Operations — SWD

REPORT OF FIELD TESTS

ON

VERTICAL WATERWHEEL GENERATORS

FOR

DEPARTMENT OF THE ARMY

Corps of Engineers

GIBSON DAM POWER HOUSE

OKLAHOMA

UNIT NO. 2

SERIAL NOS. 154448, 154449, 154450, 154451

12,500 KVA, 13,800 VOLTS, 523 AMPERES, 90% POWER FACTOR

100 RPM - 3 PHASE - 60 CYCLES

2-25-54 W.O. Rowe

FEB 2004
RECEIVED

ALLIS-CHALMERS MANUFACTURING COMPANY
MILWAUKEE 1, WISCONSIN

FEBRUARY, 1954

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I N T R O D U C T I O N

This report covers tests made by the Allis-Chalmers Manufacturing Company on Generator Unit No. 2, of their manufacture, at Gibson Dam Power House, Oklahoma. These tests were made in fulfillment of the contract specifications.

All tests were made in accordance with the applicable standards of the AIEE Test Code for Synchronous Machines, AIEE No. 503, June, 1945, and the American Standards Association, unless specifically noted.

The tests were made between November 9th and November 17th, 1953. All tests were witnessed by Mr. F.C. Taylor, Representative of the Southwest Division, U. S. Army, Corps of Engineers Office, Dallas, Texas.

List of Tests Conducted on Each Generator Immediately After Erection

1. Alignment of turbine and generator shafts by mechanical rotation of unit.
2. Megger test for insulation resistance.
3. Dielectric test of armature at 28,600 volts.

   Dielectric test of field at 5,000 volts.

Note: Over speed tests were not run on subject units because of bearing trouble and lack of head.

LIST OF TESTS CONDUCTED ON EACH GENERATOR

1. Resistance of armature and field windings.
2. Test for time required for main exciter rheostat to make full travel.

LIST OF TESTS CONDUCTED ON UNIT NO. 2

1. Resistance test of armature and field winding.
2. Test rof time required for the main exciter rheostat to make full travel.
3. No load saturation test.
4. Short circuit saturation test.
5. Conventional efficiendy test.
6. Test to determine maximum temperature rises of the various parts of the generator. This test was made at both 100 % and 115 % load.
7. Three phase short circuit test from 105 % voltage.
8. Test for determination of wave form deviation factor.
9. Test to determine saturated and unsaturated direct axis transient reactance.
10. Test to determine negative sequence reactance.
11. Test to determine zero sequence reactance.
12. Test to determine direct axis and quadrature axis subtransient reactances.
13. Test to,determine telephone interference factor.
14. Zero power factor regulation test.

S U M M A R Y O F R E S U L T S

;ator Resistance at 75°C is (Ohms T-T)	.2008	
otor Resistance at 40°C is (Ohms)	.2341	
o Load Saturation Curve is plotted on	0-19103	
hort Circuit Saturation Curve is plotted on	0-19103	
eviation Factor of Wave Form is less than	4.0%	
alanced Telephone Interference Factor is	23.1	
Residual Telephone Interference Factor is	11.32	
Short Circuit Ratio is	1.366	
Unsaturated Direct Axis Subtransient Reactance (Xd'') is	38.2%	35.0%
Unsaturated Quadrature Axis Subtransient Reactance (Xq'') is	41.8%	43.0%
Unsaturated Direct Axis Transient Reactance (Xd') is	44.4%	39.0%
Saturated Direct Axis Transient Reactance Xd') is	38.8%	
Negative Sequence Reactance is	40.0%	39.0%
Zero Sequence Reactance is	20.7%	30.0%

RESULTS OF FULL LOAD HEAT RUN

Approximate Hours Run	5.5
Armature Volts	13,790
Armature Amperes	514.5
Field Amperes	500.0
Field Volts (Measured at Rings)	128.5
Maximum Temperature Rise of Iron, °C by therm.	37.31
Maximum Temperature Rise of Ducts, °C by therm.	26.11
Maximum Temperature Rise of Coils, °C by detector	47.01
Temperature Rise of Rotor Coils, °C by resistance	33.61
Average Temperature of Inlet Air, °C	33.89

RESULTS OF 115% LOAD HEAT RUN

pproximate Hours Run . . (Continued From Rated Load Heat Run)..	2.0
rmature Volts	13,850
rmature Amperes	592.0
Field Amperes	633.5
Field Volts (Measured at Rings)	173.0
Maximum Temperature Rise of Iron, ^{o}C by Therm.	41.37
Maximum Temperature Rise of Ducts, ^{o}C by Therm.	29.97
Maximum Temperature Rise of Coils, ^{o}C by Therm.	57.17
Temperature Rise of Rotor Coils, ^{o}C by Res.	49.17
Average Temperature of Inlet Air, ^{o}C	36.33

hree Phase Short Circuit Test

The three phase short circuit test was made by abruptly short circuiting the generator when operating at no-load, rated frequency and 5 percent above rated voltage for a period of not more than 10 seconds. An oscillogram of the current waves, voltage, field volts and a timing wave was taken during the test and one current wave was practically completely offset. This oscillogram is included in this report.

Wave Form

An oscillogram was taken of the terminal wave form of the voltage of the machine with the generator operating at rated voltage and frequency at no-load. This oscillogram is included in this report.

Tests Conducted on Units 1, 2, 3, & 4

1. Resistance Test of Stator and Rotor Windings.

Resistance of Unit No. 1 Stator Winding

Terminal-to-terminal 0.2017 Ohms at 75°C

Resistance of Unit No. 1 Rotor Winding

0.2365 Ohms at 40°C

Resistance of Unit No. 2 Stator Winding

Terminal-to-terminal 0.2008 Ohms at 75°C

Resistance of Unit No. 2 Rotor Winding

0.2341 Ohms at 40°C

Resistance of Unit No. 3 Stator Winding

Terminal-to-terminal 0.2000 Ohms at 75°C

Resistance of Unit No. 3 Rotor Winding

0.236 Ohms at 40°C

Tests Conducted on Units 1, 2, 3, & 4 (Continued)

Resistance of Unit No. 4 Stator Winding

Terminal-to-terminal 0.2000 Ohms at 75°C

Resistance of Unit No. 4 Rotor Winding

0.236 Ohms at 40°C

2. Operation test of pilot exciter field reducing relays was not accomplished due to compounding trouble on the pilot exciters.

3. Test for time required for the main exciter rheostat to make full travel.

Unit No. 1	27.4 Sec.
Unit No. 2	19.5 Sec.
Unit No. 3	28.4 Sec.
Unit No. 4	33.9 Sec.

UNIT NO. 2

Efficiency at 90 Percent Power Factor

Load	25%	50%	75%	100%	115%
KVA	3,125	6,250	9,380	12,500	14,380
KW	2,816	5,630	8,435	11,250	12,930
Field Amperes	375	420	484	570	634
Friction & Windage	44.46	44.46	44.46	44.46	44.46
Core Loss	139.00	139.00	139.00	139.00	139.00
Field I^2R at 75°C	37.10	45.54	61.85	85.90	106.20
Stator I^2R at 75°C	5.15	20.60	46.40	82.40	109.00
Stray Loss	1.20	8.00	19.20	32.40	41.80
Total Losses	226.91	257.60	309.91	384.16	440.46
Total Output	2816.00	5630.00	8435.00	11250.00	12930.00
Total Input	3042.91	5887.60	8744.91	11634.16	13370.46
Percent Efficiency	92.55	95.62	96.46	96.70	96.71
Guaranteed Efficiency	92.45	95.60	96.45	96.60	96.60

Efficiency at 100 Percent Power Factor

KVA	3,125	6,250	9,380	12,500	14,380
KW	3,125	6,250	9,380	12,500	14,380
Field Amperes	330	350	389	425	457
Friction & Windage	44.46	44.46	44.46	44.46	44.46
Core Loss	139.00	139.00	139.00	139.00	139.00
Field I^2R at 75°C	28.75	32.32	39.95	47.65	55.13
Stator I^2R at 75°C	5.15	20.60	46.40	82.40	109.00
Stray Loss	1.20	8.00	19.20	32.40	41.80
Total Losses	218.56	244.38	289.01	345.91	389.39
Total Output	3125.00	6250.00	9380.00	12500.00	14380.00
Total Input	3343.56	6494.38	9669.01	12845.91	14769.39
Percent Efficiency	93.46	96.23	97.01	97.31	97.36
Guaranteed Efficiency	93.20	96.10	96.80	97.00	97.00

TEST PROCEDURE

1. Measurement of Resistance

The cold stator resistance of the generator was measured with a Kelvin Bridge by taking a reading between each pair of line terminals. The average of these three readings was taken as the terminal-to-terminal stator resistance. At the time these measurements were made the temperature of the stator coils as determined by the temperature detectors was noted. The average of the temperature detector readings was taken as the stator copper temperature.

The rotor resistance was measured with the Kelvin Bridge at the slip rings of the rotor. The temperature of the rotor coils was measured by attaching thermometers to the rotor coils well distributed around the machine. The average of the thermometer readings was taken as the temperature of the rotor copper.

The resistance measurements are tabulated in the Summary of Results.

2. Saturation Curve

The saturation curve was obtained by driving the generator at rated speed by its waterwheel with the generator terminals open, and with various values of excitation. At each value of field excitation, simultaneous readings of excitation amperes and terminal volts were taken. This data has been plotted on the Characteristic Curves Sheet.

3. Short Circuit Saturation

The short circuit saturation curve was obtained by short-circuiting the leads to the machine through a circuit breaker and again varying the machine excitation at rated speed. For each value of excitation, simultaneous readings of excitation amperes and line amperes were taken. This data is plotted on the Characteristic Curves Sheet.

4. Telephone Interference Factor

The telephone interference factor was measured with a standard impedance network. Readings of balanced TIF were taken with the instrument connected across the terminal-to-terminal voltage. This reading includes all harmonics except the triples. Terminal-to-neutral readings were also taken. This reading includes all harmonics including the triples. The square root of the difference of the squares of the two values is the value of the triple frequency harmonics or the residual component of telephone interference. The telephone interference measurements and calculations are given on the test summary.

5. Wave Form

An oscillogram of the open circuit voltage was taken with the machine operating at rated speed and rated voltage. The deviation factor for each line-to-line voltage has been determined from this oscillogram in accordance with the method set forth in the AIEE Test Code for Synchronous Machines dated June, 1945.

6. Short Circuit Tests

Oscillograms of the short circuit currents were taken from the values of open circuit voltage of 42.2, 75.4, and 105.7 percent. In obtaining these oscillograms the generator was operated at rated speed with the necessary excitation to give the desired terminal voltage. The test breaker was then closed to short circuit the generator and a record of the line currents was made on the oscillograms. Also included on the oscillograms were field voltage, stator voltage and a 60 cycle timing wave. Values of direct axis transient and subtransient reactance were calculated from the data on the oscillograms. Sample copies of the short circuit oscillograms and oscillograph calibrations are included in this report.

7. Procedure During Efficiency Tests

The pilot exciter of generator No. 2 was connected for use as a tachometer generator, with constant excitation furnished from the station battery. The pilot exciter voltage was matched against a constant voltage source output and a zero center recording voltmeter was connected to read the difference between the constant voltage source output and the pilot exciter voltage. The pilot exciter voltage was adjusted to 107.0 volts to equal the constant voltage source output. With these voltages equal, the stylus of the recording voltmeter was set to ride on the exact center of the chart. The pilot exciter output of 107.0 volts at 100 R.P.M. corresponds to 1.07 volts per R.P.M. At approximately 10% or 10 R.P.M.

overspeed the pilot exciter voltage was computed to be 107.0 + (10) (1.07) or 117.7 volts. The pilot exciter voltage was adjusted to this value and sufficient resistance was added in series with the recording voltmeter to cause the stylus to ride on the left margin of the chart. The pilot exciter voltage was then set to 107.0 - (10) (1.07) or 96.3 volts corresponding to 10% underspeed, and the stylus was then found to ride on the right margin of the chart. The total chart width represented a speed variation of 20 R.P.M. or .50 R.P.M. per division. The chart speed was found to be 3.176 seconds per inch. After calibrating the chart, the pilot exciter excitation was set to give 107.0 volts at rated speed. This pilot exciter field setting was held constant during all deceleration tests. During this calibration procedure the generator was held at rated synchronous speed as shown by a hand tachometer.

A. Windage and Friction

Deceleration runs for windage and friction were made by driving Unit No. 2 by Unit No. 1 slightly above 10 percent overspeed. Unit No. 2 was cut loose from Unit No. 1 by opening the breaker connecting the two units. The field breaker of Unit No. 2 was then opened and the unit allowed to develerate to about 10 percent underspeed. A continuous curve of speed versus time was recorded by the recording voltmeter. When Unit No. 2 had dropped below 10 percent underspeed Unit No. 1 with its field removed and which had

already been develerated more rapidly with the governor control to the resynchronizing speed was reconnected to Unit No. 2. Both fields of the machines were again applied and the units pulled into synchronizm.

Four develeration runs for windage and friction were made. Two runs were made at the start of the develeration tests, another after the core loss tests and the last after the stray loss tests. The total friction and windage of the exciters, generator and waterwheel as well as the friction of the bearings, and core loss of the pilot exciter.

The curves of $\frac{dN}{dt}$ versus speed of generator have been plotted and are included in this report.

Total friction and windage loss is determined from the following equation as given in the AIEE Test Code for Synchronous Machines, AIEE No. 503, June, 1945.

$$Kw. = 0.4622 \times 10^{-6} WR^2 N \frac{dN}{dt}$$

Where: W = Weight of rotating parts in pounds

R = Radius of gyration of rotating parts in feet

N = Speed in rpm at which loss is to be determined.

$\frac{dN}{dt}$ = Slope of the speed-time curve at the speed N in rpm per second

Kw. = Total losses tending to decelerate the machine.

The value of WR^2 for the generator, main and pilot exciter was calculated as 14,100,000 lb.ft^2. This also includes the waterwheel WR^2 which was calculated by the manufacturer at 1,290,000 lb.ft^2.

The average value of F&W, used in calculations, is 56.10 KW and includes F&W of generator, exciters, and waterwheel. It also includes core loss of the pilot exciter.

Deducting 11.64 KW for turbine windage and friction given by The Baldwin-Lima-Hamilton Corporation leaves 44.46 KW generator and exciter windage and friction. The value of 44.46 KW friction and windage was used in the calculation of efficiency.

B. Core Loss

The core loss was measured by maintaining constant excitation on the generator during the develeration period with the terminals open-circuited. The main field of the generator was excited from the main exciter which, in turn, was excited from the powerhouse battery supply. Values of excitation were maintained to give the desired voltage at the rated speed of the generator. The main exciter excitation was varied by means of the motor operated field rheostat to obtain constant output of the main exciter. The total loss is determined from the speed time curve by means of the same equation. The losses thus determined consist of the total friction and windage of the generator and waterwheel, the I^2R of the main exciter armature, exciter stray loss, the I^2R of the main field and the core loss of the exciter and generator. The core loss of the generator is determined by subtracting all the other losses from the total loss. The variation of the core loss with generator voltage is plotted on the Characteristic Curves Sheet.

The core loss used in the efficiency calculations is taken from the normal voltage intercept of the core loss curve.

C. Short Circuit Loss

The short circuit loss was measured in the same manner as the core loss except that during the deceleration period the generator leads were short circuited. The excitation was maintained constant during the deceleration period. Readings of stator amperes, field amperes and stator coil temperatures were taken during each run. The total loss is determined in the same manner as for the core loss test. The short circuit loss is then found by subtracting the total windage and friction, main exciter armature I^2R, exciter stray loss, exciter core loss, and the main field I^2R from the total loss.

