10 CFR 50.55a(a)(3)(i)

Palo Verde Nuclear
Generating Station

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102-05296-CDM/TNW/GAM
June 19, 2005

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
Unit 3
Docket No. STN 50-530
10 CFR 50.55a(a)(3)(i) Request for Alternatives to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits," for a Portion of the PVNGS Unit 3 Pressurizer that was Subjected to Heating Above Code Parameters (ISI Relief Request 33)

Pursuant to 10 CFR 50.55a(a)(3)(i), Arizona Public Service Company (APS) requests NRC approval of a proposed alternative to 10 CFR 50.55a(c), "Reactor Coolant Pressure Boundary." Specifically, APS requests approval of alternatives to ASME Section III, Sub-Section NB-1120, "Temperature Limits," for a portion of the PVNGS Unit 3 pressurizer base material surrounding the heater sleeves that was subjected to temperatures above those for which design stress intensity values are given in the Code. This reactor coolant pressure boundary relief request is being tracked by APS as Inservice Inspection (ISI) Program Relief Request 33.

APS requests approval of this relief request by June 21, 2005, in order to support startup of PVNGS Unit 3 from the current shutdown. The need for this relief request was only recently identified, and this condition has been entered in the PVNGS corrective action program.

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The regulatory commitment associated with this submittal is in Enclosure 2. If you have any questions, please contact Thomas N. Weber at (623) 393-5764.

Sincerely,

CDM/TNW/GAM

Enclosure:
1. 10 CFR 50.55a(a)(3)(i) Request for Alternative to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits" for a Portion of the PVNGS Unit 3 Pressurizer
2. Regulatory Commitment

cc:
B. S. Mallett	NRC Region IV Regional Administrator
M. B. Fields	NRC NRR Project Manager
G. G. Warnick	NRC Senior Resident Inspector for PVNGS

Enclosure 1

10 CFR 50.55a(a)(3)(i) Request for Alternative to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits" for a Portion of the PVNGS Unit 3 Pressurizer

ISI Relief Request No. 33

10 CFR 50.55a(a)(3)(i) Request for Alternatives to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits," for a Portion of the PVNGS Unit 3 Pressurizer that was Subjected to Heating above Code Parameters

