UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 15, 2000

LICENSEE: Omaha Public Power District

FACILITY: Fort Calhoun Station, Unit No. 1

SUBJECT: MEETING SUMMARY - BASIS FOR PREDICTION OF RT_{PTS} AT LICENSE EXPIRATION AND REVISED FLUENCE SUBMITTAL

On March 13, 2000, a public meeting was held between NRC staff, Omaha Public Power District (OPPD), and OPPD's contractor, ABB-Combustion Engineering (ABB-CE), at the NRC headquarters offices in Rockville, Maryland. The purpose of the meeting was to continue discussions regarding OPPD's proposed revised fluence amendment submittal and a supplemental ABB-CE report. The report will provide a revised methodology for calculating the adjusted reference temperature (RT_{PTS}) at the end of the Fort Calhoun Station (FCS) current license term. Attachment 1 lists the meeting participants. The presentation slides used for the meeting are included as Attachment 2.

After introductions and a brief overview of the meeting, OPPD summarized the previous meeting held on January 6, 2000. OPPD further discussed their application of Position 2.1 of Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," with the Mihama Unit 1 surveillance data to demonstrate that Fort Calhoun would not exceed the pressurized thermal shock (PTS) screening criterion.

The limiting material in the Fort Calhoun reactor pressure vessel for the current license term is the axial weld that was fabricated using tandem weld wire heat number 12008/27204. The material that will be limiting for the proposed license renewal period is the axial weld that was fabricated using tandem weld wire heat number 27204/27204. The licensee indicated that surveillance capsules in Diablo Canyon Unit 1 and Palisades contain samples from welds fabricated using tandem weld wire heats. The licensee also indicated that three surveillance capsules in Mihama Unit 1 contain samples from welds fabricated using tandem weld wire heats 12008/27204. The licensee provided analyses of the Diablo Canyon Unit 1, Palisades and Mihama Unit 1 surveillance data to demonstrate that the RT_{PTS} value for the axial welds using these combinations of weld wires would be below the PTS criteria in the PTS rule, 10 CFR 50.61, at the end of the proposed license renewal date of 2033.

As the meeting concluded, OPPD agreed to calculate the RT_{PTS} value from surveillance data two ways; one with the temperature correction applied before the calculations, and the other with the temperature correction applied after.

/RA/

L. Raynard Wharton, Project Manager, Section 2
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Docket No. 50-285

Enclsoures: 1. Meeting Attendees
2. Presentation Slides

cc w/encls: See next page

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March 13, 2000, Meeting With Omaha Public Power District

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Enclosure 1

OMAHA PUBLIC POWER DISTRICT
Fort Calhoun Nuclear Station

Meeting with NRC to Discuss
Use of Position 2.1 of Reg. Guide 1.99, Rev.02
and Data from the Mihama 1 Plant
for Current License and License Renewal Terms

March 13, 2000

Enclosure 2

Agenda

- Purposes & Objectives
- Summary of January 6, 2000 Meeting
- Progress on Obtaining Mihama 1 Data
- Evaluation of "6 Items for Determining Applicability"
- CEN-636 Reanalysis (Application of Position 2.1)
- Closing Remarks

Purpose

- Respond to issues discussed at the January 6, 2000 meeting
- Describe the approach for analysis of the Mihama 1 data
- Discuss the expected results

Objectives

- Demonstrate applicability of Mihama 1 data
- Agree on the methodology for analysis of the Mihama 1 data
- Establish groundwork for successful re-submittal of reanalysis of RT_{PTS} analyses (CEN-636)

Summary of January 6, 2000 Meeting Between NRC and OPPD

- Applying R.G. 1.99, Rev. 02 Position 2.1 with the Mihama 1 surveillance data to demonstrate operation to 2033 with RT_{PTS} <270°F for limiting axial weld (12008/27204)
- NRC provided list of 6 evaluation items to determine if surveillance data from Mihama Unit 1 are applicable to the FCS RV
- Credit improvements for weld combination in:
  - Chemistry Factor
  - Margin term of 10 CFR 50.61 embrittlement correlation

Summary of January 6, 2000 Meeting Between NRC and OPPD (cont.)

- The weld combination of 27204/27204 becomes more limiting than 12008/27204
- Application of Position 2.1 using 27204 data also being performed as part of the reanalysis of RT_{PTS} data (CEN-636)
- 27204 outlier data point noted---*will be addressed today in reanalysis of RT_{PTS} data*

Summary of January 6, 2000 Meeting Between NRC and OPPD (cont.)