The short circuit loss thus determined consists of the I^2R loss in the stator copper and the stray loss. The stray loss is then segregated by subtracting the stator I^2R loss from the short circuit loss.

The stator I^2R loss is calculated from the test values of stator current in conjunction with the test value of stator resistance corrected to the temperature of the stator copper during the deceleration test. The variation of stray load loss with stator current is plotted on the Characteristic Curves sheet as well as the stator I^2R corrected to 75°C. The stray loss used in the efficiency calculations is taken from the normal current intercept of this loss curve.

8. Field Losses

The field I^2R losses used in the computation of efficiencies are found from the field amperes for each load and the test value of the field resistance corrected to 75°C.

The field amperes for each load were calculated by the latest accepted method as described in the AIEE Test Code for Synchronous Machines (AIEE No. 503, June, 1945), using the saturation and short circuit curves given on the Characteristic Curves sheet and using the calculated value of Potier reactance drop of 18.1 percent.

9. Heat Runs

Rated Load

The machine was put on the line and adjusted as close to rated KVA as possible. The line currents and voltages were measured with calibrated test instruments connected in the circuits of the powerhouse instrument transformers. The field voltage was measured across the collector rings with a pair of special copper brushes, and the field current with a calibrated 50 M.U. shunt in series with the field winding. Armature iron and duct temperatures were measured with mercury thermometers attached by means of glue and felt pads. Thermometers were placed in the inlet and outlet air streams in such a manner as to obtain average temperatures. Temperature detector readings were taken with a calibrated temperature bridge.

The temperature rises tabulated under "Summary of Tests" are the difference between the maximum final temperature and average inlet air temperature. The inlet air temperature was maintained as close as possible to 40°C in accordance with the contract. The final temperature of the field was calculated from its hot resistance value as measured by the voltmeter-ammeter method and a measured resistance of 0.2205

ohms at 23.9°C by the Kelvin Bridge Method when cold.

The temperature rise of the stator coils during the full KVA heat run was 47.01°C.

115% Load

The above procedure was duplicated at 115% of rated KVA.

10. Reactance Measurements

The values of saturated and unsaturated direct axis transient and subtransient reactances were calculated from the oscillograms taken during the short circuit tests on the generator. Calculations were made in accordance with the AIEE Test Code for Synchronous Machines. These values of reactance are plotted on Sheet 0-19109.

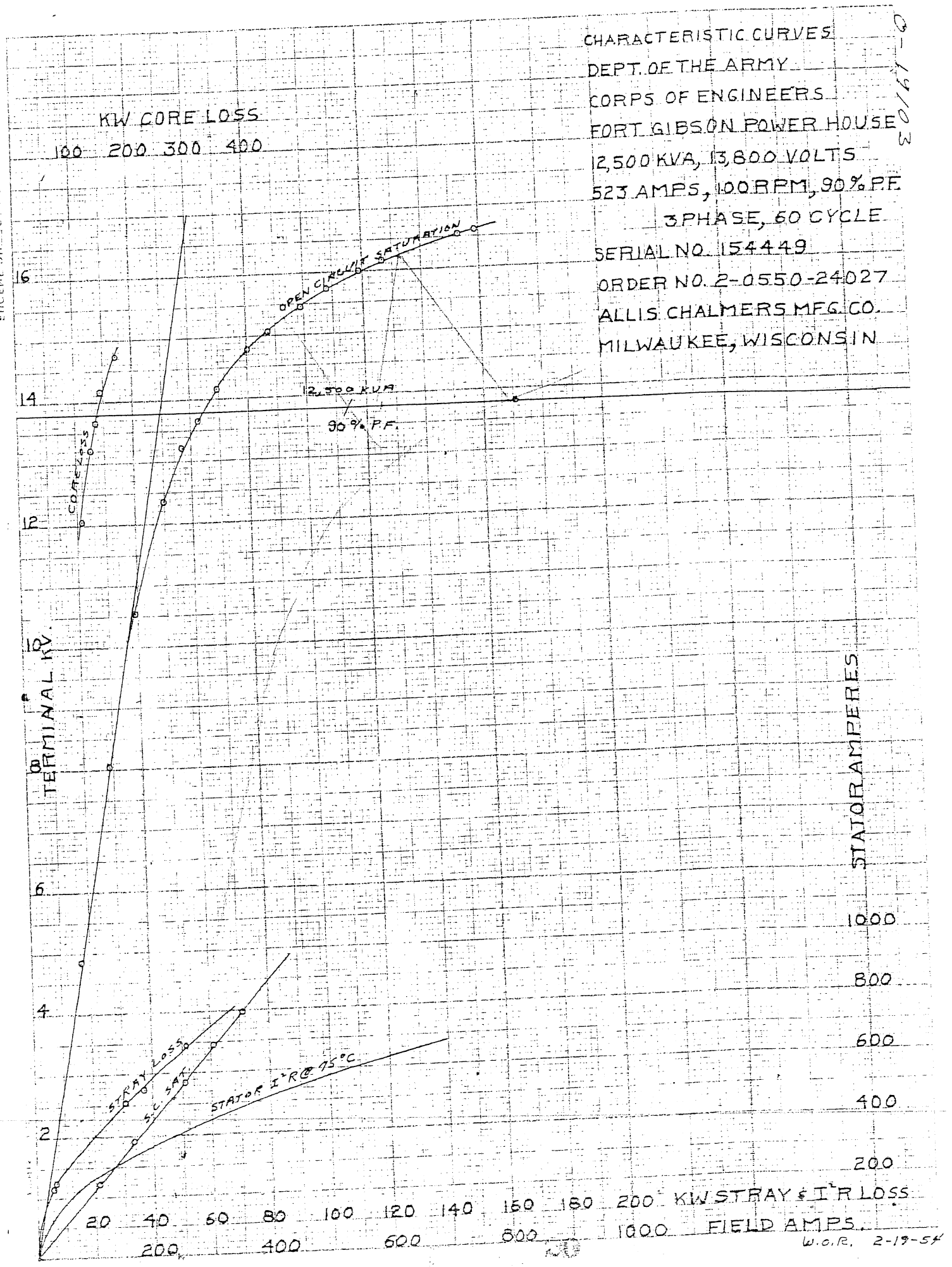
Zero sequence reactance was determined according to the method of paragraph 1.894 of the AIEE Test Code for Synchronous Machines. Test measurements and reactance calculations are given on the zero sequence test sheet.

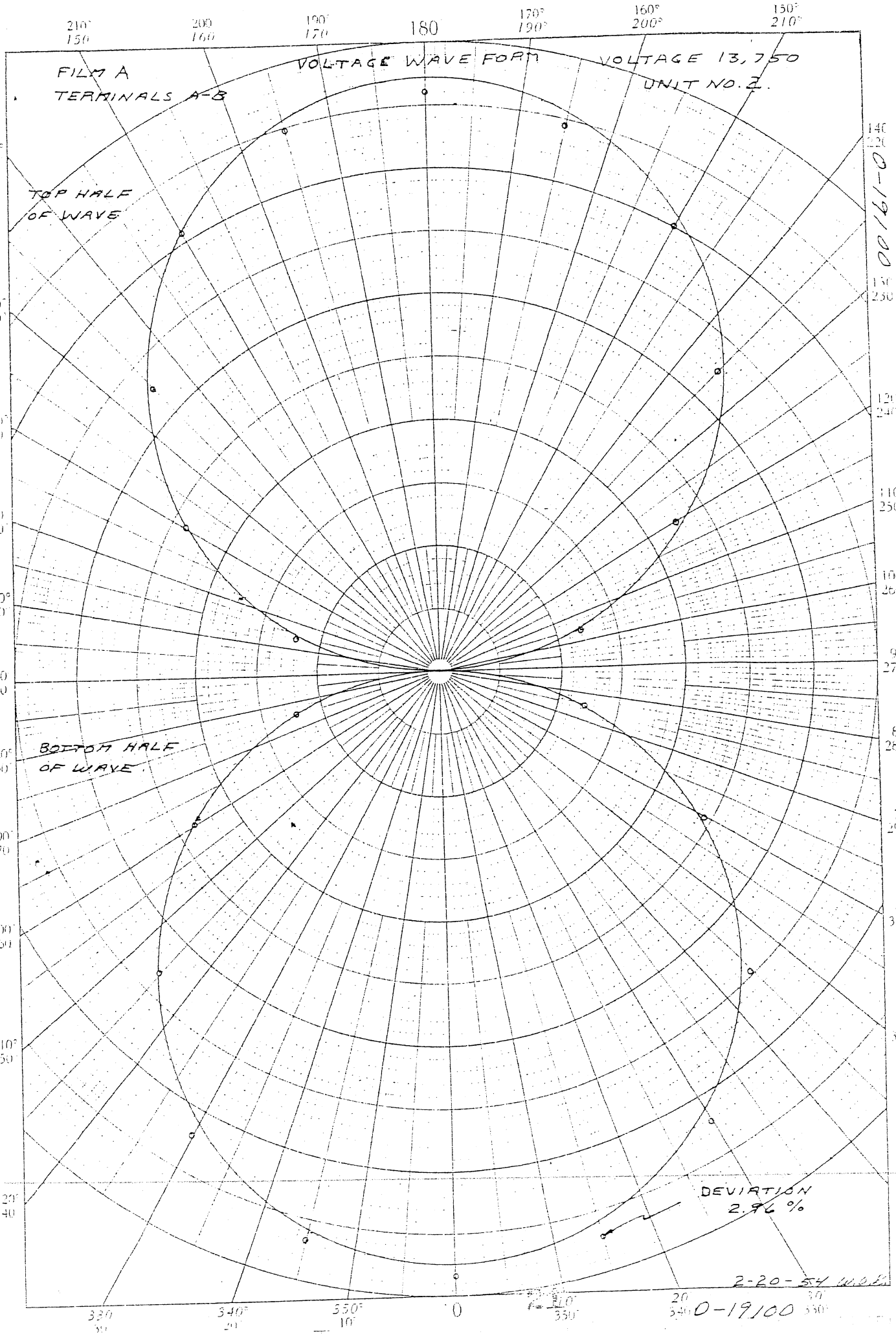
The negative sequence reactance was determined from the test data of the no-load saturation curve, synchronous impedance curve and the single phase short circuit curve in accordance with paragraph 1.887 of the AIEE Test Code for Synchronous Machines, June, 1945. Test curves and calculations for negative sequence reactance, unsaturated quadrature-axis subtransient reactance and short circuit ratio are given on sheet 0-19104.

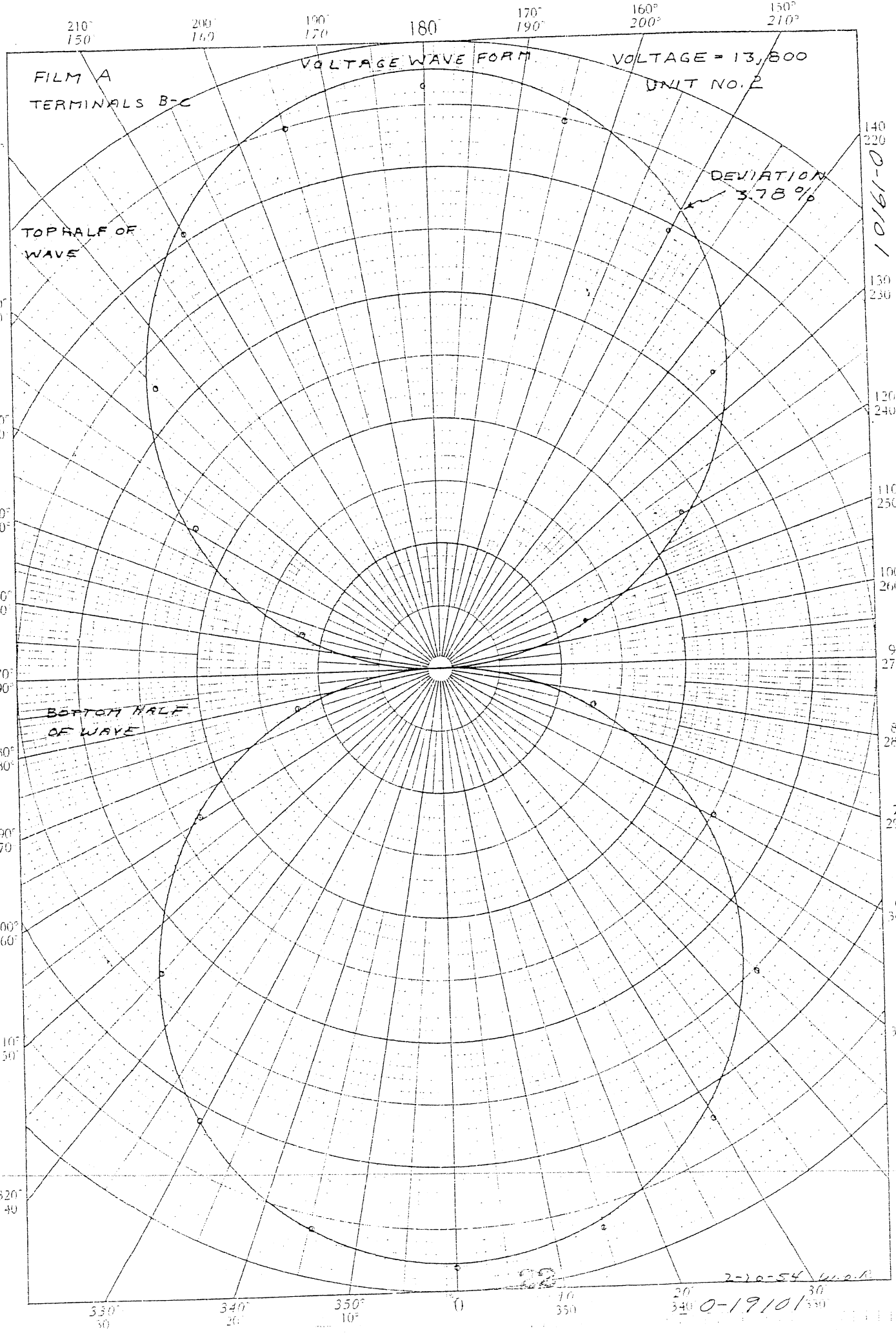
11. Water Measurements

The water measurements were not made on this unit since the piping installation was not adaptable to measurement of water with our 6-inch orifice plate as was intended.

