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CLIENT:	**PLANT:**
FPL Energy Duane Arnold, LLC	Duane Arnold Energy Center (DAEC)

CALCULATION TITLE:

RPV Circumferential and Axial Weld Examination Relief

NON-PROPRIETARY, REDACTED VERSION

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1.0 OBJECTIVE

The purpose of this calculation is to justify the elimination of the reactor pressure vessel (RPV) circumferential weld examinations in the vessel beltline region to the end of the extended period of operation (60 years or 54 EFPY) for the Duane Arnold Energy Center (DAEC). This evaluation is based on the methodology presented in Reference [1]. This evaluation includes the estimate of the probability of failure due to a limiting event (i.e., low temperature over-pressurization, or LTOP) for the case of 90% axial weld inspection of the RPV axial welds in the RPV beltline region.

2.0 METHODOLOGY

The evaluation was performed using the same methodology used in Reference [1]. A Monte Carlo simulation was performed to determine the beltline circumferential and axial welds failure probability using a project specific version, VIPERXP [2], of the program VIPER Version 1.2 developed by Structural Integrity Associates [3]. The software, VIPER, was developed as part of the program contained in Reference [1] for the BWR RPV beltline shell weld inspection recommendations. The project specific version of VIPER was verified in Reference [2]. The code verified for use is identical to the code used in BWRVIP-05 [1]. The only reason for the different executable is to allow use of the program under the Windows XP operating system.

The detailed description of the methodology is documented in Reference [1].

3.0 REACTOR VESSEL AXIAL AND CIRCUMFERENTIAL WELD CONFIGURATIONS

The DAEC RPV weld configuration including the beltline region is shown in Figure 1 [4]. There is one circumferential weld, DE (VCB-A2), in the beltline region. Four axial welds, (E1 (VLB-A2), E2 (VLB-A1), D1 (VLA-A1), and D2 (VLA-A2)), have at least a portion of their length in the beltline region. The azimuth location for each of these four axial welds is also shown in Figure 1. The length of each axial weld is approximately 146.125 inches [13].

All other axial and circumferential welds are located outside of the beltline region. Only the portions of welds within the beltline region are subjected to significant neutron fluence from the reactor core. Neutron fluence on the welds outside the beltline regions is considered insignificant. These areas outside the beltline region contribute insignificant risk to the RPV integrity and are therefore not included in the evaluation.

There is only one circumferential shell weld in the beltline region of the DAEC RPV, which is located between the lower intermediate shell and lower shell, at an elevation of 238.625 inches [4].

4.0 BELTLINE AXIAL SHELL WELD INSPECTION ACCESIBILITY

The past inspection coverage results for the DAEC RPV are provided in References [6] and [13]. The results summarized in Table 1 include OD and ID examination percentages.

5.0 REACTOR VESSEL FLUENCE

The maximum fluence at the end of 60 years or 54 effective full power years (EFPY) of operation is obtained from Table 2-1, Table 7-1, and Table 7-2 of Reference [5], and is shown in Tables 2 and 3.

In the beltline region, the fluence distribution varies as a function of vessel azimuth and elevation due to the fuel bundle configuration. The maximum 54 EFPY fluence is 7.51×10^{18} n/cm^2 in Shell Ring 2 (5° Azimuth), as shown in Table 2. The maximum 54 EFPY fluence in the circumferential weld DE (VCB-A2) is 5.85×10^{18} n/cm^2. The maximum 54 EFPY fluence in the beltline axial welds is 6.29×10^{18} n/cm^2 per Table 7-1 of Reference [5]. The maximum fluence from Shell Ring 2 is used for the beltline axial welds for conservatism. Note that it is significantly conservative to assume the peak fluence for all portions of the welds that fall in the beltline region. Actual fluence profiles typically show significant variation from this peak value both axially and circumferentially in the beltline region.

The 54 EFPY peak ID fluence of 7.51×10^{18} n/cm^2 is as shown in References [5] and [7] and also shown in Tables 2 and 4.

6.0 REACTOR VESSEL DIMENSIONS AND WELD CHEMISTRY

The relevant DAEC RPV dimensions are as follows:

Shell Inside Radius (base metal)	92.69" [8, Page 42], [12, Sheet 84 of S11]
Shell Wall Thickness	4.469" [8, Page 42], [12, Sheet 84 of S11]
Clad Thickness	3/16" [12, Page S21-1 and Sheet 84 of S11]
Shell Mean Radius (Including Cladding)	94.83" [((92.69"-3/16")*2+4.469"+3/16")/2]

The weld chemistry and other material properties of the DAEC RPV were obtained from Reference [7], and are shown in Table 4.

7.0 LOADING CONDITIONS AND OTHER INPUTS

Other loading conditions and input for this analysis are:

Vessel Temperature	
Operating	533° F [9, Region B, EPU conditions]
Event (LTOP)	88° F [10, Page 21]
Vessel Pressure	
Operating	1025 psig [9, Region B, EPU conditions]
Event (LTOP)	1,150 psig [10, Page 21]
Crack Geometry:	Axial Elliptical Crack with an aspect ratio a/l = 0.1 360° Circumferential Crack

Flaw Density	30 flaws/m^3 (1.8 flaws/total length of beltline axial welds) 30 flaws/m^3 (3.67 flaws/360° beltline circumferential welds)

Assuming a double V weld, the area of the weld profile is calculated as:

Area = C x 2 x t
= 12.51868 $inches^2$

where: t = vessel thickness including cladding
= 4.469" + 3/16"
= 4.6565"
c = base of triangle shown below
= TAN (30°) x $\frac{t}{2}$

The volume is therefore the Area times the length of the weld. The length of an axial weld is 146.125" [13]. The length of a circumferential weld is the circumference (based on the mean radius of 94.83" specified in Section 6.0).

