208	208	208	120	120	120	2.60	2.60	2.60	0.250	0.250	0.250	400.0	11.0	.50	73
111	09:20	209	208	210	121	121	121	2.62	2.62	2.63	0.251	0.251	0.251	400.3	10.9	.49	72
		ADJUSTED LOAD, VOLTAGE AND FREQUENCY TO RATED.															
112	09:30	208	208	208	120	120	120	2.60	2.60	2.60	0.250	0.250	0.250	400.0	11.1	.51	72
113	09:40	208	208	208	120	120	120	2.60	2.60	2.60	0.250	0.250	0.250	400.0	11.1	.51	72
114	09:50	208	208	208	120	120	120	2.60	2.60	2.60	0.250	0.250	0.250	400.0	11.1	.51	72
115	10:00	208	208	208	120	120	120	2.60	2.60	2.60	0.250	0.250	0.250	400.0	11.1	.51	72
		TRIAL #1															
116	10:15	208	208	208	1204	120.1	120.2	2.60	2.60	2.60	0.250	0.250	0.250	400.0	11.1	.51	72
117		210	210	210	121.4	121.4	121.6	0	0	0	0	0	0	408.5	6.1	.27	72
		TRIAL #2															
118		208	208	208	120.4	120.0	120.2	2.60	2.60	2.60	0.250	0.250	0.250	400.0	10.6	.48	72
119		211	211	211	121.8	121.6	122.0	0	0	0	0	0	0	408.0	6.1	.28	72
		TRIAL #3															
120		208	208	208	1204	120.0	120.2	2.60	2.60	2.60	0.250	0.250	0.250	400.0	10.6	.48	72
121	14:25	212	212	212	1222	122.2	122.4	0	0	0	0	0	0	408.0	6.1	.28	72

NOTES: LINE CURRENT MEASURED USING C.T. No 1305-L1; 1306-L2; 1307-L3

EXCITER FIELD CURRENT MEASURED USING 1A, 50mV SHUNT No 113

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 614.1-I - Typical test record for voltage and frequency regulation test.

-2-

X-4633

Test.]

METHOD 615.1b

INHERENT VOLTAGE REGULATION TEST

615.1.1 General. The inherent voltage regulation is used by design engineers to aid in the selection of the voltage regulator and overvoltage safety equipment. It is important that the inherent voltage regulation of production generators) remains approximately the same as the regulation for the first article generators).

615.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition a variable dc source for external excitation shall be required. If this method is not performed as a set test, a prime mover capable of meeting the speed requirements as specified in the procurement document will be required.

615.1.3 Procedure.

615.1.3.1 Preparation for test.

a. Connect the load and field instrumentation in accordance with the applicable figure on MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and speed specified in the procurement document and provide the external excitation supply to the generator.

CAUTION: When operating the generator under manual voltage control care must be exercised in going from rated load to no load. The terminal voltage may rise to 150 percent of rated terminal voltage and exceed the voltage ratings of test instruments connected in the circuit.

615.1.3.2 Test.

a. Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated speed. During this period record all instrument reads at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and speed may be made to maintain rated load at rated voltage and speed. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and speed control systems shall be made unless permitted by the procurement document. Adjustments to load, voltage or speed controls shall be recorded on the data sheet at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variation about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or speed has been made.

b. After stabilization has occurred apply and drop rated load several times (3 should be sufficient) to assure that the no load and rated load voltage and speed values are repeatable and that the voltage and speed regulation is within the limits specified in the procurement document. If any adjustments are necessary, step a must be repeated. Reapply rated load. No further adjustments of the field voltage shall be made for the remainder of this method.
c. Starting with rated load, obtain the following load conditions in one step from the previous load step. During each step record all instrument readings (see figure 615.1-I).

    1. Rated load
    2. No load
    3. Rated load
    4. No load
    5. Rated load
    6. No load

d. Repeat steps a thru c above for all other voltage connection(s) and frequency(ies) specified in the procurement document.

615.1.4 Results.

a. Obtain the average of the three no load voltage readings and the average of the three rated load voltage readings.
b. Substitute the averages obtained in step a above in the following formula to obtain the inherent voltage regulation:

$$\text{Inherent voltage regulation (in percent)} = \frac{V_{n1} - V_{r1}}{V_{r1}} \times 100$$

Where: V_{n1} is the average no load voltage.

V_{r1} is the average rated load voltage.

c. Compare the computed inherent voltage regulation with the procurement document requirements.

615.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Upper and lower limits of acceptable inherent voltage regulation in percent of rated voltage.
b. Voltage connection(s) and speed(s) at which this method is to be performed.
c. Allowable speed regulation.

TEST DATA

DESCRIPTION 10KW, 60HZ 120V, SINGLE PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 16
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 1
MODEL NO. SF-10.0-MD	INHERENT VOLTAGE REGULATION TEST	DATE MARCH 17, 1971
SERIAL NO. 17765		RECORDER S. Wright
REF: MIL-STD-705/615.1		PROJ. ENGR. J. Jones
		SHIFT LEADER H. Smith
		OBSERVER J. Doe

INST. →		316		077		108		417		288		312	055				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD					AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS				°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0815	STARTED SET - APPLIED RATED LOAD															
	0825		120.0	2.60	104	.250	10.0		.80		60.0	16.1	1.32				76
	0835		119.8	2.60	104	.250	10.0		.80		60.0	16.1	1.32				76
	0845		119.5	2.55	102	.248	9.8		.80		60.1	16.1	1.30				78
	0855	ADJUSTED VOLTAGE AND FREQ. TO RATED															
	0905		120.0	2.60	104	.250	10.0		.80		60.0	16.4	1.32				77
	0915		120.0	2.60	104	.250	10.0		.80		60.0	16.4	1.32				77
	0925		120.0	2.60	104	.250	10.0		.80		60.0	16.4	1.32				77
	0935		120.0	2.60	104	.250	10.0		.80		60.0	16.4	1.32				77
	0940		120.0	2.60	104	.250	10.0		.80		60.0	16.4	1.32				77
	0941		181.7	0	0	0	0		—		61.6	16.4	1.32				77
	0942		120.2	2.60	104	.250	10.0		.80		60.0	16.4	1.32				77
	0943		181.7	0	0	0	0		—		61.6	16.4	1.32				77
	0944		120.2	2.60	104	.250	10.0		.80		60.0	16.4	1.32				77
	0945		181.7	0	0	0	0		—		61.6	16.4	1.32				77

NOTES: LINE CURRENT MEASURED USING C.T. No. 1305
EXCITER FIELD CURRENT MEASURED USING 2A, 100 mV SHUNT No. 1785

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 615.1-I Typical test record for inherent voltage regulation test.

X-4634

Regulation Test.]

METHOD 619.1d

VOLTAGE DIP FOR LOW POWER FACTOR LOADS TEST

619.1.1 General. Oscillograms of the output voltage made during the sudden application of low power factor loads indicate the ability of a generator set to start motors.

619.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. An oscillograph, a non-inductive shunt, galvanometer matching networks and galvanometers having a minimum flat frequency response (flat within +/- 5 percent from dc to 3,000 Hertz); and a voltage-linear, non-saturating reactive load of 0.4 (or less) power factor lagging will also be required.

619.1.3 Procedure.

619.1.3.1 Preparation for test.

a. Connect the field and load instrumentation in accordance with the applicable figures of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
b. Unless otherwise specified connect the voltage measuring galvanometer and matching network across any line-to-neutral (phase) connection which provides the input to the voltage regulator sensing circuit. Make this connection at the generator output terminals.
c. Connect the current measuring galvanometer and matching network across a shunt in the line associated with the voltage measuring galvanometer.
d. If the set contains an internal load bank, it shall be disconnected. If a voltage regulator reactive droop compensator is installed on the set, it shall be made inoperative.

619.1.3.2 Test.

a. Start and operate the generator set under control of the voltage regulator and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period readings of the load and field instrumentation and ambient temperature shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage or frequency shall be limited to those adjustments available to the operator, specifically, adjustments to the voltage or frequency adjust devices. on sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control system shall be made unless permitted by the procurement document. Adjusts to load, voltage or frequency shall be recorded on the stabilization data sheet. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made (see figure 619.1-II).

b. Using the galvanometer matching network, adjust the peak-to-peak voltage trace amplitude to a minimum of 3 inches (approximately 75 millimeters) as viewed on the oscillograph viewing screen. Set the oscillograph chart speed such the individual waveform peaks will be clearly visible. Set the oscillograph time marker to at least 0.01 seconds per line or use a 60 Hertz timing trace.

c. Immediately after the generator set has stabilized and the oscillograph has been adjusted, reduce the load to zero.

d. Adjust the terminal voltage and frequency to their rated values (generator nameplate values at the voltage connection and frequency used).

e. Apply the 0.4 or less power factor load (or as specified) and adjust this load to draw twice rated current (this will be a 1/2 per unit (P.U.) load impedance at the rated voltage connection used in step b above). A balanced three phase reactive load is required for three phase machines. If, while the applied load is drawing twice rated current, the set output voltage as measured on rms meter differs by more than two percent from the rated value, the reactive load shall be readjusted to compensate for this voltage difference. (NOTE: Several trial runs and readjustments may be necessary to insure that the equation is satisfied for the measured values of I_{ZPF} and E_{ZPF}.) The new equivalent load current required shall be calculated from the following equation:

$$I_{ZPF} = \frac{2\ I_R \times E_{ZPF}}{E_R}$$

Where: I_{ZPF} = The new equivalent load current.

E_{ZPF} = The resultant voltage at the low power factor load coincident with I_{ZPF}.

I_R = Rated current (from the generator nameplate data at the specified voltage connection).

E_R = Rated voltage (at the specified voltage connection).

f. Using the galvanometer matching network, adjust the peak-to-peak current trace amplitude to a minimum of 1.5 inches (approximately 40 millimeters).

g. Reduce the load to zero.

h. Read the load and field instrumentation and record the steady-state readings.

i. With the oscillograph adjusted as above, operate the oscillograph and apply the low power factor load in one step. After allowing the voltage and frequency to return to steady-state conditions after the transient period, stop the oscillograph, read the load and field instrumentation and record the readings.
j. Repeat steps g thru i above two additional times allowing the voltage and frequency to return to steady-state conditions after each load application.
k. Repeat steps a thru j above for each additional voltage connection and frequency specified in the procurement document.

619.1.4 Results.

a. From the oscillograms, check to insure that the load reactance was not saturated and introduce excessive harmonics by determining that the ratios of the peak-to-peak voltage to the peak-to-peak current remain constant from the instant the reactive load is first applied until steady-state conditions are reached (see figure 619.1-I).
b. Using the oscillograms and the corresponding voltmeter readings, determine the voltage dip in percent using the following equation:

$$\text{Voltage Dip, in percent} = \frac{V_{NL} - V_{D}}{V_{RATED}} \times 100$$

Where: V_{NL} = Voltmeter read at no load prior to applying load.

V_{RATED} = Rated voltage for which the generator is connected.

V_{D} = Calculated voltage dip during the transient period where

$$V_{D} = \frac{DV_{L}}{L}$$

V_{L} = Steady-state voltameter reading after application of load.

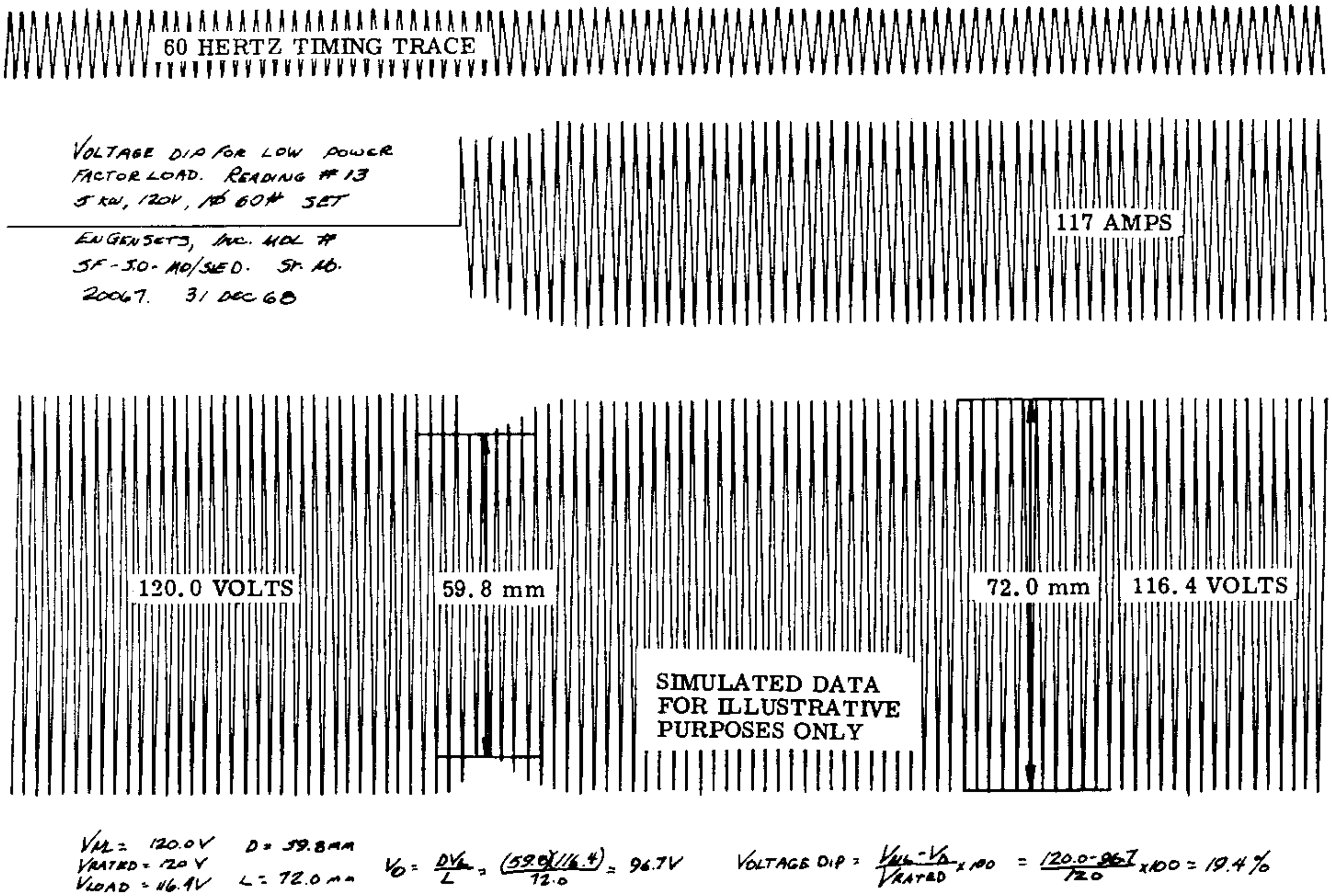
D = Measured minimum peak-to-peak amplitude of the voltage trace during the transient period following load application.

L = Measured peak-to-peak amplitude of the steady-state voltage after load application.

c. Calculate the minimum voltage, in percent of rated voltage, during the transient period after the application of the low power factor load by subtracting the voltage dip, in percent, obtained in b above from 100 percent.
d. From the oscillograms, use the timing lines or the 60 Hertz timing trace and determine the recovery time (no load to load) to the nearest 0.01 second. The recovery time is the time from the application of load until the voltage reaches the voltage value specified in the procurement document.
e. Compare these results with the requirements of the procurement document.

619.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Allowable voltage dip (no load to load), in percent of rated voltage or the minimum value of voltage, in percent of rated voltage, permitted during the transient period.
b. Required recovery time (no load to load) and the voltage value to which it is to be measured.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Load conditions, if other than 1/2 P.U. impedance at 0.4, or less, power factor lagging (twice rated current).
e. Phase connections for voltage herein.



MIL-STD-705C

Figure 619.1-I Portion of an oscillogram showing voltage dip calculations for application of load.

X-4635

Calculations For Application of Load.]

TEST DATA

DESCRIPTION 5KW, 60HZ 120V SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SE-5.0-MD

SERIAL NO. 10776

REF: MIL-STD-705/619.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

VOLTAGE DIP FOR LOW POWER FACTOR LOAD

TEST NO. 16

SHEET 1 OF 1

DATE 9 AUGUST 71

RECORDER L. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		117		227		336		445		554		110	312				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD					AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		Hz	VOLTS	AMPS				°F
SYM.				X25	X1	X25	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	13:00		STARTED SET, APPLIED RATED LOAD														
	13:10		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				77
	13:20		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				77
	13:30		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				77
	13:40		1200	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				77
	13:45		121.2	0	0	0	0		—		61.0	8.3	0.27				77
	13:47		120.0	4.16	104	.20	5.0		0.40		60.0	21.3	0.83				
	13:50		121.2	0	0	0	0		—		61.1	8.3	0.27				
	13:52		120.0	4.16	104	.20	5.0		0.40		60.0	21.4	0.83				
	13:55		121.2	0	0	0	0		—		61.1	8.3	0.27				
	13:58		120.0	4.16	104	.20	5.0		0.40		60.1	21.2	0.81				

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: C.T. # 1101
SHUNT # 1310, 1A, 50 mV

FIGURE 619.1-II. TYPICAL TEST RECORD FOR VOLTAGE DIP FOR LOW POWER FACTOR LOADS TEST.

X-4636

Power Factor Loads Test.]

METHOD 619.2c

VOLTAGE DIP AND RISE FOR RATED LOAD TEST

619.2.1 General. Oscillograms of the output voltage made during the sudden application and removal of load enables the voltage transient response of a generator set to be determined.

619.2.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. An oscillograph as described and illustrated in MIL-HDBK-705, method 106.1, paragraph 106.1.3, a non-inductive shunt, galvanometer matching networks and galvanometers having a minimum flat frequency response (flat within plus or minus 5 percent from dc to 3,000 Hertz) shall also be required.

619.2.3 Procedure.

619.2.3.1 Preparation for test.

a. Connect the field and load instrumentation in accordance with the applicable figures of MIL-STD-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Unless otherwise specified connect the voltage measuring galvanometer and matching network across any line-to-neutral connection which provide the input to the voltage regulator sensing circuit. Make this connection at the generator output terminals.
c. Connect the current measuring galvanometer and matching network across a shunt in the line associated with the voltage measuring galvanometer.
d. If the set contains an internal load bank, it shall be disconnected. The voltage regulator reactive droop compensator shall be made operative, if applicable.

619.2.3.2 Test.

a. Start and operate the generator set under control of the voltage regulator and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period readings of the load and field instrumentation and ambient temperature shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage or frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to load, voltage or frequency shall be recorded on the stabilization data sheet. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjust to the load, voltage or frequency has been made (see figure 619.2-II).

b. Using the galvanometer matching networks, adjust the amplitudes of the voltage and current traces to minimums of 3 and 1.5 inches (approximately 75 and 40 millimeters) respectively. On dc sets use an unenergized galvanometer for a zero voltage trace. Adjust the oscillograph chart speed such that individual waveform peaks will be clearly visible. Adjust the oscillograph time marker to 0.01 seconds per line maximum or use a 60 Hz timing trace.

c. After the stabilization has occurred record all instrument readings.

d. With the oscillograph adjusted as in step b above, operate the oscillograph and reduce the load to zero in one step (do not use set circuit breaker to remove load). After allowing the voltage and frequency to return to steady state conditions after the transient period, record all instrument readings.

e. Reapply the load in one step and allow the voltage and frequency to return to steady state conditions. Record all instrument readings.

f. Repeat steps d and e above a sufficient number of times to obtain the oscillographic recordings of 3 voltage dips and 3 voltage rises.

g. Repeat steps a thru f above for each additional voltage connection and frequency specified in the procurement document.

h. Repeat steps a thru g above for any other load conditions specified in the procurement document.

619.2.4 Results.

a. From the oscillograms check to insure that the load reactance was not saturated and introducing excessive harmonics by determining that the ratios of the peak-to-peak voltage to the peak-to-peak current remain constant from the instant the load is first applied until steady-state conditions are reached. (For ac generators only - see figure 619.2-I).

b. Using the no load to load oscillograms and the corresponding voltmeter readings, determine the voltage dip in percent using the following equation:

$$\text{Voltage Dip, in percent} = \frac{V_{NL} - V_{D}}{V_{RATED}} \times 100$$

Where V_{NL} = Voltmeter reading at no load prior to applying load.

V_{RATED} = Rated voltage for which the generator is connected.

V_{D} = Calculated voltage dip during the transient period where

$$V_{D} = \frac{D_{DL}}{L}$$

V_{L} = steady-state voltmeter reading after application of load.

D = Measured minimum peak-to-peak amplitude of the ac voltage trace during the transient period following load application. (For dc sets use the minimum trace excursion from the zero reference line).

L = Measured amplitude, peak-to-peak for ac of the steady-state voltage after load application.

c. Calculate the minimum voltage, in percent, during the transient period after the application of the load by subtracting the voltage dip, in percent, obtained in step b above from 100 percent.

d. From the oscillograms use the timing lines or the 60 Hertz timing trace and determine the recovery time (no load to load) to the nearest 0.01 second. The recovery time is the time from the application of load until the voltage reaches the stable voltage value as specified in the procurement document.

e. Using the load to no load oscillograms and the corresponding voltmeter readings determine the voltage rise in percent using the following equation:

$$\text{Voltage Rise, in percent} = \frac{V_{R} - V_{L}}{V_{RATED}} \times 100$$

Where V_{R} = Calculated voltage rise during the transient period

$$\text{where } V_{R} = \frac{RV_{NL}}{_{NL}}$$

R = Measured maximum peak-to-peak amplitude of the ac voltage trace during the transient period following load removal. (For dc sets use the maximum trace excursion from the zero reference line).

NL = Measured amplitude, peak-to-peak for ac, of the steady-state voltage after removing load.

V_{NL} = Steady-state voltmeter reading after removing load.

V_{RATED} = Rated voltage for which the generator is connected.

V_{L} = Steady-state voltmeter reading prior to removing load.

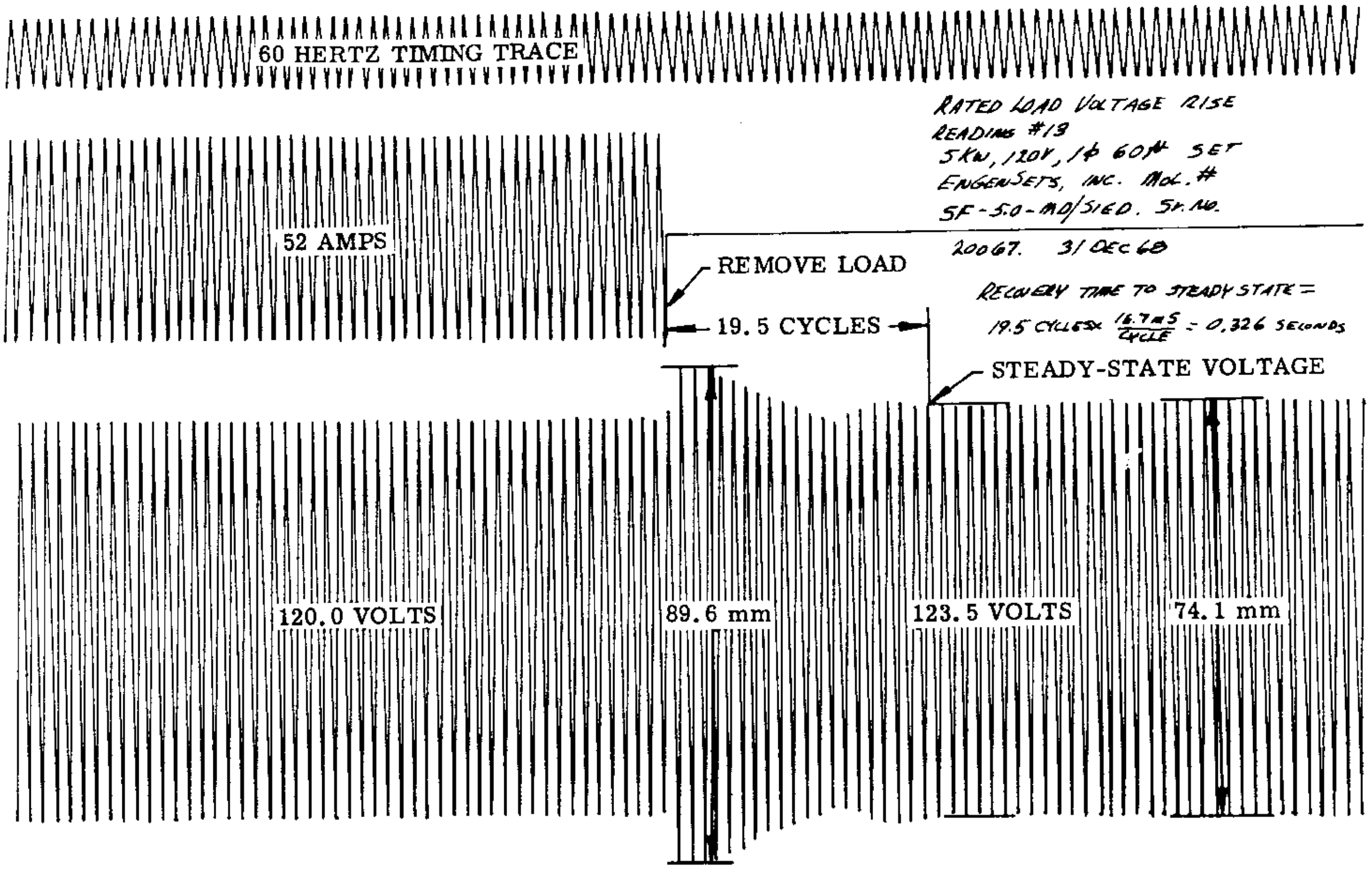
f. Calculate the maximum voltage in percent, during the transient period after removal of load by adding the voltage rise, in percent, obtained in step e above to 100 percent.

g. From the oscillograms, use the timing lines or the 60 Hz timing trace and determine the recovery time (load to no load) to the nearest 0.01 second. The recovery time is the time from the removal of load until the voltage reaches the stable voltage value as specified in the procurement document.

h. Compare these results with the requirements of the procurement document.

619.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Allowable voltage dip, no load to rated load, in percent of rated voltage, or the minimum value of voltage, in percent of rated voltage, permitted during the transient period after apply load.
b. Required recovery time, no load to rated load, and the stable voltage value, in percent of rated voltage, to which it is measured.
c. Allowable voltage rise, rated load to no load, in percent of rated voltage or the maximum value of voltage, in percent of rated voltage permitted during the period after removal of load.
d. Required recovery time, rated load to no load, and the stable voltage value to which it is to be measured, if different from item b above.
e. Voltage connection(s) and frequency(ies) at which this method is to be performed.
f. Load conditions, if other than rated load.
g. Additional transient response requirements in addition to those above, if any.



$V_{NL} = 123.5$ V $R = 89.6$ mm
$V_{RATED} = 120$ V $NL = 74.1$ mm
$V_L = 120.0$ V

$V_R = \frac{R V_{NL}}{NL} = \frac{(89.6)(123.5)}{74.1} = 149.3$ V

VOLTAGE RISE $= \frac{V_R - V_L}{V_{RATED}} \times 100 = \frac{149.3 - 120.0}{120} \times 100 = 24.4\ \%$

Figure 619.2-I. Portion of an oscillogram showing voltage rise calculations for removal of load.

X-4637

Calculations For Removal of Load.]

TEST DATA

DESCRIPTION 5KW, 60 HZ 120 SINGLE - PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 16
MFGR. ENGENSETS, INC.	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 1
MODEL NO. SF-5.0-MO	VOLTAGE DIP AND RISE FOR RATED LOAD TEST	DATA 24 may 88
SERIAL NO. 10776		RECORDER Robert Smith
REF. MIL-STD-705/619.2		PROJ. ENGR. Billy Adol
		SHIFT LEADER M. Jackson
		OBSERVER S. Wonder

INST. →		117		227		336		445		554		110	312				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD					AVG AMB TEMP.
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS				°F
SYM.				X 25	X 1	X 25	X 1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	13.00		STARTED SET, APPLIED RATED LOAD														
	13.10		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				77
	13.20		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				77
	13.30		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				77
	13.40		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.76				77
	13.45		121.2	0	0	0	0		—		61.00	8.3	0.27				77
	13.4		120.0	2.88	52	.20	5.0		0.80		60.0	17.3	0.75				
	13.50		121.2	0	0	0	0		—		61.1	8.3	0.27				
	13.52		120.0	2.08	52	.20	5.0		0.80		60.0	17.3	0.75				
	13.55		121.2	0	0	0	0		—		61.1	8.3	0.27				
	13.58		120.0	2.08	52	.20	5.0		0.80		60.1	17.3	0.75				

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: C.T. # 1101
SHUNT # 1310, 1A, 50 mV

FIGURE 619.2-II. TYPICAL TEST RECORD FOR VOLTAGE DIP AND RISE FOR RATED LOAD TEST

X-4798

Rated Load Test.]

METHOD 620.1b

VOLTAGE UNBALANCE WITH UNBALANCED LOAD TEST

(LINE-TO-NEUTRAL LOAD)

620.1 General. A generator set must have the capability to maintain a reasonably balanced voltage among the phases when an unbalanced load is applied. Line to line voltage unbalance has a serious effect on polyphase motor load. The negative sequence voltages cause heating of the windings and loss of torque. Line-to-neutral voltage deviations from rated voltage affect single phase loads. Lights and single phase motors may have either too low or too high a voltage impressed on them for either efficient or safe operation.

620.1.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

620.1.3 Procedure.

620.1.3.1 Preparation for test. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document. Note that only one voltmeter shall be used to all voltages and this voltmeter shall have an accuracy of +/- 0.5 percent of the reading or better.

620.1.3.2 Test.

a. Start and operate the generator set at rated voltage, no load, rated frequency, and under control of the voltage regulator. Record all instrument readings.
b. Apply the specified load between terminals $L_1 - L_0$, $L_2 - L_0$, and $L_3 - L_0$ in turn. Record all instrument readings at each line-to-neutral condition (see figure 620.2-I).
c. Repeat 620.1.3 for each of the other specified voltage connection(s) and frequency(ies).

620.1.4 Results.

a. Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.
b. Compare the largest differences expressed in percent with the maximum allowable difference specified in the procurement document.

620.1.4.1 Sample calculations.

$L_1 - L_2 = 200.0$ volts
$L_2 - L_3 = 203.0$ volts
$L_3 - L_1 = 210.0$ volts

maximum difference = 10.0 volts

Rated Voltage = 208.0 volts

$$\frac{10.0}{208.0} \text{ X } 100 = 4.81 \text{ percent}$$

620.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Load(s) to be applied as unbalanced loads in percent of rated line-to-neutral load.
b. Maximum acceptable values of line-to-line voltage unbalance expressed as percent of rated voltage.
c. Maximum acceptable values of line-to-neutral voltage unbalance expressed as a percent of rated voltage.
d. Voltage connection(s) and frequency(ies) at which this method is to be performed.

TEST DATA

DESCRIPTION 10 KW, 60 HZ
120/208 V 3-PHASE
GENERATOR SET
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 13761
REF: MIL-STD-705/620.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

VOLTAGE UNBALANCE WITH UNBALANCED LOAD
TEST
(LINE-TO-NEUTRAL LOAD)

TEST NO. 24
SHEET 1 OF 1
DATE MARCH 24, 1971
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER J. Smith
OBSERVER L. See

INST. →		7264						1528			1476	319	216				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE L1-L2	L2-L3	L3-L1	L1-L0	L2-L0	L3-L0	LINE CURRENT L1	L2	L3	OUTPUT POWER	POWER FACTOR	FREQ	DIFFERENCE L-L	L-N		AVG AMB TEMP
UNITS	HRS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	–	HZ	%	%		°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10.00	STARTED SET															
	10.10	208.0	208.0	208.1	120.0	120.0	120.1	0	0	0	0	–	60.0	–	–		76
		200.0	198.5	207.0	115.1	117.0	121.1	8.6	0	0	.83	.80	60.0	4.1	5.0		
		208.0	208.0	208.1	120.0	120.0	120.0	0	0	0	0	–	60.0	–	–		
		207.0	200.0	198.5	121.1	115.1	117.0	0	8.6	0	.83	.80	60.0	4.1	5.0		
		208.0	208.0	208.1	120.0	120.0	120.0	0	0	0	0	–	60.0	–	–		
		198.5	207.0	200.0	117.0	121.1	115.1	0	0	8.6	.83	.80	60.0	4.1	5.0		77

SAMPLE CALCULATION =

$$\frac{207-198.5}{208} \times 100 = \frac{8.5}{208} \times 100 = 4.1\%$$

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T NOS L_1 - [illegible]5; L_2 - [illegible]6, L_3 - [illegible]

FIGURE 620.1-I. Typical test record for voltage unbalance with unbalanced load test.

X-4638

Unbalanced Load Test.]

METHOD 620.2b

VOLTAGE UNBALANCE WITH UNBALANCED LOAD TEST

(LINE-TO-LINE)

620.2.1 General. A generator set must have the capability to maintain a reasonably balanced voltage among the phases when an unbalanced load is applied. Line-to-line voltage unbalance has a serious effect on polyphase motor load. The negative sequence voltages cause heating of the windings and loss of torque.

620.2.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

620.2.3 Procedure.

620.2.3.1 Preparation for test. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for a specified voltage and frequency condition. Note that only one voltmeter shall be used to measure the line-to-line voltages and this voltmeter shall have an accuracy of +/- 0.5 percent of the reading or better.

620.2.3.2 Test.

a. Start and operate the generator at rated voltage, no load, rated frequency, and under control of the voltage regulator. Record all instrument readings.
b. Apply the specified load between terminals $L_1 - L_0$, $L_2 - L_0$ and $L_3 - L_0$ in turn. Record all instrument readings at each line-to-line condition (see figure 620.2-I).
c. Repeat 620.2.3 for each of the other specified voltage connection(s) and frequency(ies).

620.2.4 Results.

a. Express the difference between any of the maximum and minimum line-to-line voltages as a percent of rated line-to-line voltages.
b. Compare the largest differences expressed in percent with the maximum allowable difference specified in the procurement document.

620.2.4.1 Sample calculations.

Reading No. 222

$L_1 - L_2 = 200$ volts
$L_2 - L_3 = 203$ volts
$L_3 - L_1 = 210$ volts

Maximum line-to-line difference = 10 volts
Rated line-to-line voltage = 208 volts

$$\frac{10}{208} \times 100 = 4.81 \text{ percent}$$

620.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Load(s) to be applied as unbalanced load in percent of rated line-to-line load.
b. Maximum acceptable values of line-to-line voltage unbalance expressed as a percent of rated voltages.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.

TEST DATA

DESCRIPTION 10 KW, 60 HZ
120/208 V 3-PHASE
GENERATOR SET
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 10761
REF: MIL-STD-705/620.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

VOLTAGE UNBALANCE WITH UNBALANCED LOAD
TEST
(LINE-TO-NEUTRAL LOAD)

TEST NO. 24
SHEET 1 OF 1
DATE MARCH 24, 1971
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER J. Smith
OBSERVER L. Lee

INST. →		7264						1528			1476	319	216				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE						LINE CURRENT			OUT PUT POWER	POWER FACTOR	FREQ	DIFFERENCE			AVG AMB TEMP
		L1-L2	L2-L3	L3-L1	L1-L0	L2-L0	L3-L0	L1	L2	L3				L-L	L-N		
UNITS	HRS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	—	HZ	%	%		°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10.00	STARTED SET															
	10.10	208.0	208.0	208.1	120.0	120.0	120.1	0	0	0	0	—	60.0	—	—		76
		200.0	198.5	207.0	115.1	117.0	121.1	8.6	0	0	.83	.80	60.0	4.1	5.0		
		208.0	208.0	208.1	120.0	120.0	120.0	0	0	0	0	—	60.0	—	—		
		207.0	200.0	198.5	121.0	115.1	117.0	0	8.6	0	.83	.80	60.0	4.1	5.0		
		208.0	208.0	208.1	120.0	120.0	120.0	0	0	0	0	—	60.0	—	—		
		198.5	207.0	200.0	117.0	121.1	115.1	0	0	8.6	.83	.80	60.0	4.1	5.0		77

SAMPLE CALCULATION =

$$\frac{207-198.5}{208} \times 100 = \frac{8.5}{208} \times 100 = 4.1\%$$

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. NOS L_1 - [illegible]; L_2 - [illegible], L_3 - [illegible]

FIGURE 620.1-I. Typical test record for voltage unbalance with unbalanced load test.

X-4638

Unbalanced Load Test.]

METHOD 620.4b

VOLTAGE UNBALANCE TEST (THREE WIRE, SINGLE PHASE)

620.4.1 General. A generator set must have the capability to maintain balanced voltages to the system when an unbalanced load is applied. Voltage deviations from rated voltage affect single phase loads. Lights and single phase motors may have either too low or too high a voltage impressed on them for either efficient or safe operation.

620.4.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

620.4.3 Procedure.

620.4.3.1 Preparation for test. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document. Note that only one voltmeter shall be used to measure all voltages and this voltmeter shall have an accuracy of +/- 0.5 percent of the reading or better.

620.4.3.2 Test.

a. Start and operate the generator set at rated voltage, no load, rated frequency, and under control of the voltage regulator. Record all instrument readings.
b. Apply the specified load between terminals $L_1 - L_0$, $L_2 - L_0$ and $L_1 - L_2$ in turn. Record all instrument readings at each load condition (figure 620.4-I).

620.4.4 Sample calculations.

a. Express the greatest difference between the two line-to-neutral voltages as a percent of rated line-to-neutral voltage.
b. Compare this difference expressed in percent with the maximum allowable difference specified in the procurement document.

620.4.4.1 Sample calculations.

$L_1 - L_0 = 118.0$ volts

$L_2 - L_0 = 122.0$ volts

Voltage Difference = 4 volts

Rated Line to Neutral Voltage = 120 volts

$$\frac{4.0}{120.0} \times 100 = 3.33 \text{ percent}$$

620.4.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Load(s) to be applied as unbalanced load in percent of rated line-to-neutral load.
b. Maximum acceptable value of line-to-neutral voltage unbalance in percent of rated voltage.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.