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Background Information

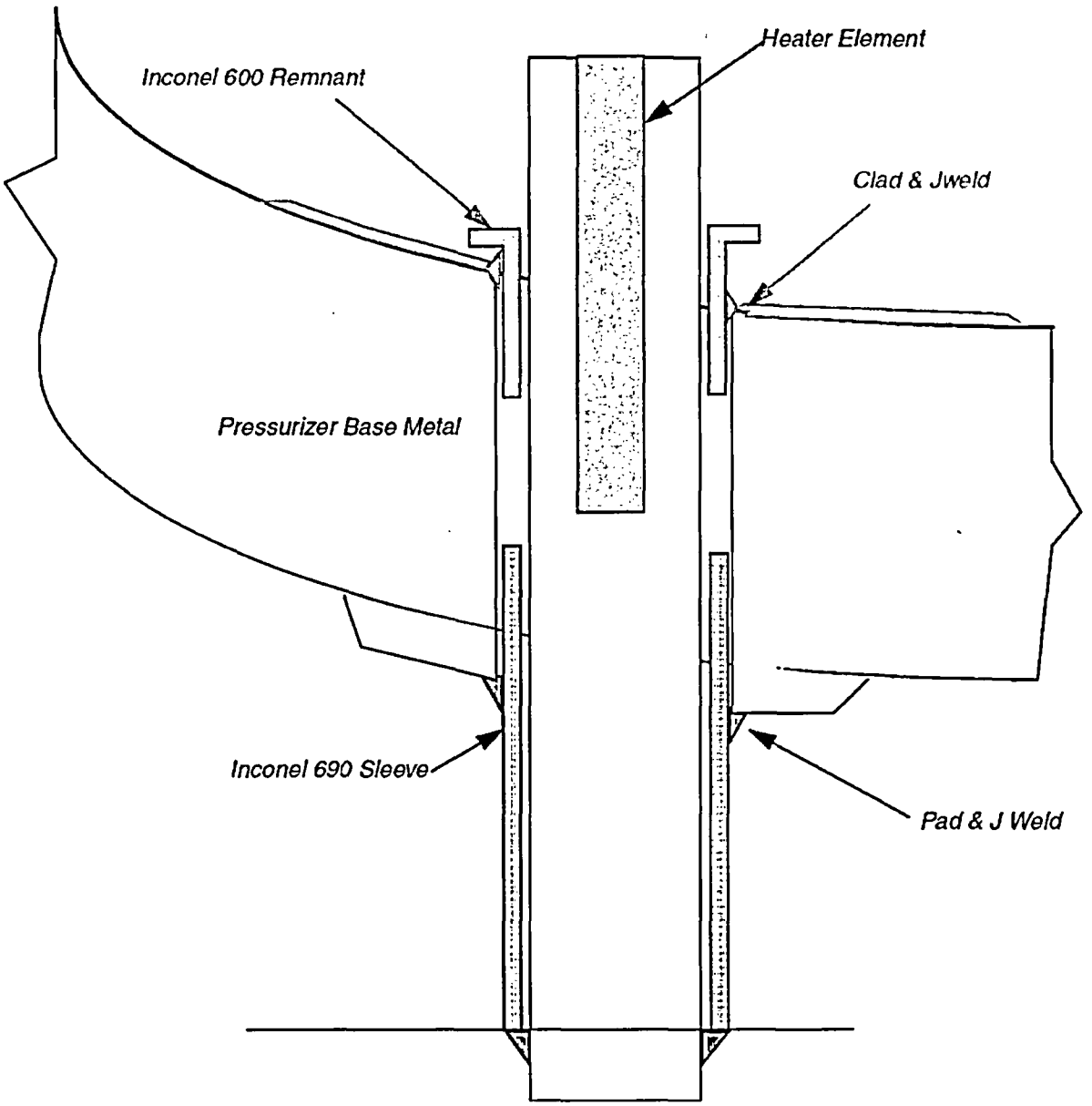
Palo Verde Nuclear Generating Station (PVNGS) Unit 3 has a pressurizer containing 36 heater sleeves attached to the bottom head. In the last Unit 3 refueling outage during fall 2004, the original Alloy 600 heater sleeves were replaced with Alloy 690 heater sleeves to address concerns with primary water stress corrosion cracking. The Unit 3 pressurizer heaters that were removed were replaced with new heaters. The new heaters, provided by Framatome ANP, Inc., began failing shortly after starting up Unit 3 in November 2004. Unit 3 was shut down for reactor coolant pump maintenance and replacement of nine failed heaters on May 23, 2005. During preparations for startup from the short-notice outage, five more Framatome heaters failed and the decision was made to replace all of the Framatome heaters with heaters from a different manufacturer prior to starting up. On June 15, 2005, Framatome notified APS that during the heater failure investigation, it was discovered that the heaters had been incorrectly fabricated with a longer heating element than the design specification. The longer heating elements, covered by the heater sheaths, extended down into the heater sleeves and pressurizer shell, exposing the sleeves and shell to elevated temperatures.

It has been determined at this time that the pressurizer base material surrounding the heater sleeves was subjected to temperatures above 700°F and up to 779°F for up to 3,700 hours. The pressurizer base material is SA-533, Grade A, Class 1. The highest temperature for which design stress intensity values are given for this material is 700°F, as stated in ASME Section III, Article NB-1000, Subsection NB-1120, "Temperature Limits." Therefore, APS requests approval of an alternative to ASME Section III, Sub-Section NB-1120 for the portion of the PVNGS Unit 3 pressurizer base material surrounding the heater sleeves that was subjected to temperatures above those for which design stress intensity values are given in the Code.

The NRC granted ISI Relief Requests 23 and 29 associated with heater sleeve replacement on October 9, 2003, and November 5, 2004, respectively. Assessments have concluded that there are no immediate impacts of this overheating condition on ISI Relief Request Nos. 23 and 29. However, any long term impacts of the Unit 3 pressurizer heater overheating condition on ISI Relief Requests 23 and 29 (e.g., fatigue effects over a 60-year plant life) will be assessed by July 29, 2005.

A cross section illustration of the pressurizer heater sleeve penetration (not to scale) is provided in Sketch 1 below.