The two weld volumes are therefore:

V_{axial} = length x Area x number of welds
= 146.125 inches x 12.51868 $inches^2$ x 2
= 3658.6 circumference x area

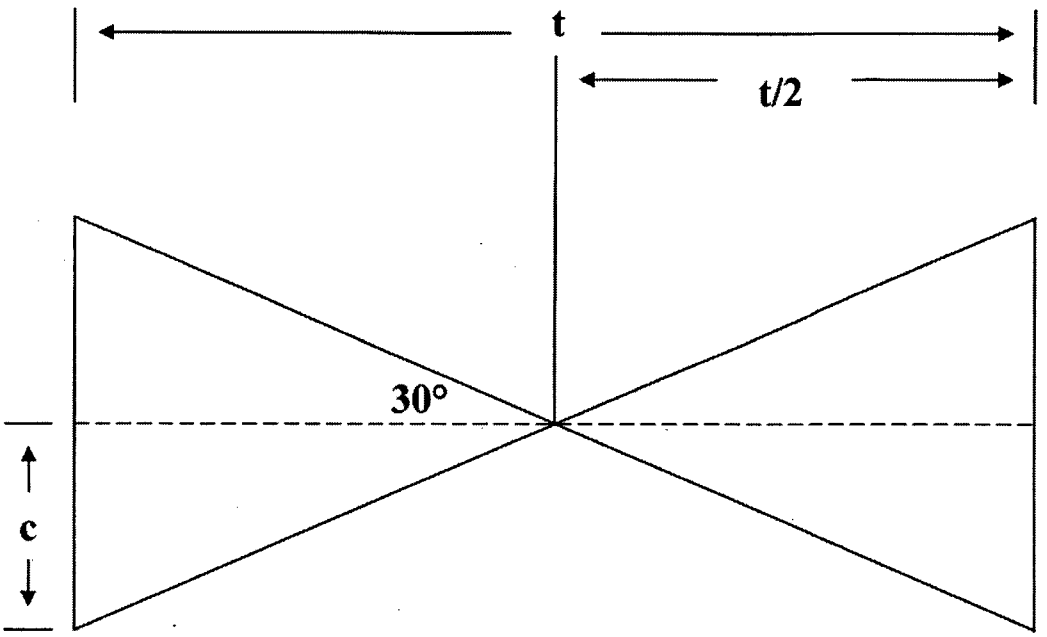
V_{circ} = circumference x Area
= 2 π r x Area
= 2 π x 94.83 inches x 12.51868 $inches^2$
= 7459 $inches^3$

where: r = mean radius from Section 6.0
= 94.83 inches

And, the number of flaws is then calculated as volume x flaw density. The conversion from $inches^3$ to $meter^3$ is 1.6387064 x 10^{-5}.

# of Axial flaws = 3658.6 $inches^3$ x 1.6387064 x 10^{-5} x 30 flaws/m^3
= 1.8 flaws

# of circumferential flaws = 7459 $inches^3$ x 30 flaws/m^3
= 3.67 flaws



Information regarding Flaw Size Distribution and Clad Stress Mean and Standard Deviation is based on proprietary information from BWRVIP-05.

The fracture toughness is represented as follows [14, page 30]:

$$K_{Ic} = \begin{cases} 36.2 + 49.4\exp(0.0104(T\text{-}RT_{ndt})) & T\text{-}RT_{ndt} \leq 50°F \\ 55.1 + 28\exp(0.0214(T\text{-}RT_{ndt})) & T\text{-}RT_{ndt} > 50°F \end{cases} \quad (1)$$

where: K_{Ic} = fracture toughness for crack initiation ksi $\sqrt{in}$
T = metal temperature at postulated crack tip (°F)
RT_{ndt} = reference temperature of nil ductility transition for unirradiated material.

Time to stress corrosion initiation and growth is determined with proprietary method. See BWRVIP-05.

The applied loading includes an axial pressure stress of 10.69 ksi and a hoop stress of 21.39 ksi, both of which are due to an operating pressure of 1,025 psi. Both values are calculated using thin-wall cylinder pressure stress equations, using the outer radius of the vessel. Residual stress [1] is expressed as a 3rd polynomial as follow:

Residual stress is determined by proprietary method. See BWRVIP-05.

8.0 ANALYSES

From the inspection coverage in Table 1, the anticipated overall percentage of the weld length for the beltline axial welds inspected during future outages is calculated to be:

% overall inspected = 90.0% (lower bound used)

Based on the average inspection coverage, the following cases were analyzed for the beltline axial and circumferential welds:

- A baseline case of 90% (which equates to "essentially 100%") inspection coverage for the beltline axial welds, with fluence corresponding to 54 EFPY.
- A baseline case of 90% ("essentially 100%") inspection coverage for the beltline circumferential weld, with fluence corresponding 54 EFPY.
- 0% inspection coverage for the beltline circumferential weld, with fluence at 54 EFPY.