- The shift/margin needs to be adjusted based on differences between the FCS cold leg temperature (currently 543°F) and the other plants whose surveillance data are used.
- OPPD agreed to supply comments on the Surveillance Section of the RVID for FCS

  Status: Complete (see Letter LIC-00-0011, dated February 14, 2000)

Summary of January 6, 2000 Meeting Between NRC and OPPD (cont.)

- Following table summarizes RV weld materials and chemistry factors as previously described

Identification of Welds in the Fort Calhoun Reactor Vessel Beltline

Weld Identification	Weld Electrode Heat No., Flux Type and Lot No.	Chemistry Factor (°F)[a]
2-410 A/C	51989 Linde 124, #3687	89.03
3-410 A/C	12008 & 13253 (T)[b] Linde 1092, #3774	208.68
3-410 A/C	13253 (T)[b] Linde 1092, #3774	189.05
3-410 A/C	12008 & 27204 (T)[b] Linde 1092, #3774	231.06
3-410 A/C	27204 (T)[b] Linde 1092, #3774	226.81
9-410	20291 Linde 1092, #3833	188.41

Notes:

(a) Chemistry Factor from Table 1 of Regulatory Guide 1.99, Revision 02.

(b) "T" denotes a tandem arc weld; other welds are single arc.

Progress on Obtaining Mihama 1 Data

- Kansai Electric Power Co. provided OPPD with non-proprietary data for Mihama 1
- OPPD acquired WCAP-7374 (RV Radiation Surveillance Program)-Unrestricted Distribution
- OPPD has sent a data request to Kansai
- OPPD and Kansai have reached an agreement to exchange RV data

Progress on Obtaining Mihama 1 Data (cont.)

- Formal signing of agreement should occur by the end of March
- Kansai considers some data proprietary
- Only non-proprietary data discussed today

Mihama 1 Surveillance Data Applicability to Fort Calhoun

- NRC handout from 1/6/00 meeting identified six items "to determine if the weld surveillance data from the Mihama Unit 1 reactor vessel are applicable to the Fort Calhoun vessel"
- Also stated that the use of data from foreign plants was complicated because they did not follow the same 10CFR50, Appendix B program
- The following discussion addresses how each of the six NRC items have been or will be resolved

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

Six Items for Applicability Assessment:

(1) Unirradiated and irradiated Charpy data

(2) Irradiation temperature of the capsule based on PWR cold leg

(3) Neutron flux of capsules

(4) Gamma Heating of capsules

(5) Neutron spectrum of capsules

(6) Chemistry of surveillance data

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(1) Applicability of unirradiated Charpy data:

- Unirradiated Charpy data from Table 2 of WCAP-7374, "Kansai Electric Power Mihama Unit 1 Reactor Vessel Radiation Surveillance Program", S.E. Yanichko, dated January 1970
- Individual Charpy specimen data are for the tandem weld wire heat 12008/27204 (verified by Fabrication Records)
- Data are used as-reported to establish the unirradiated Charpy curve and to be checked against the Charpy index temperatures cited by Kansai

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(1) Applicability of irradiated Charpy data:

- Irradiated Charpy data for the irradiated tandem weld wire heat 12008/27204 are from three surveillance capsules (V, R and S per WCAP-7374) as reported by Kansai to OPPD
- Individual irradiated Charpy specimen data have been requested from Kansai
- Data will be used to establish the irradiated Charpy curve and checked against the Charpy index temperatures cited by Kansai for verification of the Charpy shift values

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(2) Applicability of irradiation temperature of the capsule based on PWR cold leg:

- Kansai verified with OPPD a value of 289°C (552°F) for the Mihama Unit 1 cold leg temperature
- Westinghouse has confirmed that this cold leg temperature is reasonable for similarly configured two-loop Westinghouse NSSSs
- Consider temperature difference explicitly

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(3) Applicability of neutron flux of capsules:

- Neutron flux corresponding to each irradiated and tested capsule from Mihama Unit 1 requested from Kansai
- Requested source reference and a description of the methodology used to calculate the neutron flux
- Westinghouse has confirmed that the Mihama flux is typical for similarly configured Westinghouse reactor vessels

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(4) Applicability of gamma heating of capsules:

- Regulatory Guide 1.99, Rev. 2 criterion is that Charpy specimen temperature matches vessel wall temperature within +/- 25°F
- Commonly accepted that cold leg temperature is best indicator of irradiation temperature of the included Charpy specimens; Response (2) established applicability of T_{cold} data

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(4) Applicability of gamma heating of capsules (cont.):

- Westinghouse has confirmed that the design and construction of the Mihama Unit 1 surveillance capsules are the same as that for other surveillance capsules that they fabricated during this timeframe
- Thus, gamma heating of the Mihama 1 capsules is the same as for domestic Westinghouse plants
- This establishes the applicability of the Mihama Unit 1 surveillance capsules to Fort Calhoun

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(5) Applicability of neutron spectrum of capsules

- CEOG Report CEN-405-P, Rev 3 (Application of Reactor Vessel Surveillance Data for Embrittlement Management, dated September 1996) evaluated surveillance data from Westinghouse and CE plants
- CEN-405-P demonstrated that Westinghouse and CE data were equally predictable using Reg. Guide 1.99, Rev.02

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(5) Applicability of neutron spectrum of capsules (cont.):

- CEN-405-P concluded that irradiation environment was similar for the capsules from both; no definitive differences between the spectra; need only to consider differences in the irradiation temperature and the neutron flux
- CEN-405-P conclusions consistent with BGE findings: acceptable to use McGuire 1 surveillance weld data to determine RT_{PTS} for Calvert Cliffs Unit 1

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(5) Applicability of neutron spectrum of capsules (cont.):

