INTERPRETING A THERMAL KIT

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Louisiana Power & Light Company

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ABSTRACT

Proper interpretation and application of the turbine vendor thermal kit are the keys to developing a good PEPSE model.

This paper will discuss thermal kit methodology and how to properly apply this information when making PEPSE analyses.

Users are asked to submit in advance any questionable thermal kit information for inclusion in the presentation.

PREDICTING THE PERFORMANCE OF 1800-RPM LARGE STEAM TURBINE-GENERATORS OPERATING WITH LIGHT WATER-COOLED REACTORS

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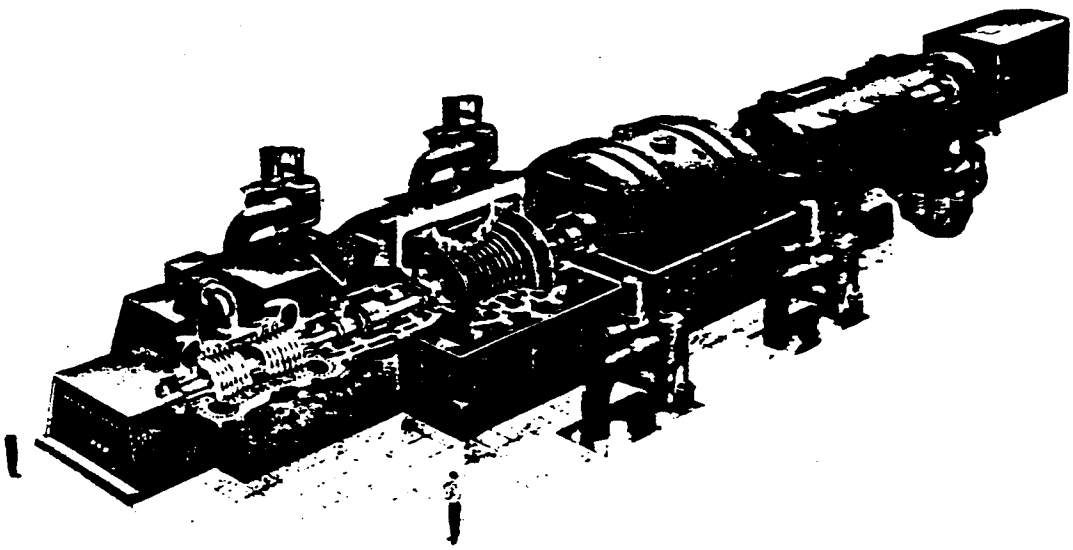


TABLE I

EFFICIENCY CALCULATION PROCEDURES
(Corrections are multiplying factors)

TURBINE SECTION	HIGH PRESSURE	LOW PRESSURE					
STAGE GROUP TYPE	NONCONDENSING	NONCONDENSING			CONDENSING		
Column	1	2	3	4	5	6	7
Bowl conditions	Wet to 100 F superheat	Superheated	Superheated	Saturated/Wet	Superheated	Superheated	Saturated/Wet
Exhaust conditions	Wet	Superheated	Saturated	Wet	Superheated	Saturated	Wet
Note	1	2	3	1	2	3	1
EFFICIENCY CALCULATION:							
Base efficiency	Fig. 3	Fig. 3	Fig. 3	Fig. 4	Fig. 3	Fig. 3	Fig. 4
Initial volume flow, correction	----	-----	-----	Fig. 5	-----	-----	Fig. 5
Governing stage correction	Fig. 1A-C	-----	-----	-----	-----	-----	-----
Moisture, correction	Fig. 2	-----	-----	Fig. 7	-----	-----	Fig. 7
END POINT CORRECTION:							
Condensing exhaust pressure	----	-----	-----	-----	Fig. 14, 15	-----	Fig. 14, 15
Exhaust loss	Fig. 8	Fig. 8	-----	Fig. 8	Fig. 14, 16	-----	Fig. 14, 16

NOTE: 1) Use AE from equilibrium properties, superheated or saturated/wet, as appropriate.

2) Use AE from equilibrium, superheat properties when the isentrope ends in the superheat region.
Use AE from Fig. 9, supersaturated enthalpy when the isentrope ends in the moisture region.

3) Columns 3 and 6 are used to calculate the dry portion of the superheated to wet expansion - that is, from the bowl to the saturation line. The following column, 4 or 7, is used to calculate the wet portion of the expansion - that is, from the saturation line to exhaust.

For superheated bowl to saturation line expansion (Columns 3 and 6), use AE from Fig. 9, supersaturated enthalpy.

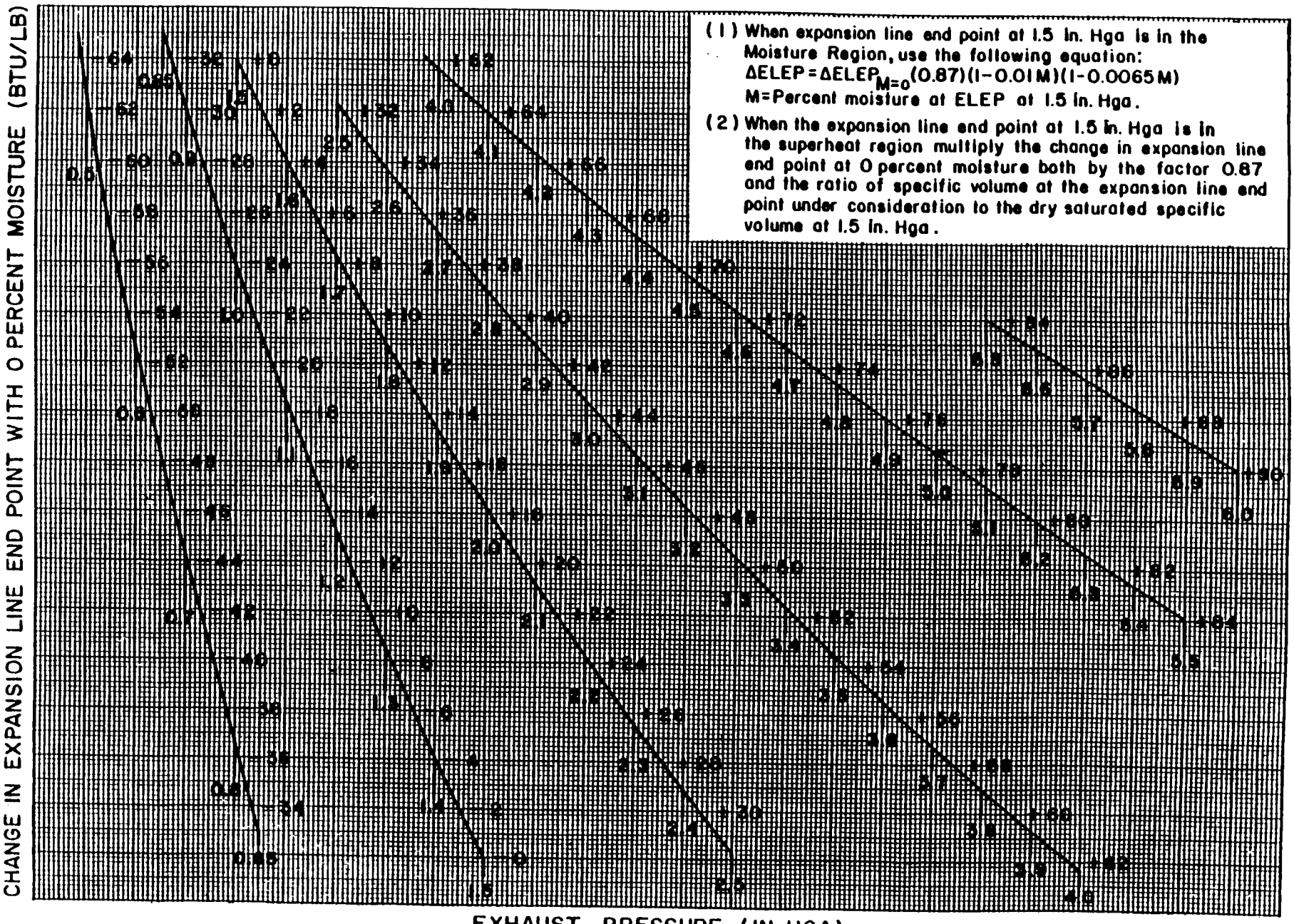


Fig. 15. Correction to expansion line end point for exhaust pressure

Unit 2

325 HA 869

2915-174R-0

406,500 KW @ 3.5" HG. ABS. 3% MU
TC4F-26" LSB 3600 RPM
2400 PSIG 1000°/1000°F

EXTRACTION STAGE SHELL PRESSURES

TO DETERMINE THE EXTRACTION STAGE SHELL PRESSURE MULTIPLY THE FOLLOWING FACTORS BY: $\frac{\text{FLOW TO THE FOLLOWING STAGE}}{10^6}$