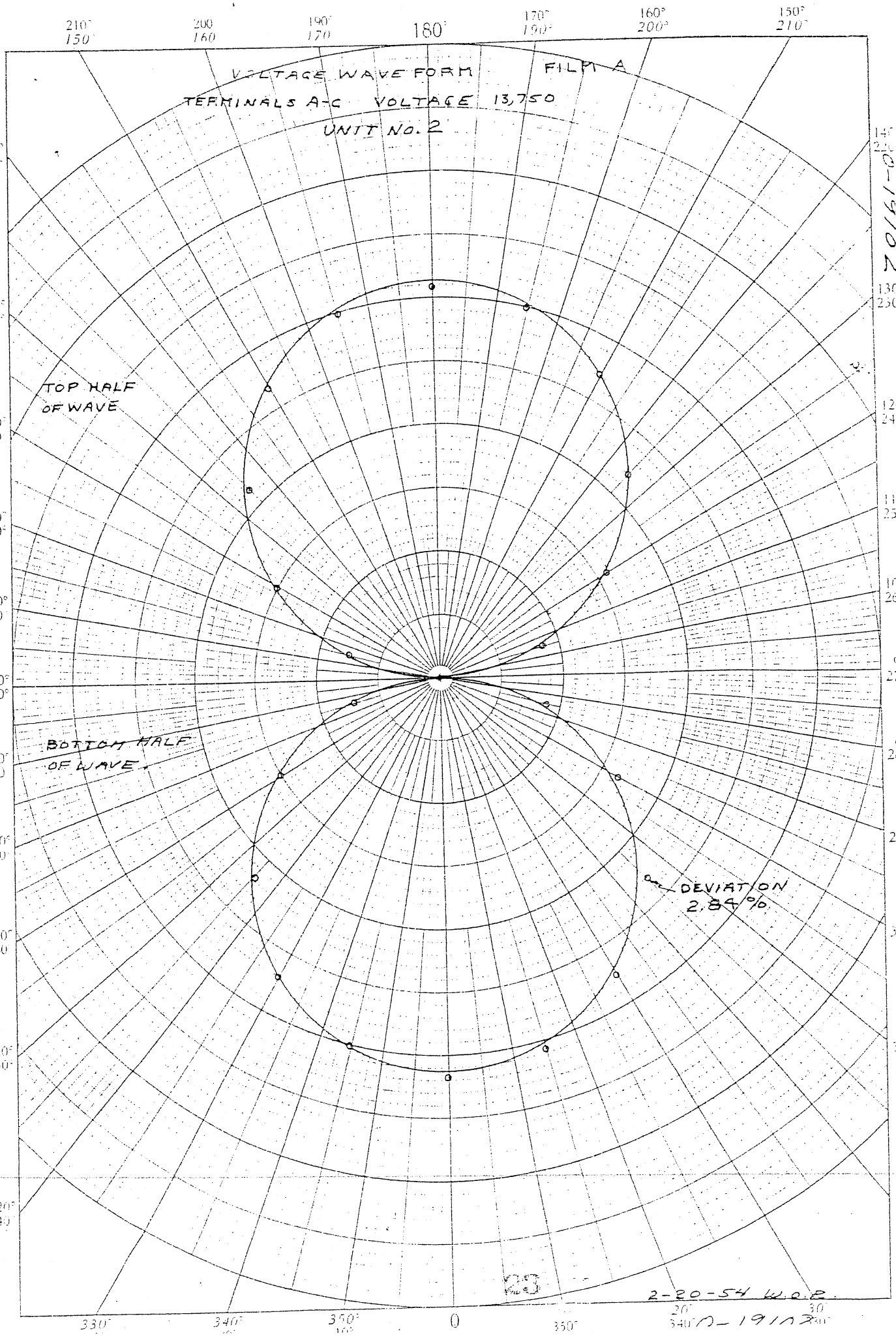
In order to obtain 40°C inlet air from the coolers during the full load heat run it was necessary to throttle the cooler inlet water by means of the outlet valve. This throttling resulted in a water flow of 1/2 of 1 scale division on the flowmeter. The same throttling condition prevailed throughout the 115% load heat run.


CHARACTERISTIC CURVES
DEPT. OF THE ARMY
CORPS OF ENGINEERS
FORT GIBSON POWER HOUSE
12,500 KVA, 13,800 VOLTS
523 AMPS, 100 RPM, 90% P.F.
3 PHASE, 60 CYCLE
SERIAL NO. 154449
ORDER NO. 2-0550-24027
ALLIS CHALMERS MFG. CO.
MILWAUKEE, WISCONSIN
KW CORE LOSS
100 200 300 400
OPEN CIRCUIT SATURATION
12,500 KVA
90% P.F.
CORE LOSS
TERMINAL KV.
STATOR AMPERES
STRAY LOSS
S.C. SAT.
STATOR I²R @ 75°C
20 40 60 80 100 120 140 160 180 200 KW STRAY & I²R LOSS
200 400 600 800 1000 FIELD AMPS.
W.O.R. 2-19-54


FILM A
TERMINALS A-B
VOLTAGE WAVE FORM
VOLTAGE 13,750
UNIT NO. 2.
TOP HALF OF WAVE
BOTTOM HALF OF WAVE
DEVIATION 2.96 %
2-20-54
0-19100
0-19100
180
0



KEUFFEL & ESSER CO., N. Y. NO. 359-31


VOLTAGE WAVE FORM FILM A
TERMINALS A-C VOLTAGE 13,750
UNIT No. 2
TOP HALF OF WAVE
BOTTOM HALF OF WAVE.
DEVIATION 2.84%
2-20-54 W.O.B.
0-19102

DECELERATION RUNS FOR FRICTION AND WINDAGE LOSS

DEPT OF THE ARMY

CORPS OF ENGINEERS

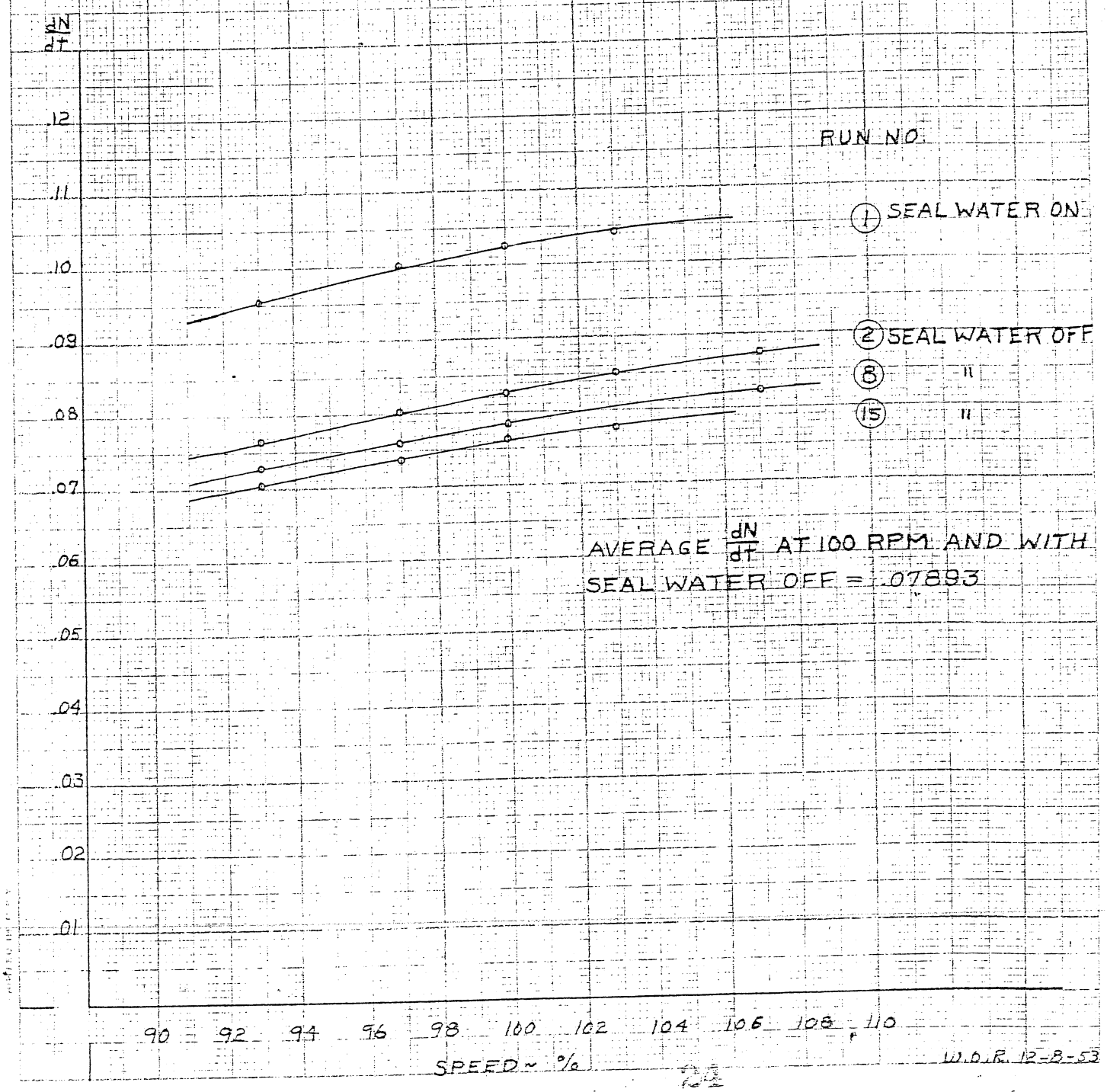
FORT GIBSON POWER HOUSE

12500 KVA, 13,800 VOLTS, 523 AMPS

90% P.F., 100 RPM, 3 PHASE, 60 CY.

SERIAL NO. 154449

UNIT NO. 2

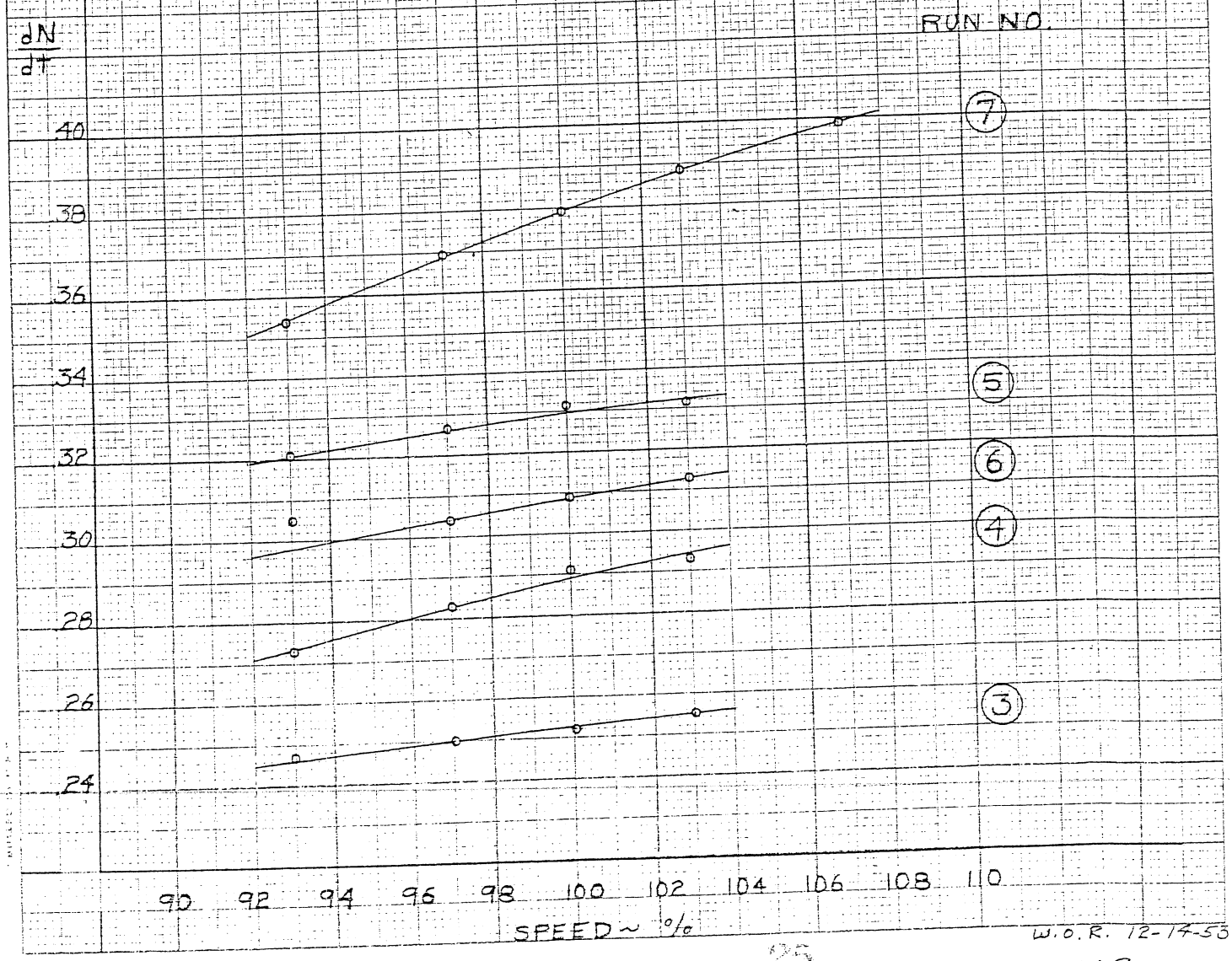


W.O.R. 12-8-53

0-1906

DECELERATION RUNS FOR CORE LOSS
DEPT. OF THE ARMY
CORPS OF ENGINEERS
FORT GIBSON POWER HOUSE
12,500 KVA, 13,800 VOLTS, 523 AMPS,
80% P.F., 100 RPM, 3 PH, 60 CY,
SERIAL NO. 154448
UNIT NO. 2

RUN NO.	TERMINAL VOLTS	FIELD AMPS
7	14,720	393.5
5	14,150	345.0
6	13,650	313.5
4	13,200	285.0
3	12,050	234.5



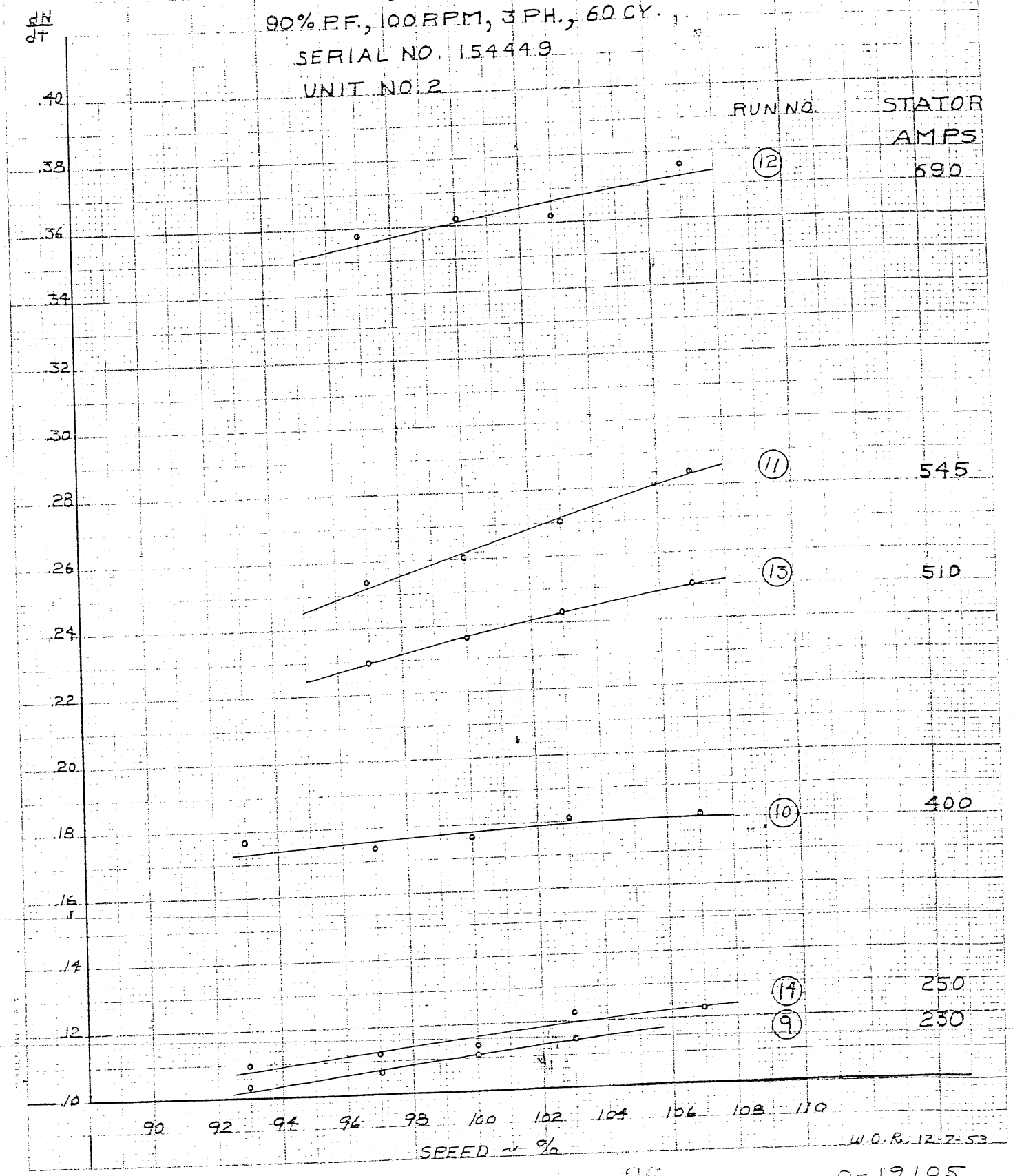
W.O.R. 12-14-53

0-19107

0-19102

25

DECELERATION RUNS FOR STRAY LOSS
DEPT OF THE ARMY
CORPS OF ENGINEERS
FORT GIBSON POWER HOUSE
12500 KVA, 13800 VOLTS, 523 AMPS
90% P.F., 100 RPM, 3 PH., 60 CY.
SERIAL NO. 154449
UNIT NO. 2