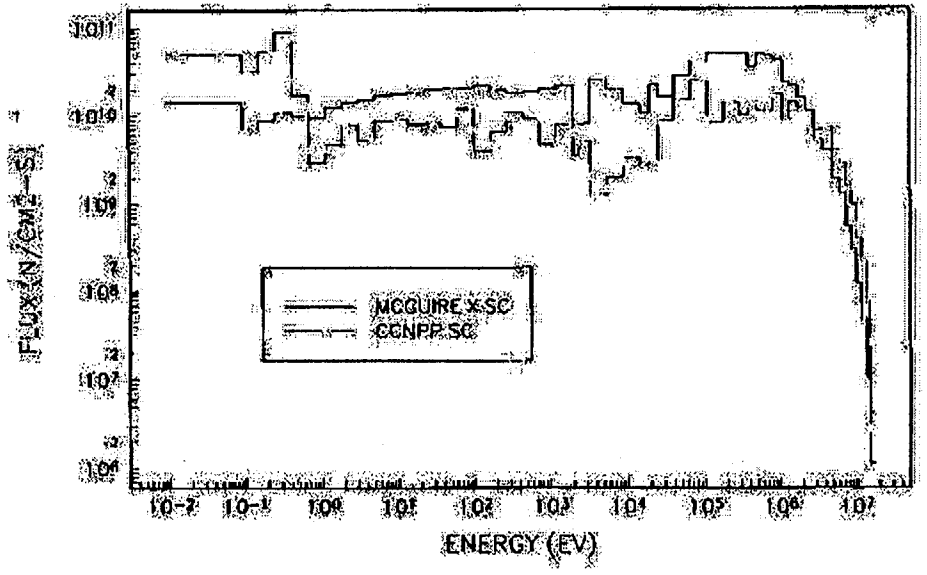


Figure 3-15

Absolute Flux versus Energy for McG-1 Capsule X and CC-1 Capsule 97°

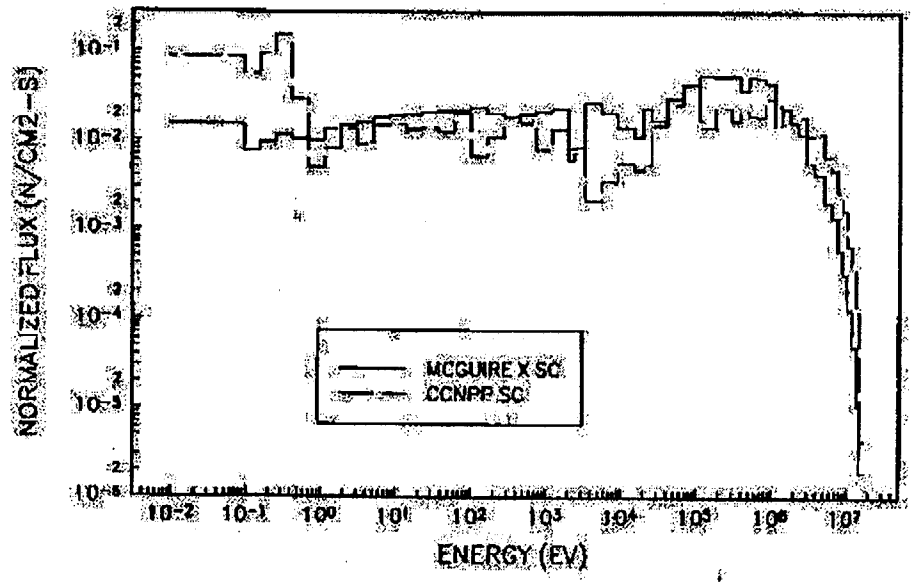
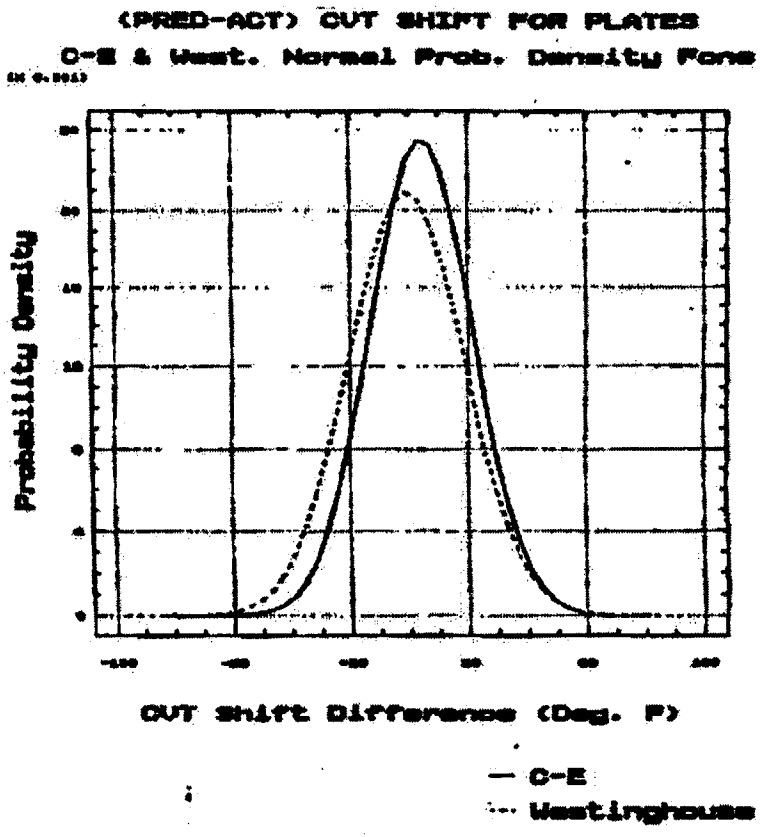


