

AUG 24 1977

Distribution w/enclosure:

Docket Nos. 50-438/439

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Tennessee Valley Authority
 ATTN: Mr. Godwin Williams, Jr.
 Manager of Power
 830 Power Building
 Chattanooga, Tennessee 37401

Gentlemen:

SUBJECT: DIESEL GENERATOR 300 TEST QUALIFICATION PROGRAM FOR
 GRAND GULF UNITS 1 & 2 (50-416/417, AND ACCEPTABILITY
 OF THIS PROGRAM FOR QUALIFICATION OF THE BELLEFONTE
 UNITS 1 & 2 (50-438/439) DIESEL GENERATORS

We have reviewed the information submitted by letter from J. E. Gilleland to O. D. Parr dated May 16, 1977, supporting qualification testing of the diesel generators for the Bellefonte plant. The basis of a portion of the Bellefonte diesel qualification is testing performed on similar diesel generator units for Grand Gulf. The information submitted consisted of:

- (1) complete documentation of the 300 start and load tests performed on the Grand Gulf diesel generators,
- (2) a comparison of the specifications of the Bellefonte and Grand Gulf diesel generators, and
- (3) an evaluation of the effect that the minor design differences noted would have on the acceleration of the Bellefonte diesel generator unit to design speed.

On the basis of our review, we conclude that:

- a. The 300 start and load test program performed on the Grand Gulf diesel generators is an acceptable demonstration of conformance to Items 2 and 3 of Branch Technical Position EICSB 2 "Diesel Generator Reliability Qualification Testing" for the Grand Gulf diesel generators.
- b. Because of the similarity of the Bellefonte and Grand Gulf diesel generators, the test program of Item (a) above is also acceptable for the Bellefonte diesel generators.

A detailed report of our evaluation is attached.

It should be noted that the above cited qualification test program does not include the margin tests required to demonstrate conformance with Item 1 of Branch Technical Positions EICSB 2. Therefore, conformance

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with the margin testing requirement remains an item which will be resolved in the FSAR stage of review for both Grand Gulf and Bellefonte.

Sincerely,

Original Signed by
Olan Parr

Olan D. Parr, Chief
Light Water Reactors Branch No. 3
Division of Project Management

Enclosure:
As Stated

cc:
See next page

R

OFFICE >	LWR #3	LWR #3	PSB: DES		
SURNAME >	WJPike: <i>WJP</i>	ODParr	F. ROSA		
DATE >	8/24/77	8/24/77	8/24/77		

DIESEL GENERATOR 300 TEST QUALIFICATION PROGRAM FOR
GRAND GULF UNITS 1 & 2 (50-416/417, AND ACCEPTABILITY
OF THIS PROGRAM FOR QUALIFICATION OF THE BELLEFONTE
UNITS 1 & 2 (50-438/439) DIESEL GENERATORS

The Nuclear Regulatory Commission has reviewed the information submitted by

letter from J. E. Gilleland to O. D. Parr dated May 16, 1977, supporting qualification of the diesel generators for the Bellefonte plant on the basis of the qualification testing performed on similar diesel generator units for Grand Gulf. This information consisted of:

- (1) complete documentation of the 300 start and load tests performed on the Grand Gulf diesel generators (Attachment 1 - sample data sheet),
- (2) a comparison of the specifications of the Bellefonte and Grand Gulf diesel generators (Attachment 2), and
- (3) an analysis of the effect that the minor design differences noted would have on the acceleration of the Bellefonte diesel generator unit to design speed (Attachment 3).

We conclude the 300 start and load qualification test program performed by Delaval on the 7000 kw diesel generator unit to be installed at the Grand Gulf Nuclear Plant is acceptable. The basis for this conclusion is that the results of this testing demonstrate that the diesel generator unit has met or exceeded requirements 2 and 3 of Branch Technical Position EICSB 2 "Diesel Generator Reliability Qualification Testing."