10 CFR 50.55a(a)(3)(i) Request for Alternatives to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits," for a Portion of the PVNGS Unit 3 Pressurizer that was Subjected to Heating above Code Parameters



Sketch 1: Cross Section of Pressurizer Heater Sleeve Penetration (Not to Scale)

ISI Relief Request No. 33

10 CFR 50.55a(a)(3)(i) Request for Alternatives to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits," for a Portion of the PVNGS Unit 3 Pressurizer that was Subjected to Heating above Code Parameters

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I. ASME Code Component(s) Affected

PVNGS Unit:	3
Component number:	B4.20
Description:	Pressurizer lower head base material surrounding the 36 pressurizer heater sleeves.
Code Class:	1

II. **Applicable Code Edition and Addenda**

The Second 10-year inservice inspection interval code for Palo Verde Nuclear Generating Station (PVNGS) Unit 3 is the American Society of Mechanical Engineers (ASME) Code, Section XI, 1992 Edition, 1992 Addenda.

The construction code for PVNGS Unit 3 is ASME Section III, 1971 Edition, and 1973 Winter Addenda.

The installation code for PVNGS Unit 3 is ASME Section III, 1974 Edition, and 1975 Winter Addenda.

III. **Applicable Code Requirements**

Sub-article NB-1120, ASME Section III 1971 Edition, and 1973 Winter Addenda states the following:

> "The rules of Subsection NB shall not be used for items which are to be subjected to metal temperatures other than those for which design stress intensity values are given in Tables I.1.0 [I-1.0]. Above those temperatures, the creep and stress rupture characteristics of the materials permitted to be used become significant factors which are not presently covered by the rules of this Subsection. Fatigue design curves and specified methods for fatigue analysis are not applicable above 700 F for materials covered by Fig. I-9.1, above 800 F for materials covered by Fig. I-9.2, and above 500 F for materials covered by Fig. I-9.3."

ISI Relief Request No. 33

10 CFR 50.55a(a)(3)(i) Request for Alternatives to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits," for a Portion of the PVNGS Unit 3 Pressurizer that was Subjected to Heating above Code Parameters

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IV. Reason For Request

It has been determined at this time that the pressurizer base material surrounding the heater sleeves was subjected to temperatures above 700°F and up to 779°F for up to 3,700 hours. The pressurizer base material is SA-533, Grade A, Class 1. The highest temperature for which design stress intensity values are given for this material is 700°F, as stated in ASME Section III, Article NB-1000, Subsection NB-1120, "Temperature Limits." Therefore, APS requests approval of an alternative to ASME Section III, Sub-Section NB-1120 for the portion of the PVNGS Unit 3 pressurizer base material surrounding the heater sleeves that was subjected to temperatures above those for which design stress intensity values are given in the Code.

V. Proposed Alternatives and Basis for Use

Proposed Alternatives:

1. For the portion of the Unit 3 pressurizer base material that was exposed to temperatures above 700°F, proposed alternative 1 is to use the requirements of NH-3211(c) and (d) which state that the experimental and analytical methods of Subsection NB remain applicable if the designer demonstrates that the elevated temperature service parameters (time, stress level, and temperature) do not introduce significant creep effects.

2. For the portion of the Unit 3 pressurizer base material that was exposed to temperatures above 700°F, proposed alternative 2 is to use applicable design stress intensity values given in the Code Case N-499-2 for SA-533 Grade B material to be used for SA-533 Grade A material up to 779°F for up to 3,700 hours.

Basis for Use:

When the temperature limits of Subsection NB for Section III, Class 1 construction are exceeded, the rules for elevated temperature design in Section III, Division 1, Subsection NH for Class 1 Components in elevated temperature service may be used, as defined in the scope of Subsection NH:

NH-1100 SCOPE (2001 Edition, No Addenda)
NH-1110 ASPECTS OF CONSTRUCTION COVERED BY THESE RULES
(a) Subsection NH contains rules for materials, design, fabrication, examination, testing, and overpressure relief of Class 1 components, parts, and appurtenances which are expected to function even when metal temperatures exceed those covered by the rules and stress limits of Subsection NB and Tables 2A, 2B, and 4 of Section II, Part D, Subpart 1.
(b) The rules of Subsection NH are applicable to Class 1 components independent of the type of contained fluid — water, steam, sodium, helium, or any other process fluid.
(c) The stress limits and design rules of Subsection NB are applicable only to service conditions where creep and relaxation effects are negligible. Consequently, the rules of Subsection NB only guard against the time-independent failure modes—ductile rupture, gross distortion (buckling and incremental collapse), and fatigue. Therefore, those portions of the component, part, or appurtenance which are at all times experiencing temperatures within the range covered by Tables 2A, 2B, and 4 of Section II, Part D, Subpart 1 may be designed in compliance with the rules of NH-3000 in Subsection NH, or alternatively, in compliance with the rules of NB-3000. In addition, the rules of Subsection NH extend specific rules of NB-3000 to elevated temperature service, provided the designer can demonstrate that the combined effects of temperature, stress level, and duration of loading do not introduce significant creep effects.

In addition, NH-3211(c) permits the designer to apply the experimental and analytical methods of Subsection NB if it can be demonstrated that the elevated temperature service conditions, including times, stress levels and temperatures, do not introduce significant creep effects.

NH-3200 DESIGN BY ANALYSIS (2001 Edition, No Addenda)
NH-3210 DESIGN CRITERIA
NH-3211 Requirements for Acceptability
For a Class 1 component intended for elevated temperature service, the requirements for the acceptability of a design based on analysis shall be as stipulated in (a) through (d) below.
(a) The design shall be such that the calculated or experimentally determined stresses, strains, and deformations will not exceed the limits described in this Subarticle;
(b) The design details shall conform to the rules of NH-3100 and to those given in subsequent Subarticles applicable to the specific component;
(c) If the designer has demonstrated that the elevated temperature service parameters (time, stress level, and temperature) do not introduce significant

creep effects,[1] then the experimental and analytical methods of Subsection NB shall be applicable. The other restrictions on temperature maxima that appear in Subsection NB [see NB-3228.5(e)] shall not apply provided the designer demonstrates the validity of values and methods for the higher temperatures.

(d) For portions of the component which do not experience elevated temperature service, the rules of NB-3000 may be used to satisfy (a) and (b) above. Alternatively, properties and allowable stress values from Subsection NB may be used in analyses to demonstrate compliance with the rules of NH-3200.

Footnote 1 - A report documenting the experimental data or calculations based on experimental data or both shall demonstrate that the elevated temperature service does not introduce creep effects. This document shall be incorporated into the Stress Report (NCA-3550) and shall be approved by the Owner by means of a certified revision to the Design Specifications (NCA-3250).

Subsection NH only provides rules and material properties for a very limited subset of materials and does not include low alloy steel plate materials like the SA-533 plate used to fabricate the bottom head of the pressurizer. However, Code Case N-499-2 does provide coverage and material properties for use of SA-533 Grade B, Class 1 plate and SA-508 Class 3 forgings and their weldments for limited elevated temperature service for Section III, Division 1, Class 1 construction.

Code Case N-499-2 specifically addresses SA-533 Grade B, Class 1 plate, while the bottom head of the Palo Verde Unit 3 pressurizer was fabricated from SA-533 Grade A. The nominal composition of SA-533 Grade B is defined as Mn-1/2Mo-1/2Ni while SA-533 Grade A is defined as Mn-1/2Mo. Both Grades have specified minimum yield strength of 50 ksi and tensile strength of 80 ksi. The design stress intensity values for both Grades A and B of SA-533 in Table 1.1 of Appendix I of Section III are identical. A comparison of the allowable stress values for Section III and Section VIII applications of these Grades is shown in Table 1 below.

At temperatures from 100°F to 700°F the stress allowables are identical for the two grades. Note that at temperatures of 850°F and higher (except for 900°F), the allowable stress values are slightly higher for the Grade A material than for the SA-302 Grade C, which is equivalent in nominal composition to the SA-533 Grade B. Allowable stresses for the SA-533 Grade A material at temperatures of 900°F and above are values obtained from time dependent properties. Allowable stresses for the SA-302 Grade C material at temperatures of 850°F and above are values obtained from time dependent properties.