EXTR. NO.	1	2	3 (XO)	4	5	6	7
FACTOR	187.6	95.5	59.0	37.9	15.7	10.1	6.1

NOTE:

1. APPLY THE FACTOR FOR EXTRACTION NO. 1 TO THE FLOW TO THE FIRST REHEAT STAGE TO DETERMINE THE PRESSURE AHEAD OF THE INTERCEPT VALVE. HIGH PRESSURE TURBINE EXHAUST FLANGE PRESSURE EQUALS PRESSURE AHEAD OF THE INTERCEPT VALVE DIVIDED BY 0.90.

2. FLOW TO FOLLOWING STAGE EQUALS THROTTLE FLOW MINUS LEAKAGES AND ALL EXTRACTIONS FROM PRECEDING STAGES AND STAGE IN QUESTION PLUS ANY STEAM RETURNED TO THE TURBINE AHEAD OF THE STAGE IN QUESTION.

3. USE 3% PRESSURE DROP BETWEEN SHELL STAGE PRESSURE AND TURBINE SHELL FLANGE PRESSURE EXCEPT WHERE EXTRACTIONS ARE AT THE END OF A SHELL CASING.

4. THESE FACTORS ARE TO BE APPLIED FOR HEAT BALANCE CALCULATIONS AT RATED STEAM TEMPERATURES ONLY.

5. THE GENERAL ELECTRIC CO. RECOMMENDS THAT EXTRACTION PIPING AND FEEDWATER HEATERS BE DESIGNED FOR 15% GREATER PRESSURE THAN THAT OBTAINED AT MAXIMUM GUARANTEE THROTTLE FLOW TO ALLOW FOR POSSIBLE VARIATIONS OF EXTRACTION PRESSURES FROM EXPECTED VALUES DUE TO MANUFACTURING TOLERANCE ON DRAWING AREAS, FLOW COEFFICIENTS, DEPOSITS IN STEAM PATHS, ETC.

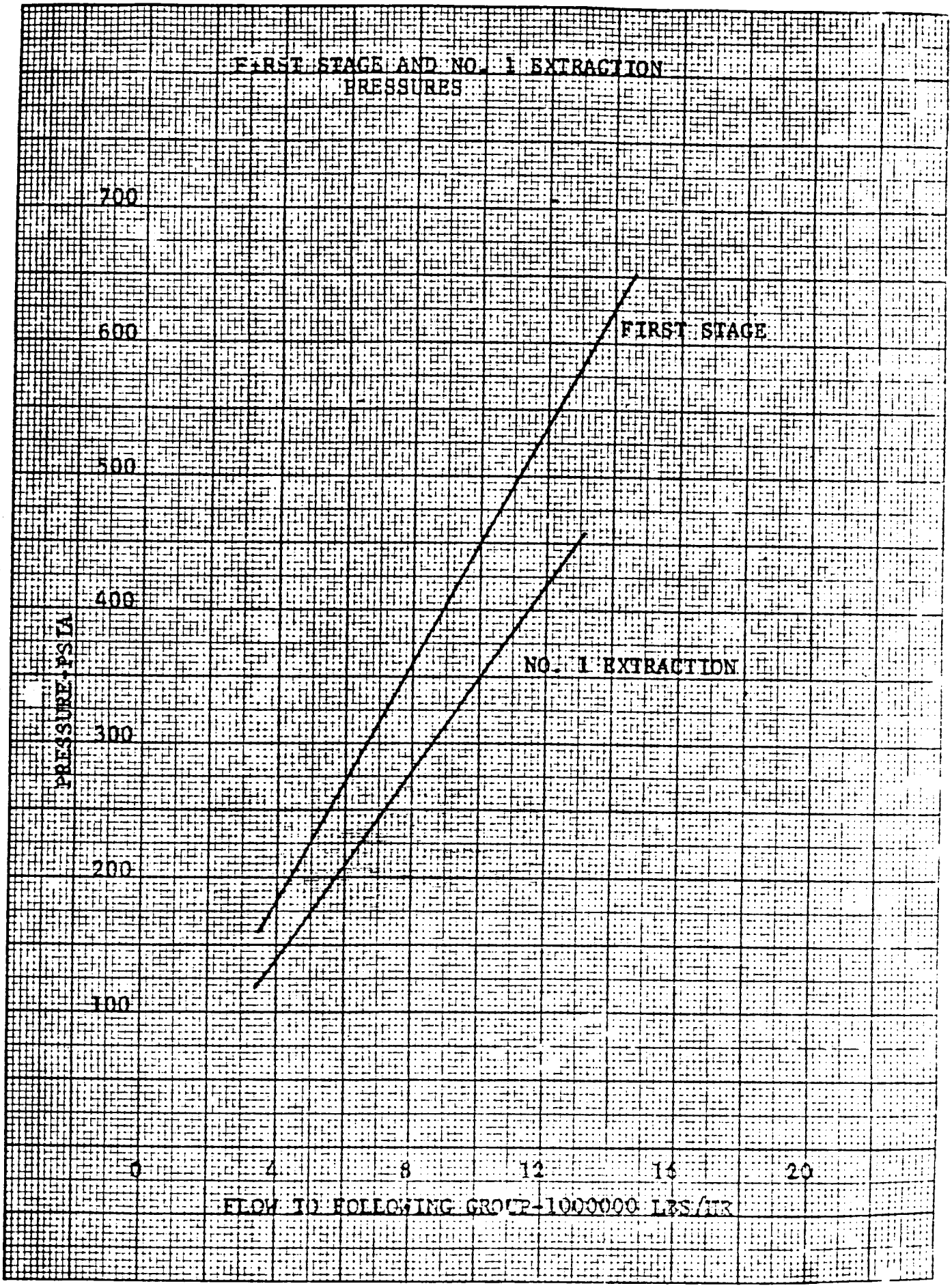
GENERAL ELECTRIC COMPANY
SCHENECTADY, NEW YORK

