PP&L

NUCLEAR ENGINEERING

CALCULATION / STUDY COVER SHEET
and
NUCLEAR RECORDS TRANSMITTAL SHEET

File # R2-1

1. Page 1 of 11

*▷2. TYPE: CALC. ▷3. NUMBER: EC -013 -0964 ▷4. REVISION: 0

5. TRANSMITTAL#: 9412124 *▷6. UNIT: 3 *▷7. QUALITY CLASS: F *▷8. DISCIPLINE: E

▷9. DESCRIPTION: FLOW DIVERSION - VALVES: HV-B21-1F016, HV-B21-1F019, HV-B21-2F016, HV-B21-2F019

SUPERCEDED BY: EC- -

10. Old Calculation#: SE-B-NA-038-R1 Alternate#: SE-B-NA-038 11. Cycle: _

12. Computer Code or Model used: _____ Fiche [ ] Discs [ ] Amount _____

13. Application: APPENDIX R

*▷14. AFFECTED SYSTEMS: 013, 013H, 083A, 062A

** If N/A then line 15 is mandatory.

*▷15. NON-SYSTEM DESIGNATOR: THYD

16. Affected Documents: _____

17. References: SE-1-NA-004, SE-B-NA-034, GEK-73610B

18. Equipment / Component #: HV B211F016, HVB211F019, HV B212F016, HV B212F019

19. DBD Number: DBD019, DBD016, DBD050, PBD076.

▷20. PREPARED BY	▷21. REVIEWED BY
Print Name: MJM	Print Name: JGR
Signature: *N/A BACKFIT EFFORT*	Signature: *N/A BACKFIT EFFORT*
▷22. APPROVED BY / DATE	*23. ACCEPTED BY PP&L / DATE*
Print Name: M B DETAMORE 5/13/94	Print Name:
Signature: *N/A BACKFIT EFFORT*	Signature: *N/A BACKFIT EFFORT*

TO BE COMPLETED BY NUCLEAR RECORDS

NR-DCS SIGNATURE/DATE: 12-19-94

ADD A NEW COVER PAGE FOR EACH REVISION

* Verified Fields
▷ REQUIRED FIELDS

FORM NEPM-QA-0221-1, Revision 1 CALCLOG\NEPM\FORM221.R1A

PP&L	NUCLEAR FUELS & SYSTEMS ENGINEERING ANALYSIS/CALCULATION COVER SHEET	Calc. No. SE-B-NA-038
		Superseded by p.2
		SRMS File Code P5-7

TITLE: Flow Diversion — Valves: HV-821-1F016, HV-B21-1F019, HV-B21-2F016, HV-B21-2F019

SSES UNIT I + II

SSES CYCLE N/A

Rev. No.	Total No. of Pages	Prepared By	Date	Reviewed By	Date	Approved By	Date
0	11	A.J. White	5/18/88	J.H. Hefling	5/19/88	Michael B. Delamore	6/9/88
1	16.	M.D. Murphy	3/9/89	J.H. Hefling	3/9/89	Michael B. Delamore	3/13/89

DC220.0-A1 Rev. 0

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REVISION DESCRIPTION INDEX

Rev. No.	Revised Pages	Affected Sections	Description/Purpose of Revision
1	3, 3A, 4A	Results, Appendix A	Added additional Calculation with model for water flow through the valves at 98 psig (onset of shutdown cooling).

PP&L Form 2454 (10/83) Cat #973401		SE -B- NA-038 Rev. 00

Dept. SE
Date 2/17 19 88
Designed by AJW
Reviewed by
Approved by

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

ER No. _____

PROJECT Appendix R (Bth 2) Sht. No. 2B of _____
Flow Diversion Valves
HV-B21-1F016, HV-B21-1F019
HV-B21-2F016, HV-B21-2F019

Table of Contents

PP&L Form 2454 (10/83)
Cat. #973401

SE -B- N A=0 3 8 Rev. 00

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PROJECT Appendix R (Path 2) Flow Diversion Valves HV-B21-1F016, HV-B21-1F019 HV-B21-2F016, HV-B21-2F019

Sht. No. 2C of 11

I Purpose This calculation will show that the units can be successfully shutdown using Appendix R Path 2 components even if neither of the main steam line drain valves HV-B21-1F016 (HV-B21-2F016) nor HV-B21-1F019 (HV-B21-2F019) can be closed and the F021 valve spuriously opens on each unit allowing steam flow to the H.P. condenser on each unit.