The analyses were performed using the COMBINED inspection probability of detection (PoD) curves in VIPER. The "COMBINED" inspection PoD applies for an inspection using a combination of different inspection techniques.

The probability of occurrence for an LTOP event is 1×10^{-3} / year [10].

The analyses were performed using VIPERXP developed by Structural Integrity [2, 3].

9.0 RESULTS OF ANALYSIS

Table 5 presents the PoF results for 60 years (54 EFPY) for the RPV beltline axial welds and the beltline circumferential weld, including the consideration of the LTOP occurrence probability of $1x10^{-3}$ per year. The PoF for the beltline circumferential weld due to an LTOP event is $1.5x10^{-9}$ at 60 years (54 EFPY) and $2.5x10^{-11}$ per year (see Table 6). The $1.5x10^{-9}$ value is less than the value of $1.78x10^{-5}$ for the CB&I plant in Reference [10, Table 2.6-5]. The $1.78x10^{-5}$ value reported in Reference [10, Table 2.6-5] is for 64 EFPY. The equivalent value to have a one to one comparison with the value determined in this calculation would be for 54 EFPY. Using the value of $2.0x10^{-7}$ [10, Table 2.6-4] for 32 EFPY and interpolating to determine the 54 EFPY value yields a result of $1.23x10^{-5}$. The $1.5x10^{-9}$ value is less than the interpolated value of $1.23x10^{-5}$ for the CB&I plant determined from Reference [10, Tables 2.6-4 and 2.6-5]. The difference between the two inspection coverage cases (0% and 90%) at the circumferential weld is $5.0x10^{-11}$ probability of failure event per year. This difference is less than the $1x10^{-6}$ per year requirement as specified in Regulatory Guide 1.174 [11].

The probability of failure event for the beltline axial welds due to an LTOP event is $2.24x10^{-7}$ at 60 years (54 EFPY) and $3.74x10^{-9}$ per year (see Table 6) for 90% inspection.

10.0 CONCLUSIONS

It is shown that the probability of failure for both 0% and 90% inspection coverage for the DAEC beltline circumferential weld remains essentially the same. These results justify the elimination of the RPV circumferential weld examination in the vessel beltline region to the end of the extended period of operation (60 years or 54 EFPY), since the probability of failure for both 0% and 90% inspection coverage is approximately the same. The probability of failure for the circumferential welds is below that calculated in Reference [10], further justifying the elimination of the RPV circumferential weld examination in the vessel beltline region to the end of the extended period of operation (60 years of 54 EFPY). The DAEC inspection coverage on axial welds satisfies ASME Code requirements. The probability of failure per reactor year for the axial welds shown in Table 6 is well below the probability of $5x10^{-6}$ quoted in Reference [15]. The $3.74x10^{-9}$ probability for axial weld failure in Table 6 includes an LTOP frequency of $1x10^{-3}$ per year.

11.0 REFERENCES

1. EPRI Report No. TR-105697, "BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations (BWRVIP-05)," September 1995, **EPRI PROPRIETARY**, SI File No. BWRVIP-01-205P.

2. Structural Integrity Associates Calculation No. DAEC-20Q-350, Revision 0, "Verification of VIPER Version 1.2 program for Microsoft Operation System Windows XP, a project specific version of VIPER Version 1.2," 10/26/2002.

3. VIPER Version 1.2, Structural Integrity Associates Inc. 1/5/98.

4. Duane Arnold Energy Center, IES Utilities, Inc., Drawings:
   a. Drawing No. VS-01-41, Revision 1, "Vessel Shell Ring Layout," December 1994, SI File No. DAEC-20Q-224.
   b. Drawing No. VS-01-01A, Revision 2, "Reactor Vessel Welds," December 1997, SI File No. DAEC-20Q-224.

5. "Non-Proprietary Version of Duane Arnold Energy Center Reactor Pressure Vessel Fluence Evaluation at 32 EFPY and 54 EFPY," TransWare Enterprises Report No. FPL-FLU-001-R-004, Revision 0, January 2008, SI File No. DAEC-20Q-243.

6. "Technical Letter Report on Third 10-Year Interval Inservice Inspection Requests For Relief For IES Utilities, Inc. Duane Arnold Energy Center Docket Number: 50-331," SI File No. DAEC-20Q-239.

7. Structural Integrity Associates Calculation No. DAEC-20Q-324, Revision 1, "ΔRT_{NDT} and ART Evaluation."

8. GE Report No. GE-NE-A22-00100-08-01-R2, Revision 2, "Pressure-Temperature Curves for Duane Arnold Energy Center, (Non-Proprietary Version)," August 2003, SI File No. DAEC-20Q-201.

9. APED-A41-003, Revision 2, 11/7/2005, GE Drawing No. 729E762, "Reactor Thermal Cycles," SI File No. DAEC-20Q-203.

10. Safety Evaluation Report, "Final Safety Evaluation of the BWR Vessel and Internals Project BWRVIP-05 Report (TAC No. M93925)," Office of Nuclear Reactor Regulation, July, 1998.

11. United States Nuclear Regulatory Agency, Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis."

12. Attachment D to APED-B11-232, Revision 3, "Stress Report, 183" BWR Vessel, Duane Arnold Energy Center, Iowa Electric Light and Power Co. CBIN Contract No. 68-2967, GE Purchase Order #205-H1289," VPF #2655-330-1, 8/28/72, SI File No. DAEC-20Q-207P (*Note: Although this reference has a proprietary file number associated with it, this attachment is non-proprietary*).