Because of the similarity of the Bellefonte and Grand Gulf diesel generator units, Tennessee Valley Authority has referenced the Grand Gulf 300 start qualification test in lieu of repeating this portion of the qualification test program for the Bellefonte diesel generators. The diesel generator units for Grand Gulf and Bellefonte Nuclear Plants are identical (see Attachment 2) in capacity and other features, except for the following: (1) the generator voltage for the Bellefonte unit is 6900 V as compared with 4160 V for the Grand Gulf units, and 2) the capacity of the jacket water cooler for the Bellefonte diesel generator unit is approximately 3% greater than the Grand Gulf unit.

The larger voltage output for the Bellefonte diesel generator unit results in a slightly larger generator and consequently in a larger generator system rotational inertia value. The diesel engine system rotational inertia value remains unchanged since the engines are identical and produce the same torque. The larger generator system rotational inertia for the Bellefonte diesel generator units will result in about a 10% increase in acceleration starting time, i.e. 0 to 450 rpm. The acceleration starting times for either the Bellefonte and Grand Gulf diesel generator units should be well within the allowable 10 second interval. Also the shop load qualification tests which will be performed on the Bellefonte diesel generator units prior to delivery will verify the capability for starting and reaching 450 rpm within 10 seconds, and taking on the load block as required. The results of this testing will be evaluated during the OL review.

We have reviewed the Delaval analysis (Attachment 3) on the expected differences in starting times between the Grand Gulf and Bellefonte diesel generator units and concur with the conclusion that the difference in starting time will not be more than 10%, and that the 10 second start requirement will be met by the Bellefonte units.

On the basis of our review, we conclude that:

- a. The 300 start and load test program performed on the Grand Gulf diesel generators is an acceptable demonstration of conformance to Items 2 and 3 of Branch Technical Position EICSB 2 "Diesel Generator Reliability Qualification Testing" for the Grand Gulf diesel generators.
- b. Because of the similarity of the Bellefonte and Grand Gulf diesel generators, the test program of Item (a) above is also acceptable for the Bellefonte diesel generators.

It should be noted that the above cited qualification test program does not include the margin tests required to demonstrate conformance with Item 1 of Branch Technical Positions EICSB 2. Therefore, conformance with the margin testing requirement remains an item which will be resolved in the FSAR stage of review for both Grand Gulf and Bellefonte.

PURPOSE

To perform tests as outlined in Qualification Test Procedure, Rev. 2, dated November 30, 1976 for the above engine under Test Method

2.6.1.1.

INSTRUMENTATION

Temperature Recorder, Foxboro S/N 1652300

Frequency Meter, Weston Model 339, S/N 1572

Watt Meter, Weston Model 329, S/N 2851

Voltmeter, Weston Model 341, S/N 25619

Ammeter, Weston Model 370, S/N 8932

Visicorder, Honeywell Model 1508A, S/N 0305J/J71

Transducers

IPAC Series 750, Frequency Transducer

Transdata Inc. Model 10P5101, Voltage Transducer

Transdata Inc. Model 10C5101, Current Transducer

Transdata Inc. Model 20W5101, Kilowatt Transducer

DESCRIPTION OF TEST

Prior to the official start of testing, the engine was run to establish a load of 1750 KW on rheostat "A" and 1750 KW on rheostat "B". Throughout the test these rheostats were kept equal to or greater than 1750 KW. Appropriate test panel timers were then adjusted to achieve the required time for load pickup. The engine was also run for a period of time to establish normal operating temperatures.

A "forced cooling" system was used in cooling the engine back to the standby temperatures after each run. The system circulated engine jacket water through its cooler and engine lube oil through an additional cooler and the engine.

The start number, standby and operating temperatures, the starting air pressure before and after the test, and the generator parameters were recorded on data sheet E-236.

The engine lube oil and jacket water out of the engine were recorded on a temperature recorder to show the engine at standby temperature, its rise to normal operating temperature, and its return to standby temperature for each official start.