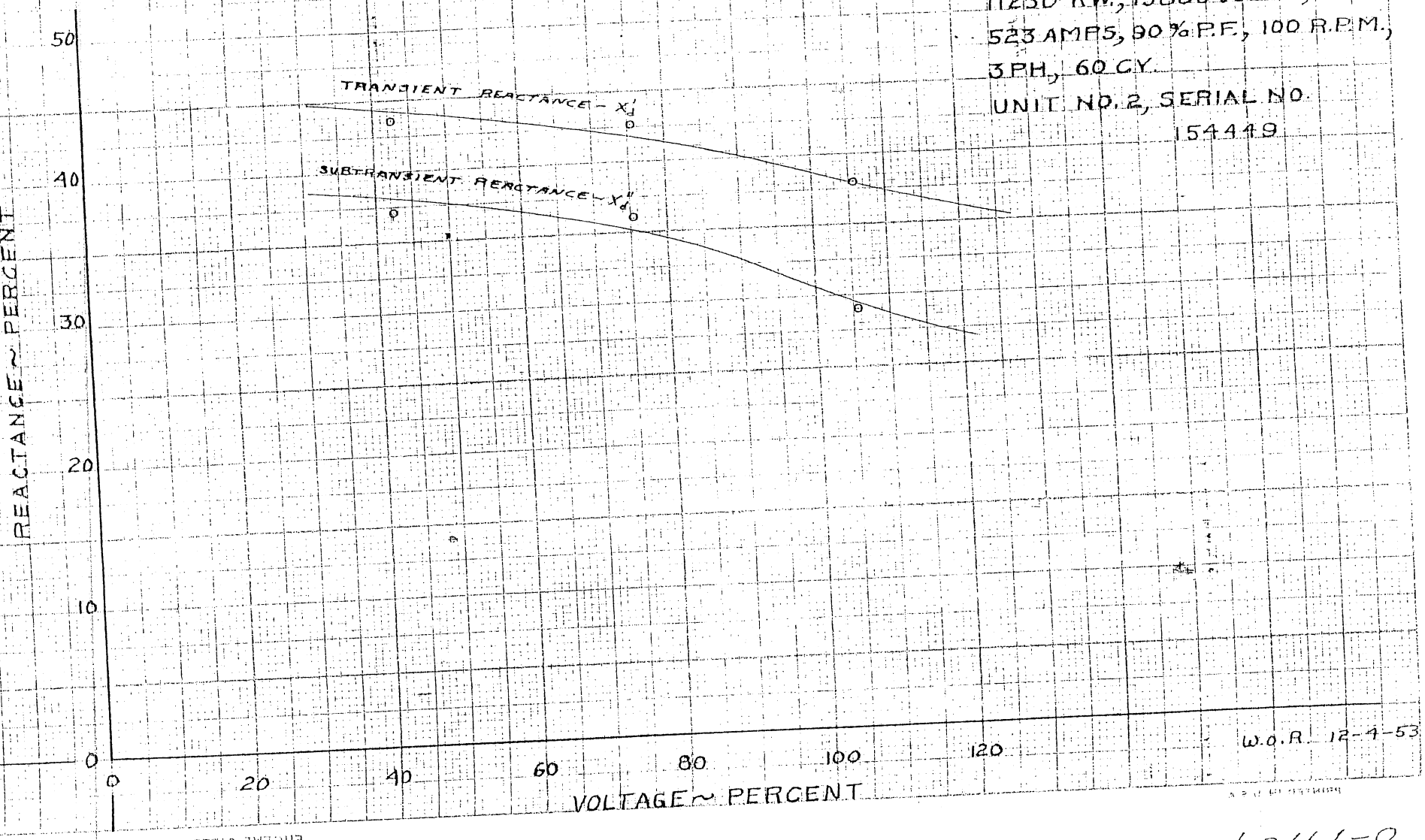


W.O.R. 12-7-53

0-19105

TRANSIENT AND SUBTRANSIENT REACTANCE VERSUS VOLTAGE

DEPT. OF THE ARMY
CORPS OF ENGINEERS
FORT GIBSON POWER HOUSE
FORT GIBSON DAM, OKLA.
11250 KW., 13800 VOLTS,
523 AMPS, 90% P.F., 100 R.P.M.,
3 PH., 60 CY.
UNIT NO. 2, SERIAL NO.
154449

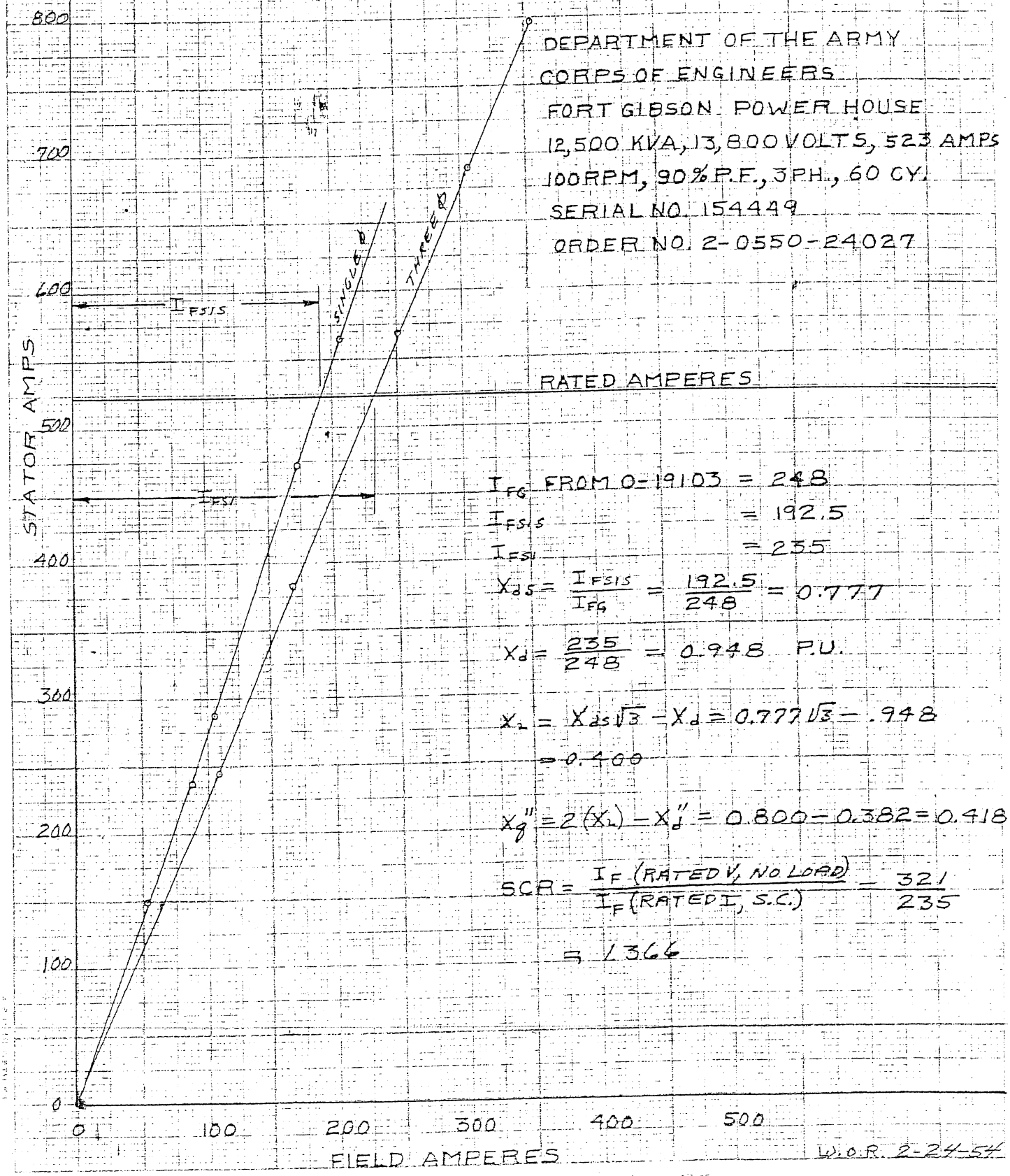


W.O.R. 12-4-53

60161-0

60161-0

SHORT CIRCUIT SATURATION CURVES & CALCULATIONS FOR NEGATIVE SEQUENCE REACTANCE, UNSATURATED X_q'' AND SCR



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
FORT GIBSON POWER HOUSE
12,500 KVA, 13,800 VOLTS, 523 AMPS
100 RPM, 90% P.F., 3 PH., 60 CY.
SERIAL NO. 154449
ORDER NO. 2-0550-24027

I_{FG} FROM 0-19103 = 248

I_{FS1S} = 192.5

I_{FS1} = 235

$$X_{ds} = \frac{I_{FS1S}}{I_{FG}} = \frac{192.5}{248} = 0.777$$

$$X_d = \frac{235}{248} = 0.948 \text{ P.U.}$$

$$X_2 = X_{ds}\sqrt{3} - X_d = 0.777\sqrt{3} - .948$$

$$= 0.400$$

$$X_q'' = 2(X_2) - X_d'' = 0.800 - 0.382 = 0.418$$

$$SCR = \frac{I_F\ (\text{RATED V, NO LOAD})}{I_F\ (\text{RATED I, S.C.})} = \frac{321}{235}$$

$$= 1.364$$

W.O.R. 2-24-54

0-19104

0-19104

REACTANCE CALCULATIONS

FROM INITIAL CURRENTS DURING SHORT CIRCUIT TESTS

Oscillogram No.	E	E	E
Element No.	3	6	4
Ohms in Series with Vibrator	2	10	2
RMS Amps per Inch	604	540	780
Current Trans. Ratio	1200/5	1200/5	1200/5
RMS Short Circuit Amps (Transient Value)	499	527	494
Percent Voltage	42.2	42.2	42.2
Percent X'_d	44.3	41.8	44.7
Average X'_d		43.6	
RMS Short Circuit Amps (Subtransient Value)	565.5	627	596
Percent X''_d	39.1	35.2	37.0
Average X''_d		37.1	

REACTANCE CALCULATIONS

FROM INITIAL CURRENTS DURING SHORT CIRCUIT TESTS

Oscillogram No.	D	D	D
Element No.	3	4	6
Ohms in Series with Vibrator	5	5	15
RMS Amps per Inch	1018	1363	762
Current Trans. Ratio	1200/5	1200/5	1200/5
RMS Short Circuit Amps (Transient Value)	920	933	920
Percent Voltage	75.4	75.4	75.4
Percent X'_d	42.8	42.3	42.8
Average X'_d		42.63	
RMS Short Circuit Amps (Subtransient Value)	1106	1068	1109
Percent X''_d	35.7	36.9	35.6
Average X''_d		36.6	

REACTANCE CALCULATIONS

FROM INITIAL CURRENTS DURING SHORT CIRCUIT TESTS

Oscillogram No.	F	F	F
Element No.	3	4	6
Ohms in Series with Vibrator	5	5	15
RMS Amps per Inch	1018	1363	762
Current Trans. Ratio	1200/5	1200/5	1200/5
RMS Short Circuit Amps (Transient Value)	1397	1415	1522
Percent Voltage	105.7	105.7	105.7
Percent X'_d	39.55	39.0	36.3
Average X'_d		38.28	
RMS Short Circuit Amps (Subtransient Value)	1817	2135	1762
Percent X''_d	30.4	25.9	31.3
Average X''_d		29.2	

ZERO SEQUENCE TEST

$$Z_o = \frac{100 \text{ (Per Unit Volts)}}{\text{Per Unit Amperes}} \qquad \text{(Percent)}$$

$$\text{P.U. Volts} = \frac{1630}{13{,}800/1.732} = .2043$$

$$\text{P.U. Amps} = \frac{517}{523} = .989$$

$$Z_o = \frac{100\ (.2043)}{.989} = 20.7\ \%$$

SAMPLE CALCULATIONS

Short Circuit Loss

Deceleration Run No. 12

Stator Amperes = 690 Field Amperes = 304
Slope at 100 RPM from curve 0-19105 = .361 RPM per second.
Total KW loss = 0.4622 x 15.39 x 100 x .361 = 256.6 KW
Main Exciter Loss = 3.42
Gen. Field Loss = 21.59
Stator Resistance at 32.3°C = .1734 Ohms T-T
Stator I^2R Loss = 123.70 KW
Stray Loss = Total KW Loss - (Friction & Windage + Exciter Loss + Gen.Field Loss + Stator I^2R Loss + Water Wheel Friction & Windage)
Stray Loss = 256.6 - (44.46 + 3.42 + 21.59 + 123.70 + 11.64) = 51.79 KW

Telephone Interference

$$TIF = \frac{\text{Micro Amperes}}{\text{Volts}}$$

From TIF Calibration Curve 0-16773
Terminal to Terminal
66.0 x 40 = 2640
49 x 1 = 114.2

$$\text{Balanced TIF} = \frac{2640}{114.2} = 23.1$$

Terminal to Neutral
42.8 x 40 = 1712
66.0 x 1 = 66.5

$$TIF = \frac{1712}{66.5} = 25.77$$

$$\text{Residual TIF} = \sqrt{(\text{Term-to-Neut.})^2 - (\text{Term-to-Term})^2}$$

$$= (25.77)^2 - (23.1)^2$$

Residual TIF = 11.32

SAMPLE CALCULATIONS

Windage & Friction Loss

Deceleration Run Nos. 2, 8, & 15

Slope at 100 RPM from curve 0-19106 - 0.07893 RPM per second
KW Loss = 0.4622 x 15.39 x 100 x 0.07893 = 56.1 (includes water wheel F&W of 11.65 KW)

Open Circuit Loss

Deceleration Run No. 7

Terminal Volts = 14,720 Field Amperes = 393.5
Slope at 100 RPM from curve 0-19107 = 0.379 RPM per second
Total KW Loss = 0.4622 x 15.39 x 100 x 0.379 = 269.3 KW

Exciter Losses

Main Exciter I^2R and Brush Loss	=	4.78
Main Exciter Stray Loss	=	.42
Main Exciter Core Loss	=	.20
Total Main Exciter Loss	=	5.40

Gen. Field & Brush I^2R = 36.20

Core Loss = Total Loss - (Friction and windage and Exciter Loss + Gen. Field Loss + Water Wheel Loss)

Core Loss = 269.3 - (44.46 + 5.40 + 36.20 + 11.64) = 171.6 KW

FORM 176-2-1
PRINTED 12-45

ALLIS-CHALMERS MANUFACTURING COMPANY

ON COMPLETE TESTS TAKE VOLTAGE READINGS AT APPROXIMATELY 25, 35, 45, 55, 75, 85, 95, 100, 105, 110, 120, 130, AND 140% OF NORMAL. VOLTAGE READINGS MUST BE TAKEN WITH INCREASING VALUES OF EXCITATION. IF, FOR ANY REASON, THE EXCITATION IS DECREASED, IT SHOULD BE BROUGHT DOWN TO ZERO AND THEN INCREASED TO THE POINT TO BE READ.