13. FPL Energy Duane Arnold, LLC Document Number NG-08-0078, "Transmittal of Comments and List of Documents Regarding DAEC-20Q-338," SI File No. DAEC-20Q-200.

14. NUREG/CR-4486, "VISA-II – A Computer Code for Predicting the Probability of Reactor Pressure Vessel Failure."

15. Supplement to Final Safety Evaluation, "Supplement to Final Safety Evaluation of the BWR Vessel and Internals Project BWRVIP-05 Report (TAC No. MA3395)," United States Nuclear Regulatory Commission, March 7, 2000, SI File No. BWRVIP-01-205P.

Table 1: Axial Inspection Coverage Results [6, Table NDE-R001]

Weld Identification	2007 RFO ID examination Percent Coverage [13]	2005 RFO ID examination Percent Coverage [13]	1996 RFO14 OD examination Percent Coverage [6, Table NDE-R001]
E1 (VLB-A2)	No Exam	90.4	95.8
E2 (VLB-A1)	No Exam	90.8	95.4
D1 (VLA-A1)	90.8	No Exam	96.6
D2 (VLA-A2)	91.5	No Exam	96.7

Table 2: Peak Neutron Fluence for Energy > 1.0 MeV for DAEC RPV Weld and Shell Locations at the Inner Surface [5]

Weld/Nozzle/Shell Location	32 EFPY		54 EFPY	
	Elevation [cm (in)]	Peak Fluence (n/cm^2)	Elevation [cm (in)]	Peak Fluence (n/cm^2)
Peak Weld - Weld E1/E2 (50° azimuth)	753.43 (296.63)	3.50E+18	735.65 (289.63)	6.29E+18
Peak Nozzle - Nozzle N16A (40° azimuth)[1]	883.92 (348.00)	1.58E+18	883.92 (348.00)	2.89E+18
Peak Shell – Shell 2 (4° azimuth for 32 EFPY; 5° azimuth for 54 EFPY)	746.6076 (293.94)	4.27E+18	736.4476 (289.94)	7.51E+18

1) Value corresponds to peak value around vessel cutout for nozzle, elevation is nozzle centerline.

Table 3: Maximum > 1.0 MeV Neutron Fluence in DAEC RPV Axial and Circumferential Welds [5]

Shell Location	Weld	Azimuth (Degrees)	32 EFPY Fluence (n/cm^2) 0T at Weld	54 EFPY Fluence (n/cm^2) 0T at Weld
Shell Ring 1	D1	54	2.62E+18	4.90E+18
	D2	234	2.62E+18	4.90E+18
Shell Ring 2	E1	310	3.50E+18	6.29E+18
	E2	130	3.50E+18	6.29E+18
Shell Ring 3	F1	67.5	4.55E+16	8.81E+16
	F2	247.5	4.55E+16	8.81E+16

Shell Location	Weld	Elevation [cm (in)]	32 EFPY Fluence (n/cm^2) 0T at Weld	54 EFPY Fluence (n/cm^2) 0T at Weld
Shell 1-2	DE	606.1075 (238.625)	3.28E+18	5.85E+18
Shell 2-3	EF	977.265 (384.75)	4.83E+16	9.31E+16

Table 4: Weld Chemistries and ART Values for 54 EFPY [7]

	Description	Code No.	Heat No.	Flux Type & Lot No.	Initial RT_{NDT} (°F)	Chemistry Cu (wt %)	Chemistry Ni (wt %)	Chemistry Factor (d) (°F)	Adjustments For 1/4t: ΔRT_{NDT} (°F)	Margin Terms: σ_Δ (°F)	Margin Terms: σ_I (°F)	ART_{NDT} (°F)
Plates	**Shell Ring #1**											
	1-18		C6439-2		40	0.090	0.510	58.00	45.02	17.00	0.00	119.0
	1-19		B0402-1		40	0.130	0.470	87.10	67.61	17.00	0.00	141.6
	Shell Ring #2											
	1-20		B0436-2		10	0.150	0.640	111.00	93.78	17.00	0.00	137.8
	1-21		B0673-1(a)		10	0.150	0.65 (c)	148.71	125.64	8.50	0.00	152.6
	Description	**Code No.**	**Heat No.**	**Flux Type & Lot No.**	**Initial RT_{NDT} (°F)**	**Chemistry Cu (wt %)**	**Chemistry Ni (wt %)**	**Chemistry Factor (d) (°F)**	**Adjustments For 1/4t: ΔRT_{NDT} (°F)**	**Margin Terms: σ_Δ (°F)**	**Margin Terms: σ_I (°F)**	**ART_{NDT} (°F)**
Welds	**Lower**											
	D1,D2		432Z4521	Lot B020A27A	-50	0.010	0.980	20.00	14.57	7.29	0.00	-20.9
	D1,D2		432Z0471	Lot B003A27A	-50	0.030	0.910	41.00	29.87	14.94	0.00	9.7
	Lower-Intermediate											
	E1,E2		432Z4521	Lot B020A27A	-50	0.010	0.980	20.00	15.92	7.96	0.00	-18.2
	E1,E2		432Z0471	Lot B003A27A	-50	0.030	0.910	41.00	32.64	16.32	0.00	15.3
	Girth											
	DE		09L853	Lot L017A27A	-50	0.030	0.880	41.00	31.83	15.91	0.00	13.7
	DE		07L669	Lot K004A27A	-50	0.030	1.020	41.00	31.83	15.91	0.00	13.7
	DE		CTY538	Lot A027A27A	-50	0.030	0.830	41.00	31.83	15.91	0.00	13.7
	Description	**Code No.**	**Heat No.**	**Plate Location**	**Initial RT_{NDT} (°F)**	**Chemistry Cu (wt %)**	**Chemistry Ni (wt %)**	**Chemistry Factor (°F)**	**Adjustments For 1/4t: ΔRT_{NDT} (°F)**	**Margin Terms: σ_Δ (°F)**	**Margin Terms: σ_I (°F)**	**ART_{NDT} (°F)**
Nozzles	Nozzle N16		Q2Q5VW (b)		40	0.180	0.850	141.75	84.14	17.00	0.00	158.1
	Nozzle N2		Q2Q6VW (b)		40	0.180	0.840	141.60	42.40	17.00	0.00	116.4