TEST DATA

DESCRIPTION 10KW, 60HZ 120/240 V, SINGLE-PHASE GENERATOR SET

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 10776

REF: MIL-STD-705/620.4

VOLTAGE UNBALANCE TEST (3 WIRE - SINGLE PHASE)

TEST NO. 99

SHEET 1 OF 1

DATE MARCH 26, 1971

RECORDER R. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Doe

INST. →		312			212		316		618		406						1076
READ NO. ↓	TIME	TERMINAL VOLTAGE L_1-L_2	TERMINAL VOLTAGE L_1-L_0	TERMINAL VOLTAGE L_2-L_0	LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		VOLTAGE DIFFERENCE				AVG AMB TEMP
UNITS	HRS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AS %			°F
SYM.					X5		X5										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0800	STARTED		SET													
	0805	240	120.0	120.0		0		0		—		60.0	0	0			72
L_1-L_0	0810	239.6	118.3	121.3	2.60	13.0	.25	1.25		.80		60.0	3.0	2.5			
L_2-L_0	0815	240.0	122.0	118.0	2.60	13.0	.25	1.25		.80		60.0	4.0	3.33			
L_1-L_2	0820	238.0	119.0	119.0	2.60	13.0	.50	2.50		.80		60.0	0	0			

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. # 1308

Figure 620.4-I: Typical test record for voltage unbalance test (three wire, single phase).

X-4640

METHOD 621.1b

UNBALANCED LOAD HEATING TEST

621.1.1 General. The generator set must be capable of withstanding without damage unbalanced loads for long periods of time.

621.1.2 Apparatus. Instrumentation for measuring load conditions, field conditions, field voltage and current, temperature of the generator windings and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

621.1.3 Procedure.

621.1.3.1 Preparation for test.

a. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Connect switch(es) to the generator armature winding(s) for which the temperature rise is to be determined, such that the winding(s) may be isolated for resistance measurement (if rapid access is available to isolate the individual winding(s) this step may be omitted).
c. Attach the necessary thermal instrumentation in accordance with MIL-HDBK-705, method 202.1 and make the necessary winding resistance measurements in accordance with MIL-STD-705, method 401.1.

621.1.3.2 Test.

a. Start and operate the generator set at rated voltage, no load, rated frequency, and under control of the voltage regulator.
b. Apply the specified unbalanced load.
c. Add balanced load at rated power factor, until rated current is recorded at one or the other of the two terminals to which the sample phase load is connected.

NOTE: The current will not be the same in the lines to which the single phase load is applied, if the power factor of the three phase load is other than unity. As soon as the current at either terminal is at rated value, discontinue adding three phase load.

d. Allow the generator set to stabilize at the above conditions. During this period record all instrument readings including ambient temperature at minimum intervals of 10 minutes. If necessary adjustments to the voltage and frequency may be made to maintain rated conditions. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On sets utilizing a droop type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the voltage and frequency controls shall be recorded on the data sheets at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the voltage or frequency has been made (see figure 621.1-I.

e. After stabilization has occurred, stop the set so that temperatures of rotating components and windings may be taken. For application of the contact method to rotating parts, or the resistance method to the armature coils (see MIL-HDBK-705, methods 110.1 and 202.1); a quick shutdown of the set is mandatory.

   CAUTION: Do not connect bridges, meters or temperature measuring equipment for measuring resistance or temperature to circuits which may still be energized, e.g., during the time that the set is coming to a stop.

f. Immediately after the shutdown, start to record the resistance bridge readings of the windings and the temperature of the components, where the contact method of measuring temperature rise is used.

   Readings of resistance measurements shall be recorded in accordance with instructions given in MIL-HDBK-705, method 110.1

   The first thermocouple reading shall be taken and recorded within 30 seconds after shutdown and additional readings taken and recorded at approximately 30 second intervals until one reading has been recorded after the temperature has begun to decrease, or three minutes has elapsed since set shutdown, whichever is longer, being certain that the maximum temperature reached by each component has been recorded. Continuous or multi-point temperature recorder(s) may be used to record component temperatures as long as the above time requirements are met.

g. Repeat steps a thru f above for each of the windings specified in the procurement document.

621.1.4 Results. Compare the temperature rise(s) with the procurement document requirements.

621.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Allowable temperature rise for the windings, giving the method of measurement.
b. Unbalanced load to be applied, in percent of rated phase load.
c. Voltage connection(s) and frequency (ies) at which this method is to be performed.

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120/208 V THREE PHASE GENERATOR SET

MFGR. ENGENSETS, INC.

MODEL NO. SE-10.0-MD

SERIAL NO. 107671

REF: MIL-STD-705/621.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

UNBALANCED LOAD HEATING TEST

TEST NO. 96

SHEET 1 OF 2

DATE MARCH 26, 1971

RECORDER L. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		107						312			418			210	156	372	1076
READ NO. ↓	TIME	TERMINAL VOLTAGE						LINE CURRENT			OUTPUT POWER			FREQ	EXCITER FIELD		AVG AMB TEMP
		L_1-L_2	L_2-L_3	L_3-L_1	L_1-L_0	L_2-L_0	L_3-L_0	L_1	L_2	L_3	L_1	L_2	L_3				
UNITS	HRS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	KW	KW	Hz	VOLTS	AMPS	°F
SYM.								X10	X10	X10	X10	X10	X10				
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1100	STARTED SET															
	1102	208.0	208.0	208.0	120.0	120.0	120.0	0	0	0	0	0	0	60.0	8.3	0.91	72
	1105	APPLIED SINGLE PHASE LOAD TO L_1-L_2															
	1107	207.0	209.0	209.0	119.0	119.0	121.0	.87	.87	0	.072	.072	0	60.0	10.1	1.02	72
	1110	APPLIED SYMETRICAL THREE PHASE LOAD															
	1120	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.0	1.51	72
	1130	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1140	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1150	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1200	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1212	SHUT DOWN SET FOR RESISTANCE READING							T_1-T_4								
	1220	RESTARTED SET - APPLIED UNBALANCED LOAD															
	1230	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.1	1.51	72
	1240	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1250	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1300	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1310	207.0	208.5	208.5	119.0	119.5	121.0	3.47	3.40	2.61	.333	.326	.250	60.0	16.3	1.51	72
	1312	SHUT DOWN SET FOR RESISTANCE READING								T_1-T_5							
	1320	RESTARTED SET - APPLIED UNBALANCED LOAD															

NOTES: LINE CURRENT MEASURED USING CT Nos. L_1-1305; L_2-1306; L_3-1307

EXCITER FIELD CURRENT MEASURED USING 2A, 50 mV SHUNT No 008

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

X-4641

Figure 621.1-I: Portion of a typical test record for unbalanced load heating test.

Load Heating Test.]

METHOD 625.1d

SHORT CIRCUIT TEST
(MECHANICAL STRENGTH)

625.1.1 General. The mechanical design of the generator must be adequate to withstand the stresses caused by abnormal operating conditions including sustained short circuits.

625.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, short-circuit current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, a shorting switch shall be required.

625.1.3 Procedure.

625.1.3.1 Preparation for test.

a. Deactivate the circuit interrupter.
b. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
c. Connect the ammeter in series with the shorting switch directly to the short circuit current.

625.1.3.2 Test.

a. Start and operate the set and allow the set to stabilize at rated load, rated voltage and rated frequency (speed). During this period record all instrument readings including ambient temperature at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage, and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On sets utilizing a droop-type frequency control system such as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recordings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made. After stabilization occurs apply the short circuit(s) for the time specified in the procurement document. Record all instrument readings including the steady-state short-circuit current for each short circuit condition.
c. Repeat steps a and b above for all other voltage connections and frequencies specified in the procurement document.

d. Inspect the generator and exciter windings, the voltage regulator and all control devices (as applicable) for damage resulting from the application of each short-circuit. List on the data sheet any damage that has occurred to any of the components.

625.1.4 Results. The sustained short-circuit current shall be calculated as a percent of rated current and compared with the value given in the procurement document.

625.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Type(s) of short circuit to be applied.
b. Voltage connection(s) and frequency(ies) at which this method is to be performed.
c. Length of time short circuit is to be applied.
d. Minimum acceptable value of sustained short-circuit current.

TEST DATA

DESCRIPTION 10KW, 400 Hz 120V SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. HF-10.0-MD

SERIAL NO. 01417

REF: MIL-STD-705/625.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

SHORT CIRCUIT TEST

(MECHANICAL STRENGTH)

TEST NO. 37

SHEET 1 OF 1

DATE FEBRUARY 10, 1971

RECORDER J. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		1013		918		672		498		311		1001	976				1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD			SHORT CIRCUIT CURRENT		AVG. AMB TEMP.
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS		AMPS	AMPS	°F
SYM.				x40	x1	x40	x1								x100	x1	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	13:00	STARTED UNIT APPLIED RATED LOAD															
	13:30		120.0	2.60	104	0.250	10.0		0.80		400.0	16.5	0.76				77
	13:40		120.0	2.60	104	0.250	10.0		0.80		400.0	16.5	0.76				77
	13:50		120.0	2.60	104	0.250	10.0		0.80		400.0	16.5	0.76				77
	14:00		120.0	2.60	104	0.250	10.0		0.80		400.0	16.5	0.76				77
	14:05	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.16	416	
	14:05	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.15	415	
	14:06	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.15	415	
	14:06	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.15	415	
	14:07	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.16	415	
	14:07	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.15	416	
	14:08	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.16	415	
	14:08	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.15	415	
	14:09	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.15	415	
	14:09	APPLIED SHORT CIRCUIT FOR 10 SEC.													4.15	415	
NOTES:	LINE CURRENT MEASURED USING C.T No 1305																
	SHORT CIRCUIT CURRENT MEASURED USING C.T No 1306																

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 625.1-I - Typical test record for short circuit test (mechanical strength).

X-4642

METHOD 630.1d

PARALLEL OPERATING TEST

630.1.1 General. It is sometimes necessary to connect two or more generator sets (which are designed for parallel operation) in parallel to supply power requirements greater than the rating of an individual set. Generator sets may also be connected in parallel to assure an uninterrupted supply of power if it becomes necessary for one generator set to be shut down for maintenance or service. When two or more generator sets are connected in parallel, the capability should exist for supplying power equal to their combined ratings without overloading any one of the individual units. In order to do so, the sets must divide the system load in proportion to their individual set ratings, and power exchange between the sets so connected must be kept to a minimum. Power exchange is the difference between the maximum and minimum power output delivered by a set, for constant system load conditions. Power exchange may be determined by oscillographic measurements.

630.1.2 Apparatus. Instrumentation for measuring load conditions and phase rotation shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) for recording voltage and frequency as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1, an oscillograph as described and illustrated in MIL-HDBK-705, method 106.1, transducers for real and reactive power as described and illustrated in MIL-HDBK-705, method 103.1 and a non-inductive shunt will be required. The galvanometers used with non-inductive shunts to measure current shall have a flat frequency response (flat within +/- 5 percent) from dc to 3,000 Hz. Galvanometers used with power (real or reactive) transducers shall be of the low frequency response type and shall have a flat frequency response (flat within +/- 5 percent) from dc to 11 Hz. When using computing type galvanometers, they shall have a flat frequency response (flat within +/- 5 percent) from dc to at least twice the frequency of the generator sets under test.

630.1.3 Procedure. The following instructions are for paralleling two sets of the same power (and frequency) rating. For paralleling more than two sets of different power ratings, this method may be followed by extension of the procedure.

CAUTION: Do not close any load switches or circuit interrupters until specifically directed to do so. Closing the load switches or circuit interrupters at any other time may damage both the equipment and the test apparatus.

630.1.3.1 Preparation for test.

a. Connect the generator sets to be paralleled for one of the voltage connections and frequencies specified in the procurement document.
b. Connect each of the sets, through individual load switches, to a common system load using the proper phase sequence (like output terminal numbers on each set are connected together on the same line). Connect the individual set instrumentation and system load

instrumentation in accordance with the applicable figure in MIL-HDBK-705, method 205.1, paragraph 205.1.10. The active power (watts) delivered by one set is recorded on the oscillograph.

c. Using the operating instructions on the set or in the technical manual, check, and if necessary, initially adjust the governor and voltage regulator paralleling controls.

   1. On sets that are paralleled with droop, check the frequency and voltage regulation while in the parallel operation mode (voltage droop compensator operative but the sets are not actually operating in parallel). If necessary, adjust both sets for identical regulation values. These regulation values must be within those values specified in the procurement document for parallel operation.
   2. On sets that are paralleled without droop, the voltage at the parallel receptacle must be equal in both magnitude and polarity. Interconnect the sets utilizing the paralleling cable.

d. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of one of the sets or to a generator coil which is used as the voltage sensing input to the voltage regulator of one of the sets.

e. Use the phase sequence indicator to assure the phase rotation of each generator is the same.

f. Open all circuit interrupters and load switches.

630.1.3.2 Test.

a. Operate the sets at rated voltage, rated frequency and at no load.

b. Close the circuit interrupter and turn on the paralleling circuits on set number 1.

c. Apply the minimum system load specified in the procurement document.

d. On set number 2, turn on the synchronizing lights and paralleling circuits. Adjust the frequency of set number 2 to a higher frequency than the bus frequency, then slowly reduce the frequency of set number 2 until the lights simultaneously brighten and go dark in approximately 5 second intervals. (NOTE: If one light is bright while the other is dark, one of the sets is incorrectly wired and must be corrected before proceeding further. See 630.1.3.1b.)

e. Close the circuit interrupter of set number 2 at the instant both synchronizing lights go dark.

CAUTION: Closing the switch under any condition other than with the synchronizing lights dark may cause severe damage to the generator sets and test apparatus.

f. With the generator sets operating in parallel, and with the system loaded to the minimum load value specified in the procurement document, make small adjustments to the governors (by means of the frequency adjust device only) to equally divide the kW load between the sets. Make small adjustments to the voltage regulators (by means of the voltage adjust device only) to obtain a minimum and equal current, thereby dividing the reactive load equally between the sets.

g. Increase the system load in small increments and balance this load between each set using the real and reactive load sharing controls until each set is carrying rated load. No further adjustments shall be made to either the load sharing controls or the voltage and frequency adjust devices for the remainder of this test unless specifically directed otherwise.
h. In one step, reduce the system load to the minimum value specified in the procurement document. Operate the sets at this system load condition for one hour. Read and record the load instrumentation readings for each set and the system load at 15 minute intervals. Adjust the voltage and frequency chart speed recording meter(s) to 12 inches per minute for the first 30 seconds and then to 12 inches per hour during the remainder of the one hour period. Adjust the oscillograph trace amplitudes and chart speed such that periodic pulsations of power and current are clearly visible. Operate the oscillograph for 30 seconds at 15 minute intervals during this one hour of operation.
i. Increase the system load in four approximately equal steps until the combined rating of the sets is applied. At each of the four load steps operate the sets for one hour taking readings and recordings as in step h above.
j. Adjust the recording meter(s) chart speed(s) to 12 inches per minute and the oscillograph chart speed to at least twice the speed used in step h above.
k. With the sets operating at system rated load, reduce the load in one step to the minimum load value specified in the procurement document. Operate the sets at this load condition for a minimum of 30 seconds. (If the procurement document limits the transient load value, use the specified value). Read and record all load instrumentation readings mark the recording charts.
l. In one step, reapply the system rated load in k above and operate the sets at this load condition for a minimum of 30 seconds. Read and record all load instrumentation readings and mark the recording charts.
m. Repeat steps k and l above two additional times; then reduce the system load to the minimum specified value.
n. On sets having a reverse power protective device, slowly adjust the frequency adjust device on one of the sets in such a manner as to increase the load on that set until the circuit interrupter on the other set opens or the specified value of reverse power is exceeded. Read and record the value of reverse power at which the circuit interrupter opens or record that the specified value of reverse power was attained without the circuit interrupter opening. (Note and record the indication of the malfunction indicator as applicable).
o. Resynchronize the sets, parallel them again and repeat step n above using the other set.
p. On sets having permissive paralleling provisions, close the circuit interrupter on one of the sets and slowly adjust the frequency of the other set until the synchronizing lights simultaneously brighten and go dark in approximately 5 second intervals. At the onset of their peak brightness, momentarily close the circuit interrupter on the set. Record whether or not the circuit interrupter actually closed.

q. Repeat step p above except hold the circuit interrupter actuating switch closed until the circuit interrupter actually closes. Record whether or not the circuit interrupters on either set opened and any indication of the malfunction indicator, as applicable.
r. Repeat steps p and q above using the other set.
s. Repeat steps a thru r above for each of the other voltage connections and frequencies specified in the procurement document.

630.1.4 Results.

630.1.4.1 Active power division.

a. Using the individual set load instrumentation data, determine the kilowatt output for each set, in percent of its nameplate rating, at each load condition. This is the active power division for each set.
b. Determine the difference in the percentage of kilowatt load carried by each set by subtract the values calculated in step a at each of the load conditions.

630.1.4.2 Active power exchange.

a. From the oscillograms, determine at each load condition the maximum and minimum values of active power carried by one set.
b. Subtract the minimum value from the maximum value, divide by the nameplate rating of the set and multiply by 100. This is the active power exchange in percent of the nameplate rating of the individual set.

630.1.4.3 Reactive power division.

a. Using the individual set load instrumentation data, determine the KVAR output for each set at each load condition. This is the reactive power division for each set.
b. Determine the difference in the reactive power by subtracting the values calculated in step a above for each load condition. Divide the remainder by the individual set's KVAR rating. This is the percent unbalance in the reactive power division.

630.1.4.4 Load current pulsation.

a. From the oscillograms, determine at each load condition the maximum and minimum values of load current carried by one set.
b. Subtract the minimum value from the maximum value, divide by the nameplate current rating of the set and multiply by 100. This is the load current pulsation in percent of the nameplate rating of the individual set.

630.1.4.5 Voltage and frequency stability and transient response.

a. From the recording charts, determine the voltage and frequency stability bandwidths for each load condition of 630.1.3.1, steps h and i. Refer to method 608.2.

b. For each of the load transients performed in 630.1.3.2, steps h and m, determined the following (refer to method 608.1):

1. Recovery times.
2. The overshoot.
3. The undershoot.
4. The regulation for voltage and frequency.

630.1.4.6 Compare these results with the procurement document requirements.

630.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and frequency(ies) at which the method is to be performed.
b. Minimum and maximum system load values.
c. Voltage and frequency droop control settings at which this method is to be performed, if applicable.
d. Maximum load transient, if other than specified in this method.
e. Active (kilowatt) power difference allowed, in percent of individual set rating.
f. Reactive power difference allowed, in percent of individual set rating.
g. Maximum active power exchange allowed, in percent of individual set rating.
h. Maximum load current pulsation exchange in percent of individual set rating, if applicable.
i. Maximum value of reverse power at which the circuit interrupter is to operate if applicable.
j. Malfunction indicator requirements, if applicable.
k. Maximum allowable long-term voltage stability bandwidth or deviation in percent of rated voltage.
l. Maximum allowable long-term frequency stability bandwidth or deviation in percent of rated frequency.
m. Maximum allowable short-term voltage stability bandwidth or deviation in percent of rated voltage.
n. Maximum allowable short-term frequency stability bandwidth or deviation in percent of rated frequency.
o. Maximum allowable voltage time.
p. Maximum allowable frequency recovery time.
q. Maximum allowable voltage overshoot and undershoot, if applicable.
r. Maximum allowable frequency overshoot and undershoot.
s. Maximum allowable voltage regulation.
t. Maximum allowable frequency regulation.

TEST DATA

DESCRIPTION 60KW, 60Hz 120/208V 3-PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 61
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 3
MODEL NO. SE-600-MD	PARALLEL OPERATION TEST	DATE AUG 3, 1970
SERIAL NO. 0087	SET #0087 PARALLELED	RECORDER S. Wright
REF: MIL-STD-705/630.1	WITH SET #0103	PROJ. ENGR. J. Flores
		SHIFT LEADER H. Smith
		OBSERVER L. Lee

INST. →		11038			1081						534		671		422		1076
READ NO. ↓	TIME	TERM. VOLTAGE			LINE CURRENT						OUTPUT POWER		POWER FACTOR		FREQUENCY		AVG AMB TEMP
		L1-L2	L2-L3	L3-L1	L1	L1	L2	L2	L3	L3							
UNITS	HRS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS	KW	KW	—			Hz	°F
SYM.					X80	X1	X80	X1	X80	X1	X80	X1					
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1330	119.5	120.0	120.0	2.06	164.8	2.05	164.0	2.05	164.0	.575	46.0		0.79		60.0	82
	1345	119.5	120.0	120.0	2.06	164.8	2.05	164.0	2.05	164.0	.575	46.0		0.79		60.0	82
	1345	APPLIED RATED LOAD															
	1350	119.5	120.0	119.8	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	83
	1405	119.5	120.0	120.0	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	83
	1420	119.6	120.1	119.9	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	83
	1435	119.6	120.1	120.0	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	84
	1450	119.6	120.1	120.0	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	83
		TRANSIENT RESPONSE															
	1455	120.1	120.3	120.3	0	0	0	0	0	0	0	0		—		60.1	
		119.6	120.0	120.0	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	
		120.0	120.2	120.3	0	0	0	0	0	0	0	0		—		60.1	
		119.7	120.0	120.0	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	
		120.1	120.2	120.3	0	0	0	0	0	0	0	0		—		60.1	
		119.6	120.0	120.0	2.66	212.8	2.64	211.2	2.65	212.0	.750	60.0		0.78		60.0	
		REVERSE POWER PROTECTIVE DEVICE CHECK															
	1500										.160	12.8					
		DEVICE ACTUATED - REVERSE POWER MALFUNCTION INDICATOR "ON" - SET DROPPED OFF THE LINE															

NOTES: LINE CURRENT MEASURED USING C.T. # L1 - 1307
L2 - 1308
L3 - 1309

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 630.1-I: Portion of a typical test record for parallel operation test.

X-4643

Operation Test.]

TEST DATA

DESCRIPTION 60KW, 60Hz 120/208V, 3-PHASE GENERATOR SET	PHILADELPHIA REGION DEFENSE CONTRACT ADMINISTRATION SERVICE	TEST NO. 61
MFGR. ENGENSETS, INC	PARALLEL OPERATION	SHEET 1 OF 2
MODEL NO. SE-60.0-MD	RESULTS	DATE AUG 10, 1970
SERIAL NO. 0087 & 0103		RECORDER J. Wright
REF: MIL-STD-705/630.1		PROJ. ENGR. J. Jones
		SHIFT LEADER H. Smith
		OBSERVER J. Lee

INST. →																	
READ NO. ↓						NOM. SYSTEM LOAD	S/N 0087		S/N 0103		% DIFFERENCE						
UNITS						%		%		%		%					
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	ACTIVE POWER DIVISION					50		47		53		6					
						62.5		60		65		5					
						75		73		77		4					
						87.5		88		87		1					
						100		100		100		0					
							MAX.	MIN	MAX	MIN							
	ACTIVE POWER EXCHANGE						KW	KW	KW	KW							
						50	28.8	27.6	32.4	31.2		2					
						62.5	36.6	35.4	39.5	38.3		2					
						75	44.3	43.1	46.7	45.5		2					
						87.5	53.2	52.1	52.7	51.5		2					
						100	60.6	59.4	60.6	59.9		2					
	REACTIVE POWER DIVISION							KVAR		KVAR		% [illegible]					
						50		22.0		23.4		3					
						62.5		28.0		28.9		2					
						75		34.0		35.6		3					
						87.5		39.3		40.2		2					
						100		45.0		46.1		2					
NOTES:																	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 630.1-II: Portion of typical results for parallel operation test.

X-4644

Test.]

METHOD 640.1d

MAXIMUM POWER TEST
(FOR GASOLINE AND DIESEL GENERATOR SETS)

640.1.1 General. The maximum power of a generator set is a function of the ambient conditions (temperature and altitude) and the mechanical condition of the engine at any particular time.

640.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, pressures and temperatures shall be as described and illustrated in MIL-HDBK-705.

640.1.3 Procedure.

CAUTION: This procedure subjects the generator set to a severe overload which may be damaging if maintained for too long a period of time.

640.1.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Install appropriate thermocouples to measure the following temperatures:

(NOTE: Not all sets will require instrumentation of all of the listed items. The list contains items normally instrumented. However, some sets may require additional thermal instrumentation).

1. Engine coolant (engine outlet and inlet).
2. Spark plug(s).
3. Exhaust gas(es) [the exhaust manifolds) shall be drilled and tapped as close as possible to the combustion chamber(s).]
4. Lubricating oil sump.
5. Engine combustion air in (located at the inlet of the intake manifold).

c. Install appropriate pressure instrumentation to measure the following items:

1. Exhaust pressure (combined exhaust gases in exhaust manifold).
2. Intake air manifold pressure (between air filters and manifold).

d. Obtain and record the barometric and water vapor pressures (see MIL-HDBK-705, method 220.2).
e. On generator sets having more than one power output system; e.g. high voltage ac and law voltage dc (disregard the battery charging system) or two ac systems of different frequencies, maintain the system with the lowest power rating at rated load for all parts of this test. The load in the system with the highest power rating is then varied as indicated below to determine the maximum power of the set.

f. Bypass the set circuit interrupter if required.
g. Connect the set to a source of fuel containing a specified fuel required by the procurement document.

640.1.3.2 Test.

a. Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency (speed). During this period, readings of all instruments including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specially adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on both the data sheet and recording chart(s). Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current recordings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made. Refer to figure 640.1-I. If this test is performed immediately following another test which as established stabilization values, stabilization will be considered valid once all the previously established values and operating parameters are obtained (initial stabilization readings therefore must include all values needed for subsequent testing). Note: Operation of the set shall not be interrupted between this test and the test that established stabilization values.
b. Perform this test using resistive load only (on ac sets remove reactive load after stabilization).
c. For sets with droop-type governors (except turbocharged engine-driven generator sets):

    1. Alternately increase the load, voltage and frequency in small increments until the fuel system controls are in the maximum fuel position as permitted by the governor control linkage and the voltage and frequency are within 1 percent of their rated values. The maximum load shall not exceed 125 percent of rated load. (NOTE: Small increments should be taken to avoid passing the maximum power at the rated voltage and frequency point and to avoid racing or bogging the engine).
    2. Hold the conditions in step 1 above for two minutes. However, if the voltage and frequency cannot be maintained within 1 percent of their rated values, the load must be adjusted to the point at which the voltage and frequency can be maintained within 1 percent of their rated values for two minutes.

CAUTION: It may be necessary to reduce the load to a value below the rated kilowatt load for a short period of time to prevent serious overheating or damage to the generator set if the above conditions cannot be readily attained. (Monitor instrumentation).

3. During the two minute period record all instrument readings including thermal and pressure instrumentation. (On 3-phase sets it is not necessary to record line-to-line voltages).
4. Reduce the load to rated kilowatt load and allow the generator set to cool for 10 minutes.
5. Repeat steps 1 thru 4 above until three valid sets of maximum power data are obtained.

d. For sets with isochronous-type governors (except for turbocharged engine-driven generator sets), repeat step c above but do not adjust the frequency.
e. For turbocharged engine-driven generator sets with droop-type governors:

    1. Load the set to 125 percent of rated load unless otherwise specified in the procurement document. Adjust the frequency to the rated value and maintain the load for 5 minutes unless otherwise specified in the procurement document.
    2. Record all instrument readings including thermal and pressure instrumentation.

f. For turbocharged engine-driven generator sets with isochronous-type governors, repeat step e above but do not adjust the frequency.
g. Repeat steps a thru f above as applicable for all other voltage connections and frequencies specified in the procurement document.

640.1.3.3 Repeat procedure. Repeat 640.1.3 for all fuels specified in the procurement document.

640.1.4 Results.

a. Average the three valid maximum power readings for each load, voltage, frequency and fuel condition. This average is the observed maximum power value.
b. Except when performed as part of method 720.1, the Altitude Operation Test; correct the observed maximum power value to standard conditions using the procedure in MIL-HDBK-705, method 220.2, paragraph 220.2.3. This is the corrected maximum power value. (NOTE: The observed maximum power value for supercharged engine-driven generator sets, including turbocharged engines, is not to be corrected to standard conditions). Compare these results with the procurement document requirements.

640.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Minimum value of maximum required. (For turbocharger engine-driven generator sets: The value of load and length of time the set is to be operated at this load if other than specified herein).
b. Voltage connection(s) and frequency(ies) at which this method is to be performed.
c. Fuel(s) to be used in performing this method, if applicable.

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

MAXIMUM POWER TEST

(FOR GASOLINE AND DIESEL GEN. SETS)

DESCRIPTION 10KW, 60HZ 120V, SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 21067

REF: MIL-STD-705/640.1

TEST NO. 12

SHEET 1 OF 2

DATE 5 AUGUST, 1970

RECORDER J. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER J. Lee

INST. →		377	153		217		706	809	342	118			916				1076
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ.	EXCITER FIELD		ENG AIR IN	ENG. AIR OUT	SPARK PLUGS CYL 1	CYL 2	CYL 3	CYL 4	AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	°F	°F	°F	°F	°F	°F	°F
SYM.			X40	X1	X40	X1			X1	X.02							
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	10:00	STARTED SET - APPLIED RATED LOAD															
	10:10	120.0	2.60	104	0.250	10.0	.80	60.0	7.6	48.0	77	92	375	401	406	382	76
	10:20	120.4	2.62	105	0.251	10.4	.796	60.3	7.8	48.4	79	95	390	415	422	396	77
	10:30	120.4	2.62	105	0.251	10.4	.796	60.3	7.9	48.4	79	95	395	420	427	400	77
		ADJUSTED LOAD, VOLTAGE AND FREQUENCY															
	10:40	120.0	2.60	104	0.250	10.0	.80	60.0	8.0	48.2	80	98	398	425	431	403	78
	10:50	120.0	2.60	104	0.250	10.0	.80	60.0	8.1	48.2	81	98	400	428	434	407	78
	11:00	120.0	2.60	104	0.250	10.0	.80	60.0	8.1	48.2	81	98	400	428	433	405	78
	11:10	120.0	2.60	104	0.250	10.0	.80	60.0	8.1	48.2	81	98	401	428	433	406	78
	11:20	120.0	2.60	104	0.250	10.0	.80	60.0	8.1	48.2	81	98	400	428	433	405	78
			2.63	105	0.313	12.5											
	11:25	118.8	~~3.8~~	~~152~~	~~0.464~~	~~18.56~~	1.0	59.4	12.3	58.4							
			2.63	105	0.313	12.5											
	11:40	118.8	~~3.75~~	~~150~~	~~0.450~~	~~18.0~~	1.0	59.4	12.6	58.4							
			2.63	105	0.313	12.5											
	11:55	118.8	~~3.75~~	~~150~~	~~0.450~~	~~18.0~~	1.0	59.4	12.6	58.4							
								12.5									
	AVERAGE OBSERVED MAX POWER = ~~16.28~~ KW																

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T NO. 1306

EXCITER FIELD CURRENT MEASURED USING A 1A, 50MV SHUNT

Figure 640.1-I: Portion of a typical test record for maximum power test(for gasoline and diesel generator sets).

X-4645

Power Test.]

METHOD 640.2d

MAXIMUM POWER TEST
(DETERMINATION OF REQUIREMENTS FOR PRODUCTION SETS)

640.2.1 General. The maximum power of a generator set is a function of the ambient conditions (temperature and altitude), and the mechanical condition of the engine at any particular time.

640.2.2 Apparatus. None required.

640.2.3 Procedure. Unless otherwise specified in the procurement document, the minimum acceptable corrected maximum power limit shall not be less than 95 percent of the average of the maximum power values of the first article generator sets (taken prior to endurance test), corrected to standard conditions using the procedure in MIL-HDBK-705, method 220.2, paragraph 220.2.3.

Min Acceptable Max. Power Limit =

Avg. First Article Set Max. Power (corrected) X 0.95

640.2.4 Results. Use the value obtained above as the minimum maximum power requirement in method 640.4.

640.2.5 Procurement document requirement. The following item must be specified in the individual procurement document:

The minimum acceptable value of maximum power, if other than that specified herein.

METHOD 640.4a

MAXIMUM POWER TEST

FOR GASOLINE AND DIESEL, GENERATOR SETS (PRODUCTION SETS)

640.4.1 General. The maximum power of a generator set is a function of the ambient conditions (temperature and altitude) and the mechanical condition of the engine at any particular time.

640.4.2 Apparatus. Instrumentation for measuring load conditions, temperatures and pressures shall be as described and illustrated in MIL-HDBK-705.

640.4.3 Procedure.

CAUTION: This procedure subjects the generator set to a severe overload which may be damaging if maintained for too long a period of time.

640.4.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
b. Install appropriate thermocouples to measure the following temperatures.

    1. Lubricating oil sump.
    2. Engine combustion air in (located at the inlet of the intake manifold).

c. Obtain and record the barometric and water vapor pressures (see MIL-HDBK-705, method 220.2).
d. On generator sets having more than one power output system, e.g., high voltage ac and low voltage dc (disregard the battery charging system) or two ac system of different frequencies, maintain the system with the lowest power rating at rated load for all parts of this test. The load on the system with the highest power rating is then varied as indicated below to determine the maximum power of the set.
e. Bypass the set circuit interrupter if required.
f. Connect the set to a source of fuel as required by the procurement document.

640.4.3.2 Test.

a. Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency (speed). During this period readings of all instrumentation including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control system shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet. Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive recorded readings of the lubricating oil temperature either remain unchanged or have only minor variations about an equilibrium condition with no evident continued or decrease in value after the last adjustment to the load, voltage or frequency has been made. Refer to figure 640.4-I. If this test is performed immediately following another test which has established stabilization values, stabilization will be considered valid once all the previously established values and operating parameters are obtained (initial stabilization readings therefore must include all values needed for subsequent testing). Note: Operation of the set shall not be interrupted between this test and the test that established stabilization values.

b. Perform this test using resistive load only (on ac sets remove the reactive portion of the load after stabilization).

c. For sets with droop-type governors (except turbocharged engine-driven generator sets):

1. Alternately increase the load, voltage and frequency in small increments until the fuel system controls are in the maximum position as permitted by the governor control linkage and the voltage and frequency are within 1 percent of their rated values. The load shall not exceed 125 percent of rated load. (Note: Small increments should be taken to avoid pass the maximum power at the rated voltage and frequency point and to avoid racing or bogging the engine.)
2. Hold the conditions in step 1 above for two minutes. However, if the voltage and frequency cannot be maintained within 1 percent of their rated values, the load must be adjusted to the point at which the voltage and frequency can be maintained within 1 percent of their rated values for two minutes.

CAUTION: It may be necessary to reduce the load to a value below the rated kilowatt load for a short period of time to prevent serious overheating or damage to the generator set if the above conditions cannot be readily attained. (Monitor instrumentation.)

3. During the two minute period record all instrument readings including thermal instrumentation.
4. Reduce the load to approximately rated kilowatt load and allow the generator set to cool for 10 minutes.
5. Repeat steps 1 thru 4 above until three valid sets of maximum power data are obtained.

d. For sets with isochronous-type governors (except for turbocharger engine-driven generator sets), repeat step c above, but do not adjust the frequency.
e. For turbocharged engine-driven generator sets with droop-type governors:

   1. Load the set to 125 percent of rated load unless otherwise specified in the procurement document. Adjust the frequency to the rated value and maintain the load for 5 minutes unless otherwise specified in the procurement document.
   2. Record all instrument readings including thermal instrumentation.

f. For turbocharger engine-driven generator sets with isochronous-type governors, repeat step e above, but do not adjust the frequency.

640.4.4 Results.

a. Average the three valid maximum power readings. This average is the observed maximum power value.
b. Correct the observed maximum power value to standard conditions using the procedure in MIL-HDBK-705, method 220.2, paragraph 220.2.3. This is the corrected maximum power value. (Note: The observed maximum power value for supercharged engine-driven generator sets, including turbocharged engines, is not to be corrected to standard conditions).
c. Compare the corrected maximum power value to the procurement document requirements.

640.4.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Minimum value of maximum power required. (For turbocharger generator sets: The value of load and length of time the set is to be operated at this load and length of time the set is to be operated at this load if other than as specified herein). If no value is given, perform method 640.2.
b. Voltage connection and frequency at which this method is to be performed.
c. Fuel to be used in performing this method.

TEST DATA

DESCRIPTION 10KW, 60Hz 120V SINGLE PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 4
	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 1
MFGR. ENGENSETS, INC		DATE FEBRUARY 10, 1971
MODEL NO. SF-10.0-MD	MAXIMUM POWER TEST	RECORDER D. Wright
SERIAL NO. 21069		PROJ. ENGR. J. Jones
REF: MIL-STD-705/640.4		SHIFT LEADER H. Smith
		OBSERVER L. Lee

INST. →		489	9172		476		211	2062	1377								1076
READ NO. ↓	TIME	TERM VOLT.	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	LUBE OIL	CARB AIR IN							AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	Hz	°F	°F							°F
SYM.			X40	X1	X40	X1											
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	14:00	STARTED UNIT - APPLIED RATED LOAD															70
	14:20	120.0	2.60	104	0.250	10.0	0.80	60.0	154	74							71
	14:30	120.0	2.60	104	0.250	10.0	0.80	60.0	159	74							71
	14:40	120.0	2.60	104	0.250	10.0	0.80	60.0	162	75							71
	14:50	120.0	2.60	104	0.250	10.0	0.80	60.0	163	75							71
	15:00	120.0	2.60	104	0.250	10.0	0.80	60.0	163	75							71
	15:10	120.0	2.60	104	0.250	10.0	0.80	60.0	163	75							71
	15:20	120.0	2.60	104	0.250	10.0	0.80	60.0	163	75							71
			2.63	105	0.313	12.5											
	15:25	118.8	~~4.67~~	~~188~~	~~0.545~~	~~21.8~~	1.0	59.4	177	76							71
			2.63	105	0.313	12.5											
	15:40	118.8	~~4.41~~	~~177~~	~~0.525~~	~~21.0~~	1.0	59.4	181	77							71
			2.63	.05	0.313	12.5											
	15:55	118.8	~~4.41~~	~~177~~	~~0.525~~	~~21.0~~	1.0	59.4	181	77							71

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

12.5
OBSERVED MAX. POWER = ~~21.3~~KW

NOTES: BAROMETRIC PRESSURE: 29.85 IN Hg
WET BULB: 63°F LINE CURRENT MEASURED USING C.T. No. 1305
DRY BULB: 71°F

Figure 640.4-I. Typical Test Record for Maximum Power Test.

X-4646

METHOD 650.1a

RIPPLE VOLTAGE TEST

650.1.1 General. The ripple voltage is the alternating output voltage of a direct current generator. This alternating caused by the generator characteristics and may be large enough to cause the generator to be unsuitable for some application.

650.1.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a low range true rms sensing, ac voltmeter of suitable frequency rating and with an internal resistance of at least 1,000 ohms per volt and a blocking capacitor (non-electrolytic type) with a capacitance of 1 microfarad or greater shall be required.