1/7/63 325 HA 869
BC L. A. Eisur

Figure 19

WESTINGHOUSE ELECTRIC CORPORATION

CURVE NO. AF084-0296



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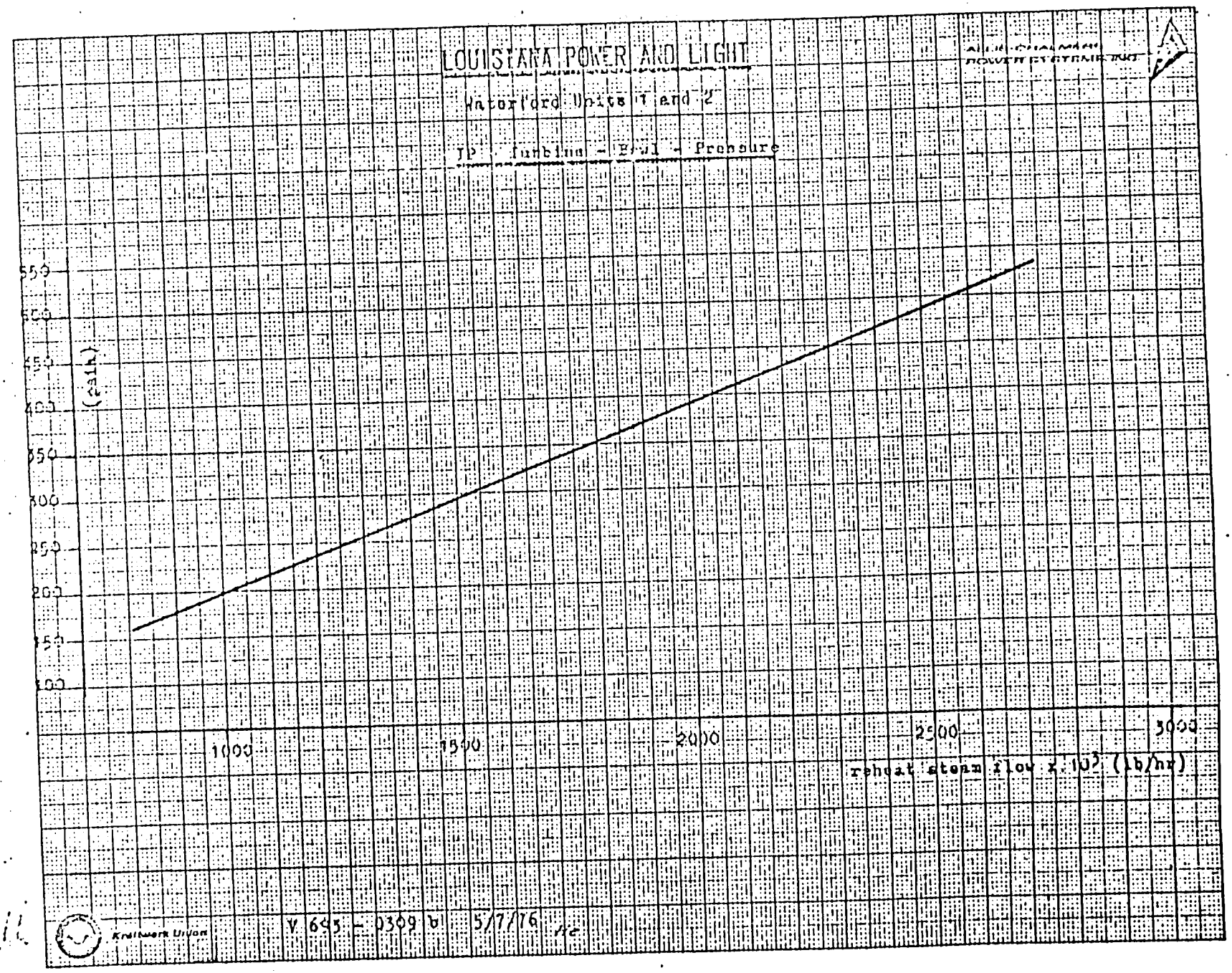
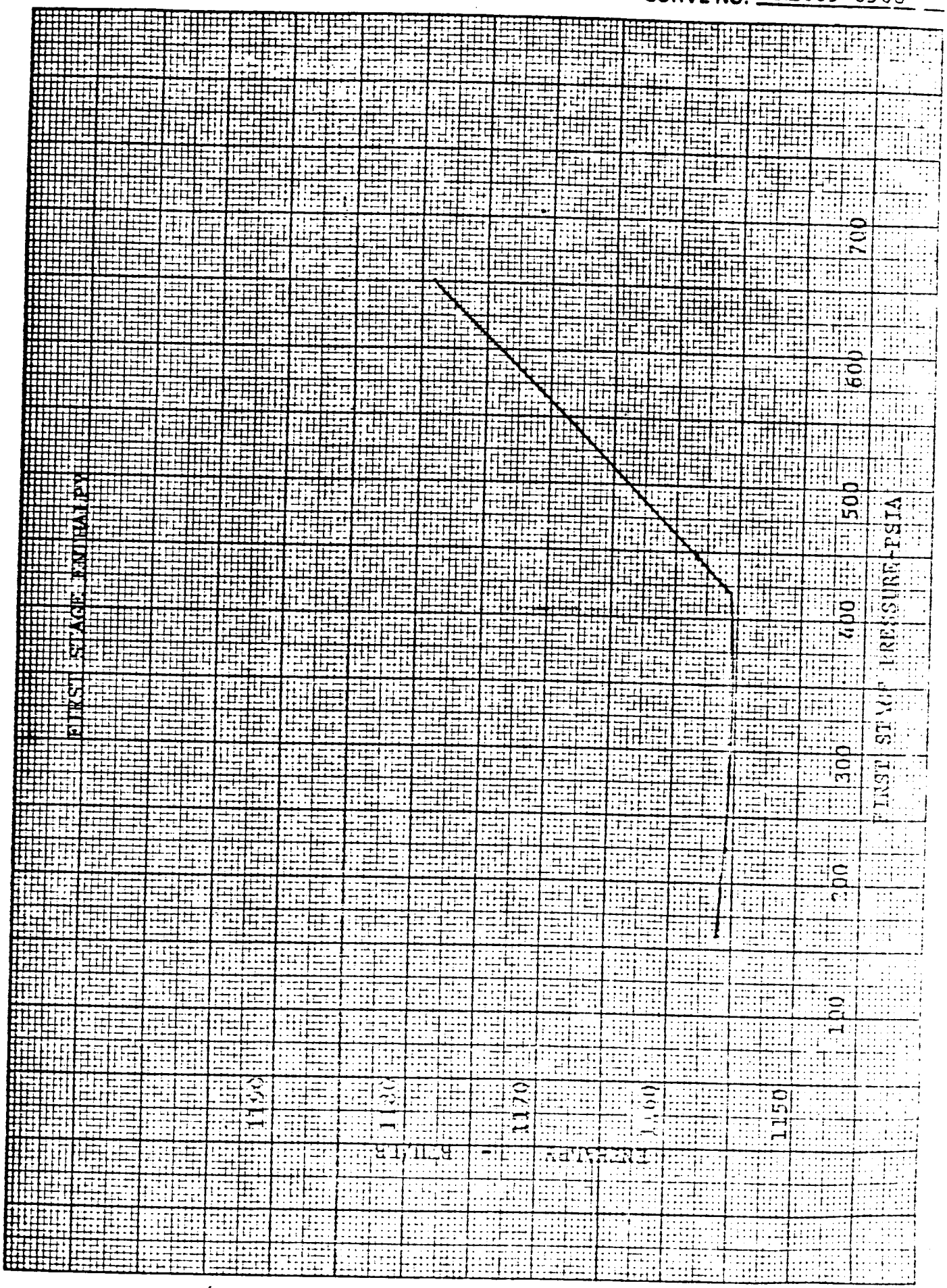