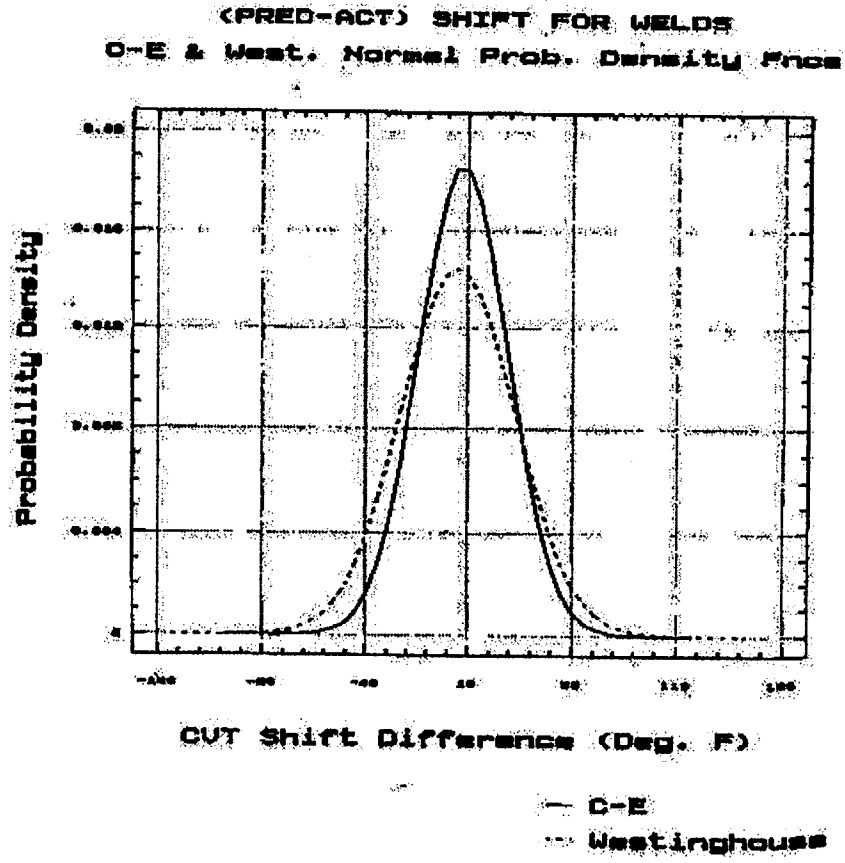
Figure 3-16

Normalized Flux versus Energy for McG-1 Capsule X and CC-1 Capsule 97°

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(5) Applicability of neutron spectrum of capsules (cont.):





Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(5) Applicability of neutron spectrum of capsules (cont.):

- Westinghouse confirmed Mihama 1 neutron spectrum is comparable to domestic Westinghouse PWRs
- CEN-405P concluded neutron spectrum is a second order effect on embrittlement
- Approach is consistent with prior observations:
  1: dpa provides the same quality of fit as neutron fluence with PWR surveillance data embrittlement
  2: NRC sponsored embrittlement correlations do not identify neutron spectrum as an independent or dependent variable (NUREG/CR-6551, November 1998)

Mihama 1 Surveillance Data Applicability to Fort Calhoun (cont.)

(6) Applicability of surveillance chemistry data:

- Kansai reported copper and nickel contents of 0.19 and 1.08 w/o; OPPD requested supporting information.
- Weld qualification analyses by Combustion Engineering (Chattanooga) for heat 12008 and 27204 yielded copper and nickel contents of 0.19 and 0.97/0.98 w/o
- Kansai values are fully consistent with a heat 12008 and 27204 weld deposit, and traceability of the Mihama Unit 1 surveillance weld has been established based on fabrication records from CE-Chattanooga

Approach for Analysis of Surveillance Weld Data

Overview:

Calculations performed in accordance with Position 2.1 of Regulatory Guide 1.99, Rev. 02 and November 12, 1997 Guidelines for Industry provided by NRC, with enhanced methodology of NUREG/CR-6551

Process Steps:

1. Calculation of chemistry factor (CF) performed in accordance with Table 1 of R.G. 1.99, Rev.02
2. Ratio Method used to adjust surveillance data to best estimate chemistry for weld (CF_{BE}/CF_{Surv}= ratio); multiply shift by ratio to obtain adjusted shift "if there is clear evidence that the Cu or Ni content of the surveillance weld differs from that of the vessel"

Approach for Analysis of Surveillance Weld Data (cont.)

Process Steps (cont.)

3. Temperature adjustment is refinement of concept provided in November 12, 1997 NRC Guidelines; the 11/12/97 recommendation was to adjust the derived CF by 1°F per 1°F difference in irradiation temperature after CF has been derived using adjusted shift measurements
4. For FCS analysis performed temperature adjustment before CF has been derived by adjusting shift measurements using the more rigorous method of NUREG/CR-6551 with T_{cold} to identify differences with fluence and temperature

Approach for Analysis of Surveillance Weld Data (cont.)

Rationale for temperature adjustment:

- Equation from NUREG/CR-6551 identifies effect of T_{cold} difference with fluence; 11/12/97 guidelines assume no effect of fluence
- Effect of T_{cold} difference is included in subsequent analysis for computing CF; i.e., both adjustments (T_{cold} and ratio method) are applied consistently and explicitly, and are used to minimize the sum of the squares
- Equation from NUREG/CR-6551 based on over 600 surveillance data; i.e., statistically rigorous

Approach for Analysis of Surveillance Weld Data (cont.)

Shift Adjustment Example (Mihama 1 data):

- Adjustment for T_{cold} difference:

  Unadjusted shift plus calculated temperature difference = shift adj. for temp.

  At 1.2E19 n/cm^2, 205.2+5.3= 210.5°F

- Adjustment for CF difference:

  Shift adj. for temp times ratio = fully adjusted shift

  At 1.2E19 n/cm^2, 210.5°F x 1.017= 214.1°F

Approach for Analysis of Surveillance Weld Data (cont.)

