Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

John A. Scalice
Site Vice President, Watts Bar Nuclear Plant

10 CFR 50.12
10 CFR 50.90

JUN 2 0 1997

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of) Docket No. 50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) - REQUEST FOR EXEMPTION FROM 10 CFR 50.60, "ACCEPTANCE CRITERIA FOR FRACTURE PREVENTION MEASURES FOR LIGHTWATER NUCLEAR POWER REACTORS FOR NORMAL OPERATION" AND REQUEST FOR LICENSE AMENDMENT TO TECHNICAL SPECIFICATIONS (TS) - PRESSURE TEMPERATURE LIMITS REPORT (PTLR) (WBN-TS-97-004)

The purpose of this letter is to request an exemption from certain requirements of 10 CFR 50.60, "Acceptance Criteria for Fracture Prevention Measures for Lightwater Nuclear Power Reactors for Normal Operation," in accordance with the provisions of 10 CFR 50.12. If approved, TVA requests that Appendix A of the Facility Operating License No. NPF-90, WBN Unit 1 Technical Specifications, be amended to support revisions to the Pressure Temperature Limits Report in accordance with 10 CFR 50.90.

Paragraph 10 CFR 50.60 states that all lightwater nuclear power reactors must meet the fracture toughness and material surveillance program requirements for the reactor coolant pressure boundary as set forth in 10 CFR 50, Appendices G and H. Paragraph 10 CFR 50.60(b) specifies that proposed alternatives to the described requirements of 10 CFR Part 50 Appendices G and H may be used when an exemption is granted by NRC under 10 CFR 50.12.

This exemption is requested to allow the application of American Society of Mechanical Engineers (ASME) Code Case N-514, "Low Temperature Overpressure Protection," in determining the acceptable low temperature overpressure protection (LTOP) setpoints for WBN Unit 1. To produce and use new curves without the use of ASME Code Case N-514, would increase the possibility of

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an inadvertent actuation of the power operated relief valves (PORVs) or limit the operators in restart of the unit without some significant heating of the reactor coolant system. This would create both an operational and economical hardship for TVA without a compensating increase in the level of plant safety. This exemption request is similar to those granted for Turkey Point, Sequoyah and McGuire Nuclear Plants on May 11, 1993, June 18, 1993 and October 13, 1994, respectively.

Enclosure 1 provides the subject exemption request with a detailed discussion of the application of ASME Code Case N-514 methodology for the WBN LTOP setpoints. In addition, TVA has attached to Enclosure 1, a Draft Revision 5 of the PTLR that utilizes the new methodology. The LTOP setpoints are reflected in Figures 3.1-1 through 3.1-4 of the Draft PTLR.

Enclosure 2 provides the proposed technical specification amendment to Section 5.9.6, "Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR)." This change, located in the administrative section of the Technical Specifications, adds the reference to this exemption request as Reference 5 and also adds the letter in which NRC accepts TVA's analytical methods for performing the WBN LTOP setpoints.

Enclosure 3 provides the proposed determination of No Significant Hazard Consideration performed pursuant to 10 CFR 50.92 for the Technical Specification Amendment in Section 5.9.6.

Enclosure 4 provides the proposed environmental impact evaluation.

TVA requests that this exemption from certain requirements of 10 CFR 50.60 be processed in an expeditious manner. It is TVA's understanding that Code Case N-514 is expected to be accepted by the NRC in the next revision of Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI." Revision 12 of the regulatory guide has been released in draft (DG-1050) for public review and comment and that revision includes Code Case N-514. However, it is not anticipated that the regulatory guide would be issued in sufficient time for TVA to make the necessary changes to the PTLR and submit a license amendment request for NRC's approval.

TVA is requesting that NRC's review of the exemption request be completed by October 1, 1997, as the current LTOP curves will no longer be valid after February 8, 1998. Upon approval, the draft PTLR must be approved and issued with the new methodology and submitted to NRC in accordance with Technical Specification 5.9.6, "Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR)," Item c. If the exemption request is not approved, TVA must obtain Westinghouse services to perform the necessary

analysis that would allow operation beyond the 1.5 effective full power years (EFPY) curves. Following completion of the analysis, internal documents must be revised, and instrument setpoints must be adjusted to the new analyzed setpoints.

TVA requests that subsequent review and approval of the license amendment be completed no later than January 8, 1998. TVA requests a 30-day implementation period for this license amendment following issuance. If you should have any questions, please contact P. L. Pace at (423) 365-1824.

Sincerely,

J. A. Scalice

Subscribed and sworn to before me
on this 20th day of June 1997

E. Jeannette Long
Notary Public
My Commission Expires July 1, 1997

Enclosures
cc (Enclosures):

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. Robert E. Martin, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

Mr. Michael H. Mobley, Director
Division of Radiological Health
3rd Floor
L & C Annex
401 Church Street
Nashville, Tennessee 37243

Request for Exemption fron 10 CFR 50.60
Acquisition Criteria for Fracture Prevention M
Measures for Lightwater Nuclear Power REactors
for Normal Operation and Request for Licensing
Amendment to TEc Spec Pressure Temperature
Limits Reports (PTLR) *WBNTS-97-004)
Rec'd w/ltr dtd 6/20/97
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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT UNIT 1
REQUEST FOR EXEMPTION

Discussion

Pressure/temperature (P/T) limits for the low temperature overpressure protection (LTOP) events can be characterized by two parameters: (1) the system enabling temperature, and (2) the vessel maximum pressure. According to current regulatory guidelines, the LTOP system must be enabled at temperatures less than or equal to RT_{NDT} +90 degrees Fahrenheit (F), where RT_{NDT} is the adjusted reference temperature, including margin, at the one quarter thickness (¼T) location. At temperatures greater than RT_{NDT} +90 degrees F, LTOP need not be provided. The maximum LTOP system pressure is determined based on system-specific considerations, but is chosen so that the maximum pressure attained in the vessel will not exceed the P/T limit curve defined by Appendix G to the American Society of Mechanical Engineers (ASME) Sections III and XI and 10 CFR Part 50, Appendix G.

The LTOP system at WBN is referred to as cold overpressure mitigation system (COMS). Current COMS/LTOP limits produce operational constraints by limiting the range available to the operator to heatup and cooldown the plant. The "operating window" for heatup and cooldown of the reactor coolant system (RCS) is determined by the difference between the maximum allowable pressure (determined from ASME Section XI, Appendix G) and the reactor coolant pump (RCP) seal pressure, adjusted for COMS/LTOP overshoot and instrument error.

COMS/LTOP can have a significant economic impact by restricting plant operation. In addition, the narrow "operating window" can have an adverse impact if it increases the possibility of an unnecessary actuation of the COMS.

TVA's submittal of the PTLR dated March 10, 1994, for WBN requested an exemption to 10 CFR 50.60 based on approvals by NRC of exemptions submitted by Turkey Point Nuclear Plant and TVA's Sequoyah Nuclear Plant (SQN) to use ASME Code Case N-514 in establishing their LTOP setpoints. Since WBN Unit 1 had not operated and the reactor vessel had not experienced any radiation embrittlement (i.e., increase in RT_{NDT}), the NRC staff did not consider the WBN request appropriate. To resolve the issue, WBN withdrew the previous request for exemption in a letter dated December 23, 1994 and provided the current heatup and cooldown curves based on 7 effective full power years (EFPY). Without changing the original COMS/LTOP setpoints, the basis was changed to 1.5 EFPY curves rather than the 7 EFPY curves modified by Code Case N-514.

The 7 EFPY P/T limit curves used for heatup and cooldown provide little margin for the operating window at this time due to the material chemistry and upper shelf energy of the intermediate reactor vessel forging. Until WBN has data from the surveillance capsules, a theoretical value for fluence must be used in the calculation of the ASME Appendix G limits. These elements in concert with each other

provide WBN with conservative but highly restrictive operating limits at the low temperature end of the curves.

The use of the 1.5 EFPY curves as the COMS/LTOP setpoint basis provided WBN with the most margin legitimately achievable between the COMS/LTOP setpoints and the 7 EFPY heatup and cooldown curves. However, these setpoints can only be justified for the first operating cycle unless Code Case N-514 is approved. Generating curves for 3.5 EFPY as the COMS/LTOP setpoint basis for the second cycle will result in lower setpoints and either reduced margin between the 7 EFPY curves and the new COMS/LTOP setpoints or reduced range of the "operating window" if the margin is maintained. This action would:

1) increase the possibility of an inadvertent actuation of the PORVs,

2) increase the possibility of cavitating the RCP, or

3) severely limit the operators in restart of the unit without some significant heating of the RCS inventory before an RCP could be started, if the range of the window is reduced.

This would create both an operational and economical hardship for TVA without a compensating increase in the level of plant safety.

The present margin between the one pump operating 7 EFPY 60 degree F per hour heatup curve and the COMS/LTOP setpoint at 100 degrees F is 65 psig. This margin would be reduced to about half if the COMS/LTOP setpoints are recalculated at 3.5 EFPY. The "operating window" at 100 degrees F using the 60 degree per hour 7 EFPY heatup curve is only 17 psig (from 325 psig RCP start pressure to 342 psig on the 7 EFPY curve). This window increases to 38 psig at 150 degrees F and requires using the P2500 computer instead of analog instruments in both cases to reduce the instrument error to a point where there is an "operating window." Maintaining the margin and reducing the "operating window" is not an option for WBN. By using ASME Code Case N-514 the present margins and "operating window" remain unchanged.

The ASME Full Committee and Board of Nuclear Codes and Standards approved Code Case N-514 for use in plants having COMS/LTOP systems. This code case enables the COMS/LTOP system to limit the maximum pressure in the vessel to 110 percent of the pressure determined to satisfy Appendix G of Section XI, Article G-2215. This is consistent with the philosophy in Sections NB-3000 and NB-7000 of ASME Section III. In addition, Code Case N-514 requires the COMS/LTOP system to be effective at coolant temperatures less than 200 degrees F or at coolant temperatures corresponding to a reactor vessel metal temperature less than RT_{NDT} plus 50 degrees F, whichever is greater. Since the current RT_{NDT} for WBN Unit 1 is 181.1 degrees F, the code case will be applicable at temperatures below 231 degrees F. Applying Code Case N-514 to the 7 EFPY Appendix G curves will

maintain the current operating margin in the region of the P/T limit curves when COMS/LTOP is active.

Code Case N-514

ASME Code Case N-514 allows setting the COMS/LTOP actuation setpoints such that the 10 CFR 50, Appendix G curves are not exceeded by more than 10 percent. The application of this code case to WBN Unit 1 allows continued operation with the present setpoints.

The ASME Working Group on Operating Plant Criteria (WGOPC) developed code guidelines to define COMS/LTOP limits that would avoid unnecessary operational restrictions, provide adequate margins against failure, and reduce the potential for unnecessary activation of pressure-relieving devices used for LTOP.

The philosophy used by the WGOPC for developing these guidelines is to ensure that the COMS/LTOP limits are still below the P/T limits for normal operation, but allow the pressure that may occur with activation of pressure-relieving devices to exceed the P/T limits, provided acceptable margins are maintained during these events. This philosophy protects the pressure vessel from COMS/LTOP events, and still maintains the PTLR P/T limits applicable for normal heatup and cooldown in accordance with Appendix G to 10 CFR Part 50 and Sections III and XI of the ASME code.

Inherent Margins to 10 CFR Part 50, Appendix G

There are numerous conservatisms in the development of Appendix G P/T curve calculations. Some of these are as follows:

1. The safety factor of 2 on the principal membrane (pressure) stresses.

2. A margin factor applied to RT_{NDT} by using Regulatory Guide 1.99, Revision 2.

3. An assumed defect in the reactor vessel wall with a depth equal to ¼ of the thickness of the vessel was (¼T) and a length equal to 1½ times the thickness of the vessel wall.

4. Assumed reference flaw oriented in both longitudinal and circumferential directions and limiting material property. At WBN, the only weld in the core region is oriented in the circumferential direction.

5. The limiting toughness is based upon a reference value (K_{IM}) which is the lower bound of the dynamic crack initiation and arrest toughness.

6. A 2-sigma margin term is applied in determining the adjusted reference temperature (ART) that is used in calculating the limiting toughness.

7. The disregarding of increased mechanical properties of the vessel that accompany material embrittlement (elevated yield strength and flow stress).

These conservatisms support the determinations made by the WGOPC in the development of Code Case N-514.

Bases for Exemption

The requested exemption to the regulations is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security.

TVA considers the requested exemption to meet the criteria in 10 CFR 50.12(a)(2) in that special circumstances are present. These special circumstances include:

1. 10 CFR 50.12(a)(2)(ii)

The application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule.

Basis - The basis for the COMS/LTOP setpoints is to preclude RCS pressure from exceeding the Appendix G curves when there is a potential for brittle failure of the reactor vessel material. ASME Code Case N-514 recognizes the conservatism of the Appendix G curves and allows establishing a setpoint that preserves the acceptable margin of safety while maintaining operational margins for RCP operation at low temperatures and pressures. Setpoints established in accordance with Code Case N-514 will also minimize the potential for an unnecessary actuation of protection system pressure-relieving devices. Therefore, establishing COMS/LTOP setpoints using Code Case N-514 criteria satisfies the underlying purpose of the ASME code and NRC's regulations to ensure nuclear power plant systems and components are operated with an acceptable level of safety and environmental impact.

Based on the above, the application of the regulation in the particular circumstances is not necessary to achieve the underlying purpose of the rule.

2. 10 CFR 50.12(a)(2)(iii)

Compliance would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted, or that are significantly in excess of those incurred by others similarly situated.

Basis - Administrative restrictions on RCP operations while at low RCS temperatures would result in an unnecessary burden in that an excessive delay would be required to ensure an unrealistic minimum RCS temperature is attained before starting RCPs. This temperature would have to be achieved by external heating methods which could introduce undesirable thermal transients in the RCS. TVA considers this burden can be alleviated by the application of the code case. The guidelines developed by the WGOPC for COMS/LTOP P/T limits provide acceptable margin against crack initiation and failure of reactor vessels. These limits do not significantly change the likelihood of vessel failure associated with normal heatup and cooldown P/T limits. Moreover, the COMS/LTOP guidelines will reduce the potential for unnecessary activation of protection system pressure-relieving devices. Consequently the COMS/LTOP limits developed by the WGOPC provide both economic and safety benefits.

Therefore, compliance would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted.

Conclusion

ASME Code Case N-514 allows setting the COMS/LTOP setpoints such that the Appendix G curves are not exceeded by more than 10 percent. The ASME code committee has concluded the LTOP guidelines provide acceptable margin against crack initiation and failure in reactor vessels, and will reduce the potential for unnecessary activation of protection system pressure-relieving devices. Consequently, the current COMS/LTOP setpoints provide both operational and safety benefits with no adverse safety or environmental impact. The use of Code Case N-514 provides an acceptable level of quality and safety.

The need for implementation of Code Case N-514 at WBN involves the avoidance of certain operational restrictions associated with low temperature operation of the plant. Use of Appendix G P/T limits to determine the PORV setpoints would result in pressure setpoints within the operating window, but no margin would be available for normal operating pressure surges. Therefore, operating with these limits could result in an unnecessary challenge to the PORVs and cavitation of the RCPs during normal operation. Additionally, the need to raise the RCS inventory by external heating methods to a temperature high enough to avoid PORV activation when starting a RCP from a RCS cold shutdown condition could result in undesirable

thermal transients in the RCS. Compliance with the currently approved pressure and/or temperature limits which have not been modified in accordance with Code Case N-514 for LTOP (COMS) setpoints would result in an economic hardship to TVA, without a compensating increase in the level of quality or safety.

