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AUTH.NAME AUTHOR AFFILIATION
CUTTER,A.B. Carolina Power & Light Co.
RECIP.NAME RECIPIENT AFFILIATION
DENTON,H.R. Office of Nuclear Reactor Regulation, Director

SUBJECT: Forwards "Chemical Analysis of Reactor Vessel Head Torus-to-Dome Weld Samples From HB Robinson Unit 2," to resolve pressurized thermal shock issues. Finding to date re matl properties program encl.

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Carolina Power & Light Company

SERIAL: NLS-84-191

JUN 29 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
PRESSURIZED THERMAL SHOCK - MATERIAL PROPERTIES

Dear Mr. Denton:

SUMMARY

During the past three years, Carolina Power & Light Company (CP&L) has undertaken a very broad scope project designed to resolve the Pressurized Thermal Shock (PTS) issue for H. B. Robinson Steam Electric Plant Unit No. 2 (HBR2). That project has produced a triad of programs which each individually resolve the issue. The triad consists of 1) the HBR2 Flux Reduction Program (reference CP&L letter of September 30, 1983, Serial: LAP-83-439), 2) the HBR2 PTS Risk Study (reference CP&L letter of November 7, 1983, Serial: LAP-83-511), and 3) the HBR2 Material Properties program. The purpose of this letter and the attached reports is to document the findings to date associated with the Material Properties program.

In summary, based on reviewing documentation and taking samples from HBR2 reactor vessel head welds similar to welds in the HBR2 reactor vessel beltline, it is concluded that the weld chemistry for the HBR2 critical weld is much better, from a PTS perspective, than previously assumed. Based on the improved chemistry for the beltline welds, calculations show that HBR2 will not exceed the PTS screening criteria during its design lifetime. By using these results combined with the results of the other two programs mentioned previously, CP&L has concluded that the PTS issue is completely resolved for HBR2.

DISCUSSION

Attached to this letter are the following:

1) Summary of Findings Related to HBR2 Reactor Vessel Materials

2) RT_{NDT} Calculations for HBR2 Reactor Vessel Beltline Welds

3) Chemical Analysis of Reactor Vessel Head Torus to Dome Weld Samples from HBR2

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These three documents form the basis for the conclusions mentioned above. It has been the objective of CP&L's Material Properties program to develop best estimate values for the Reactor Vessel weld chemistries and where appropriate, substitute these values for assumed values which were considered to be overly conservative. Attachment 1 summarizes these efforts. Attachment 2 provides the calculations which support Attachment 1. Attachment 3 explains the sampling process and weld correlation process used by CP&L to draw its conclusions relative to the chemistry of the critical weld. The combined results are as follows:

Weld	Best Estimate Chemistry	End of License RT_{NDT}
lower girth weld	Cu .19% Ni .8%	160°F
beltline longitudinal weld	Cu .22% Ni .04%	137°F
upper girth weld	Cu .17% Ni 1.0%	153°F

Based on these results, the girth welds will have 140° and 147°F margin, respectively, at the end of license and the longitudinal welds will have 133° margin when compared to the PTS screening criteria.

CONCLUSION

Although CP&L is aware of NRC's continuing review of our PTS programs, CP&L believes that the weight of evidence on the docket is sufficient to conclude that HBR2 can safely operate for the remainder of its design lifetime without any undue risk associated with PTS. Carolina Power & Light Company, therefore, requests that the NRC formally recognize these results and close out this issue with respect to H. B. Robinson Steam Electric Plant Unit No. 2.

If you or your staff have any questions regarding this letter, please contact Mr. S. R. Zimmerman at (919) 836-6242.

Yours very truly,

A. B. Cutter - Vice President
Nuclear Engineering & Licensing

CGL/ccc (9912CGL)
Attachments

cc: Mr. J. P. O'Reilly (NRC-RII)
Mr. G. Requa (NRC)
Mr. F. Schroeder (NRC)
Mr. T. Spies (NRC)
Mr. S. A. Varga (NRC)
Mr. Steve Weise (NRC-HBR)
Mr. R. Woods (NRC)

Attachment 1

SUMMARY OF FINDINGS RELATED TO H. B. ROBINSON UNIT NO. 2 REACTOR VESSEL MATERIALS

Introduction

This report and its attachments will document the evidence uncovered to date by Carolina Power & Light Company (CP&L) with respect to the chemical content and makeup of the H. B. Robinson Unit No. 2 (HBR2) reactor vessel beltline welds. Based on that evidence, CP&L has concluded that the reactor vessel beltline welds are significantly less sensitive to embrittlement from neutron radiation than previously assumed. That reduction in sensitivity assures that HBR2 will not reach the Pressurized Thermal Shock (PTS) screening criteria during its design lifetime.