II Methodology The following inputs were used to do this analysis.

1. From SE-1-NA-004 Rev 0 by Mike Murphy of SE, the flow path 16, 19, 21 to the condenser is defined as Path 1 in the calculation (This has no relationship to Appendix R Path 1). Choke flow occurs at the condenser inlet with a flow rate of 20.4 lbm/sec at 1000 # reactor pressure. The flow rate decreases significantly at lower pressures and has a linear relationship with reactor pressure (See Sheet No. 33, 34 of SE-1-NA-004 Rev 0 which are attached as Appendix A and Appendix B)
2. The amount of steam available for RCIC in lbm/sec is taken from a graph of Mass Flow Requirements at specific pressures with vessel inlet flow in lbm/sec plotted against time. To maintain a constant level, vessel outlet flow equals vessel inlet flow during steady state conditions at a constant pressure. Plots of mass flow requirements at specific pressures are taken from calculation SE-B-NA-034, Boildown Time calculation, which is attached as Appendix D.

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PROJECT Appendix R (Path 2) Sht. No. 2D of 11
Flow Diversion Valves
HV-B21-1F016, HV-B21-1F019
HV-B21-2F016, HV-B21-2F019

3. Shutdown is assumed to occur at 100°F per hour. Thus at 1000#, the reactor coolant temperature is 545°F; within one hour the unit will be depressurized to 400# or 445°F. Within the next hour, the unit will be depressurized to 110# or 334°F. Shutdown cooling is available at 98# which will be at a reactor coolant temperature of approximately 325°F. Thus, within 2.5 hours of the SCRAM, shutdown cooling can be commenced.

4. RCIC steam requirements are taken from Curve (1) from the RCIC expected performance curve GE-A.P.E.D. Steam ring pressures in #G are plotted against required steam flow in lbm/hour. This is attached as Appendix C.

5. There are no other steam or liquid flow diversions caused by the Control Room fire.

6. The RHR loop provided on the RSP can be used to inject into the vessel below 280# reactor pressure.

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III Results

Steam Flow

Time	Pressure, psia	RCIC Requirements*	Drain Line Flowrate	Steam Available
0	1000.0	9.17 lbm/sec	20.4 lbm/sec	160 lbm/sec
1 hr	400.0	8.3 lbm/sec	8.2 lbm/sec	41 lbm/sec
2 hr	110.0	2.56 lbm/sec	2.5 lbm/sec	29 lbm/sec

Liquid Flow

Steam line Pressure, psia	Condensor Inlet Pressure when flow chokes, psia	Maximum liquid flow lbm/sec
113 psia	28.83 psia	18.0

Conclusion

Safe shutdown can be acheived on Path 2 with the Main Steam Line Drain valves open if there are no other flow

* 33000 lbm/hr Maximum steam chest capacity from page 12-19 of RCIC Design Description.

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diversions caused by the Control Room Fire. This Conclusion is Made because, in all cases at all pressures, the steam available, generated by decay heat, is far greater than the RCIC requirements added to the flow diversion through the open steam line drain valves.

With the steam lines full of water at the onset of shutdown cooling (98 psig) the Maximum flow diversion through the steam line drain valves is 18 lbm/sec. As the pressure decreases, this flow rate will decrease, approximately linearly with the pressure.

IV References

1. SE-1-NA-004, Rev 0.
2. G.E - A.P.E.D. RCIC Turbine pressure VS. Steam Flow.
3. SE - B-NA - 034 Boildown Time Calculation
4. Design Description, Chapter 12, RCIC.
5. GEK-73610B.