TVA requests that this exemption from certain requirements of 10 CFR 50.60 be processed in an expeditious manner. It is TVA's understanding that the NRC plans to endorse ASME Code Case N-514 in the next revision of Regulatory Guide 1.147 as Revision 12 of the regulatory guide is currently issued in draft (DG-1050) for public comment. However, TVA does not anticipate that the regulatory guide will be issued in final form in sufficient time for TVA to make the necessary changes to the PTLR and submit a license amendment request for NRC's approval.

ENCLOSURE 1
ATTACHMENT 1

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1
PRESSURE TEMPERATURE LIMITS REPORT (PTLR)
DRAFT REVISION 5

APPENDIX "A"

TO RCS SYSTEM DESCRIPTION N3-68-4001

WATTS BAR UNIT 1

RCS PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

REVISION 5 (DRAFT)

Prepared by :

_____

Checked by:

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Approved by :

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RCS PRESSURE AND TEMPERATURE LIMITS REPORT FOR WATTS BAR UNIT 1

1.0 RCS Pressure and Temperature Limits Report (PTLR)

This PTLR for Watts Bar Unit 1 has been prepared in accordance with the requirements of Technical Specification 5.9.6. Revisions to the PTLR shall be provided to the NRC after issuance.

The Technical Specifications affected by this report are listed below:

LCO 3.4.3. RCS Pressure and Temperature (P/T) Limits
LCO 3.4.12 Cold Overpressure Mitigation System (COMS)

2.0 RCS Pressure and Temperature Limits

The limits for LCO 3.4.3 are presented in the subsection which follows. These limits have been developed (Ref. 1, 4) using the NRC-approved methodologies specified in Specification 5.9.6.

2.1 RCS Pressure and Temperature (P/T) Limits (LCO 3.4.3)

2.1.1 The RCS temperature rate-of-change limits are (Ref. 1):

a. A maximum heatup Rate 100 ^{o}F per hour.
b. A maximum cooldown Rate 100 ^{o}F per hour.
c. A maximum temperature change of 10 ^{o}F in any 1-hour period during inservice hydrostatic and leak testing operations above the heatup and cooldown limit curves.

2.1.2 The RCS P/T limits for heatup, cooldown, inservice hydrostatic and leak testing, and criticality are specified by Figures 2.1-1 and 2.1-2 (Ref. 1).

NOTE: The heat-up and cool-down curves are based on beltline conditions and do not compensate for pressure differences between the pressure transmitter and reactor midplane/beltline or for instrument inaccuracies. Refer to Table 2.1-3 for pressure differences (Ref. 2). Site Engineering Setpoint and Scaling documents SSD-1-P-68, -63, -64, -66, and -70 provide the adjusted curves for temperature and pressure limits which are compensated for pressure differential and instrument inaccuracy to be used for heatup and cooldown.

3.0 Cold Overpressure Mitigation System (LCO 3.4.12)

The lift setpoints for the pressurizer Power Operated Relief Valves (PORVs) are presented in the subsection which follows. These lift setpoints have been developed using the NRC-approved methodologies specified in Specification 5.9.6.

3.1 Pressurizer PORV Lift Setting Limits

The pressurizer PORV lift setpoints are depicted in Figures 3.1-1 through 3.1-4 and specified by Table 3.1-1 (Ref. 2). The limits for the COMS setpoints are contained in the 7 EFPY curves adjusted per ASME Code Case N-514 for Heatup (Figure 3.1-5 and Table 3.1-2) and Cooldown (Figure 3.1-6 and Table 3.1-3) (Ref. 1) which are based on beltline conditions and are not compensated for pressure differences between the pressure transmitter and the reactor midplane/beltline or for instrument inaccuracies. Refer to Table 2.1-3 for pressure differences (Ref. 2). R5

NOTE: These setpoints include allowance for pressure difference between the pressure transmitter and reactor midplane, and also includes 63 psig pressure channel uncertainty. Site Engineering Setpoint and Scaling documents for instrument loop numbers 1-T-68-1B and 1-T-68-43B contain the adjusted curves compensated for pressure differential and instrument inaccuracy which provides the PORV lift limits for the COMS.

4.0 Reactor Vessel Material Surveillance Program

The reactor vessel material irradiation surveillance specimens shall be removed and examined to determine changes in material properties. The removal schedule is provided in Table 4.0-1. The results of these examinations shall be used to update Figures 2.1-1, 2.1-2, and 3.1-1 through 3.1-4.

The pressure vessel steel surveillance program (Ref. 3) is in compliance with Appendix H to 10 CFR 50, entitled "Reactor Vessel Material Surveillance Program Requirements". The material test requirements and the acceptance standard utilize the reference nil-ductility temperature, RT_{NDT}, which is determined in accordance with ASTM E208. The empirical relationship between RT_{NDT} and the fracture toughness of the reactor vessel steel is developed in accordance with Appendix G, "Protection Against Non-Ductile Failure", to Section III of the ASME Boiler and Pressure Vessel Code. The surveillance capsule removal schedule meets the requirements of ASTM E185-82. The removal schedule is provided in Table 4.0-1.

5.0 Supplemental Data Tables

Table 5.1 contains a comparison of measured surveillance material 30 ft-lb transition temperature shifts and upper shelf energy decreases with Regulatory Guide 1.99, Revision 2, predictions. This table was intentionally left blank since no capsules were removed to date.

Table 5.2 shows calculations of the surveillance material chemistry factors using surveillance capsule data. This table was intentionally left blank since no capsules were removed to date.

Table 5.3 provides the required Watts Bar Unit 1 reactor vessel toughness data. The bolt-up temperature is also included in this table.

Table 5.4 provides a summary of the fluence values used in the generation of the heatup and cooldown limit curves.

Table 5.5 provides a summary of the adjusted reference temperature (ART) values of the Watts Bar Unit 1 reactor vessel beltline materials at the 1/4-T and 3/4-T locations for 7 EFPY.

Table 5.6 shows example calculations of the adjusted reference temperature (ART) values at 7 EFPY for the limiting Watts Bar Unit 1 reactor vessel material (Intermediate Shell Forging 05).

Table 5.7 provides a summary of the fluence values used in the Pressurized Thermal Shock (PTS) evaluation.

Table 5.8 provides RT_{PTS} values for Watts Bar Unit 1 for 32 EFPY.

Table 5.9 provides RT_{PTS} values for Watts Bar Unit 1 for 48 EFPY.

REFERENCES

1. WCAP-13829 Revision 1, "Heatup and Cooldown Limit Curves for Normal Operation for Watts Bar Unit 1", February 1995.

2. Westinghouse Letter to TVA, WAT-D-9448, "Revised COMS PORV Setpoints," August 27, 1993.

3. WCAP-9298, Revision 1, "Watts Bar Unit 1 Reactor Vessel Radiation Surveillance Program", April 1993.

4. Westinghouse Letter to TVA, WAT-D-9526, "COMS".

5. WCAP-14040, Revision 1, "Methodology Used To Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves", December 1994.

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MATERIAL PROPERTY BASIS

LIMITING MATERIAL: INTERMEDIATE SHELL FORGING 05

INITIAL RT_{NDT} 47 °F

LIMITING ART AT 7 EFPY: 1/4-T, 181.1 °F

3/4-T, 147.7 °F

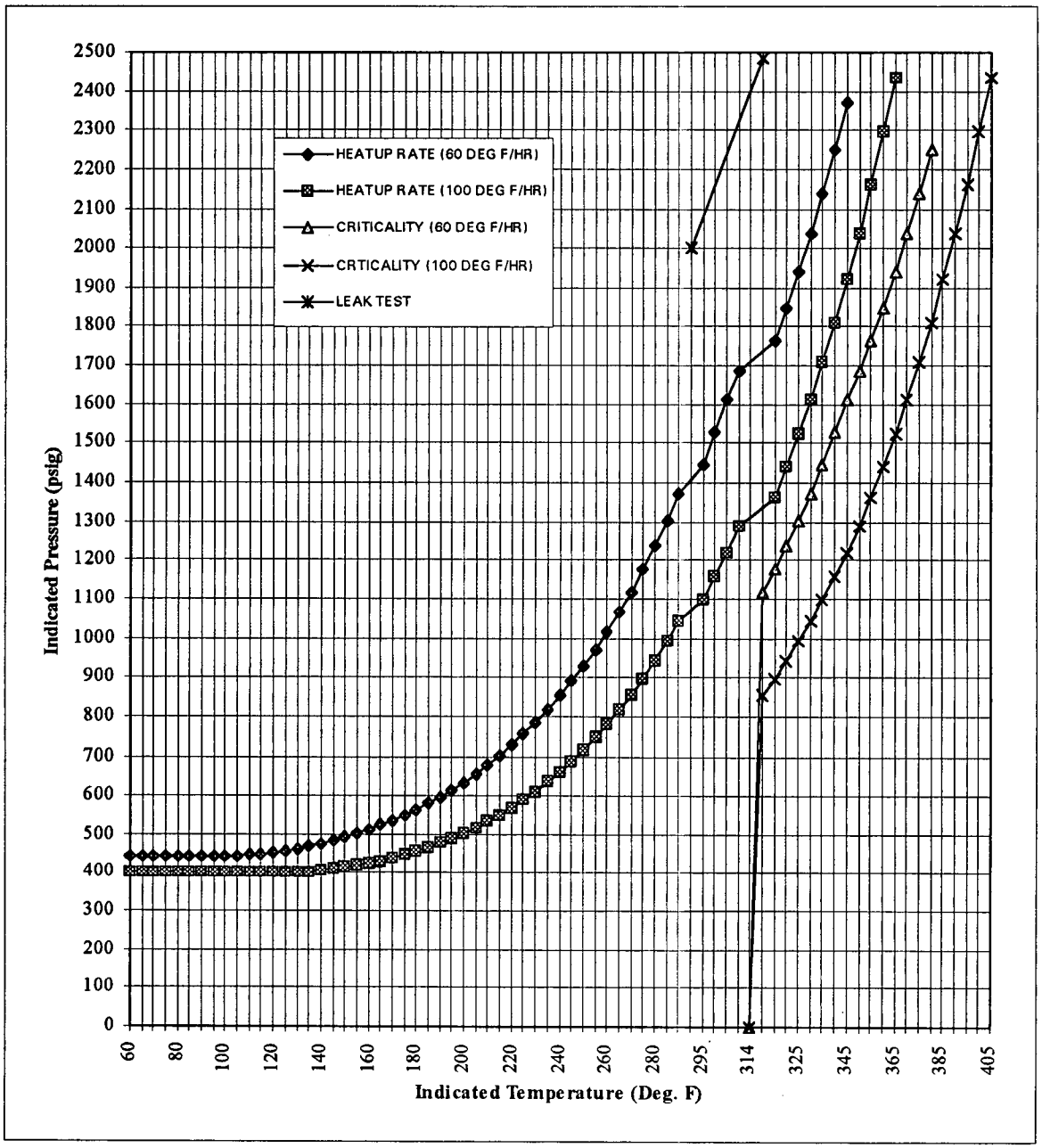


Figure 2.1-1

Watts Bar Unit 1 Reactor Coolant System Heatup Limitations (Heatup rates of 60 and 100 °F/hr) Applicable for the First 7 EFPY (Without Margins for Instrumentation Errors)

(Plotted Data (Ref. 1) provided on Table 2.1-1)

Table 2.1-1
Watts Bar Unit 1 Heatup Limits
(Data points plotted in Figure 2.1-1)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	HEATUP RATE (60 °F/HR)	HEATUP RATE (100 °F/HR)	LEAK TEST LIMITS	CRITICALITY LIMITS (60 °F/HR)	CRITICALITY LIMITS (100 °F/HR)
60	443.05	401.48			
65	443.05	401.48			
70	443.05	401.48			
75	443.05	401.48			
80	443.05	401.48			
85	443.05	401.48			
90	443.05	401.48			
95	443.05	401.48			
100	443.05	401.48			
105	444.11	401.48			
110	446.29	401.48			
115	449.34	401.48			
120	453.33	401.48			
125	458.10	401.48			
130	463.72	402.34			
135	470.07	404.05			
140	477.24	406.56			
145	485.17	409.93			
150	493.84	414.14			
155	503.41	419.16			
160	513.86	425.01			
165	525.20	431.68			
170	537.41	439.16			
175	550.72	447.59			
180	565.12	456.94			
185	580.63	467.24			
190	597.27	478.55			
195	615.30	490.90			

Table 2.1-1
Watts Bar Unit 1 Heatup Limits
(Data points plotted in Figure 2.1-1)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	HEATUP RATE (60 °F/HR)	HEATUP RATE (100 °F/HR)	LEAK TEST LIMITS	CRITICALITY LIMITS (60 °F/HR)	CRITICALITY LIMITS (100 °F/HR)
200	634.60	504.29			
205	655.51	518.93			
210	678.00	534.82			
215	702.06	551.92			
220	727.92	570.53			
225	755.91	590.51			
230	785.79	612.21			
235	818.05	635.46			
240	852.61	660.68			
245	889.70	687.66			
250	929.52	716.88			
255	972.27	748.15			
260	1018.19	781.76			
265	1067.49	818.06			
270	1120.42	856.92			
275	1177.15	898.66			
280	1237.98	943.47			
285	1303.13	991.58			
290	1373.09	1043.20			
293			2000		
295	1447.99	1098.55			
300	1527.97	1157.76			
305	1612.31	1221.51			
310	1686.16	1289.68			
314			2485	0 to 1120.42	0 to 856.92
315	1765.15	1362.69		1177.15	898.66
320	1849.89	1440.81		1237.98	943.47

Table 2.1-1
Watts Bar Unit 1 Heatup Limits
(Data points plotted in Figure 2.1-1)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	HEATUP RATE (60 °F/HR)	HEATUP RATE (100 °F/HR)	LEAK TEST LIMITS	CRITICALITY LIMITS (60 °F/HR)	CRITICALITY LIMITS (100 °F/HR)
325	1940.35	1524.60		1303.13	991.58
330	2037.07	1614.19		1373.09	1043.20
335	2140.54	1709.92		1447.99	1098.55
340	2250.90	1812.16		1527.97	1157.76
345	2368.62	1921.54		1612.31	1221.51
350		2038.25		1686.16	1289.68
355		2162.68		1765.15	1362.69
360		2295.42		1849.89	1440.81
365		2436.49		1940.35	1524.60
370				2037.07	1614.19
375				2140.54	1709.92
380				2250.90	1812.16
385				2368.62	1921.54
390					2038.25
395					2162.68
400					2295.42
405					2436.49

MATERIAL PROPERTY BASIS

LIMITING MATERIAL:	INTERMEDIATE SHELL FORGING 05
INITIAL RT_{NDT}	47 °F
LIMITING ART AT 7 EFPY:	1/4-T, 181.1 °F
	3/4-T, 147.7 °F