WESTINGHOUSE ELECTRIC CORPORATION

CURVE NO. AE085-0508



SIGNATURE JHL/JLW DATE 11/30/72 CURVE NO. AE085-0508

325 HA 866

2915-171R--0

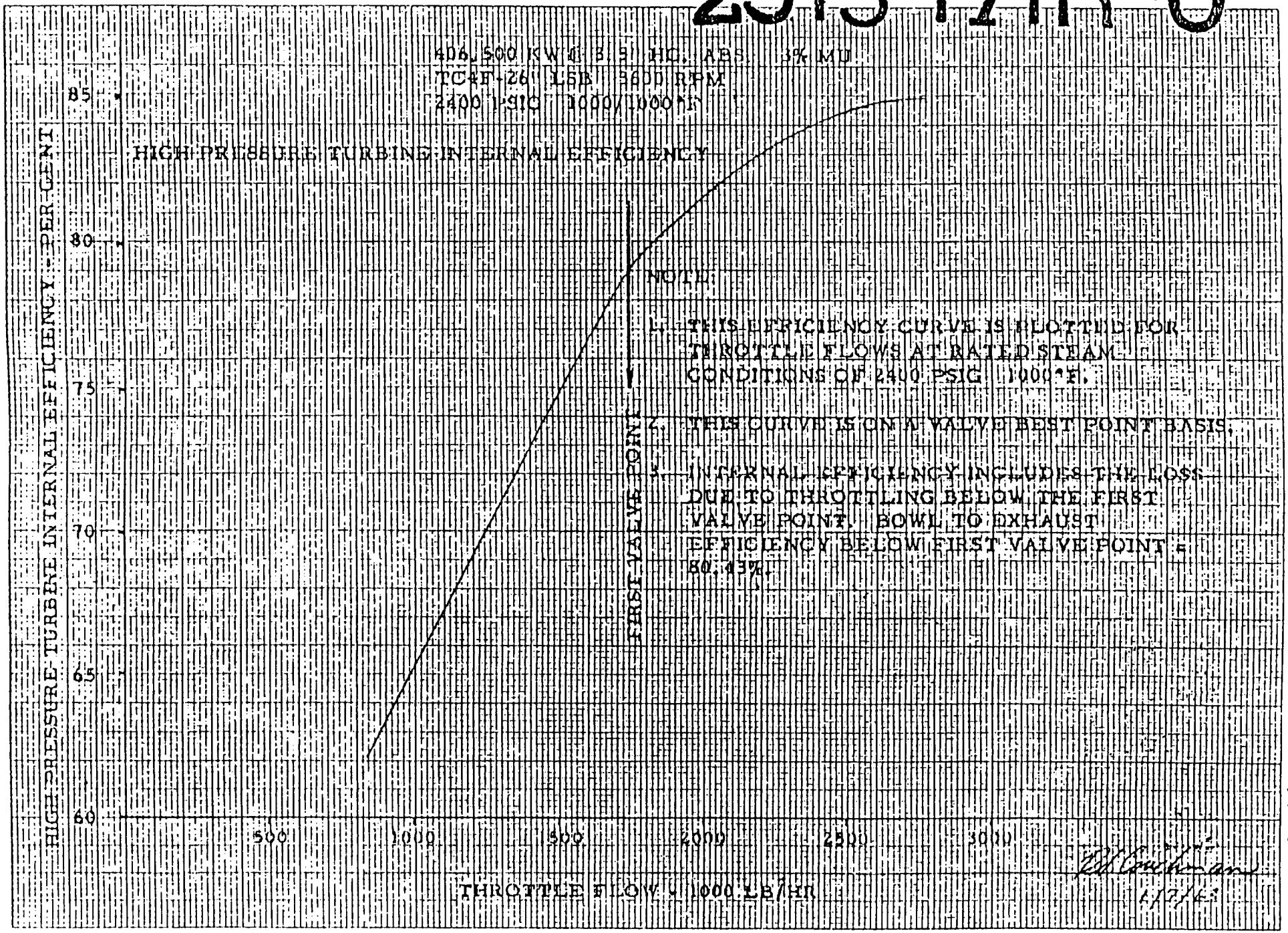


Figure 16

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK

325 HA 866

Unit 2

325 HA 867

2915-172R-0

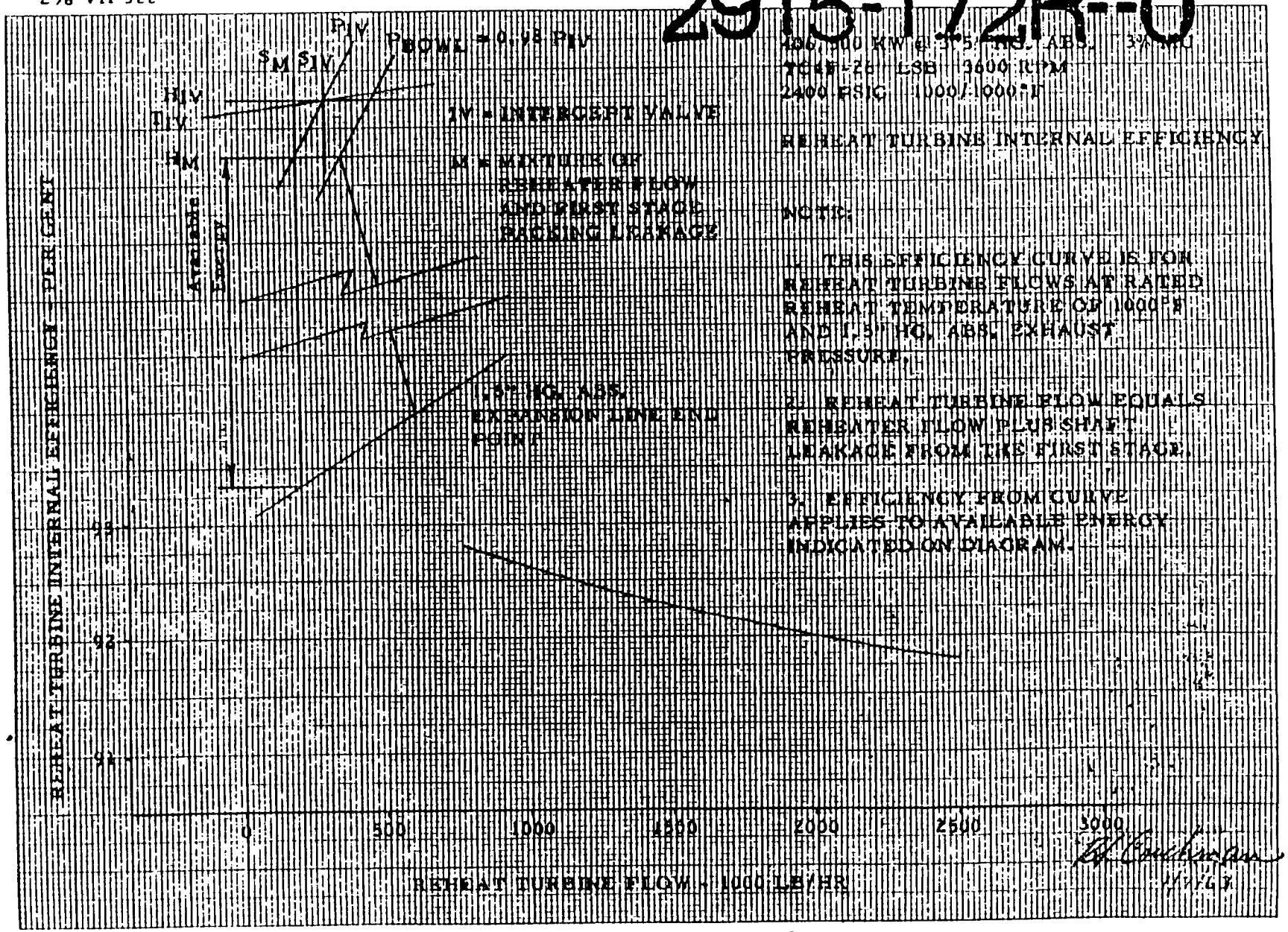
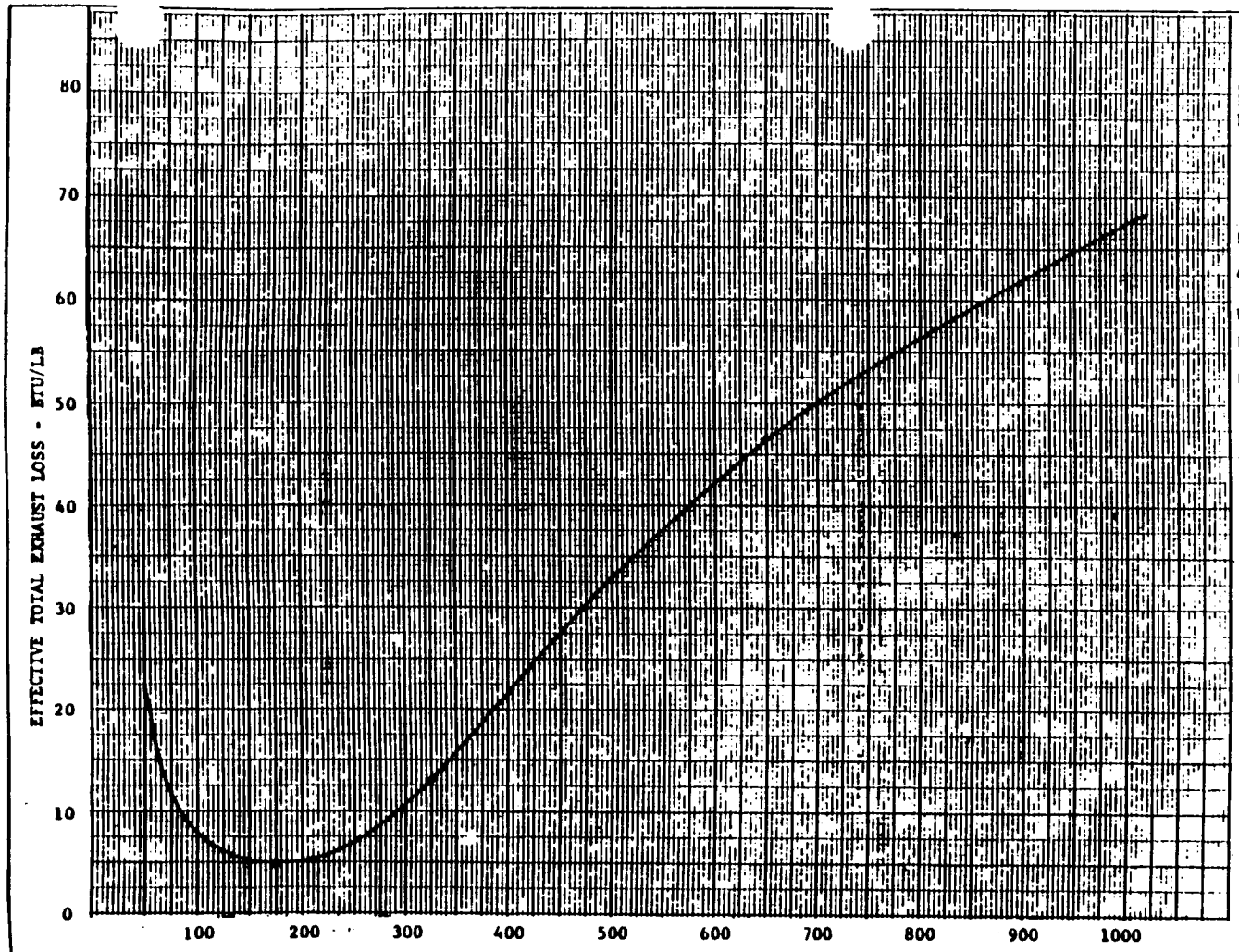


