PILGRIM NUCLEAR POWER STATION REACTOR PRESSURE VESSEL FLUENCE EVALUATION AT END OF CYCLE 15 AND 54 EFPY (NON-PROPRIETARY)

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This document has been prepared in accordance with the requirements of 10CFR50 Appendix B, 10CFR21, and TransWare Enterprises Inc.'s 10CFR50 Appendix B quality assurance program.

ACKNOWLEDGMENTS

TransWare wishes to acknowledge Mr. George Mileris and Mr. Richard Weader of Entergy Nuclear Operations, Inc. for their diligence and resolve to provide the vast amount of mechanical design and operating history data detail for the Pilgrim Nuclear Power Station reactor fluence evaluation. TransWare also wishes to extend an acknowledgment to Mr. Raymond Pace for his support and management of this project.

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1
INTRODUCTION

This report presents the results of the reactor pressure vessel (RPV) fluence evaluation performed for the Pilgrim Nuclear Power Station (hereinafter referred to as the "Reactor"). Reactor pressure vessel fluence is determined for energy >1.0 MeV at welds and shells in the reactor pressure vessel beltline region. Projected fluence values are presented for energy >1.0 MeV at two points in time: 1) the end of the Reactor's operating cycle 15; and 2) the end of the design lifetime of 54 effective full power years (EFPY). This evaluation was performed in accordance with guidelines presented in U. S. Nuclear Regulatory Guide 1.190 [1] for use in evaluating the effects of embrittlement on RPV material in the reactor beltline region as required in 10CFR50 Appendix G. The reactor beltline region, as defined in Appendices G and H of 10CFR50, includes the region that directly surrounds the effective height of the reactor core as well as those areas of the RPV that exceed a neutron fluence (E>1.0 MeV) of 1.00E+17 n/cm^2.

Neutron fluence profiles are presented azimuthally in one degree increments at the inner surface of the RPV wall for the RPV circumferential welds in the reactor beltline region. In addition, inner surface values are presented for the RPV beltline vertical weld locations for the entire height of the weld in the RAMA model in one inch increments.

The fluence values presented in Sections 2 and 7 of this report represent the RAMA best estimate values, assuming no statistical bias. Appendix A reports the adjustments needed to obtain best estimate fluence values with a bias, as outlined in U. S. Regulatory Guide 1.190 [1], if the Reactor's cycle 4 surveillance capsule evaluation is included.

The fluence values presented in this report were calculated using the RAMA Fluence Methodology [2]. The RAMA Fluence Methodology (hereinafter referred to as the Methodology) has been developed for the Electric Power Research Institute, Inc. (EPRI) and the Boiling Water Reactor Vessel and Internals Project (BWRVIP) for the purpose of calculating neutron fluence in Boiling Water Reactor (BWR) components.

The Methodology has been approved by the U. S. Nuclear Regulatory Commission [3] for application in accordance with U. S. Regulatory Guide 1.190 [1]. Benchmark testing has been performed using the Methodology for several surveillance capsule and reactor pressure vessel fluence evaluations. [[

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The information and associated evaluations provided in this report have been performed in accordance with the requirements of 10CFR50 Appendix B.

2
SUMMARY OF RESULTS

This section provides a summary of the results of the reactor pressure vessel fluence evaluation for the Reactor. The primary purpose of this evaluation is to determine the reactor pressure vessel fluence for energy range >1.0 MeV at selected welds and shells in the reactor pressure vessel beltline region. Fluence values are calculated at the end of operating cycle (EOC) 15 and projected through the end of design life at 54 EFPY. Fluence is calculated at the inner surface (0T) and 1/4T locations for each RPV weld and shell. Detailed tables of all results are presented in Section 7 of this report. Section 7 also contains detailed tables of the predicted RPV neutron fluence at one degree increments in the azimuth for the RPV circumferential welds in the core beltline region; and fluence profiles for RPV vertical welds in the core beltline at one inch increments over the entire height of the weld included in the RAMA model at the inner surface of the RPV wall.