	Section III, Class 1 Design Stress Intensity, S_m		Section VIII, Division 1 Allowable Stress Values, S		
Spec.	SA-533	SA-533	SA-533	SA-533	SA-302
Grade	A	B	A	B	C
Nom. Comp.	Mn-1/2Mo	Mn-1/2Mo-1/2Ni	Mn-1/2Mo	Mn-1/2Mo-1/2Ni	Mn-1/2Mo-1/2Ni
	(ksi)	(ksi)	(ksi)	(ksi)	(ksi)
-20 to 100	26.7	26.7	22.9	22.9	22.9
150	26.7	26.7	22.9	22.9	22.9
200	26.7	26.7	22.9	22.9	22.9
250	26.7	26.7	22.9	22.9	22.9
300	26.7	26.7	22.9	22.9	22.9
400	26.7	26.7	22.9	22.9	22.9
500	26.7	26.7	22.9	22.9	22.9
600	26.7	26.7	22.9	22.9	22.9
650	26.7	26.7	22.9	22.9	22.9
700	26.7	26.7	22.9	22.9	22.9
750			22.9	22.9	22.9
800			22.9	22.9	22.9
850			22.1		20.0
900			13.3		13.7
950			10.0		8.2
1000			6.3		4.8

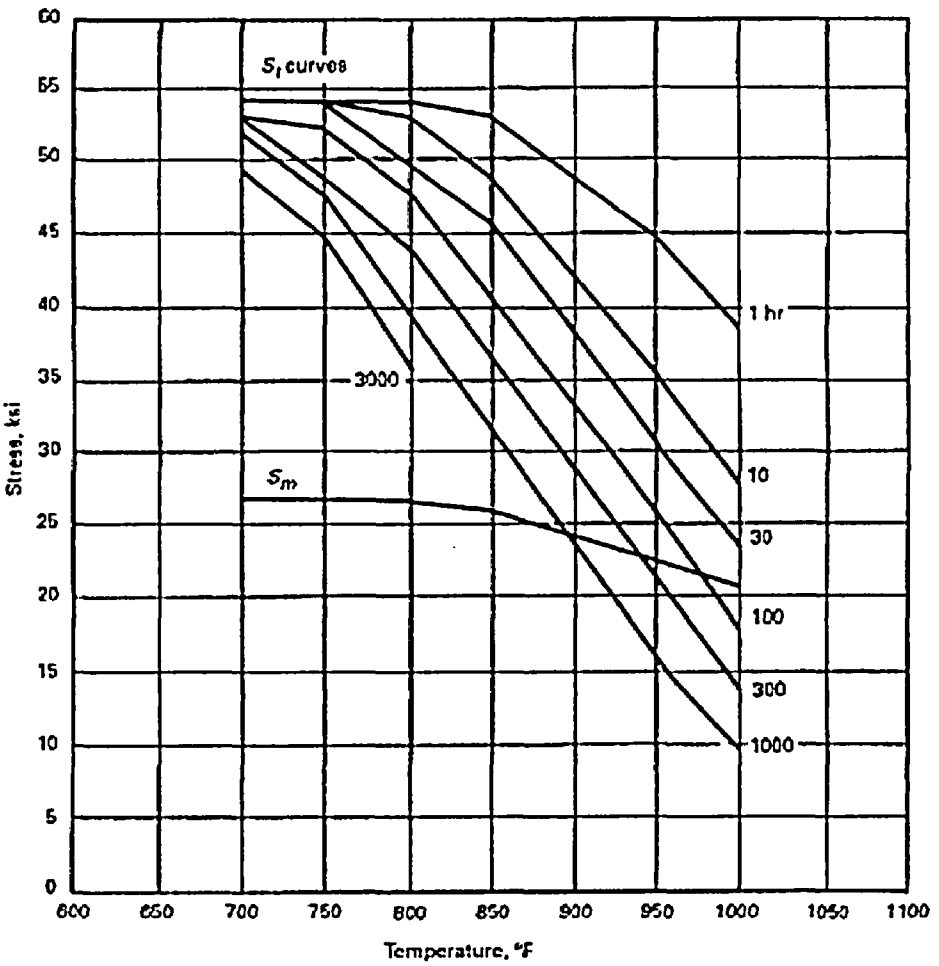
Table 1
Comparison of Allowable Stress Values for ASME Section III and Section VIII Applications

Based on the equivalence of the mechanical properties of SA-533 Grade A and B in both the time-independent and time-dependent temperature regimes, the properties given in Code Case N-499 for SA-533 Grade B can be applied equally to the SA-533 Grade A material of the pressurizer head.