Figure 18

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK

325 HA 867



EXHAUST LOSS CURVE

LAST ROW BLADE LENGTH = 40.0"
LAST ROW MEAN DIAMETER = 120.0"
LAST ROW ANNULUS AREA = 105.7 FT^2

$H_{ELEP} = H_{TEP} - ETEL\ (1-.01M)$

$\Delta H_{TEP} = \Delta H_{ELEP}\ (1-.01M)$

WHERE:

H_{ELEP} = ENTHALPY @ EXPANSION LINE END POINT
H_{TEP} = ENTHALPY @ TURBINE END POINT
ETEL = EFFECTIVE TOTAL EXHAUST LOSS
M = % MOISTURE @ EXPANSION LINE END POINT

EXHAUST VOLUMETRIC FLOW BASED ON SPECIFIC VOLUME AT EXPANSION LINE END POINT

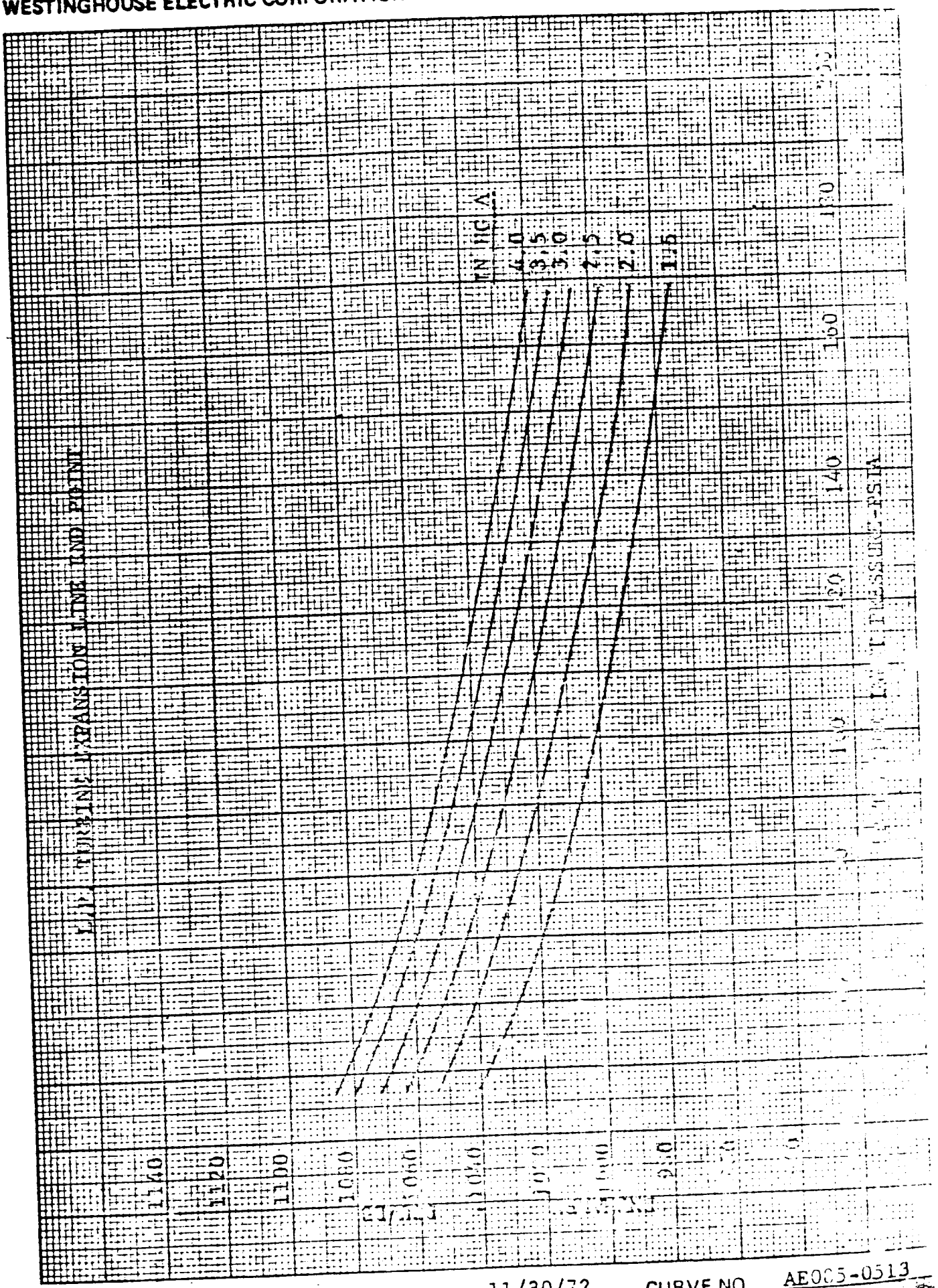
$V_{ELEP} \simeq V_{DS}\ (1-.01M)$

EXHAUST PRESSURE (IN. HGA.)	DRY SATURATED SPECIFIC VOLUME (CU. FT/LB)
0.5	1256.6
1.0	652.4
1.5	445.0
2.0	339.3
2.5	275.0
3.0	231.6
3.5	200.3

AX913-0007

WESTINGHOUSE ELECTRIC CORPORATION

CURVE NO. AE085-051.