The visicorder strip charts show that from the time of the start initiation signal until the engine was up to synchronous speed and the 3500 KW load was picked up was no more than seven seconds. The first 270 starts were conducted from the standby keep-warm temperature and the engine was run until the normal operating temperatures of the lube oil and jacket water were reached. This took approximately ten minutes. The engine was then stopped and the lube oil and jacket water were cooled back to their standby keep-warm conditions. This took approximately 15 minutes. Starts No. 270 through 300 were conducted from the normal half-load temperatures of lube oil and jacket water. These starts were conducted on approximately an eleven-minute cycle.

The 300 start test proceeded on a 24-hour-per-day schedule.

Although the engine successfully started, run #299 was voided because the engine did not reach frequency within the required time. This was because the operator tried to start the unit before the engine shutdown mechanism had had time to reset itself.

Minor maintenance work was done on the air compressor after start 55 and routine engine maintenance was performed after starts #130, 244 and 275.

A total of 305 official starts were made during the test without any failures after initiation of the start signal.

The test as outlined in the Qualification Test Procedure, Rev. 2, dated November 30, 1976 for Test Method 2.6.5 was completed without any failures.

The test was observed, logged and signed by:

- H. Henricks, De Laval Senior Research Engineer
- H. Schilling, De Laval Senior Research Engineer
- D. Reid, De Laval Research Engineer
- D. Garton, De Laval Quality Control Engineer
- R. Reinsch, Representing Bechtel Corp.
- A. G. Watson, Representing Bechtel Corp.

ENCLOSURES

- A. Data sheets for 2.6.1.1 - Starts #1 to #305 dated 12/11/76 to 12/16/76
- B. Visicorder strip chart recordings - Starts #1 to #305 dated from 12/11/76 to 12/16/76.
- C. Temperature recorder charts - Starts #1 to #305 dated from 12/11/76 to 12/16/76

MFG. De Laval
 MODEL DSRV-15-4
 SERIAL NO. 7433
 RATING 700 KW
 @ 450 RPM

DELAVAL TURBINE INC.
 ENGINE & COMPRESSOR DIVISION
 300 START TEST SCHEDULE

TEST NUMBER 2.6.5
 METHOD NO. 2.6.5.1
 DATE 12-11-76
 TESTED BY [Signature]
 WITNESS [Signature]

CONTRACT or ORDER NO. 9645-M-018.0

Middle South Energy - Unit #1

TEST NO.	TIME	KW	FREQ.	VOLTS	AMPS	LUBE OIL TEMP. OF		JACKET WATER TEMP. OF		START AIR - PSI		ΔP	W.C. AND TEMP.
						IN	OUT	IN	OUT	START	STOP		
1	1540	3950	60	4160	520	159	160	158	162	215	185	30	72
2	1618	3900	60	4160	520	166	175	153	160	244	215	29	72
3	1641	3800	60	4160	520	166	175	153	160	244	215	29	71
4	1706	3800	60	4160	520	166	175	153	160	244	215	29	71
5	1727	3800	60	4160	520	167	175	154	170	244	215	29	70
6	1756	3800	60	4160	520	167	175	155	170	244	215	29	70
7	1822	3800	60	4160	520	167	175	155	170	244	215	29	69
8	1846	3800	60	4160	520	167	175	155	170	244	215	29	68
9	1911	3800	60	4160	520	167	175	155	170	244	215	29	67.5
10	1936	3800	60	4160	520	167	175	155	170	244	215	29	67
11	2000	3850	60	4160	525	167	175	155	170	244	215	29	67
12	2027	3850	60	4160	525	167	175	155	170	244	215	29	67
13	2044	3850	60	4160	520	168	175	156	170	220	190	30	66.5