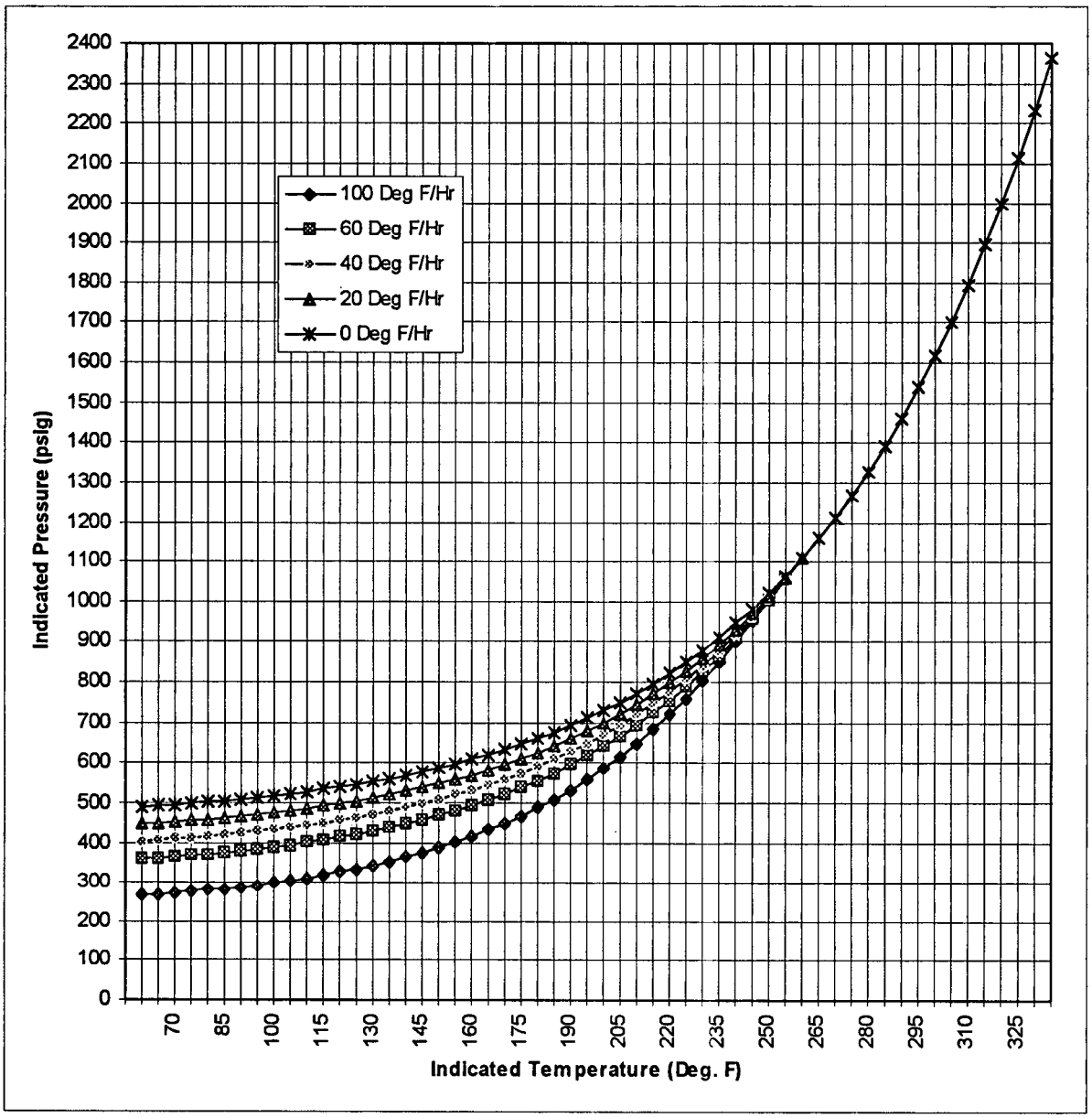


Figure 2.1-2

Watts Bar Unit 1 Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable for the First 7 EFPY (Without Margins for Instrumentation Errors)

(Plotted Data (Ref. 1) provided on Table 2.1-2)

Table 2.1-2
Watts Bar Unit 1 Cooldown Limits
(Data plotted on Figure 2.1-2)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	100 °F/HR	60 °F/HR	40 °F/HR	20 °F/HR	0 °F/HR
60	266.59	359.39	404.02	447.48	490.13
65	269.45	362.11	406.70	450.24	492.77
70	272.56	365.11	409.67	453.18	495.72
75	276.04	368.41	412.91	456.38	498.88
80	279.82	371.97	416.40	459.81	502.28
85	283.98	375.89	420.21	463.54	505.94
90	288.53	380.12	424.32	467.55	509.87
95	293.54	384.74	428.79	471.89	514.09
100	298.99	389.73	433.61	476.55	518.64
105	304.97	395.18	438.77	481.60	523.52
110	311.45	401.06	444.40	487.03	528.77
115	318.55	407.40	450.52	492.81	534.42
120	326.20	414.30	457.10	499.12	540.39
125	334.59	421.80	464.24	505.93	546.91
130	343.66	429.89	471.92	513.26	553.93
135	353.56	438.60	480.25	521.17	561.47
140	364.21	448.06	489.20	529.67	569.58
145	375.84	458.32	498.80	538.75	578.31
150	388.41	469.38	509.23	548.62	587.56
155	402.06	481.35	520.50	559.26	597.63
160	416.74	494.17	532.63	570.71	608.47
165	432.73	508.12	545.63	582.92	620.12
170	449.91	523.16	559.73	596.19	632.50
175	468.61	539.30	574.96	610.49	645.97
180	488.79	556.81	591.21	625.85	660.44
185	510.54	575.72	608.89	642.29	675.98
190	534.09	595.96	627.89	660.09	692.57
195	559.46	617.94	648.27	679.12	710.56
200	586.80	641.47	670.32	699.74	729.70
205	616.49	667.02	693.97	721.92	750.49
210	648.35	694.35	719.52	745.65	772.78

Table 2.1-2
Watts Bar Unit 1 Cooldown Limits
(Data plotted on Figure 2.1-2)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	100 °F/HR	60 °F/HR	40 °F/HR	20 °F/HR	0 °F/HR
215	682.74	723.96	746.96	771.30	796.64
220	719.95	755.76	776.41	798.79	822.23
225	760.01	789.97	808.37	828.31	849.99
230	803.10	826.78	842.54	860.26	879.55
235	849.59	866.62	879.31	894.47	911.51
240	899.62	909.35	918.85	931.19	945.77
245	953.53	955.36	961.60	970.69	982.53
250	1011.36	1004.81	1007.39	1013.15	1022.00
255		1057.86	1056.69	1058.81	1064.40
260			1109.45	1107.90	1109.98
265					1158.95
270					1211.57
275					1268.05
280					1328.61
285					1393.44
290					1463.21
295					1537.95
300					1618.11
305					1703.92
310					1795.88
315					1894.39
320					1999.72
325					2112.46
330					2232.88
335					2361.41

Table 2.1-3

Pressure Differentials

Number of Pumps	Delta P (psi)
0	5.2
1	31.0
2	38.0
3	52.0
4	74.0

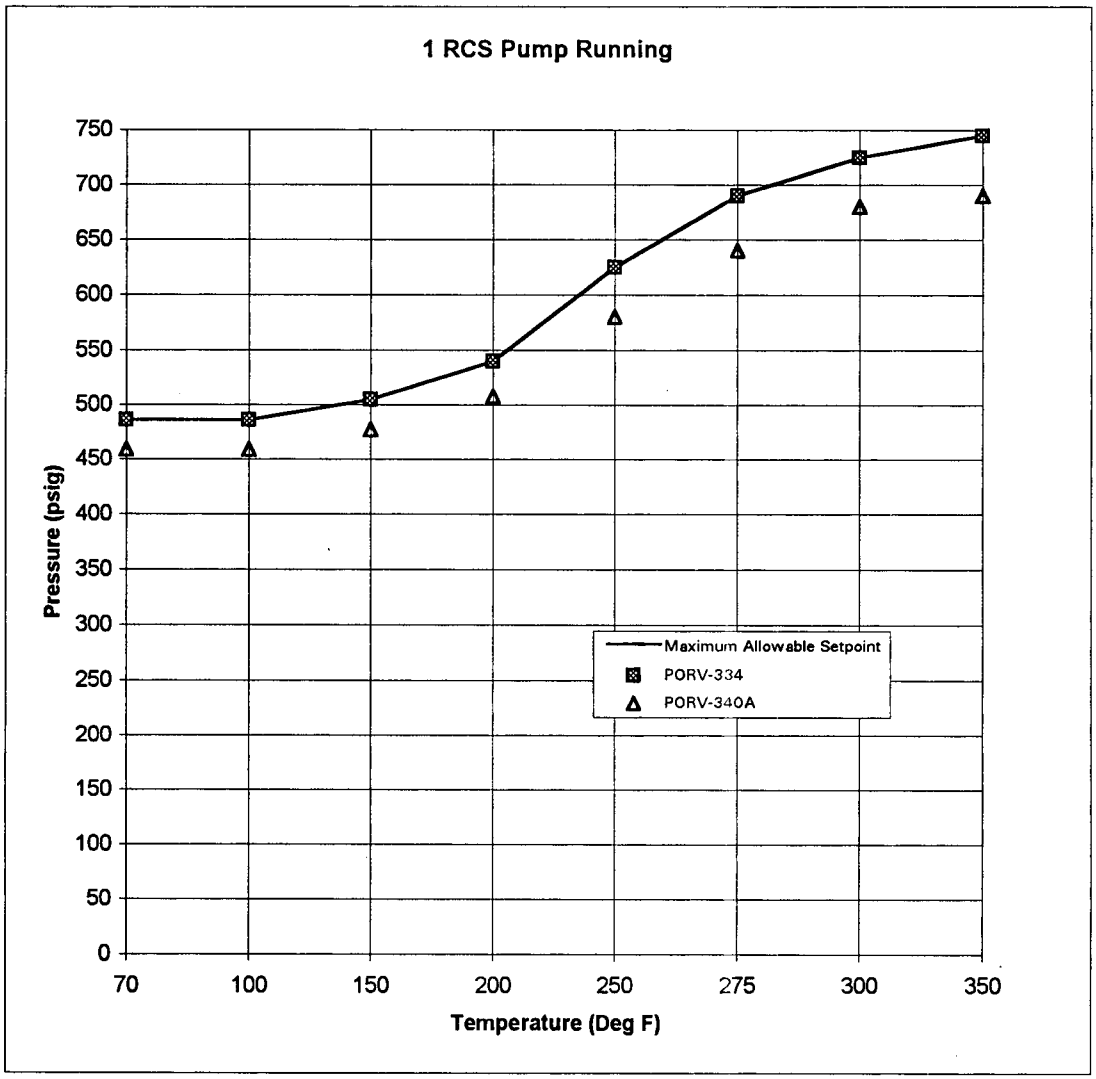


Figure 3.1-1

PORV Setpoint vs RCS Temperature
(Plotted data (Ref. 3) provided on Table 3.1-1)

NOTE: Westinghouse PORV Numbers 456 and 455A
Correspond to TVA PORV Numbers 334 and 340A

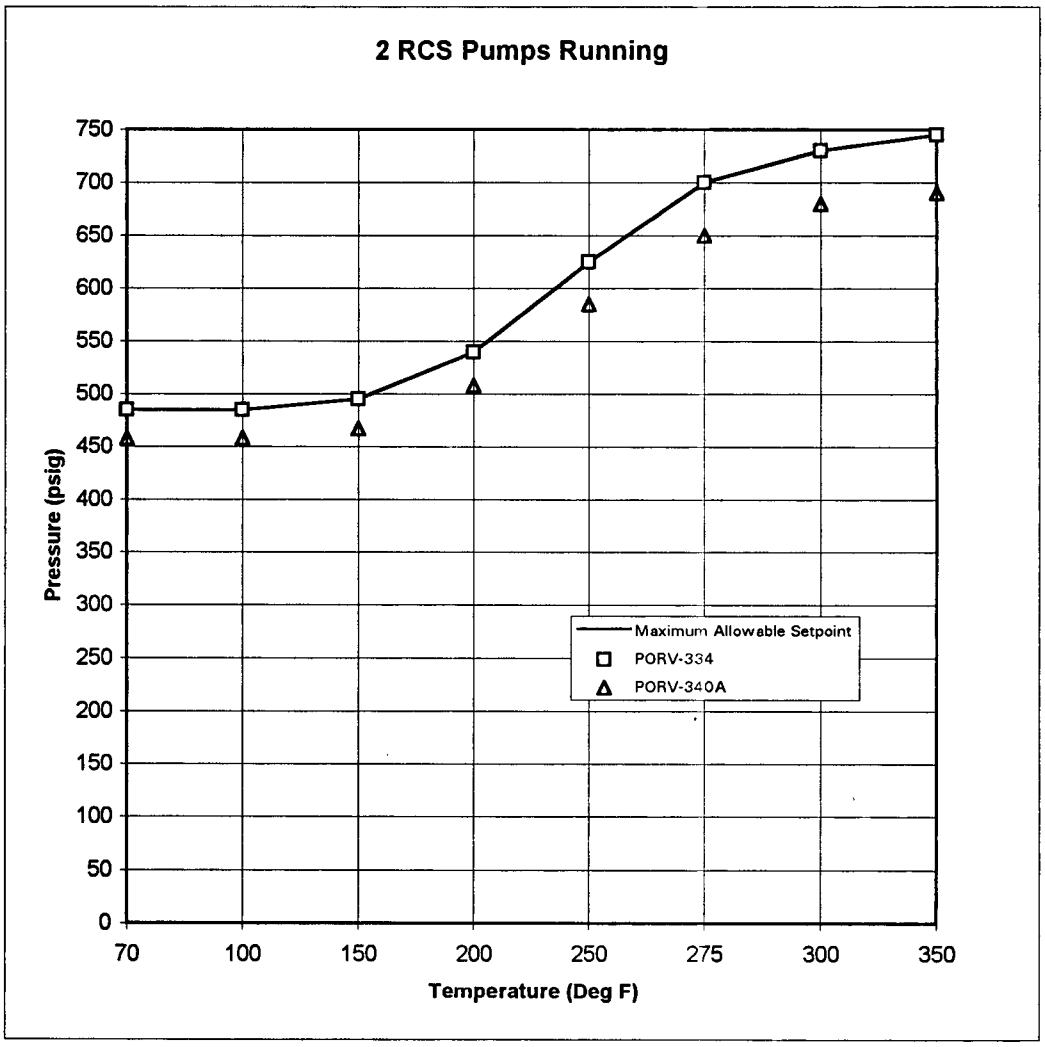


Figure 3.1-2

PORV Setpoint vs RCS Temperature
(Plotted data (Ref. 3) provided on Table 3.1-1)

NOTE: Westinghouse PORV Numbers 456 and 455A
Correspond to TVA PORV Numbers 334 and 340A