Weld Fabrication

The HBR2 reactor vessel was fabricated by Combustion Engineering for Westinghouse under a turnkey contract with CP&L. The composition of the welds is as follows:

Reactor Vessel Weld	Weld Wire Type
Lower Girth Weld	RACO 3 and Ni200 Linde 1092 Flux Heat 34B009
Beltline Longitudinal Welds	RACO 3 ARCOS B-5 Flux Heat 86054B
Upper Girth Weld	RACO 3 and Ni200 Linde 1092 Flux Heat W5214

Chemical Composition

Carolina Power & Light Company has conducted considerable research in examining weld records associated with the HBR2 beltline welds, has reviewed available documentation of welds similar to the HBR2 beltline welds and has sampled and analyzed welds similar to the HBR2 beltline welds. The results of these investigations are documented below:

Lower Girth Weld

The lower girth weld was identified early in the program as the critical weld from a PTS viewpoint. Additionally, little data was available on Heat 34B009, RACO 3 and Ni200 welds. Carolina Power & Light Company, however, was able to determine that the Dome Plate to Torus (upper circumferential) weld in the HBR2 Reactor Vessel Head was also a Heat 34B009, RACO 3 and Ni200 weld. Solid samples were extracted from that reactor vessel head weld and analyzed. The Westinghouse report on the sampling and the analysis is attached. The key results were that the

copper content was .19% and the nickel content was .8%. Therefore, CP&L has concluded that those results are the best estimate for the HBR2 lower girth weld chemistry.

Beltline Longitudinal Welds

Through its review of the welds similar to HBR2, CP&L was able to determine that both the HBR2 longitudinal welds and the surveillance weld at Connecticut Yankee were both Heat 86054B, RACO 3 welds. Analysis of the Connecticut Yankee surveillance weld is documented in WCAP 10433 which has been previously submitted to the NRC on several dockets. The weld chemistry of the Connecticut Yankee surveillance welds is a copper content of .22% and a nickel content of .054%. Carolina Power & Light Company believes that these results represent the best estimate for the weld chemistry of the HBR2 longitudinal welds.

Upper Girth Weld

The HBR2 upper girth welds is in a relatively low neutron flux area and has never been considered to be the limiting weld from a PTS standpoint. Carolina Power & Light Company examined the records of a number of Heat W5214, RACO 3 and Ni200 welds. Additionally, CP&L was able to sample and analyze a portion of the Millstone 1 surveillance weld which is also a W5214 weld. Finally CP&L took chip samples from the Torus to Flange weld on the HBR2 Reactor Vessel head which is also a Heat W5214 and Ni200 weld. The results from these investigations are shown below:

Source	% Cu	% Ni
Historical Records	.18	1.0
Millstone 1 Surveillance Weld	.19	.98
HBR2 Head Sample	.17	1.0

Based on the above, CP&L believes that the best estimate of the weld chemistry for the upper girth weld is a copper content of .17% and a nickel content of 1.0%.

It must be noted that these results do not coincide with measurements taken from the HBR2 surveillance weld which is also a W5214 weld. Carolina Power & Light Company believes that the above results represent the best chemistry. Even if the conservative results of the surveillance weld are utilized, however, HBR2 will not reach the PTS screening criteria during its design lifetime.

End of Current License RT_{NDT}

Based on the results of the HBR2 Reactor Vessel Material Program, CP&L has recalculated the end of current license RT_{NDT} values for the HBR2 beltline welds. The actual calculations are attached to this report and utilize the methodology outlined in the Proposed PTS rule published in the Federal

Register on February 7, 1984. The fluence values utilized are based on the Flux Management Program outlined in CP&L's letter of September 30, 1983 (Serial: LAP-83-439). The results of these calculations are shown below:

Weld	Chemical Composition	Fluence (27EFPY)	RT_{NDT} (27EFPY)
Lower Girth Weld	Cu - .19% Ni - .8%	$1.89 \times 10^{19} n/cm^2$	160°F
Beltline Longitudinal Welds	Cu - .22% Ni - .04%	$3.36 \times 10^{19} n/cm^2$ (peak @ 8.95°off ℄)	137°F
Upper Girth Weld	Cu - .17% Ni - 1.0%	$1.75 \times 10^{19} n/cm^2$	153°F

Conclusions

Based on the best estimate chemistry, the HBR2 reactor vessel will not approach the proposed PTS screening criteria during its current license.

RT_{NDT} CALCULATIONS FOR H. B. ROBINSON UNIT 2 REACTOR VESSEL BELTLINE WELDS

$$RT_{NDT} = I + M_1 + [-10 + 470\ Cu + 350\ CuNi]\ f^{.270}$$

$I = -56°F$

$M_1 = 59°F$

Lower Girth Weld

$$RT_{NDT} = -56 + 59 + [-10 + 470\ (.19) + 350\ (.19)(.8)](1.89)^{.270}$$

$$= -56 + 59 + [-10 + 89.3 + 53.2]\ (1.19)$$

$$= -56 + 59 + (132.5)(1.19)$$

$$= -56 + 59 + 157$$

$$= 160°F$$

Beltline Longitudinal Welds

$$RT_{NDT} = -56 + 59 + [-10 + 470\ (.22) + 350(.22)(.04)]\ (3.36)^{.270}$$

$$= -56 + 59 + (-10 + 103.4 + 3.08)\ (1.39)$$

$$= -56 + 59 + 134$$

$$= 137°F$$

Upper Girth Weld

$$RT_{NDT} = -56 + 59 + [-10 + 470(.17) + 350\ (.17)(1.0)]\ (1.75)^{.270}$$

$$= -56 + 59 + (-10 + 79.9 + 59.5)\ (1.16)$$

$$= -56 + 59 + (129.4)\ (1.16)$$

$$= -56 + 59 + 150$$

$$= 153°F$$