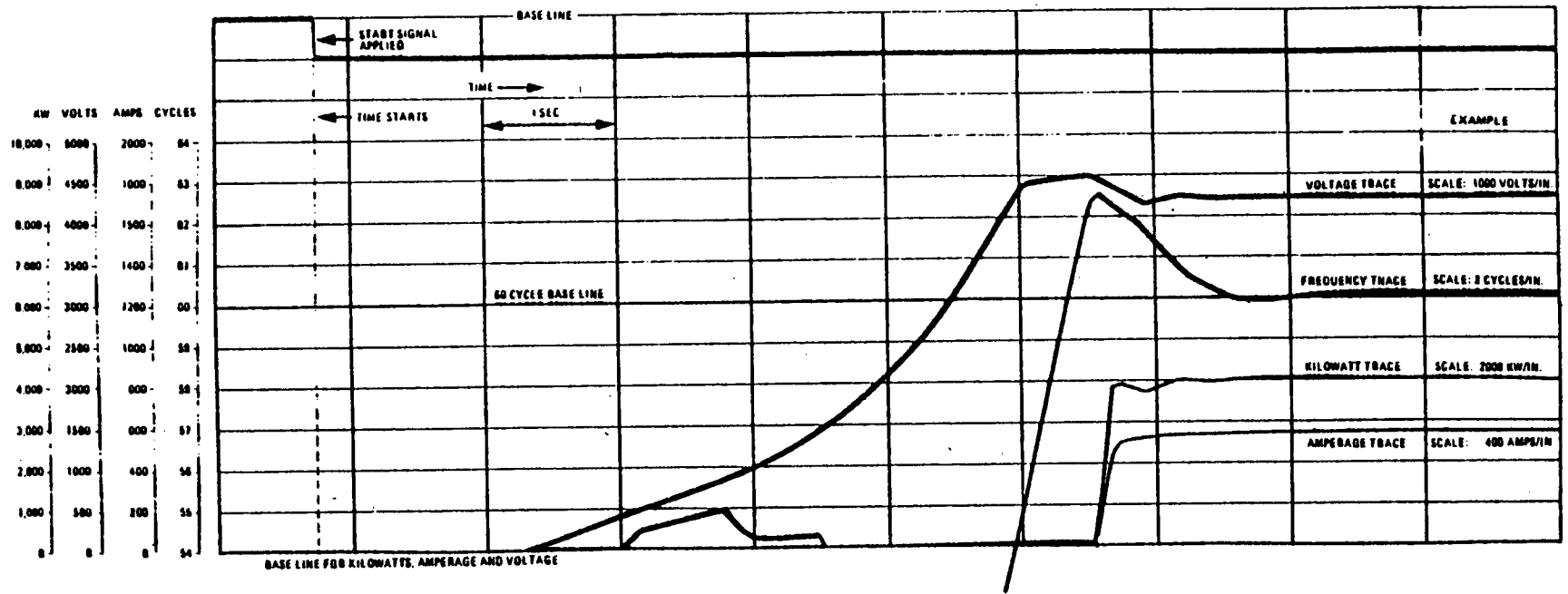
REGISTERED PHOSPHATE

CHECKED MISC ORDER

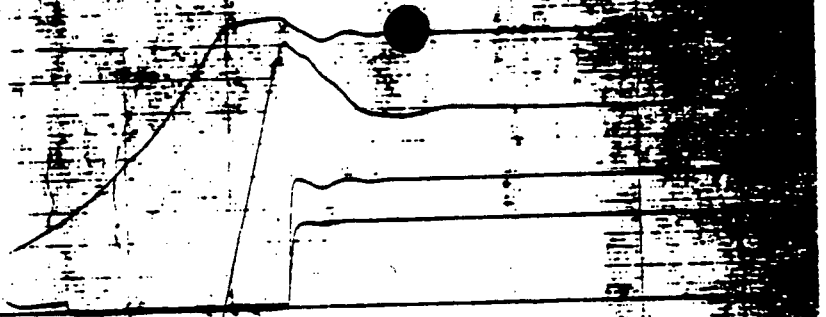
Witness # 1-3 starts H. Duane Clark, DE
 Witness # 2-3 starts C. Walter Bubb, CO