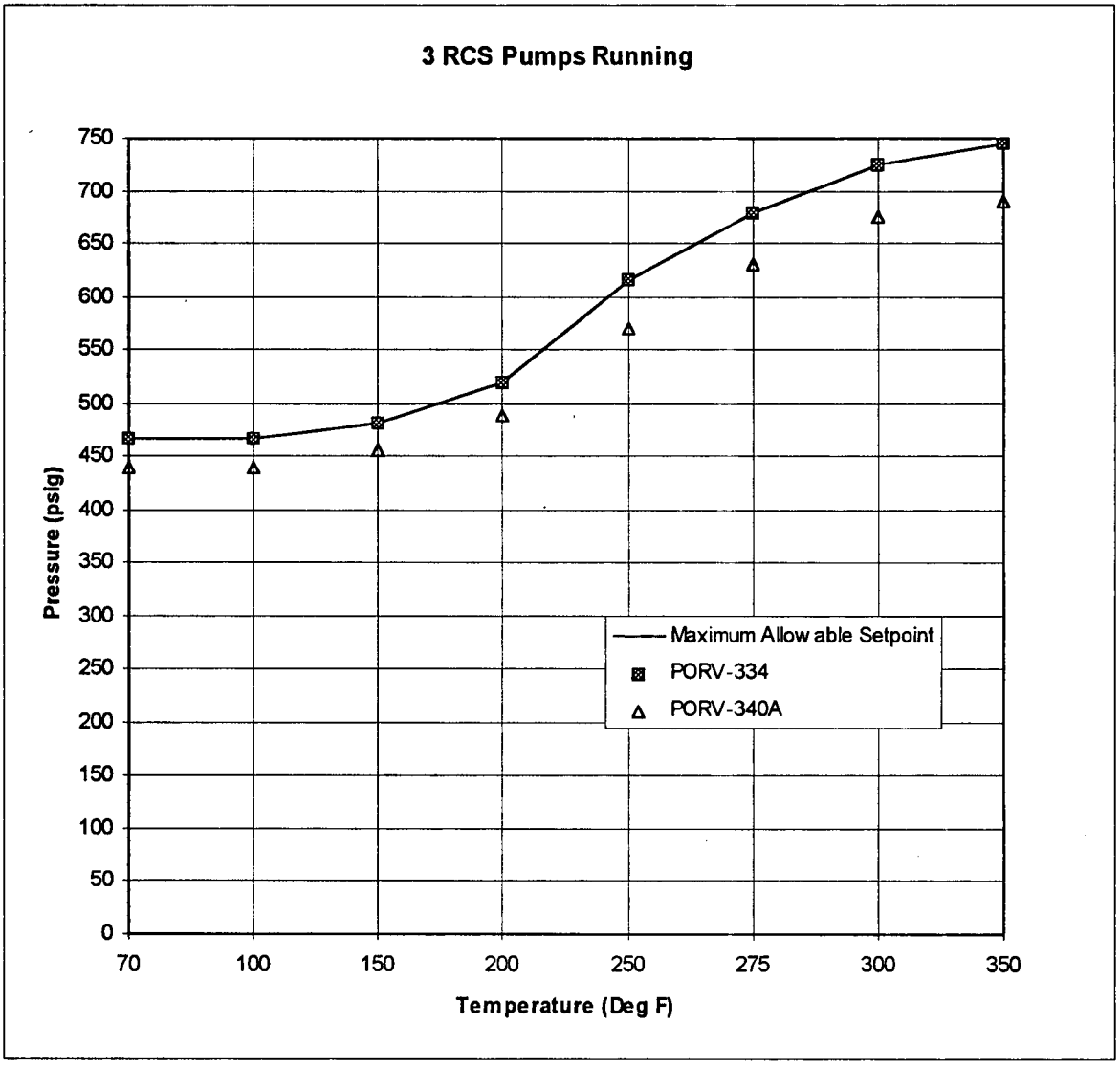


Figure 3.1-3

PORV Setpoint vs RCS Temperature
(Plotted data (Ref. 3) provided on Table 3.1-1)

NOTE: Westinghouse PORV Numbers 456 and 455A
Correspond to TVA PORV Numbers 334 and 340A

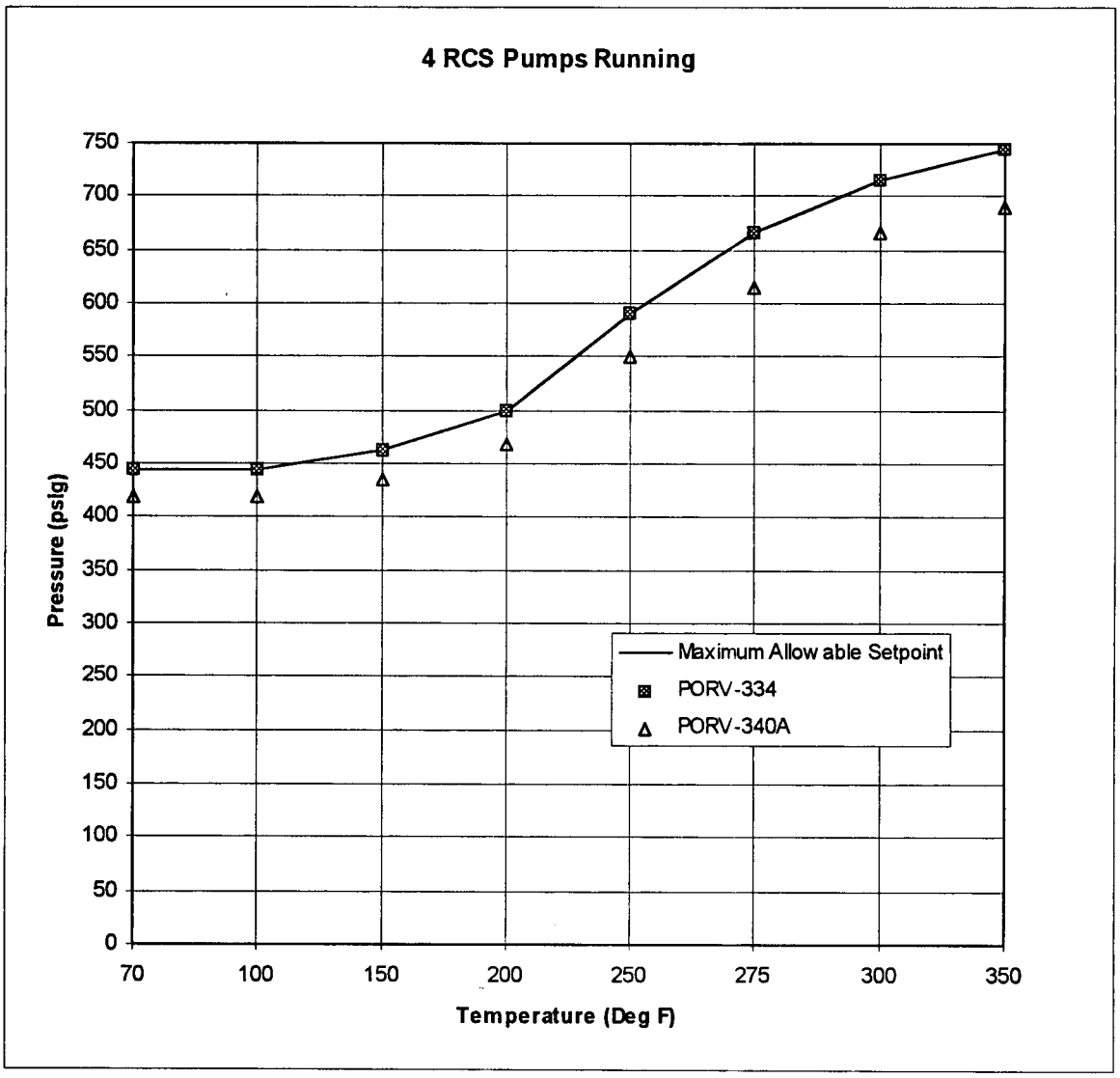


Figure 3.1-4

PORV Setpoint vs RCS Temperature
(Plotted data (Ref. 3) provided on Table 3.1-1)

NOTE: Westinghouse PORV Numbers 456 and 455A
Correspond to TVA PORV Numbers 334 and 340A

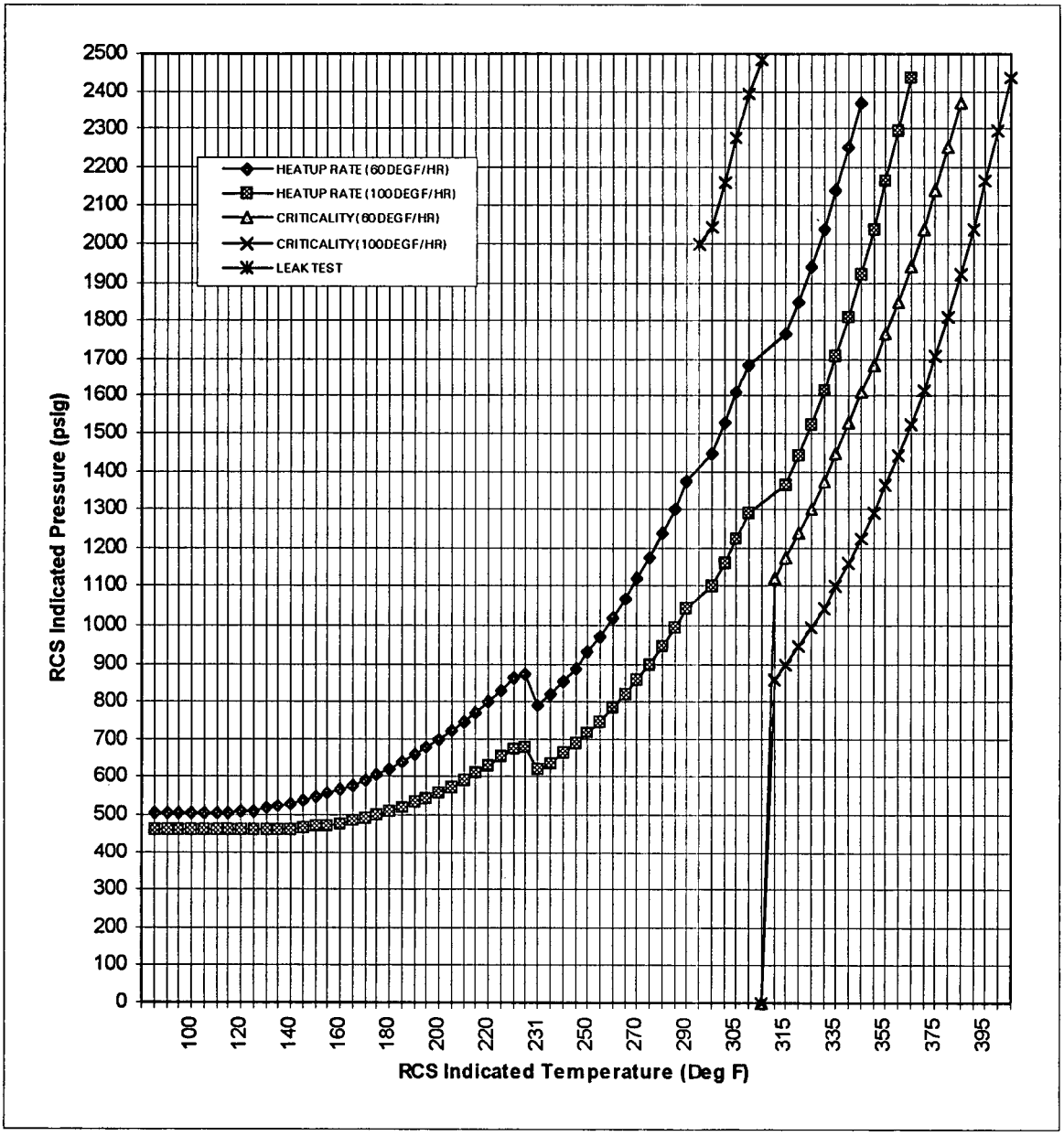
Table 3.1-1
Watts Bar Unit 1 PORV Setpoints vs Temperature
(Data (Ref. 3) plotted on Figures 3.1-1 through 3.1-4)

TEMP (F)	SETPOINTS (PSIG)							
	1 RCS PUMP OPERATING		2 RCS PUMPS OPERATING		3 RCS PUMPS OPERATING		4 RCS PUMPS OPERATING	
	PORV-334	PORV-340A	PORV-334	PORV-340A	PORV-334	PORV-340A	PORV-334	PORV-340A
70	486	459	485	458*	467	440*	445*	418*
100	486	459	485	458*	467	440*	445*	418*
150	505	477	495	467	482	455*	462	435*
200	540	508	540	508	520	488	500	468
250	625	580	625	585	615	570	590	550
275	690	640	700	650	680	630	665	615
300	730	680	730	680	725	675	715	665
350	745	690	745	690	745	690	745	690
450	2350	2350	2350	2350	2350	2350	2350	2350

- Setpoint violates pump seal limit. The pump seal limit includes a 63 psig adjustment for pressure channel uncertainty.

MATERIAL PROPERTY BASIS

LIMITING MATERIAL: INTERMEDIATE SHELL FORGING 05
INITIAL RT_{NDT} 47 °F
LIMITING ART AT 7 EFPY: 1/4-T, 181.1 °F
3/4-T, 147.7 °F



R5

Figure 3.1-5

Watts Bar Unit 1 Reactor Coolant System Heatup Limitations (Heatup rates of 60 and 100°F/hr) Applicable for the First 7 EFPY (Without Margins for Instrumentation Errors) Including 10% Relaxation in Pressure for Temperature < 231 °F per ASME Code Case N-514

(Plotted Data (Ref. 1) provided on Table 3.1-2)

Table 3.1-2
Watts Bar Unit 1 Heatup Limits
(Data (Ref. 1) plotted on Figure 3.1-5)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	HEATUP RATE (60 °F/HR)	HEATUP RATE (100 °F/HR)	LEAK TEST LIMITS	CRITICALITY LIMITS (60 °F/HR)	CRITICALITY LIMITS (100 °F/HR)
85	506	462			
90	506	462			
95	506	462			
100	506	462			
105	506	462			
110	506	462			
115	506	462			
120	509	462			
125	512	462			
130	517	462			
135	523	462			
140	530	463			
145	538	465			
150	547	469			
155	557	473			
160	568	478			
165	580	484			
170	593	492			
175	607	500			
180	623	510			
185	640	521			
190	658	532			
195	678	545			
200	699	560			
205	722	575			

R5

Table 3.1-2
Watts Bar Unit 1 Heatup Limits
(Data (Ref. 1) plotted on Figure 3.1-5)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	HEATUP RATE (60 °F/HR)	HEATUP RATE (100 °F/HR)	LEAK TEST LIMITS	CRITICALITY LIMITS (60 °F/HR)	CRITICALITY LIMITS (100 °F/HR)
210	746	592			
215	773	611			
220	801	631			
225	832	653			
230	865	676			
231	872	682			
231	792	620			
235	818	638			
240	853	663			
245	890	690			
250	930	719			
255	972	750			
260	1018	784			
265	1068	820			
270	1121	858			
275	1177	900			
280	1238	945			
285	1303	993			
290	1373	1044			
293			2000		
295	1448	1100	2046		
300	1528	1159	2162		
305	1612	1223	2277		
310	1686	1291	2393		
314			2485	0.0 to 1121	0.0 to 858

R5

Table 3.1-2
Watts Bar Unit 1 Heatup Limits
(Data (Ref. 1) plotted on Figure 3.1-5)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	HEATUP RATE (60 °F/HR)	HEATUP RATE (100 °F/HR)	LEAK TEST LIMITS	CRITICALITY LIMITS (60 °F/HR)	CRITICALITY LIMITS (100 °F/HR)
315	1765	1364		1177	900
320	1850	1442		1238	945
325	1940	1525		1303	993
330	2037	1615		1373	1044
335	2141	1711		1448	1100
340	2251	1813		1528	1159
345	2369	1922		1612	1223
350		2039		1686	1291
355		2163		1765	1364
360		2296		1850	1442
365		2437		1940	1525
370				2037	1615
375				2141	1711
380				2251	1813
385				2369	1922
390					2039
395					2163
400					2296
405					2437