Fluence Data

	Location	Wall Thickness (in.): Full	Wall Thickness (in.): 1/4t	Fluence at ID (n/cm^2)	Attenuation, 1/4t $e^{-0.24x}$	Fluence @ 1/4t (n/cm^2)	Fluence Factor, FF $f^{(0.28-0.10\log f)}$
Plates	**Shell Ring #1**						
	1-18	4.469	1.117	5.85E+18	0.765	4.47E+18	0.7762
	1-19	4.469	1.117	5.85E+18	0.765	4.47E+18	0.7762
	Shell Ring #2						
	1-20	4.469	1.117	7.51E+18	0.765	5.74E+18	0.8448
	1-21	4.469	1.117	7.51E+18	0.765	5.74E+18	0.8448
Welds	**Lower**						
	D1,D2	4.469	1.117	4.90E+18	0.765	3.75E+18	0.7286
	D1,D2	4.469	1.117	4.90E+18	0.765	3.75E+18	0.7286
	Lower-Intermediate						
	E1,E2	4.469	1.117	6.29E+18	0.765	4.81E+18	0.7960
	E1,E2	4.469	1.117	6.29E+18	0.765	4.81E+18	0.7960
	Girth						
	DE	4.469	1.117	5.85E+18	0.765	4.47E+18	0.7762
	DE	4.469	1.117	5.85E+18	0.765	4.47E+18	0.7762
	DE	4.469	1.117	5.85E+18	0.765	4.47E+18	0.7762
Nozzles	Nozzle N16	4.469	1.117	2.89E+18	0.765	2.21E+18	0.5936
	Nozzle N2	4.469	1.117	6.82E+17	0.765	5.22E+17	0.2995

(a) Material in the surveillance program with adjusted CF in accordance with Reference [6].
(b) Estimated copper in accordance with Reference [4].
(c) Best-estimate nickel from all available data in Reference [6].
(d) CF values do not include the ratio procedures adjustments in RVID [5]. These adjustments are not required by RG1.99, R2 [1].

Table 5: Probability of Failure Due to LTOP Event Per 60 Years

Number of Simulations		PoF per 60 years (54 EFPY) for Axial Welds	PoF per 60 years (54 EFPY) for Circumferential Weld	
		90%	0%	90%
10 Million	Peak Fluence at 60 years (54 EFPY)	2.24×10^{-7}	1.5×10^{-9}	1.8×10^{-9}

Note: The results include a probability of LTOP Event = 1×10^{-3} /year, [10]. Also, note that for the circumferential weld at peak fluence only, PoF per 60 years for 90% inspection is greater than PoF at 0%. This is not unexpected, as it falls within the uncertainties in the probabilistic fracture mechanics evaluation.

Table 6: Probability of Failure Due to LTOP Event Per Year

Number of Simulations		PoF per year for Axial Welds	PoF per year for Circumferential Weld	
		90%	0%	90%
10 Million	Peak Fluence at 60 years (54 EFPY)	3.74×10^{-9}	2.5×10^{-11}	3.0×10^{-11}
Difference between the two inspection coverage cases		Only one case was run so there is no comparison to report.	5.0×10^{-11}	

Note: The results include a probability of LTOP Event = 1×10^{-3} /year [10]. Also, note that for the circumferential weld at peak fluence only, PoF per 60 years for 90% inspection is greater than PoF at 0%. This is not unexpected, as it falls within the uncertainties in the probabilistic fracture mechanics evaluation.