650.1.3 Procedure.

650.1.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10.
b. Connect the low range ac voltmeter in series with the blocking capacitor across the generator set load terminals.

650.1.3.2 Test.

a. Start and operate the set at rated speed, rated voltage and at no load. Record all instrument readings.
b. Apply 25 percent; 50 percent; 75 percent; and 100 percent of rated load and adjust the generator sets, voltage and speed to rated values at each step. Record all instrument readings at each load condition.

650.1.4 Results.

a. The ripple voltage is read directly on the low range ac voltmeter under all conditions of load. Convert the value of ripple voltage to percent of rated voltage using the following formula:

$$\frac{V_{rip}}{V_{rated}} \times 100 = \text{Percent of rated voltage}$$

Where: V_{rip} = Observed ripple voltage
V_{rated} = Rated voltage

b. Compare these readings with the maximum allowable ripple voltage specified in the procurement document.

650.1.5 Procurement document requirements. The following item must be specified in the individual procurement document:

Maximum allowable value of ripple voltage in percent of rated voltage.

TEST DATA

DESCRIPTION 3KW D-C 28 VOLTS GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. DC-3.0-MD

SERIAL NO. 1326

REF: MIL-STD-705/650.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

RIPPLE VOLTAGE TEST

TEST NO. 66

SHEET 1 OF 1

DATE FEBRUARY 11, 1971

RECORDER

PROJ. ENGR.

SHIFT LEADER

OBSERVER

INST. →		117		210		314		106									1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		SPEED		RIPPLE VOLTAGE									AVG AMB TEMP
UNITS	HRS		VOLTS		AMPS		RPM	VOLTS	AS %								°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	11:25	STARTED		SET													
	11:28		28.0		0		3600	2.3	8.2								76
	11:30		28.0		26.7		3600	2.1	7.5								76
	11:35		28.0		53.5		3600	1.9	6.8								76
	11:40		28.0		80.2		3600	1.8	6.4								76
	11:46		28.0		107		3600	1.7	6.1								76

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING A 200 AMP, 50 mV SHUNT No 1309

Figure 650.1-I. Typical Test Record for Ripple Voltage Test.

X-4647

METHOD 651.1d

JUDGING OF COMMUTATION TEST (AC SETS)

651.1.1 General. Excessive sparking at the exciter commutator or generator slip rings will shorten the life of the brushes and will damage the commutator or slip rings.

651.1.2 Apparatus. Instrumentation for measuring the load conditions shall be as described and illustrated in MIL-HDBK-705.

651.1.3 Procedure.

651.1.3.1 Preparation for test.

a. Examine the brushes for wear, pitting or other signs of unsatisfactory service. Record these conditions on the data sheet (see figure 651.1-II).
b. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.

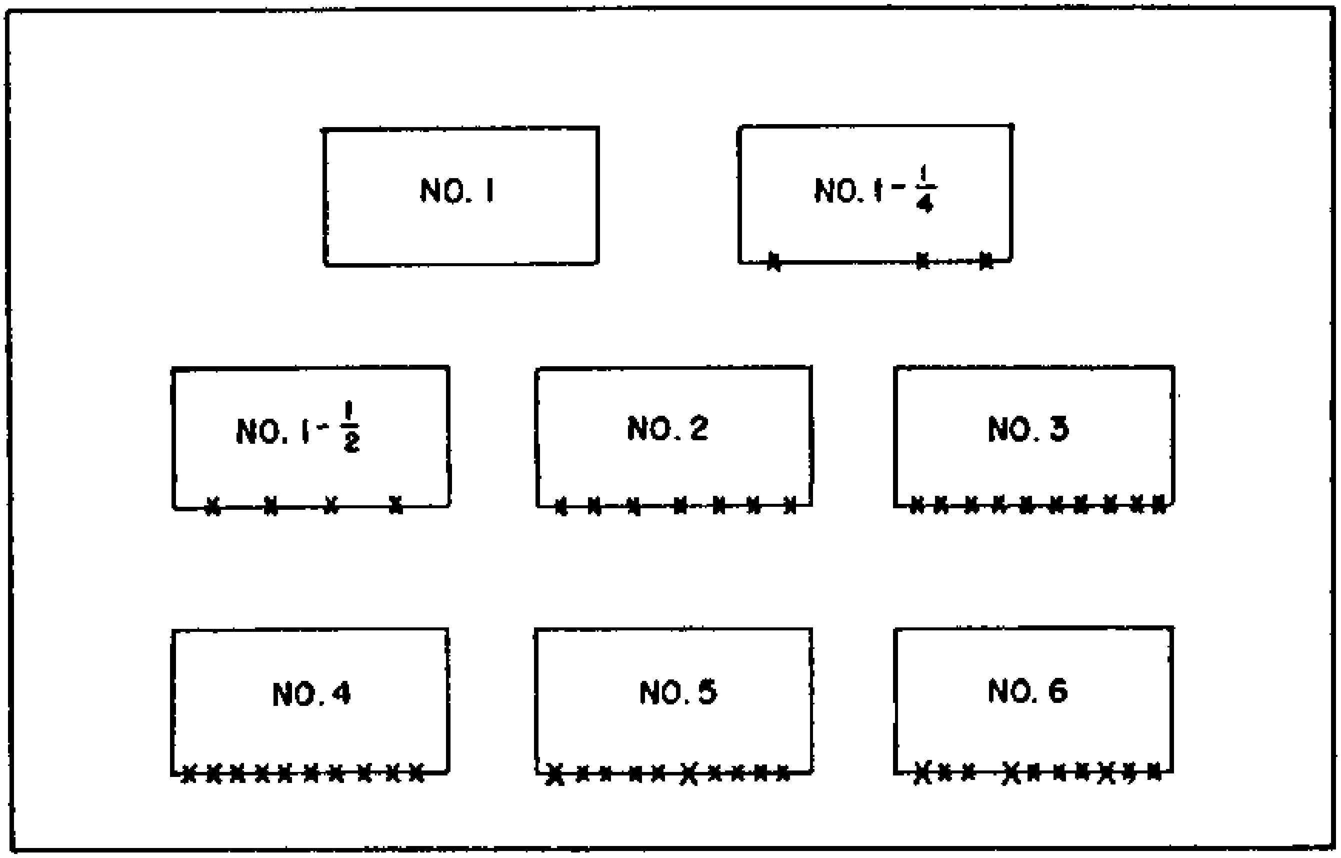
651.1.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency and rated load for at least one hour.
b. Compare the observed sparking of each brush with the chart shown in figure 651.1-I using at least two observers.
c. Record the chart pattern number which most closely corresponds to the sparking observed at each brush.
d. Repeat steps b and c above at each load voltage connection and frequency condition specified in the procurement document.
e. After shutdown the commutator, slip rings, and brushes shall be examined for wear, pitting, or other signs of unsatisfactory service. Record these conditions on the data sheet.

651.1.4 Results. Compare the results with the procurement document requirements.

651.1.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. The voltage connection(s) and frequency(ies) at which this method is to be performed.
b. Load conditions at which this method is to be performed.
c. Acceptable values of sparking pattern (see figure 651.1-I).



1. -BLACK WITH NO SPARK SHOWING

1 1/4 -SLIGHT INTERMITTENT SPARKING

1 1/2 -SLIGHT CONTINUOUS SPARKING

2 -CONTINUOUS SPARKING HEAVIER THAN 1 1/2 STREAMERS JUST BEGIN TO EXTEND FROM THE EDGE OF THE BRUSH

3 -SPARKS HEAVIER THAN 2

4 -SPARKS HEAVIER THAN 3

5 -SPARKS HEAVIER THAN 4

6 -SPARKS- ENTIRE BRUSH COVERED WITH CONTINUOUS HEAVY SPARKS

FIGURE NO. 651.1-1 SPARKING CHART FOR USE IN JUDGING OF COMMUTATION

X-4648

TEST DATA

DESCRIPTION 60 KW 400 HZ 120/208 V, THREE PHASE MOTOR GENERATOR SET	PHILADELPHIA REGION	TEST NO. 18
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 1
MODEL NO. AFC-400	JUDGING OF COMMUTATION TEST	DATE 22 NOVEMBER 1971
SERIAL NO. 10701	(AC SETS)	RECORDER L. Wright
REF: MIL-STD-705/651.1		PROJ. ENGR. J. Jones
		SHIFT LEADER H. Smith
		OBSERVER L. Lee

INST. →		101			202			303			404		505				
READ NO. ↓	TIME	TERMINAL VOLTAGE			LINE CURRENT			OUTPUT POWER			POWER FACTOR		FREQUENCY		SPARKING NUMBER		
		L_1-L_2	L_2-L_3	L_3-L_1	L_1	L_2	L_3	L_1	L_2	L_3							
UNITS	HRS.	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	KW	KW		—		HZ			
SYM.					X50	X50	X50	X50	X50	X50							
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0800	BRUSH CONDITION - GOOD - NO SIGNS OF UNSATISFACTORY CONDITIONS															
	0830	STARTED SET - APPLIED RATED LOAD															
	0900	208	208	208	4.17	4.17	4.17	.40	.40	.40		.80		400			
	0930	208	208	208	4.17	4.17	4.17	.40	.40	.40		.80		400			
		BRUSH	#1	POSITIVE												1 1/2	
			#2	NEGATIVE												3	
			#3	POSITIVE												1	
			#4	NEGATIVE												2	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. NOS. L_1 - 1305; L_2 - 1306; L_3 - 1307

Figure 651.1-II: Typical test record for judging of commutation test (AC sets).

X-4649

Test.]

METHOD 651.2d

JUDGING OF COMMUTATION TEST (DC SETS)

651.2.1 General. Excessive sparking at the commutator will shorten the life of the brushes and will damage the commutator.

651.2.2 Apparatus. Instrumentation for described and illustrated in MIL-HDBK-705.

651.2.3 Procedure.

651.2.3.1 Preparation for test.

a. Examine the brushes for wear, pitting, or other signs of unsatisfactory service. Record these conditions on the data sheet (see figure 651.2-II).
b. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10.

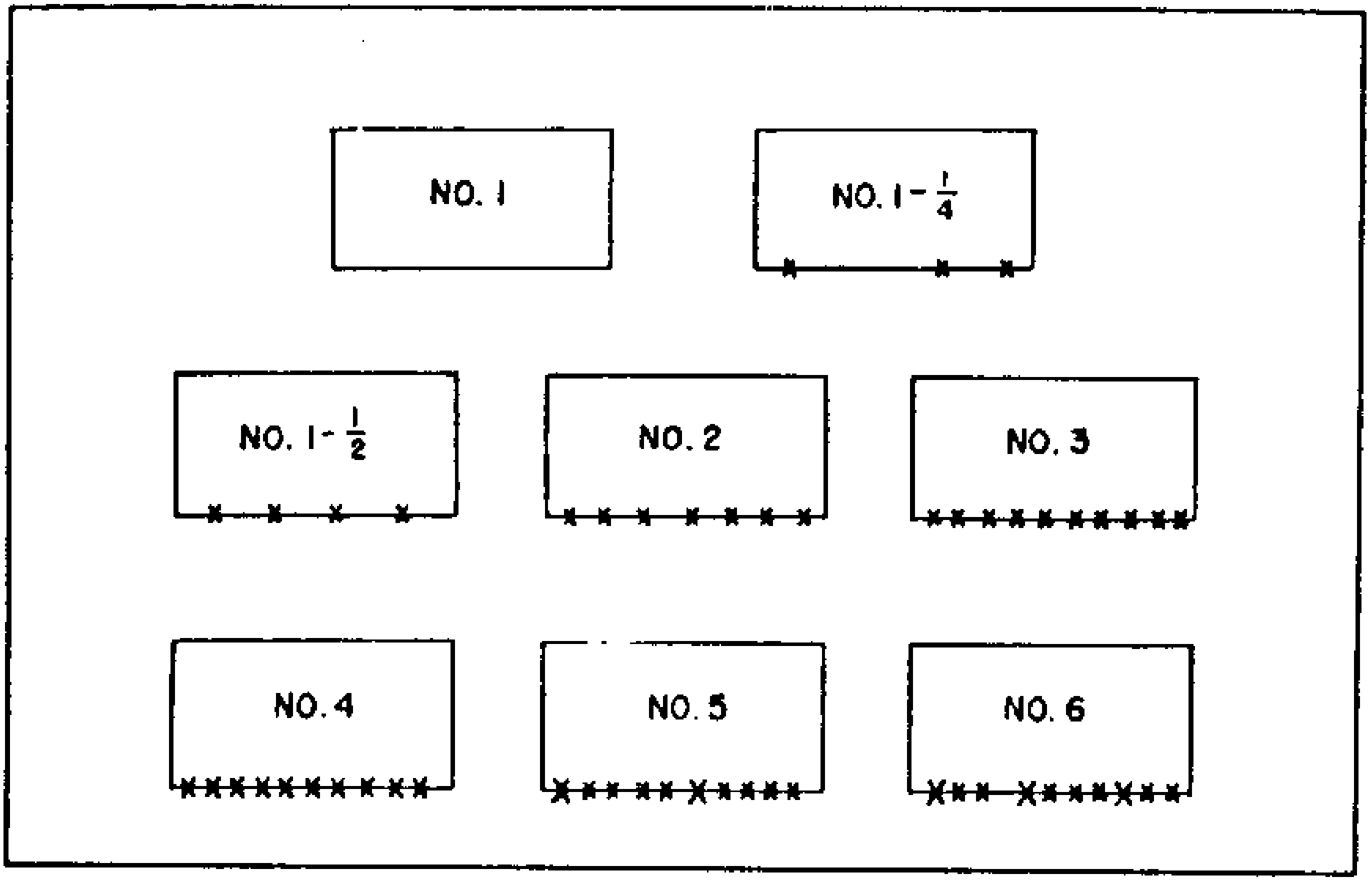
651.2.3.2 Test.

a. Start and operate the generator set at rated voltage, rated speed and at rated load for at least 30 minutes.
b. Compare the observed spar of each brush with the chart shown in figure 651.2-I using at least two observers.
c. Record the chart pattern number which most closely corresponds to the sparking observed at each brush.
d. Repeat steps b and c above at each load voltage connection and frequency condition specified in the procurement document.
e. After shutdown, the commutator and brushes shall be examined for wear, pitting, or other signs of unsatisfactory service. Record these conditions on the data sheet.

651.2.4 Results. Compare the results with the procurement document requirements.

651.2.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. Load conditions at which this method is to be performed.
b. Acceptable values of sparking pattern (see figure 651.2-I).



1 – BLACK WITH NO SPARK SHOWING

1 1/4 – SLIGHT INTERMITTENT SPARKING

1 1/2 – SLIGHT CONTINUOUS SPARKING

2 – CONTINUOUS SPARKING HEAVIER THAN 1 1/2 STREAMERS JUST BEGIN TO EXTEND FROM THE EDGE OF THE BRUSH

3 – SPARKS HEAVIER THAN 2

4 – SPARKS HEAVIER THAN 3

5 – SPARKS HEAVIER THAN 4

6 – SPARKS- ENTIRE BRUSH COVERED WITH CONTINUOUS HEAVY SPARKS

FIGURE NO. 651.2-I SPARKING CHART FOR USE IN JUDGING OF COMMUTATION

X-4650

TEST DATA

DESCRIPTION 7.5 KW 3600 RPM
28 V, DIRECT CURRENT
GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. 7.5 - DC

SERIAL NO. 108

REF: MIL-STD-705/651.2

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

JUDGING OF COMMUTATION TEST
(DC SETS)

TEST NO. 20
SHEET 1 OF 1
DATE 23 NOVEMBER 1971
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. Doe

INST. →		102		203		CAL		411									
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		SPEED		SPARKING NUMBER							
UNITS			VOLTS		AMPS		KW										
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0800	BRUSH CONDITION GOOD															
	0830	STARTED SET - APPLIED RATED LOAD															
	0830		28.0		268		7.5		3600								
	0900		28.0		268		7.5		3600								
		BRUSH	#1								1½						
		"	#2								1						
		"	#3								2						
		"	#4								2						

SIMULATED DATA
FOR ILLUSTRATIVE
PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING 500A, 50mV SHUNT 013

Figure 651.2-II: Typical test reocrd for judging of commutation test (DC sets).

X-4651

Test.]

METHOD 652.1b

SHAFT CURRENT TEST

652.1.1 General. Presence of shaft current will damage the bearings of the generator.

651.1.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a low resistance ac ammeter or dc millivoltmeter and low resistance loads (one with a probe for contact the generator shaft, the other with a means of making a low resistance contact with the frame of bearing support) shall be required.

651.1.3 Procedure.

651.1.3.1 Preparation for test. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.

651.1.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency (speed) and at a load condition specified in the procurement document.
b. With the low resistance ac ammeter, or dc millivoltmeter, connected between the shaft and the frame or bear support, record all instrument readings (see figure 652.1-I).
c. Repeat steps a and b above for each specified load condition.

652.1.4 Results. Compare the results with the procurement document requirements.

652.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and frequency(ies) at which this method is to be performed.
b. Allowable shaft current for each specified load current.

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120 V, SINGLE PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 47
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 1
MODEL NO. SF-10.0-MD	SHAFT CURRENT TEST	DATE APRIL 8, 1971
SERIAL NO. 11701		RECORDER L. Wright
REF: MIL-STD-705/652.1		PROJ. ENGR. J. Jones
		SHIFT LEADER H. Smith
		OBSERVER L. Lee

INST. →		107		312		418		512		210		317					1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		SHAFT CURRENT					AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ		AMPS				°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1015	STARTED SET - APPLIED RATED LOAD															
	1020		120.0	2.60	104	.25	10.0		.80		60.0		1.73				74
	1022		120.0	2.08	83	.25	10.0		1.00		60.0		1.53				
	1025		120.0	0	0	0	0		—		60.0		.76				

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED USING C.T. No. 1305

Figure 652.1-I: Typical test record for shaft current test.

X-4652

METHOD 655.1a

DC CONTROL TEST

655.1.1 General. In certain instances, it may be necessary to operate a generator set with a value of dc control voltage other than the rated value.

655.1.2 Apparatus. Instrumentation for measuring load conditions shall be a described and illustrated in MIL-HDBK-705. A recording meter(s) as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document) for recording voltage and frequency, an oscilloscope (and camera) as described in MIL-HDBK-705, method 106.1, paragraph 106.1.2 and a dc voltmeter and ammeter as described and illustrated in MIL-HDBK-705, methods 101.1 and 102.1 will be required.

655.1.3 Procedure.

655.1.3.1 Preparation for test.

a. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10. Unless otherwise specified, connect the signal input terminals of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator.
b. Locate a point in the dc bus which supplies the dc control power for the generator set. Connect a dc ammeter at this point to indicate the total current drawn by the dc control circuitry and place a dc voltmeter to indicate the bus voltage with respect to ground.

CAUTION: Make sure that the ammeter does not read the starting motor solenoid current or the battery charging current.

c. Disconnect the set batteries.

655.1.3.2 Test.

a. Using fully charged slave batteries and cable, start the set. Record on the data sheet whether or not the set started (see figure 655.1-I).
b. If the set is required to have reverse polarity protection, shut the set down, disconnect any belt driven battery charging alternator, and remove the slave cable. Reverse the battery polarity and attempt to restart the set. Record if the set started and whether any damage occurred. If the set is equipped with fuse protection, check the fuse before proceeding with step c below and record if fuse replacement was necessary. Reconnect the belt-driven alternator, if applicable.
c. Reconnect the slave batteries (with correct polarity), then start and operate the generator set at rated voltage, rated frequency and rated load.

d. Operate the recording meter (s) at a minimum chart speed of 6 inches per hour. Use the oscilloscope to observe and take photographic data of all line-to-neutral voltage waveform and note whether or not any spikes or notches occur. Read the instrumentation and record the readings along with any observation of spikes or notches in the waveform.
e. With the set operating at rated load, remove the slave cable. Record whether or not the set continues to operate without batteries.
f. With the set operating without the slave batteries or internal batteries and recording meter chart speed(s) at 12 inches per minute, reduce the load to zero in one step. Record the dc control voltage and current.
g. Apply rated load in one step us the set circuit interrupter. Record the dc control voltage and current.
h. Repeat f and g two additional times and after the third time and with the set operating at rated load, read the instrumentation and record the readings. Using the oscilloscope, take photographic data to compare to that observed in d above. Mark the recording charts corresponding to operation with and without batteries and examine for erratic governor or voltage regulator operation.
i. With the set operating at rated load, adjust the battery charging system voltage to the maximum operating value specified in the procurement document. On sets with no alternator adjustment, disconnect the batteries and resistively load the battery charging system to achieve the desired voltage.
j. Repeat f thru h above. After repeating f thru h above, return battery charging system voltage to nominal value.
k. With the set operating at rated load, adjust the battery charging system voltage to the minimum operating value specified in the procurement document.
l. Repeat f thru h above. After repeating f thru h above, return the battery charging system voltage to nominal value.

655.1.4 Results. The recorded data shall indicate, as a minimum, the following results:

a. Operation of the set using the slave receptacle.
b. Operation of reverse polarity protection device as applicable.
c. Operation at the nominal maximum and minimum dc control voltage as specified in the procurement document, and its effect on the operation of the set.
d. Maximum dc control current at each of the conditions specified in 655.1.3.2 above.
e. Observed spikes or notches in the generator voltage waveform.
f. Voltage and frequency steady state bandwidth. See method 608.2 for methods of calculation.
g. Compare these results with the procurement document requirements.

655.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum dc control current.
b. Nominal, maximum and minimum voltage limits for the dc control circuitry.
c. Reverse polarity device requirements, as applicable.
d. Allowable discontinuities (spikes or notches) in the generator voltage waveform, if any are allowable.
e. Maximum steady state voltage and frequency bandwidth.

TEST DATA

DESCRIPTION 15 KW, 60 HZ
120 Y, SINGLE - PHASE
GEN SET
MFGR. ENGENSETS, INC
MODEL NO. SF-15.0-MD
SERIAL NO. 4166
REF: MIL-STD-705/655.1

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA
D.C. CONTROL TEST

TEST NO. 86
SHEET 1 OF 1
DATE DECEMBER 10, 1970
RECORDER S. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. See

INST. →		377	153		217		706	809	342	067		912
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	D.C. CONTROL			AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS		
SYM.			X40	X1	X40	X1						
COL.	1	2	3	4	5	6	7	8	9	10	11 … 16	17
	11:15	STARTED SET USING SLAVE BATTERIES										75
	11:18	SHUT SET DOWN										
	11:25	ATTEMPTED TO START SET WITH BATTERY POLARITY REVERSED - SET WOULD NOT CRANK										
	11:30	CHECKED CONTROL PANEL FUSE - OK NO REPLACEMENT NECESSARY										
	11:40	STARTED SET USING SLAVE BATTERIES WITH CORRECT POLARITY - APPLIED RATED LOAD										
	11:45	120.0	3.90	156	.375	15.0	.80	60.0	27.6	1.30		75
	11:50	NO SPIKES OR NOTCHES NOTED IN VOLTAGE WAVEFORM SEE O-SCOPE PICTURE #1										
	12:00	REMOVED SLAVE BATTERIES - NO NOTICABLE CHANGE IN SET OPERATION										
	12:16	120.0	3.90	156	.375	15.0	.80	60.0	29.5	1.35		
	12:11	120.0	0	0	0	0	—	60.0	29.5	1.03	REMOVED LOAD IN ONE STEP	
	12:12	120.0	3.90	156	.375	15.0	.80	60.0	29.5	1.35	APPLIED LOAD IN ONE STEP	
	12:13	120.0	0	0	0	0	—	[illegible]	29.5	1.03	REMOVED LOAD IN ONE STEP	
	12:14	120.0	3.90	156	.375	15.0	.80	[illegible]	29.5	1.35	APPLIED LOAD IN ONE STEP	
	12:15	120.0	0	0	0	0	—	[illegible]	29.5	1.03	REMOVED LOAD IN ONE STEP	
	12:16	120.0	3.90	156	.375	15.0	.80	60.0	29.5	1.35	APPLIED LOAD IN ONE STEP	
	12:20	120.0	3.90	156	.375	15.0	.80	60.0	34.8	1.56	ADJUSTED BATTERY CHARGING VOLTAGE TO MAX.	
	12:21	120.0	0	0	0	0	—	60.0	34.8	1.13	REMOVED LOAD IN ONE STEP	
	12:22	120.0	3.90	156	.375	15.0	.80	60.0	34.8	1.56	APPLIED LOAD IN ONE STEP	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:
C.T. # 1377
T.I. # 016
OSCILLOSCOPE # 870

SMEFB Form 28
16 Sep 69

FIGURE 655.1-I PORTION OF A TYPICAL TEST RECORD FOR D.C. CONTROLS TEST

X-4653

Test.]

METHOD 660.1d

INCLINED OPERATION TEST

660.1.1 General. A generator set must be capable of normal operation including filling and draining liquids fran the set when it is placed in various inclined positions.

660.1.2 Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a recording meter(s) as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document) for recording voltage and frequency will be required. Also a means of measuring fuel capacity and a means of positioning the generator set in various inclined positions will be required.

660.1.3 Procedure.

660.1.3.1 Preparation for test. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the required voltage and frequency condition. Unless otherwise specified, connect the signal input terminals of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator.

660.1.3.2 Test.

NOTE: For generator sets not equipped with an internal fuel tank(s), it will not be necessary to perform steps a, b, and e below.

a. With the generator set on a level surface and the fuel tank determine the capacity of the fuel tank in gallons. This shall be accomplished by measuring, either by volume or weight, the amount of fuel required to fill the tank. Record on the data sheet the amount of fuel required to fill the tank (see figure 660.1-I).
b. Drain the fuel tank.
c. With the set on a level surface check the level(s) of the lubricating oil and hydraulic oil (if used) and add or drain sufficient oil to bring the level(s) to the full mark as indicated by the dipstick(s).
d. Using blocks or ramps, raise the front end of the generator set so that the angle between the horizontal and the generator set base is at the maximum angle specified in the procurement document.
e. Determine and record the quantity of fuel required to fill the fuel tank with the generator set in the inclined position.
f. Read and record the lubricating and hydraulic (if used) oil level(s). Record distance above or below the normal full mark within 1/16 inch.
g. Inspect the set for excess oil around all fittings, tanks and seals. Wipe off any fuel and oil deposits found and note on the data sheet results of inspection.
h. Operate the recording meter(s) at a chart speed os 12 inches per hour.
i. Using the set fuel tank, start the engine and note and record whether or not the engine starts normally. On sets without a set fuel tank use an external fuel source.

j. Unless otherwise specified in the procurement document, operate the set at rated voltage, rated frequency and rated load for one hour. During this time periodically inspect the set to see if engine lubrication is satisfactory (excessive noises in engine, etc.), that there is no leakage of lubricant and hydraulic oil (if used) from seals and that the fuel system functions satisfactorily and does not leak or spill over. Read and record the load instrumentation at the beginning and the end of the specified period of operation at the inclined position. Also mark the recording chart to relate to the data sheet. Note and record any unusual modes of vibration.
k. Shut down the set and inspect the set for leaks as in step g above.
l. Allow the set to remain shut down for a minimum of five minutes.
m. Restart the set and note specifically if the set starts normally. Note on the data sheet any difficulty in starting the engine.
n. Shut the set down.
o. Repeat steps b thru n above except that the rear end of the generator set is raised above the horizontal.
p. Repeat steps b thru n above except that the left side of the generator set is raised above the horizontal.
q. Repeat steps b thru n above except that the right side of the generator set is raised above the horizontal.

660.1.4 Results. The data sheet shall tabulate the following items for each set position:

a. Location of leaks.
b. Location of abnormal vibrations.
c. Excessive noises.
d. Abnormal starting.
e. Amount of fuel required to fill the set fuel tank in each position.
f. Lubricating and hydraulic oil dipstick readings in each position.
g. Load instrumentation readings.
h. Maximum observed steady-state voltage and frequency bandwidth as recorded on the recording meter(s). See method 608.2 for method of calculation.
i. Compare these results with the requirements of the procurement document.

660.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Angle(s) of inclination from the horizontal at which this method is to be performed.
b. Length of time for operation at each inclined position if other than one hour.
c. Voltage connection and frequency at which this method is to be performed.
d. Maximum allowable long-term steady voltage and frequency bandwidth, if applicable.

TEST DATA

DESCRIPTION 10KW, 60Hz
120 V SINGLE PHASE
0.8 POWER FACTOR GEN SET
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 10076
REF: MIL-STD-705A/660.1

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

INCLINED OPERATION AT
15° FROM HORIZONTAL

TEST NO. 6
SHEET 1 OF 1
DATE AUG 3, 1970
RECORDER D. Wright
PROJ. ENGR. H.E. Doo
SHIFT LEADER Mc Too
OBSERVER D. See

INST. →							301	206		112		416	512		918
READ NO. ↓	TIME	INCLINATION	FUEL TO FILL TANK	LUBE OIL LEVEL	1ST START	2ND START	TERM. VOLT	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	NOTES	AVG AMB TEMP
UNITS			GAL				VOLTS	X60	AMPS	X40	KW	—	Hz		°F
SYM.															
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14 15 16	17
1	1030	FRONT	9.5	1/2" LOW	OK		120.0	2.60	104	.250	10.0	.80	60.0	SLIGHT FUEL LEAK	76
2	1130						120.0	2.60	104	.250	10.0	.80	60.0	AT FILLER NECK	77
3	1135					OK					—				
4	1200	REAR	9.5	1/2" HI	OK		120.0	2.60	104	.250	10.0	.80	60.0	NOTHING UNUSUAL	77
5	1300						120.0	2.60	104	.250	10.0	.80	60.0		77
6	1305					OK									
7	1330	L-SIDE	8.0	OK	OK		120.0	2.60	104	.250	10.0	.80	60.0	TOOL BOX VIBRATING	77
8	1430						120.0	2.60	104	.250	10.0	.80	60.0	SLIGHTLY	77
9	1435					OK									
10	1500	R-SIDE	10.0	OK	OK		120.0	2.60	104	.250	10.0	.80	60.0	TOOL BOX VIBRATING	77
11	1600						120.0	2.60	104	.250	10.0	.80	60.0	SLIGHTLY	77
12	1605					OK									

NOTES: ACTUAL FUEL TANK CAPACITY 10.0 GAL.
SET OPERATED FOR 1 HOUR IN EACH INCLINED POSITION.

SMEFB Form 28
16 Sep 69

FIGURE 660.1-I TYPICAL TEST RECORD FOR INCLINED OPERATION

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

X-4654

METHOD 661.2c

SOUND LEVEL TEST

661.2.1 General. For a general discussion of sound level testing and a description of the testing apparatus required, see method 115.1 of MIL-HDBK-705.

661.2.2 Apparatus. Sound level meter (conforming to ASA Standard 40).

661.2.3 Procedure.

661.2.3.1 Preparation for test.

a. Transport the unit to a quiet area where extraneous sounds are not evident and where the operating noise cannot be reverberated from obstructions.
b. If the engine-generator set is equipped with a housing, secure the doors in the normal ambient operating position, unless otherwise specified.

661.2.3.2 Test.

a. Record the following environmental conditions:

    1. Temperature.
    2. Barometric pressure.
    3. Wind speed.
    4. Weather (i.e., cloudy, sunny).
    5. Humidity.

b. Record the ambient sound level reading with the generator set off. If the background noise is not at least 10dB less than the noise (generator set), then corrections for background noise must be made.
c. Operate the generator set at rated load, rated speed, and rated voltage.
d. Record the sound level readings in the specified manner. The readings shall be taken with the microphone in the positions and height specified in the procurement document.
e. Turn the set off and record the ambient sound level reading.

661.24 Results. Compare the sound level measurements with the limits specified.

661.2.5 Procurement document requirements. The following details will be specified in the procurement document:

a. Standard reference level.
b. Maximum ambient db level.
c. Weighting network.
d. Distance at which measurements are to be taken.
e. Position(s) of microphone and microphone height.
f. Position of housing doors if other than specified in this test method.

METHOD 670.1b

FUEL CONSUMPTION TEST

670.1.1 General. The length of time the generator set will operate at rated load on a specific amount of fuel is vital logistic information. It is also used to provide an indication of engine deterioration during an endurance run.

670.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current and ambient and fuel temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, the following apparatus shall be provided.

Balance scale, platform scale or fuel flowmeter
Auxiliary fuel container
Auxiliary fuel lines
Stopwatch
Means of accurately measuring the fuel tank capacity
Means of measuring the specific gravity of the fuel

670.1.3 Procedure.

670.1.3.1 Preparation for test.

a. Connect the load and field instrumentation in accordance with the applicable figure in MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Depending upon which procedure (balance scale, platform scale or flowmeter) is to be used, provide the auxiliary fuel supply as directed in that procedure.
c. Shut off or disconnect the regular set fuel supply and install the auxiliary fuel lines from the fuel container.
d. Connect the temperature measuring devices in accordance with MIL-HDBK-705 to measure the ambient temperature and the fuel temperature.
e. If the flowmeter procedure is used, connect the flowmeter in the fuel supply line prior to starting the set.

670.1.3.2 Test.

a. Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency. During this period, readings of all instruments including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices on generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet. Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued or decrease in value after the last adjustment to the load, voltage or frequency has been trade.

b. Perform one of the following procedures.

670.1.3.2.1 Balance scale procedure.

a. Supply fuel from auxiliary container mounted on a platform balance or other scale.
b. After stabilization has occurred, set the balance weights at any convenient value slightly less than the total weight of the fuel and container.
c. Start the stopwatch when the balance weights fall and record the total weight.
d. Reduce the balance weight a convenient amount and record the amount of the weights removed.
e. Stop the stopwatch when the balance weights fall and record the total weight and the elapsed time.
f. Repeat steps a thru d above until the timed portion of the test exceeds the test duration in table I.
g. From the total elapsed time and total of the weights removed determine the fuel consumption in terms of pounds per hour as follows:

$$\text{Fuel Consumption} = \frac{\text{Pounds}}{\text{Hours}}$$

h. Using the value obtained step f above, compute the rate of fuel consumption per kilowatt hour, as follows:

i. Repeat 670.1.3.2 for each load condition specified in the procurement document.
j. Determine the capacity of the generator set fuel tank in pounds of fuel.
k. For each specified load, compute the number of continuous hours the generator set will operate on a full tank of fuel. The following formula shall be used.

$$\text{Operating Hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per Hour)}}$$

670.1.3.2.2 Alternate procedure for weighing fuel.

a. Supply fuel from the auxiliary fuel container, mounted on a platform balance, or other weighing device.

b. After stabilization has occurred, record weight readings every one-half hour for the duration of the test as called for in table I.
c. Determine the average hourly fuel consumption rate in pounds per hour, as follows:

$$\text{Fuel Consumption} = \frac{\text{Pounds}}{\text{Hours}}$$

d. Using the average value obtained in step c above, fuel consumption per kilowatt hour, as follows:

$$\text{Power per kWH} = \frac{\text{Fuel Consumption (Pounds Per Hour)}}{\text{kW Load}}$$

e. Repeat 670.1.3.2 for each load condition specified in the procurement document.
f. Determine the capacity of the generator set fuel tank in pounds of fuel.
g. For each specified load test, compute the number of continuous hours the generator set will operate on a full tank of fuel. The following formula shall be used:

$$\text{Operating Hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per Hour)}}$$

670.1.3.2.3 Alternate procedure using flowmeter.

NOTE: Flowmeters may be used to determine the fuel rate. They usually are calibrated in either gallons per hour, or pounds per hour, for a fuel of a definite specific gravity and temperature.

a. After stabilization has occurred record the fuel consumption rate, and continue to record the fuel consumption rate at half-hour intervals for the duration of the test as called for in table I.
b. Determine the average of the readings (correct for fuel specific gravity and temperature). This is the fuel consumption rate and should be converted, if necessary, to pounds per hour.
c. Using the average value obtained in step b above, compute the rate of fuel consumption per kilowatt hour, as follows:

$$\text{Pounds per kWH} = \frac{\text{Fuel Consumption (Pounds per Hour)}}{\text{kW Load}}$$

d. Repeat 670.1.3.2 for each load condition specified in the procurement document.
e. Determine the capacity of the generator set fuel tank in pounds of fuel.
f. For each specified load test, compute the number of continuous hours the generator set will operate on a full tank of fuel. The following formula shall be used:

$$\text{Operating Hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per Hour)}}$$

670.1.4 Results. Compare the operating hours or the fuel consumption rate per kWH with the limits specified in the procurement document.

670.1.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. Load condition(s) at which this method is to be performed, if other than as specified herein.
b. Number of hours set must operate at specified load conditions when using set fuel tank.
c. Voltage connection(s) and frequency(ies) at which this method is to be performed.
d. Types of fuel(s) to be used, if other than as specified herein.
e. Duration of test if other than as specified in table I.

TABLE I. DURATION OF FUEL CONSUMPTION TEST

Generator Set Rated Load	Duration of Test
0 - 3.0 kW	2 hours
3.1 - 15.0 kW	4 hours
Greater than 15 kW	6 hours

TEST DATA

DESCRIPTION 10 KW, 60 HZ 120 VOLT SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 13067

REF: MIL-STD-705/670.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

FUEL CONSUMPTION TEST

BALANCE SCALE PROCEDURE

TEST NO. 40

SHEET 1 OF 1

DATE FEBRUARY 11, 1971

RECORDER J. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER J. Lee

INST. →		2710	2210		2112		2411	2517	2605	2812	SCALE: 1618					117	1076
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ.	EXCITER FIELD		WEIGHT REMOVED		TIME FOR WEIGHT TO FALL		TOTAL TIME	FUEL TEMP	AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	LBS	TOTAL	MIN	SECS	HRS	°F	°F
SYM.			X40	X1	X40	X1						LBS					
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:15	STARTED	SET		APPLIED		RATED LOAD										75
	09:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35						76	76
	09:10	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35						76	76
	09:20	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35						76	76
	09:30	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	5	26	17	0:26:17	76	76
	10:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	10	25	57	0:52:15	76	77
	10:30	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	6	15	26	05	1:18:27	76	76
	11:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	20	26	30	1:44:57	76	76
	11:30	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	25	26	21	2:11:18	76	75
	12:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	30	25	46	2:37:04	76	76
	12:30	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	35	26	12	3:03:16	76	76
	13:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	40	25	56	3:29:12	76	77
	13:30	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	45	26	12	3:55:24	76	77
	14:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	50	25	51	4:21:15	76	77
	14:30	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	55	26	00	4:47:15	76	76
	15:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	60	25	52	5:13:07	76	76
	15:30	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	65	26	07	5:39:14	76	76
	16:00	120.0	2.60	104	0.250	10.0	0.80	60.0	8.3	1.35	5	70	25	53	6:05:07	76	76
	16:28	SHUTDOWN	SET														

NOTES: LINE CURRENT MEASURED USING C.T. # 1365

FUEL CONSUMPTION AT RATED LOAD = 1.16 LB/KWH

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 670.1-I. Typical Test Record for Fuel Consumption Test.