The restrictions to Service Levels B, C or D and limit on the number of cycles prescribed in Code Case N-499-2 were developed to address the specific design duty cycle for which the Code Case was originally requested. These limits are not relevant to the temperature exposure of the Palo Verde pressurizer head because it was not an intended design condition. Separate thermal and stress analyses are being performed to evaluate the temperature and stress levels resulting from the overheating. The purpose of using Code Case N-499-2 is to establish that the elevated temperature service parameters (time, stress level, and temperature) did not introduce significant creep effects. Thus, the analytical methods of Subsection NB can be applicable to the analyses being performed.

Elevated temperature, tensile, toughness and creep data were supplied to the ASME B&PV Code Committee to develop and approve Code Case N-499. Code Case N-499-2 provides the evaluated experimental data for material properties and design stress intensities for limited elevated temperature service of SA-533 plate and SA-508 forging materials. The properties provided include the time independent and time dependent design stress intensity values, yield strengths and tensile strengths and expected minimum stress to rupture. These properties are used to evaluate the extent to which creep damage may have been introduced into the pressurizer head material.

It has been determined at this time that the pressurizer bottom head material surrounding the heater sleeves was exposed to a maximum temperature of 779°F for a total time period of 3,700 hours. Referring to the S_{mt} values in Figure 1 from Code Case N-499-2 at a maximum temperature of 779°F, the time independent S_m value is still controlling, although the S_t values are only shown up to 3,000 hour time durations. To further evaluate whether the pressurizer head exposure could have produced any significant creep effects, S_t values for longer times were developed based on the 2/3 of minimum rupture criteria used to establish time dependent allowables for Subsection NH (Ref. 1). Figure 2, below, shows the same S_{mt} values shown in Figure 1. S_t curves at 10,000 and 100,000 hours have been added based on the Subsection NH criteria of 2/3 of the minimum stress to rupture. In addition, the allowable stresses, S, for Section VIII, Division 1, which are based on 80% of the 100,000 hour stress to rupture have been added for comparison. The maximum pressurizer head temperature of 779°F is represented by the point on the S_m curve at the calculated stress level of 20.3 ksi. The 3,700 hour exposure represents only 3.7% of the 100,000 hour time to rupture. Time dependent allowables do not become controlling at 10,000 hours until about 848°F.



GENERAL NOTE: S_{mt} is the lower of S_m and S_t at any given temperature.