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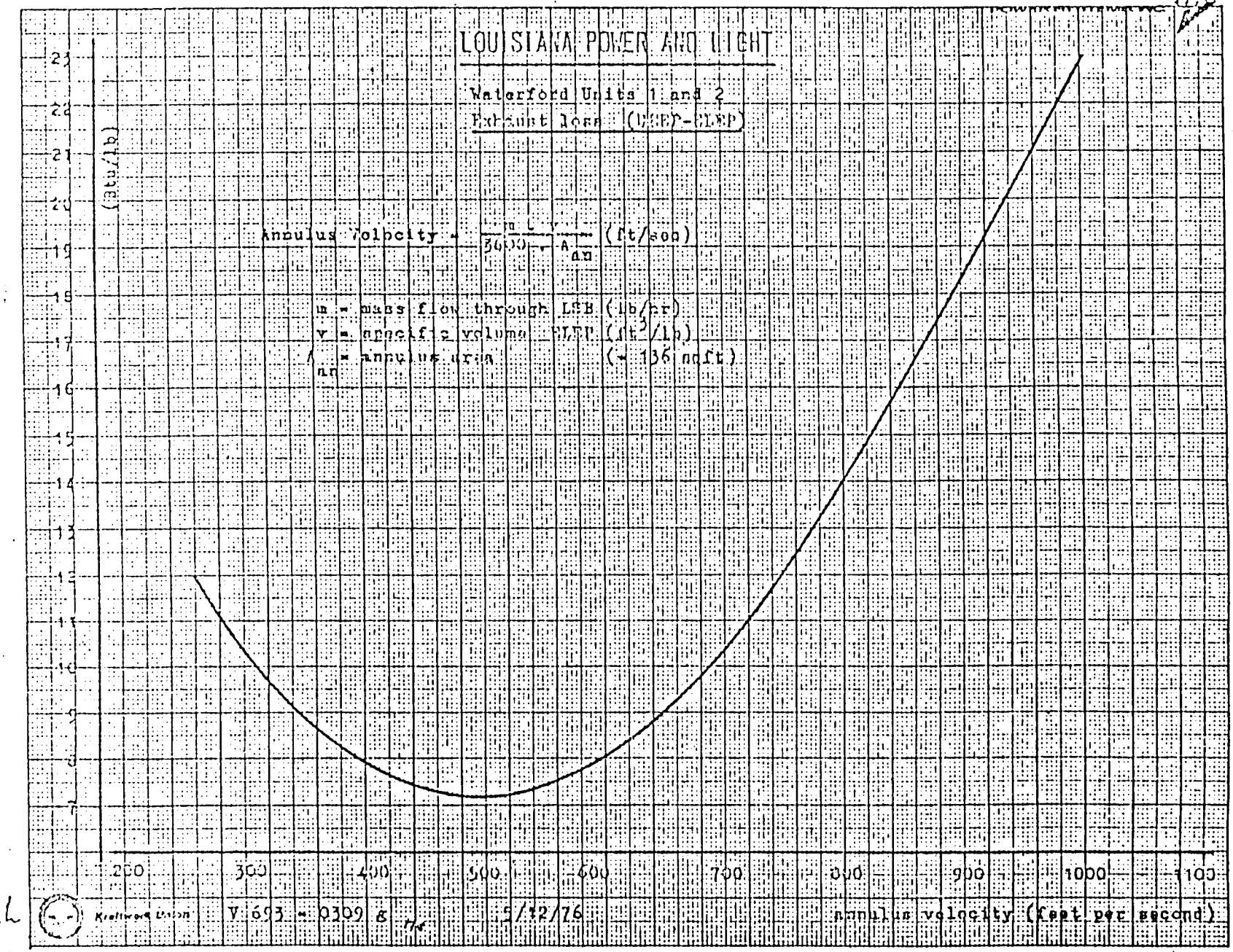
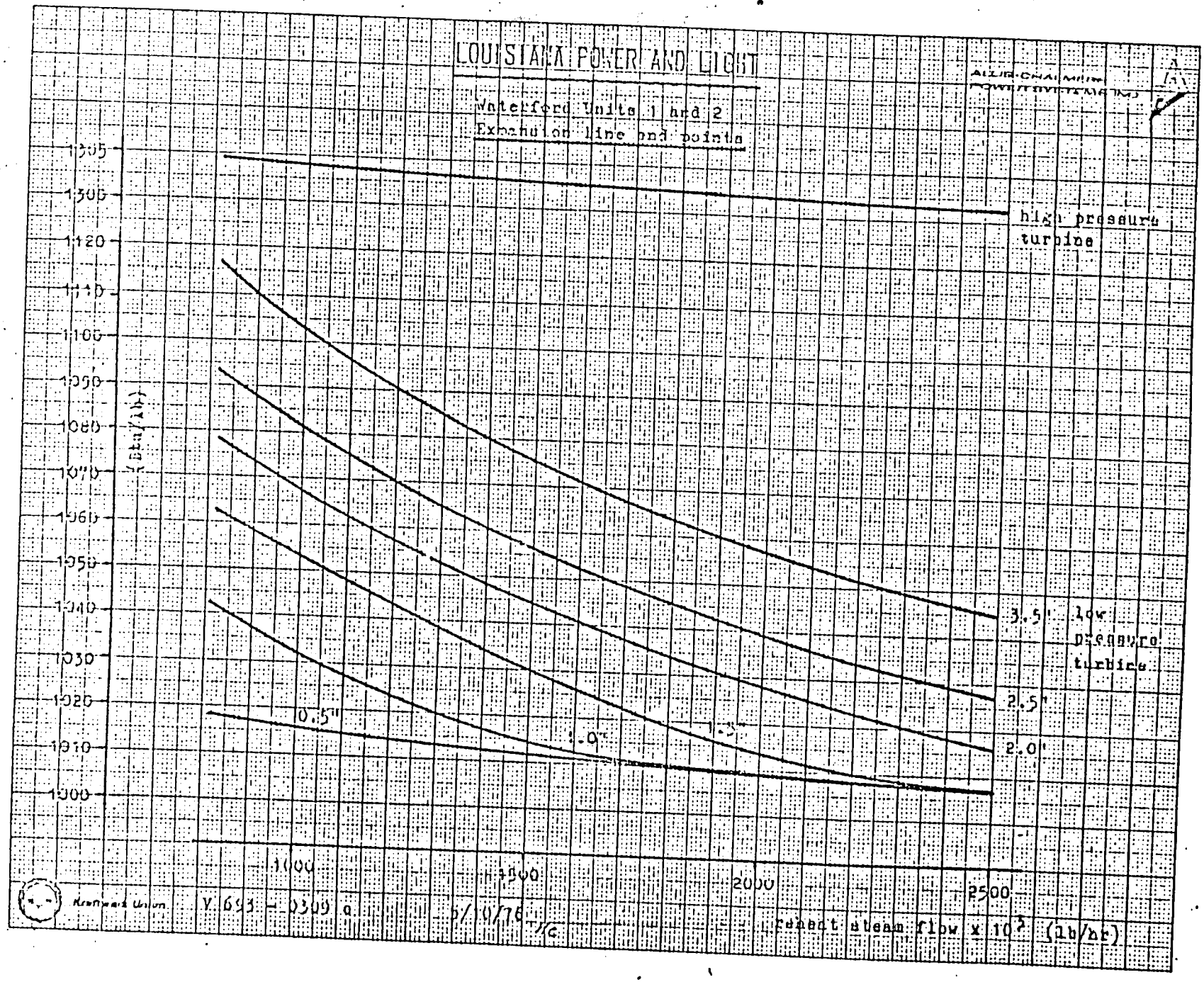