RECORD THE VOLTAGE OF ALL PHASES TO SEE THAT THEY ARE BALANCED. (NORMAL POINT ONLY).

DRIVING MOTOR							MACHINE ON TEST						
INPUT		FIELD AMP	RPM	KW INPUT	KW ARM & BRUSH I²R	KW INPUT MINUS I²R	KW CORE LOSS	RATIO= VOLTS METER	VOLTS ACTUAL	FIELD AMP	FIELD VOLTS	RPM	
VOLTS	AMP												METER NO.
							GENERATOR RESISTANCES						SCALE
							UNIT NO. 1						
		STATOR								ROTOR			
				Temperature °C by Detector								Temperature by Thermometer °C	
A - B	1.758	X.10		1	33.5			Across Rings				33.4	
A - C	1.749	X.10		2	33.0			1.153 x .2				33.4	
B - C	1.749	X.10		3	34.0							33.6	
				4	34.5							33.5	
				5	34.5								
				6	34.5								
				7	35.0								
				8	35.0								
				9	35.0								
				10	34.5								
				11	34.0								
							UNIT NO. 2						
												Temperature by Thermometer °C	
A - B													
A - B	1.682	X.10		1	25.0			Across Rings				24.2	
A - C	1.682	X.10		2	25.0			1.1025 x .2				23.4	
B - C	1.682	X.10		3	25.5							24.2	
				4	25.0							23.3	
				5	24.0							24.1	
				6	24.0							24.2	
				7	25.0								
				8	24.5								
				9	24.5								
				10	24.75								
				11	24.75								
				12	25.0								
				IDLE D.M. INPUT	I²R OF D. M.	FIXED LOSSES	WINDAGE & FRICTION						

DRIVING MOTOR			TESTED BY		APPROVED BY	
SERIAL NO.	DRIVE	DIRECT BELT GEAR	NAME	P. A. Rieland A. Seidl W. O. Rowe	TEST DEPT.	ENG'G DEPT.
			DATE	11-10-53		

PULLEY OR GEAR RATIO=

TYPE	KVA ~~KW~~ ~~HP~~	PF	VOLTS	AMP	PHASES	CYCLES	RPM	AIR GAP SPECIFIED	AIR GAP ACTUAL
AV	12,500	.90	13,800	523	3	60	100		

CUSTOMER

~~CORE LOSS AND SATURATION~~

ORDER NO 2-0550-24027 SERIAL NO. 35 ROTOR NO.

FORM 176-2-1
PRINTED 12-49

ALLIS-CHALMERS MANUFACTURING COMPANY

ON COMPLETE TESTS TAKE VOLTAGE READINGS AT APPROXIMATELY 25, 35, 45, 55, 75, 85, 95, 100, 105, 110, 120, 130, AND 140% OF NORMAL. VOLTAGE READINGS MUST BE TAKEN WITH INCREASING VALUES OF EXCITATION. IF, FOR ANY REASON, THE EXCITATION IS DECREASED, IT SHOULD BE BROUGHT DOWN TO ZERO AND THEN INCREASED TO THE POINT TO BE READ.

RECORD THE VOLTAGE OF ALL PHASES TO SEE THAT THEY ARE BALANCED. (NORMAL POINT ONLY).

DRIVING MOTOR							MACHINE ON TEST						
INPUT		FIELD AMP	RPM	KW INPUT	KW ARM & BRUSH I²R	KW INPUT MINUS I²R	KW CORE LOSS	RATIO= VOLTS METER	VOLTS ACTUAL	FIELD AMP	FIELD VOLTS	RPM	
OLTS	AMP												
					GENERATOR RESISTANCES								METER NO.
					UNIT NO. 3								SCALE
		STATOR								ROTOR			
				Temperature °C by Detector								Temperature °C by Thermometer	
				1	30.1			Across Rings					
-B	1.715	X.10		2	31.0								
-C	1.714	X.10		3	31.0			2.295 x 0.1				32.0	
-A	1.716	X.10		4	30.4								
				5	30.3							33.0	
				6	30.0								
				7	30.0							32.7	
				8	30.5								
				9	30.5							32.5	
				10	30.9								
				11	31.0								
				12	30.9								
					UNIT NO. 4								
				1	--			Across Rings					
-B	1.714	X.10		2	31.5								
-C	1.713	X.10		3	--			1.138 x .2					
				4	29.5								
-B	1.713	X.10		5	--							30.0	
				6	32.0								
				7	--							31.0	
				8	31.0								
				9	--							30.3	
				10	29.0								
				11	--							31.0	
				12	31.0								
				IDLE D.M. INPUT	I²R OF D. M.	FIXED LOSSES	WINDAGE & FRICTION						

DRIVING MOTOR			TESTED BY		APPROVED BY	
RIAL NO.	DRIVE	DIRECT BELT GEAR	NAME	T. Armbruster T. Johnson	TEST DEPT.	ENG'G DEPT.
LLEY OR GEAR RATIO=			DATE	11-14-53 11-10-53		

TYPE	KVA ~~KW~~ ~~HP~~	PF	VOLTS	AMP	PHASES	CYCLES	RPM	AIR GAP SPECIFIED	AIR GAP ACTUAL
AV	12,500	.90	13,800	523	3	60	100		

CUSTOMER

~~CORE LOSS AND SATURATION~~

ORDER NO 2-0550-24027 SERIAL NO. ROTOR NO.

FORM 176-2-1
PRINTED 12-49

ALLIS-CHALMERS MANUFACTURING COMPANY

ON COMPLETE TESTS TAKE VOLTAGE READINGS AT APPROXIMATELY 25, 35, 45, 55, 75, 85, 95, 100, 105, 110, 120, 130, AND 140% OF ORMAL. VOLTAGE READINGS MUST BE TAKEN WITH INCREASING VALUES OF EXCITATION. IF, FOR ANY REASON, THE EXCITATION IS DECREASED, IT SHOULD BE BROUGHT DOWN TO ZERO AND THEN INCREASED TO THE POINT TO BE READ.

RECORD THE VOLTAGE OF ALL PHASES TO SEE THAT THEY ARE BALANCED. (NORMAL POINT ONLY).

DRIVING MOTOR							MACHINE ON TEST						
INPUT		FIELD AMP	RPM	KW INPUT	KW ARM & BRUSH I²R	KW INPUT MINUS I²R	XX ~~KW FIXED LOSS X~~	RATIO= VOLTS METER	VOLTS XX ~~VOLTS X~~	FIELD AMP	FIELD VOLTS	RPM	
OLTS	AMP												METER NO.
							volts	13997	9397	44474	49370		SCALE
							A=C	A=B	B=C				
							x120	x120	x120	x13.33	x1		
								40.0	40.5	6.3	21.0		
								66.8	67.0	10.7	35.5		
								87.7	88.0	14.8	47.0		
								103.0	103.1	18.8	59.0		
								109.9	110.0	21.4	67.0		
							113.8	113.8	114.0	23.5	73.5		
							117.9	117.9	118.1	26.0	81.0		
								122.9	123.2	30.1	93.5		
								125.1	125.8	32.9	102.5		
								128.8	129.0	37.1	116.0		
								130.9	131.1	40.4	126.5		
								133.0	133.5	44.6	140.5		
								134.2	135.0	47.5	150.0		
								137.8	138.1	57.5	179.0		
								138.1	138.7	59.2	186.0		
				IDLE D.M. INPUT	I²R OF D. M.	FIXED LOSSES	WINDAGE & FRICTION						

DRIVING MOTOR			TESTED BY		APPROVED BY	
SERIAL NO.	DRIVE	DIRECT BELT GEAR	NAME	T. Armbruster W. Rowe A. Seidl T. Johnson	TEST DEPT.	ENG'G DEPT.
PULLEY OR GEAR RATIO=			DATE	11-11-53		

TYPE	KVA	PF	VOLTS	AMP	PHASES	CYCLES	RPM	AIR GAP SPECIFIED	AIR GAP ACTUAL
AV	~~XX BE~~ 12,500								
	12,500	.90	13,800	523	3	60	100		

CUSTOMER Dept. of the Army Corps. of Engineers Fort Gibson Power House

CORE LOSS AND SATURATION

ORDER NO 2-0550-24027 SERIAL NO. 154449 ROTOR NO.

FORM 176-2-1
PRINTED 12-49

ALLIS-CHALMERS MANUFACTURING COMPANY

ON COMPLETE TESTS TAKE VOLTAGE READINGS AT APPROXIMATELY 25, 35, 45, 55, 75, 85, 95, 100, 105, 110, 120, 130, AND 140% OF NORMAL. VOLTAGE READINGS MUST BE TAKEN WITH INCREASING VALUES OF EXCITATION. IF, FOR ANY REASON, THE EXCITATION IS DECREASED, IT SHOULD BE BROUGHT DOWN TO ZERO AND THEN INCREASED TO THE POINT TO BE READ.

RECORD THE VOLTAGE OF ALL PHASES TO SEE THAT THEY ARE BALANCED. (NORMAL POINT ONLY).

DRIVING MOTOR							MACHINE ON TEST						
INPUT		FIELD AMP	RPM	KW INPUT	KW ARM & BRUSH I²R	KW INPUT MINUS I²R	KW CORE LOSS	RATIO= VOLTS METER	VOLTS ACTUAL	FIELD AMP	FIELD VOLTS	RPM	
VOLTS	AMP												METER NO.
													SCALE
						TELEPHONE	INTERFERENCE						
TIF Terminal-Terminal									Terminal-Neutral				
Meter No.				13897	577	577			13997	577	577		
				Volts	Volts	Amps			Volts	Volts	Amps		
Multiplier				x120					x120				
			A-B	107.0	43.0	5.5		A-N	61.80	14.5	2.6		
			B-C	107.1	43.0	5.5		B-N	61.85	14.5	2.6		
			A-C	107.0	43.0	5.5		C-N	61.80	14.5	2.6		
			A-B	114.2	49.0	16.3		A-N	66.0	16.5	6.6		
			B-C	114.4	49.0	16.0		B-N	66.1	16.5	6.6		
			A-C	114.2	49.0	16.3		C-N	66.0	16.5	6.5		
			A-B	121.0	54.5	13.5		A-N	69.0	18.5	6.5		
			B-C	121.3	54.5	13.5		B-N	70.0	18.5	6.5		
			A-C	121.0	54.5	13.5		C-N	69.9	18.5	6.5		
				IDLE D.M. INPUT	I²R OF D. M.	FIXED LOSSES	WINDAGE & FRICTION						

DRIVING MOTOR			TESTED BY		APPROVED BY	
SERIAL NO.	DRIVE	DIRECT BELT GEAR	NAME	T. Armbruster A. Seidl W. Rowe T. Johnson	TEST DEPT.	ENG'G DEPT.
PULLEY OR GEAR RATIO=			DATE			

TYPE	KVA	PF	VOLTS	AMP	PHASES	CYCLES	RPM	AIR GAP SPECIFIED	AIR GAP ACTUAL
AV	12,500	.90	13,800	523	3	60	100		

CUSTOMER

ORDER NO 2-0550-24027 SERIAL NO. 154449 ROTOR NO.

~~XCORE LOSS AND SATURATION XX~~

UNIT 2

ALLIS-CHALMERS MANUFACTURING COMPANY

Form MG 10-1-45

DATA SHEET

TURE RESISTANCE BETWEEN TERMINALS				TEMPERATURES DURING RESISTANCE TESTS			FIELD RESISTANCE AT RINGS					
WHEN KELVIN BRIDGE IS USED RECORD BATTERY VOLTAGE	AIR TEMP.			ARMATURE	FIELD		WHEN KELVIN BRIDGE IS USED RECORD BATTERY VOLTAGE	COLD AIR TEMP.				
	VOLTS	AMP	OHMS.	THERMOMETER DETECTOR	COPPER	IRON		VOLTS	AMP	OHMS.		
INST. NO.							INST. NO.					
TERMINAL 1-2							STANDING					
TERMINAL 2-3							RUNNING					
TERMINAL 3-1							ROTOR	INSULATION MEG. OHMS			PUNCTURE TEST VOLTS	SECONDS
							STATOR					

SHORT CIRCUIT TEST

DRIVING MOTOR					ALTERNATOR								
ARMATURE		FIELD AMP I_f	KW EXI_a	DRIV. MOTOR $I_a^2R_a$	$EXI_a - I_a^2R_a = KN$	SHORT CIR. LOSS $KN - K_1 = K_2$	COPPER LOSS	STRAY LOSS $K_2 - 1.5I_a^2R_a$	ARMATURE TRANS. RATIO 1200/5		ACTUAL AMP I_a	FIELD		RPM	STATOR COIL TEMPERATURE BY DETECTOR-THERMOMETER
VOLTS	AMP I_a								AMP LINE 1	AMP LINE 2		VOLTS	AMP		
					meter no.							49370	44474		
					scale				2.5	2.5		300	75		
									x120	x120		x1	x13.33		
									2.06	2.04		27.0	8.2		
									3.18	3.18		40.5	12.6		
									4.75	4.75		59.0	18.9		
					scale				5.0	5.0					
									x240	x240					
									2.88	2.88		71.0	23.0		
									3.33	3.33		83.0	26.8		

TYPE	KVA	VOLTS	DRIVING MOTOR NO	APPROVED
AV	XX 12,500	13,800		TEST DEPT. / ENG. DEPT.

AMP	SPEED	PHASES	CYCLES
523	100	3	60

ACTUAL AMP = (AVG. OF AMP LINE 1 AND AMP LINE 2) X TRANS. RATIO
COPPER LOSS = (ACTUAL AMP)² (ARM. RES. BETWEEN TERMINALS) X 1.5

ARM. RES. FOR COPPER LOSS TAKEN AT AVERAGE STATOR COIL TEMP. —5°C (WHEN BY DETECTOR) OR —10 C. (WHEN BY THERMOMETER

XXXXXXXX

PULLEY OR GEAR RATIO

xxxxxxx T.Armbruster
W.Rowe
xxxxxxxT.Johnson
A. Seidl

TESTED BY

DATE 11-12-53

AC SHORT CIRCUIT, SHORT CIRCUIT CORE LOSS, AND RESISTANCES

ORDER NO. 2-0550-24027 SERIAL NO. 154449

339

Form MG 9-1-46

ALLIS-CHALMERS MANUFACTURING COMPANY

DATA SHEET

ATURE RESISTANCE BETWEEN TERMINALS			
WHEN KELVIN BRIDGE IS USED RECORD BATTERY VOLTAGE	AIR TEMP.		
	VOLTS	AMP	OHMS.
INST. NO.			
TERMINAL 1-2			
TERMINAL 2-3			
TERMINAL 3-1			

TEMPERATURES DURING RESISTANCE TESTS		
ARMATURE	FIELD	
THERMOMETER DETECTOR	COPPER	IRON

FIELD RESISTANCE AT RINGS			
WHEN KELVIN BRIDGE IS USED RECORD BATTERY VOLTAGE	COLD		
	AIR TEMP.		
	VOLTS	AMP	OHMS
INST. NO.			
STANDING			
RUNNING			

	INSULATION	PUNCTURE TEST	
	MEG. OHMS	VOLTS	SECONDS
ROTOR			
STATOR			

SHORT CIRCUIT TEST

DRIVING MOTOR						ALTERNATOR										
ARMATURE		FIELD AMP I_f	KW $E \times I_a$	DRIV. MOTOR $I_a^2 R_a$	$E \times I_a - I_a^2 R_a = KN$	SHORT CIR. LOSS $KN - K_1 = K_2$	COPPER LOSS	STRAY LOSS $K_2 - 1.5 I_a^2 R_a$	ARMATURE			FIELD		RPM	STATOR COIL TEMPERATURE BY DETECTOR-THERMOMETER	
VOLTS	AMP I_a								TRANS. RATIO		ACTUAL AMP I_A	VOLTS	AMP			
									AMP LINE 1	AMP LINE 2						
						METER NO.			5156			44474				
						MULTIPLIER			x120			x13.33				
									3.95			13.1				
									3.13			10.4				
									2.40			8.0				
									1.99			6.6				
									1.25			4.1				
									4.73			15.6				

TYPE	AMP	SPEED	PHASES	CYCLES
AV	523	100	3	60

KVA 12,500 VOLTS 13,800

ACTUAL AMP = (AVG. OF AMP LINE 1 AND AMP LINE 2) X TRANS. RATIO
COPPER LOSS = (ACTUAL AMP)^2 (ARM. RES. BETWEEN TERMINALS) X 1.5

ARM. RES. FOR COPPER LOSS TAKEN AT AVERAGE STATOR COIL TEMP. — 5°C. (WHEN BY DETECTOR) OR —10°C. (WHEN BY THERMOMETER)

DRIVING MOTOR NO.