R5

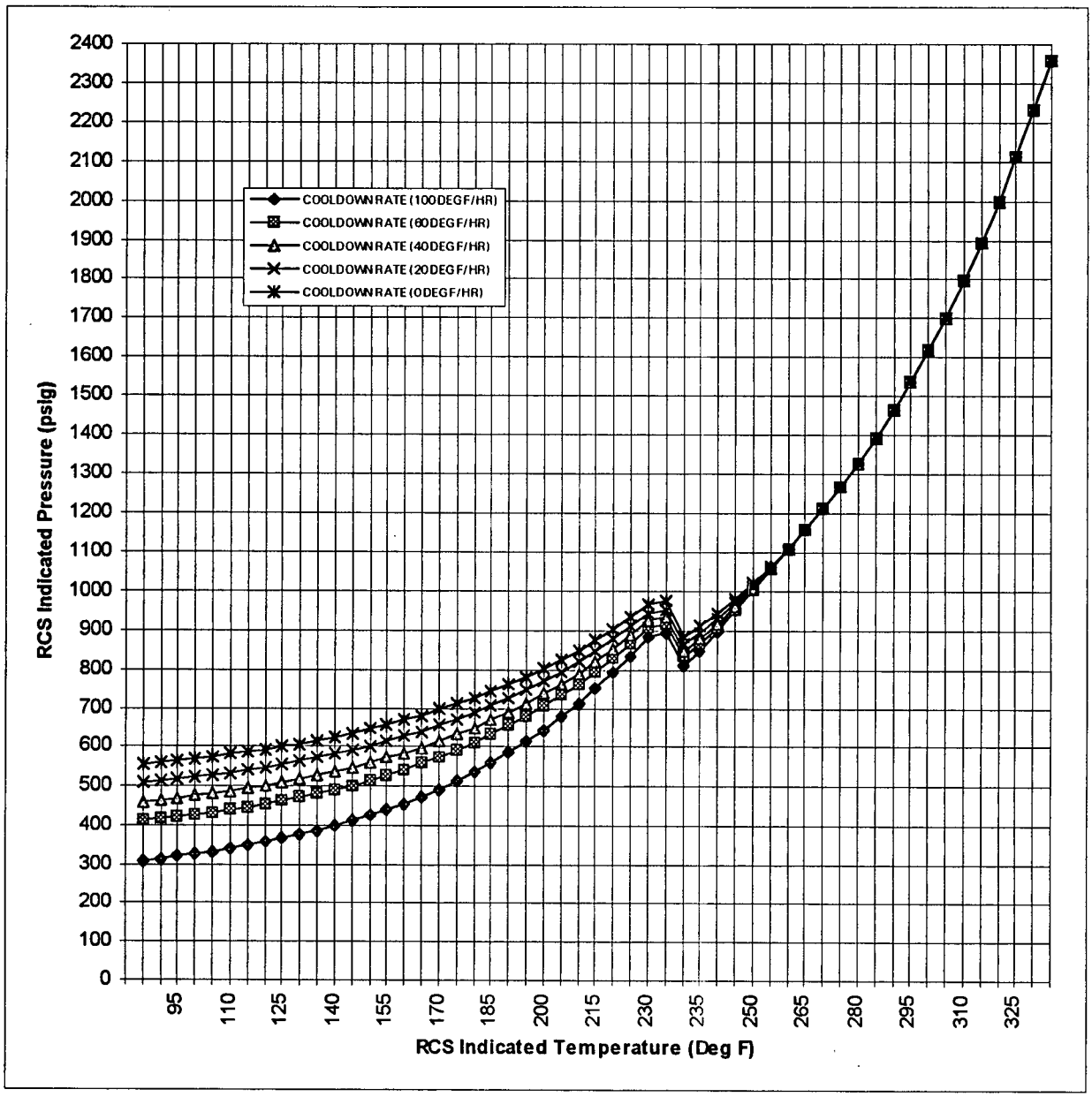
MATERIAL PROPERTY BASIS

LIMITING MATERIAL: INTERMEDIATE SHELL FORGING 05

INITIAL RT_{NDT} 47 °F

LIMITING ART AT 7 EFPY: 1/4-T, 181.1 °F

3/4-T, 147.7 °F



R5

Figure 3.1-6

Watts Bar Unit 1 Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable for the First 7 EFPY (Without Margins for Instrumentation Errors) Including 10% Relaxation in Pressure for Temperatures < 231 °F per ASME Code Case N-514

(Plotted Data (Ref. 1) provided on Table 3.1-3)

Table 3.1-3
Watts Bar Unit 1 Cooldown Limits
(Data (Ref. 1) plotted on Fig 3.1-6)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	100 °F/HR	60 °F/HR	40 °F/HR	20 °F/HR	0 °F/HR
85	312	413	462	510	557
90	317	418	467	514	561
95	323	423	472	519	566
100	329	429	477	524	570
105	335	435	483	530	576
110	343	441	489	536	582
115	350	448	496	542	588
120	359	456	503	549	594
125	368	464	511	557	602
130	378	473	519	565	609
135	389	482	528	573	618
140	401	493	538	583	627
145	413	504	549	593	636
150	427	516	560	603	646
155	442	529	573	615	657
160	458	544	586	628	669
165	476	559	600	641	682
170	495	575	616	656	696
175	515	593	632	672	711
180	538	612	650	688	726
185	562	633	670	707	744
190	588	656	691	726	762
195	615	680	713	747	782
200	645	706	737	770	803
205	678	734	763	794	826
210	713	764	791	820	850
215	751	796	822	848	876
220	792	831	854	879	904
225	836	869	889	911	935

R5

Table 3.1-3
Watts Bar Unit 1 Cooldown Limits
(Data (Ref. 1) plotted on Fig 3.1-6)

RCS TEMPERATURE (°F)	INDICATED PRESSURE (PSIG)				
	100 °F/HR	60 °F/HR	40 °F/HR	20 °F/HR	0 °F/HR
230	883	909	927	946	968
231	894	918	935	954	975
231	812	835	850	867	886
235	850	867	879	894	912
240	900	909	919	931	946
245	954	955	962	971	983
250	1011	1005	1007	1013	1022
255	1064	1058	1057	1059	1064
260	1110	1110	1109	1108	1110
265	1159	1159	1159	1159	1159
270	1212	1212	1212	1212	1212
275	1268	1268	1268	1268	1268
280	1329	1329	1329	1329	1329
285	1393	1393	1393	1393	1393
290	1463	1463	1463	1463	1463
295	1538	1538	1538	1538	1538
300	1618	1618	1618	1618	1618
305	1704	1704	1704	1704	1704
310	1796	1796	1796	1796	1796
315	1894	1894	1894	1894	1894
320	2000	2000	2000	2000	2000
325	2112	2112	2112	2112	2112
330	2233	2233	2233	2233	2233
335	2361	2361	2361	2361	2361

R5

Table 4.0-1
Surveillance Capsule Removal Schedule

Capsule	Vessel Location (deg.)	Capsule Lead Factor	Removal Time (a)(b)(d)	Estimated Capsule Fluence (n/cm^2) (c)
U	56.0	3.6	1st Refueling Outage	3.60×10^{18}
W	124.0	3.6	5.4	1.90×10^{19}
X	236.0	3.6	8.9	3.19×10^{19}
Z	304.0	3.6	17.8	6.38×10^{19}
V	58.5	3.6	Stand-By	----
Y	238.5	3.6	Stand-By	----

(a) Effective Full Power Years (EFPY) from plant startup.

(b) Removal times are based on not-to-exceed criteria of E185-82, Section 7.6.2. Capsules should be removed on the last cycle prior to reaching the indicated time.

(c) Based on design basis fluence of 3.18×10^{19} n/cm^2 ($E > 1.0$ MeV).

(d) Withdraw two capsules before the vessel exceeds 5.4 EFPY. The results of the capsule analysis will be reviewed and should an amended removal schedule be required, two standby capsules are available for additional monitoring.[1] If the results of capsule testing predict an end of life use of < 50 ft-lb, TVA will perform the necessary analysis required by Appendix G, IV.A.1 to ensure adequate safety margins.[2]

TABLE 5.1						
Comparison of the Watts Bar Unit 1 Surveillance Material 30 ft-lb Transition Temperature Shifts and Upper Shelf Energy Decrease with Regulatory Guide 1.99, Revision 2, Predictions						
Material	Capsule	Fluence ($x\ 10^{19}$ n/cm^2, E > 1.0 MeV)	30 ft-lb Transition Temperature Shift		Upper Shelf Energy Decrease	
			Predicted[a] (°F)	Measured (°F)	Predicted[a] (%)	Measured (%)
Intermediate Shell Forging 05 (tangential)						
Intermediate Shell Forging 05 (axial)						
Weld Metal						
HAZ Metal						

(a) Based on Regulatory Guide 1.99, Revision 2, methodology using average weight percent values of Cu an Ni.

NOTE: No capsules have been removed from the Watts Bar Unit 1 reactor vessel at this time.

TABLE 5.2						
Watts Bar Unit 1 Calculation of Chemistry Factors Using Surveillance Capsule Data						
Material	Capsule	Fluence (n/cm^2, E > 1.0 MeV)	FF	ΔRT_{NDT} (°F)	$FF*\Delta RT_{NDT}$ (°F)	FF^2
Intermediate Shell Forging 05 (Tangential)						
Intermediate Shell Forging 05 (Axial)						
	Sum:					
	Chemistry Factor =					
Weld Metal						
	Sum:					
	Chemistry Factor =					

NOTE: No capsules have been removed from the Watts Bar Unit 1 reactor vessel at this time.

TABLE 5.3			
Watts Bar Unit 1 Reactor Vessel Toughness Table (Unirradiated)			
Material Description	Cu (%) [a]	Ni (%) [a]	Initial RT_{NDT} (°F) [b]
Closure Head Flange	0.13	0.75	-42
Vessel Flange	--	0.92	-40 [c]
Intermediate Shell Forging 05	0.17	0.80	47
Lower Shell Forging 04	0.08	0.83	5
Circumferential Weld	0.05	0.70	-43

NOTES:

a) Average values of copper and nickel weight percent.
b) Initial RT_{NDT} values are measured values.
c) Used in the consideration of flange requirements for heatup/cooldown curves. Per methodology given in WCAP-14040, the minimum boltup temperature is 60 F.

TABLE 5.4					
Watts Bar Unit 1 Reactor Vessel Surface Fluence Values at 7 EFPY (n/cm^2, E > 1.0 MeV)					
Azimuthal	0°	15°	25°	35°	45°
Surface	4.13×10^{18}	6.15×10^{18}	6.96×10^{18}	5.67×10^{18}	6.50×10^{18}

TABLE 5.5		
Summary of ARTs for the Watts Bar Unit 1 Reactor Vessel Beltline Materials at the 1/4-T and 3/4-T Locations for 7 EFPY		
Component	7 EFPY [a]	
	1/4-T (°F)	3/4-T (°F)
Intermediate Shell Forging 05	181.11 [b]	147.70 [b]
Lower Shell Forging 04	77.68	56.54
Circumferential Weld	60.14	25.72

NOTES:
(a) Calculated using the peak vessel fluence of 6.96×10^{18} n/cm^2 (E > 1.0 MeV).
(b) Used to generate the heatup/cooldown curves.

TABLE 5.6		
Calculation of Adjusted Reference Temperatures at 7 EFPY for the Limiting Watts Bar Unit 1 Reactor Vessel Material (Intermediate Shell Forging 05)		
Parameter	Values	
Operating Time	7 EFPY	
Material	Inter. Shell Forging 05	Inter. Shell Forging 05
Location	1/4-T	3/4-T
Chemistry Factor (CF), °F	132	132
Fluence (f), $\div 10^{19}$ n/cm^2 (E > 1.0 MeV) (a)	0.4188	0.1517
Fluence Factor (FF)(b)	0.758	0.505
ΔRT_{NDT} = CF x FF, °F	100.1	66.7
Initial RT_{NDT} (I), °F	47	47
Margin (M), °F (c)	34	34
ART = I + (CFxFF) + M, °F per Regulatory Guide 1.99, Revision 2	181.1	147.7

NOTES:

(a) Fluence, f, is based upon $f_{surf} = 6.96 \times 10^{18}$ n/cm^2. The Watts Bar Unit 1 reactor vessel wall thickness is 8.465 inches at the beltline region.

(b) $FF = f^{(0.28 - 0.10 \log f)}$

(c) Margin is calculated as $M = 2(\sigma_i^2 + \sigma_\Delta^2)^{0.5}$. The standard deviation for the initial RT_{NDT} margin term, σ_i, is 0 °F since the initial RT_{NDT} value is a measured value. The standard deviation for the ΔRT_{NDT} margin term, σ_Δ, is 17 °F for the forging, except that σ_Δ need not exceed 0.5 times the mean value of ΔRT_{NDT}.

TABLE 5.7					
Watts Bar Unit 1 Reactor Vessel Surface Fluence Values at 32 and 48 EFPY (n/cm^2, E > 1.0 MeV)					
EFPY	0°	15°	25°	35°	45°
32	1.89×10^{19}	2.81×10^{19}	3.18×10^{19}	2.59×10^{19}	2.97×10^{19}
48	2.84×10^{19}	4.22×10^{19}	4.77×10^{19}	3.89×10^{19}	4.46×10^{19}

TABLE 5.8							
RT_{PTS} Values for Watts Bar Unit 1 for 32 EFPY							
Material	CF (°F)	Surface Fluence (n/cm^2, E > 1.0 MeV)	FF	RT_{NDT} (CF x FF) (°F)	I (°F)	M (°F)	RT_{PTS} (°F)
Inter. Shell Forging 05	132	3.18×10^{19}	1.30	171.6	47	34	253
Lower Shell Forging 04	51	3.18×10^{19}	1.30	66.3	5	34	106
Circ. Weld	68	3.18×10^{19}	1.30	88.4	-43	56	102

TABLE 5.9							
RT_{PTS} Values for Watts Bar Unit 1 for 48 EFPY							
Material	CF (°F)	Surface Fluence (n/cm^2, E > 1.0 MeV)	FF	RT_{NDT} (CF x FF) (°F)	I (°F)	M (°F)	RT_{PTS} (°F)
Inter. Shell Forging 05	132	4.77×10^{19}	1.39	185.5	47	34	265
Lower Shell Forging 04	51	4.77×10^{19}	1.39	70.9	5	34	110
Circ. Weld	68	4.77×10^{19}	1.39	94.5	-43	56	108