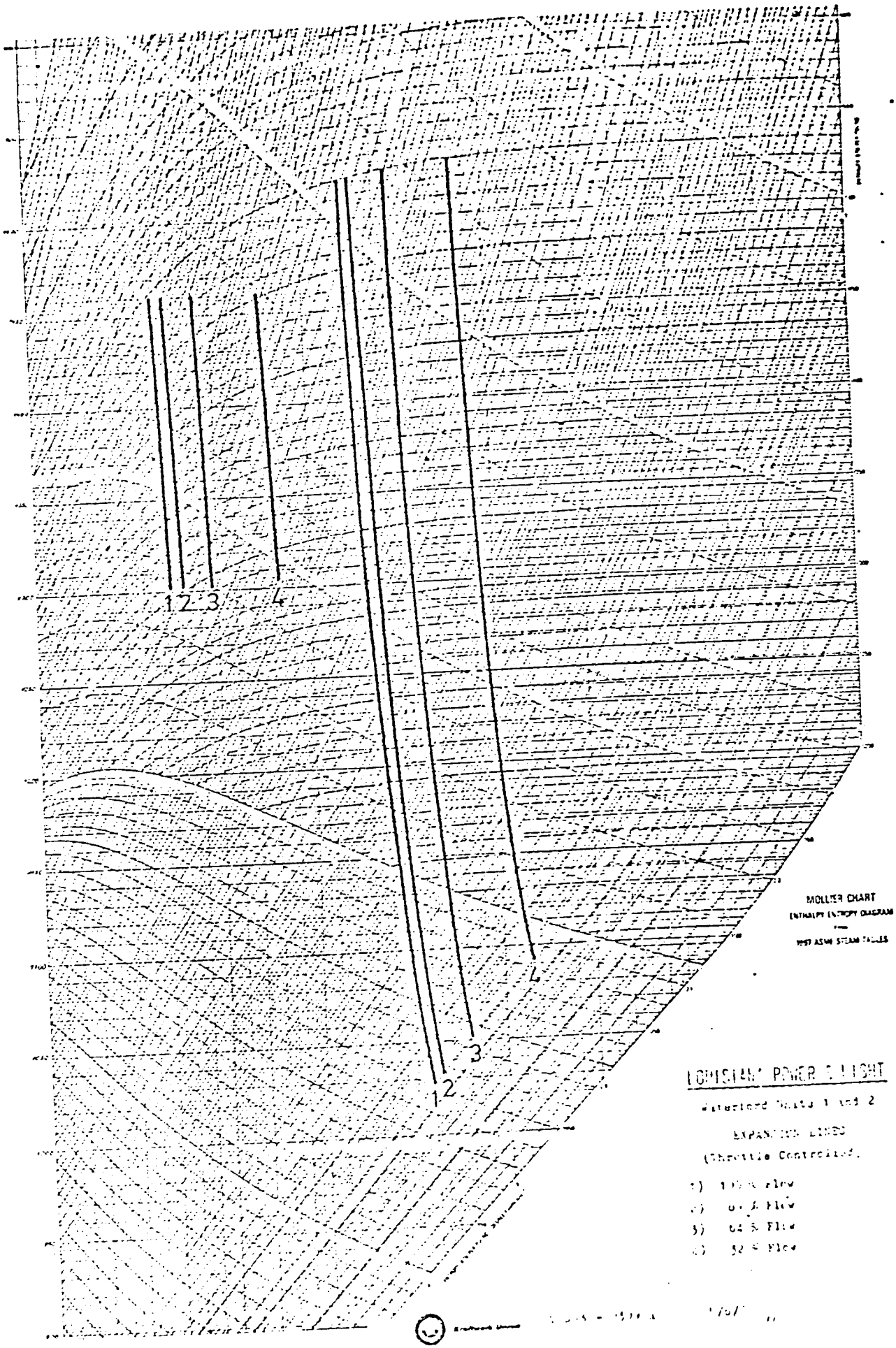
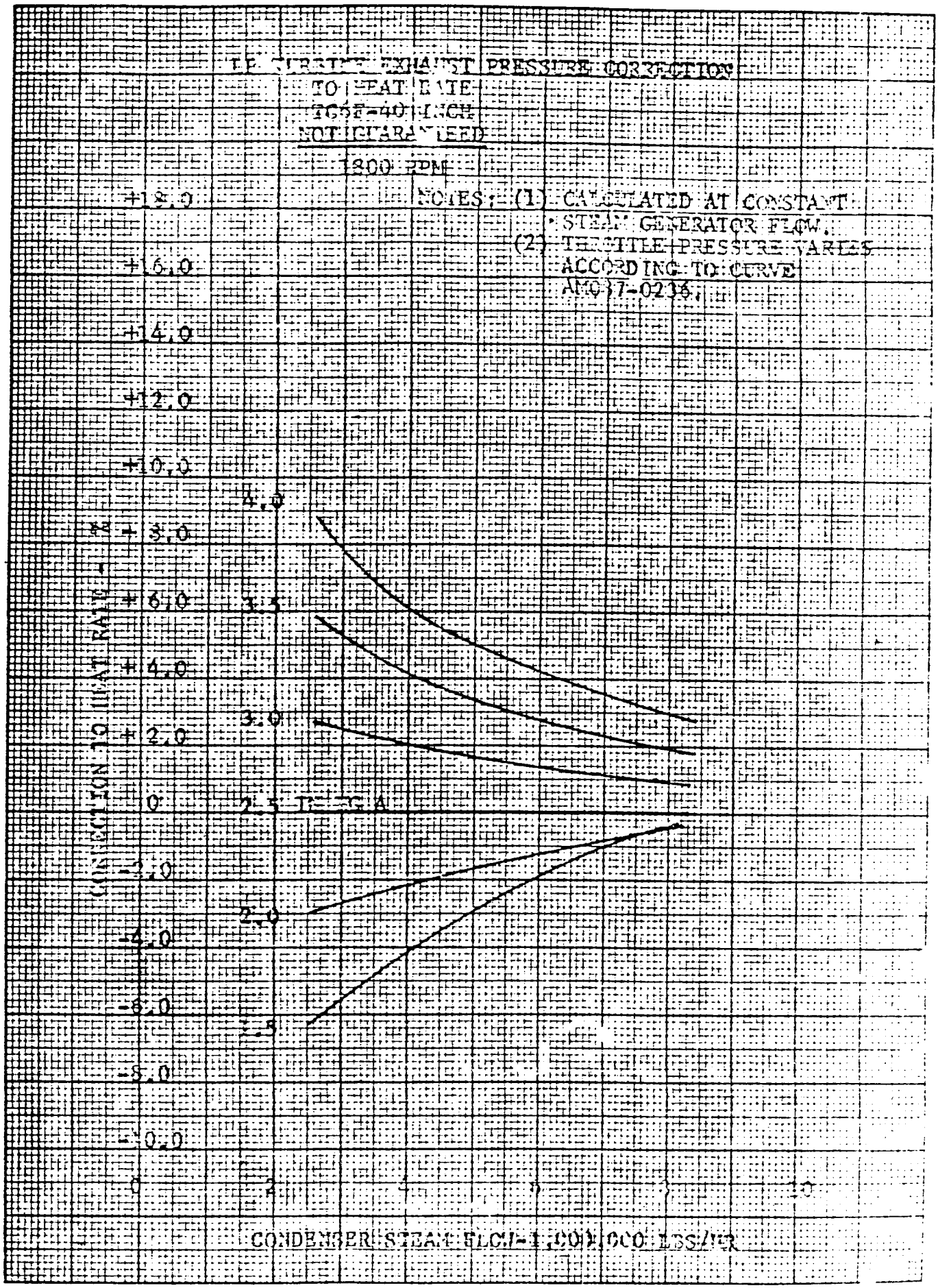
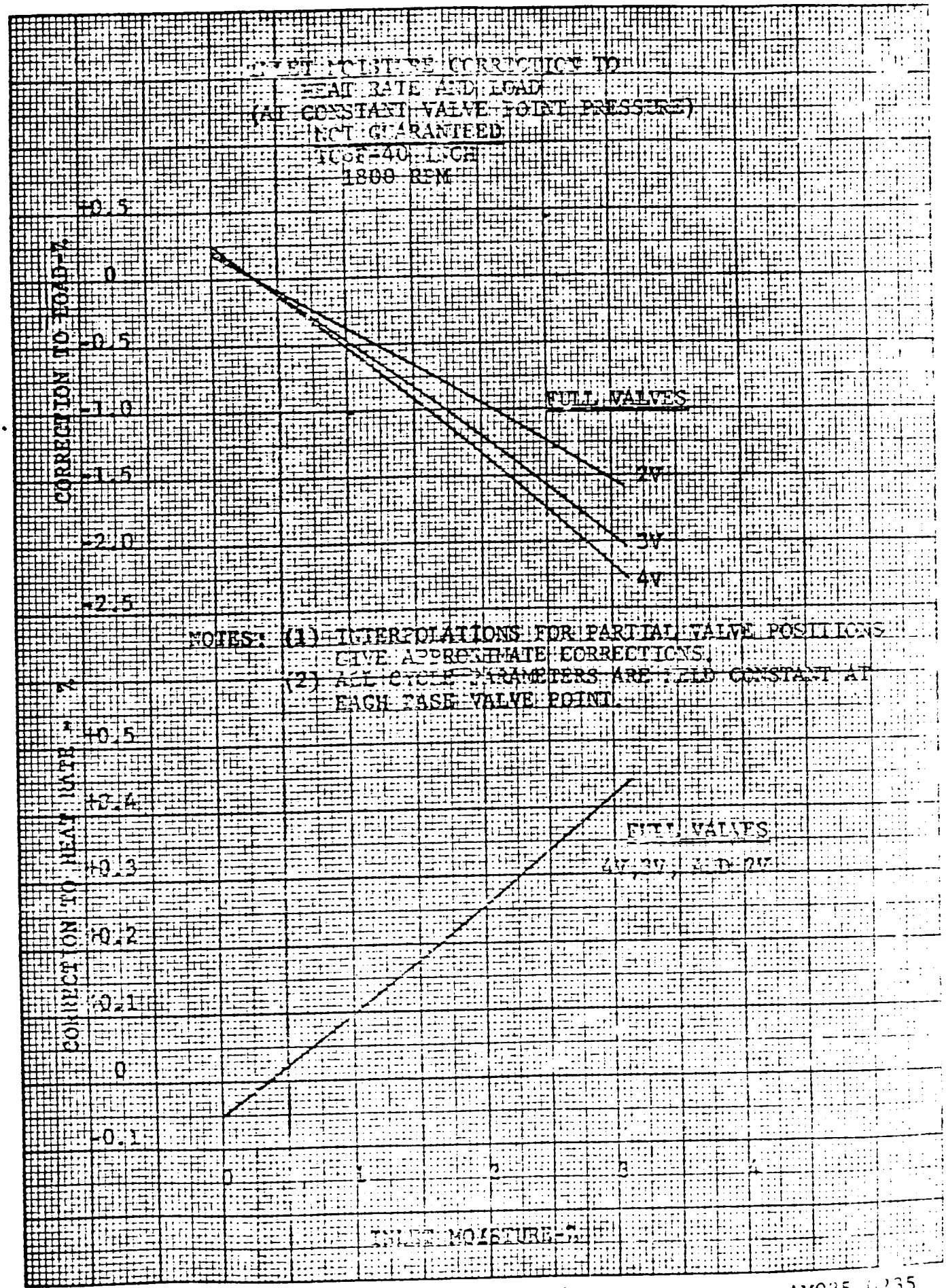