APPENDIX A

3.0 Results

3.1 Flow Paths 1, 2, 3, 4

The maximum attainable flow rates for paths 1 thru 4 are presented here in Tabular form and also graphically in Figure 3.1.1 Choking occurred at the condenser inlet in all cases. Refer to Section 1.0 to determine flow path configuration.

Path #	Reactor Press (lbf/in²)	Flow Rate lbm/sec
1	1000	20.40
	500	10.20
2	1000	9.52
	500	4.75
3	1000	9.63
	500	4.82
4	1000	0.732
	500	0.367

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An additional run was made for path 1 using the TSHOCS computer code. The fluid state was assumed to be saturated liquid at 98 psig. Choking occured at the condenser inlet at a flow rate of 18.0 lbm/sec. Pipe exit static pressure upstream of the choke point was 28.83 psia.

APPENDIX B

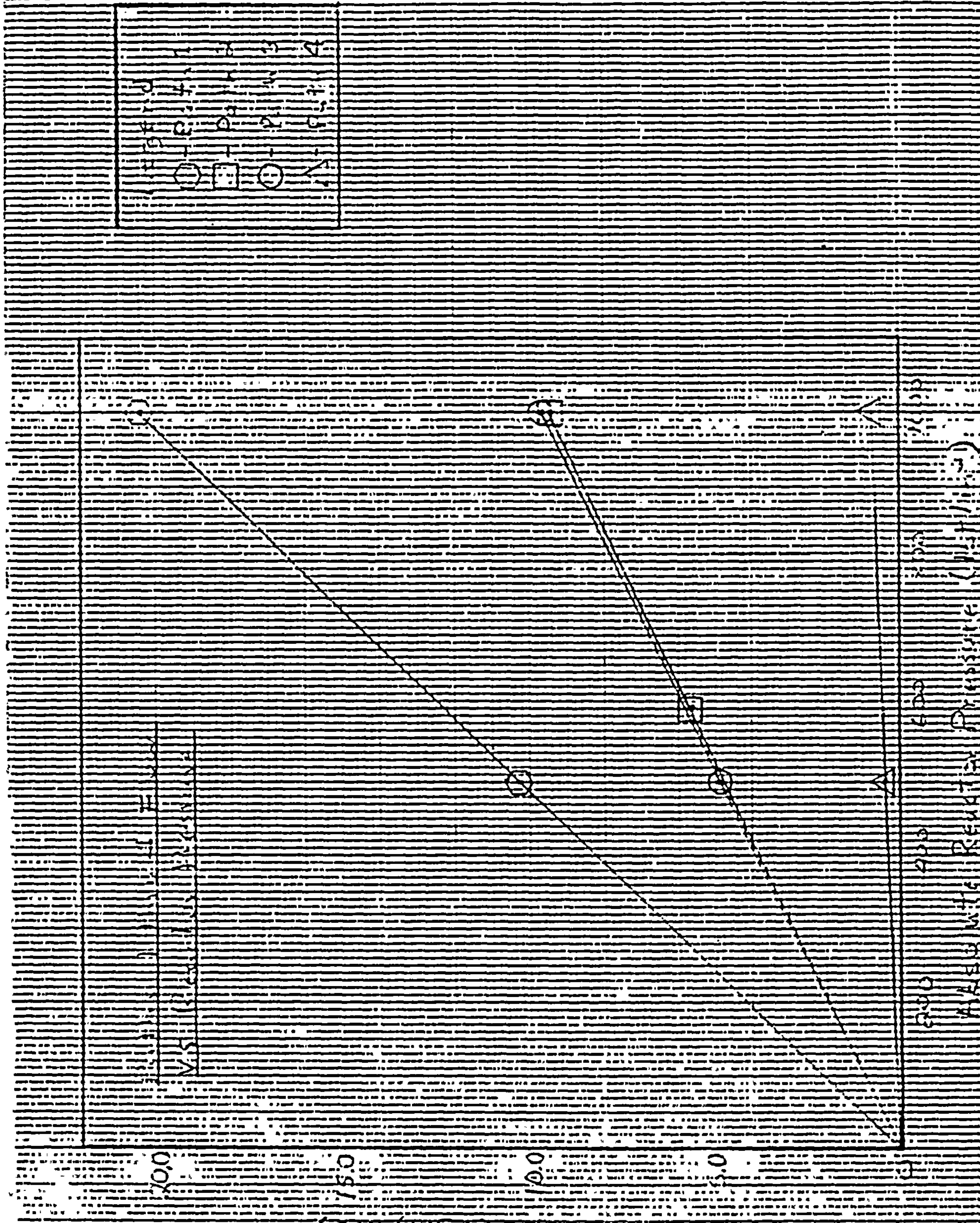
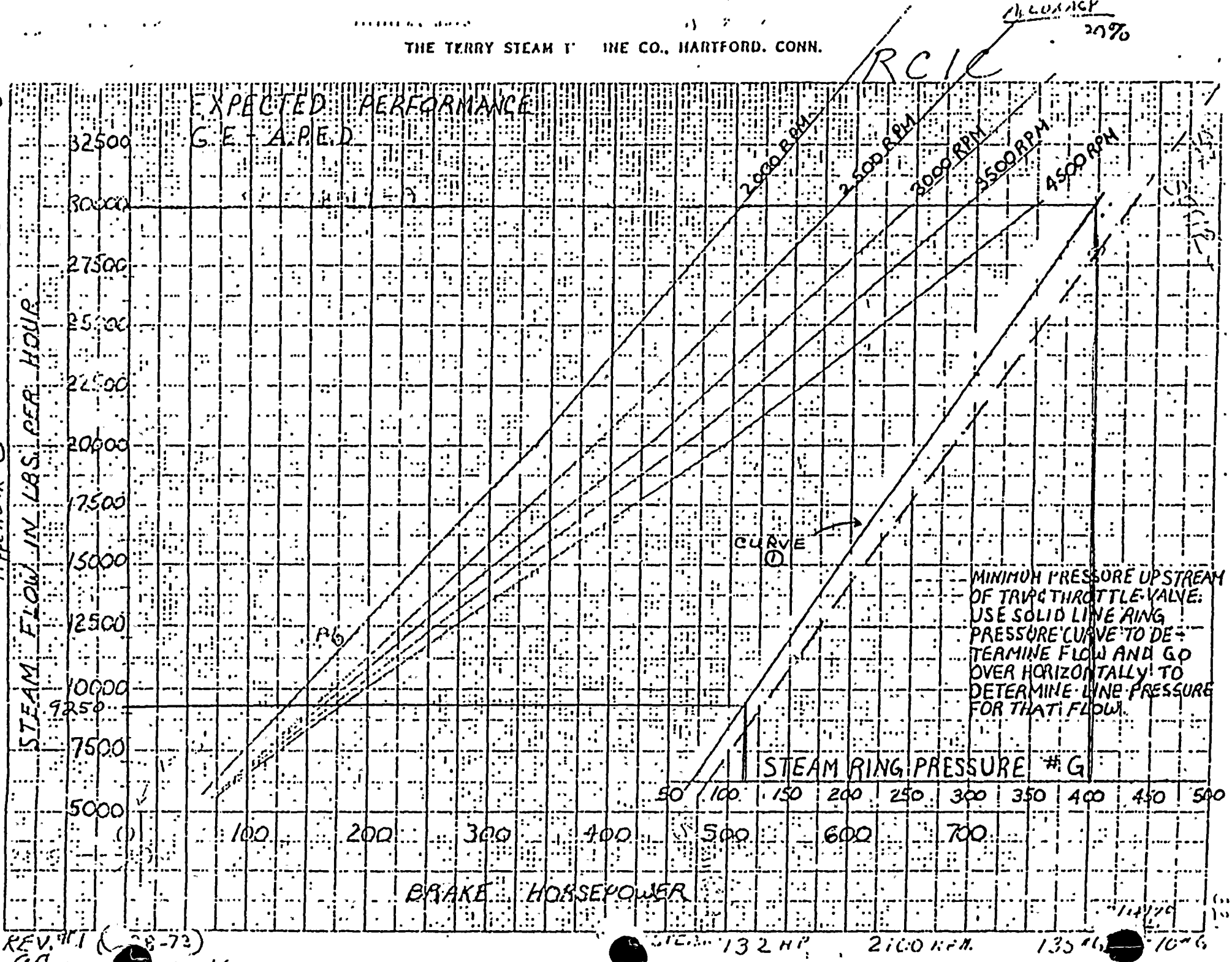