REMARKS

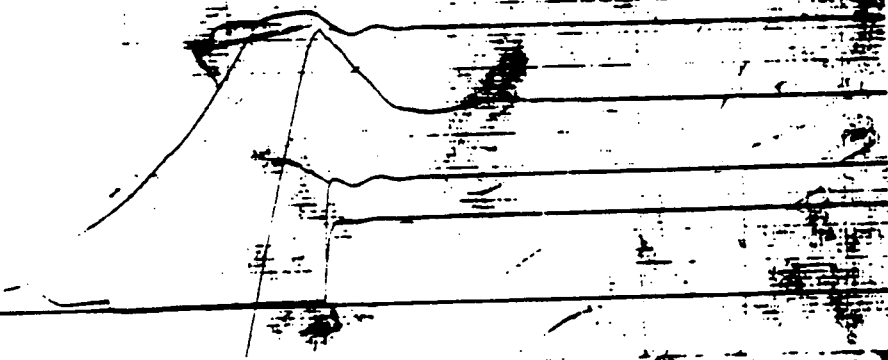
STRIP CHART SCALE IDENTIFICATION



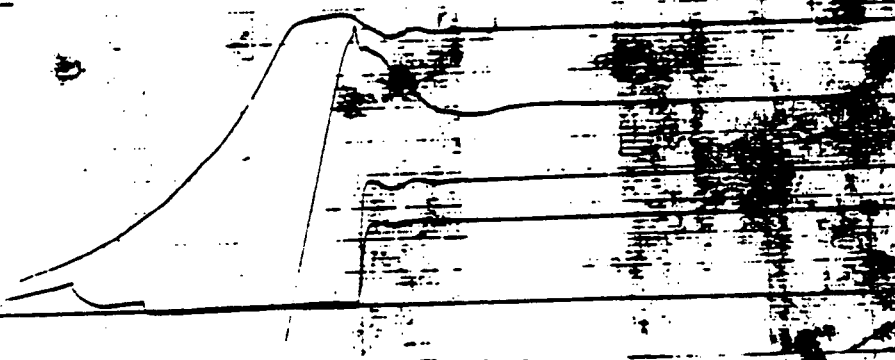
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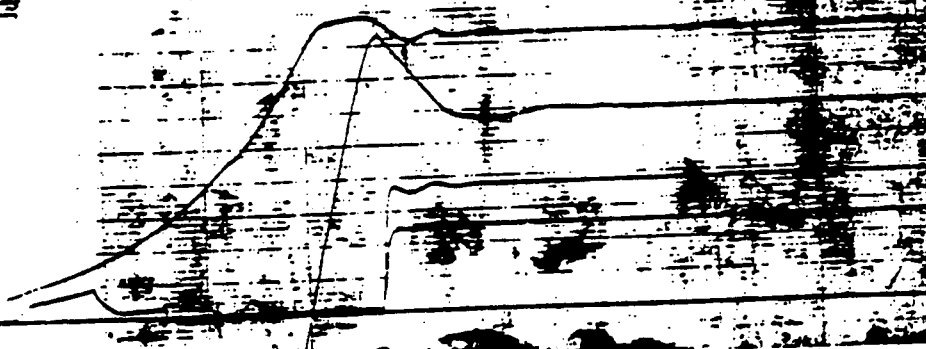
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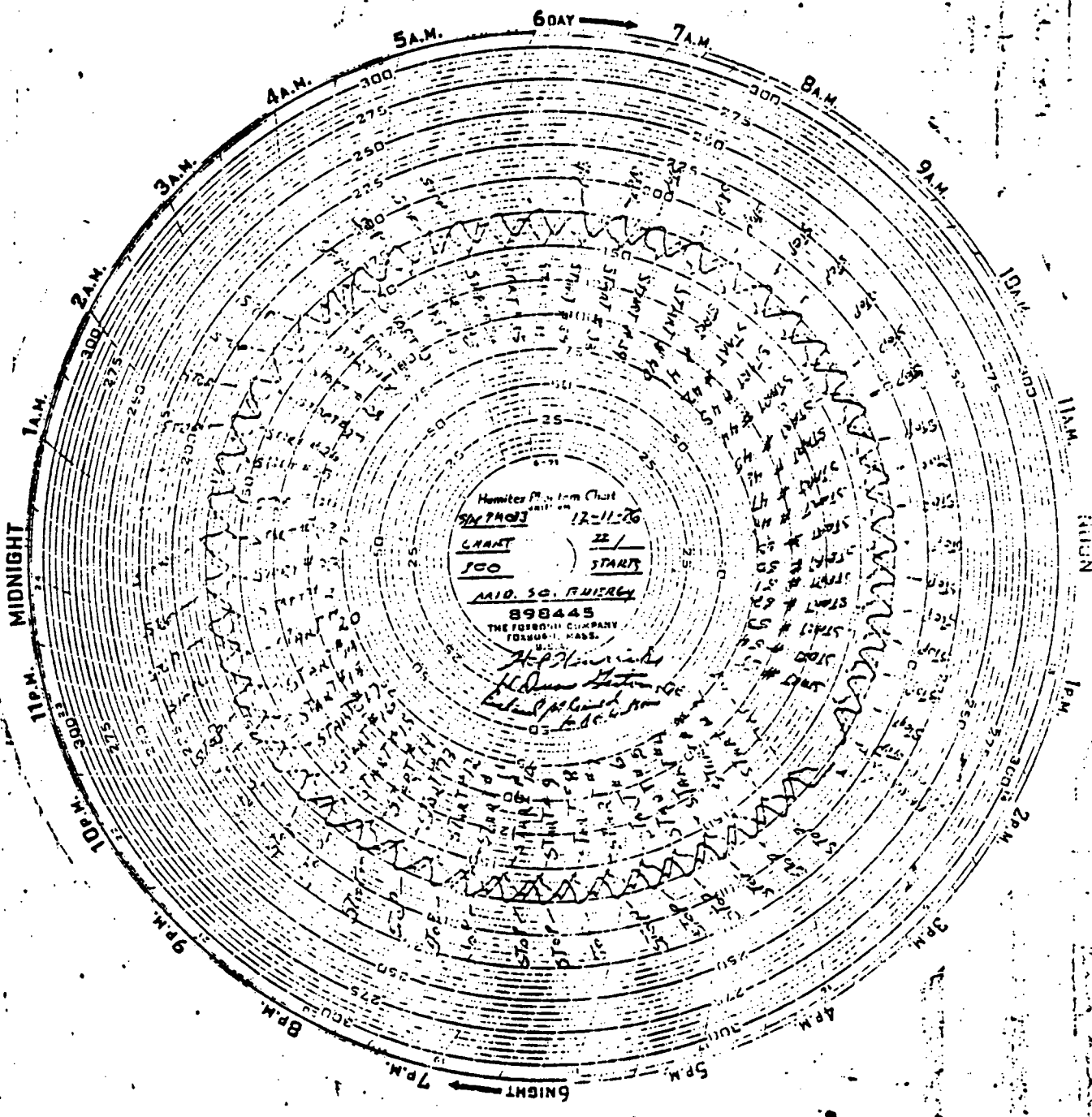


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Hammer Plot from Chart
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CHART 22 /
100 START

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898445
THE FERRIS COMPANY
TOLSON, MASS.
H. P. ...