DIRECT BELT OR GEAR DRIVE

PULLEY OR GEAR RATIO

APPROVED

TEST DEPT.	ENG. DEPT.
~~A. Seidl~~	
W. Rowe	
T. Johnson	
T. Armbruster	

TESTED BY

DATE 11-14-53

AC SHORT CIRCUIT, SHORT CIRCUIT CORE LOSS, AND RESISTANCES

ORDER NO. 2-0550-24027 SERIAL NO. 154449 PAGE NO. 40

FORM 175-2-1
PRINTED 12-45

ALLIS-CHALMERS MANUFACTURING COMPANY

ON COMPLETE TESTS TAKE VOLTAGE READINGS AT APPROXIMATELY 25, 35, 45, 55, 75, 85, 95, 100, 105, 110, 120, 130, AND 140% OF RMAL. VOLTAGE READINGS MUST BE TAKEN WITH INCREASING VALUES OF EXCITATION. IF, FOR ANY REASON, THE EXCITATION IS DECREASED, IT SHOULD BE BROUGHT DOWN TO ZERO AND THEN INCREASED TO THE POINT TO BE READ.

RECORD THE VOLTAGE OF ALL PHASES TO SEE THAT THEY ARE BALANCED. (NORMAL POINT ONLY).

DRIVING MOTOR							MACHINE ON TEST						
INPUT		FIELD AMP	RPM	KW INPUT	KW ARM & BRUSH I²R	KW INPUT MINUS I²R	~~KW~~ Amps	RATIO= VOLTS METER	VOLTS ~~ACTUAL~~	FIELD AMP	~~POWER~~ VOLTS Amps	RPM	
OLTS	AMP												METER NO.
							5156	9397	13997	44474	8584		
							x160	x120	x120	x13.33	x160		SCALE
							3.27	115.1	115.0	64.0	3.23		
				IDLE D.M. INPUT	I²R OF D. M.	FIXED LOSSES	WINDAGE & FRICTION						

DRIVING MOTOR			TESTED BY		APPROVED BY	
ERIAL NO.	DRIVE	DIRECT BELT GEAR	NAME	T. Armbruster A. Seidl W. Rowe ~~T. Johnson~~	TEST DEPT.	ENG'G DEPT.
ULLEY OR GEAR RATIO=			DATE	11-15-53		

TYPE	~~KVA~~ ~~KW~~ ~~BH~~	PF	VOLTS	AMP	PHASES	CYCLES	RPM	AIR GAP SPECIFIED	AIR GAP ACTUAL
AV	12,500	.90	13,800	523	3	60	100		

~~ENGINEERING DEPARTMENT~~

CUSTOMER

ORDER NO 2-0550-24027 SERIAL NO. 154449 41 ROTOR NO.

ALLIS-CHALMERS MFG. CO.
MILWAUKEE, WIS.

Alternating Current Heat Run Test Sheet

A. M.	P. M.	ARMATURE VOLTS	AMP	AMP	FIELD VOLTS STUDS	AMPS. EXC.	R. P. M.	ARM. COIL TEMP. BY DETECTOR °C 1	2	6	7	8	12
MULTIPLIER		X120	X160	X160	X1	X13.33							
8:30		115.5	3.25	3.23	88.0	26.0	100	64.5	64.8	66.0	65.2	65.2	64.0
9:30		115.3	3.32	3.31	90.0	26.5	100	72.0	72.0	73.5	73.0	72.5	70.5
10:00		115.0	3.23	3.23	116.0	39.5	100	74.0	74.2	76.0	75.2	75.0	72.7
11:00		115.0	3.23	3.23	139.5	39.0	100	80.2	80.5	82.3	81.5	80.5	79.0
11:30		114.9	3.20	3.22	137.0	38.1	100	82.5	83.0	84.5	84.0	83.0	81.0
12:00		115.0	3.22	3.23	139.0	38.6	100	82.5	83.0	84.9	84.1	83.5	81.0
	12:30	114.9	3.12	3.13	130.5	36.8	100	81.0	81.4	83.0	82.3	82.0	79.5
	1:00	115.0	3.19	3.20	132.5	37.5	100	79.9	81.2	81.9	81.4	80.8	78.2
	1:30	114.9	3.19	3.20	132.5	37.5	100	79.2	80.2	81.2	80.7	80.0	78.0
	2:00	114.8	3.20	3.23 *	132.8	37.5	100	79.0	79.3	80.9	80.5	80.0	77.2
					128.5	37.5			RISE = 47.01°C				

REMARKS

Hot Fld. Res. = $\frac{128.5}{3775 \times 13.33}$ = 0.257 Ohms

Fld. Temp. = $\frac{.257}{.229}$(234.5 + 33.89) − 234.5 = 67.5°C

Fld. Temp. Rise = 67.5 − 33.89 = 33.61°C

STATION	DUCT		INLET 1	2	3	4	5	6	7	8	AIR TEMP. °C OUTLET 1	2	3	4	5	6
			36.0	32.7	32.5	35.3	36.0	32.0	32.5	35.0						
		COOLING	38.9	34.5	34.2	38.1	38.0	33.5	34.0	37.5						
		WATER	41.0	36.0	36.0	40.0	40.0	34.8	35.0	39.8						
		OFF	45.0	38.5	38.5	43.0	44.0	37.0	37.5	43.0						
			46.5	39.5	39.5	45.0	46.0	38.0	38.5	44.5						
			36.0	34.5	34.5	36.0	39.5	35.0	35.0	38.0						
			33.5	32.0	32.0	33.5	39.0	34.5	34.5	37.5						
		COOLING WATER ON	33.0	32.0	32.0	33.0	38.0	34.0	34.0	37.0		56.0		56.5		
		1/2 OF 1 SCALE	33.0	32.0	32.0	33.0	38.0	34.0	34.0	37.0	57.2	56.8		54.5		56.0
70.2 71.2 58.8 60.0		DIVISION ON FLOW METER	32.5	31.8	32.0	33.0	38.0	34.0	34.0	36.0						
Rise 37.31°C	Rise = 26.11°C		Average = 33.89°C								Avg. = 56.16					

TIME	NORMAL LOAD TEMP. °C	RISE °C	TIME	TEMP. °C NORMAL LOAD	RISE °C	APPROVED
ROTOR COILS			INSIDE ARM.			TEST DEPT. / ENG. DEPT.
IRON			ARM. COILS			~~STATOR MEGOHMS~~
RING			POLE TIP			~~ROTOR MEGOHMS~~
SLIP RING			AIR			TESTED BY: T.F.Armbruster, A. Seidl, W. O. Rowe, T. Johnson
						DATE 11-17-53

RATIO OF TRANSFORMATION

METER NO.	TERMINAL I-II	TERMINAL II-III	TERMINAL I-III
~~STATOR~~	* Voltage on Rings		
VOLTS ROTOR			

E= (TEST)

NOISE IDLE

NOISE AT % LOAD

VENTILATION

TYPE AV — K.V.A. 12,500 — VOLTS 13,800 — AMPS 523 — R.P.M. 100 — PH 3 — CY 60

ORDER NO. 2-0550-24027 — SERIAL NO. 154449 — ROTOR NO.

ALLIS-CHALMERS MFG. CO.
MILWAUKEE, WIS.

Alternating Current Heat Run Test Sheet

	ARMATURE			FIELD			ARM. COIL TEMP. BY DETECTOR °C						REMARKS
R NO.	9397	8584	5156										
. M. / P. M.	VOLTS	AMP	AMP	VOLTS STUDS	AMPS. EXC.	R P M	1	2	6	7	8	12	
ULTIPLIER	X120	X160	X160	X1	X13.33								
2:30	115.2	3.72	3.72	174.5	47.0	100	82.0	82.5	84.5	83.5	83.0	80.5	
3:00	115.4	3.71	3.72	174.5	47.4	100	86.0	86.5	88.5	87.6	87.2	85.0	
3:00	115.1	3.71	3.71	177.0	47.6	100	89.1	89.6	91.3	91.4	90.5	87.0	
4:00	115.4	3.70	3.70	177.0	47.5	100	90.5	91.0	93.5	92.5	91.5	89.0	RISE = 57.17°C
				173.0	47.5	Across Rings							

HOT FIELD RESISTANCE = $\frac{173.0}{47.5 \times 13.33}$ = 0.273 OHMS

FIELD TEMPERATURE = $\frac{.273}{.231}$ (234.5 + 36.3) - 234.5 = 85.5

FIELD TEMPERATURE RISE = 85.5 - 36.33 = 49.17°C

IRON TEMP. °C			DUCT TEMP. °C			INLET ~~WING COIL TEMP. °C~~ ~~BY THERMOMETER~~				AIR TEMP. °C INLET AMBIENT				AIR TEMP. °C OUTLET					
						1	2	3	4	5	6	7	8	1	2	3	4	5	6
			COOLING WATER ON			33.0	32.0	32.0	33.5	38.5	34.5	34.5	37.0						
			½ OF 1 SCALE			34.0	33.0	33.0	34.5	39.5	35.0	35.0	37.5						
			DIVISION OF FLOW			34.5	33.5	33.5	35.0	40.8	36.0	36.0	39.0	61.0	60.8	62.0			
			METER			35.0	34.0	34.0	35.8	40.8	36.0	36.0	39.0	62.8	61.2	62.1			
														AVERAGE = 60.98					
1:00	77.7	76.2	66.3	65.8		AVG. INLET AIR TEMPERATURE = 36.33°C								RISE = 24.65°C					
RISE = 41.37°C			RISE = 29.97°C																

		NORMAL LOAD TEMP. °C	RISE °C		TEMP. °C NORMAL LOAD	RISE °C	APPROVED	
TIME				TIME			TEST DEPT.	ENG. DEPT.
ROTOR	COILS			INSIDE ARM.			~~STATOR WEDGING~~	T. Armbruster
	IRON			ARM. COILS			~~ROTOR WEDGING~~	W. O. Rowe
	RING			POLE TIP				A. Seidl
	SLIP RING			AIR			TESTED BY	T. Johnson
							DATE 11-17-53	

RATIO OF TRANSFORMATION	TERMINAL I-II	TERMINAL II-III	TERMINAL I-III
METER NOS.			
S STATOR			
VOLTS ROTOR			

E₂ = (TEST)
NOISE IDLE
NOISE AT % LOAD
VENTILATION

TYPE AV — K V A 12,500 VOLTS 13,800 AMPS 523 R P M 4100 PH 3 CY 60

ORDER NO 2-0550-24027 SERIAL NO. 154449 ROTOR NO.

FORM 176-2-1
PRINTED 12-49

ALLIS-CHALMERS MANUFACTURING COMPANY

ON COMPLETE TESTS TAKE VOLTAGE READINGS AT APPROXIMATELY 25, 35, 45, 55, 75, 85, 95, 100, 105, 110, 120, 130, AND 140% OF 'ORMAL. VOLTAGE READINGS MUST BE TAKEN WITH INCREASING VALUES OF EXCITATION. IF, FOR ANY REASON, THE EXCITATION IS DECREASED, IT SHOULD BE BROUGHT DOWN TO ZERO AND THEN INCREASED TO THE POINT TO BE READ.

RECORD THE VOLTAGE OF ALL PHASES TO SEE THAT THEY ARE BALANCED. (NORMAL POINT ONLY).

DRIVING MOTOR							MACHINE ON TEST						
INPUT		FIELD AMP	RPM	KW INPUT	KW ARM & BRUSH I²R	KW INPUT MINUS I²R	KW CORE LOSS	RATIO= VOLTS METER	VOLTS ACTUAL	FIELD AMP	FIELD VOLTS	RPM	
VOLTS	AMP												METER NO.
													SCALE
		RHEOSTAT TRAVEL TIME											
		FROM RESISTANCE ALL IN TO ALL OUT AND VICE VERSA											
									TEST 1			TEST 2	
		UNIT NO. 1							27.4 sec.			27.4 sec.	
		UNIT NO. 2							19.4 sec.			19.6 sec.	
		UNIT NO. 3							28.4 sec.			28.4 sec.	
		UNIT NO. 4							34.0 sec.			33.8 sec.	
				IDLE D.M. INPUT	I²R OF D. M.	FIXED LOSSES	WINDAGE & FRICTION						

DRIVING MOTOR			TESTED BY		APPROVED BY	
ERIAL NO.	DRIVE	DIRECT BELT GEAR	NAME	T. Armbruster A. Seidl	TEST DEPT.	ENG'G DEPT.
ULLEY OR GEAR RATIO=			DATE	11-11-53		

TYPE	KVA ~~KW~~ ~~HP~~	PF	VOLTS	AMP	PHASES	CYCLES	RPM	AIR GAP SPECIFIED	AIR GAP ACTUAL
AV	12,500	.90	13,800	523	3	60	100		

~~CORE LOSS AND SATURATION~~

44

CUSTOMER

ORDER NO 2-0550-24027

SERIAL NO. 154449

ROTOR NO.

UNITS 1-2-3-4

FORM 176-2-1
PRINTED 12-49

ALLIS-CHALMERS MANUFACTURING COMPANY

ON COMPLETE TESTS TAKE VOLTAGE READINGS AT APPROXIMATELY 25, 35, 45, 55, 75, 85, 95, 100, 105, 110, 120, 130, AND 140% OF ORMAL. VOLTAGE READINGS MUST BE TAKEN WITH INCREASING VALUES OF EXCITATION. IF, FOR ANY REASON, THE EXCITATION IS DECREASED, IT SHOULD BE BROUGHT DOWN TO ZERO AND THEN INCREASED TO THE POINT TO BE READ.

RECORD THE VOLTAGE OF ALL PHASES TO SEE THAT THEY ARE BALANCED. (NORMAL POINT ONLY).