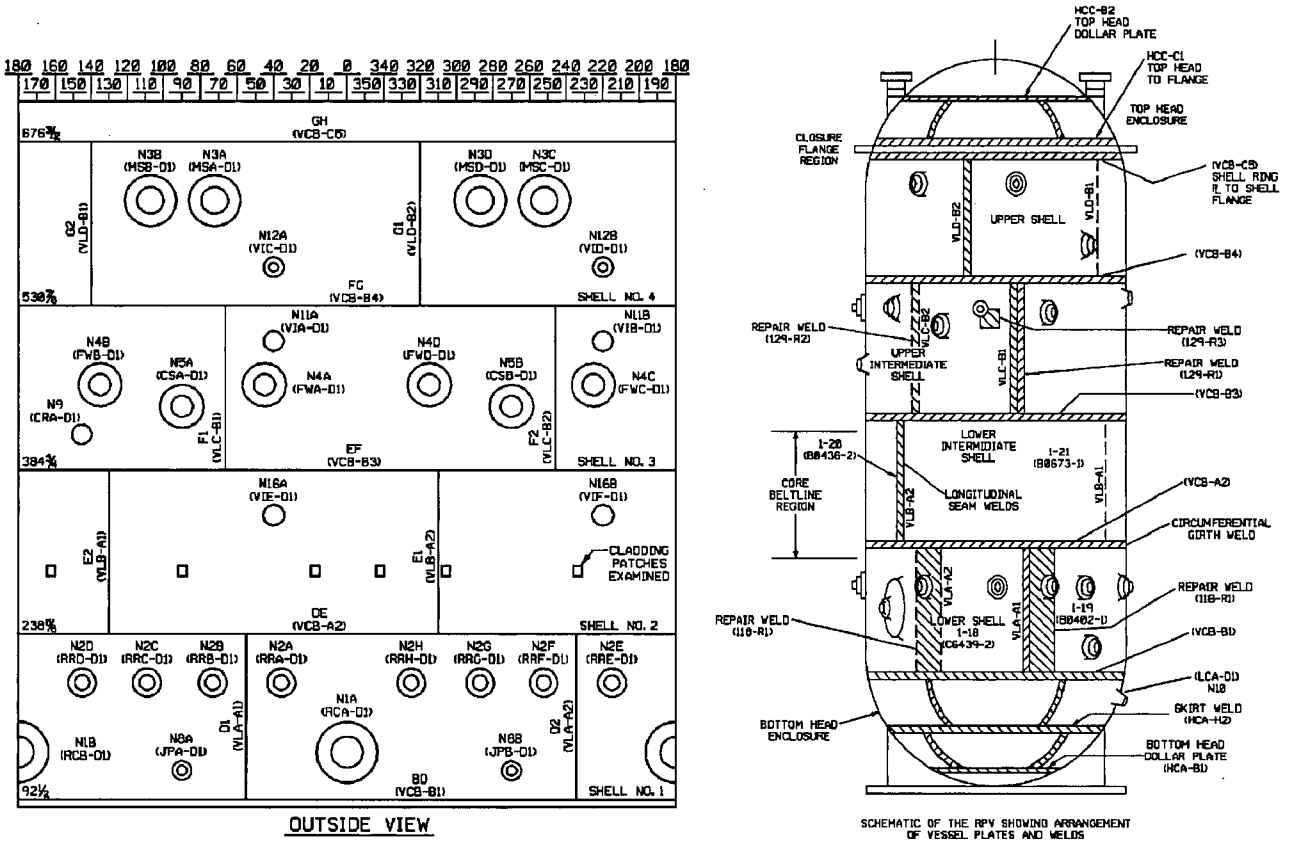


Figure 1: DAEC RPV Shell Weld Locations and Identifications [4]

APPENDIX A:
LISTING OF COMPUTER INPUT AND OUTPUT FILES

Note: The files included in the attached listing are provided in the computer files associated with this calculation.

Filename	Description
Peak Fluence Case	
Axlp90fv.inp	Axial Welds with Normal Peak Fluence at 54 EFPY with 90% Inspection Input File.
Cirp0fv.inp	Circumferential Weld with Normal Peak Fluence at 54 EFPY with 0% Inspection Input File.
Cirp90fv.inp	Circumferential Weld with Normal Peak Fluence at 54 EFPY with 90% Inspection Input File.
Axlp90fv.out	Axial Welds with Normal Peak Fluence at 54 EFPY with 90% Inspection Output File.
Cirp0fv.out	Circumferential Weld with Normal Peak Fluence at 54 EFPY with 0% Inspection Output File.
Cirp90fv.out	Circumferential Weld with Normal Peak Fluence at 54 EFPY with 90% Inspection Output File.

Enclosure 3 to NG-09-0663
Change to LRA Table 3.2.2-2 Regarding Stainless Steel Bolting

NRC Request

In a telephone conference call on October 2, 2009, the NRC questioned whether the High Pressure Coolant Injection (HPCI) System contained stainless steel bolts subject to aging management review. Two vent valves, V23-0078 and V23-0079, HPCI suction line inboard and outboard vent valves, have been identified as having stainless steel bolting.

DAEC Response

For completeness, stainless steel bolting is being added to LRA Table 3.2.2-2, as follows.

In LRA Table 3.2.2-2, Summary of Aging Management Review Results High Pressure Coolant Injection System, on page 3.2-41, the following new line item is added:

Component Type	Intended Function	Material	Environment	Aging Effect Requiring Management	Aging Management Program	NUREG-1801 Volume 2 line Item	Table 3.X.1 item	Notes
Fasteners, bolts, washers, nuts	Pressure boundary	Stainless steel	Air - indoor uncontrolled (external)	Loss of preload	Bolting Integrity Program			F, 207