Figure B.1

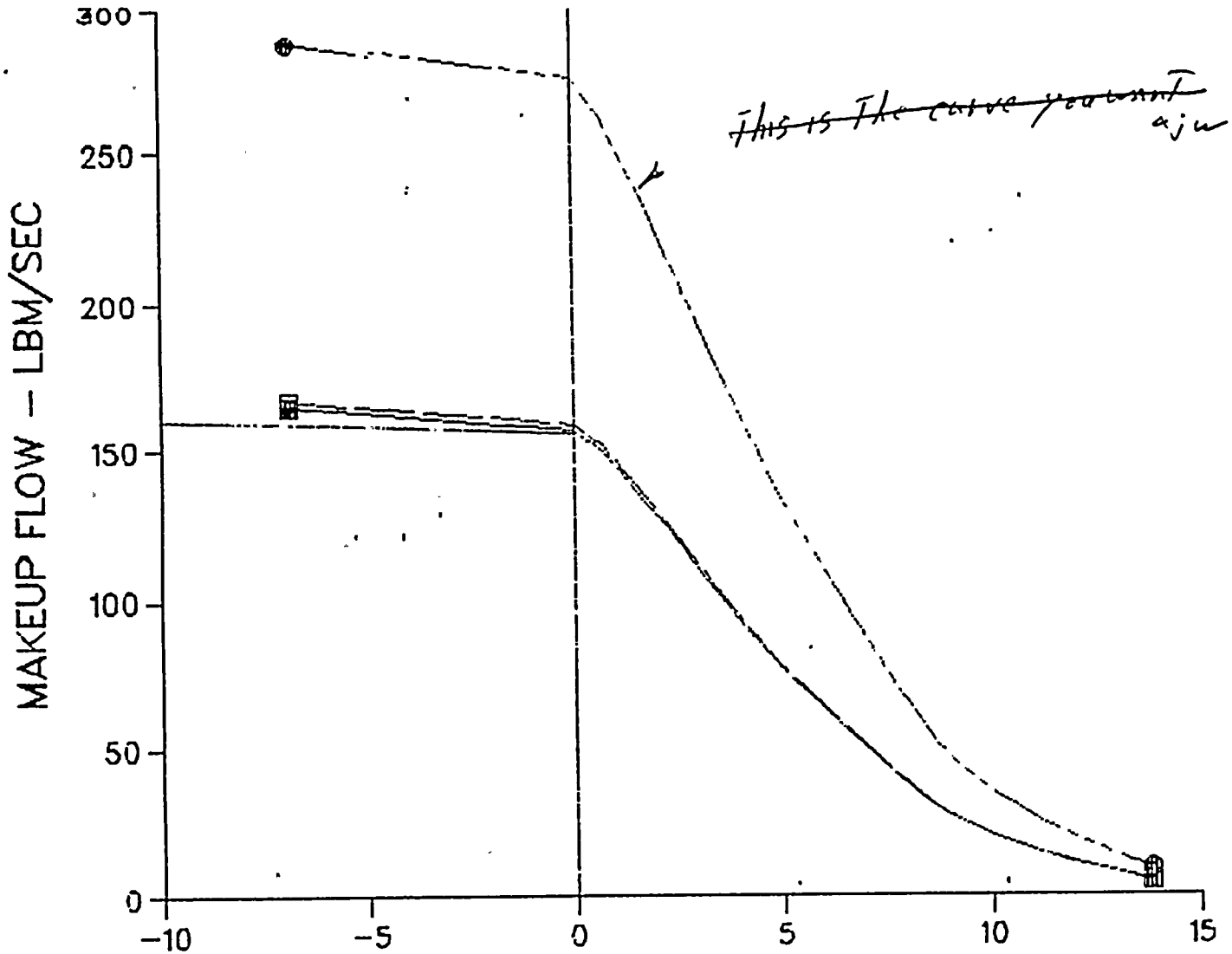
THE TERRY STEAM T' INE CO., HARTFORD, CONN.