DRIVING MOTOR							MACHINE ON TEST						
INPUT		FIELD AMP	RPM	KW INPUT	KW ARM & BRUSH I²R	KW INPUT MINUS I²R	KW CORE LOSS	RATIO= VOLTS METER	VOLTS ACTUAL	FIELD AMP	FIELD VOLTS	RPM	
VOLTS	AMP												METER NO.
													SCALE
			ZERO SEQUENCE REACTANCE										
			Per paragraph 1.894 of AIEE test code for synchronous machines										
			meter no.				8584	5156			9597		
							Amps	Amps			Volts (L-N)		
							PH.	NEUT.					
							x240	x160			x10		
							1.65	3.23			163.0		
							1.76	3.44			173.0		
				IDLE D.M. INPUT	I²R OF D. M.	FIXED LOSSES	WINDAGE & FRICTION						

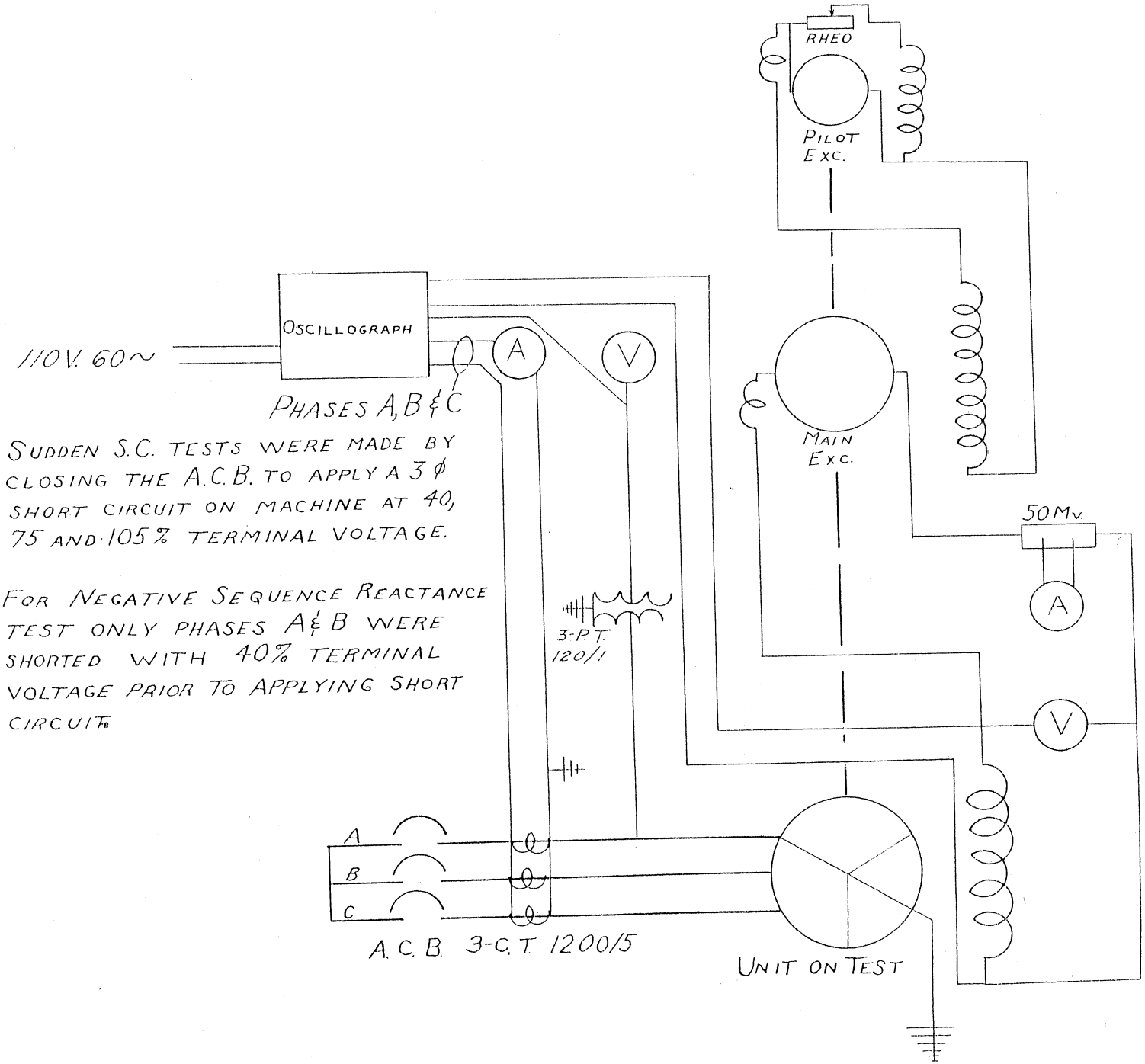
DRIVING MOTOR			TESTED BY		APPROVED BY	
SERIAL NO.	DRIVE	DIRECT BELT GEAR	NAME	T. Armbruster A. Seidl W. Rowe T. Johnson	TEST DEPT.	ENG'G DEPT.
PULLEY OR GEAR RATIO=			DATE	11-14-53		

TYPE	~~KVA~~ ~~HP~~	PF	VOLTS	AMP	PHASES	CYCLES	RPM	AIR GAP SPECIFIED	AIR GAP ACTUAL
AV	12,500	.90	13,800	523	3	60	100		

CUSTOMER

~~X CORE LOSS AND SATURATION X~~

ORDER NO. 2-0550-24027 SERIAL NO. 154449 ROTOR NO.



SUDDEN SHORT CIRCUIT TEST WIRING DIAGRAM

SUDDEN S.C. TESTS WERE MADE BY CLOSING THE A.C.B. TO APPLY A 3 ϕ SHORT CIRCUIT ON MACHINE AT 40, 75 AND 105% TERMINAL VOLTAGE.

FOR NEGATIVE SEQUENCE REACTANCE TEST ONLY PHASES A & B WERE SHORTED WITH 40% TERMINAL VOLTAGE PRIOR TO APPLYING SHORT CIRCUIT.

ALLIS-CHALMERS MFG. CO. MILWAUKEE, WIS., U. S. A.

MOTOR & GENERATOR DESIGN DEPT.

DRAWN THT DATE 4-4-52 TRACED _____ DATE _____

CHECKED _____ DATE _____ O. K. _____ DATE _____

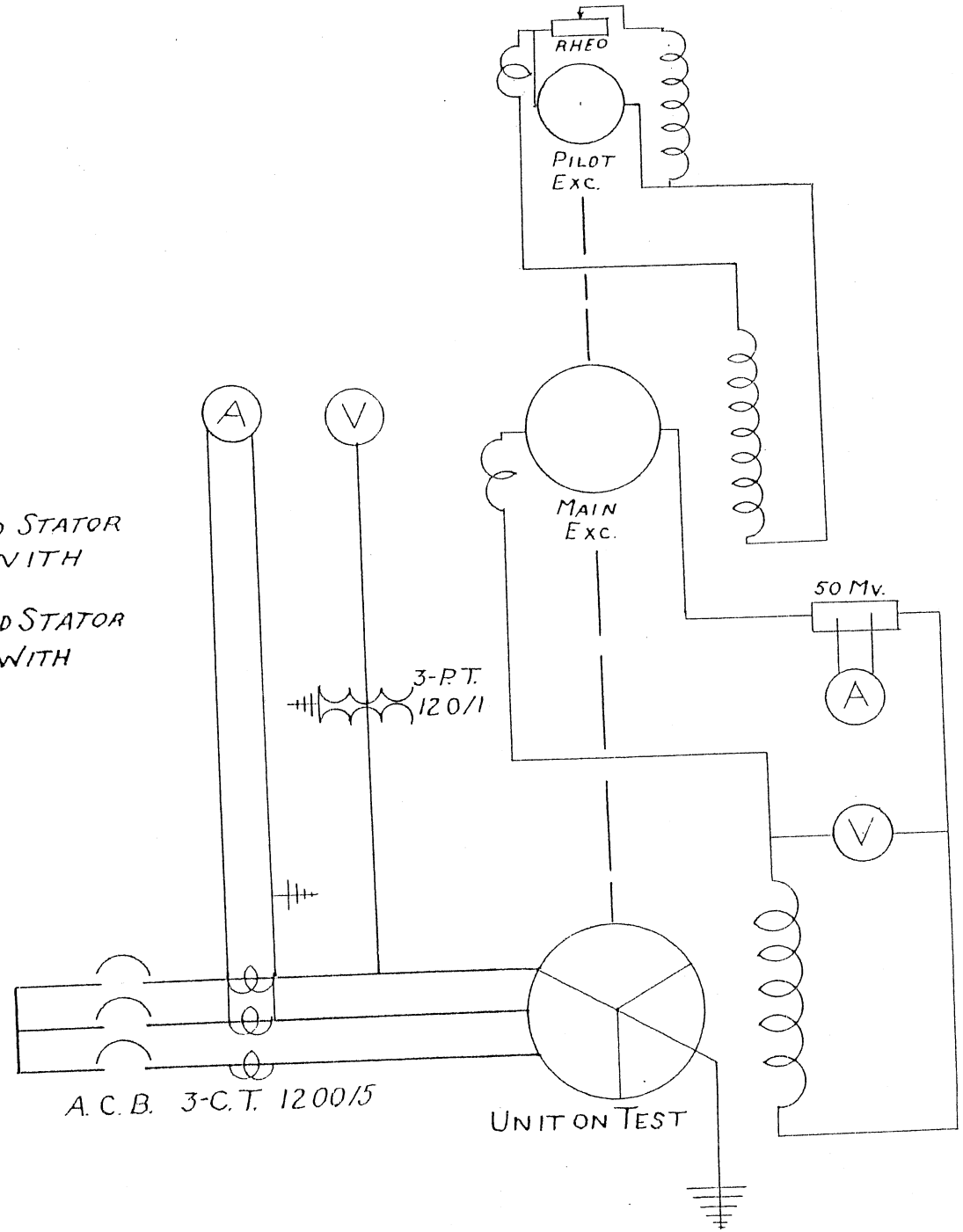
SIMILAR TO _____ SCALE _____ = 12"

10

0-18381

RM 5080-2-2 11-52 10M SCHILLER-MILWAUKEE

NOTE:
FOR O.C. SATURATION READ STATOR VOLTS AND FIELD AMPS WITH A.C.B. OPEN.
FOR S.C. SATURATION READ STATOR AMPS AND FIELD AMPS WITH A.C.B. CLOSED.



OPEN CIRCUIT & SHORT CIRCUIT SAT. WIRING DIAGRAMS

ALLIS-CHALMERS MFG. CO. MILWAUKEE, WIS., U. S. A.

MOTOR & GENERATOR DESIGN DEPT.

DRAWN TKL DATE 12/4/41 TRACED _____ DATE _____

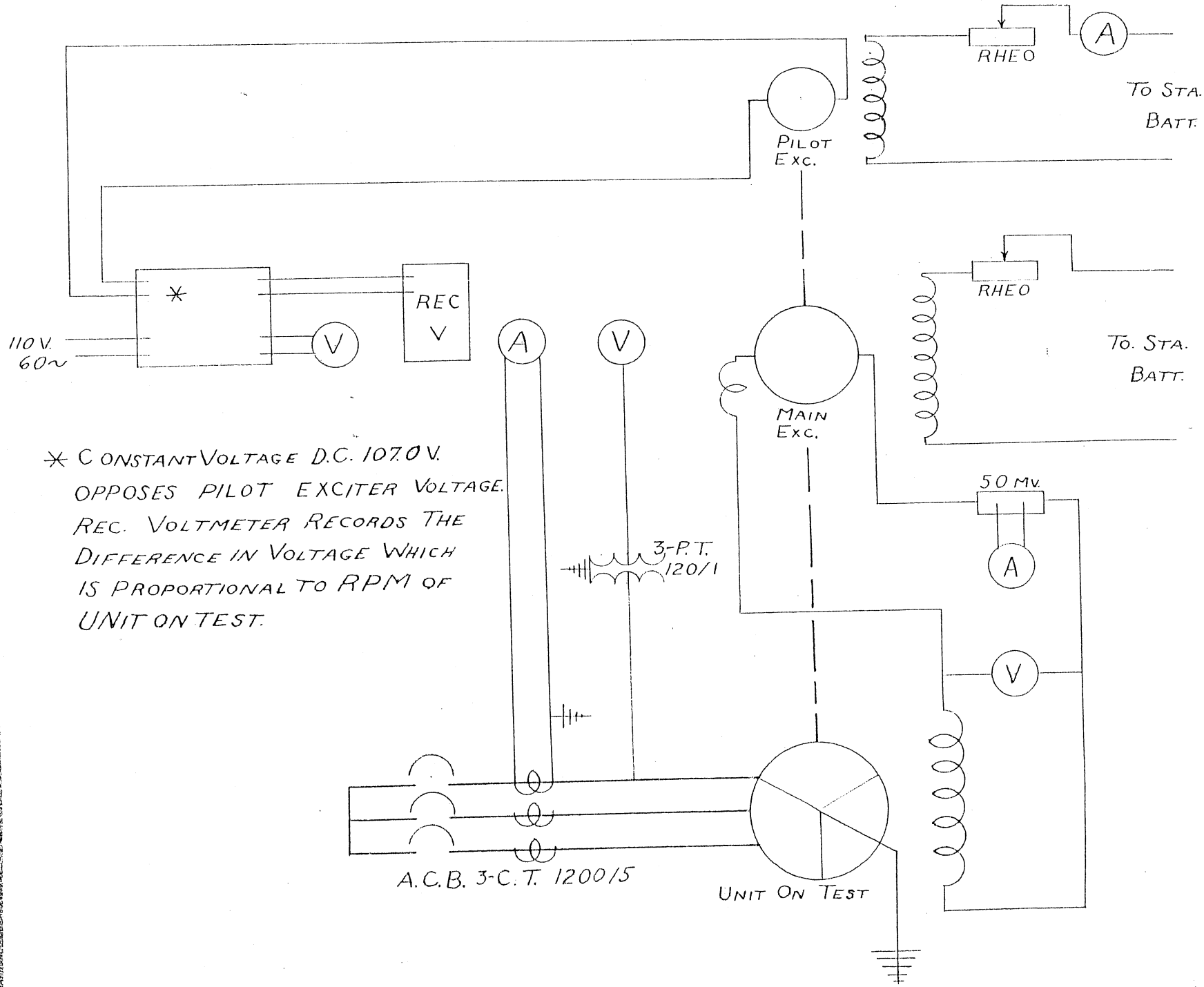
CHECKED _____ DATE _____ O. K. _____ DATE _____

SIMILAR TO _____ SCALE _____

0-18979

0-18979

RM 5080-2-2 11-52 10M SCHILLER-MILWAUKEE



* CONSTANT VOLTAGE D.C. 107.0 V. OPPOSES PILOT EXCITER VOLTAGE. REC. VOLTMETER RECORDS THE DIFFERENCE IN VOLTAGE WHICH IS PROPORTIONAL TO RPM OF UNIT ON TEST.