Figure 1 – S_{mt} Values from Code Case N-499-2

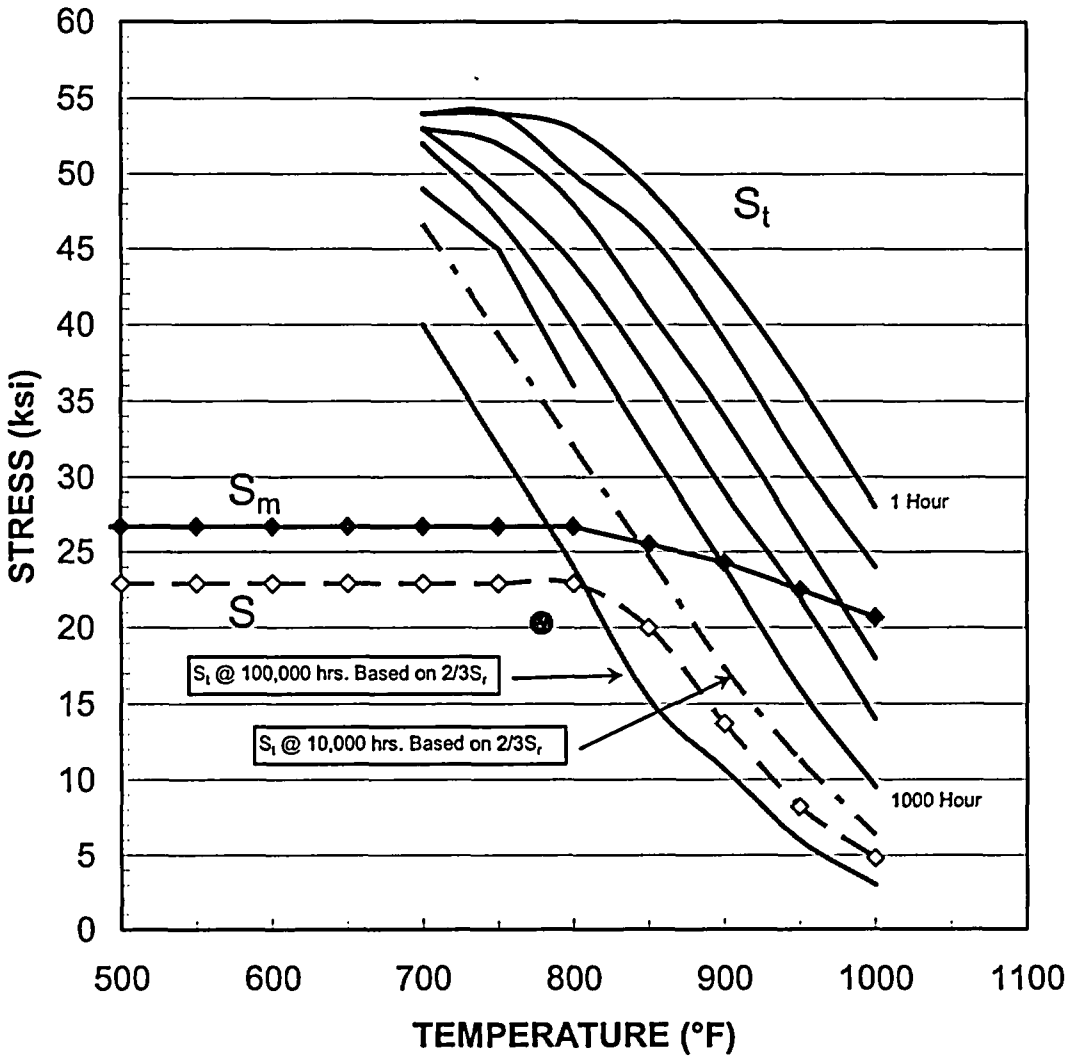


Figure 2 – Comparison of S_{mt} and S Values for SA-533 Plate With Pressurizer Temperature Exposure

Figure 3 compares the 3,700 hour exposure at a maximum stress level of 20.3 ksi to the S_t values from Code Case N-499. The S_t values represent 2/3 of the minimum stress to rupture for the material (Ref. 1). The 3,700 hour exposure at this stress represents only about 1.2% of the time for the extrapolated time dependent S_t value at 800°F.