REV. 1 (6-28-73)

AFTER SHUTDOWN MAKEUP FLOW NEEDED TO KEEP CONSTANT WATER LEVEL

RX PRESSURE = 1000 PSIA



~~This is the curve you want~~ ajw 2/17/85

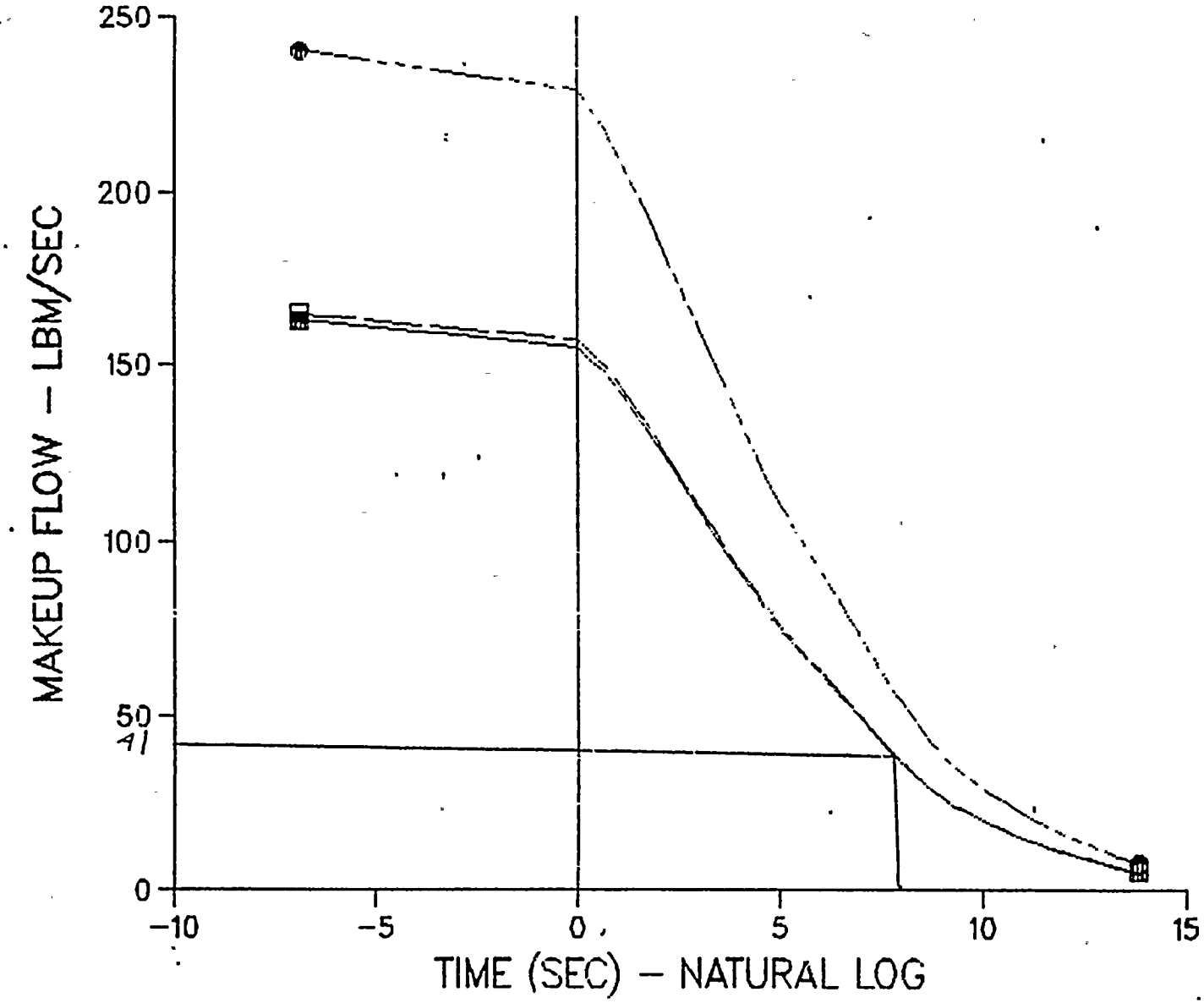
Appendix D

Legend

- HSUB = 55.725
- HSUB = 70.63
- HSUB = 542.6

From SE-B-NA-034

AFTER SHUTDOWN MAKEUP FLOW NEEDED TO KEEP CONSTANT WATER LEVEL
RX PRESSURE = 400 PSIA



Legend

- HSUB = 54.11
- HSUB = 69.05
- HSUB = 424.2

from SE-B-NA-034

AFTER SHUTDOWN MAKEUP FLOW NEEDED TO KEEP CONSTANT WATER LEVEL
RX PRESSURE = 100 PSIA

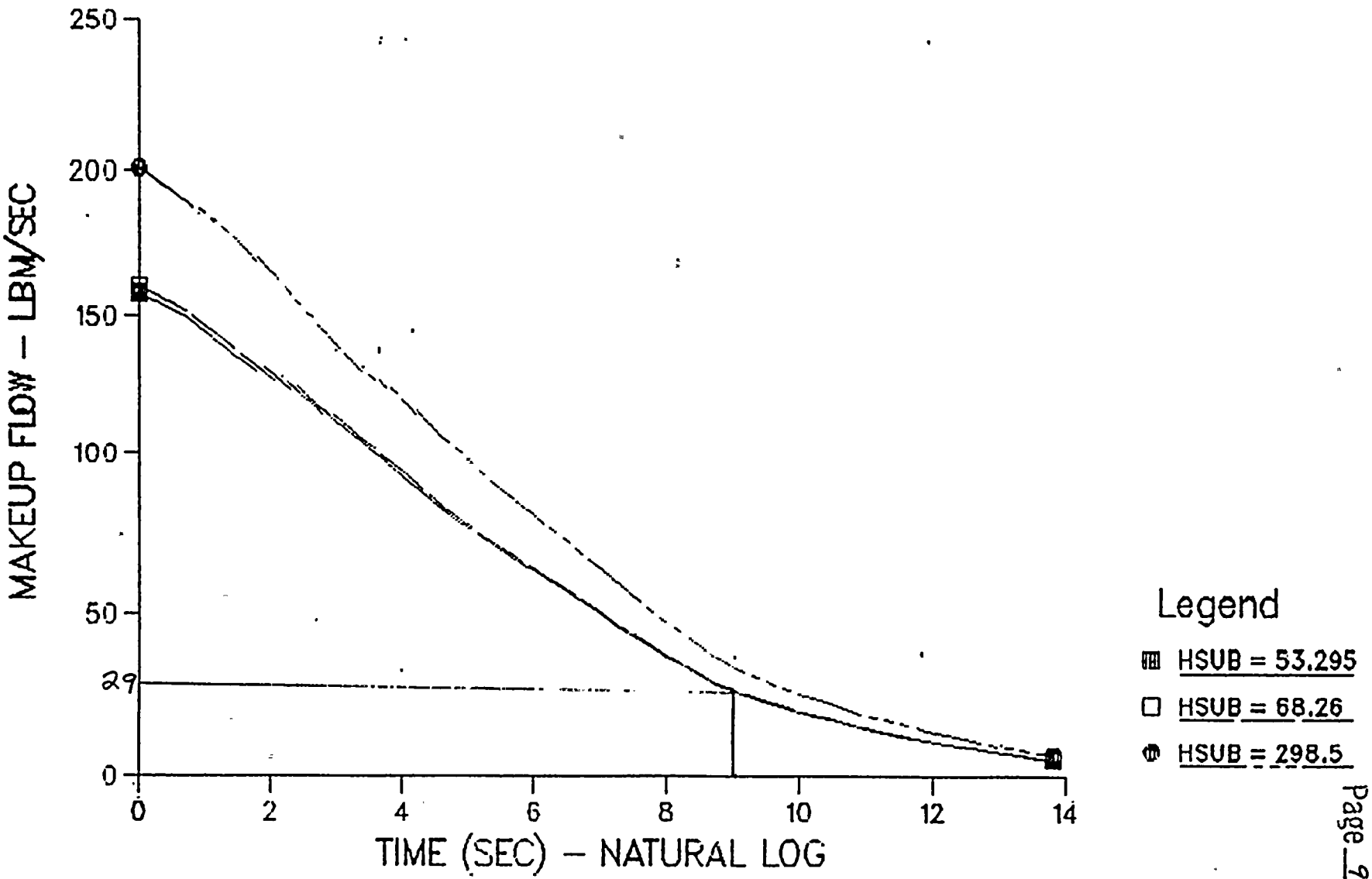


Table 1-2. RCIC System Specifications and Parameters

RCIC Pump Operation		
Flow Rate	Injection Flow - 600 gpm Cooling Water Flow - 16 gpm Total Pump Discharge - 616 gpm (Includes no margin for Pump Wear)	
Water Temperature Range	40 to 140°F	
NPSH	20 foot minimum	
Developed Head	2940 feet at 1172 psia reactor pressure 525 feet at 165 psia reactor pressure	