X-4655

METHOD 680.1c

TEMPERATURE RISE TEST
(GENERATOR ONLY)

680.1.1 General. Temperature rise tests are used by design engineers to assure each operating component is operating well within its rated temperature range and serve as a check on the manufacturing processes.

680.1.2 Apparatus. Instrumentation for measuring load conditions, generator and exciter field voltage and current, generator and ambient temperatures, and coil resistances shall be as described and illustrated in MIL-HDBK-705. In addition an electrical prime mover capable of driving the generator at rated output conditions shall be required.

680.1.3 Procedure.

680.1.3.1 Preparation for test.

a. Refer to the procurement document to determine which components have maximum temperature rises specified.
b. Attach the necessary thermal instrumentation for these components and the ambient temperature in accordance with MIL-HDBK-705, method 202.1 and make necessary winding resistance measurements in accordance with MIL-HDBK-705, method 401.1.
c. Mechanically connect the generator to the prime mover. Be sure to shield the generator from air currents caused by the prime mover, adjacent machinery, belts or pulleys.
d. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-7051, method 205.1, paragraph 205.1.10 for a voltage connection and frequency specified in the procurement document.

680.1.3.2 Test.

a. Start and operate the prime mover so that the generator is operating at rated voltage and rated frequency (speed) while under control of the voltage regulator. Apply rated load and allow the generator to stabilize at rated load, rated voltage and rated frequency. During this period record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage shall be limited to those adjustments that would normally be available to the operator when the generator is installed in the set configuration, specifically adjustments to the voltage adjust devices. No other adjustments to the voltage control system shall be make unless permitted by the procurement document. Adjustments to load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when:

1. Three consecutive voltage and current readings of the field(s) remain unchanged after the last load, voltage and frequency adjustments has been made and,
2. The average ambient temperature has not been changed by more than 5 F deg. (2.73 C deg.) for the final six data readings.

b. After stabilization has occurred shut down the equipment so that temperatures of rotating components and windings may be taken. For application of contact method to rotating parts, or the resistance method to the armature coils (see MIL-HDBK-705, method 110.1 and 202.1), a quick shutdown is mandatory.

CAUTION: Do not connect bridges, meters of temperature measuring equipment for measuring resistance or temperature to circuits which may still be energized, e.g., during the time that the generator is coming to a stop.

c. Immediately after the shutdown, start to record the resistance bridge readings of the coils and the temperature of the components where the contact method of measuring temperature rise is used. Readings of resistance measurements shall be recorded in accordance with instructions given in MIL-HDBK-705, method 110.1.

The first reading shall be taken and recorded within 30 seconds after shutdown and additional readings taken and recorded at approximately 30 second intervals until one reading has been recorded after the temperature has begun to decrease, or three minutes has elapsed since the generator shutdown, whichever is longer, being certain that the maximum temperature reached by each component has been recorded. Continuous or multipoint temperature recorder(s) may be used to record component temperatures as long as the above time requirements are met.

d. Repeat steps a thru c above for each of the coils specified in the procurement document.

e. Repeat steps a thru d above at each additional specified voltage connection, frequency, stabilization voltage, and load condition.

680.1.4 Results.

a. From the data obtained, compute the temperature rise of each specified component, in accordance with instructions given in MIL-HDBK-705, method 110.1.

NOTE: To compute the temperature rise of a component, subtract the average ambient temperature of the air (immediately preceding shutdown) from the maximum temperature reached by each component.

b. Compare the temperature rise of every component, with the maximum temperature rise specified, for that component, in the procurement document.

680.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable temperature rise allowed for each component and class of insulation, for the method of measurement.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.
c. The stabilization voltage(s), if other than rated, at which this method is to be performed.
d. The load condition(s), if other than rated, at which this method is to be performed.

TEST DATA

DESCRIPTION 10KW, 60HZ
120V SINGLE-PHASE
GENERATOR ONLY

MFGR. ENGENSETS, INC.
MODEL NO. SE-10.0-MD
SERIAL NO. 21067
REF: MIL-STD-705/680.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

TEMPERATURE RISE TEST

TEST NO. 1
SHEET 1 OF 1
DATE FEBRUARY 11, 1971
RECORDER J. Wright
PROJ. ENGR.
SHIFT LEADER H. Smith
OBSERVER

INST. →		201	113		476		194	819	348	106	342	118	910				1076
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	GENERATOR FIELD		EXCITER FIELD		GEN FRAME	GEN AIR IN	GEN AIR OUT		AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	VOLTS	AMPS	°F	°F	°F		°F
SYM.			X40	X1	X40	X1				X.5		X.02					
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:50	STARTED DRIVE MOTOR - BROUGHT SET TO RATED SPEED, VOLTAGE AND LOAD															
	09:00	120.0	2.63	105	0.25	10.0	0.80	62.2	21.6	47.2	7.0	45.5	110	81	106	—	80
	09:10	120.0	2.61	104	0.25	10.0	0.80	59.6	24.3	51.1	8.5	54.0	111	83	108		82
	09:20	ADJUSTED VOLTAGE AND FREQUENCY TO RATED															
	09:30	120.0	2.60	104	0.25	10.0	0.80	60.0	23.6	50.1	8.2	53.6	111	83	107		82
	09:40	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	50.4	8.3	54.0	111	83	108	-	82
	09:50	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	60.4	8.3	54.0	111	83	108		81
	10:00	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	50.4	8.3	54.0	111	83	107		82
	10:00	SHUTDOWN FOR RESISTANCE READING T_1-T_4															
	10:05	RESTARTED															
	10:15	120.0	2.60	104	0.25	0.0	0.80	60.0	23.5	50.2	8.2	53.6	111	82	107		81
	10:25	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	50.4	8.3	54.0	111	83	108		82
	10:35	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	50.4	8.3	54.0	111	83	107		82
	10:45	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	50.4	8.3	54.0	111	83	108		82
	10:55	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	50.4	8.3	54.0	111	83	108		82
	11:05	120.0	2.60	104	0.25	10.0	0.80	60.0	23.8	50.4	8.3	54.0	111	83	107		82
	11:05	SHUTDOWN FOR RESISTANCE READING T_2-T_5															

NOTES:
GENERATOR FIELD CURRENT MEASURED USING A 50 A, 50 mV SHUNT # 1067
EXCITER FIELD CURRENT MEASURED USING A 2 A, 50 mV SHUNT # 1011
LINE CURRENT MEASURED USING C.T. # 1306

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 680.1-I. Portion of a Typical Test Record for Temperature Rise Test (Generator Only).

X-4656

Rise Test.]

METHOD 680.2b

TEMPERATURE RISE TEST
(ALTERNATE LOADING METHOD)

680.2.1 General. Temperature rise tests are used by design engineers to assure each component is operating well within its rated temperature range and serve as a check on the manufacturing process.

680.2.2 Apparatus. Instrumentation for measuring load conditions, generator and exciter field voltage and current, generator and ambient temperatures, and coil resistances shall be as described and illustrated in MIL-HDBK-705. In addition, an electrical prime mover capable of driving the generator at the conditions specified herein shall be required.

680.2.3 Procedure.

680.2.3.1 Preparation for test.

a. Refer to the procurement document to determine which components have maximum temperature rises specified.
b. Attach the necessary thermal instrumentation in accordance with MIL-HDBK-705, method 202.1. Be sure to include the generator frame and bearing(s). Make the necessary winding resistance measurements in accordance with MIL-HDBK-705, method 401.1.
c. Mechanically connect the generator to the prime mover. Be sure to shield the generator from air currents caused by the prime mover, adjacent machinery, belts or pulleys.
d. Connect the load and field instrumentation in accordance with the applicable figure of this method.
e. From method 415.0, the Open Circuit Core Test, determine the generator field current necessary to create a core loss equal to twice the rated voltage full load core loss of the generator.
f. Determine the value of the current that is to flow in the armature windings during the short-circuit period. The following formula shall be used:

$$I_t = 2I_a$$

Where: I_t is the short-circuit current in the armature during this method.
I_a is the rated armature current.

This current will create twice the full-load copper loss in the armature.

680.2.3.2 Test.

a. Start and operate the prime mover such that the generator is at rated frequency (speed) with the field adjusted to the value determined in 680.2.3.1e and at no load for 30 minutes.

b. Decrease the field current to approximately zero and immediately apply the short-circuit and adjust the field current such that the armature current will be of the value determined in 608.2.3.1 f above (I┌t┐). Operate under the short-current conditions for 30 minutes.
c. During steps a and b above read and record all instrument readings at 15 minute intervals (see figure 680.2-I).
d. Repeat steps a through c above until the temperature becomes stabilized as evidenced by frame and bearing temperatures remain unchanged over a 1-hour period.
e. Repeat steps a and b above except that operating cycles shall be reduced to 15 minutes, until frame and bearing temperatures remain unchanged for 30 minutes. Record all instrument readings prior to each adjustment.
f. Repeat steps a and b above except that operating cycles shall be reduced to 5-minute periods, until frame and bearing temperatures remain unchanged for 30 minutes. Record all instrument readings prior to each adjustment.
g. After these procedures have been accomplished, the generator shall then be considered as having achieved temperature stabilization, provided the ambient temperature has not changed more than 5 F deg. (2.73 C deg.) during the last 30 minutes of operation.
h. As soon as the generator is considered stable, immediately shut down the equipment so that temperatures of rotating components and windings may be taken. For application of the contact method to rotating parts, or the resistance method to the armature coils (see MIL-HDBK-705, methods 110.1 and 202.1), a quick shutdown is mandatory.

CAUTION: Do not connect bridges, meters or temperature measuring equipment for measuring resistance or temperature to circuits which may still be energized, e.g., during the time that the generator is coming to a stop.

i. Immediately after the shutdown, start to record the resistance bridge readings of the coils and the temperature of the components where the contact method of measuring temperature rise is used. Readings of resistance measurements shall be recorded in accordance with instructions given in MIL-HDBK-705, method 110.1.

The first thermocouple reading shall be taken and recorded within 30 seconds after shutdown and additional readings taken and recorded at approximately 30 second intervals until one reading has been recorded after the temperature has begun to decrease, or three minutes has elapsed since generator shutdown, whichever is longer, being certain that the maximum temperature reached by each component has been recorded. Continuous or multipoint temperature recorder(s) may be used to record component temperatures as long as the above time requirements are met.

j. Repeat steps a thru i above for each of the coils specified in the procurement document.
k. Repeat steps a thru j above for each additional specified voltage connection and frequency specified in the procurement document.

680.2.4 Results.

a. From the data obtained, compute the temperature rise of each specified component, in accordance with instructions given in MIL-HDBK-705, method 110.1.

NOTE: To compute the temperature rise of a component, subtract the average ambient temperature of the air (immediately preceding shutdown) from the maximum temperature reached by each component.

b. Compare the temperature rise of every component with the maximum temperature rise specified, for the component, in the procurement document.

680.2.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Maximum allowable temperature rise allowed for each component and class of insulation, for the method of measurement.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.

TEST DATA

DESCRIPTION 500 KW 60 Hz 120/208 V, THREE PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 17
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 2
MODEL NO. SF-500.0	TEMPERATURE RISE TEST	DATE 22 NOVEMBER 1971
SERIAL NO. 113	(ALTERNATE LOADING METHOD)	RECORDER [signature]
REF: MIL-STD-705/680.2		PROJ. ENGR. [signature]
		SHIFT LEADER H. Smith
		OBSERVER [signature]

INST. →		101			202			303			508	117	222	1013			1076
READ NO. ↓	TIME	TERMINAL VOLTAGE			LINE CURRENT			OUTPUT POWER			FREQ	EXCITER FIELD		GEN FRAME	GEN BEARING	GEN AIR IN	AVG AMB TEMP
		L_1-L_2	L_2-L_3	L_3-L_1	L_1	L_2	L_3	L_1	L_2	L_3							
UNITS	HRS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	KW	KW	Hz	VOLTS	AMPS	°F	°F	°F	°F
SYM.					X800	X800	X800	X800	X800	X800							
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	11:00	STARTED SET															
	11:03	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	77	79	77	77
	11:18	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	78	79	77	77
	11:33	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	79	80	77	77
	11:33	APPLIED SHORT CIRCUIT - ADJUSTED CURRENT TO TWICE RATED															
	11:35	40	40	40	4.33	4.33	4.33	.173	.173	.173	60.0	18.3	.76	79	80	77	77
	11:50	40	40	40	4.33	4.33	4.33	.173	.173	.173	60.0	18.3	.76	83	85	77	77
	12:05	40	40	40	4.33	4.33	4.33	.173	.173	.173	60.0	18.3	.76	87	88	77	77
	12:06	OPENED SHORT CIRCUIT ADJUST EXCITER FIELD CURRENT															
	12:07	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	88	89	77	77
	12:22	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	90	92	77	77
	12:37	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	91	94	77	77
	12:39	APPLYED SHORT															
	12:40	40	40	40	4.33	4.33	4.33	.173	.173	.173	60.0	18.3	.76	91	94	77	77
	12:55	40	40	40	4.33	4.33	4.33	.173	.173	.173	60.0	18.3	.76	92	95	77	77
	13:10	40	40	40	4.33	4.33	4.33	.173	.173	.173	60.0	18.3	.76	92	95	77	77
	13:10	OPENED SHORT															
	13:11	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	92	95	77	77
	13:26	270	270	270	0	0	0	0	0	0	60.0	37.3	1.88	92	95	77	77

NOTES: LINE CURRENT MEASURED USING C.T. Nos L_1-11773; L_2-11774; L_3-11775
EXCITER FIELD CURRENT MEASURED USING 2A 50 mV SHUNT No DOS

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 680.2-I: Portion of a typical test record for temperature rise test (alternate loading method).

X-4657

Rise Test.]

METHOD 690.1d

ENDURANCE TEST

690.1.1 General. The endurance run approximates, under controlled conditions, the wear and deterioration a generator set receives in field service. The endurance run consists of operating the set for a specified period of time and adhering to a specified schedule of maintenance. Prior to, during, and after the endurance run, certain performance checks are made.

690.1.2 Apparatus. Instrumentation of measuring load conditions, field voltage and current, pressures, and temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, a recording meter(s), as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document) for recording voltage and frequency, and an elapsed time meter will be required.

690.1.3 Procedure.

690.1.3.1 Preparation for test.

a. Unless otherwise specified in the procurement document, the generator set shall be placed outdoors such that it is completely exposed to the weather on all sides; and placed directly on a level, solid reinforced concrete surface at least 3 inches thick and having a total weight at least equal to the weight (wet) of the set. The set shall not be restrained in any manner.
b. Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage and frequency condition specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. Connect the exciter field instrumentation and generator field instrumentation, if applicable. For generator sets having more than one power output system (e.g., high voltage ac and low voltage dc, set battery charging system not included, or two ac systems of different frequencies), separate loads and instrumentation are required for each system. The elapsed time meter for monitoring set operating hours shall be relay operated from commercial power with the relay coil being energized from the set convenience receptacle or the generator side of the set circuit interrupter.
c. Install appropriate thermocouples to measure the following temperatures. (NOTE: Not all sets will require instrumentation of all of the listed items. The list contains item normally instrumented, however, additional thermal instrumentation may be required for the specified performance checks.):

    1. Engine coolant (inlet and outlet).
    2. Spark plug(s).
    3. Exhaust gas (combined exhaust gases in exhaust manifold or turbine tailpipe).

4. Lubricating oil sump and gallery for first article sets (and sump only for production sets).
5. Engine combustion air in (located at the inlet of the intake manifold).
6. Control panel cubicle (ambient air, inside).
7. Ambient temperature (in accordance with MIL-HDBK-705, method 202.1, paragraph 202.1.4).
8. Generator stator frame (top and bottom, outside).
9. Generator cooling air (inlet and outlet).
10. Air entering generator set.

d. Install appropriate pressure instrumentation to measure the following items:

1. Exhaust pressure (combined exhaust gases in exhaust manifold or turbine tailpipe).
2. Intake air manifold pressure (between air filters and manifold).
3. Ambient barometric pressure.

690.1.3.2 Test.

690.1.3.2.1 Pre-Endurance. Within 8 hours of the start of the endurance run the following test methods shall be performed.

a. Method 608.1, Frequency and Voltage Regulation Stability and Transient Response Test (Short Term).
b. Method 640.1, Maximum Power Test (for Gasoline and Diesel Generator Sets) or method 640.3, Maximum Power Test (Turbine Generator Sets) as applicable.
c. Method 670.1, Fuel Consumption Test. Perform this method for a minimum of 15 minutes at rated load only. Do not compute tank capacity or operating hours on a full fuel tank.
d. Method 651.1, Commutation Test (AC Units) and method 651.2, Commutation Test (DC Units). These methods are not applicable for brushless machines.
e. Additional performance checks, if specified in the procurement document. NOTE: No adjustments, other than those permitted in the maintenance and service schedule of the procurement document, shall be made after the above performance checks except as required in subsequent performance checks.

690.1.3.2.2 Endurance. Start and operate the set at the specified voltage connection and frequency using the applicable fuel and lubricating oil (s) specified in the procurement document. Doors, shrouds, access panels, etc., shall be properly positioned in accordance with the instructions on the set or in the technical manual. The first 50 hours of testing under this method shall be performed utilizing the set fuel tank, if provided. If an auxiliary fuel supply is used for the remainder of testing under this method, the set fuel tank(s), if provided, shall be three-quarters full at all times and the static head from the auxiliary fuel supply shall not exceed 4 feet above the set base. The set shall be loaded in accordance with the cyclic load schedule of table I, unless otherwise specified in the procurement document.

The one hundred hour cycle shall be repeated as required to complete the endurance time specified in the procurement document. For a set with more than one power output system, each system shall be loaded in accordance with the cyclic load schedule of table I. Throughout the entire endurance test, the set shall be operated continuously without shutdown except for the scheduled maintenance and service as permitted by the procurement document.

a. All external thermal, load, electrical (including elapsed time meter) and pressure instrumentation shall be read and the readings recorded on the data sheet at maximum time intervals of one hour. The required thermal and pressure data is given in paragraphs 640.1.3.1 c and d. All generator set panel instruments, including the engine gauges, shall be read at maximum time intervals of four hours and the readings recorded on the data sheet. When reading the set panel instrumentation, the set shall be visually inspected for leaks, excessive vibration, loose bolts, etc., with findings recorded on the data sheet and repairs if applicable.

b. The voltage and frequency shall be recorded continuously throughout the endurance run. The minimum chart speed shall be 6 inches per hour except as otherwise specified in the individual performance tests. At the time of each instrumentation reading the voltage and frequency recording chart(s) shall be marked with the time of day, elapsed hours of endurance, corresponding data reading number and any indications of abnormal or unusual set performance, with explanations.

c. Prior to the scheduled maintenance and servicing of any item specified in the procurement document, perform method 608.1 Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) for rated load only.

(NOTE: In the event unscheduled service is required more frequently than at hundred hour intervals, the minimum time between the performance of method 608.1 shall be 100 hours.)

d. In addition to the data recorded above, a separate log book identified by set nomenclature and serial number shall be maintained throughout the endurance run. The log book shall contain, as a minimum, the following information:

1. Date, shift hours, elapsed endurance hours and a brief statement on the prevailing weather conditions.
2. All adjustments, if made, as permitted by the procurement document.
3. Information regarding scheduled maintenance performed. This shall include the time and number of men to perform each service or maintenance operation.
4. Title, method number and data sheet numbers for all performance checks.
5. All shutdowns, with explanations.
6. Results of periodic visual inspection of the set.
7. In a separate section of the log book, all parts replacement, repairs, and oil consumption between oil changes shall be tabulated. These entries shall also include elapsed endurance hours, total set hours (set hour meter reading) and date.

690.1.3.2.3 Post-Endurance.

a. Immediately after completing the endurance run and prior to any maintenance or servicing of the set, repeat the performance checks listed in 690.1.3.2.1.
b. Perform the scheduled maintenance and servicing but do not overhaul the set.
c. For first article sets, after performance of the final scheduled maintenance and servicing (and after any additional tests required to be performed after the endurance run as specified in the procurement document), disassemble the generator set sufficiently for the inspection of the combustion chambers, pistons, piston rings, valves, manifolds, and all parts and passages in the engine block, bearings, crankshaft, connecting rods, and cylinder head. Inspect the rotor, stator and exciter surfaces for any indication of rubbing. Inspect the drive system for warpage, cracks and other deterioration. Clean and inspect the fuel and governor. Ferromagnetic parts, such as connecting rods, piston pins, camshaft, springs, bolts, pistons, and crankshaft, shall be subjected to inspection for cracks and defects. Carefully examine all nonferrous parts to detect cracks, checks, blowholes, sand, or any weakening effects. Record all defects or abnormalities on a separate data sheet. Reassemble or recondition the generator set as required by the procurement document.

690.1.4 Results. The results of this test shall include all recorded data, recording charts, data from all performance checks, the log book, disassembly data and a summary. The summary shall briefly analyze the results of this test, in 100 hour segments, including any abnormalities of the operation of the set.

690.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Length of endurance run.
b. Cyclic load schedule, if different from table I.
c. Additional instrumentation requirements, if any.
d. Additional performance checks required, if any, and the elapsed hours during the endurance at which they are to be performed or if other than those specified in MIL-HDBK-705.
e. Scheduled service and maintenance required and the hours of operation at which they are to be performed.
f. Reassembly or reconditioning instructions, if applicable.
g. Fuel(s) and lubricant(s) to be used during the performance of this method.
h. Performance requirements to satisfy the tests in 690.1.3.2.1.

TABLE I - Cyclic load schedule.

RUN NUMBER	PERCENT OF RATED LOAD	NUMBER OF ENDURANCE HOURS AT EACH LOAD
1	50	24
2	0	4
3	75	24
4	25	24
5	100	24

TEST DATA

DESCRIPTION 10KW, 60HZ, 120V, SINGLE-PHASE GENERATOR SET
MFGR ENGENSETS
MODEL NO. SF-10.0-MD
SERIAL NO. 12967
REF. MIL-STD-705/690.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE
ENDURANCE TEST

TEST NO. 47
SHEET 1 OF 1
DATE JAN 29 1971
RECORDER [signature]
PROJ. ENGR. [signature]
SHIFT LEADER [signature]
OBSERVER [signature]

Time (HRS)	Term. voltage (VOLTS)	Line current AMPS x25	Line current AMPS x1	Output power KW x25	Output power KW x1	Power factor	Freq (HZ)	Exciter field VOLTS	Exciter field AMPS	Oil sump °F	Oil gallery °F	Spark plugs Cyl #1 °F	Cyl #2 °F	Cyl #3 °F	Cyl #4 °F	Carb air in °F	Engine air in °F	Engine air out °F
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18, 19
15:30	STARTED SET APPLIED 75% LOAD PLACED SET ON ENDURANCE RUNNING ON SET TANK																	
16:30	120.0	3.12	78.0	.300	7.50	.80	60.0	21.3	1.27	150	180	405	392	401	375	12	[illegible]	25
17:30	120.0	3.12	78.0	.300	7.50	.80	60.0	21.7	1.27	152	175	395	372	393	368	5	4	21
18:30	120.0	3.12	78.0	.300	7.50	.80	60.1	21.8	1.26	151	175	395	371	390	366	5	4	21
19:30	120.0	3.12	78.0	.300	7.50	.80	60.0	21.7	1.26	150	174	394	368	388	366	4	3	20
20:30	120.0	3.12	78.0	.300	7.50	.80	60.1	21.7	1.26	149	173	396	366	388	365	2	1	18
21:30	120.0	3.12	78.0	.300	7.50	.80	60.1	21.6	1.26	149	173	393	363	386	363	1	-1	16
22:30	120.0	3.12	78.0	.300	7.50	.80	60.0	21.6	1.26	148	171	393	363	385	363	-1	-2	15
23:30	120.0	3.12	78.0	.300	7.50	.80	60.0	21.6	1.26	147	171	392	364	385	362	-2	-3	14
23:30	SHUTDOWN SET FOR OIL CHECK 1Q OIL ADDED																	
24:40	RESTARTED SET APPLIED 75% LOAD																	
1/30/71 00:40	120.0	3.12	78.0	.300	7.50	.80	60.0	21.7	1.26	146	170	390	365	387	362	-4	-4	13
01:40	120.0	3.12	78.0	.300	7.50	.80	60.0	21.7	1.26	144	168	388	364	386	362	-4	-4	13
02:40	120.0	3.12	78.0	.300	7.50	.80	60.1	21.6	1.26	143	166	387	364	387	361	-6	-6	11
03:40	120.0	3.12	78.0	.300	7.50	.80	60.0	21.6	1.26	143	167	388	361	385	360	-7	-7	10
04:40	120.0	3.12	78.0	.300	7.50	.80	60.0	21.6	1.26	142	166	386	362	384	361	-7	-7	10
05:40	120.0	3.12	78.0	.300	7.50	.80	60.0	21.6	1.26	142	164	385	361	384	360	-7	-7	12
06:40	120.0	3.12	78.0	.300	7.50	.80	60.1	21.6	1.26	140	162	386	362	384	359	-9	-9	8
07:40	120.0	3.12	78.0	.300	7.50	.80	60.0	21.6	1.26	141	164	387	361	383	360	-8	-8	9

Time (HRS)	Exh °F	Gen air in °F	Gen air out °F	Gen frame top °F	Gen frame bottom °F	Cont. panel °F	Set air in °F	Wet bulb °F	Avg amb °F	Pressures exh in Hg	Air in in H_2O	Baro in Hg	End hours	Tester initials	Set instruments voltage (VOLTS)	Current %	Freq (HZ)
COL	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34		
16:30	796	12	16	20	15	13	13	—	12	3.6	0.5	27.74	1	[initials]	120.5	76	59.8
17:30	768	5	9	13	11	6	11	—	11	3.6	0.5	27.81	2	[initials]			
18:30	768	5	9	13	11	8	5	—	4	3.6	0.5	27.81	3	[initials]			
19:30	770	4	8	12	10	7	4	—	4	3.6	0.5	27.82	4	[initials]	120.5	76	59.8
20:30	767	2	6	10	8	5	3	—	3	3.6	0.5	27.83	5	[initials]			
21:30	765	0	4	6	6	3	1	—	1	3.6	0.5	27.83	6	[initials]			
22:30	766	-1	3	7	5	2	-1	—	-1	3.6	0.5	27.84	7	[initials]			
23:30	766	-2	2	6	4	1	-3	—	-3	3.6	0.5	27.85	8	[initials]	120.5	76	59.8
1/30/71 00:40	764	-3	1	5	3	2	-4	—	-4	3.6	0.5	27.86	9	[initials]			
01:40	764	-3	1	5	3	2	-4	—	-4	3.6	0.5	27.86	10	[initials]			
02:40	765	-5	-1	3	1	2	-6	—	-6	3.6	0.5	27.86	11	[initials]			
03:40	764	-4	-2	2	0	-3	-7	—	-7	3.6	0.5	27.90	12	[initials]	120.5	76	59.8
04:40	765	-6	-2	2	0	-3	-7	—	-7	3.6	0.5	27.90	13	[initials]			
05:40	770	-6	-2	2	0	-3	-7	—	-7	3.4	0.5	27.90	14	[initials]			
06:40	767	-8	-4	0	-2	-5	-9	—	-9	3.6	0.5	27.90	15	[initials]			
07:40	768	-7	-3	1	-1	-4	-8	—	-8	3.6	0.5	27.92	16	[initials]	120.5	76	59.8

NOTES: LINE CURRENT MEASURED USING C.T. NO. 123
RECORDING METER NO. 1523 - CHART SPEED = 12"/HR
EXCITER FIELD CURRENT MEASURED USING 2A, 50 mV SHUNT No. 362

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 690.1-1. Portion of a typical test record for endurance test.

X-4658

Test.]

METHOD 695.1a

RELIABILITY TEST

695.1.1 General. The reliability test is designed to measure the probability that a generator set will perform as intended. While this test method is called Reliability Test", the actual parameter developed will be the Mean-Time-Between Failure (MTBF). This method may be used for a time-terminated reliability test or a probability ratio sequential reliability test as required by the procurement document.

695.1.2 Apparatus. Instrumentation for measuring load conditions and ambient temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, recording meters as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document) for recording voltage and frequency, and an elapsed-time meter will be required.

695.1.3 Procedure.

695.1.3.1 Preparation of test.

a. Unless otherwise specified in the procurement document, the generator set shall be placed outdoors such that it is completely exposed to the weather on all sides, and shall be placed directly on a level, solid reinforced concrete surface at least 3 inches thick and having a total weight at least equal to the weight (wet) of the generator set. The generator set should not be restrained in any manner. If the generator set must be restrained to prevent "walking", the test results shall so indicate.
b. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10, for the voltage and frequency condition specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage-sensing input to the voltage regulator. For generator sets having more than one output system (e.g., voltage ac and low voltage dc, set battery charging system riot included, or two ac systems or different frequencies), separate loads and instrumentation are required for each system. The elapsed-time meter for monitoring set operating hours shall be relay operated for commercial power with the relay coil being energized fran the set convenience receptacle or the generator side of the coil of the circuit interrupter.

695.1.3.2 Failure definition. The contracting officer shall have final determination of all failure classifications. The failure definition below shall be used unless otherwise specified in the procurement document:

a. A reliability-chargeable failure shall be defined as an event other than scheduled maintenance in which malfunction occurs, resulting in the replacement of the malfunctioning item (part, component, subassembly, or assembly) by a like item, except as provided in the servicing and adjustment schedule in the procurement document; and also resulting the removal, adjustments or repair of the malfunction item or any adjustment or repair required because of faulty workmanship (as defined explicitly or quantitatively in the procurement document) in manufacture or assembly.

b. Additionally, any impending malfunction detected which constitutes a safety hazard to operating personnel or would cause serious damage to the equipment if continued in operation shall be considered a chargeable failure.
c. Those malfunctions occurring as dependent or secondary failure or as a result of improper maintenance procedures or operator error shall be excluded from considerations as chargeable failure, as are those resulting in proven design modification, applicable to all production items, that satisfies the contracting officer as to its effectiveness.

695.1.3.3 Test.

695.1.3.3.1 Performance evaluation. Within 24 hours before the reliability test the following test methods shall be performed without generator set temperature, pressure, exciter, or generator field instrumentation, unless expressly needed for maximum power correction or stabilization verification:

a. Method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Method 640.1, Maximum Power Test (for Gasoline and Diesel Generator Sets).
c. Method 670.1, Fuel Consumption Test. Perform this method for a minimum of 2 hours at rated load only. Do not compute tank capacity or operating hours on a full fuel tank.

695.1.3.3.2 Reliability operation. Start and operate the set at the specified voltage connection and frequency using the applicable fuel, coolant and lubricating oil(s) specified in the procurement document. Doors, shrouds, access panels, etc., shall be properly positioned in accordance with the instructions on the set or in the technical manual. The first 50 hours of testing under this method shall be performed utilizing the set fuel tank, if provided. If an auxiliary fuel supply is used for the remainder of testing under this method, the set fuel tank(s), if provided, shall be at least three-quarters full at all times and the static head from the auxiliary fuel supply shall not exceed 4 feet above the set base. The set shall be operated at the loads specified in table I unless otherwise specified in the procurement document. For sets with more than one output system, each system shall be loaded as specified in table I. Throughout the entire duration of this method, the set shall be operated continuously without shutdown except for the required scheduled maintenance and servicing as permitted by the procurement document and as provided in 695.1.3.3.3.

a. All external load, elapsed-time meter and generator set panel instrumentation shall be read and the readings recorded at least once each 8 hours. When reading the set panel instrumentation, the set shall be visually inspected for leaks, excessive vibration, loose bolts, etc., with findings recorded on the data sheet and repairs made if applicable.

b. The voltage and frequency shall be recorded continuously throughout the duration of this method. The minimum chart speed shall be 6 inches per hour except as otherwise specified in the vidual performance tests. At the time of each instrumentation reading the voltage and frequency recording chart(s) shall be marked with the time of day, elapsed hours of test and corresponding data reading number. Any indications of abnormal or unusual set performance, with explanations, shall be included on the data sheets.

c. Immediately prior to the scheduled maintenance and servicing of any item specified in the procurement document, perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term), for rated load only omitting stabilization requirements. All operating time during the performance of this paragraph shall be included as reliability-creditable hours. (NOTE: In the event service is performed more frequently than at 100-hour intervals, the minimum time between the performance of method 608.1 shall be 100 hours.)

d. In addition to the data recorded above, a separate log book identified by set nomenclature and serial number shall be maintained throughout the reliability evaluation. The log book shall contain, as a minimum, the following information:

1. Date, shift hours, elapsed reliability hours and brief statement on the prevailing weather conditions.
2. All adjusts, if made, as permitted by the procurement document and man-hours expended.
3. Information regarding scheduled and unscheduled maintenance performed. This shall include clock hours, man-hours, and number of men to perform each service or maintenance operation.
4. Title, method number, and data sheet numbers for all performance checks.
5. All shutdowns, with explanation.
6. Results of periodic visual inspection of the set.
7. In a separate section of the log book, all replacement or repair of parts and oil consumption between oil changes shall be tabulated. These entries shall also include elapsed reliability hours, total set hours (set hour meter reading) and date.

e. In addition to the data recorded above, failure analysis sheets shall be prepared for each incident and shall be reported on forms similar to that in figure 695.1-I.

TABLE I

Cyclic load schedule

Run Number	Percent of Rated Load	Number of Hours at Each Condition
1	50	24
2	0	4
3	75	24
4	25	24
5	100	24

695.1.3.3.3 Reliability duration. The duration of this method shall be in accordance with MIL-STD-781, test plan III, unless otherwise specified in the procurement document. If a time-terminated test is specified, the duration of this method shall be 500 hours unless otherwise specified in the procurement document. The cyclic load schedule in table I shall be repeated as required to fulfill these requirements. After 1200 hours of operation under this method and every 1000 hours thereafter, the set shall be shut down at other than scheduled maintenance shutdowns for at least 72 hours but not more than 120 hours. During this period of shutdown no servicing, maintenance or adjusting of the set shall be permitted. This shutdown period is to determine the ability of the set to start after prolonged shutdown.

695.1.3.4 Post reliability.

a. Within the 24 hours after the completion of the Reliability Test and prior to any maintenance or servicing of the set, repeat the performance checks listed in 695.1.3.3.1.

695.1.4 Results.

a. The results of this test shall include all recorded data, recording charts, data from all performance checks, the log book, failure reports, and a summary. The summary shall briefly analyze the results of this test including any abnormalities of the operation of the set and shall include, but not be limited to, the following:

   1. Elapsed time meter reading when failure occurred.
   2. Description of failed components.
   3. Cause of each failure.
   4. Man-hours to isolate and repair each failure.
   5. Corrective action taken to correct each failure.

b. The results from step a above, shall be used for determination of the MTBF and the Maintenance Ratio (MR) with the following formulas used for these calculations:

$$\frac{\text{Total Operational Hours}}{\text{Number of Failures}} = \text{MTBF (Observed)}$$

$$\frac{\text{Total Man-hours for Preventative and Corrective Maintenance}}{\text{Total Operational Hours}} = \text{MR}$$

695.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Test termination criteria, if other than specified herein.
b. Accept/reject criteria if other than test plan III of MIL-STD-781 as specified herein.
c. Number of sets to be subjected to this method.
d. Load schedule if different from that in table I.
e. Additional performance checks required, if any, and the elapsed hours when they shall be performed.

f. Scheduled maintenance and service required and the hours of operation at which they shall be performed.
g. Fuels and lubricants to be used for the performance of this method.
h. Voltage connections and frequency at which this method shall be performed.
i. Minimum acceptable value of "specified" value for MTBF.
j. Maximum allowable Maintenance Ratio (MR), if specified.
k. Performance requirements to satisfy the tests in 695.1.3.3.1.
l. Failure definition if other than as specified herein.

RELIABILITY PROGRAM
FAILURE REPORT

TEST: Method 695.1 ETM HRS:______________ END HRS:________________
UNIT:__________KW, ________________HZ DATE:____________________
MFGR:________________________________ TIME:____________________
SET S/N:_____________________________ WEATHER:_________________
LOAD:____________FUEL:_____________ VOLTAGE:_________________
FAULT INDICATORS:____
SET PANEL INDICATORS:____
FAULT INDICATORS:____
SET PANEL INDICATORS:____
FAILURE:____
____
____
HOW FAILURE DETECTED:____
____
____
____
FAILED ITEM:____
REPAIR ACTION:____
____
____
____
SPECIAL TOOLS: NO________________ YES__________________
TYPE:____
____

FIND PROB AREA W/O TEST EQUIP		FINE PROB ITEM W/TEST EQUIP		DISASSEMBLE		REPLACEMENT OR REPAIR		REASSEMBLE		ADJUSTMENT		CHECKOUT	
HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
MEN		MEN		MEN		MEN		MEN		MEN		MEN	

TOTAL HOURS FOR ALL PHASES OF REPAIR:________________________
REMARKS:____
____
____
RECORDER:____
CONTRACTING OFFICER FAILURE CLASSIFICATION:__________________

Figure 695.1-I

METHOD 701.d

STARTING AND OPERATION TEST
(EXTREME COLD BATTERY START)

701.1.1 General. The generator set must satisfactorily start and operate in extreme low temperature environments.

701.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient and set temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) for recording voltage and frequency (speed) shall be required. The recording meters shall be as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document).

A controlled temperature room shall be used having sufficient capacity to maintain the specified low temperature with the set operating at rated load for the duration of this test. This controlled temperature room shall be as described and illustrated in MIL-HDBK-705, method 114.2.

701.1.3 Procedure.

701.1.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures.

(Note: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented, however, some sets may require additional thermal instrumentation). The thermal instrumentation shall be installed in accordance with the instructions in MIL-HDBK-705, method 202.1.