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
1.	Buried Piping and Tanks Inspection Program	Implement Buried Piping and Tank Program. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.7	Prior to the period of extended operation
2.	BWR Vessel Internals Program	Perform an EVT-1 inspection of 5% of the top guide locations.	18.1.14	Within six years of entering the period of extended operation
3.	BWR Vessel Internals Program	Perform an EVT-1 inspection of an additional 5% of the top guide locations.	18.1.14	Within 12 years of entering the period of extended operation
4.	Electrical Cables and Connections Program	Implement an Electrical Cables and Connections Program and complete the first inspection prior to the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.17	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
5.	Electrical Cables and Connections Used in Instrumentation Circuits Program	Implement an Electrical Cables and Connections Used in Instrumentation Circuits Program and complete the first inspection prior to the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.18	Prior to the period of extended operation
6.	Electrical Connections Program	Implement an Electrical Connections Program and complete the one time inspection prior to the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.19	Prior to the period of extended operation
7.	Electrical Penetration Assemblies Program	Implement an Electrical Penetration Assemblies Program. [Revised in DAEC letter NG-09-0764 in response to new Program Commitments RAI]	18.1.20	Prior to the period of extended operation
8.	External Surfaces Monitoring Program	Revise the inspection program to address inspector qualifications, types of components, degradation mechanisms, aging effects, acceptance criteria, and inspection frequency.	18.1.21	Prior to the period of extended operation
9.	Fire Protection Program	Revise program to include criteria for visual inspection of fire barriers, walls, ceilings, and floors to examine for signs of age related degradation.	18.1.22	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
10.	Fire Protection Program	Enhance procedures to inspect the entire diesel driven fire pump fuel supply line for age related degradation.	18.1.22	Prior to the period of extended operation
11.	Fire Water System Program	Implement maintenance activities to perform volumetric examinations for pipe wall thinning of fire protection piping periodically during the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.23	Prior to the period of extended operation
12.	Fire Water System Program	Enhance procedures to include NFPA 25 criteria for sprinklers regarding replacing or testing.	18.1.23	Prior to the period of extended operation
13.	Fire Water System Program	Enhance procedures to perform visual inspection of fire hydrants annually.	18.1.23	Prior to the period of extended operation
14.	Fuel Oil Chemistry Program	Revise the program to require particulate testing of fuel oil samples from the diesel fire pump day tank.	18.1.25	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
15.	Fuel Oil Chemistry Program	Enhance procedures to require sampling and testing of new fuel oil delivered to the diesel fire pump day tank; and to require that purchase orders and sampling procedures for diesel fuel delivered to and stored in the diesel fire pump day tank prohibit the delivery and use of biodiesel fuel. [Revised in letter NG-09-0764 in response to RAI B.3.25-1]	18.1.25	Prior to the period of extended operation
16.	Fuel Oil Chemistry Program	Enhance procedures to perform periodic (10 year) draining, cleaning and visual inspection of the diesel fuel oil day tanks, diesel fire pump day tank, and diesel driven air start air compressor fuel oil tanks. [Revised in letter NG-09-0764 in response to RAI B.3.25-4]	18.1.25	Prior to the period of extended operation
17.	Fuel Oil Chemistry Program	Implement procedures to require bottom thickness testing of the Standby Diesel Generator Day Tanks and the Diesel Fire Pump Day Tank. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.25	Prior to the period of extended operation
18.	Fuse Holders Program	Implement a Fuse Holders Program and complete the first test prior to the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to RAI B.3.26-1 and New Program Commitments RAI]	18.1.26	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
19.	Inaccessible Medium Voltage Cable Program	Implement an Inaccessible Medium Voltage Cable Program and complete the first inspection or test prior to the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.27	Prior to the period of extended operation
20.	Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components Program	Implement an Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components Program. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.28	Prior to the period of extended operation
21.	Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems Program	Enhance procedures to monitor for corrosion and wear of the supporting steel and rails.	18.1.29	Prior to the period of extended operation
22.	Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems Program	Enhance procedures to record usage of the reactor building and turbine building cranes.	18.1.29	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
23.	Lubricating Oil Analysis Program	Enhance procedures to include diesel fire pump.	18.1.30	Prior to the period of extended operation
24.	Metal Enclosed Bus Program	Implement a Metal Enclosed Bus Program and complete the first inspection prior to the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.31	Prior to the extended operation
25.	One-Time Inspection Program	Implement a One-Time Inspection Program and complete the one-time inspections prior to the period of extended operation. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.32	Prior to the period of extended operation
26.	Reactor Vessel Surveillance Program	Implement a procedure to evaluate the BWRVIP ISP data as it becomes available. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.35	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
27.	Reactor Vessel Surveillance Program BWRVIP-74-A BWR PRV Inspection and Flaw Evaluation Guidelines for License Renewal	Revise the Reactor Vessel Surveillance Program to implement the recommendations of BWRVIP-116 BWR Vessel and Internals Project Integrated Surveillance Program Implementation for License Renewal.	18.1.35	Prior to the period of extended operation
28.	Reactor Vessel Surveillance Program	Implement BWRVIP-116 with the conditions documented in Sections 3 and 4 of the NRC Staff's SE dated March 1, 2006 for BWRVIP-116, including the following: • NRC approval will be obtained for any change in the withdrawal schedules of the DAEC Reactor Vessel surveillance capsules. • If a standby capsule is removed from the DAEC Reactor Vessel without the intent to test it, the capsule will be stored in a manner which maintains it in a condition which would permit its future use, including during the period of extended operation, if necessary. [Revised in DAEC letter NG-09-0663 in response to RAI B.3.35-1]	18.1.35	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
29.	Selective Leaching of Materials Program	Implement and complete a program to include one-time visual inspection and hardness measurement of selected components susceptible to selective leaching. [Revised in DAEC letter NG-09-0764 in response to New Program Commitments RAI]	18.1.36	Prior to the period of extended operation
30.	Structures Monitoring Program	Enhance procedures to include structures and structural components not currently in Maintenance Rule Program.	18.1.37	Prior to the period of extended operation
31.	Structures Monitoring Program	Enhance procedures to include periodic sampling of groundwater for pH, chloride and sulfate concentration on a 10 year periodicity.	18.1.37	Prior to the period of extended operation
32.	Structures Monitoring Program	Enhance procedures to include a elastomer inspection to prevent leakage through containment penetration.	18.1.37	Prior to the period of extended operation
33.	Structures Monitoring Program	Enhance procedures to include a requirement to contact the proper personnel to allow opportunistic inspection of the buried concrete foundation.	18.1.37	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
34.	Structures Monitoring Program	Enhance procedures to include opportunistic inspections of the buried concrete foundation on a 10 year periodicity.	18.1.37	Prior to the period of extended operation
35.	Metal Fatigue of Reactor Vessel Coolant Pressure Boundary Program	Enhance procedures to incorporate the requirements of NUREG/CR-6260 locations into the implementing procedures.	18.2.2	Prior to the period of extended operation
36.	Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel (CASS) Program	Implement a Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel (CASS) Program. [Revised in DAEC letter NG-09-0764 in response to New Program Commitment RAI]	18.1.38	Prior to the period of extended operation
37.	BWR Vessel Internals Program	Inspect a sample of the rim hold-down bolts by VT-3 until an expanded technical basis for not inspecting is approved by the NRC.	18.1.14	Prior to the period of extended operation
38.	Reactor Vessel Circumferential Weld TLAA	Submit a relief request to address the frequency requirements of the inservice inspection of the RPV circumferential welds. (BWRVIP-05)	18.3.1.4	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
39.	Quality Assurance Program (Corrective Action, Confirmation Process, Administrative Controls)	Expand the scope of its 10 CFR Part 50, Appendix B Quality Assurance program to include non-safety-related structures and components subject to an AMR for license renewal.	UFSAR 17.1.2	Prior to the period of extended operation
40.	Operating Experience	Perform an operating experience review of extended power uprate and its impact on aging management programs for systems, structures, and components (SSCs) before entering the period of extended operation.		Prior to the period of extended operation
41.	Bolting Integrity Program	Revise the implementing procedures for the ASME Section XI Inservice Inspection Subsections IWB, IWC, and IWD Program; ASME Section XI Inservice Inspection, Subsection IWF Program; External Surfaces Monitoring Program; Structural Monitoring Program; and Buried Piping and Tanks Program such that they specifically address the inspection of fasteners (bolting, washers, nuts, etc.) for signs of leakage, corrosion/loss of material, cracking, and loss of preload/loss of prestress, as applicable. [Added in letter NG-09-0764 in response to RAI B.3.6-02]	18.1.6	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
42.	BWR Penetrations Program	The implementing document for the BWR Penetrations Program will be revised to specify that guidance in BWRVIP-14, -59 and -60 is to be considered in the evaluation of crack growth in stainless steel, nickel alloys and low-alloy steels, respectively, when flaws are identified and evaluation required. [Added in letter NG-09-0764 in response to RAI B.3.10-5]	18.1.10	Prior to the period of extended operation
43.	Fire Protection Program	DAEC Fire Barrier Penetration Seal Inspection Surveillance shall be enhanced to require at least 10 percent of each type of seal to be inspected each refueling cycle. [Added in letter NG-09-0764 in response to RAI B.3.22-1]	18.1.22	Prior to the period of extended operation
44.	Fire Protection Program	The DAEC Cardox System annual operability test shall be enhanced to include an inspection for corrosion and mechanical damage. [Added in letter NG-09-0764 in response to RAI B.3.22-1]	18.1.22	Prior to the period of extended operation
45.	ASME Class 1 Small-bore Piping Inspection Program	Implement an ASME Code Class 1 Small-bore Piping Inspection Program. [Added in letter NG-09-0764 in response to RAI B.3.3-2]	18.1.40	Prior to the period of extended operation