Table 2-1 summarizes the peak fluence results for this evaluation for energy >1.0 MeV at EOC 15 (20.7 EFPY) and 54 EFPY. One value represents the peak fluence for the weld locations and the other represents the value at the shell locations. Note that the peak fluence for both the RPV welds and shells occurs at the inner surface (0T) at the point closest to the edge of the core. The peak fluence for the weld locations is in vertical welds 1-338 A and 1-338 C with a value of 1.14E+18 n/cm^2 at 54 EFPY. The peak fluence for the RPV shells is in the lower intermediate shell with a value of 1.28E+18 n/cm^2 at 54 EFPY. Figure 3-2 illustrates the positioning of the shells in the reactor.

It was observed that the threshold fluence value of 1.00E+17 n/cm^2 was reached prior to the end of operating cycle 15 (20.7 EFPY) at the 0T and 1/4T thickness in a majority of the lower intermediate shell locations. Several locations in the lower shell exceed the threshold value, but no welds in upper shell are expected to exceed 1.00E+17 n/cm^2 during the Reactor's design life. The elevation range over which the fluence value exceeds 1.00E+17 n/cm^2 is 512.13 cm (201.63 inches) to 929.95 cm (366.12 inches) for 54 EFPY.

It was determined that the recirculation inlet (jet pump) nozzle, with a central axis elevation of 508 cm, was positioned within the bounds of the 1.0E+17 n/cm^2 threshold range. The peak fluence value is along the upper edge of the nozzle with a value of 1.30E+17 n/cm^2 for EOC 15 and 2.81E+17 n/cm^2 for 54 EFPY.

Table 2-1
Peak >1.0 MeV Neutron Fluence for Pilgrim Nuclear Power Station RPV Weld and Shell Locations at the Inner Surface

Weld/Shell Location	Elevation [cm (in)]	Peak Fluence for EOC 15 (20.7 EFPY) (n/cm^2)	Peak Fluence for 54 EFPY (n/cm^2)
Weld 1-338 A / C	776.94 (305.88)	4.96E+17	1.14E+18
Lower Intermediate Shell (25° azimuth)	791.21 (311.50)	5.51E+17	1.28E+18

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This neutron fluence evaluation for the Pilgrim Nuclear Power Station RPV shell and weld locations has been performed in accordance with the guidelines presented in Regulatory Guide 1.190.

3
DESCRIPTION OF THE REACTOR SYSTEM

This section describes the Reactor fluence model used in the reactor pressure vessel fluence evaluation. The fluence model is based on plant-specific basic design inputs that include component mechanical designs, material compositions, and reactor operating history. Plant-specific mechanical design drawings and structural material data were provided by Entergy Nuclear Operations, Inc. [5] and were used to build the Pilgrim Nuclear Power Station RAMA geometry model. Detailed operating history data from core simulator models was provided for cycles 1 through 15 [6].

3.1 Reactor System Mechanical Design Inputs

The Reactor is modeled with the RAMA Fluence Methodology. The Methodology employs a three-dimensional modeling technique to describe the reactor geometry for the neutron transport calculations. Detailed mechanical design information is used in order to build an accurate three-dimensional RAMA computer model of the reactor system. The mechanical design information for Pilgrim Nuclear Power Station was provided by Entergy Nuclear Operations, Inc. [5].

Pilgrim Nuclear Power Station is a General Electric BWR/3 class reactor with core loading of 580 fuel assemblies. The rated thermal power output of the reactor was 1998 MWt for cycles 1-14. A power up-rate was achieved in cycle 15, raising the power to 2028 MWt.

Figure 3-1 illustrates the basic planar geometry configuration of the reactor at the axial elevation corresponding to the core mid-plane. This figure identifies the positioning of the surveillance capsules relative to the inside surface of the reactor pressure vessel wall. All radial regions comprising the fluence model are illustrated. Beginning at the center of the reactor and projecting outwards, the regions include: the core region; core reflector region (bypass water); central shroud wall; downcomer water region including the jet pumps; reactor pressure vessel (RPV) wall; mirror insulation; biological shield (concrete wall); and cavity regions between the RPV and biological shield. Also shown are the azimuthal positions of the surveillance capsules in the downcomer region at 120, 210, and 300 degrees and the jet pump assemblies at 30, 60, 90, 120, 150, 210, 240, 270, 300, and 330 degrees. Shroud repair tie rods were installed in the reactor at the beginning of cycle 11 and are positioned at 45, 135, 225 and 315 degrees.