1. Ambient air temperature.
2. Engine coolant (engine outlet and inlet).
3. Spark plug(s).
4. Lubricating oil (sump and gallery).
5. Engine combustion air in (located at the inlet of the intake manifold).
6. Storage battery electrolyte (thermocouples) shall be so located that the electrolyte temperature at the center of the electrolyte is measured.
7. Heater coolant (air or liquid-into and out of the heater).
8. Heater exhaust.
9. Battery box air (at each end of battery box).
10. Engine exhaust gas.
11. Generator stator frame (top and bottom, outside).
12. Generator cooling air (inlet and outlet).
13. Control panel cubicle (ambient air, inside).
14. Air entering generator set.

b. Start and operate the generator set until the lubricating oil is warm to drain. Drain the coolant from the engine block, the radiator, coolant pump, heater, and all coolant lines. Be sure that the set is completely drained. Fill the coolant system with the proper solution of antifreeze. Fill and label a small transparent container (approximately 8 ounces) with a sample of the antifreeze used.
c. Drain the fuel from all fuel tanks, lines, strainer, pumps and filters. Flush tanks with low temperature fuel using approximately 10 percent of tank capacity. Clean all fuel strainers and replace filter elements. Install new gaskets on strainer and filter elements. Fill fuel tanks to approximately 10 percent rated capacity with fuels of the proper grade (low temperature fuel specified in the procurement document). Fill and label a small container (approximately 8 ounces) with a sample of each fuel used.
d. Drain the lubricating oil from the engine, filters, strainer and lines. Install new filters and clean the strainers. Use new gaskets. Fill with proper grade lubrication oil. Fill a small container with a sample (approximately 8 ounces) of the oil used.
e. Operate the winterization and ether system as applicable. See that all controls work properly. It may be necessary to temporarily bypass some controls if the ambient temperature is too high. Do not operate the heater for longer than necessary to perform the checkout.
f. Operate any fuel pr pumps on the set with the discharge lines open to clear lines of normal ambient fuel.
g. On all units, as applicable, check the spark plugs, magneto, distributor, valve clearances, injector timing, etc. Check instruction manual or operating and servicing instructions to see that all set requirements or recommendations have been performed.
h. Start and operate the generator set for approximately 15 minutes at no load to allow the arctic fuels and lubricant to thoroughly circulate. During this period open oil lines at gages and safety controls to drain normal temperature oil. Shut down the set and drain all set fuel tanks as well as the oil from the air cleaners. Fill set fuel tanks, except for sets with gasoline engines. Refill the air cleaner oil reservoirs with the proper grade of lubricating oil. Fill the air cleaner oil reservoirs with the proper grade of lubricating oil. Fill and label a small container with a sample (approximately 8 ounces) of fuel and oil used.
i. If a storage battery is part of the set, fill it with electrolyte having the specific gravity recommended for arctic operation. Determine that the batteries have been cycled and completely charged (see MIL-HDBK-705, method 222.1) before placing them in the cold room.
j. Place containers of fuel, lubricant, and coolant in the cold room.
k. Place the generator set in the cold room. If the set is equipped with a three-way valve for an auxiliary fuel supply, connect the fuel supply to the engine thru the three-way valve using the auxiliary fuel hoses (length and size of hoses are specified in the procurement document) supplied with the generator set. The auxiliary fuel supply must have sufficient capacity to furnish fuel for a minimum period of 6 hours when operating at rated frequency (speed) and at no load. This auxiliary fuel supply shall be in the cold room. Set fuel supply valve in the auxiliary fuel position.

l. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the recording meters(s) from the commercial utility.)

m. Where temperature measurements are made by means of thermocouples, the thermocouple leads shall be brought out of the cold room to permit the temperature to be read by instruments located in normal ambient temperatures. All electrical instruments, except those provided as part of the generator set, shall be located outside the cold room with the exception of shunts used in determining field currents. In addition to the circuitry shown in the applicable figure of MIL-HDBK-705 (see step k above), provisions shall be made for measuring the voltage on the generator side of the circuit breaker with instruments located outside the cold room.

701.1.3.2 Test.

a. For sets with gasoline engine, decrease the temperature in the cold room and when the ambient temperature has reached approximately 0 deg. F (-17.7 deg. C) open the auxiliary fuel container and fill the set tank. (Note: The volatility of artic fule at temperatures above 0 deg. F (-17.7 deg. C) necessitates storing the fuel in sealed containers.) Fill and label a small container with a sample of the fuel used. Place this sample along side samples of fuel, lubrication oil, and coolant taken previously, in preparation for test, in a location in the cold chamber where they may be observed.

b. For sets with gasoline engines, start and operate the set for approximately 15 minutes at no load to allow the arctic fuel to thoroughly circulate. Then shut down the set.

c. Expose the complete generator set (including all fuels, lubricants, coolants and hydraulic oils to be used during this method) to the specified low temperature until such time as all components are at the specified low temperature or until 24 hours have elapsed, whichever comes later. During all steps of this test, all of the eight ambient thermocouples shall indicate temperatures equal to or colder than the specified low temperature. After all temperatures are equal to or below the specified low temperature, check all devices - such as hoses, wiring, door latches, and panel latches for compliance with requirements of the procurement documents. Prepare the set for extreme cold start by explicitly following the operating instructions on the set. Examine fuel, oil, and coolant samples for any irregularities due to cold temperature. Record any irregularity on the data sheet.

d. By following the operating instructions, place the heater switch in the "ON" position, if applicable. Record the time the switch was placed in the "ON" position and the elapsed time required for the ignition of the fuel. Warm up the recording meter(s) by placing the switch in the standby operation position, if applicable.

e. Record the readings of temperature devices continuously during the period that the winterization equipment is in operation. (See figure 701.1-I).

f. The heater shall be operated a minimum of 50 minutes and a maximum of 55 minutes. The heater shall be turned off and the time of operation recorded. After the heater is turned off, perform the two required cranking cycles with the set inactive (to preclude starting). (Warning: Care must be taken in cranking the engine. Excessive cranking can damage the starter. See the instructions on the set or the technical manual for the time.) Turn on the recording meter(s) and leave the meter(s) on until the entire method 701.1 is completed. Then start the engine. The set must be operating at rated voltage and rated frequency without further use of any type of starting aids or winterization equipment within 1 hour from the time the heater switch was first turned on. After the engine starts, allow the engine to warm up at no load, rated voltage and rated frequency for a period of 15 minutes.

NOTE: The recording meter(s) shall be operated at a minimum speed of 12 inches per hour during the portions of the test where steady-state loading conditions exist and shall be operated at a speed of 12 inches per minutes at least 30 seconds before, during, and after a load change.

g. Just before applying rated load, reset the frequency to the rated value and record the amount the frequency had drifted from the time of set start.

h. Within 16 minutes after the engine starts, apply rated load in one step with the circuit interrupter, starting with the interrupter in the off position. Leave rated load on the set for 30 seconds, then drop the load to no load in one step using the circuit interrupter. Operate at no load for 30 seconds. Again, using the circuit interrupter, apply and drop rated load two more times with 30 seconds of operation in each load condition. Next apply rated load and operate for 5 minutes.

i. After 5 minutes of rated load operation, drop the load to no load in one step and operate the set at no load, rated voltage and rated frequency until temperature stabilization of the engine occurs. During this period readings of all instrumentation including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If adjustments to the voltage and frequency may be made to maintain operation at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the voltage or frequency controls shall be recorded on both the data sheet and the recording chart(s). Unless otherwise specified in the procurement document, engine temperature stabilization will be considered to have occurred when two consecutive recorded readings of the engine coolant and oil temperatures remain unchanged.

j. Apply rated load in one step and allow the generator set to stabilize at rated load, rated voltage, and rated frequency. During this period, readings of all instrumentation including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. When the generator set under test is diesel driven, remove the auxiliary fuel hose from the auxiliary fuel supply for 5 minutes during the time the set is operating at rated load from the auxiliary fuel supply, then replace the hose and continue operation from the auxiliary fuel supply for at least 10 minutes. Change the fuel transfer valve to the set tank position and continue the test using the set fuel tank. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjusts available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on both the data sheet and recording chart(s). Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

k. After stabilization has occurred, unless otherwise specified in the procurement document, operate the generator set in accordance with the instructions on the set or in the technical manual and perform the following methods at the specified low temperature, voltage connection and frequency:

   1. Method 510.1, Rheostat Range Test.
   2. Method 511.1, Regulator Range Test.
   3. Method 513.2, Indicating Instrument Test (Electrical).
   4. Method 608.1, Voltage and Frequency Regulation, Stability and Transient Response Test (Short Term). In addition to the required data, all thermal instrumentation as specified in 701.4.3.1 shall be read and recorded at the same time for the stabilization portion of this test.

   NOTE: The above methods are listed in numerical order; however they need not be performed in this order. Method 510.1 shall only be performed on sets so equipped.

l. If the total operating time between the start of the no load stabilization run (step i) and the completion of the tests listed in step k above is less than 8 hours, then continue to run the set at no load, rated operation time is at least 8 hours.

701.4 Results. Results shall be as specified in the methods listed in paragraph 701.4.3.2 k. Compare the manner in which the generator set functioned, as denoted by the instrument and temperature readings, with the procurement documents.

701.5 Procurement document requirements. The following details must be specified in the individual procurement document:

a. Temperature at which method is to be performed.
b. Type of fuel, lubricating oil, and coolant to be used.
c. Additional tests to be performed not listed in 701.4.3.2 k of this method.
d. Voltage connection and frequency at which this method is to be performed.
e. Allowable starting time if different than specified in 701.1.3.2 f of this method.
f. Requirements for auxiliary fuel supply system.
g. Maximum and minimum voltage values between which the generator set shall perform.
h. The maximum allowable voltage regulation (droop).
i. The accuracy requirements of the panel instruments.
j. Maximum allowable short-term frequency stability bandwidth or deviation in percent of rated frequency.
k. Maximum allowable frequency recovery time after a load change.
l. Maximum allowable frequency overshoot or undershoot during a load change.
m. Maximum allowable frequency regulation (droop).
n. Maximum allowable short-term voltage stability bandwidth or deviation in percent of rated voltage.
o. Maximum allowable voltage recovery time after a load change.
p. Maximum allowable voltage overshoot or undershoot during a load change.
q. Engine temperature requirements.
r. Requirements for checking devices in 701.1.3.2 c.

TEST DATA

DESCRIPTION 15KW, 60HZ 120V SINGLE PHASE GENERATOR SET

MFGR. ENGENSETS, INC.

MODEL NO. SF-15.0-MD

SERIAL NO. 10629

REF: MIL-STD-705/701.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

STARTING AND OPERATING TEST

(EXTREME COLD, BATTERY START)

TEST NO. 27

SHEET 1 OF 2

DATE FEBRUARY 12, 1971

RECORDER [signature]

PROJ. ENGR. [signature]

SHIFT LEADER [signature]

OBSERVER [signature]

INST. →		489	51172		476		211	2062	1072	319	1167						1076
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		POWER OUTPUT		POWER FACTOR	FREQ	EXCITER FIELD		HEATER COOLANT		LUBE OIL		ENG AIR IN	CONT COMP.	A/G AMB TEMP.
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	IN	OUT	SUMP	GALLERY	°F	°F	°F
SYM.			X40	X1	X40	X1				X.5	°F	°F	°F	°F			
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	07:50	24 HOUR SOAK AT -65°F COMPLETE															
	07:55	CHECKED ALL DOORS, HOSES, AND SWITCHES FOR FREEDOM OF MOVEMENT - ALL OK															
	08:00	—	—	—	—	—	—	—	—	—	-65	-65	-66	-65	-65	-65	-66
	08:10	HEATER SWITCH ON															-65
	08:12	HEATER OPERATING															
	08:20	—	—	—	—	—	—	—	—	—	-25	+40	-55	-60	-50	-65	-65
	08:30	—	—	—		—		—		—	0	+70	-40	-59	-40	-48	-66
	08:40	—	—	—				—	—	—	+50	100	-20	-48	-30	-40	-65
	08:50	—	—	—	—			—		—	70	150	-5	-42	-2	-35	-65
	09:00	—	—	—	—	—	—			—	100	175	+15	-34	+25	-30	-65
	09:01	FIRST CRANKING CYCLE IGNITION OFF 30 SEC.															
		SECOND CRANKING CYCLE IGNITION OFF 30 SEC.															
	09:05	THIRD CRANKING CYCLE IGNITION ON 10 SEC ENGINE STARTED															-65
	09:05	HEATER TURNED OFF															
	09:06	120.0	0	0	0	0	—	60.0	18.2	1.32	—	—	78	+79	65	-50	-66
	09:16	120.0	0	0	0	0	—	60.0	18.8	1.33	—	—	106	108	72	-53	-65
	09:22	APPLIED RATED LOAD FOR 30 SEC.															
	09:23	APPLIED RATED LOAD FOR 30 SEC.															
	09:24	APPLIED RATED LOAD FOR 30 SEC.															

NOTES: LINE CURRENT MEASURED USING C.T. # 1306

EXCITER FIELD CURRENT MEASURED USING A 1 A, 50 mV SHUNT # 377

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 701.1-I. Portion of a Typical Test Record for Starting and Operating Test (Extreme Cold, Battery Start).

X-4659

and Operating Test.]

METHOD 701.2d

STARTING AND OPERATING TEST
(MODERATE COLD BATTERY START)

701.2.1 General. The generator set must satisfactorily start and operate in moderate low temperature environments without the use of any winterization equipment.

701.2.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient and set temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) for recording voltage and frequency (speed) shall be required. The recording meters shall be as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document).

A controlled temperature room shall be used having sufficient capacity to maintain the specified low temperature with the set operating at rated load for the duration of this method. This controlled temperature room shall be as described and illustrated in MIL-HDBK-705, method 114.2.

701.2.3 Procedure. If this method is performed immediately following method 701.1 or method 702.1, omit 701.2.3.1 and steps a and b of 701.2.3.2 except that the tester may change the batteries.

701.2.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures. (Note: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented; however, some sets may require additional thermal instrumentation). The thermal instrumentation shall be installed in accordance with the instructions in MIL-HDBK-705, method 202.1.

   1. Ambient air temperature.
   2. Engine coolant (engine outlet and inlet).
   3. Spark plug(s).
   4. Lubricating oil (sump and gallery).
   5. Engine combustion air in (located at the inlet of the intake fold).
   6. Storage battery electrolyte (thermocouples) shall be located that the electrolyte temperature at the center of the electrolyte is measured).
   7. Engine exhaust gas.
   8. Generator stator frame (top and bottom, outside).
   9. Generator cooling air (inlet and outlet).
   10. Control panel cubicle (ambient air, inside).
   11. Air entering generator set.

b. Start and operate the generator set until the lubricant oil is warm enough to drain. Drain the coolant from the engine block, the radiator, coolant pump, heater, and all coolant lines. Be sure that set is completely drained. Fill the coolant system with the proper solution of antifreeze. Fill and label a small transparent container (approximately 8 ounces) with a sample of the antifreeze used.
c. Drain the fuel from all fuel tanks, lines, strainers, pumps and filters. Flush tanks with low temperature fuel using approximately 10 percent of tank capacity. Clean all fuel strainers and replace filter elements. Install new gaskets on strainer and filter elements. Fill fuel tanks to approximately 10 percent rated capacity with fuels of the proper grade flow temperature fuel specified in the procurement document). Fill and label a small container (approximately 8 ounces) with a sample of each fuel used.
d. Drain the lubrication oil fran the engine, filters, strainers and lines. Install new filters and clean the strainers. Use new gaskets. Fill with proper grade lubricating oil. Fill and label a small container with a sample (approximately 8 ounces) of the oil used.
e. Operate any fuel priming pumps on the set with the distance lines open to clear lines of normal ambient fuel.
f. On all units, as applicable, check the spark plugs, magneto, distributor, valve clearances, injector timing, etc. Check instruction manual or operating and servicing instructions to see that all set requirements or recommendations have been performed.
g. Start and operate the generator set for approximately 15 minutes at no load to allow the fuels and lubricants to thoroughly circulate. During this period open oil lines at gages and safety controls to drain normal temperature oil. Shut down the set and drain all set fuel tanks as well as the oil fran the air cleaners. Fill set fuel tanks, except for sets with gasoline engines. Fill and label a small container with a sample (approximately 8 ounces) of fuel used.
h. If a storage battery is part of the set, fill it with electrolyte having the specific gravity recommended for moderate cold operation. Determine that the batteries have been cycled and completely charged (see MIL-HDBK-705, method 222.1) before placing them in the cold room.
i. Place containers of fuel, lubricant, and coolant in the cold room.
j. Place the generator set in the cold room. If the set is equipped with a three-way valve for an auxiliary fuel supply, connect the fuel supply to the engine thru the three-way valve using the auxiliary fuel hoses (length and sizes of hoses are specified in the procurement document) supplied with the generator set. The auxiliary fuel supply must have sufficient capacity to furnish fuel for a minimum period of 6 hours when operating at rated frequency (speed) and at no load. This auxiliary fuel supply shall be in the cold room. Set fuel supply valve in the auxiliary fuel position.
k. Connect the load and the field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the recording meter(s) from the commercial utility.)

1. Where temperature measurements are made by means of thermocouples, the thermocouple leads shall be brought out of the cold room to permit the temperature to be read by instruments located in no ambient temperatures. All electrical instruments, except those provided as part of the generator set, shall be located outside the cold room with the exception of shunts used in determining field currents. In addition to the circuitry shown in the applicable figure of MIL-HDBK-705 (see step k above), provisions shall be made for measuring the voltage on the generator side of the circuit breaker with instruments located outside the cold room.

701.2.3.2 Test.

a. For sets with gasoline engines, start the cold room and when the ambient temperature has reached approximately 0 deg. F (-17.7 deg. C) open the auxiliary fuel container and fill the set tank. (Note: The parameters of arctic fuel at temperatures above 0 deg. F (-17.7 deg. C) necessitates storing the fuel in sealed containers.) Fill and label a small container with a sample of the fuel used. Place this sample alongside samples of fuel, lubricating oil and coolant taken previously, in preparation for test, in a location in the cold chamber where they may be observed.
b. For sets with gasoline engines, start and operate the set for approximately 15 minutes at no load to allow the arctic fuel to thoroughly circulate. Then shut down the set.

NOTE: Apply rated load during this period of operation to assure the setting of the load bank for the operation portion of this method.

c. Expose the complete generator set to the specified low temperature until such time as all components are at the specified low temperature or until 24 hours have elapsed, whichever comes later. During all steps of this test, all of the eight ambient thermocouples shall indicate temperatures equal to or colder than the specified low temperature. After all temperatures are equal to or below the specified low temperature, check all devices - such as hoses, wiring, door latches, and panel latches for compliance with requirements of the procurement document. Prepare the set for moderate-cold starting by explicitly following the operating instructions on the set. Examine fuel, oil, and coolant samples for any temperature. Record any irregularity on the data sheet.

d. Turn on the recording meter(s) and leave the meter(s) on until the entire method 701.2 is completed.

NOTE: The recording meter(s) shall be operated at a minimum speed of 12 inches per hour during the portions of the test where steady-state loading conditions exist and shall be operated at a minimum speed of 12 inches per minute at least 30 seconds before, during, and after a load change.

e. By following the instructions on the set or in the technical manual, start the generator set. Prior to the first attempt to start, but within the allotted 5 minutes, complete two required cranking cycles with the set inactive (to preclude sing). Record the time when cranking is started. Record the time when the set starts. See figure 701.2-I.

Warning: Care must be taken in cranking the engine. Excessive cranking may damage the starter. See the instructions on the set or the technical manual for the maximum cranking time.

f. Allow the engine to warm up at no load, rated voltage and rated frequency for a period of 15 minutes.
g. Just before applying rated load, reset the frequency to the rated value and record the amount the frequency had drifted from the time of set start.
h. Within 16 minutes after the engine starts, apply rated load in one step with the circuit interrupter, starting with the interrupter in the off position. Leave rated load on the set for 30 seconds, then drop the load to no load in one step using the circuit interrupter. Operate at no load for 30 seconds. Again, using the circuit interrupter, apply and drop rated load two more times with 30 seconds of operation in each load condition. Next apply rated load and operate for 5 minutes.
i. After 5 minutes of rated load operation, drop the load to no load in one step and operate the set at no load, rated voltage and rated frequency until temperature stabilization of the engine occurs. During this period readings of all instrumentation including thermal instrumentations shall be recorded at minimum 10 minute intervals. If necessary, adjustments to the voltage and frequency may be made to maintain operation at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the voltage or frequency controls shall be recorded on both the data sheet and the recording chart(s). Unless otherwise specified in the procurement document, engine temperature stabilization will be considered to have occurred when two consecutive recorded readings of the engine coolant and oil temperatures remain unchanged.
j. Apply rated load in one step and allow the generator set to stabilize at rated load, rated voltage, and rated frequency. During this period, readings of all instrumentation including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. When the generator set under test is diesel driven, remove the auxiliary fuel hose from the auxiliary fuel supply for 5 minutes during the time the set is operating at rated load from the auxiliary fuel supply, then replace the hose and continue operation from the auxiliary fuel supply for at least 10 minutes. Change the fuel transfer valve to the set tank position and continue the test using the set fuel tank. If necessary, adjustments to the load, voltage

and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on both the data sheet and recording(s). Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

k. After stabilization has occurred, unless otherwise specified in the procurement document, operate the generator set in accordance with the instructions on the set or in the technical manual and perform the following methods at the specified low temperature, voltage connection and frequency:

1. Method 510.1, Rheostat Range Test.
2. Method 511.1, Regulator Range Test.
3. Method 513.2, Indicating Instrument Test (Electrical).
4. Method 608.1, Voltage and Frequency Regulation, Stability and Transient Response Test (Short Term). In addition to the required data, all thermal instrumentation as specified in 701.2.3.1 shall be read and recorded at the same time for the stabilization portion of this test.

NOTE: The above methods are listed in numerical order; however, they need not be performed in this order. Method 510.1 shall only be performed on sets so equipped.

l. If the total operating time between the start of the no load stabilization run (step i) and the completion of the tests listed in k above does not equal 8 hours, then continue to run the set at no load, rated voltage and rated frequency until the accumulated operating time is equal to 8 hours.

701.2.4 Results. Results shall be as specified in the methods listed in 701.2.3.2 k. Compare the manner in which the generator set functioned, as denoted by the instrument and temperature readings, with the procurement document requirements.

701.2.5 Procurement document requirements. The following details must be the individual procurement document:

a. Temperature at which method is to be performed.
b. Type of fuel, lubricating oil, and coolant to be used.

c. Additional tests to be performed not listed in 701.2.3.2 k of this method.
d. Voltage connection and frequency at which this method is to be performed.
e. Allowable heating and starting time if different than specified in 701.2.3.2f of this method.
f. Duration of cranking cycle (gee 701.2.3.2 e).
g. Requirements of auxiliary fuel supply system.
h. Maximum and minimum voltage values.
i. Maximum and minimum voltage values between which the generator set shall perform
j. The maximum allowable voltage regulation.
k. The accuracy requirements of the panel instruments.
l. Maximum allowable short-term frequency stability bandwidth or deviation in percent of rated frequency.
m. Maximum allowable frequency recovery tine after a load change.
n. Maximum allowable frequency overshoot or undershoot during a load change.
o. Maximum allowable frequency regulation (droop).
p. Maximum allowable short-term voltage stability bandwidth or deviation in percent of rated voltage.
q. Maximum allowable recovery time after a load change.
r. Maximum allowable voltage overshoot or undershoot during a load change.
s. Maximum allowable engine temperatures after 1 hour of operation at rated load.

TEST DATA

DESCRIPTION 15KW, 60HZ 120V, SINGLE-PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 77
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 2
MODEL NO. SF-15.0-MD	STARTING AND OPERATING	DATE NOVEMBER 23, 1970
SERIAL NO. 10629	(MODERATE COLD BATTERY START)	RECORDER [illegible]
REF: MIL-STD-705/701.2		PROJ. ENGR. [illegible]
		SHIFT LEADER [illegible]
		OBSERVER [illegible]

INST. →	489	51172		476		211	2062	1072	319	1167						1076
READ NO ↓ TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	EXCITER FIELD		ENGINE COOLANT		LUBE OIL		GENERATOR AIR		AVG AMB TEMP
UNITS HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	IN	OUT	SUMP	GALLERY	IN	OUT	°F
SYM.		X40	X1	X40	X1				X.5	°F	°F	°F	°F	°F	°F	
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0750	—	—	—	—	—	—	—	—	—	-26	-25	-27	-28	-26	-26	-25
0755	FIRST CRANKING CYCLE - IGNITION OFF - 30 SEC															
	SECOND CRANKING CYCLE - IGNITION OFF - 30 SEC															
0758	THIRD CRANKING CYCLE - IGNITION ON - 10 SEC ENGINE STARTED															-25
0800	120.0	0	0	0	0	—	60.0	18.6	1.32	-24	-10	-20	-5	-26	-20	-26
0810	120.0	0	0	0	0	—	60.2	18.9	1.32	-5	+20	+2	+30	-25	-18	-25
0813	APPLIED RATED LOAD FOR 30 SECONDS															
0814	APPLIED RATED LOAD FOR 30 SECONDS															
0815	APPLIED RATED LOAD FOR 30 SECONDS															
0816	APPLIED RATED LOAD															
0820	120.0	3.90	156	.375	15.0	.80	60.0	32.4	2.71	+50	+90	+40	115	-26	-5	-27
0821	DROPPED LOAD - BEGIN NO LOAD STABILIZATION															
0830	120.0	0	0	0	0	—	60.0	19.2	1.33	+80	130	70	160	-25	-8	-27
0840	120.0	0	0	0	0	—	60.0	19.3	1.33	+90	140	90	140	-26	-8	-25
0850	120.0	0	0	0	0	—	60.0	19.4	1.33	93	145	96	142	-25	-9	-26
0900	120.0	0	0	0	0	—	60.0	19.4	1.33	94	146	96	142	-25	-10	-26
0910	120.0	0	0	0	0	—	60.0	19.4	1.33	94	146	96	142	-26	-10	-26
0910	APPLIED RATED LOAD - BEGIN RATED LOAD STABILIZATION															
0920	120.0	3.90	156	.375	15.0	.80	60.0	33.7	2.72	98	150	99	148	-26	-2	-27

NOTES:
LINE CURRENT MEASURED USING A C.T. No 1378
EXCITER FIELD CURRENT MEASURED USING A 5A, 100mV SHUNT No 009
RECORDING VOLTAGE & FREQUENCY METER No 1707 CHART SPEED = AS MARKED

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 701.2-I Portion of a typical test record for starting and operating (moderate cold, battery start) test.

X-4660

and Operating Test.]

METHOD 701.3c

STARTING AND OPERATING TEST (EXTREME COLD, MANUAL CRANK)

701.3.1 General. The generator set satisfactorily start and operate under extreme low temperature environments.

701.3.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient and set temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) for recording voltage and frequency (speed) shall be required. The recording meters shall be as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document).

A controlled temperature room shall be used having sufficient capacity to maintain the specified low temperature with the set operating at rated load for the duration of this test. This controlled temperature room shall be as described and illustrated in MIL-HDBK-705, method 114.2.

701.3.3 Procedure.

701.3.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures. (Note: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented, however, some sets may require additional thermal instrumentation). The thermal instrumentation shall be installed in accordance with the instructions in MIL-HDBK-705, method 202.1.

   1. Ambient air temperature.
   2. Engine coolant (engine outlet and inlet).
   3. Spark plug(s).
   4. Lubricating oil (sump and gallery).
   5. Engine combustion air in (located at the inlet of the intake manifold).
   6. Heater coolant (air or liquid-into and out of the heater).
   7. Heater exhaust gas.
   8. Engine exhaust gas.
   9. Generator stator frame (top and bottom, outside).
   10. Generator cooling air (inlet and outlet).
   11. Control panel cubicle (ambient air, inside).
   12. Air entering generator set.

b. Start and operate the generator set until the lubricating oil is warm enough to drain. Drain the coolant from the engine block, the radiator, coolant pump, heater, and all coolant lines. Be sure that the set is completely drained. Fill the coolant system with the proper solution of antifreeze. Fill and label a small transparent container (approximately 8 ounces) with a sample of the antifreeze used.

c. Drain the fuel form all fuel tanks, lines, strainers, pumps and filters. Flush tanks with low temperature fuel using 10 percent of tank capacity. Clean all fuel strainers and replace filter elements.

Install new gaskets on strainer and filter elements. Fill fuel tanks to approximately 10 percent rated capacity with fuels of the proper grade (low temperature fuel specified in the procurement document). Fill and label a small container (approximately 8 ounces) with a sample of each fuel used.

d. Drain the lubricating oil from the engine, filters, strainers and lines. Install new filters and clean the strainers. Use new gaskets. Fill with proper grade lubricating oil. Fill a small container with a sample (approximately 8 ounces) of the oil used.

e. Operate the winterization and ether system as applicable. See that all controls work property. It may be necessary to disconnect some controls if ambient temperature is too high. Do not operate the heater for longer than necessary to perform the checkout.

f. Operate any fuel priming pumps on the set with the discharge lines open to clear lines of normal ambient fuel.

g. On all units, as applicable, check the spark plugs, magneto, distributor, valve clearances, injector timing, etc. Check instruction manual or operating and servicing instructions to see that all set requirements or recommendations have been performed.

h. Start and operate the generator set for approximately 15 minutes at no load to allow the arctic fuels and lubricants to thoroughly circulate. During this period open oil lines at gages and safety controls to drain normal temperature oil. Shut down the set and drain all set fuel tanks as well as the oil fran the air cleaners. Fill set fuel tanks, except for sets with gasoline engines. Fill and label a small container with sample (approximately 8 ounces) of fuel used.

i. Place containers of fuel, lubricant, and coolant in the cold room.

j. Place the generator set in the cold room. If the set is equipped with a three-way valve for an auxiliary fuel supply, connect the fuel supply to the engine thru the three-way valve using the auxiliary fuel hoses (length and size of hoses are specified in the procurement document) supplied with the generator set. The auxiliary fuel supply must have sufficient capacity to furnish fuel for a minimum period of 6 hours when operating at rated frequency (speed) and at no load. This auxiliary fuel supply shall be in the cold room. Set the fuel supply valve in the auxiliary fuel position.

k. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing output to the voltage regulator. (Power the recording meter(s) from the commercial utility.)

l. Where temperature measurements are made by means of thermocouples, the thermocouple leads shall be brought out of the cold room to permit the temperature to be read by instruments located in normal ambient temperatures. All electrical instruments, except those provided as part of the generator set, shall be located outside the cold room with the exception of shunts used in determining field currents. In addition to the circuitry shown in the applicable figure of MIL-HDBK-705 (see step j above), provisions shall be made for measuring the voltage on the generator side of the circuit breaker with instruments located outside the cold room.

701.3.3.2 Test.

a. For sets with gasoline engines, start the cold room and when the ambient temperature has reached approximately 0 deg. F (-17.7 deg. C) open the auxiliary fuel container and fill the set tank. (Note: The parameters of arctic fuel at temperatures above 0 deg. F (-17.7 deg. C) necessitates storing the fuel in sealed containers.) Fill and label a small container with a sample of the fuel used. Place this sample alongside samples of fuel, lubricating oil, and coolant taken previously, in preparation for test, in a location in the cold chamber where they may be observed.
b. For sets with gasoline engines, start and operate the set for approximately 15 minutes at no load to allow the arctic fuel to thoroughly circulate. Then shut down the set.

NOTE: Apply rated load during this period of operation to assure the setting of the load bank for the operation portion of this method.

c. Expose the complete generator set (including all fuels, lubricants, coolants and hydraulic oils to be used during this method) to the temperature until such time as all components are at the temperature or until 24 hours have elapsed whichever comes later. During all steps of this test, all of the eight ambient thermocouples shall indicate temperatures equal to or colder than the specified low temperature. After all temperatures are equal to or below the specified low temperature, check all devices - such as hoses, wiring, door latches, and panel latches for compliance with requirements of the procurement documents. Prepare the set for extreme-cold start by explicitly following the operating instructions on the set. Examine fuel, oil, and coolant samples for any irregularities due to cold temperature. Record any irregularity on the data sheet.
d. By following the operating instructions, place the winterization equipment in operation. Record the time heat was first applied to the set. Warm up the recording meter(s) by placing the switch in the standby operation position, if applicable.
e. Record the readings of temperature devices continuously during the period that the winterization equipment is in operation. (See figure 701.3-I).
f. Operate the winterization equipment until the set is sufficiently warm to start but no longer than the time allowed in the procurement document. The heater shall be turned off and the tine of operation recorded. Turn on the recording meter(s) and leave the meter(s) on until the entire method 701.3 is complete. Then start the engine in accordance with the operating instructions on the set or the technical manual. Record the number of cranks required. The set

must be operating at rated voltage and rated frequency without further use of any type of starting aids or winterization equipment within the specified period from the time heat was first applied to the set. After the engine starts, allow the engine to warm up at no load, rated voltage and rated frequency for a period of 15 minutes.

NOTE: The recording meter(s) shall be operated at a minimum speed of 12 inches per hour during the portions of the test where steady-state loading conditions exist and shall be operated at a minimum speed of 12 inches per minute at least 30 seconds before, during, and after a load change.

g. Just before applying rated load, reset the frequency to the rated value and record the amount the frequency had drifted from the time of set start.

h. Within 16 minutes after the engine starts, apply rated load in one step with the circuit interrupter, starting with the interrupter in the off position. Leave rated load on the set for 30 seconds, then drop the load to no load in one step using the circuit interrupter. Operate at no load for 30 seconds. Again, using the circuit interrupter, apply and drop rated load two more times with 30 seconds of operation in each load condition. Next apply rated load and operate for 5 minutes.

i. After 5 minutes of rated load operation, drop the load to no load in one step and operate the set at no load, rated voltage and rated frequency until temperature stabilization of the engine occurs. During this period readings of all instrumentation including thermal instrumentation shall be recorded at min 10 minute intervals. If necessary, adjusts to the voltage and frequency may be made to maintain operation at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control system shall be made unless permitted by the procurement document. Adjustments to the voltage or frequency controls shall be recorded on both the data sheet and recording chart(s). Unless otherwise specified in the procurement document, engine temperature stabilization will be considered to have occurred when two consecutive recorded readings of the engine coolant and oil temperatures remain unchanged.

j. Apply rated load in one step and allow the generator set to stabilize at rated load, rated voltage, and rated frequency. During this period, readings of all instrumentation including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. When the generator set under test is diesel driven, remove the auxiliary fuel hose from the auxiliary fuel supply for 5 minutes during the time the set is operating at rated load from the auxiliary fuel supply, then replace the hose and continue from the auxiliary fuel supply for at least 10 minutes. Change the fuel transfer valve to the set tank position and continue the test using the set fuel tank. If necessary, adjusts to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjusts to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on both the data sheet and recording chart(s). Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency had been made.

k. After stabilization has occurred, unless otherwise specified in the procurement document, operate the generator set in accordance with the instructions on the set or in the technical manual and perform the following methods at the specified low temperature, voltage connection and frequency:

   1. Method 510.1, Rheostat Range Test.
   2. Method 511.1, Regulator Range Test.
   3. Method 513.2, Indicating Instrument Test (Electrical).
   4. Method 608.1, Voltage and Frequency Regulation, Stability and Transient Response Test (Short Term). In addition to the data, all thermal instrumentation as specified in 701.3.3.1 shall be read and recorded at the same time for the stabilization portion of this test.

   NOTE: The above methods are listed in numerical order; however, they need not be performed in this order. Method 510.1 shall only be performed on sets so equipped.

l. If the total operating time between the start of the no load stabilization run and the completion of the tests listed in k above is less than 8 hours, then continue to run the set at no load, rated voltage and rated frequency until the accumulated operating time is at least 8 hours.

701.3.4 Results. Results shall be as specified in the methods listed in 701.3.3.2 k. Compare the manner in which the generator set functioned, as denoted by the instrument and temperature readings, with the procurement document requirements.

701.3.5 Procurement document requirements. The following details be specified in the individual procurement document:

a. Temperature at which method is to be performed.
b. Type of fuel, lubricating oil, and coolant to be used.
c. Additional tests to be performed not listed in 701.3.3.2 k of this method.
d. Voltage connection and frequency at which this method is to be performed.
e. Allowable heating and starting time.
f. Requirements for auxiliary fuel supply system.
g. Maximum and minimum voltage values between which the generator set shall perform.
h. The maximum allowable voltage regulation (droop).
i. The accuracy requirements of the panel instruments.
j. Maximum allowable short-term frequency stability bandwidth or deviation in percent of rated frequency.
k. Maximum allowable frequency recovery time after a load change.
l. Maximum allowable frequency overshoot or undershoot during a load change.
m. Maximum allowable frequency regulation (droop).
n. Maximum allowable short-term voltage stability bandwidth or deviation in percent of rated voltage.
o. Maximum allowable voltage recovery time after a load change.
p. Maximum allowable voltage overshoot or undershoot during a load change.
q. Engine temperature requirements.
r. Requirements for checking devices in 701.3.3.2 c.

TEST DATA

DESCRIPTION 3KW, 60HZ 120V, SINGLE PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-3.0-MD

SERIAL NO. 01364

REF: MIL-STD-705/701.3

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

STARTING AND OPERATING

(EXTREME COLD-MANUAL CRANK)

TEST NO. 37

SHEET 1 OF 2

DATE FEBRUARY 17, 1971

RECORDER L Wright

PROJ. ENGR. [illegible]

SHIFT LEADER A. Smith

OBSERVER [illegible]

INST. →		489	51172		476		211	2062	1072	319	1167						1076
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	EXCITER FIELD		LUBE OIL SUMP	LUBE OIL GALLERY	SPARK PLUGS CYL 1	CYL 2	CYL 3	CYL 4	AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	°F	°F	°F	°F	°F	°F	°F
SYM.			X10	X1	X10	X1											
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0750	24 HOUR SOAK AT -65°F COMPLETE															
	0755	CHECKED ALL SWITCHES FOR FREEDOM OF MOVEMENT - ALL OK															
	0800	—	—	—	—	—	—	—	—	—	-65	-65	-65	-65	-65	-65	-65
	0800	FIRST APPLIED TORCH TO SET															
	0810	—	—	—	—	—	—	—	—	—	+10	+15	-30	-12	-32	-8	-65
	0812	STARTED MANUAL CRANKS															
	0814	ENGINE STARTED AFTER 13 CRANKS WITH STARTER ROPE															
	0824	120.0	0	0	0	0	—	60.8	12.3	0.62	30	50	+255	271	260	266	-65
	0830	APPLIED RATED LOAD FOR 30 SEC															
	0831	APPLIED RATED LOAD FOR 30 SEC															
	0832	APPLIED RATED LOAD FOR 30 SEC															
	0833	APPLIED RATED LOAD															
	0835	120.0	3.1	31.0	0.30	3.0	.80	60.0	20.1	0.78	50	73	310	306	322	318	-65
	0838	DROPPED LOAD - BEGIN NO LOAD STABILIZATION.															
	0848	121.3	0	0	0	0	—	61.6	11.7	0.60	55	76	272	271	283	279	-65
	0858	121.3	0	0	0	0	—	61.6	11.8	0.60	58	78	275	270	281	277	-65
	0908	121.3	0	0	0	0	—	61.6	11.8	0.60	59	79	272	270	282	278	-65
	0918	121.3	0	0	0	0	—	61.6	11.8	0.60	59	79	270	271	281	281	-66
	0920	APPLIED RATED LOAD - BEGIN RATED LOAD STABILIZATION															

NOTES:
LINE CURRENT MEASURED USING C.T. No 1308
EXCITER FIELD CURRENT MEASURED USING 1A, 50 mV SHUNT No 007
RECORDING VOLTAGE + FREQUENCY METER No 1877 CHART SPEED = AS MARKED

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 701.3-I Portion of a typical test record for starting and operating test (extreme cold, manual crank).