TABLE A-1
DUANE ARNOLD LICENSE RENEWAL COMMITMENTS[1]

Item No.	System, Component or Program	Commitment[2]	Section	Schedule
46.	BWR Vessel Internals Program	The BWR Vessel Internals Program will incorporate the crack growth rate evaluations specified in the BWRVIP-100-A report. Plant-specific inspection intervals will be developed for DAEC core shroud welds that are exposed to a neutron fluence value equal to or greater than 1 X 10^{21} n/cm^2 (E > 1 MeV), as needed. [Added in letter NG-09-0663 in response to RAI B.3.14-5]	18.1.14	Prior to the period of extended operation
47.	Reactor Internals	DAEC will submit an analysis for loss of preload in core plate hold-down bolts due to stress relaxation to the NRC for Staff review. The analysis will use projected neutron fluence values for the end of the period of extended operation. The analysis will be submitted 2 years prior to entering the period of extended operation. [Added in letter NG-09-0663 in response to RAI 4.2.7-1]	18.3.1.7	Two years prior to entering the period of extended operation

[1]Table is updated to reflect DAEC correspondence through 10/23/2009
[2]In the table, the term "implement" means that the program is described in an approved procedure or other approved formal document; the test, inspection or monitoring procedure has been developed and approved; and the first test, inspection or monitoring activity has been scheduled.