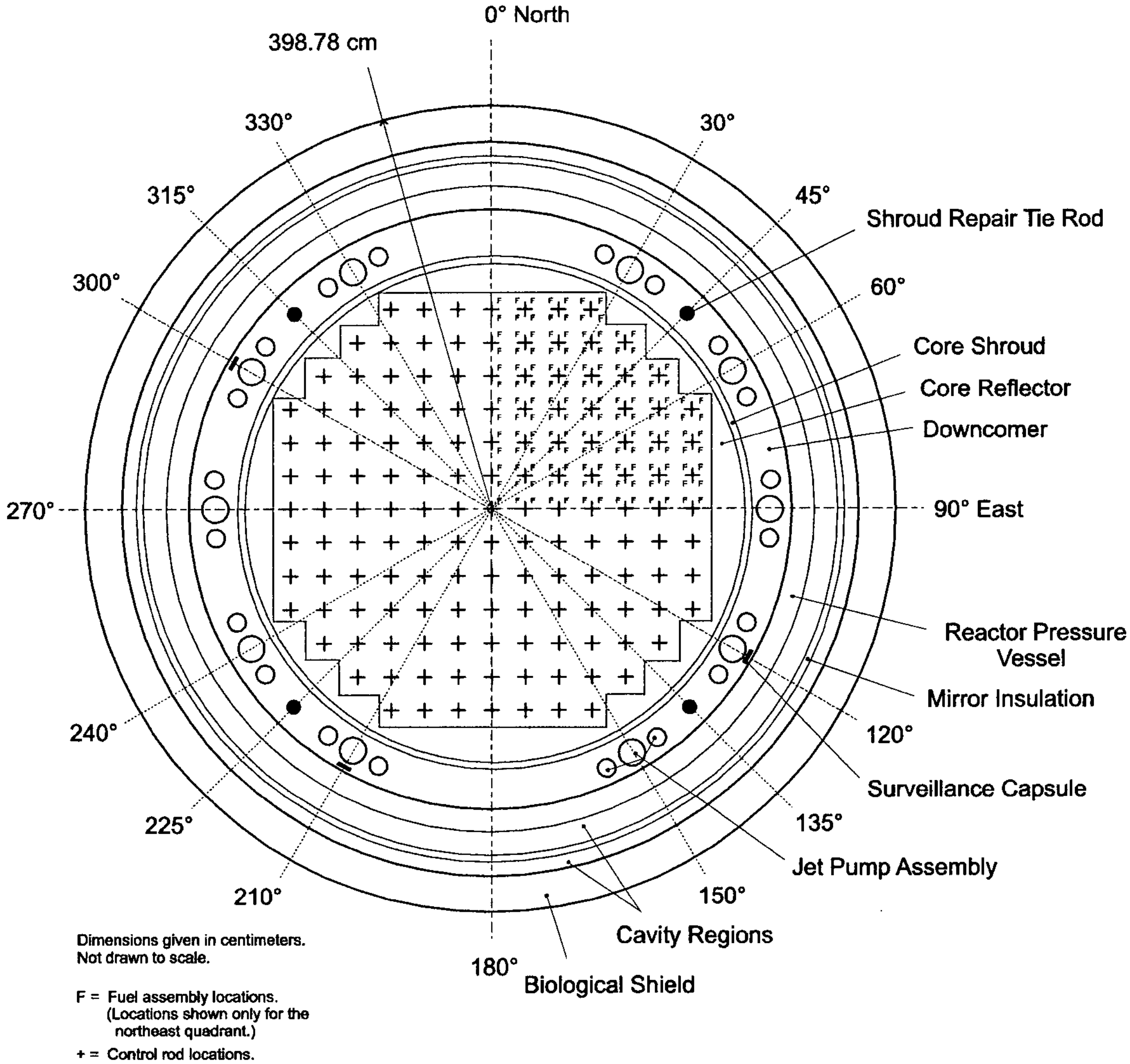

Figure 3-1
Planar View of the Pilgrim Nuclear Power Station Reactor at the Core Mid-plane Elevation