Kraftwerk Union V 693 - 0309 8 Hf 5/12/76




1 2 3 4
1 2 3 4
MOLLIER CHART
LOUISIANA POWER & LIGHT
Waterford Units 1 and 2
EXPANSION LINES
(Throttle Controlled)


LP TURBINE EXHAUST PRESSURE CORRECTION
TO HEAT RATE
TC6F-40 INCH
NOT GUARANTEED
1800 RPM
NOTES: (1) CALCULATED AT CONSTANT STEAM GENERATOR FLOW.
(2) THROTTLE PRESSURE VARIES ACCORDING TO CURVE AV087-0236.
CORRECTION TO HEAT RATE
+8.0
+6.0
+4.0
+2.0
+10.0
+12.0
+14.0
0
-2.0
-4.0
-6.0
-8.0
-10.0
4.0
3.5
3.0
2.5
2.0
1.5
T-G A
0
2
CONDENSER STEAM FLOW-1,000,000 LBS/HR

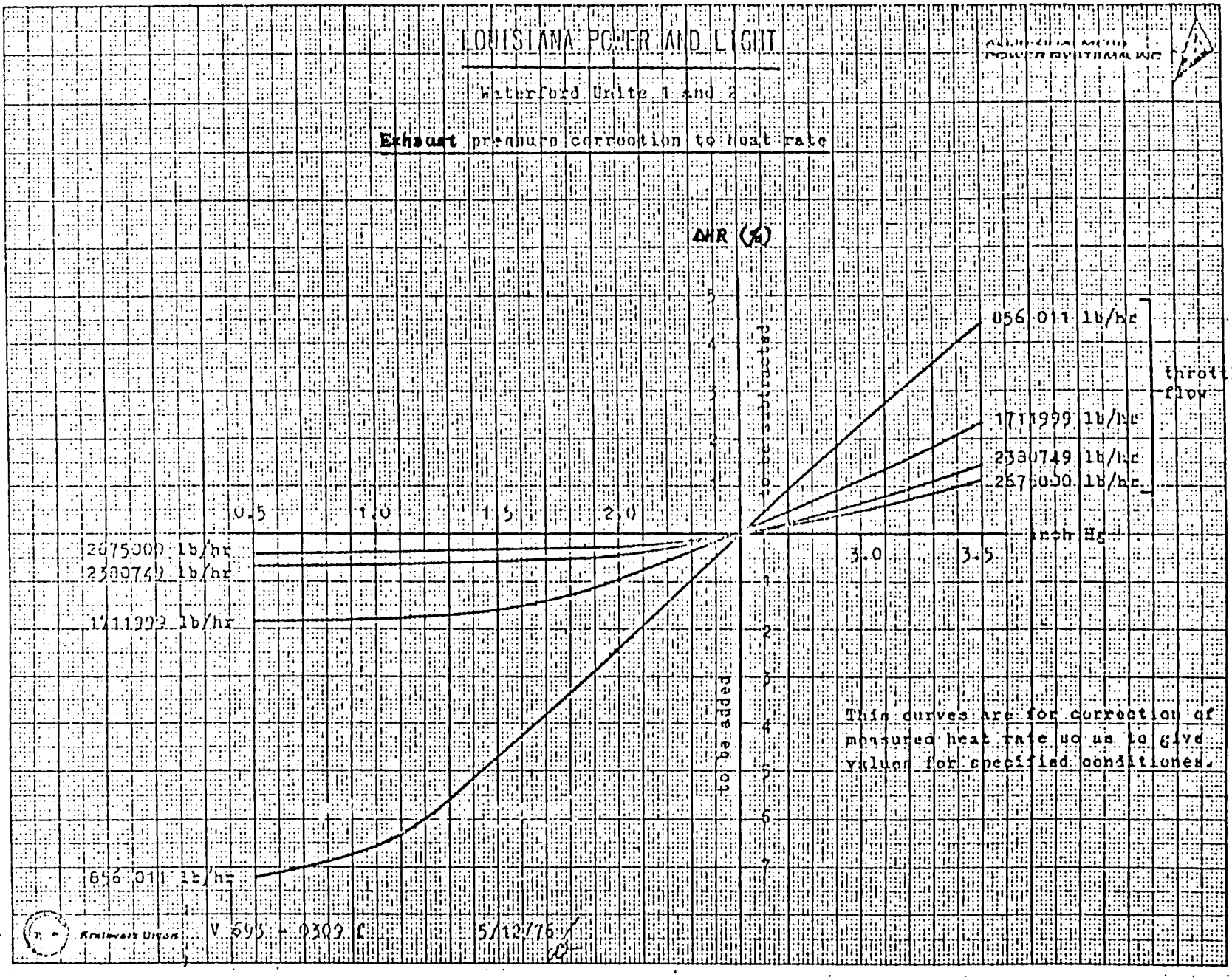


SIGNATURE JHL/JLW DATE 11/28/72 CURVE NO. AM085-0235

LOUISIANA POWER AND LIGHT

Waterford Units 1 and 2

Exhaust pressure correction to heat rate



Westinghouse Nuclear Energy Systems

V 695 - 0309 C 5/12/76

Exhaust pressure correction to generator output

% change in generator output

1.5

3.0

3.5 inch Hg.

exhaust pressure

391-420 MW

To be subtracted

To be added

This curve is to be used to correct the measured generator output.