Chemistry Factor (CF) Derivation :

- Multiply each adjusted shift by corresponding fluence factor (FF)* and sum
- Square each fluence factor (FF) and sum
- CF = sum of (adj. Shift x FF) divided by sum of $(FF)^2$

* $FF=f^{(0.28-0.1*\log_{10}f)}$ where:

f=best estimate neutron fluence in units of 10^{19} n/cm^2 (E>1MeV) at clad-base metal interface

Approach for Analysis of Surveillance Weld Data (cont.)

Data Scatter Evaluation:

- Multiply computed CF by corresponding fluence factor (FF) to get predicted shift
- Subtract predicted shift from corresponding value of measured shift
- If all measurements are within one sigma (28°F) of the predicted shift the criterion for scatter is satisfied and the data are credible
- Limited scatter permits use of $\sigma_\Delta/2$ = 14°F for welds

Analysis of Surveillance Weld Data

Surveillance Data:

- Weld Wire Heat 12008 and 27204 from Mihama Unit 1 corresponding to FCS beltline weld 3-410 A/C
- Weld Wire Heat 27204 and 27204 from Diablo Canyon Unit 1 and Palisades supplemental capsule corresponding to FCS beltline weld 3-410 A/C

Mihama 1 Surveillance Weld Data
Weld Wire Heat 12008 and 27204

Test results:

- Data Source: Kansai Electric Power Company
- Initial RT_{NDT} = -50°C (-58°F) based on Charpy and drop weight tests on the unirradiated material

Mihama 1 Surveillance Weld Data Weld Wire Heat 12008 and 27204 (cont.)

Test results (cont.):

- 30 ft-lb index temperatures:

  Initial T_{30} = -72°C (-97.6°F)

  First capsule T_{30} = 32°C (89.6°F) at 0.6 E19 n/cm^2

  Second capsule T_{30} = 42°C (107.6°F) at 1.2 E19 n/cm^2

  Third capsule T_{30} = 54°C (129.2°F) at 2.1 E19 n/cm^2

Mihama 1 Surveillance Weld Data Weld Wire Heat 12008 and 27204 (cont.)

Analysis:

- Three sets of post-irradiation test results available from Mihama 1 for analysis
- Calculation of chemistry factor performed in accordance with Regulatory Guide 1.99, Rev. 02, Position 2.1
- Ratio Method used to adjust Mihama 1 data by factor of 1.017 to best estimate chemistry for weld;

  Mihama weld CF = 227.2°F (0.19 Cu, 1.08 Ni) <u>vs.</u>

  BE weld CF = 231.06°F (0.219 Cu, 0.996 Ni)

Mihama 1 Surveillance Weld Data Weld Wire Heat 12008 and 27204 (cont.)

Analysis for difference in T_{cold}:

- Mihama 1 operates at 552°F versus Fort Calhoun at 543°F
- Used equation from NUREG/CR-6551 with T_{cold} to identify difference with fluence and temperature:

  (a) At 6E18 n/cm^2, shift was 4.3°F higher at 543°F

  (b) At 1.2E19 n/cm^2, shift was 5.3°F higher at 543°F

  (c) At 2.1E19 n/cm^2, shift was 7.4°F higher at 543°F

Mihama 1 Surveillance Weld Data Weld Wire Heat 12008 and 27204 (cont.)

Shift Adjustment:

- Adjustment for T_{cold} difference:
  (a) At 6E18 n/cm^2, 187.2+4.3= 191.5°F
  (b) At 1.2E19 n/cm^2, 205.2+5.3= 210.5°F
  (c) At 2.1E19 n/cm^2, 226.8+7.4= 234.2°F
- Adjustment for CF difference:
  (a) At 6E18 n/cm^2, 191.5°F x 1.017= 194.8°F
  (b) At 1.2E19 n/cm^2, 210.5°F x 1.017= 214.1°F
  (c) At 2.1E19 n/cm^2, 234.2°F x 1.017= 238.2°F

Test Results from Mihama Unit 1 Surveillance Capsules with T_{cold} and CF Adjustment for Weld Heats 12008 and 27204 ---Non- Proprietary---

Capsule Identity	Charpy Shift (°F)	Adj.[a] Charpy Shift, °F	Neutron Fluence (n/cm²)	Irradiation Temperature (°F)
1	187.2	194.8	6.0 E18	552
2	205.2	214.1	1.2 E19	552
3	226.8	238.2	2.1 E19	552