ATTACHMENT 2

Comparison of Bellefonte Nuclear Plant and Grand Gulf Diesel Generators

	<u>BLN</u>	<u>Grand Gulf</u>
Engine Model No.	DSRV-16-4	DSRV-16-4
BHP	9758	9758
BMEP	225	225
RPM	450	450
No. of Cycles	4	4
Cylinders	16	16
Bore	17"	17"
Stroke	21"	21"
Piston speed	1575 FPM	1575 FPM
Govenor	Woodward EGB-35	Woodward EGB-35
Generator	Electric Prod.	Electric Prod.
KW	7000	7000
Voltage	6900, 60 HZ	4160, 60 HZ
PF	0.8	0.8
Excitation	E.P. Portec	E.P. Portec
Type	Static (SVS)	Static (SVS)
Jacket Water Cooler	Thermxchanger	Thermxchanger
Heat Exchanged	24,500,000 btu/hr	23,748,000 btu/hr
Flow (thru engine)	1800 GPM	1800 GPM
Lube Oil Cooler	Thermxchanger	Thermxchanger
Heat Exchanged	3,219,900 btu/hr	3,219,900 btu/hr
Oil Flow	500 GPM	500 GPM
Auxiliary Motors	Allis Chalmers	Allis Chalmers
	3ph, 60hz, 460V	3ph, 60hz, 460V
	Westinghouse 120	Westinghouse 125
	V.D.C.	V.D.C.
Auxiliary Fuel Oil Pump	IMO Model GG3DBS-187	IMO Model G3DBS-187
Auxiliary Lube Oil Pump	IMO Model A324AAX-412	IMO Model A324AAX-412
L.O. Keepwarm Pump	IMO Model GG3CHS-250	IMO Model A324AAS-250
Jacket Water Keepwarm Pump	Crane Chempump 50 GPM	Crane Chempump 50 GPM

Lube Oil Filter
Type

Prelube Filter
Type

Generator Control Panel

Air Compressor

Air Receiver

BLN

Commercial
Pleated Paper

Commercial
Pleated Paper

Delta Switchboard

IR
Mod. H25BX30
2 Stage-Type 40

Thermxchanger
305 cu. ft.

Grand Gulf

Commercial
Pleated Paper

Commercial
Pleated Paper

Delta Switchboard

IR
Mod. H25BX30
2 Stage-Type 40

Thermxchanger
305 cu. ft.

Evaluation of the Effect on Acceleration to Rated Speed
of the Greater Rotational Inertia of the BLN Diesel Generator Unit

The Grand Gulf DSRV-16-4 engine generators (S/N 74033/36) are rated at 7000 KW at 450 RPM. The total system inertia value or WK^2 is 332,340 lb. ft.² with 291,800 lb. ft.² in the E.P. generator rotor.

The BLN DSRV-16-4 engine generators (S/N 75080/83) are rated also at 7000 KW at 450 RPM. Due to different loading characteristics, the E.P. generator rotor has 326,125 lb. ft.² with identical engine and flywheel as Grand Gulf; the total system inertia value is 366,668 lb. ft.².

With identical speed governing devices, air starting system, engine rating and type, the starting time would be increased for BLN over that of Grand Gulf by the percentage difference between the system WK^2 values.

$$\text{Ratio} = \frac{366,668}{332,340} = 1.1033$$

The energy required to accelerate a system from N_1 RPM to N_2 RPM may be expressed as:

$$\begin{aligned} E &= \frac{1}{2} I \omega^2 \\ &= \frac{\pi^2}{1800 g} WK^2 (N_2^2 - N_1^2) \end{aligned}$$

Since the energy available for starting is identical for BLN and Grand Gulf and both have to accelerate from 0 to 450 RPM, the above equation may be written as:

$$\begin{aligned} E &= WK^2 \times C \\ \text{HP} &= \frac{\text{Energy}}{\text{Time}} \\ \text{or } \left(\frac{\text{Energy}}{\text{Time}} \right) \text{ BLN} &= \left(\frac{\text{Energy}}{\text{time}} \right) \text{ GG} \end{aligned}$$

$$\frac{WK^2 \text{ BLN} \times C}{\text{Time BLN}} = \frac{WK^2 \text{ GG} \times C}{\text{Time GG}}$$

$$\frac{WK^2 \text{ BLN}}{WK^2 \text{ GG}} = 1.1033 = \frac{\text{Time BLN}}{\text{Time GG}}$$

Time GG was between 5-1/2 to 6 seconds.

Time BLN would therefore be 1.1033 x 6, or 6.6 seconds.

We can safely conclude that BLN can be started in less than seven seconds or 70% of the allowable time. The shop test will be utilized to prove the capability and repeatability of starting within ten seconds and take on the load block as required.