SOURCE NOTES

1. NCO820285003

2. NCO820285004

ATTACHMENT 1

RC_ PRESSURE INDICATION (INDICATOR,

Pressure Instrumentation Error = 120

Temperature Instrumentation Error = 20

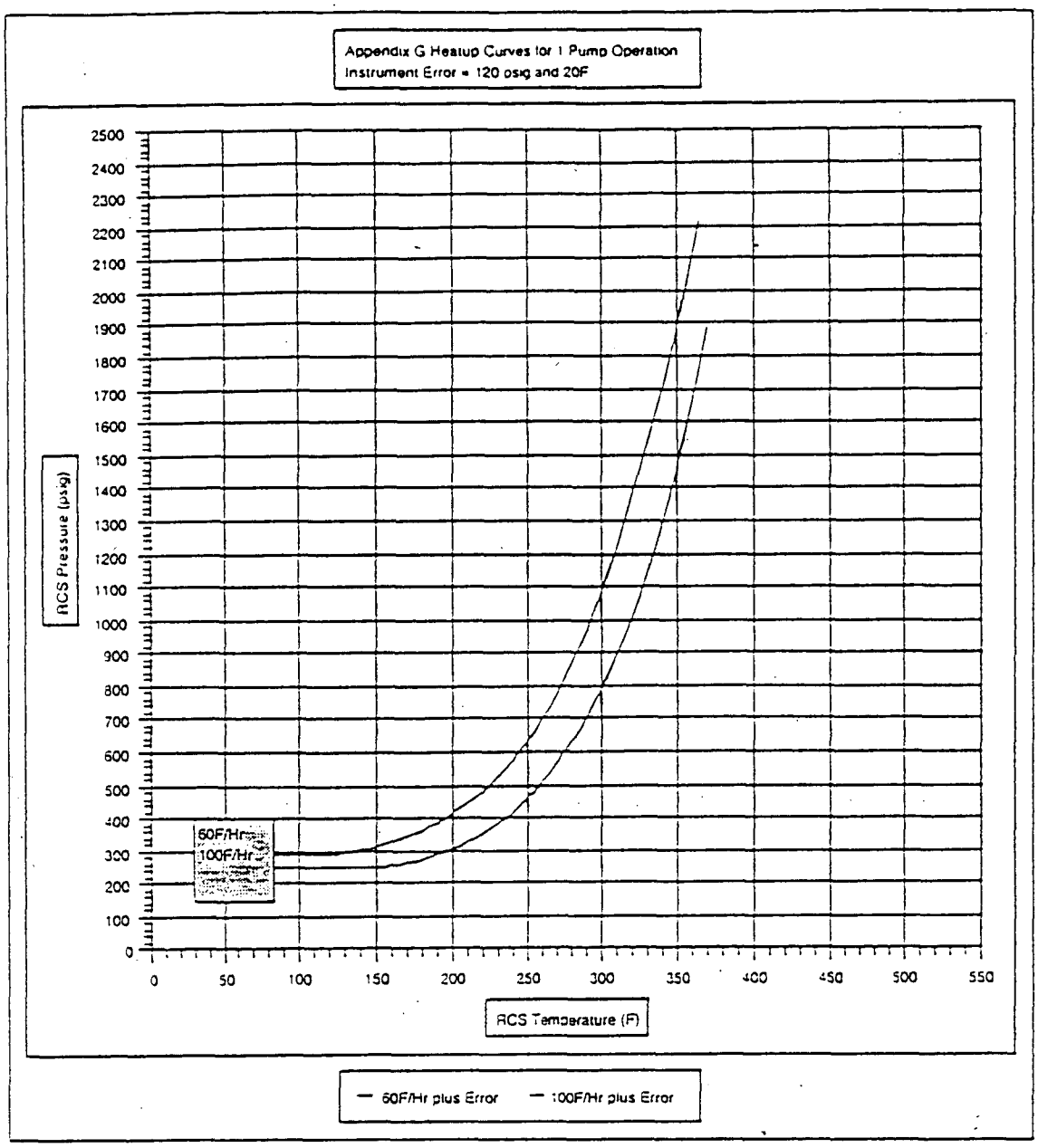
	1 Pmp	2 Pmp	3 Pmp	4 Pmp
Pressure Error due to Pmp Head Differenc	31	38	52	74
Total Pressure Error =	151	158	172	194

Heatup Curves (7 EFPY) - 1 Pump Operation

60F/Hr		100F/Hr		60F/Hr plus Error		0F/Hr plus Error	
Temp	*Press*	*Temp*	*Press*	*Temp*	*Press*	*Temp*	*Press*
60	443	60	401	80	292	80	250
65	443	65	401	85	292	85	250
70	443	70	401	90	292	90	250
75	443	75	401	95	292	95	250
80	443	80	401	100	292	100	250
85	443	85	401	105	292	105	250
90	443	90	401	110	292	110	250
95	443	95	401	115	292	115	250
100	443	100	401	120	292	120	250
105	444	105	401	125	293	125	250
110	446	110	401	130	295	130	250
115	449	115	401	135	298	135	250
120	453	120	401	140	302	140	250
125	458	125	401	145	307	145	250
130	464	130	402	150	313	150	251
135	470	135	404	155	319	155	253
140	477	140	407	160	326	160	256
145	485	145	410	165	334	165	259
150	494	150	414	170	343	170	263
155	503	155	419	175	352	175	268
160	514	160	425	180	363	180	274
165	525	165	432	185	374	185	281
170	537	170	439	190	386	190	288
175	551	175	448	195	400	195	297
180	565	180	457	200	414	200	306
185	581	185	467	205	430	205	316
190	597	190	479	210	446	210	328
195	615	195	491	215	464	215	340
200	635	200	504	220	484	220	353
205	656	205	519	225	505	225	368
210	678	210	535	230	527	230	384
215	702	215	552	235	551	235	401
220	728	220	571	240	577	240	420
225	756	225	591	245	605	245	440
230	786	230	612	250	635	250	461
235	818	235	635	255	667	255	484
240	853	240	661	260	702	260	510
245	890	245	688	265	739	265	537
250	930	250	717	270	779	270	566
255	972	255	748	275	821	275	597
260	1018	260	782	280	867	280	631
265	1067	265	818	285	916	285	667
270	1120	270	857	290	969	290	706
275	1177	275	899	295	1026	295	748
280	1238	280	943	300	1087	300	792
285	1303	285	992	305	1152	305	841
290	1373	290	1043	310	1222	310	892
295	1448	295	1099	315	1297	315	948
300	1528	300	1158	320	1377	320	1007
305	1612	305	1222	325	1461	325	1071
310	1686	310	1290	330	1535	330	1139
315	1765	315	1363	335	1614	335	1212
320	1850	320	1441	340	1699	340	1290
325	1940	325	1525	345	1789	345	1374
330	2037	330	1614	350	1886	350	1463
335	2140	335	1710	355	1989	355	1559
340	2251	340	1812	360	2100	360	1661
345	2369	345	1922	365	2218	365	1771
350		350	2038	370		370	1887
355		355	2163	375		375	2012
360		360	2295	380		380	2144
365		365	2436	385		385	2285

cannot start pump

ATTACHMENT 1
RCS PRESSURE INDICATION (INDICATOR)



ATTACHMENT 1
PRESSURE INDICATION (P2500)

Pressure Instrumentation Error = 70
Temperature Instrumentation Error = 20

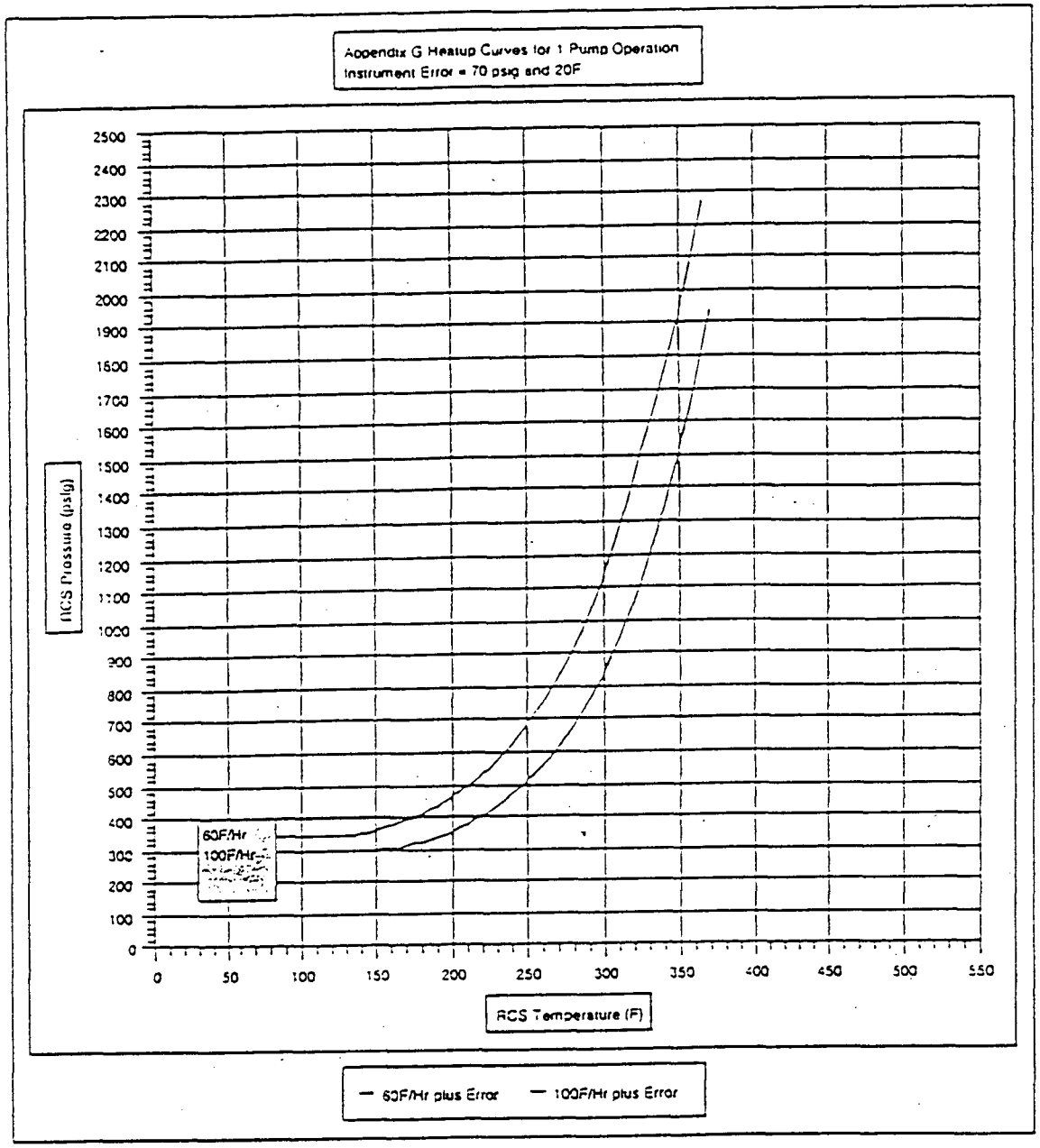
	1 Pmp	2 Pmp	3 Pmp	4 Pmp
Pressure Error due to Pmp Head Differenc	31	38	52	74
Total Pressure Error =	101	108	122	144

Heatup Curves (7 EFPY) -1 Pump Operation

60F/Hr		100F/Hr		60F/Hr plus Error		0F/Hr plus Error	
Temp	Press	Temp	Press	Temp	Press	Temp	Press
60	443	60	401	80	342	80	300
65	443	65	401	85	342	85	300
70	443	70	401	90	342	90	300
75	443	75	401	95	342	95	300
80	443	80	401	100	342	100	300
85	443	85	401	105	342	105	300
90	443	90	401	110	342	110	300
95	443	95	401	115	342	115	300
100	443	100	401	120	342	120	300
105	444	105	401	125	343	125	300
110	446	110	401	130	345	130	300
115	449	115	401	135	348	135	300
120	453	120	401	140	352	140	300
125	458	125	401	145	357	145	300
130	464	130	402	150	363	150	301
135	470	135	404	155	369	155	303
140	477	140	407	160	376	160	306
145	485	145	410	165	384	165	309
150	494	150	414	170	393	170	313
155	503	155	419	175	402	175	318
160	514	160	425	180	413	180	324
165	525	165	432	185	424	185	331
170	537	170	439	190	436	190	338
175	551	175	448	195	450	195	347
180	565	180	457	200	464	200	356
185	581	185	467	205	480	205	366
190	597	190	479	210	496	210	378
195	615	195	491	215	514	215	390
200	635	200	504	220	534	220	403
205	656	205	519	225	555	225	419
210	678	210	535	230	577	230	434
215	702	215	552	235	601	235	451
220	728	220	571	240	627	240	470
225	756	225	591	245	655	245	490
230	786	230	612	250	685	250	511
235	818	235	635	255	717	255	534
240	853	240	661	260	752	260	560
245	890	245	688	265	789	265	587
250	930	250	717	270	829	270	616
255	972	255	748	275	871	275	647
260	1018	260	782	280	917	280	681
265	1067	265	818	285	966	285	717
270	1120	270	857	290	1019	290	756
275	1177	275	899	295	1076	295	798
280	1238	280	943	300	1137	300	842
285	1303	285	992	305	1202	305	891
290	1373	290	1043	310	1272	310	942
295	1448	295	1099	315	1347	315	998
300	1528	300	1158	320	1427	320	1057
305	1612	305	1222	325	1511	325	1121
310	1695	310	1290	330	1585	330	1189
315	1765	315	1363	335	1664	335	1262
320	1850	320	1441	340	1749	340	1340
325	1940	325	1525	345	1839	345	1424
330	2037	330	1614	350	1936	350	1513
335	2140	335	1710	355	2039	355	1609
340	2251	340	1812	360	2150	360	1711
345	2369	345	1922	365	2268	365	1821
350		350	2038	370		370	1937
355		355	2163	375		375	2062
360		360	2295	380		380	2194
365		365	2436	385		385	2335

can start Pump

ATTACHMENT 1
RCS PRESSURE INDICATION (P2500)



ATTACHMENT 1
RCS PRESSURE INDICATION (INDICATOR)

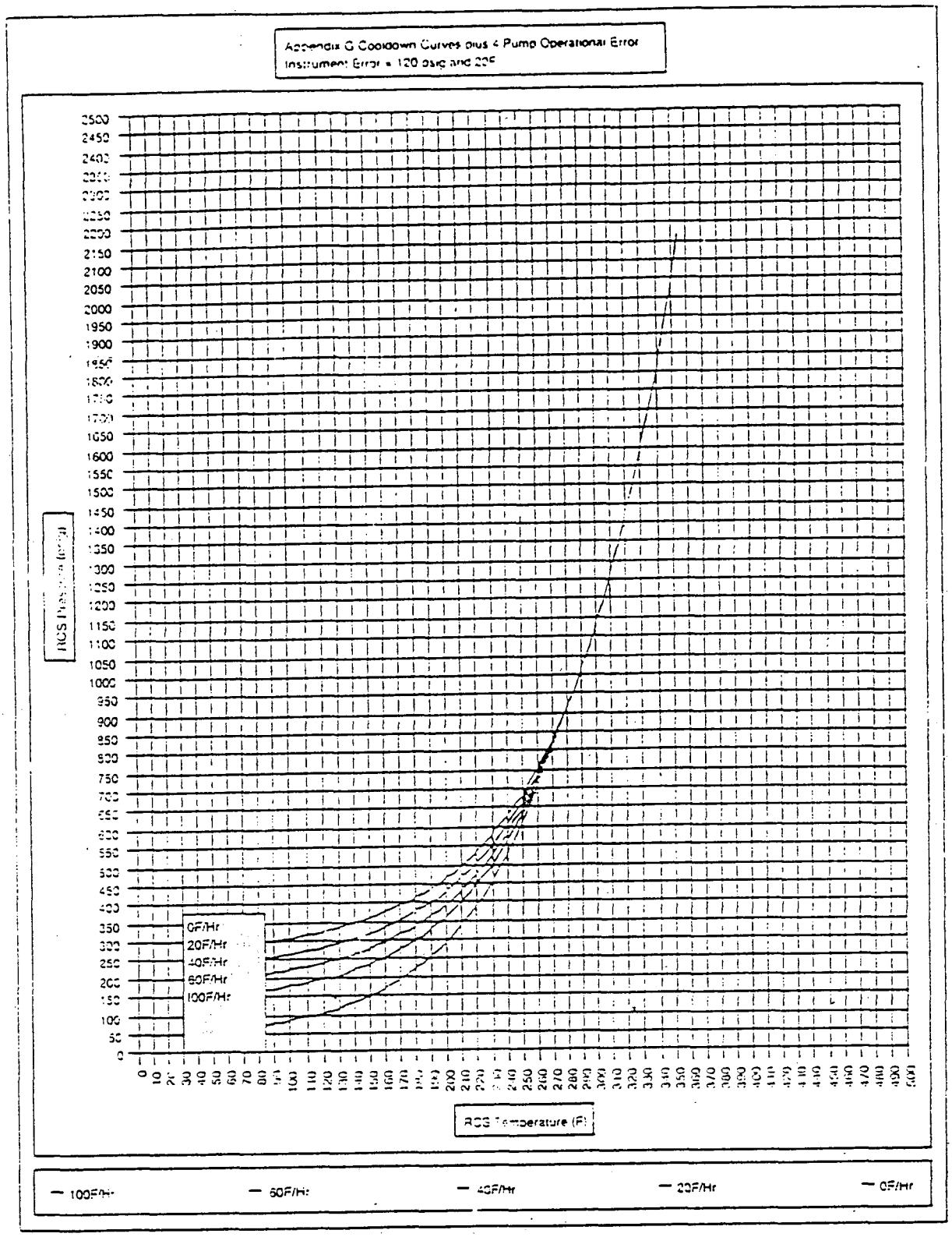
Pressure Instrumentation Error = 120
Temperature Instrumentation Error = 20