Adj.[a] Charpy Shift, °F	(FF) x Shift	Fluence Factor (FF)	(FF)²	Measured - Predicted Shift, °F
194.8	166.9	0.85696	0.7344	195 -177 = 18
214.1	225.0	1.05086	1.1043	214- 217 = -3
238.2	286.3	1.20182	1.4444	238 -248 = -10
	Σ =678.2		Σ =3.2831	

CF= 678.2/3.2831= 206.6 °F

(a) Measured Shift adjusted for FCS T_{cold} (543 °F) and best estimate chemistry

(b) Predicted Shift=FF x CF (I.e. FF x 206.6 °F)

Mihama 1 Surveillance Weld Data
Weld Wire Heat 12008 and 27204

Derived Chemistry Factor (CF):

- CF is 206.6°F based on three sets of post-irradiation test results

Evaluated data scatter:

- All three measurements within one sigma (28°F) of predicted shift (actual values of 18, -3, and -10°F)
- Limited scatter permits use of $\sigma_\Delta/2$ = 14°F

Mihama 1 Surveillance Weld Data Weld Wire Heat 12008 and 27204 (cont.)

Calculation of Adjusted Reference Temperature for Fort Calhoun Welds with Heats 12008 and 27204:

- CF = 206.6°F including adjustments for T_{cold} and CF
- Credible data permits use of σ_Δ = (28/2) = 14°F
- Initial RT_{NDT} = -58°F (measured); σ_i = 0°F
- Margin = 2 $(\sigma_\Delta^2 + \sigma_i^2)^{0.5}$ = 28°F
- ART = -58 + 28 + 206.6 f(ϕt)
- On 8/9/33, ϕt=2.431E19, and ART= 226.0°F

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Test results:

- Data source: ASTM E900 database for Diablo Canyon Unit 1 (DC1); Consumers Power for Palisades supplemental capsule (SA-60-1)
- Initial RT_{NDT} = -56°F based on generic value for CE fabricated welds

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Test results (cont.):

- 30 ft-lb index temperature shifts:

  DC1 capsule S, ΔT_{30} = 113°F at 2.84 E18 n/cm^2

  DC1 capsule Y, ΔT_{30} = 233°F at 9.41 E18 n/cm^2

  SA-60-1, ΔT_{30} = 250°F at 1.622 E19 n/cm^2

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Analysis approach:

- Three sets of post-irradiation test results available for analysis
- Calculation of chemistry factor performed in accordance with Regulatory Guide 1.99, Revision 2, Position 2.1, November 12, 1997 guidelines, and NUREG/CR-6551

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Analysis approach (cont.):

- Ratio Method used to adjust Diablo Canyon Unit 1 data by factor of 1.022 to best estimate chemistry for weld; Diablo 1 weld CF = 221.8 (0.196 Cu, 1.00 Ni) vs. BE weld CF = 226.81 (0.203 Cu, 1.018 Ni)
- Ratio Method used to adjust Palisades data by factor of 0.990 to best estimate chemistry for weld; Palisades weld CF = 229.04°F (0.194 Cu, 1.08 Ni) vs.

  BE weld CF = 226.81°F (0.203 Cu, 1.018 Ni)

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Analysis for difference in T_{cold}:

- Diablo Canyon Unit 1 operated at 539 to 540°F versus Fort Calhoun at 543°F; Palisades operated at 533°F
- Used equation from NUREG/CR-6551 with T_{cold} to identify difference with fluence and temperature:

  (a) At 2.84E18 n/cm^2, shift was 1.6°F lower at 543°F

  (b) At 9.41E18 n/cm^2, shift was 2.0°F lower at 543°F

  (c) At 1.62E19 n/cm^2, shift was 9.0°F lower at 543°F

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Shift Adjustment:

- Adjustment for T_{cold} difference:
  (a) At 2.84E18 n/cm^2, 113-1.6= 111.4°F
  (b) At 9.41E18 n/cm^2, 233-2.0= 231.0°F
  (c) At 1.62E19 n/cm^2, 250-9.0= 241.0°F
- Adjustment for CF difference:
  (a) At 2.84E18 n/cm^2, 111.4°F x 1.022= 113.8°F
  (b) At 9.41E18 n/cm^2, 231.0°F x 1.022= 236.1°F
  (c) At 1.62E19 n/cm^2, 241.0°F x 0.990= 238.6°F