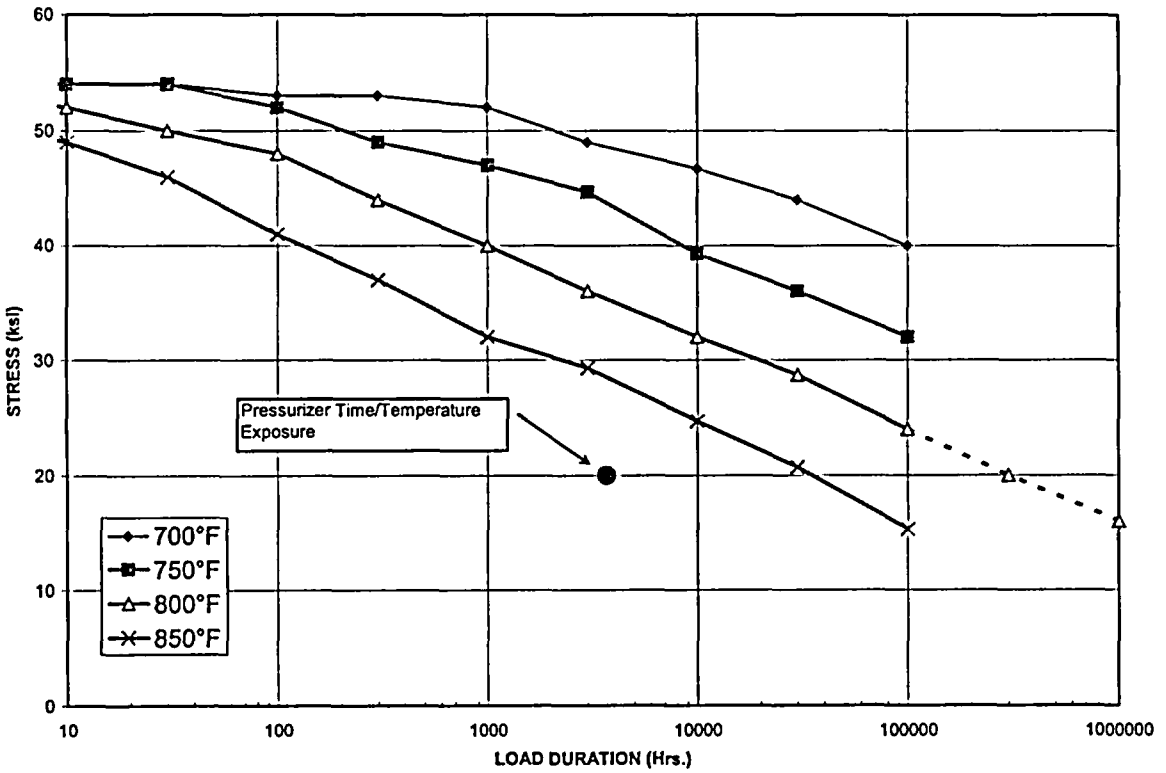


Figure 3 – Comparison of Pressurizer Head Temperature Exposure with Extrapolated S_t Value at 800°F

In addition to the comparison of the thermal exposure history with the material properties, Subsection NH, Appendix T-1200 Elastic Analysis recommends that the potential for occurrence of inelastic strains be checked against certain tests. Paragraph T-1321 states that the strain limits of T-1310 are considered to have been satisfied if the limits of any one of the tests defined in T-1322, T-1323, or T-1324 are satisfied.

T-1322 Test No. A-1 and T-1323 Test No. A-2 were evaluated using the results from the stress analysis. The results of the evaluation satisfied the limits specified in both T-1322 and T-1323.

The results from T-1322 Test No. A-1 and T-1323 Test No. A-2 demonstrate that there would not have been any significant accumulation of inelastic strains in the pressurizer head material due to the high temperature exposure.

Based on the combined results of the comparison to material properties and the Subsection NH Appendix T tests, no significant creep effects were introduced into the pressurizer head material. Therefore, the conditions can be evaluated with the analytical methods of Subsection NB.

Reference

1. Criteria for Design of Elevated Temperature Class 1 Components in Section III, Division 1, of the ASME Boiler and Pressure Vessel Code, ASME, May 1976.

VI. Duration of Proposed Alternative

APS requests that the 10 CFR 50.55a(a)(3)(i) request for alternative to 10 CFR 50.55a(c) requirement to comply with ASME Section III, Subsection NB-1120, "Temperature Limits," for a portion of the PVNGS Unit 3 pressurizer that was subjected to heating above Code parameters (ISI Relief Request 33) be granted for PVNGS Unit 3 and that the relief remain in effect for the remainder of plant life.

VII. Conclusion

10 CFR 50.55a(a)(3) states:

"Proposed alternatives to the requirements of paragraphs (c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that:

(i) The proposed alternatives would provide an acceptable level of quality and safety, or
(ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

The proposed alternative discussed in this relief request would provide an acceptable level of quality and safety since no significant creep effects were introduced into the Unit 3 pressurizer material due to the exposure to the elevated temperatures. Therefore, APS requests that the proposed alternative be authorized pursuant to 10 CFR 50.55a(a)(3)(i).

ISI Relief Request No. 33

10 CFR 50.55a(a)(3)(i) Request for Alternatives to 10 CFR 50.55a(c) Requirement to Comply with ASME Section III, Subsection NB-1120, "Temperature Limits," for a Portion of the PVNGS Unit 3 Pressurizer that was Subjected to Heating above Code Parameters

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APS requests NRC approval of the proposed relief request by June 21, 2005, to support startup of Unit 3 from the current outage.

Enclosure 3

Regulatory Commitment

The following table identifies those new actions committed to by APS in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments. Please direct questions regarding these commitments to Thomas N. Weber at (623) 393-5764.

REGULATORY COMMITMENT	DUE DATE
Any long term impacts of the Unit 3 pressurizer heater overheating condition on ISI Relief Requests 23 and 29 (e.g., fatigue effects over a 60-year plant life) will be assessed by July 29, 2005.	By July 29, 2005.