BHP, Not to Exceed	715 HP at 2940 feet developed head 100 HP at 525 feet developed head	
RCIC Turbine Operation		
	High Pressure Condition	Low Pressure Condition
Reactor Pressure (Saturation Temperature)	1172 psia	165 psia
Steam Inlet Pressure	1157 psia	150 psia
Turbine Exhaust Pressure	15 to 25 psia	15 to 25 psia

RCIC Water Temperature

The maximum water temperature range for continuous system operation shall not exceed 140°F. However, due to potential short term operation at higher temperatures, piping expansion calculations shall be based on 170°F.

Valve Operation Requirements	
Steam Supply Valve (MPL No. E51-F045)	- Open and/or close against full pressure within 15 seconds.
Pump Discharge Valves (MPL No. E51-F012/F013)	- Open and/or close against full pressure within 15 seconds.
Pump Minimum Flow Bypass Valve (MPL No. E51-F019)	- Open and/or close against full pressure within 5 seconds.

The turbine is designed for automatic initiation and operation, but these functions can be manually performed from the Control Room. In the manual mode of operation, flow into the reactor vessel can be adjusted to balance the volume and pressure of the steam removed so that level and pressure within the vessel are maintained as required.

Characteristics:

Manufacturer	Terry Turbine Co.
Capacity	100%
Steam Flow	8000 to 33,000 lbs/hr
Turbine Power	680 hp at 4500 rpm
Speed Range	2100 to 4500 rpm

	H.P. Condition	L.P. Condition
Reactor Press (Sat. Temp.)	1175 psia	165 psia
Steam Inlet Pressure	1120 psia	150 psia
Turbine Exhaust Press	15 to 25 psia	15 to 25 psia
Design Inlet Pressure	1250 psig + saturated temperature	
Design Exhaust Pressure	165 psig + saturated temperature	
Steam Supply Line	600 lbm/hr. at 1120 psig with 1"	
Steam Trap	level controlled, bypass valve	
Speed Controller Mfr.	Woodward Governor	
Type of Actuator	EGR Hydraulic Activator	