Test Results from Diablo Canyon Unit 1 and Supplemental Capsule with T_{cold} and CF Adjustment for Weld Heat 27204

Capsule Identity	Charpy Shift, °F	Adj.[a] Charpy Shift, °F	Neutron Fluence, n/cm²	Irradiation Temperature, °F
DC1-S	113	114	2.84 E18	539
DC1-Y	233	236	9.41 E18	540
SA-60-1	250	239	1.62 E19	533

Adj.[a] Charpy Shift, °F	(FF) x Shift	Fluence Factor (FF)	(FF)²	Measured - Predicted[b] Shift, °F
114	74.8	.6562	.4306	114-141=-27
236	232.0	.9830	.9662	236-212= 24
239	270.8	1.1331	1.2840	239-244= -5
	Σ =577.6		Σ =2.6808	

CF=577.6/2.6808= 215.5 °F

(a) Shift adjusted for FCS T_{cold} (543 °F) and best estimate chemistry

(b) Predicted Shift=FF x CF (I.e. FF x 215.5 °F)

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Derived Chemistry Factor (CF):

- CF is 215.5°F based on three sets of post-irradiation test results

Evaluated data scatter:

- Three measurements within one sigma (28°F) of predicted shift (actual values of -27, 24, and -5 F)
- Limited scatter permits use of $\sigma_{\Delta}/2$ = 14°F

Diablo Canyon 1 and Supplemental Capsule Data Weld Wire Heat 27204 (cont.)

Calculation of Adjusted Reference Temperature for Fort Calhoun Welds with Heats 27204 and 27204:

- CF = 215.5°F including adjustments for T_{cold} and CF
- Credible data permits use of σ_Δ = (28/2) = 14°F
- Initial RT_{NDT} = -56°F (generic); σ_i = 17°F
- Margin = 2 $(\sigma_\Delta^2 + \sigma_i^2)^{0.5}$ = 44°F
- ART = -56 + 44 + 215.5 f(ϕt)
- On 8/9/33, ϕt=2.431E19, and ART= 255.0°F

Modified Chemistry Factor for the Fort Calhoun Reactor Vessel Beltline Welds

Weld Identification	Weld Electrode Heat No.	Chemistry Factor Initial	Chemistry Factor Revised	2013 ART (°F)[a]	2033 ART (°F)[b]
2-410 A/C	51989	89.03	------	112	120
3-410 A/C	12008/13253[(c)]	208.68	------	250	268
3-410 A/C	13253	189.05	------	227	244
3-410 A/C	12008/27204	231.06	206.6	208	226
3-410 A/C	27204[(c)]	226.81	215.5	236	255
9-410	20291	188.41	------	226	243

(a) See preceding for heats 12008 & 27204 and heat 27204 (tandem); for all others used generic initial RT_{NDT} of -56°F and margin of 65.5°F; fluence of 1.728 E19.

(b) As above; except fluence of 2.431E19 (corresponding to 3/10/34)

(c) 27204 (FCS nozzle drop-out) and 12008/13253 (Maine Yankee nozzle drop-out) both in W-275 Supplemental Capsule

Analysis of Surveillance Weld Data

Conclusions:

- Three sets of surveillance data from Mihama Unit 1 corresponding to weld wire heats 12008 and 27204 were evaluated; data determined to be credible
- Two sets of surveillance data from Diablo Canyon Unit 1 and one set from Palisades supplemental capsule corresponding to weld wire heat 27204 and 27204 were evaluated; data determined to be credible
- ART calculations demonstrate Fort Calhoun vessel will not exceed the PTS screening criterion during either the present operating license to 2013 or to the proposed license renewal date to 2033

Analysis of Surveillance Weld Data (cont.)

Conclusions (cont.):

- Analysis of limiting FCS weld has been done in accordance with Regulatory Guide 1.99, Rev. 2, Position 2.1, and November 12, 1997 guidelines
- Ratio Method used to adjust surveillance data to best estimate chemistry for corresponding FCS weld
- Equation from NUREG/CR-6551 used to adjust surveillance data for differences in T_{cold}; approach used considers effect of both neutron fluence and temperature on the data before calculation of CF

Closing Remarks

- Mihama 1 RV weld data is applicable to FCS --RT_{PTS} significantly improved
- Methodology for the data analyses is acceptable
- OPPD agreement with Kansai Electric Co. will ensure information obtained is complete and verified
- Satisfactory operation of the Fort Calhoun Station RV to 2033 is demonstrated