X-4661

Operating Test.]

METHOD 701.4c

STARTING AND OPERATING TEST
(MODERATE COLD, MANUAL CRANK)

701.4.1 General. The generator set t satisfactorily start and operate in moderate low temperature environments without the use of any winterization equipment.

701.4.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient and set temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) for recording voltage and frequency (speed) shall be required. The recording meters shall be as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 (unless otherwise specified in the procurement document).

A controlled temperature room shall be used having sufficient capacity to maintain the specified low temperature with the set operating at rated load for the duration of this test. This controlled temperature room shall be as described and illustrated in MIL-HDBK-705, method 114.2.

701.4.3 Procedure. If this test is performed immediately following method 701.3, omit 701.4.3.1 and steps a and b of 701.4.3.2 except that the tester is allowed to change batteries.

701.4.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures. (Note: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented, however, some sets may require additional thermal instrumentation). The thermal instrumentation shall be installed in accordance with the instructions in MIL-HDBK-705, method 202.1.

   1. Ambient air temperature.
   2. Engine coolant (engine outlet and inlet).
   3. Spark plug(s).
   4. Lubricating oil (sump and gallery).
   5. Engine combustion air in (located at the inlet of the intake manifold).
   6. Engine exhaust gas.
   7. Generator stator frame (top and bottom, outside).
   8. Generator cooling air (inlet and outlet).
   9. Control panel cubicle (ambient air, inside)
   10. Air entering generator set.

b. Start and operate the generator set until the lubricating oil is enough to drain. Drain the coolant from the engine block, the radiator, coolant pump, heater, and all coolant lines. Be sure that the set is completely drained. Fill the coolant system with the proper solution of antifreeze. Fill and label a small transparent container (approximately 8 ounces) with a sample of the antifreeze used.

c. Drain the fuel from all fuel tanks, lines, strainers, pumps and filters. Flush tanks with approximately 10 percent of rated tank capacity low temperature fuel. Clean all fuel strainers and replace filter elements. Install new gaskets on strainers and filter elements. Fill fuel tanks to approximately 10 percent rated capacity with fuels of the proper grade (low temperature fuel specified in the procurement document). Fill and label a small container (approximately 8 ounces) with a sample of each fuel used.
d. Drain the lubricating oil from the engine, filters, strainers and lines. Install new filters and clean the strainers. Use new gaskets. Fill with proper grade lubricating oil. Fill a small container with a sample (approximately 8 ounces) of the oil used.
e. Operate any fuel priming pumps on the set with the discharge lines open to clear lines of normal ambient fuel.
f. On all units, as applicable, check the spark plugs, magneto, distributor, valve clearances, injector timing, etc. Check instruction manual or operating and servicing instructions to see that all set requirements or recommendations have been performed.
g. Start and operate the generator set for approximately 15 minutes at no load to allow the fuels and lubricants to thoroughly circulate. During this period open oil lines at gages and safety controls to drain normal temperature oil. Shut down the set and drain all set fuel tanks as well as the oil from the air cleaners. Fill set fuel tanks, except for sets with gasoline engines. Fill and label a small container with a sample (approximately 8 ounces) of fuel used.
h. Place containers of fuel, lubricant, and coolant in the cold room.
i. Place the generator set in the cold room. If the set is equipped with a three-way valve for an auxiliary fuel supply, connect the fuel supply to the engine thru the three-way valve using the auxiliary fuel hoses (length and size of hoses are specified in the procurement document) supplied with the generator set. The auxiliary fuel supply must have sufficient capacity to furnish fuel for a minimum period of 6 hours when operating at rated frequency (speed) and at no load. This auxiliary fuel supply shall be in the cold room. Set the fuel supply valve in the auxiliary fuel position.
j. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing output to the voltage regulator. (Power the recording meter(s) from the commercial utility.)
k. Where temperature measurements are made by means of thermocouples, the thermocouple leads shall be brought out of the cold room to permit the temperature to be read by instruments located in normal ambient temperatures. All electrical instruments, except those provided as part of the generator set, shall be located outside the cold room with the exception of shunts used in determining field currents. In addition to the circuitry shown in the applicable figure of MIL-HDBK-705 (see step j above), provisions shall be made for measuring the voltage on the generator side of the breaker with instruments located outside the cold room.

701.4.3.2 Test.

a. For sets with gasoline engines, start the cold room and when the ambient temperature has reached approximately 0 deg. F (-17.7 deg. C) open the auxiliary fuel container and fill the set tank. (Note: The parameters of arctic fuel at temperatures above 0 deg. F (-17.7 deg. C) necessitates storing the fuel in sealed containers.) Fill and label a small container with a sample of the fuel used. Place this sample alongside samples of fuel, lubricating oil, and coolant taken previously, in preparation for test, in a location in the cold chamber where they may be observed.

b. For sets with gasoline engines, start and operate the set for approximately 15 minutes at no load to allow the arctic fuel to thoroughly circulate. Then shut down the set.

NOTE: Apply rated load during this period of operation to assure the setting of the load bank for the operation portion of this method.

c. Expose the complete generator set (including all fuels, lubricants, coolants and hydraulic oils to be used during this method) to the specified low temperature until such time as all components are at the specified low temperature. During all steps of this test, all of the eight ambient thermocouples shall indicate temperatures equal to or colder than the specified low temperature or until 24 hours have elapsed, whichever comes later. After all temperatures are equal to or below the specified low temperature, check all devices - such as hoses, wiring, door latches, and panel latches for compliance with requirements of the procurement documents. Prepare the set for moderate-cold start by explicitly following the operating instructions on the set. Examine fuel, oil, and coolant samples from any irregularities due to cold temperature. Record any irregularity on the data sheet.

d. Turn on the recording meter(s) and leave the meter(s) on until the entire method 701.4 is completed.

NOTE: The recording meter(s) shall be operated at a minimum speed of 12 inches per hour during the portions of the test where steady-state load conditions exist and shall be operated at a minimum speed of 12 inches per minute at least 30 seconds before, during, and after a load change.

e. By following the instructions on the set or in the technical manual, start the generator set within 5 minutes. Record the time when is started. Record the number of cranks. Record the time when the set starts. See figure 701.4-I.

f. Allow the engine to warm up at no load, rated voltage and rated frequency for a period of 15 minutes.

g. Just before applying rated load, reset the frequency to the rated value and record the amount the frequency had drifted from the time of set start.

h. Within 16 minutes after the engine starts, apply rated load in one step with the circuit interrupter, starting with the interrupter in the off position. Leave rated load on the set for 30 seconds, then drop the load to no load in one step using the circuit interrupter. Operate at no load for 30 seconds. Again, using the circuit interrupter, apply and drop rated load two more times with 30 seconds of operation in each load condition. Next apply rated load and operate for 5 minutes.

i. After 5 minutes of rated load operation, drop the load to no load in one step and operate the set at no load, rated voltage and rated frequency until temperature stabilization of the engine occurs. During this period readings of all instrumentation including thermal instrumentation shall be recorded at minimum 10 minute intervals. If necessary, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjusts to the voltage or frequency controls shall be recorded on the data sheet and the recording chart(s). Unless otherwise specified in the procurement document, engine temperature stabilization will be considered to have occurred when two consecutive recorded readings of the engine coolant and oil temperature remain unchanged.

j. Apply rated load in one step and allow the generator set to stabilize at rated load, rated voltage, and rated frequency. During this period, readings of all instrumentation including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. When the generator set under test is diesel driven, remove the auxiliary fuel hose from the auxiliary fuel supply for 5 minutes during the time the set is operating at rated load from the auxiliary fuel supply. Then replace the hose and continue operation from the auxiliary fuel supply for at least 10 minutes. Change the fuel transfer valve to the set tank position and continue the test using the set fuel tank. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on both the data sheet and recording chart(s). Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

k. After stabilization has occurred, unless otherwise specified in the procurement document, operate the generator set in accordance with the instructions on the set or in the technical manual and perform the following methods at the specified low temperature, voltage connection and frequency:

1. Method 510.1, Rheostat Range Test.
2. Method 511.1, Regulator Range Test.
3. Method 513.2, Indicating Instrument Test (Electrical).
4. Method 608.1, Voltage and Frequency Regulation, Stability and Transient Response (Short Term). In addition to the required data, all thermal instrumentation as specified in 701.4.3.1 shall be read and recorded at the same time for the stabilization portion of this test.

NOTE: The above methods are listed in numerical order; however, they need not be performed in this order. Method 510.1 shall only be performed on sets so equipped.

l. If the total operating time between the start of the no load stabilization run and the completion of the tests listed in k above is less than 8 hours, then continue to run the set at no load, rated voltage and rated frequency until the accumulated operating time is at least 8 hours.

701.4.4 Results. Results shall be as specified in the methods listed in 701.4.3.2 k. Compare the manner in which the generator set functioned, as denoted by the instrument and temperature readings, with the procurement document requirements.

701.4.5 Procurement document requirements. The following details must be specified in the individual procurement document:

a. Temperature at which method is to be performed.
b. Type of fuel, lubricating oil, and coolant to be used.
c. Additional tests to be performed not listed in 701.4.3.2 k of this method.
d. Voltage connection and frequency at which this method is to be performed.
e. Allowable starting time if different than specified in 701.4.3.2 f of this method.
f. Requirements for auxiliary fuel supply systems.
g. Maximum and minimum voltage values between which the generator set shall perform.
h. The maximum allowable voltage regulation (droop).
i. The accuracy requirements of the panel instruments.
j. Maximum allowable short-term frequency stability bandwidth or deviation in percent of rated frequency.
k. Maximum allowable frequency recovery time after a load change.
l. Maximum allowable frequency overshoot or undershoot during a load change.
m. Maximum allowable frequency regulation (droop).

n. Maximum allowable short-term voltage stability bandwidth or deviation in percent of rated voltage.
o. Maximum allowable voltage recovery time after a load change.
p. Maximum allowable voltage overshoot or undershoot during a load change.
q. Engine temperature requirements.
r. Requirements for checking devices in 701.4.3.2 c.

TEST DATA

DESCRIPTION 3KW, 60HZ 120V, SINGLE-PHASE GENERATOR SET	PHILADELPHIA REGION	TEST NO. 78
MFGR. ENGENSETS, INC	DEFENSE CONTRACT ADMINISTRATION SERVICE	SHEET 1 OF 2
MODEL NO. SF-3.0-MD	STARTING AND OPERATING TEST	DATE FEBRUARY 18, 1971
IAL NO. 07130	(MODERATE COLD, MANUAL CRANK)	RECORDER J. Wright
REF: MIL-STD-705/701.4		PROJ. ENGR. J. Jones
		SHIFT LEADER H. Smith
		OBSERVER J. Doe

INST. →		489	51172		476		211	2062	1072	319	1167						1076
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ.	EXCITER FIELD		LUBE OIL		SPARK PLUGS				AVG AMB TEMP
											SUMP	GALLERY	CYL 1	CYL 2	CYL 3	CYL 4	
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	°F	°F	°F	°F	°F	°F	°F
SYM.			X10	X1	X10	X1											
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0800	—	—	—	—	—	—	—	—	—	-25	-26	-25	-25	-26	-25	-26
	0803	STARTED CRANKING															-26
	0807	ENGINE STARTED															-26
	0817	120.0	0	0	0	0	—	60.9	12.6	0.54	+15	+40	+255	+246	+248	+244	-25
	0823	APPLIED RATED LOAD FOR 30 SEC						FREQUENCY DRIFT WAS 0.4HZ									
	0824	APPLIED RATED LOAD FOR 30 SEC															
	0825	APPLIED RATED LOAD FOR 30 SEC															
	0826	APPLIED RATED LOAD															
	0830	120.0	3.1	31	.30	3.0	.80	60.1	18.7	0.76	75	115	325	317	322	314	-26
	0831	DROPPED LOAD - BEGIN NO LOAD STABILIZATION															
	0841	121.2	0	0	0	0	—	61.0	12.8	0.54	80	117	260	256	259	252	-27
	0851	121.2	0	0	0	0	—	61.0	12.8	0.54	81	118	258	256	257	250	-26
	0901	121.2	0	0	0	0	—	61.0	12.8	0.54	82	119	258	254	257	250	-26
	0910	121.2	0	0	0	0	—	61.0	12.8	0.54	82	119	258	254	257	250	-26
	0910	APPLIED RATED LOAD - BEGIN RATED LOAD STABILIZATION															
	0920	120.0	3.1	31	.30	3.0	.80	60.0	18.8	0.76	95	142	330	326	327	322	-25
	0930	120.2	3.1	31	.30	3.0	.80	60.3	18.9	0.76	99	147	333	330	330	325	-26
	0940	ADJUSTED VOLTAGE AND FREQUENCY TO RATED															
	0950	120.0	3.1	31	.30	3.0	.80	60.0	19.2	0.76	103	154	333	330	330	325	-26

NOTES: LINE CURRENT MEASURED USING C.T. No 1308
EXCITER FIELD CURRENT MEASURED USING 1A, 50mV SHUNT No 007
RECORDING VOLTAGE & FREQUENCY METER No 1877 CHART SPEED= AS MARKED

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 701.4-1 Portion of a typical test record for starting and operating test (moderate cold, manual crank).

X-4662

Operating Test.]

METHOD 702.1c
STANDBY OPERATION TEST
(EXTREME COLD)

702.1.1 General. The ability of the winterization equipment to maintain engine temperatures at such values as to permit rapid start of the generator set in arctic conditions is necessary.

702.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient and set temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, a controlled temperature room as described and illustrated in MIL-HDBK-705, method 114.2 having sufficient capacity to maintain the specified low temperature throughout this method shall be required.

702.1.3 Procedure. This method is normally performed in conjunction with method 701.1. If this is so, omit 701.1.3.1 entirely, and steps a and b of 702.1.3.2 except the tester is allowed to change batteries.

702.1.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures. (Note: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented; however, some sets may require additional thermal instrumentation.) The thermal instrumentation shall be installed in accordance with the instructions in MIL-HDBK-705, method 202.1.

1. Ambient air temperature.
2. Engine coolant (engine outlet and inlet).
3. Spark plug(s).
4. Lubricating oil (sump and gallery).
5. Engine combustion air in (located at the inlet of the intake manifold).
6. Storage battery electrolyte (thermocouple (s) shall be so located that the electrolyte temperature at the center of the electrolyte is measured).
7. Heater transfer medium (air or liquid - into and out of the heater).
8. Heater exhaust.
9. Battery box air (at each end of battery box) .
10. Engine exhaust.
11. Generator stator frame (top and bottom, outside).
12. Generator cooling air (inlet and outlet).
13. Control panel cubicle (ambient air, inside).
14. Air entering generator set.

b. Start and operate the generator set until the lubricating oil is warm enough to drain. Drain the coolant from the engine block, radiator, coolant pump, heater, and all coolant lines. Be sure that the set is completely drained. Fill and label the coolant system with the proper solution of antifreeze. Fill a small transparent container (approximately 8 ounces) with a sample of the antifreeze used.

c. Drain the fuel from all fuel tanks, lines, strainers, pumps and filters. Flush tanks low-temperature fuel with using approximately 10 percent of tank capacity. Clean all fuel strainers and replace filter elements. Install new gaskets on strainer and filter elements. Fill fuel tanks to approximately 10 percent rated capacity with fuels of the proper grade (low temperature fuel specified in the procurement document). Fill and label a small container (approximately 8 ounces) with a sample of each fuel used.
d. Drain the lubricating oil from the engine, filters, strainers and lines. Install new filters and clean the strainers. Use new gaskets. Fill with proper grade lubricating oil. Fill and label a small container with a sample (approximately 8 ounces) of the oil used.
e. Start and operate the winterization system. See that all controls work property. It may be necessary to temporarily bypass controls if the ambient temperature is too high. Do not operate the heater for longer than necessary to perform the check-out.
f. Operate any fuel priming pumps on the set with the discharge lines open to clear lines of normal ambient fuel.
g. On all units, as applicable, check the spark plugs, magneto, distributor, valve clearances, injector timing, etc. Check instruction manual or operating and servicing instructions to see that all set requirements or recommendations have been performed.
h. Start and operate the generator set for approximately 15 minutes at no load to allow the arctic fuels and lubricants to thoroughly circulate. During this period open oil lines at gages and safety controls to drain normal temperature oil. Shut down the set and drain all set fuel tanks as well as the oil from the air cleaners. Fill set fuel tanks, except for sets with gasoline engines. Fill and label a small container with a sample (approximately 8 ounces) of fuel used.
i. If a storage battery is part of the set, fill it with electrolyte having the specified gravity recommended for arctic operation. The batteries shall by cycled and completely charged (see MIL-HDBK-705, method 222.1) before placing them in the cold room.
j. Place containers of fuel, lubricant(s), and coolant in the cold room.
k. Place the generator set in the cold room. If the set is equipped with a three-way valve for an auxiliary fuel supply, connect the fuel supply to the engine thru the three-way valve using the auxiliary fuel hoses (length and size of hoses are specified in the procurement document) supplied with the generator set. The auxiliary fuel supply must have sufficient capacity to furnish fuel for a minimum period of 6 hours when operating at rated frequency (speed) and at no load. This auxiliary fuel supply shall be in the cold room. Set the fuel supply valve in the auxiliary fuel position.
l. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the record meter(s) from the commercial utility.)

m. Where temperature measurements are made by means of thermocouples, the thermocouple leads shall be brought out of the cold room to permit the temperature to be read by instruments located in normal ambient temperatures. All electrical instruments, except those provided as part of the generator set, shall be located outside the cold room with the exception of shunts used in determining field currents. In addition to the circuitry shown in the applicable figure of MIL-HDBK-705 (see step 1 above), provisions shall be made for measuring the voltage on the generator side of the circuit breaker with instruments located outside the cold room.

702.1.3.2 Test.

a. For sets with gasoline engines, decrease the temperature in the cold room and when the ambient temperature has reached approximately 0 deg. F (-17.7 deg. C) open the auxiliary fuel container and fill the set tank. (Note: The volatility of arctic fuel at temperatures above 0 deg. F (-17.7 deg. C) necessitates storing the fuel in sealed containers.) Fill and label a small container with a sample of the fuel used. Place this sample alongside samples of fuel, lubricating oil, and coolant taken previously in preparation for test, in a location in the cold where they may be observed.
b. Start and operate the set for approximately 15 minutes at no load to allow the arctic fuel to thoroughly circulate. Then shut down the set.
c. As soon as the low temperature chamber reaches the specified low temperature or immediately following the shutdown of the generator set concluding method 701.1, place the winterization equipment into standby operation in accordance with the instructions on the set or in the technical manual. If the winterization heater has separate fuel tank, fill the tank before starting the heater. During all steps of this method all of the eight ambient thermocouples shall indicate temperatures equal to or colder than the specified cold temperature. Examine fuel, oil, and coolant samples for any irregularities due to cold temperature. Record any irregularity on the data sheet.
d. Maintain the winterization equipment in standby operation for 24 hours unless otherwise specified in the procurement document.
e. Read and record all thermal instrumentation in maximum intervals of one hour.
f. During the specified operation period, keep a record of the amount of fuel added to the fuel tank if the winterization heater uses a separate fuel tank.
g. At each hourly reading inspect the battery temperature readings to determine if the batteries are overheating.
h. One hour before the end of the specified period, open the generator set at the side panels to determine if there are any fuel or coolant leads. In addition, determine if there is any frost build-up inside the housing. Record films on the data sheet.
i. At the end of the specified period, shut down the winterization equipment and start the generator set, following instructions on the set or in the technical manual. Unless otherwise specified in the procurement document, use the set batteries to start the set; but it

will not be necessary to make trial cranking with ignition or fuel shut off before attempting to start the engine. Record the elapsed time from initial cranking until the generator set starts.

j. After the engine starts, operate the set at rated voltage and rated frequency (speed) at no load. Open the side panel and inspect the set for fuel, oil, and coolant leaks. Record findings on the data sheet.
k. Using the set circuit interrupter, apply and drop half rated load in one step several times (three should be sufficient). Record electrical instrumentation readings on the data sheet.
l. Perform additional tests or inspections are required by the procurement document.

702.1.4 Results. Compare the winterization equipment and generator set document.

702.1.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. Length of time this method is to be performed if other than 24 hours.
b. Ambient temperature at which this method is to be performed.
c. Number of hours that the winterization equipment must operate before refilling the fuel tank, if the winterization equipment has a separate fuel tank.
d. Maximum allowable temperature of battery electrolyte.
e. Cranking instructions for starting engine after standby operation tests.
f. Time limit in which the set must start after initial cranking attempt.
g. Voltage connection and frequency at which this method is to be performed.
h. Type of fuel, lubricating oil, and coolant to be used.

TEST DATA

DESCRIPTION 15 KW, 60 HZ 120 V SINGLE - PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-15.0-MD

SERIAL NO. 10638

REF. MIL-STD-705/702.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

STANDBY OPERATION TEST

TEST NO. 19

SHEET 1 OF 2

DATE 14 SEPT, 1971

RECORDER [illegible]

PROJ. ENGR. [illegible]

SHIFT LEADER [illegible]

OBSERVER [illegible]

INST→	1075																
READ NO.	TIME	ENG COOLANT		LUBE OIL		ENG AIR IN	BATTERY ELECTROLYTE				HEATER COOLANT		HEATER EXHAUST	BATT BOX AIR		ENG EXHAUST	AVG AMB TEMP
		IN	OUT	SUMP	GALLERY		CELL 2	CELL 5	CELL 8	CELL 11	IN	OUT		RIGHT	LEFT		
UNITS	HRS	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F
SYM																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1915	SET	SHUT	DOWN	-PLACED	SET	IN	STANDBY	OPERATION								-65
	1925	111	175	155	150	75	26	15	17	28	90	149	1390	110	100	—	-67
	2025	108	169	123	121	70	55	59	60	57	66	139	960	125	115	—	-66
	2125	88	167	103	101	62	66	66	67	64	47	142	940	127	118	—	-65
	2225	73	167	88	86	50	71	69	69	67	39	143	917	128	119	—	-66
	2325	62	164	75	74	40	76	72	73	70	31	143	880	123	113	--	-66
9/15/25	0025	52	159	64	63	30	79	73	74	71	25	140	860	120	109	—	-66
	0125	44	154	57	55	21	82	74	75	74	21	135	870	122	110	—	-65
	0225	39	148	51	49	12	83	75	76	75	18	130	840	124	112	—	-65
	0325	36	146	47	46	5	87	77	77	77	16	125	850	121	108	—	-66
	0425	32	142	44	42	3	88	78	78	78	14	122	840	120	106	—	-67
	0525	30	140	42	40	-3	90	78	79	80	13	118	845	115	99	—	-66
	0625	27	138	40	3[illegible]	-7	92	80	80	93	12	115	845	120	104	—	-66
	0725	26	138	39	37	-10	94	80	81	94	12	114	860	123	109	—	-66
	0825	25	137	38	36	-15	95	81	81	95	12	113	860	126	111	—	-65
	0925	23	135	36	34	-16	96	82	81	95	11	112	830	129	117	—	-66
	1025	22	134	35	33	-19	97	81	8[illegible]	97	11	112	862	127	113	—	-66
	1125	22	135	35	33	19	96	82	83	97	11	111	875	113	96	—	-66
	1225	21	134	39	31	-18	96	81	82	97	10	110	830	112	94	—	-66
NOTES																	

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

FIGURE 702.1-I. Portion of a typical test record for standby operation test.

X-4663

Operation Test.]

TEST DATA

DESCRIPTION 15 KW, 60 Hz 120 V, SINGLE-PHASE GENERATOR SET
MFGR. ENGENSETS, INC.
MODEL NO SF-15.0-MD
SERIAL NO. 10638
REF: MIL-STD-705/702.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

STANDBY OPERATION TEST

TEST NO. 13
SHEET 1 OF 1
DATE 15 SEP 1970
RECORDER
PROJ. ENGR.
SHIFT LEADER
OBSERVER

INST →		136		287		324		5.6		778		143	222				
READ NO ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD					
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		Hz	VOLTS	AMPS				
SYM.				X40	X1	X40	X1										
COL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1925	ENGINE STARTED IN 20 SEC															
	1940	OPERATED CIRCUIT INTERRUPTED 3 TIMES															
	1940		120.0	0	0	0	0		—		60.0	18.4	1.32				
	1942		120.0	1.95	78.0	188	7.5		.80		60.0	31.6	2.73				
	1944		120.0	0	0	0	0		—		60.0	18.7	1.32				
	1946		120.0	1.95	78.0	188	7.5		.80		60.0	32.1	2.73				
	1948		120.0	0	0	0	0		—		60.0	19.1	1.32				
	1950		120.0	1.95	78.0	188	7.5		.80		60.0	32.7	2.73				
	1953	SHUT SET DOWN - END OF TEST															

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENT MEASURED WITH C.T. NO 1307
EXCITER FIELD CURRENT MEASURED WITH 5- 50mV SHUNT NO 188

FIGURE 702.1-II. Portion of a typical test record for standby operation test.

X-4664

Operation Test.]

METHOD 710.1d

HIGH TEMPERATURE TEST

710.1.1 General. To ensure reliable electrical power generation a generator set must be capable of operating over a wide range of environmental conditions including high ambient temperatures.

710.1.2 Apparatus. Apparatus as specified in each of the test methods listed in 710.1.3.2 f shall be required. In addition to the above-specified instrumentation; thermal instrumentation as described and illustrated in MIL-HDBK-705, methods 110.1 and 202.1; pressure instrumentation as described and illustrated in MIL-HDBK-705, method 112.1; and a temperature chamber as described and illustrated in MIL-HDBK-705, method 114.1 shall be required.

710.1.3 Procedure.

710.1.3.1 Preparation for test.

a. Install appropriate thermocouple to measure the following temperatures (NOTE: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented, however, some sets may require additional thermal instrumentation):

1. Engine coolant (engine outlet and inlet).
2. Fuel (discharge side of fuel pump and at fuel source).
3. Spark plug(s) (gasoline engines).
4. Exhaust gases (The exhaust manifolds) of reciprocating engines shall be drilled and tapped as close as possible to the combustion chamber(s). For gas turbine engines, thermocouples shall be located in the tailpipe approximately one turbine wheel diameter downstream fran the last turbine stage).
5. Lubricating oil sump and gallery for preproduction sets and sets and sump only for production sets.
6. Oil cooler (inlet and outlet).
7. Hydraulic oil sump.
8. Engine combustion air in (located at the inlet of the intake manifold).
9. Cooling air into the radiator (four thermocouples equally spaced around the circumference of the area swept by the fan blades).
10. Generator cooling air (inlet and outlet).
11. Generator stator frame (top and bottom, outside).
12. Generator exciter (stator housing for rotation exciters, transformers for static exciters).
13. Generator voltage regulator (ambient air, inside).
14. Control panel cubicle (ambient air, inside).
15. Relay and control boxes (ambient air, inside).
16. Battery electrolyte (one thermocouple for each battery placed in a centrally located cell of the battery).
17. Average ambient air temperature (MIL-HDBK-705, method 202.1).
18. Air entering generator set for housed sets.

b. Install appropriate pressure instrumentation to the following items:

   1. Pressure in the vicinity of the combustion air intake (inside enclosed sets).
   2. Exhaust gas pressure (combined exhaust gases in exhaust manifold or tailpipe).
   3. Intake air manifold pressure (between air filters and manifold).

c. Place the instrumented generator set in the temperature chamber and obtain and maintain the ambient temperature within the chamber at the value specified in the procurement document. During all parts of this method, the average of the eight ambient thermocouples (see MIL-HDBK-705, method 202.1) shall not be less than the specified temperature and of these eight thermocouples, none shall indicate more than 5 F deg. (2.78 C deg.) above or below the specified ambient.

d. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10, and as required for the test methods listed in 710.1.3.2 f below for a voltage connection and frequency specified in the procurement document.

e. Connect switch(es) to the generator armature coil(s), for which the temperature rise is to be determined, such that the coil(s) may be (if rapid access is available to this step may be omitted).

710.1.3.2 Test.

a. Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period operate the recording meter(s) at a chart speed of not less than 6 inches per hour, and record all instrument readings including ambient temperature at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control system shall be made unless permitted by the procurement document. Adjustments to load, voltage or frequency controls shall be recorded on both the data sheet and the recording chart(s) at the time of adjustment. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made (see figure 710.1-I).

b. After stabilization has occurred stop the set so that temperatures of rotating components and windings may be taken. For application of the contact method to rotating parts, or the resistance method to the armature coils (see MIL-HDBK-705, methods 110.1 and 202.1); a quick shutdown of the set is mandatory.

   CAUTION: Do not connect bridges, meters or temperature measuring equipment for measuring resistance or temperature to circuits which may still be energized, e.g., during the time that the set is coming to a stop.

c. Immediately after the shutdown, start to record the resistance bridge readings of the coils and the temperatures of the components where the contact method of measuring temperature rise is used.

   Readings of resistance measurements shall be recorded in accordance with instructions given in MIL-HDBK-705, method 110.1.

   The first thermocouple reading shall be taken and recorded within 30 and recorded at approximately 30 second intervals until one reading has been recorded after the temperature has begun to decrease, or three minutes has elapsed since set shutdown, whichever is longer, being certain that the maximum temperature reached by each component has been recorded. Continuous or multipoint temperature recorder(s) may be used to record component temperatures as long as the above time requirements are met.

d. Repeat steps a thru c above for each of the coils specified in the procurement document.
e. Repeat steps a thru d above at each additional specified voltage connection and frequency and stabilization voltage.
f. Unless otherwise specified, operate the generator set in accordance with the instructions on the set or in the technical manual and perform the following methods at the specified ambient temperature, voltage connection and frequency:

   1. Method 512.1, Circuit Interrupter Test (Short Circuit).
   2. Method 512.3, Circuit Interrupter Test (Overvoltage and Undervoltage).
   3. Method 513.2, Indicating Instrument Test (Electrical).
   4. Method 655. 1, DC Control Test.

   NOTE: The above methods are listed in numerical order; however, they need not be performed in this order.

g. Repeat paragraph a to establish stabilization values. Stabilization for the tests below will be considered valid once the set has been operated a sufficient period of time to achieve the previously established generator (or exciter) field voltage and current. The tests below shall be run sequentially with no shutdown between tests (if a shutdown occurs, for any reason, stabilization will have to be re-established):

1. Method 511.1, Regulator Range Test.
2. Method 511.2, Frequency Adjustment Range Test.
3. Method 512.2, Circuit Interrupter Test (Overload Current).
4. Method 608.1 Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term). (In addition to the required data, all thermal and pressure instrumentation as specified in 710.1.3.1 shall be read and recorded at the same time for the stabilization portion of this test).
5. Method 608.2, Long Term Frequency and Voltage Stability Test. (In addition to the required data, all thermal and pressure instrumentation as specified in 710.1.3.1 shall be read and recorded at the same time for all portions of this test).
6. Method 619.2, Voltage Dip and Rise for Rated Load Test.

NOTE: The above methods are listed in numerical order; however, they need not be performed in this order.

h. Repeat steps f and g above for each additional specified voltage connection and frequency.
i. Perform the following test for gasoline, diesel and gas turbine engine-driven generator sets:

1. Operate the set at rated load until the fuel and lubricating oil temperature are stabilized. Stabilization will be considered to have occurred when three consecutive fuel and lubrication oil temperature readings, taken at minimum intervals of 10 minutes,
2. Immediately after the third stable temperature reading, shut the set down for five minutes.
3. Restart the engine and operate the set at no load. During the restart, check for evidence of excessive heat transfer to the fuel system as evidenced by vapor lock, difficult starting, or uneven running. Operate the set at no load for sufficient time to obtain steady operation. Note on the data sheet any difficulty in starting or uneven running.

710.1.4 Results. Results shall be as specified in methods listed in 710.1.3.2 f and 710.1.3.2 g and in the individual methods specified in 710.1.3.2 b. For the test performed in 710.1.3.2 i, the data sheet shall show as a minimum, whether or not the set started and operated normally and reasons for any difficult starting or uneven running. For the test performed in 710.1.3.2 c temperature rise of each winding as specified in these results with the procurement document requirements.

710.1.5 Procurement document requirements. The following details must be specified in the procurement document:

a. Ambient temperature at which this method is to be performed.
b. Temperature rise allowed for each class of insulation, giving the method of measurement.
c. Coils, components or assemblies for which the temperatures rise is to be determined.
d. Voltage connection(s) and frequency(ies) at which temperature rise is to be determined.
e. Methods to be performed in addition to or other than those listed in 710.1.3.2 f and 710.1.3.2 g.
f. Procurement document requirements as specified in 710.1.3.2 f and 710.1.3.2 g.
g. Starting and operating requirements for the test performed in 710.1.3.2 i.

TEST DATA

DESCRIPTION 10KW, 60HZ 120V SINGLE-PHASE GEN SET
MFGR. ENGENSETS, INC
MODEL NO. SF-10.0-MD
SERIAL NO. 2701B
REF: MIL-STD-705/710.1

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

HIGH TEMPERATURE TEST

TEST NO. 39
SHEET 1 OF 2
DATE 8 DECEMBER 1970
RECORDER D. Wright
PROJ. ENGR. [illegible]
SHIFT LEADER H. Smith
OBSERVER D. See

INST. →		106	207		308		409	510	111	212	613						614
READ NO. ↓	TIME	TERM. VOLT.	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	EXCITER FIELD		ENG AIR IN	ENG AIR OUT	SPARK PLUGS CYL 1	CYL 2	CYL 3	CYL 4	AVG AMB TEMP.
UNITS	HRS.	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	°F	°F	°F	°F	°F	°F	°F
SYM.			X40	X1	X40	X1											
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:00	STARTED UNIT APPLIED RATED LOAD.															125
1	09.10	120.0	2.60	104	.250	10.0	.80	60.0	9.3	1.37	126	147	376	365	367	342	125
2	09:20	120.2	2.61	104	.254	10.2	.81	60.3	9.5	1.39	126	196	38.5	372	373	350	125
	09:30	ADJUSTED LOAD, VOLTAGE, AND FREQUENCY TO RATED															
3	09:40	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	147	383	371	372	349	125
4	09:50	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	148	384	371	373	349	125
5	10:00	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	12.7	149	384	371	372	350	125
6	10:10	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	127	149	384	370	373	349	125
	10:12	SHUT DOWN FOR RESISTANCE READING T1-T4															
	10:17	RESTARTED UNIT APPLIED RATED LOAD - NO SIGNS OF ROUGH RUNNING NO DIFFICULTY IN RESTARTING UNIT.															
7	10:30	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	148	386	372	373	351	125
8	10:40	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	148	385	371	373	350	125
7	10:50	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	148	384	371	373	350	125
10	11:00	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	148	384	371	373	350	125
	11:03	SHUT DOWN UNIT FOR RESISTANCE READING T2-T5															
	11:10	RESTARTED UNIT, APPLIED RATED LOAD															
11	11:30	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	148	385	371	372	350	125
12	11:40	120.0	2.60	104	.250	10.0	.80	60.0	9.4	1.38	126	148	384	371	372	350	125

NOTES: CT # 1311
TI # 717

SMEFB Form 28
16 Sep 69

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Belvoir

X-4665

FIGURE 710.1-I PORTION OF A TYPICAL TEST RECORD FOR HIGH TEMPERATURE TEST

Temperature Test.]

METHOD 711.1d

HUMIDITY TEST

711.1.1 General. The generator set must be capable of being exposed to the humid atmosphere of tropic or swamp areas with no damage or deterioration in performance.

711.1.2 Apparatus. The apparatus requirements of MIL-STD-705, methods 608.1 and 301.1 are necessary to perform this test. In addition, a test chamber must be used which is capable of maintaining the required humidity and temperature. The source(s) of heat and cooling for the chamber shall be so arranged that radiant heat (or cooling) shall not fall upon the unit being tested. Direct injection of CO_2 (carbon dioxide) shall not be permitted due to the acid formed by contact of CO_2 with water. The velocity of the air throughout the test area shall not exceed 150 feet per minute. The total external volume of the unit to be tested shall be not more than 50 percent of the total volume of the test chamber.

Distilled or demineralized water having a pH value of between 6.5 and 7.5 at 25 deg. C (77 deg. F) shall be used to obtain the desired humidity.

Thermometers and psychrometers must be provided for measuring temperature and humidity.