	1 Pmp	2 Pmp	3 Pmp	4 Pmp
Pressure Error due to Pmp Head Differenc	31	38	52	74
Total Pressure Error =	151	158	172	194

Cooldown Curves (7 EFPY) - 4 Pump Operation

100F/Hr		60F/Hr		40F/Hr		20F/Hr		0F/Hr	
Temp	Press	Temp	Press	Temp	Press	Temp	Press	Temp	Press
90	73	90	165	80	210	80	253	80	296
95	75	95	168	85	213	85	256	85	299
90	79	90	171	90	216	90	259	90	302
95	82	95	174	95	219	95	262	95	305
100	86	100	178	100	222	100	266	100	308
105	90	105	182	105	225	105	270	105	312
110	95	110	186	110	230	110	274	110	316
115	100	115	191	115	235	115	278	115	320
120	105	120	196	120	240	120	283	120	325
125	111	125	201	125	245	125	288	125	330
130	117	130	207	130	250	130	293	130	335
135	125	135	213	135	257	135	299	135	340
140	132	140	220	140	263	140	305	140	346
145	141	145	228	145	270	145	312	145	353
150	150	150	236	150	278	150	319	150	360
155	160	155	245	155	286	155	327	155	367
160	170	160	254	160	295	160	336	160	376
165	182	165	264	165	305	165	345	165	384
170	194	170	275	170	315	170	355	170	394
175	208	175	287	175	327	175	365	175	404
180	223	180	300	180	339	180	377	180	414
185	239	185	314	185	352	185	389	185	426
190	256	190	329	190	366	190	402	190	439
195	275	195	345	195	381	195	416	195	452
200	295	200	363	200	397	200	432	200	466
205	317	205	382	205	415	205	448	205	482
210	340	210	402	210	434	210	466	210	499
215	365	215	424	215	454	215	485	215	517
220	393	220	447	220	476	220	506	220	536
225	422	225	473	225	500	225	528	225	556
230	454	230	500	230	525	230	552	230	579
235	489	235	530	235	553	235	577	235	603
240	526	240	562	240	582	240	605	240	628
245	566	245	596	245	614	245	634	245	656
250	609	250	633	250	649	250	666	250	686
255	656	255	673	255	685	255	700	255	718
260	706	260	715	260	725	260	737	260	752
265	760	265	761	265	768	265	777	265	789
270	817	270	811	270	813	270	819	270	828
275		275	864	275	863	275	865	275	870
280		280		280	915	280	914	280	916
285		285		285		285		285	965
290		290		290		290		290	1018
295		295		295		295		295	1074
300		300		300		300		300	1135
305		305		305		305		305	1199
310		310		310		310		310	1269
315		315		315		315		315	1344
320		320		320		320		320	1424
325		325		325		325		325	1510
330		330		330		330		330	1602
335		335		335		335		335	1700
340		340		340		340		340	1806
345		345		345		345		345	1918
350		350		350		350		350	2039
355		355		355		355		355	2167

ATTACHMENT 1
RCS PRESSURE INDICATION (INDICATOR)



ATTACHMENT 1

. . 3 PRESSURE INDICATION (P2500)

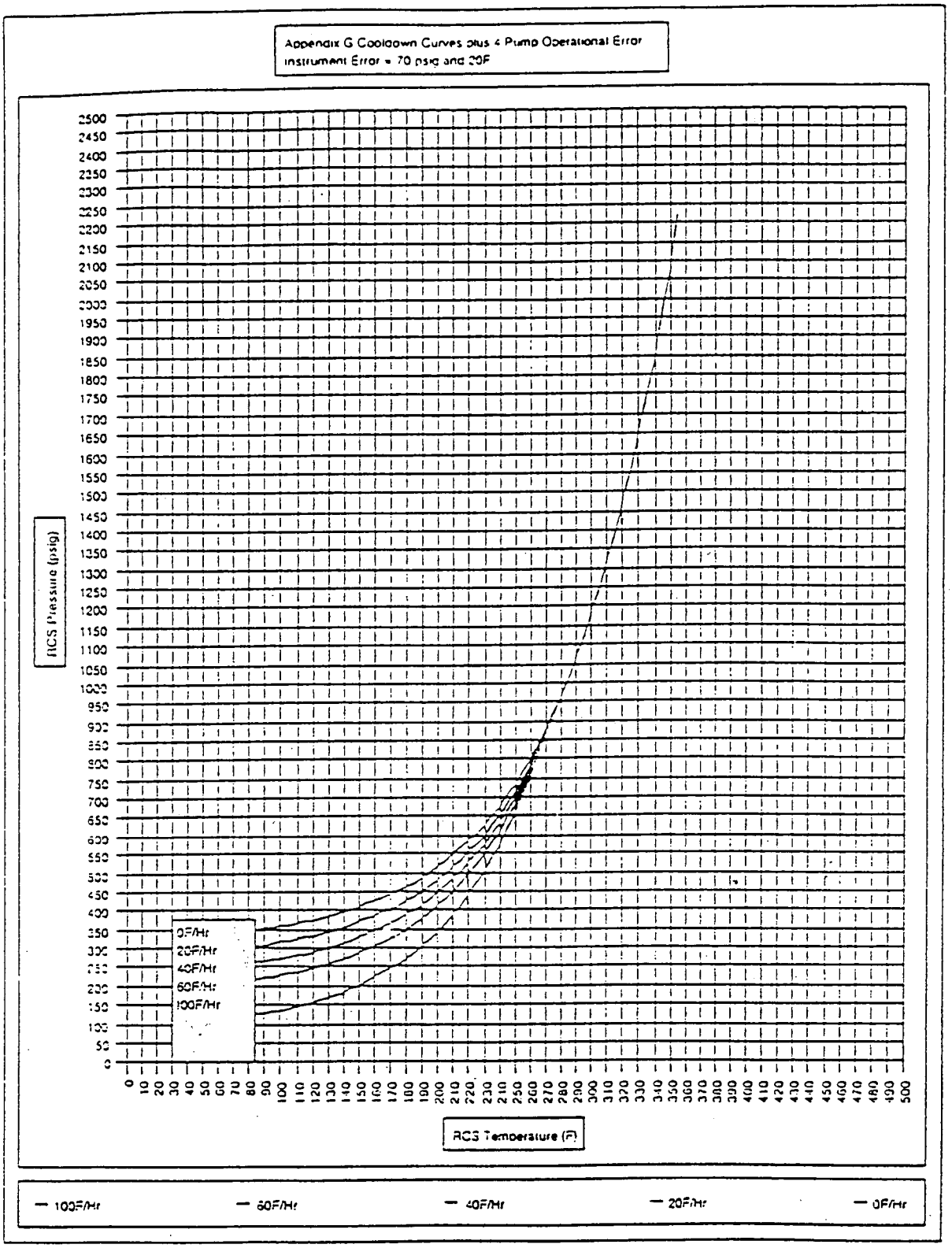
Pressure Instrumentation Error =	70			
Temperature Instrumentation Error =	20			
	1 Pmp	2 Pmp	3 Pmp	4 Pmp
Pressure Error due to Pmp Head Differenc	31	38	52	74
Total Pressure Error =	101	108	122	144

Cooldown Curves (7 EFPY) - 4 Pump Operation

100F/Hr		60F/Hr		40F/Hr		20F/Hr		0F/Hr	
Temp	Press	Temp	Press	Temp	Press	Temp	Press	Temp	Press
80	123	80	215	80	260	80	303	80	346
85	125	85	218	85	263	85	306	85	349
90	129	90	221	90	266	90	309	90	352
95	132	95	224	95	269	95	312	95	355
100	136	100	228	100	272	100	316	100	358
105	140	105	232	105	276	105	320	105	362
110	145	110	236	110	280	110	324	110	366
115	150	115	241	115	285	115	328	115	370
120	155	120	246	120	290	120	333	120	375
125	161	125	251	125	295	125	338	125	380
130	167	130	257	130	300	130	343	130	385
135	175	135	263	135	307	135	349	135	390
140	182	140	270	140	313	140	355	140	396
145	191	145	278	145	320	145	362	145	403
150	200	150	286	150	328	150	369	150	410
155	210	155	295	155	336	155	377	155	417
160	220	160	304	160	345	160	386	160	426
165	232	165	314	165	355	165	395	165	434
170	244	170	325	170	365	170	405	170	444
175	258	175	337	175	377	175	415	175	454
180	273	180	350	180	389	180	427	180	464
185	289	185	364	185	402	185	439	185	476
190	306	190	379	190	416	190	452	190	489
195	325	195	395	195	431	195	466	195	502
200	345	200	413	200	447	200	482	200	516
205	367	205	432	205	465	205	499	205	532
210	390	210	452	210	484	210	516	210	549
215	415	215	474	215	504	215	535	215	567
220	443	220	497	220	526	220	556	220	586
225	472	225	523	225	550	225	578	225	606
230	504	230	550	230	576	230	602	230	629
235	539	235	580	235	603	235	627	235	653
240	576	240	612	240	632	240	655	240	678
245	616	245	646	245	664	245	684	245	705
250	659	250	683	250	699	250	716	250	736
255	706	255	723	255	735	255	750	255	768
260	756	260	765	260	775	260	787	260	802
265	810	265	811	265	818	265	827	265	839
270	867	270	861	270	863	270	869	270	878
275		275	914	275	913	275	915	275	920
280		280		280	965	280	964	280	966
285		285		285		285		285	1015
290		290		290		290		290	1068
295		295		295		295		295	1124
300		300		300		300		300	1185
305		305		305		305		305	1249
310		310		310		310		310	1319
315		315		315		315		315	1394
320		320		320		320		320	1474
325		325		325		325		325	1560
330		330		330		330		330	1652
335		335		335		335		335	1750
340		340		340		340		340	1856
345		345		345		345		345	1969
350		350		350		350		350	2089
355		355		355		355		355	2217

ATTACHMENT 1

RCS PRESSURE INDICATION (P2500)



COMS SETPOINT ANAL (Cooldown Analysis)

Loop ID 1-T-68-10 and

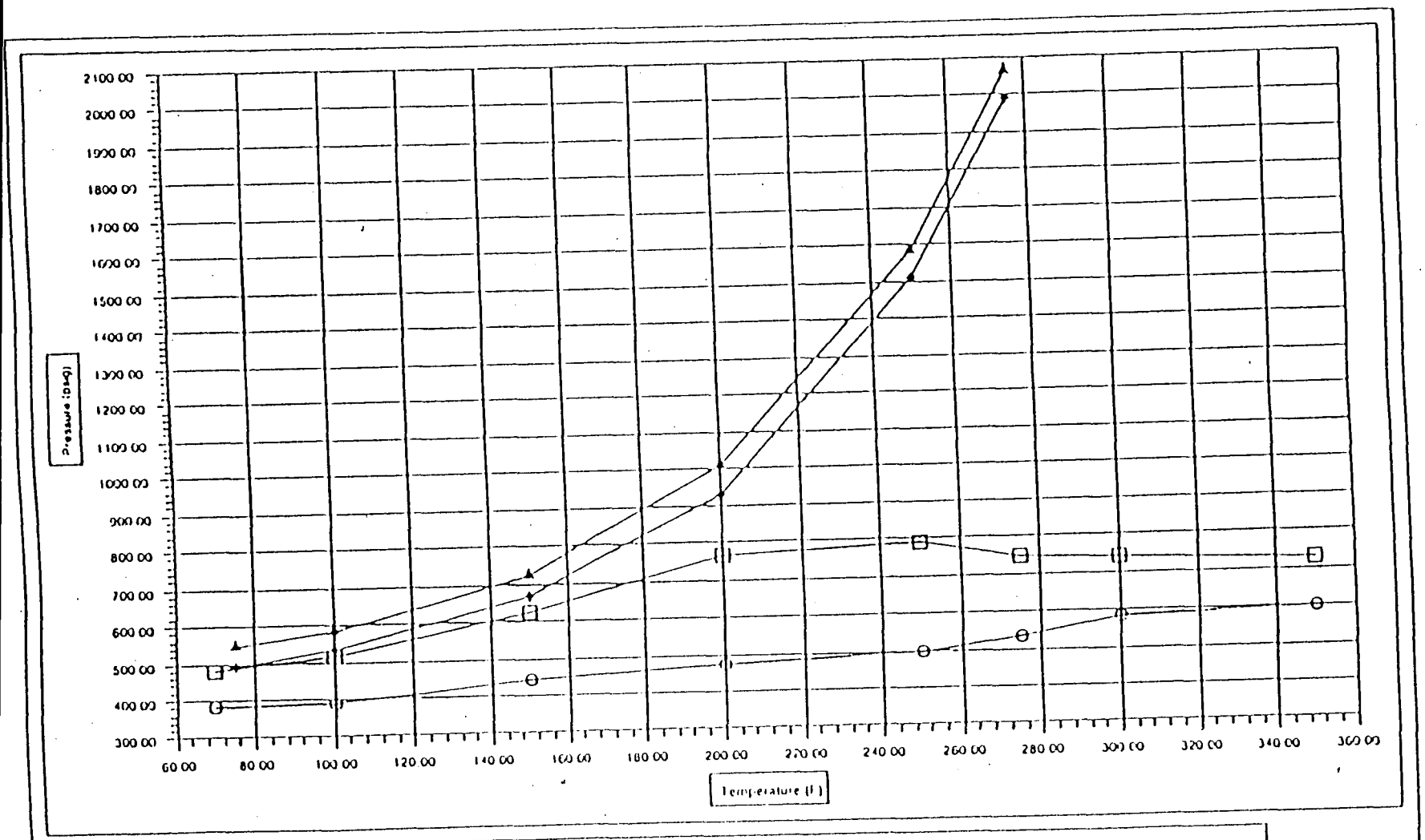
5A COMS Setpoint Analysis

	COMS Setpoints
00	302 00
00	387.00
00	440 00
00	470 00
00	500 00
00	530 00
00	580 00
00	600 00