DECELERATION TEST
WIRING DIAGRAM

ALLIS-CHALMERS MFG. CO. MILWAUKEE, WIS., U. S. A.
MOTOR & GENERATOR DESIGN DEPT.
DRAWN TKC DATE 8/16/51 TRACED _____ DATE _____
CHECKED _____ DATE _____ O. K. _____ DATE _____
SIMILAR TO _____ SCALE _____ = 12"

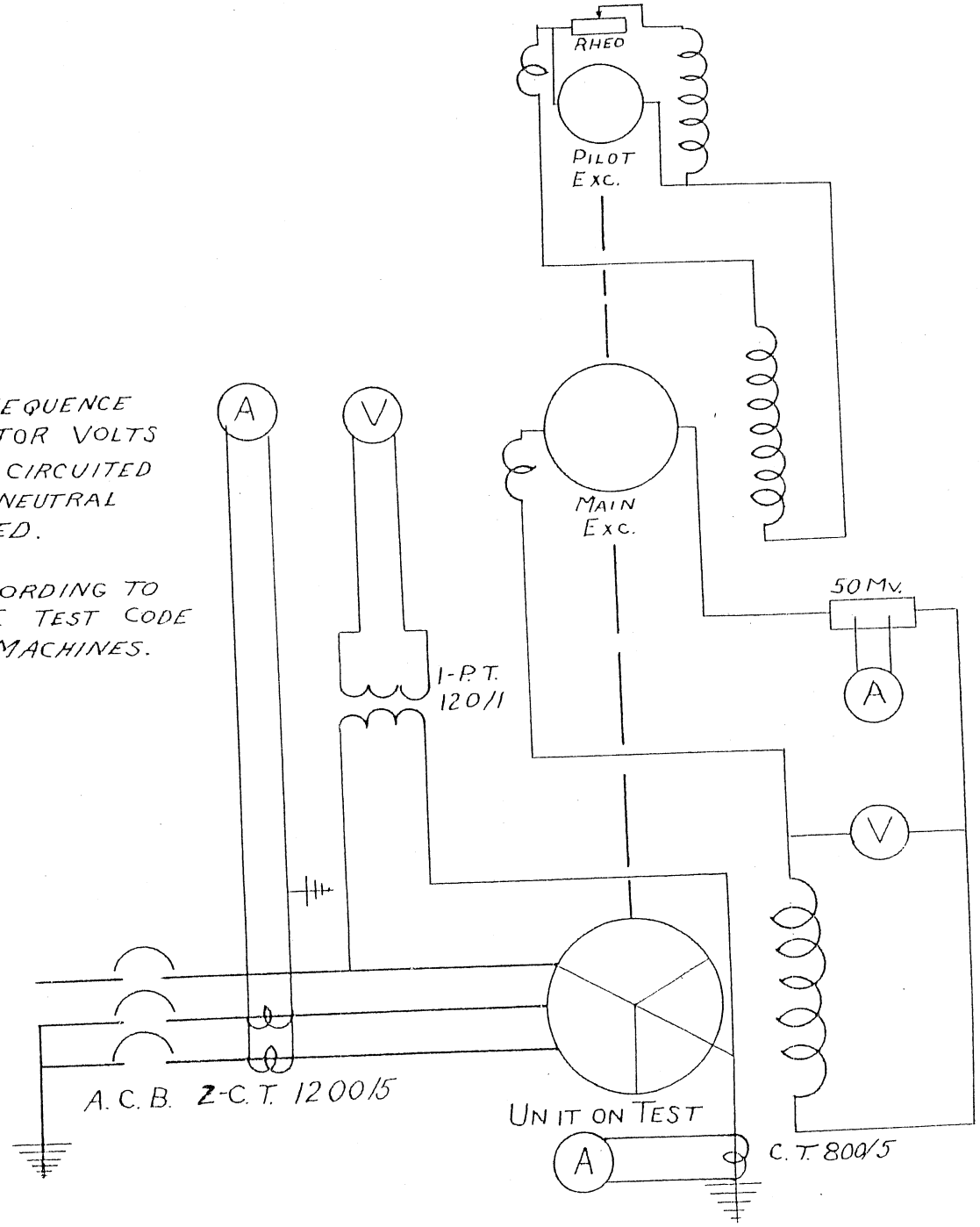
0-18982

DBS 5080-2-2 11-52 10M SCHILLER-MILWAUKEE

NOTE:

TO DETERMINE ZERO SEQUENCE REACTANCE READ STATOR VOLTS TO NEUTRAL ON OPEN CIRCUITED PHASE AND AMPS IN NEUTRAL WITH A. C. B. CLOSED.

TEST PERFORMED ACCORDING TO PARA. 1.894 OF AIEE TEST CODE FOR SYNCHRONOUS MACHINES.



ZERO SEQUENCE TEST WIRING DIAGRAM

ALLIS-CHALMERS MFG. CO. MILWAUKEE, WIS., U. S. A.

MOTOR & GENERATOR DESIGN

DEPT.

DRAWN TRT DATE 12/15/44 TRACED DATE

CHECKED DATE O. K. DATE

SIMILAR TO SCALE 1/2"

0-18880

0-18880

METER CALIBRATION RECORD

Calibration Before Shipping

Meter No. 2296 — D. C. Volts

Std.	Inst.
1.5 Scale	
1.201	1.2
.75	.752
.30	.298
15 Scale	
12.02	12.0
7.52	7.5
2.98	3.0
150 Scale	
120	120
75.1	75
29.7	30
300 Scale	
240.7	240
150.2	150
60.3	60

Meter No. 5181 — D. C. Amps

Std.	Inst.
10 Scale	
2.01	2.0
5.00	5.0
8.00	8.0
25 Scale	
5.02	5.0
12.48	12.5
20.00	20.0
50 Scale	
10.03	10.0
25.00	25
40.00	40

Meter No. 49382 — D. C. Volts

Std.	Inst.
150 Scale	
120	120
75	75
30	30
300 Scale	
60	60
150	150
240	240

Meter No. 44474 — D. C. Amps

Std.	Inst.
50 Mv. Scale	
9.95	10
24.85	25
39.90	40

Meter No. 5156 — A. C. Amps

Std.	Inst.
2.5 Scale	
1.5	1.5
2.257	2.25
5.0 Scale	
2.0	2.0
3.0	3.0
4.0	4.0

Meter No. 8584 — A. C. Amps

Std.	Inst.
2.5 Scale	
1.0	1.0
1.5	1.5
2.0	2.0
5.0 Scale	
2.0	2.0
3.5	3.5
4.495	4.5

Meter No. 89776 — A. C. Volts

Std.	Inst.
30 Scale	
16.05	16
26.1	26.0
60 Scale	
32.1	32
52.2	52

Meter No. 11085 — A.C./D.C. Watts

Std.	Inst.
500 Scale	
100	100
250	250
400	400
1000 Scale	
200	200
400	400
800	800

METER CALIBRATION RECORD

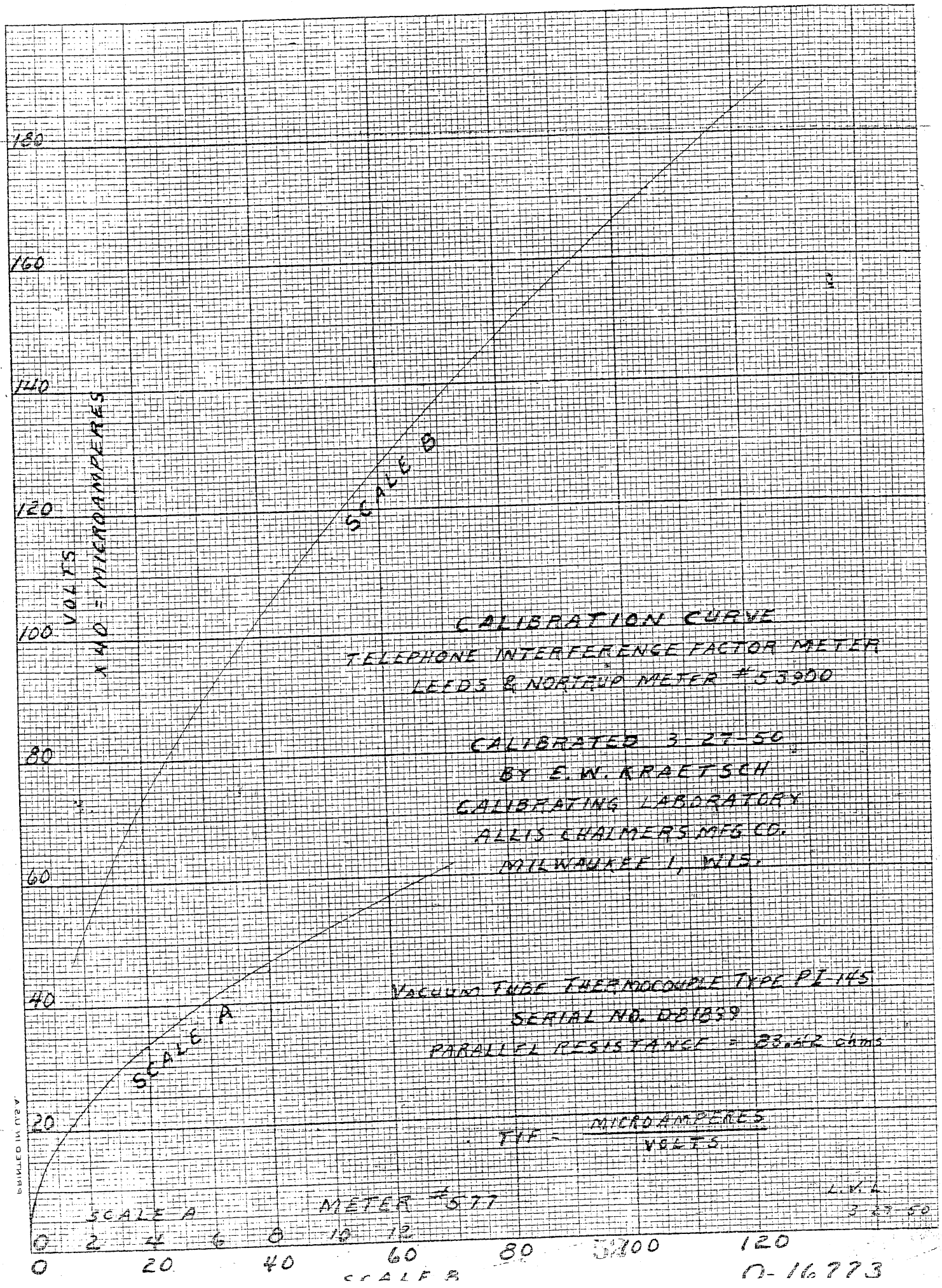
Calibration before shipping

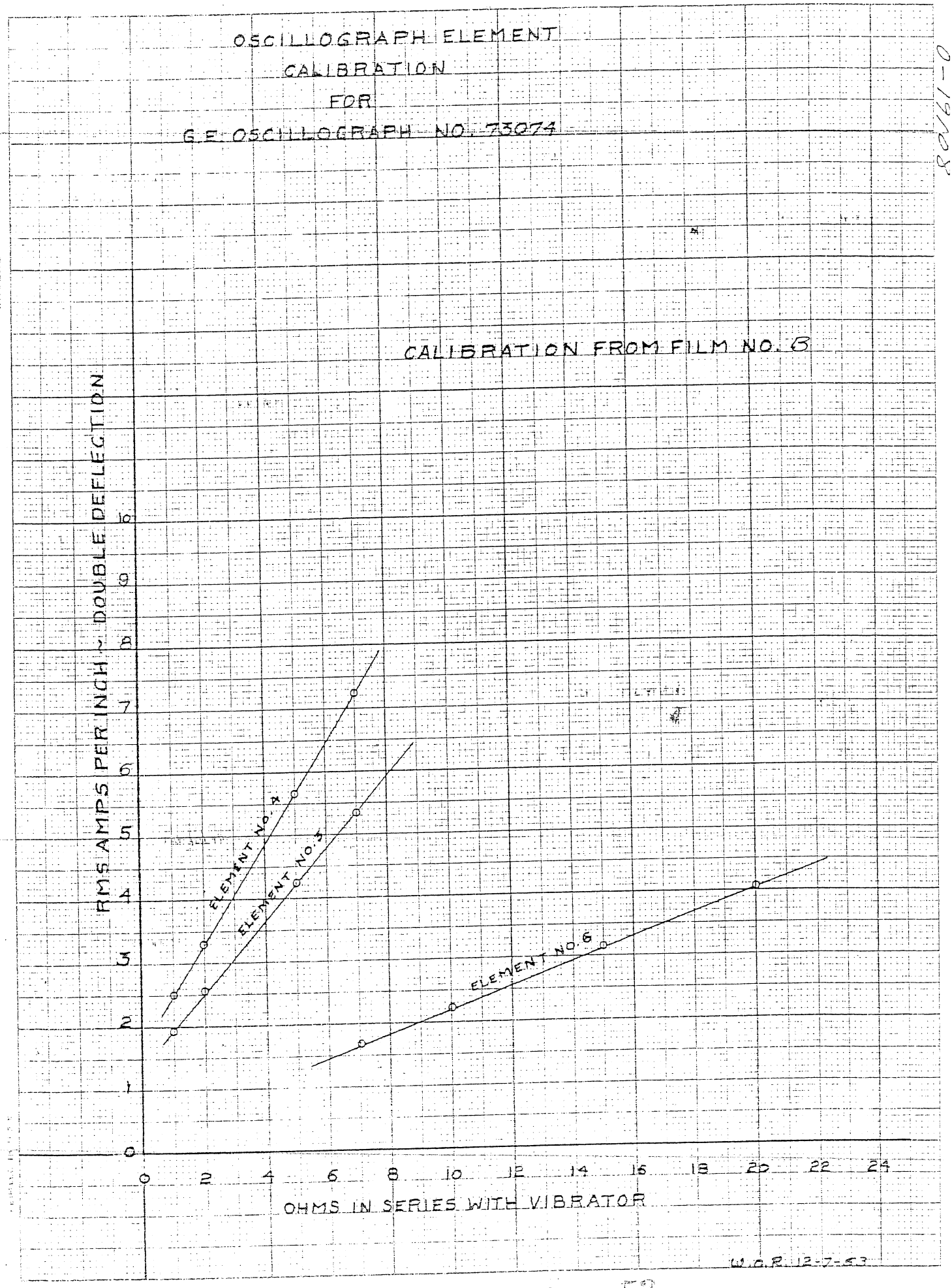
Meter No. 13997 A.C. Volts		Meter No. 9397 A.C. Volts		Meter No. None 1500 Amp Shunt	
Std.	Inst.	Std.	Inst.	Std.	Inst.
75 Scale		75 Scale		Amps	Mvs.
30	30	30	30	1000	33.25
50.1	50	50	50	1052	35.00
65.15	65	65.15	65	1202	40.0
150 Scale		150 Scale		1000 Amp Shunt	
60.1	60	60	60	802.5	40.0
100.2	100	100	100	903.0	45.0
130.2	130	130	130	1004.0	50.0
300 Scale		300 Scale		500 Amp Shunt	
120.2	120	120.1	120	280	28.0
201	200	200.5	200		
261.0	260	260	260	75 Amp Shunt	

Meter No. 49370 D.C. Volts		Meter No. 44475 D.C. Amps			
Std.	Inst.	Std.	Inst.	300	50.0
150 Scale		75 A. - 50MV. Scale			
120.2	120	10.05	10.0		
75.05	75	25.0	25.0		
30.10	30	40.0	40.0		
300 Scale					
240.7	240				
150.2	150				
60.3	60				

Note:

The calibration of these meters was rechecked when they were returned to the factory. This calibration confirmed the one made before shipping the instruments.


CALIBRATION CURVE
TELEPHONE INTERFERENCE FACTOR METER
LEEDS & NORTHUP METER #53900
CALIBRATED 3-27-50
BY E. W. KRAETSCH
CALIBRATING LABORATORY
ALLIS-CHALMERS MFG CO.
MILWAUKEE 1, WIS.
VACUUM TUBE THERMOCOUPLE TYPE PI-145
SERIAL NO. D81839
PARALLEL RESISTANCE = 33.82 ohms
TIF = MICROAMPERES / VOLTS
METER #577
L.K.A.
3-27-50
SCALE A
SCALE B
VOLTS X 40 = MICROAMPERES
0
20
40
60
80
100
120
140
160
180
0
2
4
6
8
10
12
D-16773


OSCILLOGRAPH ELEMENT
CALIBRATION
FOR
G.E. OSCILLOGRAPH NO. 73074
CALIBRATION FROM FILM NO. 6
RMS AMPS PER INCH - DOUBLE DEFLECTION
0
1
2
3
4
5
6
7
8
9
10
ELEMENT NO. 4
ELEMENT NO. 3
ELEMENT NO. 6
0
2
4
6
8
10
12
14
16
18
20
22
24
OHMS IN SERIES WITH VIBRATOR
W.O.R. 12-7-53

0-19108