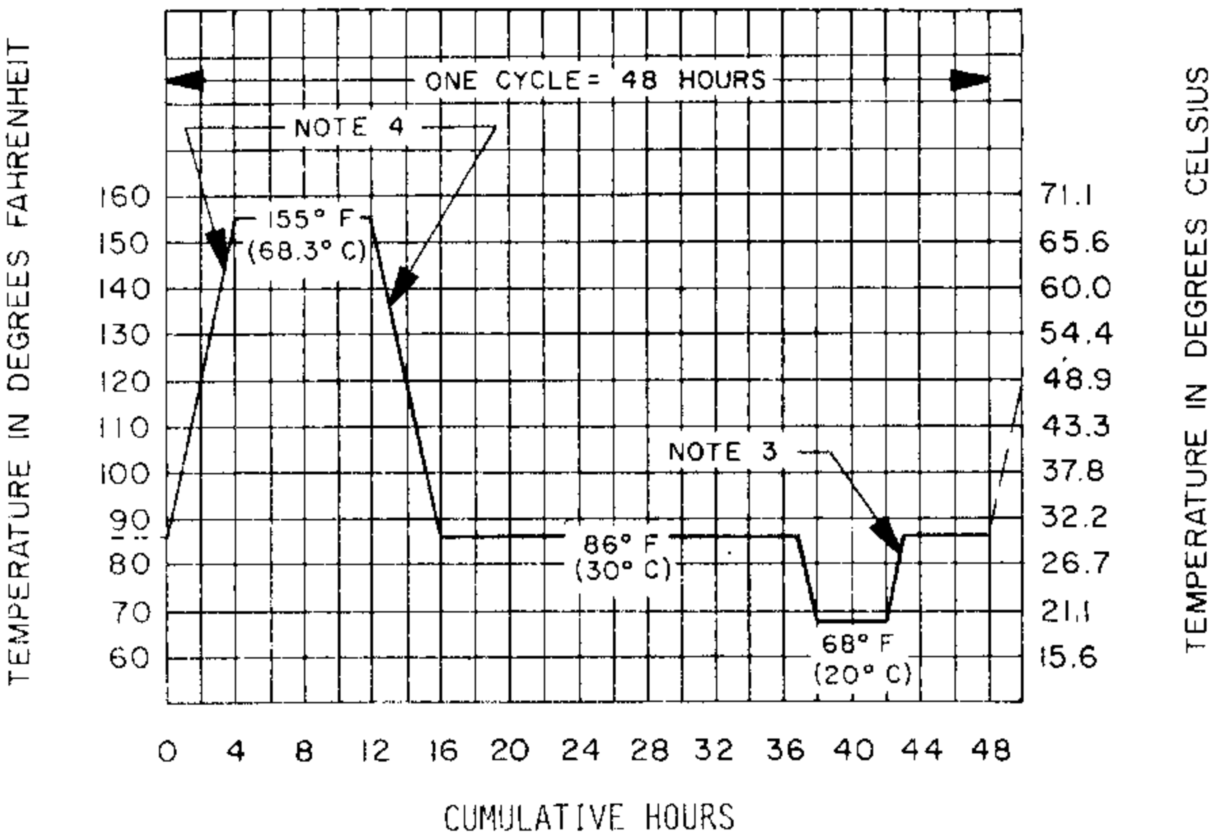
711.1.3 Procedure.

a. Perform test method 608.1 within 4 hours before the start of the humidity cycling.
b. After performing test method 608.1, but prior to the start of the humidity cycling, isolate the armature and field (exciter field only for brushless generators) and measure their insulation resistances in accordance with test method 301.1, except that the values need not be corrected for temperature. Record the resistance values and ambient temperature at which they were measured.
c. Subject the set to continuous cycling for a total of five of the 48-hour cycles described in figure 711.1-I.
d. Remove the set from the test chamber immediately upon completion of c above. Within 1 hour after removal from the test chamber and without removal of moisture, measure the insulation resistance of all circuits initially measured under b in accordance with test method 301.1, except that the set shall not be operated prior to this test and measured values shall not be corrected for temperature.
e. Reconnect all circuits and perform test method 608.1 within 4 hours after removal from the test chamber.
f. Examine the set for corrosion or other physical damage resulting from the test.
g. Record all actual test conditions and results.

711.1.4 Results. Compare the results with the requirements of the procurement document.

711.1.5 Procurement document requirements. The following items will be specified in the individual procurement document:

a. Minimum acceptable insulation resistance value.
b. Temperature, humidity, cycling and duration, if different than specified herein.
c. Definition of temperature and humidity damage.



NOTES:

1. THE ACTUAL TEMPERATURE DURING THE CYCLE SHALL BE WITHIN 5 F° (2.7 C°) OF THE TEMPERATURE SHOWN ON THE CHART.
2. RELATIVE HUMIDITY SHALL BE MAINTAINED BETWEEN 90 AND 98% AT ALL TIMES DURING THE CYCLE.
3. THE MEASURED INCREASE IN TEMPERATURE FROM 68 ± 5°F (20 ± 2.7°C) TO 86 ± 5°F (30 ± 2.7°C) SHALL NOT BE LESS THAN 18 F° (10 C°).
4. THE RATE OF TEMPERATURE CHANGE BETWEEN 86°F (30°C) AND 155°F (68.3°C) SHALL BE NOT LESS THAN 15 F° (8.3 C°) PER HOUR.

FIGURE 711.1-I. Moisture resistance test cycle.

X-4666

METHOD 711.2b

FUNGUS RESISTANCE TEST

711.2.1 General. The generator set must not permit the growth of fungi.

711.2.2 Apparatus. A mold chamber in which the temperature can be accurately controlled to +/- 1.8 F deg. (1 C deg.) and the humidity can be accurately controlled to +/- 2 percent relative humidity. The mold shall have incorporated in it provisions for growth and feeding of the test organisms and shall have been in operation a minimum of 15 days prior to the start of this procedure. The minimum fungi types present in the mold chamber for the duration of this method shall be those specified in MIL-V-173 except that "aspergillus terrus" (PQMD 82J) may be substituted for "aspergillus flavus" (QM 380) whenever the latter is called for.

711.2.3 Procedure.

711.2.3.1 Preparation for test.

a. Test cultures shall be prepared in accordance with the methods specified in MIL-V-173. These organisms shall be introduced into the chamber on soil beds, untreated leather, cork, jute bags, and canvas strips which shall be so distributed that a uniform spore suspension will probably occur after 15 days.
b. The mold chamber shall be operated in accordance with the following cycle unless otherwise stated in the procurement document:

    1. 8 hours at 85 deg. F (29.4 deg. C) and 90 percent relative humidity.
    2. 8 hours to change to 75 deg. F (24.8 deg. C) and 95 percent relative humidity.
    3. 4 hours at 75 deg. F (24.8 deg. C) and 95 percent relative humidity.
    4. 4 hours to change 85 deg. F (29.4 deg. C) and 90 percent relative humidity.

711.2.3.2 Test.

a. The set or certain components of the set (specified in the procurement documents) shall be placed into the mold chamber along with at least two vegetable tanned leather strips and two cotton duck strips to act as controls and shall be thoroughly sprayed with suspensions of the test organisms of MIL-V-173. Record these conditions on the data sheet (see figure 711.2-I).
b. The set or samples under test shall be left in the mold chamber for 30 24-hour cycles unless otherwise specified in the procurement document.
c. At the end of the prescribed time, the set and control shall be removed from the mold chamber and examine thoroughly for effects due to fungi.

711.2.4 Results. Compare any fungi with that all by the procurement document.

711.2.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. The mold chamber cycle, if other than as specified herein.
b. The duration of this method, if other than as specified herein.
c. Allowable fungi growth on the set, if any.
d. Definition of set damage, if applicable.
e. Number and type of samples to be tested, if the complete set is not tested.

TEST DATA

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

FUNGUS RESISTANCE TEST

DESCRIPTION 10KW, 60Hz 120V, SINGLE PHASE GENERATOR SET
MFGR. ENGENSETS, INC.
MODEL NO. SE-10.0-MD
SERIAL NO. 12711
REF: MIL-STD-705/711.2

TEST NO. 77
SHEET 1 OF 1
DATE SEE BELOW
RECORDER [illegible]
PROJ. ENGR. [illegible]
SHIFT LEADER H. Smith
OBSERVER [illegible]

INST. →			
READ NO. ↓	DATE	TIME	
UNITS		HRS	
SYM.			
COL	1 2	3	4 5 6 7 8 9 10 11 12 13 14 15 16 17
	JAN 15, 1971	1100	INTRODUCED FUNGI INTO MOLD CHAMBER
	JAN 30, 1971	1100	PLACED SET IN MOLD CHAMBER - SPRAYED SET WITH SUSPENSIONS OF TEST ORGANISMS - PLACED CONTROL STRIPS NEXT TO SET.
	MAR 1, 1971	1100	REMOVED SET FROM CHAMBER - EXAMINED FOR FUNGI GROWTH - NONE FOUND

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

Figure 711.2-I: Typical test record for fungus resistance test.

X-4667

METHOD 711.3c
RAIN TEST

711.3.1 General. Since most generator sets are expected to be operated outdoors, without shelter of any kind, this test is performed to assure proper operation during a heavy rain storm.

711.3.2 Apparatus. Instrumentation for measuring load conditions and rain shall be as described and illustrated in MIL-HDBK-705. In addition, a test area shall be provided.

711.3.3 Procedure.

711.3.3.1 Preparation for test.

a. Place the generator set in the rain environment location with external connections made to simulate field installation conditions as closely as possible.
b. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
c. The test area shall be at normal ambient temperature (68 to 86 deg. F or 20 to 30 deg. C) at the beginning of the test and no further regulation of temperature is required.

711.3.3.2 Test.

a. A simulated rainfall of 4 +/- 1 inches per hour or as otherwise specified in the procurement document shall be produced by water spray nozzles of such design that the water is emitted in the form of small droplets, rather than a fine mist. The temperature of the water shall be above 40 deg. F (4.44 deg. C). The spray nozzles shall be located so that the water drops impinge on the set at any angle between 15 degrees and 45 degrees from the vertical. The water shall be dispersed as uniformly as possible over the entire area.
b. Subject the set to the water spray for 3 consecutive hours. During the last hour of the test, the set shall be started and operated at rated load, rated voltage, and rated frequency (speed) for the hour.
c. After exposure to the rain, examine the set for evidence of water penetration or damage.

711.3.4 Results. The data sheet shall indicate the length of test, quantity and incident angle of the water, any malfunction, water penetration, and water damage (see figure 711.3-I).

711.3.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. The voltage connection and frequency at which this method is to be performed.
b. Any operational checks to be performed at the conclusion of this test.
c. Rainfall in inches per hour, if other than as specified herein.
d. Angle of rain impingement, if other than as specified herein.

TEST DATA

DESCRIPTION 15KW, 60HZ 120V, SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-15.0-MD

SERIAL NO. 16039

REF: MIL-STD-705/711.3

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

RAIN TEST

TEST NO. 16

SHEET 1 OF 1

DATE 2 SEPT. 1970

RECORDER S. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. See

INST. →		116	218		301		516	711	5077							037	1076
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	RAIN DEPTH							WATER TEMP	AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	Hz	IN							°F	°F
SYM.			X40	X1	X40	X1											
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0800	—	—	—	—	—	—	—	0	START RAIN						64	67
	0900	—	—	—	—	—	—	—	4.1	PLACED SET IN CHAMBER						64	71
	0930	—	—	—	—	—	—	—	6.3							64	70
	1000	—	—	—	—	—	—	—	8.2							65	70
	1030	—	—	—	—	—	—	—	10.1							65	70
	1045	STARTED SET – APPLIED RATED LOAD															
	1100	120.0	3.90	156	.375	15.0	.80	60.0	12.2							65	72
	1130	120.0	3.90	156	.375	15.0	.80	60.0	14.3							65	74
	1145	SHUT DOWN SET															
	1200	—	—	—	—	—	—	—	16.2	STOPPED RAIN - INSPECTED SET						65	74
										VISUAL INSPECTION REVEALED MINOR WATER PENETRATION IN GENERATOR AREA OF SET. NO OTHER WATER WAS OBSERVED INSIDE SET							

NOTES: LINE CURRENT MEASURED USING C.T. No. 1299

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 711.3-I Typical test record for rain test.

X-4668

METHOD 711.4b

SAND AND DUST TEST

711.4.1 General. The generator set must be capable of being exposed to severe wind driven sand and dust without deterioration in performance.

711.4.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition a test chamber shall be required in which temperature and humidity can be carefully controlled. Means must be provided to inject sand and dust into the chamber and to keep them in motion during the test.

711.4.3 Procedure.

711.4.3.1 Preparation for test.

a. The sand and dust used in the test shall be of angular structure and shall have the following characteristics, unless otherwise specified in the procurement document:

1. 100 percent of the sand and dust shall pass through a 100-mesh screen, US Standard Sieve Series.
2. 98 percent, plus or minus 2 percent, of the sand and dust shall pass through a 140-mesh screen, US Standard Sieve Series.
3. 90 percent, plus or minus 2 percent, of the sand and dust shall pass through a 200-mesh screen, US Standard Sieve Series.
4. 75 percent, plus or minus 2 percent, of the sand and dust shall pass through a 325-mesh screen, US Standard Sieve Series.
5. The chemical analysis of the dust shall be as follows:

Substance	Percent by Weight
SiO_2	97 to 99
Fe_2O_3	0 to 2
Al_2O_3	0 to 1
TiO_2	0 to 2
MgO	0 to 1
Ign. Losses	0 to 2

b. In addition to the above, sand and dust having the following characteristics may be required for special tests.

1. 40 percent, plus or minus 3 percent, shall pass through a 50-mesh screen, US Standard Sieve Series, and be retained on a 70-mesh screen.

2. 20 percent, plus or minus 3 percent, shall pass through a 70-mesh screen, US Standard Sieve Series, and be retained on a 100-mesh screen.
3. 15 percent, plus or minus 3 percent, shall pass through a 100-mesh screen, US Standard Sieve Series, and be retained on a 140-mesh screen.
4. 10 percent, plus or minus 3 percent, shall pass through a 140-mesh screen, US Standard Sieve Series, and be retained on a 200-mesh screen.
5. 10 percent, plus or minus 3 percent, shall pass through a 200-mesh Sieve Series, and be retained on a 325-mesh screen.

NOTE: The sand and dust described above shall be of 100 percent high silica beach sand graded by a dry screening with a 20-minute shaking period.

711.4.3.2 Test Procedure No. 1.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Place the generator set in the test chamber and raise and maintain the density of the sand and dust at 0.1 to 0.5 gram per cubic foot within the test space.
c. Maintain the relative humidity within the chamber at 30 percent throughout this method.
d. Maintain the air velocity through the chamber between 100 and 300 feet per minute.
e. Maintain the temperature within the chamber at 77 deg. F (25 deg. C) for a period of 6 hours.
f. After 6 hours, raise the temperature within the chamber to 160 deg. F (71.1 deg. C). Maintain this condition for an additional 6 hour period.
g. Remove the generator set from the chamber and examine the set for penetration of sand and dust. Record all visual evidence of sand and dust penetration and the condition of set in general.
h. Without further maintenance perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

711.4.3.3 Test Procedure No. 2.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Place the generator set in the test chamber and raise and maintain throughout this method the density of the sand and dust at 0.1 to 0.5 gram per cubic foot within the test space.
c. Maintain the relative humidity within the chamber at 30 percent throughout this method.
d. Maintain the temperature within the chamber at 77 deg. F (25 deg. C) for the first two 6-hour periods.
e. Maintain the air velocity within the chamber between 2,200 and 2,400 feet per minute during the first 6 hour period.

f. At the end of the first 6 hour period, reduce the air velocity to between 100 and 300 feet per minute for the second 6 hour period.
g. At the end of the second 6 hour period raise the temperature of the chamber to 160 deg. F (71.1 deg. C) and raise the air velocity to between 2,200 and 2,400 feet per minute for the third 6 hour period.
h. At the end of the third 6 hour period, reduce the air velocity to between 100 and 300 feet per minute, but maintain the 160 deg. F (71.1 deg. C) temperature for the fourth 6 hour period.
i. At the end of the fourth 6 hour period remove the generator set from the chamber and examine the set for penetration of sand and dust. Record all visual evidence of sand and dust penetration and the condition of the set in general.
j. Without further maintenance perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

711.4.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The procedure to be followed.
b. The type of sand and dust to be used.
c. The voltage requirements specified in paragraph 608.1.5a of method 608.1.
d. The frequency requirements specified in paragraph 608.1.5b of method 608.1.
e. The voltage connection and frequency at which this method is to be performed.

METHOD 711.5b
SALT FOG TEST

711.5.1 General. The generator set must be capable of being exposed to severe salt fog and sea spray without deterioration in performance.

711.5.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition the follows shall be required:

1. Exposure chamber.
2. Salt solution reservoir.
3. Means for atomizing salt solution, including suitable nozzles and a compressed air supply.
4. Means for regulating temperature within the exposure chamber.
5. Means for humidifying the air temperature higher than chamber temperature.

711.5.2.1 Chamber. The chamber and all accessories shall be made of materials such as glass, hard rubber, plastics, or (other than plywood) which will not be affected by corrosive action of salt fog and sea spray. In addition, all accessories which will come in contact with the set being tested shall be of materials that will not cause electrolytic corrosion.

The chamber and accessories shall be constructed and arranged so that there is no direct impinging of the spray or dripping of the condensate on the set under test, so that the spray circulates freely about the set to the same degree, and so that no liquid which has come in contact with the set returns to the salt solution reservoir.

The chamber shall be vented to the atmosphere.

711.5.2.2 Atomizers. The atomizers used shall be of such design and construction as to produce a finely divided, wet, dense fog.

711.5.2.3 Air supply. The compressed air entering the atomizer shall be free from all impurities such as oil and dirt. Means shall be provided to humidify and warm the compressed air as required to meet the operating conditions specified in the procurement document.

The air pressure shall be suitable to produce a finely divided dense fog with the atomizers used.

NOTE: To insure against clogging the atomizers by salt deposits, the air should have a relative humidity of at least 85 percent at the point of release to the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing heated water. The temperature of the water should be 95 deg. F (35 deg. C), or higher. The minimum temperature of the water increases with increasing volume of air and with decreasing heat insulation of the chamber and temperature of its surroundings. It should not exceed a value above which an excess of moisture is introduced into the chamber, or a value which rakes it impossible to t the requirements for operating temperature.

711.5.2.4 Salt solution. The chemical content of the salt to be used, and the amount in solution will be as specified in the procurement document.

The solution shall be kept free from solids by filtration or decantation.

The solution shall be maintained at the required specific gravity and pH factor. Only chemical pure (C.P.) hydrochloric acid or C.P. sodium hydroxide shall be used to adjust the pH. Measurement of the pH shall be made electrometrically, using a glass electrode with a saturated potassium chloride bridge, or by a colorimetric method such as bromothymol blue, provided the results are equivalent to those obtained with the electrometric method.

711.5.2.5 Operating conditions.

711.5.2.5.1 Temperature. The temperature in the exposure zone shall be maintained at the specified temperature in the procurement document. Satisfactory methods for accurately controlling the temperature are by housing the set to be tested in a properly controlled, constant temperature chamber (see MIL-HDBK-705, method 114.1), by thoroughly insulating the set under test and preheating the air to the proper temperature prior to atomization or by jacket the set and controlling the temperature of the water or the air used.

Immersion heaters shall not be used to maintain temperatures within the chamber.

711.5.2.5.2 Atomization. The conditions maintained in all parts of the exposure zone shall be such that a suitable receptacle placed at any point in the exposure zone will collect from 0.5 to 3.0 ml of solution per hour for each 80 sq. cm. of horizontal collecting area (10 cm. diameter) based on an average of at least 16 hours. The solution thus collected shall have the minimum specified sodium chloride content.

At least two clean fog collecting receptacles shall be used: one placed nearest to any nozzle, and one farthest from all nozzles. They shall be so fastened that they are not shielded by the set under test and so that no drops of solution fran the set or other sources will be collected.

When using nozzles made of material nonreactive to the salt solution, suitable atomization has been obtained in boxes having a volume of less than 12 cu. ft., with the following conditions:

a. Nozzle pressure of from 12 to 18 psi.
b. Orifices of from 0.020 to 0.030 inch diameter.
c. Atomization of approximately 3 quarts of salt solution per 10 cu. ft. of box volume, per 24 hours.

711.5.3 Procedure.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Mount the generator set in the chamber with all access covers, doors, etc. in their normal operating position.

c. Expose the set to the salt fog for the period of time specified in the procurement document and record all chamber conditions before, after, and at the end of each 24 hour exposure period.
d. After exposure, remove the set from the chamber and remove any salt deposits result from the exposure. Thoroughly examine the set and all its components for evidence of excessive corrosion and salt damage. Record the location(s) of any corrosion or damage found.
e. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term). Record any operating malfunction.

711.5.4 Results. Compare the results obtained with the procurement document requirements.

711.5.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Temperature condition of the salt fog exposure.
b. Relative humidity of the salt fog exposure.
c. Chemical content of the salt used during this method.
d. Amount of salt in solution.
e. Specific gravity of salt solution.
f. pH of salt solution.
g. Number of hours of exposure to salt fog.
h. Degree or amount of permissible corrosive action.
i. The voltage requirements specified in paragraph 608.1.5a of method 608.1.
j. The frequency requirements specified in paragraph 608.1.5b of method 608.1.
k. Voltage connection and frequency at which this method is to be performed.

METHOD 711.6b

IMMERSION TEST

711.6.1 General. The generator set must be capable of proper operation after total immersion.

711.6.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, ambient and liquid temperatures shall be as described and illustrated in MIL-HDBK-705. In addition a container of sufficient size and depth for total immersion of the generator set, and if procedure No. 2 is specified, an altitude chamber in which the container may be placed shall be required.

711.6.3 Procedures.

711.6.3.1 Procedure No. 1.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Protect the generator set for immersion only as specified in the procurement document or technical manual.
c. Completely immerse (to the depth specified in the procurement document) the generator set in a bath of tap water (or other liquid if so specified) for a period of 72 hours. During this period maintain the temperature of the water between 50 deg. F (10 deg. C) and 77 deg. F (25 deg. C) unless otherwise specified in the procurement document.
d. At the end of the 72 hour period remove the generator set from the bath and inspect for leaks and any damage caused by immersion. Estimate and record amount of liquid penetration.

e. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

711.6.3.2 Procedure No. 2.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Protect the generator set for immersion only as specified in the procurement document or technical manual.
c. Completely immerse (to the depth specified in the procurement document) the generator set in a bath of tap water.
d. Place the container in an altitude chamber containing a view plate and reduce the pressure within the chamber to the value specified in the procurement document.
e. Maintain this reduced pressure for the specified period of time.
f. At the end of the specified time period return the pressure within the chamber to atmospheric and remove the generator set from the bath. Inspect the set for leaks and any damage caused by immersion. Estimate and record amount of liquid penetration.
g. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

711.6.4 Results. Compare the results obtained with the procurement document requirements.

711.6.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Amount of protection to be given the set for immersion.
b. Whether procedure 1 or 2, or both, are to be performed.
c. Amount of liquid penetration allowable.
d. The voltage requirements specified in paragraph 608.1.5a of method 608.1.
e. The frequency requirements specified in paragraph 608.1.5b of method 608.1.
f. Voltage connection and frequency at which this method is to be performed.
g. Conditions of immersion:

    1. Procedure 1:

        a. Immersion liquid to be used, if other than as specified herein.
        b. Temperature of immersion liquid, if other than as specified herein.
        c. Duration of immersion, if other than as specified herein.
        d. Depth of immersion.

    2. Procedure 2:

        a. Pressure at which this method is to be performed.
        b. Duration of this method.
        c. Depth of immersion.

METHOD 720.1d

ALTITUDE OPERATION TEST

720.1.1 General. Atmospheric pressure decreases as altitude operation of a generator set is affected by a decrease in atmospheric pressure. It is imperative that the generator set function properly at altitudes above level.

720.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, temperatures of the ambient air and of the set, and pressures shall be as described and illustrated in MIL-HDBK-705. In addition, a pressure chamber capable of maintaining the specified ambient temperature and pressure with the generator set operate at rated load for extended periods of time shall be as described and illustrated in MIL-HDBK-705, method 114.3. A barometer to indicate atmospheric pressure within the test chamber, a psychrometer to measure relative humidity and a manometer to measure difference between chamber pressure and chamber exhaust line pressure shall be required. Recording meter(s) shall be as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 unless otherwise specified in the procurement document.

720.1.3 Procedure.

a. Install appropriate thermocouples to measure the following temperatures (Note: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented; however, some sets may require additional thermal instrumentation):

1. Engine coolant (engine outlet and inlet).
2. Fuel (discharge side of fuel pump and at fuel source).
3. Spark plug(s) (gasoline engines).
4. Exhaust gases (the exhaust manifold(s) of reciprocating engines shall be drilled and tapped as close as possible to the combustion chamber(s). For gas turbine engines, thermocouples shall be located in the tail pipe approximately one turbine wheel diameter from the last turbine stage).
5. Lubricating oil sump and gallery.
6. Oil cooler (inlet and outlet).
7. Hydraulic oil sump.
8. Engine combustion air in (located at the inlet of the intake fold).
9. Cooling air into the radiator (four thermocouples equally spaced the circumference of the area swept by the fan blades).
10. Generator cooling air (inlet and outlet).
11. Generator stator frame (top and bottom, outside).
12. Generator exciter (stator housing for rotating exciters, transformers for the static exciters).
13. Generator voltage regulator (ambient air inside).
14. Control panel cubicle (ambient air inside).
15. Relay and control boxes (ambient air inside).
16. Battery electrolyte (one thermocouple for each battery, inside central battery cell).

17. Average ambient air temperature (MIL-HDBK-705, method 202.1).
18. Air entering generator set.

b. Install appropriate pressure instrumentation to measure the following items:

   1. Pressure in the vicinity of the combustion air intake (inside enclosed sets).
   2. Exhaust gas pressure (located at the point where the engine exhaust gases discharge into the pressure chamber exhaust system).
   3. Intake manifold pressure.

c. Place the instrumented generator set in the pressure chamber and obtain and maintain the ambient temperature within the chamber at the value specified in the procurement document. During all parts of this methods, the average of the eight ambient thermocouples (see MIL-HDBK-705, method 202.1) shall be not less than the specified temperature and of these eight thermocouples, none indicating more than 5 F deg. (2.78 C deg.) above or below the specified ambient.
d. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
e. Connect switch(es) to the generator armature coil(s), for which the temperature rise is to be determined (the armature winding that gave the highest temperature rise during the high temperature test, method 710.1), such that the coil(s) may be isolated for resistance measurements. Unless otherwise specified, connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the recording meter(s) from the commercial utility.)

720.1.3.2 Test.

a. Operate the chamber at the altitude and ambient temperature specified in the procurement document until the temperature readings of all thermal instrumentation have stabilized at or above the specified ambient temperature.
b. With the set stabilized at the required altitude and temperature, turn on the recording meter(s) (chart speed to be 6 inches per hour minimum), start the set within 5 minutes by explicitly following the operating instructions on the set. The altitude during all parts of this test shall be not less than that specified. (The air pressure to be maintained in the test chamber shall be that corresponding to the specified altitude, as given in table IV of the US Standard Atmosphere, see table I.)
c. After the set has started, maintain the specified ambient temperature and altitude and allow the set to stabilize at rated load, rated voltage, and rated frequency. During this period operate the recording meter(s) at a chart speed of not less than 6 inches per hour, and record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to

maintain rated load at rated voltage and rated frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to load, voltage or frequency controls shall be recorded on both the data sheet and the recording chart(s) at the time of adjust. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued or decrease in value after the last adjustment to the load, voltage or frequency has been made (see figure 720.1-I).

d. After stabilization has occurred shut down the generator set so that the temperature of the coil of the armature that gave the highest temperature rise during the high temperature test may be taken. For application of the resistance method to the armature coil (see MIL-HDBK -705 methods 110.1 and 202.1) a quick shutdown of the set is mandatory.

CAUTION: Do not connect bridges or other equipment for measuring resistance or temperature to circuits which mat still be energized, e.g., during the time that the set is coming to a stop.

e. Immediately after the shutdown, start to record the resistance bridge readings of the coil. Readings of resistance measurements shall be recorded in accordance with instructions given in MIL-HDBK-705, method 110.1.
f. Repeat steps c, e and f above but use the load condition that gave the maximum field temperature rise during the high temperature test.
g. Unless otherwise specified, operate the generator set in accordance with the instructions on the set or in the technical manual and perform the following methods at the specified ambient temperature, ambient air pressure, voltage connection and frequency:

1. Method 511. 1, Regulator Range Test.
2. Method 513.2, Indicating Instrument Test (Electrical).
3. Method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term). (In addition to the data, all thermal and pressure instrumentation as specified in 710.1.3.1 shall be read and recorded at the same time for the stabilization portion of this test.)
4. Method 640.1, Maximum Power Test.

Note: The above methods are listed in numerical order; however, they need not be performed in this order.

720.1.4 Results. Results shall be as specified in methods listed in 720.1.3.2 g and in the individual methods specified in 720.1.3.2 d. For the test performed in 720.1.3.2 b the data sheet shall show the length of time required to the set, whether or not the set operated normally and reasons for any difficult starting or uneven running. For the test performed in 720.1.3.2 e the data sheet shall show the temperature rise of each winding as specified in MIL-HDBK-705, method 110.1. Compare these results with the procurement document requirements.

720.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Altitude and temperature at which this method is to be performed.
b. Voltage connection and frequency at which this method is to be performed.
c. Temperature rise all for the windings to be tested.
d. Maximum allowable short-term frequency stability bandwidth in percent of rated frequency.
e. Maximum allowable short-term voltage stability bandwidth in percent of rated voltage.
f. Maximum allowable frequency recovery time.
g. Maximum allowable voltage recovery time.
h. Maximum allowable frequency overshoot and undershoot.
i. Maximum allowable voltage overshoot and undershoot.

j. Maximum allowable frequency regulation (droop).
k. Maximum allowable voltage regulation (droop).
l. Minimum maximum power requirement.
m. Maximum and minimum voltages between which the generator set shall perform.
n. The accuracy of each panel instrument.
o. Methods to be performed in addition to or other than those listed in 720.1.3.2 g.

TABLE I

ATMOSPHERIC TABLE

ALTITUDE IN FEET	ATMOSPHERIC mmHg	PRESSURE in. Hg
0	760.0	29.92
1,500	719.7	28.33
2,000	706.6	27.82
3,000	681.2	26.82
4,000	656.3	25.84
5,000	632.4	24.90
6,000	609.0	23.98
8,000	564.9	22.24
10,000	522.6	20.58

TEST DATA

DESCRIPTION 10KW, 60HZ 120V, SINGLE PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SE-10.0-MD

SERIAL NO. 11077

REF: MIL-STD-705/720.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

ALTITUDE OPERATION TEST
8'000 FT

TEST NO. 93
SHEET 1 OF 2
DATE 24 NOV 1971
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. Lee

INST. →		101	202		303		405	505	108	213			1001			1076	
READ NO. ↓	TIME	TERM VOLTAGE	LINE CURRENT		OUTPUT POWER		POWER FACTOR	FREQ	EXCITER FIELD		BARO PRESS	EXH-CHAMBER PRESS	ENGINE AIR IN	ENGINE AIR OUT	CARB AIR IN	WET BULB	AVG AMB TEMP
UNITS	HRS	VOLTS	AMPS	AMPS	KW	KW	—	HZ	VOLTS	AMPS	IN-Hg	IN H_2O	°F	°F	°F	°F	°F
SYM.			X40	X1	X40	X1											
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:00	STARTED CHAMBER									22.24	0	87	88	87	78	90
	09:00										22.24	0	90	90	90	78	90
	09:00	STARTED SET IN 15 SEC. APPLIED RATED LOAD															
	0910	120.0	2.60	104	.26	10.0	.80	60.0	18.5	1.73	22.24	-3.2	92	98	91	79	90
	0920	120.0	2.60	104	.25	10.0	.80	60.0	18.7	1.73	22.24	-3.2	94	100	92	80	90
	0930	120.0	2.60	104	.25	10.0	.80	60.1	18.9	1.73	22.24	-3.2	95	103	94	80	90
	0940	120.0	2.60	104	.25	10.0	.80	60.0	19.2	1.73	22.24	-3.2	96	104	94	80	90
	0950	120.0	2.60	104	.25	10.0	.80	60.0	19.4	1.73	22.24	-3.2	96	104	94	80	90
	1000	120.0	2.60	104	.25	10.0	.80	60.0	19.5	1.73	22.24	-3.2	96	105	94	80	90
	1010	120.0	2.60	104	.25	10.0	.80	60.0	19.6	1.73	22.24	-3.2	97	105	94	80	90
	1020	120.0	2.60	104	.25	10.0	.80	60.0	19.7	1.73	22.24	-3.2	97	106	94	80	90
	1030	120.0	2.60	104	.25	10.0	.80	60.0	19.8	1.73	22.24	-3.2	97	107	94	80	90
	1040	120.0	2.60	104	.25	10.0	.80	60.0	19.8	1.73	22.24	-3.2	97	107	94	80	90
	1050	120.0	2.60	104	.25	10.0	.80	60.0	19.8	1.73	22.24	-3.2	97	107	94	80	90
	11.00	120.0	2.60	104	.25	10.0	.80	60.0	19.8	1.73	22.24	-3.2	97	107	94	80	90
	1105	SHUT DOWN FOR RESISTANCE READING							T_0	T_1							
	1110	RESTARTED SET - APPLIED RATED LOAD															
	1120	120.0	2.60	104	.25	10.0	.80	60.0	19.6	1.73	22.24	-3.1	97	107	94	80	90
	1130	120.0	2.60	104	.25	10.0	.80	60.0	19.8	1.73	22.24	-3.1	97	107	94	80	90

NOTES:
LINE CURRENT MEASURED USING C.T. No 1305
EXCITER FIELD CURRENT MEASURED USING 2A, 50mV SHUNT # 007
RECORDING VOLTAGE AND FREQ METER No 1701 CHART SPEED 12 IN/HR

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 720.1-I: Portion of a typical test record for altitude operation test.

X-4669

Operation Test.]

METHOD 731.1c

STORAGE TEST
(EXTREME COLD, -80 DEG. F)

731.1.1 General. The generator set must be capable of storage without damage in extreme low temperature environments.

731.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient and set temperatures shall be as described and illustrated in MIL-HDBK-705.

A controlled temperature room shall be used having sufficient capacity to maintain the specified extreme low temperature for the duration of this method. This controlled temperature room shall be as described and illustrated in MIL-HDBK-705, method 114.2.

731.1.3 Procedure.

731.1.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures (Note: Not all sets will require instrumentation of all the listed items. This list contains items normally instrumented; however, some sets may require additional thermal instrumentation). The thermal instrumentation shall be installed in accordance with the instructions in MIL-HDBK-705, method 202.1.

   1. Ambient air temperature.
   2. Engine coolant (engine outlet and inlet).
   3. Spark plug(s).
   4. Lubricating oil (sump and gallery).
   5. Engine combustion air in (located at the inlet of the intake manifold).
   6. Storage battery electrolyte (thermocouples) shall be so located that the electrolyte temperature at the center of the electrolyte is measured.
   7. Heater coolant (air or liquid-into and out of the heater).
   8. Heater exhaust.
   9. Battery box air (at each end of battery box).
   10. Engine exhaust gas.
   11. Generator stator frame (top and bottom, outside).
   12. Generator cooling air (inlet and outlet).
   13. Control panel cubicle (ambient air, inside).
   14. Air entering generator set.

b. Start and operate the generator set until the lubricating oil is warm enough to drain. Drain the coolant fran the engine block, the radiator, coolant pump, heater, and all coolant lines. Be sure that the set is completely drained. Fill the coolant system with the proper grade of antifreeze. Fill and label a small transparent container (approximately 8 ounces) with a sample of the antifreeze used.

c. Drain the fuel fran all fuel tanks, lines, strainers, pumps and filters. Flush tanks with low temperature fuel using approximately 10 percent of tank capacity. Clean all fuel strainers and replace filter elements. Install new gaskets on strainers and filter elements. Fill fuel tanks to approximately 10 percent rated capacity with fuels of the proper grade. Fill and label a small container (approximately 8 ounces) with a sample of each fuel used.
d. Drain the lubricating oil from the engine, filters strainers and lines. Install new filters and clean the strainers. Use new gaskets. Fill with proper grade lubricating oil. Fill a small container with a sample (approximately 8 ounces) of the oil used.
e. Operate the winterization and ether systems, as applicable. See that all controls work property. It may be necessary to temporarily bypass some controls if the ambient temperature is too high. Do not operate the heater for longer than necessary to perform the checkout.
f. Operate any fuel priming pumps on the set with the discharge lines open to clear lines of no ambient fuel.
g. On all units, as applicable, check the spark plugs, magneto, distributor, valve clearances, injector timing, etc. Check instruction manual or operating and servicing instructions to see that all set requirements or recommendations have been performed.
h. Start and operate the generator set for approximately 15 minutes at no load to allow the arctic fuels and lubricants to thoroughly circulate: During this period open oil lines at gages and safety controls to drain normal temperature oil. Shut down the set and drain all set fuel tanks as well as the oil from the air cleaners. Fill set fuel tanks,, except for sets with gasoline engines. Fill and label a small container with a sample (approximately 8 ounces) of fuel used.
i. If a storage battery is part of the set fill it with electrolyte having the specific gravity recommended for arctic operation. Determine that the batteries have been cycled and completely charged (see MIL-HDBK-705, method 222.1) before placing them in the cold room.
j. Place containers of fuel, lubricants), and coolant in the cold room.
k. Place the generator set in the cold room. If the set is equipped with a three-way valve for an auxiliary fuel supply, connect the fuel supply to the engine thru the three-way valve using the auxiliary fuel hoses (length and size of hoses are specified in the procurement document) supplied with the generator set. This auxiliary fuel supply shall be in the cold room. Set the fuel supply valve in the auxiliary fuel position.
l. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for the voltage connection and frequency specified in the procurement document.
m. Where temperature measurements are made by means of thermocouples, the thermocouple leads shall be brought cut of the cold room to permit the temperature to be read by instrument located in normal ambient temperatures. All electrical instruments, except those provided as part of the generator set, shall be located outside the cold room with the exception of shunts used in determining field current.

731.1.3.2 Test.

a. For sets with gasoline engines, start the cold room and when the ambient temperature has reached approximately 0 deg. F (-17.7 deg. C) open the auxiliary fuel container and connect it to the generator set through the auxiliary fuel connection. (Note: The parameters of arctic fuel at temperatures above 0 deg. F (-17.7 deg. C) necessitates storing the fuel in sealed containers.) Fill and label a small container with a sample of the fuel used. Place this sample alongside samples of fuel, lubrication oil, and coolant taken previously, in preparation for test, in a location in the cold chamber where they may be observed.

b. For sets with gasoline engines, start and operate the set for approximately 15 minutes at no load to allow the arctic fuel to thoroughly circulate. Then shut down the set (see figure 731.1-I).

c. Expose the generator set to an ambient temperature of -40 deg. F (-40 deg. C) or as specified in the procurement document until the temperature of all components of the set stabilize at this value. During all parts of this method, none of the eight ambient temperature thermocouples shall read warmer than the specified extreme-cold temperature.

d. Expose the generator set to an ambient temperature of -80 deg. F (-62.2 deg. C) the until the temperature of all components of the set stabilize at this value. Maintain the ambient temperature at -80 deg. F (-62.2 deg. C) for 24 hours after the stabilization is attained. During this period, inspect the set for evidence of distortion or cracking of the components, and leaks in fuel, lubrication, and cooling system.

e. Raise the ambient temperature to -40 deg. F (-40 deg. C) and maintain this temperature until the temperature of all components of the set stabilize at this value.

f. Raise the ambient temperature to normal ambient temperature and maintain this temperature until the temperature of all components of the set stabilize at this value.

g. Drain the arctic fuel, lubricating oil, and coolant from the set. Do not remove fuel strainers, filters, gaskets, etc. Refill the set with normal ambient fuel, lubricating oil, and coolant.

h. Start and operate the generator set at idle speed (reduced speed if no idle speed is attainable), inspect the set for leaks, faulty operation, etc. After the unit has been warmed up, increase the speed to rated. Inspect the set again and then apply rated load and perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

NOTE: This method may be combined with method 701.1, Starting and Operating Test (Extreme Cold) in which case, steps e, f, g, and h of this method should be deleted and after stabilization at -80 deg. F (62.2 deg. C) the ambient temperature should be raised to -65 deg. F (-53.8 deg. C) and the set stabilized at this value before proceeding with method 701.1.