COMS Setpoints plus Instrument Error and Press Overshoot	
70 00	479 72
100 00	517 34
150 00	625 91
200 00	765 21
250 00	786 12
275 00	744 08
300 00	737 82
350 00	729 82

Appendix G 1.5 EFPY Limit Curve	
75 00	544 13
100 00	583 33
150 00	721 61
200 00	1035 22
250 00	1583 93
275 00	2054 38

Adjusted Appendix G Limit Curve	
75 00	492.13
100 00	531 33
150 00	669 61
200 00	931 22
250 00	1509 93
275 00	1990 38



PORV (PCV 455A) Setpoint

PORV (PCV 455A) Setpoint plus Instrument Error and Pressure Overshoot

Appendix G Limit minus RCPs dP

Appendix G Limit 1.5 EFPY (Cooldown & Steady State)

COMS SETPOINT ANAL[illegible] [illegible]oldown Analysis)

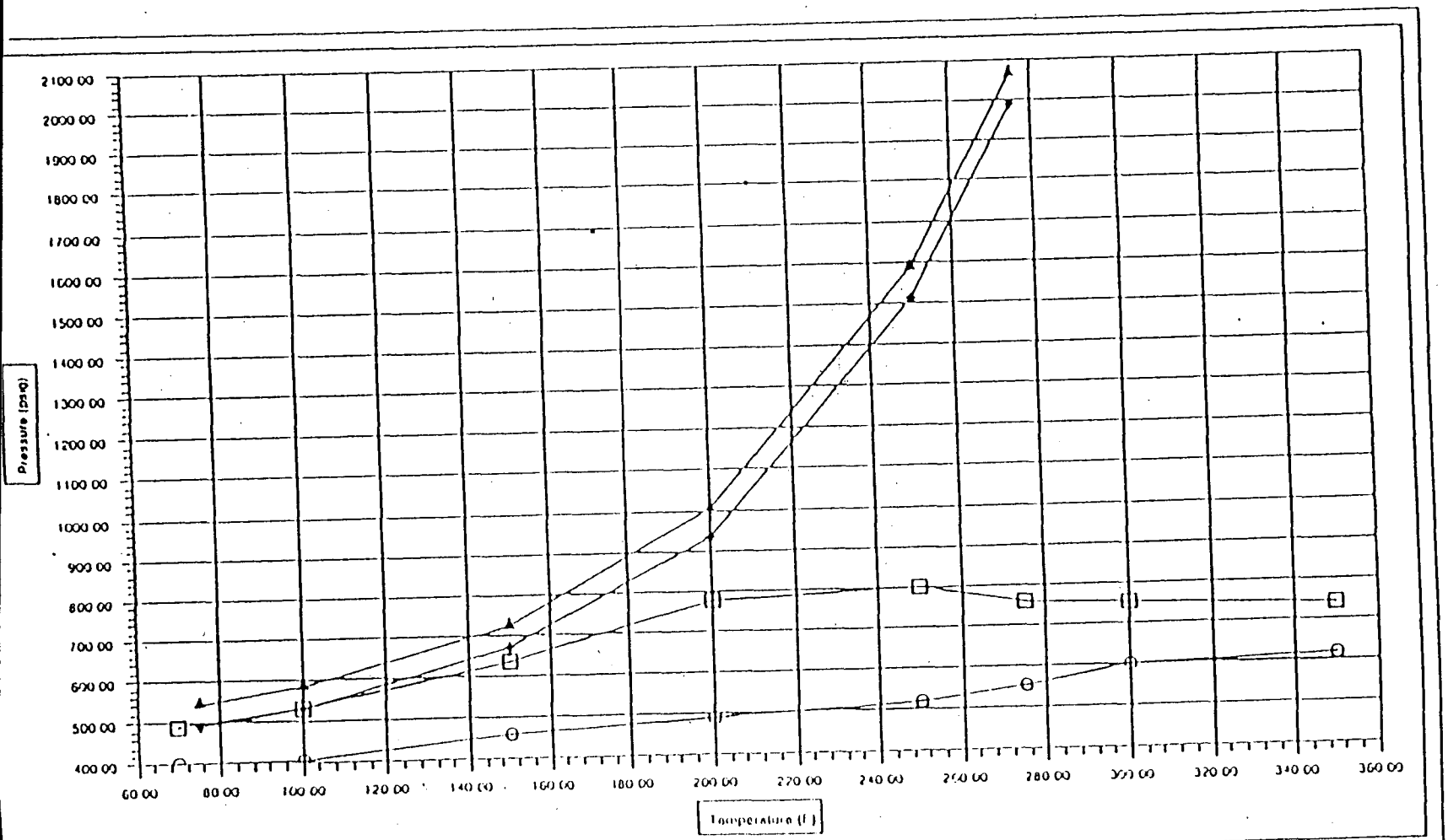
Loop ID 1-1-68-1B an[illegible]

MS Setpoint Analysis

COMS Setpoints	COMS Setpoints plus Instrument Error and Press Overshoot	
402 00	70 00	491 23
407 00	100 00	529 77
460 00	150 00	637.74
490 00	200 00	776 90
520 00	250 00	798 99
556 00	275 00	757 38
600 00	300 00	750 36
620 00	350 00	742 36

Appendix G 1.5 EFPY Limit Curve	
75 00	544 13
100 00	583 33
150 00	721 61
200 00	1035 22
250 00	1583 99
275 00	2054 38

Adjusted Appendix G Limit Curve	
75 00	492 13
100 00	531 33
150 00	669 61
200 00	931 22
250 00	1509 99
275 00	1993 38



Θ PORV (PCV 456) Setpoint

⊟ PORV (PCV-456) Setpoint plus Instrument Error and Pressure Overshoot

▲ Appendix G Limit (minus RCP [illegible])

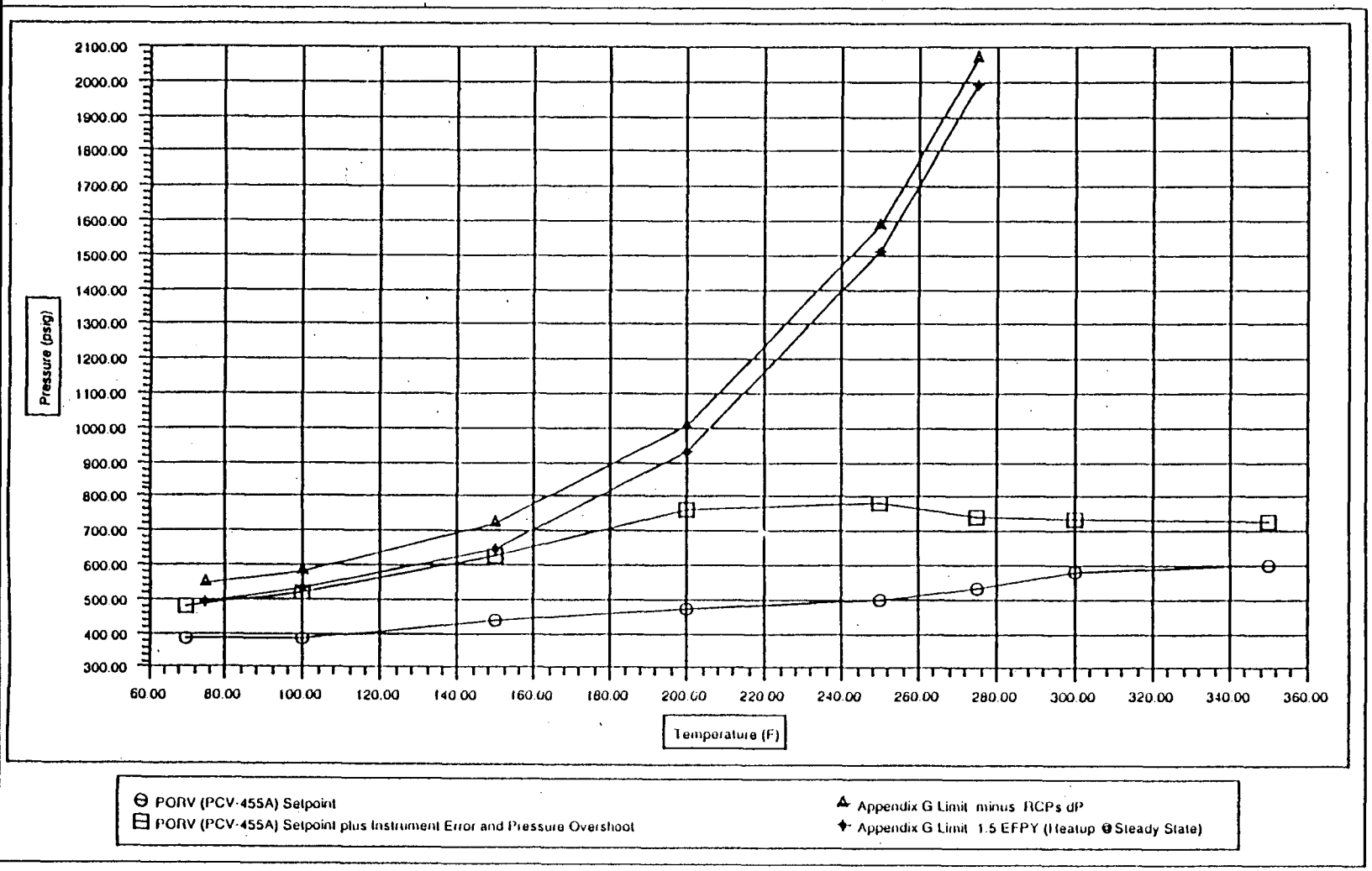
♦ Appendix G Limit 1.5 EFPY (Cooldown & Steady State)

COMS SETPOINT ANALYSIS (Heatup Analysis)

Loop ID 1-T-68-1B a[illegible]-43B

455A COMS Setpoint Analysis

	COMS Setpoints	COMS Setpoints plus Instrument Error and Press Overshoc		Appendix G 1.5 EFPY Limit Curve		Adjusted Appendix G Limit Curvi	
70.00	382.00	70.00	479.72	75.00	544.13	75.00	492.13
00.00	387.00	100.00	517.34	100.00	583.33	100.00	531.33
50.00	440.00	150.00	625.91	150.00	721.61	150.00	647.61
00.00	470.00	200.00	765.21	200.00	1005.22	200.00	931.22
50.00	500.00	250.00	786.12	250.00	1583.90	250.00	1509.90
75.00	536.00	275.00	744.08	275.00	2064.38	275.00	1990.38
00.00	580.00	300.00	737.82				
50.00	600.00	350.00	729.82				



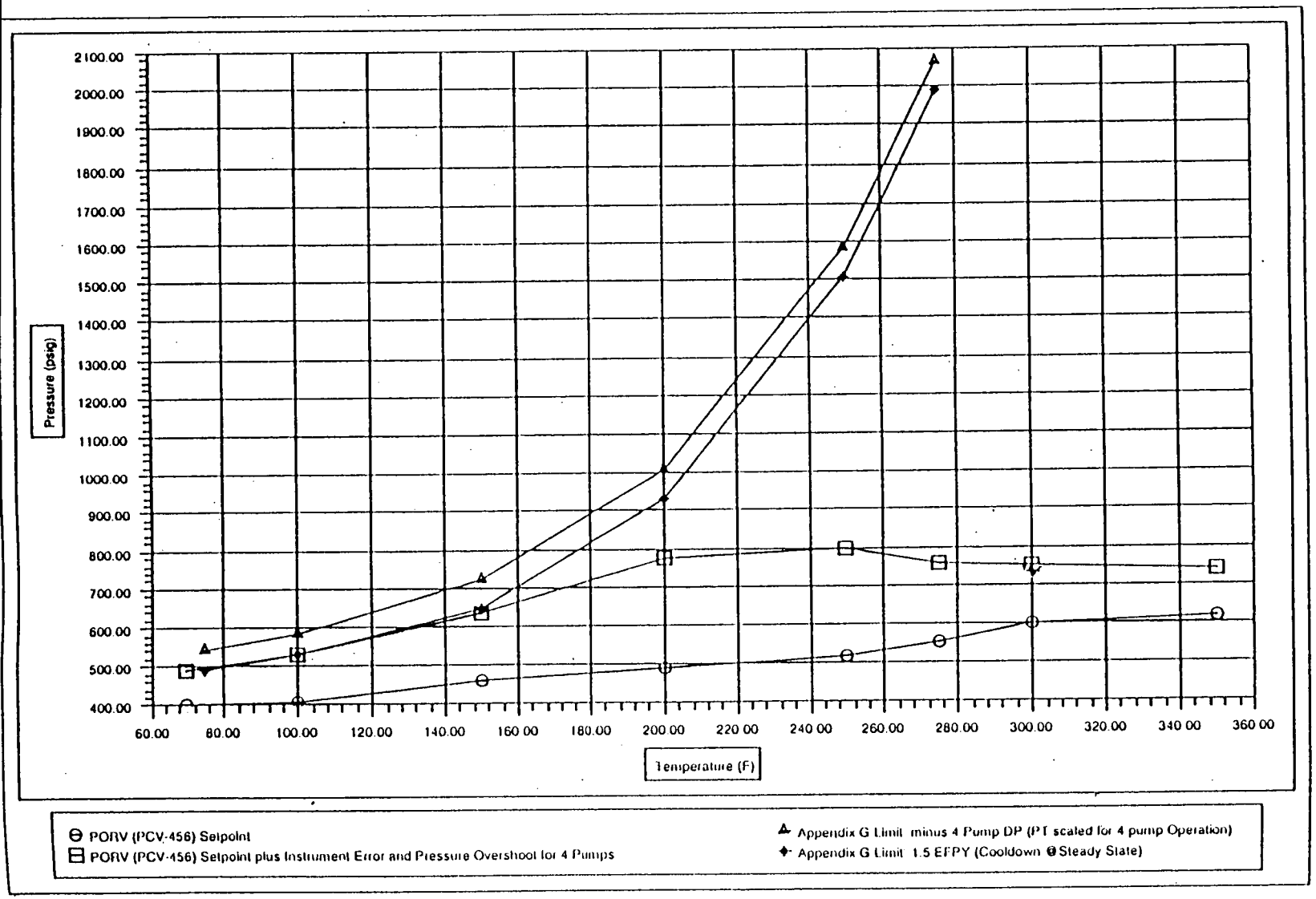
Rev 0 Prepared _____ Date _____ Checked _____ Date _____ Sheet c/o

COMS SETPOINT ANAL[illegible] (Heatup Analysis)

Loop ID 1-T-68-1B and [illegible]3B

COMS Setpoint Analysis

	COMS Setpoints	COMS Setpoints plus Instrument Error and Press Overshoot		Appendix G 1.5 EFPY Limit Curve		Adjusted Appendix G Limit Curve	
[illegible].00	402.00	70.00	491.23	75.00	544.13	75.00	492.13
[illegible].00	407.00	100.00	529.77	100.00	583.33	100.00	531.33
[illegible].00	460.00	150.00	637.74	150.00	721.61	150.00	647.61
[illegible].00	490.00	200.00	776.90	200.00	1005.22	200.00	931.22
[illegible].00	520.00	250.00	798.99	250.00	1583.90	250.00	1509.90
[illegible].00	556.00	275.00	757.38	275.00	2064.38	275.00	1990.38
[illegible].00	600.00	300.00	750.36				
[illegible].00	620.00	350.00	742.36				



Checked Date Sheet c/o