731.1.4 Results. Compare the results with the procurement document requirements.

731.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage requirements specified in paragraph 608.1.5a of method 608.1.
b. The frequency requirements specified in 608.1.5b of method 608.1.
c. The voltage connection and frequency at which this method is to be performed.
d. Extreme cold temperature, if other than as specified herein.
e. Types of fuel, lubricant, and coolant to be used.

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

DESCRIPTION 10KW, 60HZ 120V, SINGLE PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 14-761

REF: MIL-STD-705/731.1

STORAGE TEST

(EXTREME COLD, -80°F)

TEST NO. 76

SHEET 1 OF 2

DATE MARCH 1, 1971

RECORDER J. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Doe

INST. →		1076															
READ NO. ↓	TIME	ENGINE AIR		SPARK PLUGS				ENGINE	LUBE OIL		CARB AIR	GEN AIR		GEN FRAME		EXCITER	AVG AMB
		IN	OUT	CYL 1	CYL 2	CYL 3	CYL 4	EXHAUST	SUMP	GALLERY	IN	IN	OUT	TOP	BOTTOM	FRAME	TEMP
UNITS	HRS	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:10	CHAMBER		REACHED		0°F											0
	0915	STARTED		SET													-2
	0930	SHUT DOWN SET															-3
	1115																-40
	1930	-40	-40	-42	-42	-41	-42	-40	-42	-42	-40	-40	-40	-41	-41	-42	-40
3/2	0015																-80
	1610	-81	-81	-80	-80	-80	-80	-81	-80	-80	-81	-81	-80	-80	-80	-80	-82
3/3	1500	INSPECTED		SET	NO VISABLE		DAMAGE										-80
	1610	-81	-80	-81	-81	-81	-81	-80	-81	-81	-81	-81	-80	-81	-81	-81	-80
	1800																-40
3/4	0600	-42	-41	-43	-42	-42	-43	-41	-42	-41	-41	-40	-40	-42	-42	-41	-40
	1100	CHANGED		FUEL + OIL		TO NORMAL AMBIENT											+75
	1130	STARTED		SET	- NO	LEAKS OR		DIFFICULT		RUNNING NOTED							76
	1140	BEGIN STABILIZATION				FOR 619.1											
	1320	COMPLETED 619.1															

NOTES:

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 731.1-I Portion of a typical test record for storage test (extreme cold, -80 °F.).

X-4670

Test.]

METHOD 732.1c

STORAGE TEST
(EXTREME HOT, +160 DEG. F)

732.1.1 General. The generator set be capable of storage without damage in extreme high temperature environments.

732.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, set and ambient temperatures shall be as described and illustrated in MIL-HDBK-705.

732.1.3 Procedure.

732.1.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures. (Note: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented; however, some sets may require additional thermal instrumentation.) The thermal instrumentation shall be installed in accordance with the instructions in MIL-HDBK-705, method 202.1.

1. Engine coolant (engine outlet and inlet).
2. Fuel (discharge side of fuel pump and at fuel source).
3. Spark plug(s) (gasoline engines).
4. Exhaust gases (the exhaust manifolds) of reciprocating engines shall be drilled and tapped as close as possible to the combustion chamber(s). For gas turbine engines, thermocouples shall be located in the tailpipe approximately one turbine wheel diameter downstream from the last turbine stage).
5. Lubricating oil (sump and gallery).
6. Oil cooler (inlet and outlet).
7. Hydraulic oil (sump).
8. Engine combustion air in (located at the inlet of the intake manifold).
9. Cooling air into the radiator (four thermocouples equally spaced around the circumference of the area swept by the fan blades).
10. Generator cooling air (inlet and outlet).
11. Generator stator frame (top and bottom, outside).
12. Generator exciter (stator housing for rotating exciters, transformers for static exciters).
13. Generator voltage regulator (ambient air inside).
14. Control panel cubicle (ambient air inside).
15. Relay and control boxes (ambient air inside).
16. Battery electrolyte (one thermocouple for each battery, inside a central battery cell).
17. Average ambient air temperature (MIL-HDBK-705, method 202.1).
18. Air entering generator set for housed sets.

b. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10.

732.1.3.2 Test.

a. Perform method 608. 1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Place the instrumented set in a test chamber and expose the set to an and ambient temperature of 90 deg. F (32.2 deg. C) until the temperatures of all components of the set stabilize at this value. During all parts of this methods, none of the eight ambient temperature thermocouples shall read less than the specified temperature.
c. During a five hour interval, gradually raise the ambient temperature to 160 deg. F (71.1 deg. C) or as specified in the procurement document. Maintain this ambient temperature until the temperature of all components of the set stabilize at this value.
d. During a five hour interval, gradually reduce the ambient temperature to 90 deg. F (32.2 deg. C). Maintain this temperature until the temperature of all components of the set stabilize at this value.
e. Lower the ambient temperature and maintain this temperature until the temperature of all components of the set stabilizes at this value. Inspect the set for any evidence of deterioration due to high temperature.
f. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term), at normal ambient temperature.

NOTE: This test may be combined with method 710.1, High Temperature Test, in which case step d above should be deleted and the temperature gradually reduced to 125 deg. F (51.5 deg. C) in a 2-1/2 hour interval and maintained until stabilization of the temperature of all components of the set occurs. Perform steps e and f above before proceeding with method 710.1.

732.1.4 Results. Compare the results with the procurement document requirements.

732.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. The voltage requirements specified in paragraph 608.1.5a of method 608.1.
b. The frequency requirements specified in paragraph 608.1.5b of method 608.1.
c. The voltage connection and frequency at which this method is to be performed.
d. Extreme high temperature, if other than as specified herein.

TEST DATA

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

STORAGE TEST

(EXTREME HOT, +160°F)

DESCRIPTION 10KW, 60HZ 120V SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 13711

REF: MIL-STD-705/732.1

TEST NO. 89

SHEET 1 OF 2

DATE MARCH 1, 1971

RECORDER L. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		1076															
READ NO. ↓	TIME	ENGINE AIR		SPARK PLUGS				ENGINE	LUBE OIL		CARB AIR	GEN AIR		GEN FRAME		EXCITER	AVG AMB
		IN	OUT	CYL 1	CYL 2	CYL 3	CYL 4	EXHAUST	SUMP	GALLERY	IN	IN	OUT	TOP	BOTTOM	FRAME	TEMP
UNITS	HRS	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	15:30	PERFORMED METHOD 619.1															
	1600	PLACED SET IN CHAMBER															90
3/2	0800	90	90	91	90	90	91	90	91	91	91	90	90	91	91	91	90
	0800	BEGIN INCREASING AMBIENT TEMPERATURE															
	1300																160
3/3	0800	161	161	160	161	160	160	161	161	161	161	160	160	160	160	160	161
	0800	BEGIN DECREASING AMBIENT TEMPERATURE															
	1300																90
3/4	0800	91	90	90	91	91	90	91	90	91	91	90	91	90	90	90·	90
	0815	VISUAL INSPECTION REVEALED NO DAMAGE DUE TO HIGH TEMPERATURE STORAGE															
	1000	PERFORMED METHOD 619.1															

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

Figure 732.1-I Portion of a typical test record for storage test (extreme hot, +160 °F.).

X-4671

Test.]

METHOD 740.1c

VIBRATION TEST

740.1.1 General. The generator set must be capable of withstanding externally vibrations.

740.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, a synchronous drive package testing machine having a total excursion of 1 inch, a capacity of 1,000 pounds, and table measuring 5 feet by 5 feet, L.A.B. Corporation or Gaynes Engineering Co., or equal shall be required.

740.1.3 Procedure.

a. Perform Method 614.1, Voltage and Frequency Regulation Test.
b. Place the generator set on the vibration table with the set resting on its base. The set shall be unrestricted in movement on the table (fences or barriers shall be the only means used to prevent lateral movement of the set off the table). Initially, there shall be at least 1 inch clearance between the set and the fence or barrier.
c. Vibrate the generator set for the time specified in the procurement document at such a frequency that the set leaves the table momentarily at some interval during each vibration cycle of the test table. Test for proper vibration frequency by inserting a piece of cardboard, approximately 1/16 thick, between edge of the set and the platform of the machine.
d. After vibration, inspect the generator set for visual damage and record any damage on the data sheet.
e. Perform Method 614.1, Voltage and Frequency Regulation Test.

740.1.4 Results. Compare the condition of the generator set after vibration with the procurement document requirements.

740.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Duration of the vibration portion of this method.
b. Voltage connection and frequency at which the pre- and post-vibration operation methods are to be performed.
c. Allowable voltage regulation.
d. Allowable frequency regulation.
e. Definition of vibration damage.

TEST DATA

DESCRIPTION 10KW, 60Hz 120V SINGLE PHASE GENERATOR SET
MFGR. ENGENSETS, INC.
MODEL NO. SF-10.0-MD
SERIAL NO. 21067
REF: MIL-STD-705/740.1

PHILADELPHIA REGION
DEFENSE CONTRACT ADMINISTRATION SERVICE

VIBRATION TEST

TEST NO. 18
SHEET 1 OF 1
DATE FEBRUARY 12, 1971
RECORDER L. Wright
PROJ. ENGR. J. Jones
SHIFT LEADER H. Smith
OBSERVER L. Doe

INST. →																	
READ NO. ↓	TIME																
UNITS	HRS																
SYM.																	
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	09:15	STARTED VIBRATION - 1/16" THICK CARDBOARD JUST SLIPS UNDER SET															
	09:45	STOPPED VIBRATION															
			VISUAL INSPECTION REVEALED THE FOLLOWING:														
				VOLTAGE REGULATOR MOUNTING HARDWARE LOOSE													
				FUEL FILTER BOWL BROKEN													
				FUEL LINE LOOSE AT THREE CONNECTIONS (CARB, BOTH SIDES OF BOWL)													

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: ALL ITEMS TIGHTENED OR REPLACED PRIOR TO PERFORMING METHOD 614.1

Figure 740.1-I. Portion of a Typical Test Record for Vibration Test.

Test.]

METHOD 740.2c

DROP TEST (FREE FALL)

740.2.1 General. The generator set must be capable of withstanding drops fran reasonable heights to assure damage free transportability.

740.2.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition a divided table top drop tester or a hoist with a suitable sling trapping device and a flat, firm base on which to drop the set shall be than 6 inches thick and set.

740.2.3 Procedure.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. The equipment fuel tank shall be half full of fuel. Used batteries filled with water may be installed to prevent acid damage should the battery hold-down bracket fail. All liquids (except fuel) shall be at normal operating levels. Drop the set by a free fall, in that no ropes or other suspending media are supporting the set during the fall, the distance specified in the procurement document. For a corner drop the angle between the set base and the impact surface shall be 30 degrees.
c. Visually inspect the set for damage.
d. Perform method 608. 1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

740.2.4 Results.

740.2.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. The height of the drops the set must undergo.
b. The number of drops.
c. Whether the drops are to be flat, corner or both.
d. Angle of corner drop, if other than as specified herein.
e. The voltage requirements specified in paragraph 608.1.5a of method 608.1.
f. The frequency requirements specified in paragraph 608.1.5b of method 608.1.
g. The voltage connection and frequency at which this method shall be performed.

TEST DATA

DESCRIPTION 10KW, 60HZ 120V, SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

[illegible]IAL NO. 21067

REF: MIL-STD-705/740.2

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

DROP TEST (FREE FALL)

TEST NO. 19

SHEET 1 OF 1

DATE 9 SEPT. 1970

RECORDER L. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		
READ NO. ↓	TIME	
UNITS	HRS	
SYM.		
COL.	1	2–17
	09:00	PERFORMED METHOD 614.1
	09:20	DROPPED SET FROM 12" HEIGHT
	09:30	DROPPED SET ON EACH OF FOUR CORNERS FROM 12"
	09:35	VISUAL INSPECTION REVEALED NO DAMAGE TO SET
	11:00	PERFORMED METHOD 614.1

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

Figure 740.2-1 Portion of a typical test record for drop test (free fall).

X-4673

METHOD 740.3c

DROP TEST (ENDS)

740.3.1 General. The generator set must be capable of withstanding end drops which may be encountered in normal transportation.

740.3.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperatures shall be as described and illustrated in MIL-HDBK-705. In addition, a piece of 2 X 4 inch (+/- 1/2 inch) timber and a reinforced slab of concrete not less than 6 inches thick and not less than 4 feet beyond all sides of the set shall be required.

740.3.3 Procedure.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. The equipment fuel tank shall be half full of fuel. Used batteries filled with water may be installed to prevent acid damage should the battery hold-down bracket fail. All liquids (except fuel) shall be at normal operating level. Support the set at one end by the 2 inch placed at right angles to the skids and within 6 inches of the end of the skid frame.
c. Raise the opposite end of the set to the height specified in the procurement document and release to fall freely onto the concrete slab.
d. Repeat step c above 5 additional times.
e. Repeat steps c and d above with the opposite end of the set on the timber.
f. Visually inspect the set for damage.
g. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

740.3.4 Results. Compare the results with the procurement document requirements.

740.3.5 Procurement document requirements. The following item must be specified in the individual procurement document:

a. The height of the drop.
b. The voltage requirements specified in paragraph 608.1.5a of method 608.1.
c. The frequency requirements specified in paragraph 608.1.5b of method 608.1.
d. The voltage connection and frequency at which this method is to be performed.

METHOD 740.4c

LIFTING AND TOWING TEST

740.4.1 General . The generator set be capable of withstanding normal stresses of lifting during transportation and must also be capable of being towed for short distances.

740.4.2 Apparatus. The following equipment shall be required.

a. Spring scale or electrical load cell with capacity for 8 times the set dry weight.
b. A crane or other device with sufficient capacity to lift 8 times the set dry weight.
c. A winch or other device with sufficient capacity to develop a force equal to 5 times the set dry weight.
d. A level (bubble type), with minimum length of 2 feet and a one-foot ruler.
e. Tiedown bolts and assorted hardware necessary to perform this method.

740.4.3 Procedure.

a. Pick up the dry generator set using the set lifting eye(s) and having the spring balance (load cell) connected so that the set dry weight can be determined.
b. With the set being lifted with the lifting eye and clearing the determine the angle that the set deviates from level.
c. Record the weight of the set as read on the scale, then place the set down on a secure base.
d. Bolt the set down to a base that will not move under a force of 8 times the set weight using the holes in the skid base.
e. Using the same scale and lifting arrangement as in step a, apply a vertical force of 8 times the weight read on the scale in step c.
f. Using the towing eye on one end of the set, secure the set to an object that will not move under a force of 5 times the set weight. Attach the winch and scale to the towing eye at the other end of the set and apply a horizontal force equal to 5 times the set weight.

740.4.4 Results. Examine the set and record any deformation or damage. Compare the condition of the generator set following this method with the procurement document requirements.

740.4.5 Procurement document requirements. The following items must be specified in the individual procurement document.

a. Maximum allowable dry weight of the set.
b. Maximum allowable angle from level.
c. Lifting force, if other than as specified herein.
d. Towing force, if other than as specified herein.
e. Definition of lifting and towing damage.

TEST DATA

DESCRIPTION 10KW 60HZ 120/208 V 3-PHASE GENERATOR SET	PHILADELPHIA REGION
MFGR. ENGENSETS, INC.	DEFENSE CONTRACT ADMINISTRATION SERVICE
MODEL NO. SF-10.0-MD	LIFTING AND TOWING TEST
SERIAL NO. 26017	
REF: MIL-STD-705/740.4	
TEST NO. 43	SHEET 1 OF 1
DATE JAN 19, 1971	RECORDER J. Wright
PROJ. ENGR. J. Jones	SHIFT LEADER J. Smith
OBSERVER J. Lee	

INST. →		
READ NO. ↓	TIME	
UNITS	HRS	
SYM.		
COL.	1	2–17
	14:12	LIFTED SET BY LIFTING EYE CLEAR OF GROUND - WEIGHT = 814 LBS 13" FROM LEVEL
	15:00	BOLTED SET DOWN USING HOLES IN SET BASE - APPLIED A LIFTING FORCE OF 6,512 LBS TO LIFTING EYE - NO VISABLE DAMAGE OR DEFORMATION.
	1545	WITH THE TOWING EYE ON THE ENGINE END OF THE SET FIXED TO THE TEST RIG A TOWING (HORIZONTAL) FORCE OF 4070 LBS WAS APPLIED TO THE OTHER TOWING EYE - NO VISABLE DAMAGE OR DEFORMATION.

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES:

Figure 740.4-I: Typical test record for listing and towing test.

X-4674

METHOD 740.5c
RAILROAD IMPACT TEST

740.5.1 General. The generator set must be capable of withstanding the vibration and shock encountered in all forms of transportation and movement. The mechanical integrity of the set is tested by means of the shock loading encountered during the railroad at test. The test also evaluates the method of tie-down on the rail car.

740.5.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. Recording meter(s) for recording voltage and frequency shall be required. The recording meters shall be as described and illustrated in MIL-HDBK-705, methods 101.1 and 104.1 unless otherwise specified in the procurement document. In addition, two railroad cars with a total standing weight of riot less than 250,000 pounds, divided approximately equally between the two cars, and one standard flat railroad car (test car) all with standard draft gear couplings and conventional underframes, a means of moving the test car, an electrical or electronic device to determine the test car speed at impact, and shock measuring equipment as applicable, shall be required.

740.5.3 Procedure.

740.5.3.1 Preparation for test.

a. The equipment shall be mounted on the impact end of the test car in accordance with the standard loading and bracing method as shown in section 6 of the Association of American Railroads (AAR) "Rules Governing the Loading of Department of Defense Material on Open Top Cars" unless otherwise specified. No exotic or unusual tiedown methods shall be used. The longitudinal axis of the equipment shall be mounted parallel to the length of the test car.
b. Unless otherwise specified, the equipment fuel tank shall be half full of fuel. Used batteries filled with water may be installed to prevent acid damage should the battery hold-down bracket fail. All liquids (except fuel) shall be at normal operating level.
c. An load in the stationary (buffer) cars shall be secured to prevent sliding or shifting; any movement greater than two inches resulting from the test shall be justification for retest.

740.5.3.2 Procedure I Test.

a. Within four hours of the test and at the test site, perform Method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. The couplers between the stationary cars shall be compressed to remove the slack and all of the air and hand brakes shall be set.
c. Locate the test car between the stationary cars and the locomotive. A minimum of 200 feet of reasonably level track between the test car and stationary cars is required to achieve the required locomotive speeds unless an inclined ramp and tug is used. A practice test run without impacting this test car may have to be conducted to assure the required speed of impact can be achieved.

d. Position the draft gear knuckles of the stationary and test cars for coupling.
e. Install the timing device to measure the test car speed (+/- 0.05 MPH) within six feet of impact with the stationary cars.
f. Push the test car towards the stationary cars and release the test car when the desired test speed of 4 MPH (plus 0.5, minus 0.0 MPH) is reached (observed by using the locomotives speedometer or by other means), thus allowing the test car to freely impact the stationary cars. If an inclined ramp and tug is used, move the test car to the incline position for the desired speed and release the test car allowing it to freely impact the stationary cars.
g. Record the speed of impact.
h. Visually inspect the equipment for liquid leaks, deformation, loosening, breakage or change of fit of any component or part including the method of tiedown, tiedown anchors and fittings, and observations of blocking and lading. Record results of inspection and observations.

NOTE: If adjustment of the lading, reconditioning of the bracing or items of securement is required during the impact tests, testing will stop. A complete,, new impact test shall then be required.

i. Repeat 740.5.3.2b thru h at a speed of 6 MPH (plus 0.5, minus 0.0 MPH).
j. Repeat 740.5.3.2b thru h at a speed of 8 MPH (plus 0.5, minus 0.0 MPH).
k. Repeat 740.5.3.2b thru h at any other speeds specified in the procurement document.
l. Reverse the test car and repeat 740.5.3.2b thru h at 8 MPH (plus 0.5, minus 0.0 MPH) unless a higher speed is specified in the procurement document (see 740.5.3.2k). No adjustment of the lading, reconditioning of the bracing or items of securement shall be made.
m. Within four hours after completion of the four impacts and final inspection, perform Method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) at the test site.

740.5.3.3 Procedure II Test.

a. When specified, conduct test in accordance with 740.5.3.2a thru k of Procedure I test.
b. Photograph the method of tiedown, support and blocking of the equipment (both sides).
c. Remove the tiedowns, items of securement and support but not the blocking or bracing used to prevent forward movement of the equipment.
d. Reverse the test equipment on the flat car and secure the equipment in accordance with the method used in 740.5.3.1a utilizing the same support and new tiedowns.
e. Photograph the method of tiedown and blocking of the equipment (both sides).
f. Compare the photographs taken in 740.5.3.3e with those taken in 740.5.3.3b. The method of tiedown, items of securement and support must be identical in both photographs. If not, the method of securement must be repeated until it is identical to that photographed in 740.5.3.3b.

g. Repeat 740.5.3.2b thru h at 8 MPH (plus 0.5, minus 0.0 MPH) unless a higher speed is specified in the procurement document (see 740.5.3.2k).
h. Repeat 740.5.3.2m.

740.5.4 Results.

a. Compare the results of the test with the requirements of the procurement document.

b. Compare the results the tests specified in 740.5.3.2a and 740.5.3.2m with the requirements of the procurement document.

740.5.5 Procurement document requirement. The following items must be specified in the individual procurement document:

a. The quantity of equipment to be tested.
b. The equipment orientation and method of tiedown if other than that specified by the Association of American Railroads.
c. The location and orientation of shock recording or strain sensing devices if required.
d. Speeds other than as specified herein.
e. The failure definition for damage.
f. Frequency

    (1) Maximum allowable short-term stability bandwidth or deviation in percent of rated frequency.
    (2) Maximum allowable recovery time.
    (3) Maximum allowable overshoot and undershoot.
    (4) Frequency(ies) at which this method is to be performed.
    (5) Maximum allowable regulation.

g. Voltage

    (1) Maximum allowable short-term stability bandwidth or deviation in percent of rated voltage.
    (2) Maximum allowable recovery time.
    (3) Maximum allowable overshoot and undershoot, if applicable.
    (4) Voltage connection(s) at which this method is to be performed.
    (5) Maximum allowable regulation.

h. Procedure II Test if other than Procedure I Test.
i. Volume of fuel in fuel tank if other than as specified herein.

TEST DATA

DESCRIPTION 30 KW, 60 Hz 120/208 V OR 120 V 3-PHASE, GEN SET

MFGR. ENGENSETS, INC

MODEL NO. SE-10.0-MD

SERIAL NO. 21067

REF: MIL-STD-705/740.5

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

RAILROAD IMPACT TEST

TEST NO. 62

SHEET 1 OF 4

DATE 24 AUGUST, 1970

RECORDER [illegible]

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER [illegible]

INST. → PHASE INDICATOR #1376

READ NO. ↓	TIME	
UNITS		
SYM.		
COL.	1	2–17
	0930	Completed Pre-608.1 test. See sheet 2-4 for data.
	1000	Inspection after 4 MPH impact: (1) Right rear shock mount broke.
		(2) Left front door would not open.
		(3) Distorted sheet metal on control panel.

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: Procedure I, Fuel Tank Half Full

SMEFB Form 28
16 Sep 69

FIGURE 740.5-I TYPICAL TEST RECORD FOR RAILROAD IMPACT TEST

-16,606—Ft Belvoir

METHOD 740.7a

FORKLIFT HANDLING TEST

740.7.1 General. Generator sets must have the ability to withstand handling by mechanical equipment such as forklifts.

740.7.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, a hard rubber tired forklift truck of sufficient capacity for the weight of the set and six nominal 1 by 4-inch boards longer than the width of the forklift truck shall be required.

740.7.3 Procedure.

a. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).
b. Adjust the forks to the spacing appropriate for the generator set under test.
c. The generator set shall be lifted clear of the ground by the forklift truck at one side of the set and transported on the forks in the level or backtilt position across a hard pavement for a distance not less than 100 feet. Parallel pairs of 1-inch boards spaced 54 inches apart shall be laid flatwise on the pavement across the path of the forklift truck. The first pair shall be placed squarely across the truck’s path and centered 30 feet from the starting point; the second pair shall be laid 60 feet from the starting point at an angle of 60 deg. to the truck’s path so the left wheel strikes first; and the third pair shall be laid 90 feet from the starting point at about 75 deg. to the truck’s path so the right wheel strikes first. If the generator set is more than 36 inches wide and is stable on 36-inch long forks, the forks shall extend only 36 inches under the set. The forklift truck carrying the set shall travel the 100 feet in about 23 seconds at a uniform speed (normal walking speed, approximately 3 mph), and then shall be brought to a stop.
d. The generator set shall be observed during the traverse and while the forklift truck is at a stop for any damage, evidence of inadequacy, or deflection of the set that might cause damage. Record results of observations on the data sheet.
e. The forklift truck shall be moved from the side to the end of the generator set. The forks shall be run under the set as far as possible and then operated to lift the end 6 inches. Observe the set, particularly in the vicinity of the end of the forks, and record observations. If the set can thus be lifted clear of the floor, transport it on the forks aver the same 100 foot course, and record observations. If it cannot be thus lifted, report the length of the forks used.
f. Repeat step e above from the opposite end of the set.
g. Perform method 608.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

740.7.4 Results. Compare the results with the procurement document requirements.

740.7.5 Procurement document requirements. The following item must be specified in the individual procurement document:

a. The direction(s) from which a forklift shall be capable of being used to transport the set.
b. The voltage requirements specified in paragraph 608-1.5a of method 608.1.
c. The frequency requirements specified in paragraph 608-1.5b of method 608.1.
d. The voltage connection and frequency at which this method is to be performed.

METHOD 750.1C

FUEL LIFT TEST

750.1.1 General. The fuel pump must be capable of lifting fuel to the generator set.

750.1.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition an auxiliary fuel tank and a fuel line as specified in the procurement document shall be required.

750.1.3 Procedure.

750.1.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Connect the fuel line between the set and an auxiliary fuel supply located the lift distance below the fuel pump as specified in the procurement document.

750.1.3.2 Test.

a. Start and operate the set at rated voltage, rated frequency and rated load for 30 minutes from the set fuel tank. During all portions of method read and record all instrumentation at maximum intervals of 15 minutes (see figure 750.1-I). For sets without integral fuel tanks start and operate from auxiliary tank and omit paragraph b below.
b. At the end of 30 minutes of operation on the set fuel tank, with the set operating, transfer the fuel supply to the auxiliary fuel tank.
c. Continue to operate the set at rated voltage, rated frequency and rated load for one hour from the auxiliary fuel tank. During this portion of the method drop and apply rated load six times.

750.1.4 Results. Compare the operation of the set with the procurement document requirements.

750.1.5 Procurement document requirements. The following item must be specified in the individual procurement document:

a. Lift distance of the auxiliary fuel tank in relation to the set fuel pump.
b. The voltage connection(s) and frequency(ies) at which this method is to be performed.
c. Type of fuel to be used.
d. Length and size of fuel line.

TEST DATA

DESCRIPTION 10 KW 60 HZ 120 VOLT SINGLE-PHASE GENERATOR SET

MFGR. ENGENSETS, INC

MODEL NO. SF-10.0-MD

SERIAL NO. 10777

REF: MIL-STD-705/750.1b

U. S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA

FUEL LIFT TEST

TEST NO. 17

SHEET 1 OF 1

DATE APRIL 23, 1971

RECORDER L. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER K. Smith

OBSERVER L. Lee

INST. →		107		212		316		287		017							1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY							AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ						°F
SYM.				X40	X1	X40	X1										
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:10	STARTED SET - OPERATING FROM SET TANK APPLIED RATED LOAD															73
	08:25		120.0	2.60	104	.250	10.0		.80		60.0						74
	08:40		120.0	2.60	104	.250	10.0		.80		60.0						74
	08:40	SWITCHED TO AUXILARY FUEL TANK LOCATED 10 FT. BELOW SET															
	08:50	DROPPED AND REAPPLIED RATED LOAD															
	08:55		120.0	2.60	104	.250	10.0		.80		60.0						74
	09:00	DROPPED AND REAPPLIED RATED LOAD															
	09:05	DROPPED AND REAPPLIED RATED LOAD															
	09:10		120.0	2.60	104	.250	10.0		.80		60.0						74
	09:20	DROPPED AND REAPPLIED RATED LOAD															
	09:25		120.0	2.60	104	.250	10.0		.80		60.0						74
	09:30	DROPPED AND REAPPLIED RATED LOAD															
	09:35	DROPPED AND REAPPLIED RATED LOAD															
	09:40		120.0	2.60	104	.250	10.0		.80		60.0						74

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: THE SET OPERATED WITHIN SPECIFICATION LIMITS DURING ALL PARTS OF THIS TEST

Figure 750.1-I Typical test record for Fuel Lift Test.

X-4675

METHOD 760.2c

WINTERIZATION TEST

760.2.1 General. The heater and its controls function properly.

760.2.2 Apparatus. None other than the normal heater controls unless the overheat devices have to be bypassed.

760.2.3 Procedure.

a. Place the heater in operation by following the instructions on the set or in the technical manual. If the ambient temperature is such that the heater will not start, bypass the thermostats. Operate the heater for one cycle of operation.
b. If any of the thermostats were bypassed, they shall be returned to the control circuit.
c. Record whether the heater operation properly.

760.2.4 Results. Compare the results obtained with the procurement document requirements.

760.2.5 Procurement document requirements. The following item must be specified in the individual procurement document:

a. Proper operation criteria for the heater and its controls during the performance of this method.

METHOD 770.1c

RECTIFIER TEST

770.1.1 General. The rectifiers must be capable of withstanding the peak voltage and currents encountered during any operating condition.

770.1.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, a shorting switch and a memory type oscilloscope shall be required.

770.1.3 Procedure.

770.1.3.1 Preparation for test.

a. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 for one voltage connection and frequency specified in the procurement document.
b. Connect the shorting switch directly to the set output terminals.
c. Connect the memory oscilloscope to the voltage across one of the rectifiers specified in the procurement document (if necessary, slip rings shall be provided to evaluate rotating rectifiers).

770.1.3.2 Test.

a. Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period record all instrument readings including ambient temperature at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjusts to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustment to the voltage and frequency control system shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustments. Unless otherwise specified in the procurement document, stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variation about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made (see figure 770.1-I).
b. After stabilization has occurred turn on the memory oscilloscope and record the peak voltage across the rectifier as the load is reduced to zero in one step (see figure 770.1-I).
c. Again use the memory oscilloscope and record the peak voltage across the rectifier as rated load is applied in one step.

d. While at rated load use the memory oscilloscope and record the peak voltage across the rectifier as the shorting switch is closed momentarily.

NOTE: In the case of 3-phase generator sets, a symmetrical 3-phase line-to-line short circuit shall be applied.

e. Repeat steps a thru d above two additional times.
f. Connect the memory oscilloscope and shunt to indicate the current through the rectifier.
g. Repeat steps a thru d above three additional times recording the peak the rectifier in each test.
h. Repeat steps a thru g above for each rectifier specified in the procurement document.
i. Repeat steps a thru h above for each voltage connection and frequency specified in the procurement document requirements.
j. Perform any additional procedures necessary for comparison of the rectifier rating with the procurement document requirements.

770.1.4 Apparats. Compare the results with the rectifier ratings and compare both the results and the rectifier ratings with the procurement document requirements.

770.1.5 Procurement document requirements. The following items must be specified in the individual procurement document:

a. Voltage connection(s) and frequency(ies) at which this method is to be performed.
b. Peak inverse voltage rating of each rectifier to be tested.
c. Peak current rating of each rectifier to be tested.
d. Each rectifier on which this method is to be performed.

TEST DATA

DESCRIPTION 10KW, 60HZ 120 V, SINGLE PHASE GENERATOR SET

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

TEST NO. 27

SHEET 1 OF 1

DATE APRIL 25, 1971

RECORDER L. Wright

PROJ. ENGR. [illegible]

SHIFT LEADER H. Smith

OBSERVER L. Lee

MFGR. ENGENSETS, INC

MODEL NO. SE-10.0-MD

SERIAL NO. 10742

REF: MIL-STD-705/770.1

RECTIFIER TEST

INST. →		104		312		218		716		412		148	367	1174			1076
READ NO. ↓	TIME	TERMINAL VOLTAGE		LINE CURRENT		OUTPUT POWER		POWER FACTOR		FREQUENCY		EXCITER FIELD		PEAK INVERSE VOLT.			AVG AMB TEMP
UNITS	HRS		VOLTS	AMPS	AMPS	KW	KW		—		HZ	VOLTS	AMPS	DIODE	VOLTS		°F
SYM.				X40	X1	X40	X1							No			
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	08:15	STARTED SET - APPLIED RATED LOAD															
	0830		120.0	2.60	104	.250	10.0		.80		60.0	14.1	1.32				74
	0840		120.0	2.60	104	.250	10.0		.80		60.0	14.3	1.32				75
	0850		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	0900		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	0910		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	0920		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	0922	DROPPED RATED LOAD IN ONE STEP												CR1	27		
	0924	APPLIED RATED LOAD IN ONE STEP												CR1	40		
	0928	APPLIED MOMENTARY SHORT CIRCUIT												CR1	55		
	0940		120.0	2.60	104	.250	10.0		.80		60.0	14.3	1.32				75
	0950		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	1000		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	1010		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	1020		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75
	1022	DROPPED RATED LOAD IN ONE STEP												CR1	26		
	1024	APPLIED RATED LOAD IN ONE STEP												CR1	41		
	1028	APPLIED MOMENTARY SHORT CIRCUIT												CR1	55		
	1040		120.0	2.60	104	.250	10.0		.80		60.0	14.4	1.32				75

NOTES:

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

Figure 770.1-I: Portion of a typical test record for rectifier test.

X-4676

Test.]

METHOD 771.1a

LOAD BANK TEST

771.1.1 General. Load banks are added to some diesel generator sets to increase the time between major maintenance due to light load conditions. This done by keeping the engine loaded to more than 50 percent of its horsepower rating. The proper function of the load bank is of importance in keeping maintenance costs to a minimum.

771.1.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

771.1.3 Procedure.

771.1.3.1 Preparation for test.

a. Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, method 205.1, paragraph 205.1.10 to measure the load applied by the set load bank with the voltage sensing lines connected to the generator set output terminals for a voltage connection and frequency specified in the procurement document.
b. Connect the generator set integral load bank for the voltage connection used in step a above, and connect the load bank to the set electrically, if necessary.

771.1.3.2 Test.

a. Start and operate the generator set at rated voltage, rated frequency and no load. Record all instrument readings.
b. Using the load bank switch, energize the load bank at its minimum percent step. Record all instrument readings and note operation of load bank indicator light.
c. Repeat step b above for all other steps of the load bank switch.
d. Repeat step b above for any other load steps available.
e. Repeat 771.1.3 for any other voltage connection specified in the procurement document.

771.1.4 Results. Compare the power absorbed by the generator set integral load bank with the requirements specified in the requirements specified in the procurement document.

771.1.5. Procurement document requirements. The following items must be specified in the individual procurement document.

a. The tolerance band in percent of rated load within which the load bank must operate at each step, if applicable.
b. The voltage connections at which this test shall be performed.

TEST DATA

DESCRIPTION 30KW 60Hz 120/208V, 3-PHASE GENERATOR SET

MFGR. ENGENSETS, INC.

MODEL NO. SF-30.0-MD

SERIAL NO. 13057

REF: MIL-STD-705/771.1

PHILADELPHIA REGION

DEFENSE CONTRACT ADMINISTRATION SERVICE

LOAD BANK TEST

TEST NO. 76

SHEET 1 OF 1

DATE SEPT 23, 1970

RECORDER S. Wright

PROJ. ENGR. J. Jones

SHIFT LEADER H. Smith

OBSERVER L. Lee

INST. →		107						213			306				518	506	1076
READ NO.	TIME	TERMINAL VOLTAGE						LINE CURRENT			OUTPUT POWER				POWER FACTOR	FREQ	AVG AMB TEMP
		L_1-N	L_2-N	L_3-N	L_1-L_2	L_2-L_3	L_3-L_1	L_1	L_2	L_3	L_1	L_2	L_3	TOTAL			
UNITS	HRS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	AMPS	AMPS	AMPS	KW	KW	KW	KW	—	Hz	°F
SYM.								X20	X20	X20	X20	X20	X20	X1			
COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0817	STARTED		SET													
	0820	120.0	119.8	120.2	208	208	208	0	0	0	0	0	0	0	—	60.0	73
	0822	SWITCH IN		25%	LOAD	POSITION -		LIGHT	"ON"								
	0824	120.0	119.8	120.2	208	208	208	0.65	0.67	0.66	.078	.078	.079	4.70	1.0	60.0	73
	0826	SWITCH IN		50%	LOAD	POSITION -		LIGHT	"ON"								
	0828	120.0	119.8	120.2	208	208	208	1.30	1.32	1.32	.156	.156	.158	9.40	1.0	60.0	74
	0830	SWITCH IN		75%	LOAD	POSITION -		LIGHT	"ON"								
	0832	120.0	119.8	120.1	208	208	208	1.95	1.99	1.98	.234	.234	.237	14.10	1.0	60.0	74
	0835	SWITCH IN		100%	LOAD	POSITION -		LIGHT	"ON"								
	0837	120.0	119.7	120.1	208	208	208	2.60	2.60	2.60	.312	.312	.312	18.80	1.0	60.0	74

SIMULATED DATA FOR ILLUSTRATIVE PURPOSES ONLY

NOTES: LINE CURRENTS MEASURED USING C.T. L_1 - 3075
L_2 - 3036
L_3 - 3073

Figure 771.1-I: Typical test record for load bank test.

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4. ALPHABETICAL INDEX

4. ALPHABETICAL INDEX - Continued

4. ALPHABETICAL INDEX - Continued

Method	Method No.

5. NUMERICAL INDEX

5. NUMERICAL INDEX - Continued

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