As the primary interest in this fluence evaluation is the determination of the neutron fluence at specified RPV welds and shells, Figure 3-2 identifies these specific weld locations. These weld locations are referenced in the tables in Sections 2 and 7 of this report showing the RPV weld fluence results by their identification numbers. [[

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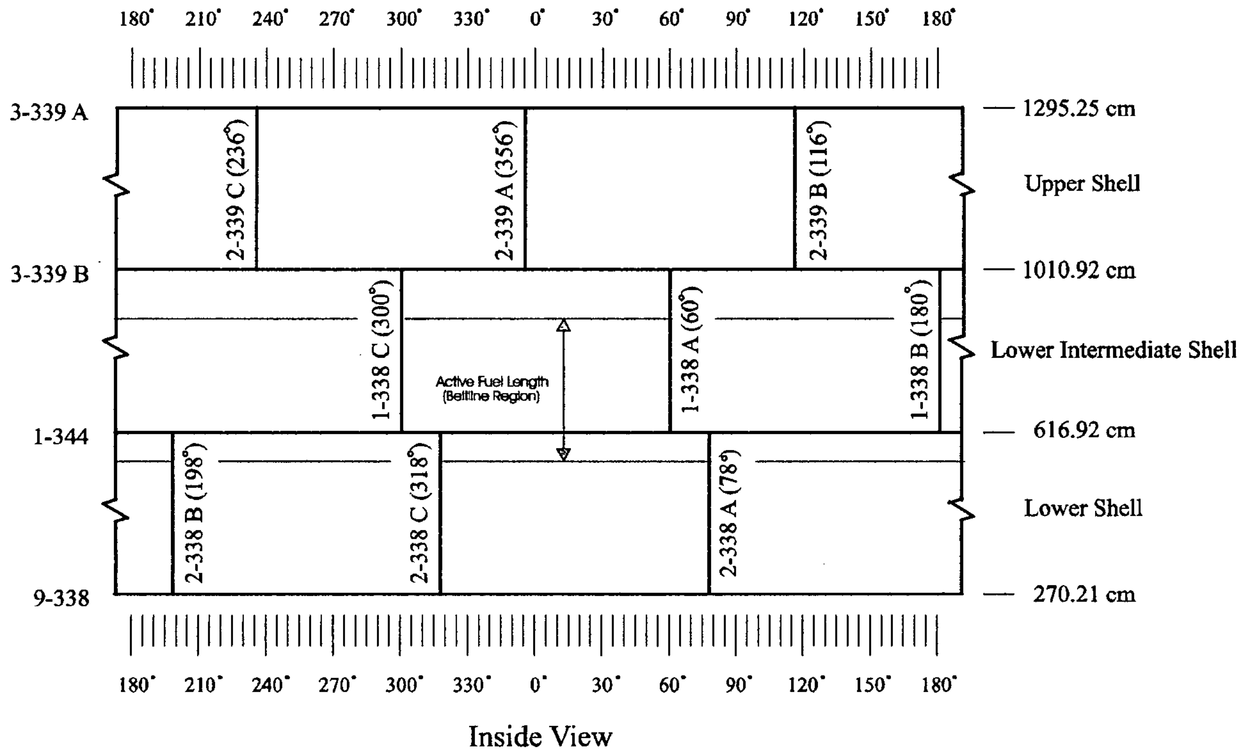

Figure 3-2
Pilgrim Nuclear Power Station RPV Shell Plates and Weld Location Identifiers

3.2 Reactor System Material Compositions

Each region of the reactor is comprised of materials that include reactor fuel, steel, water, insulation, concrete, and air. Accurate material information is essential for the fluence evaluation as the material compositions determine the neutron source, scattering, and absorption of neutrons throughout the reactor system and, thus, affect the determination of neutron fluence in the reactor components.

Table 3-1 provides a summary of the material compositions in the various components and regions of the Reactor. The attributes for the steel, insulation, concrete, and air compositions (i.e., material densities and isotopic concentrations) are assumed to remain constant for the operating life of the reactor. The attributes for the ex-core water compositions will vary with the operation of the reactor[[

]]. The attributes of the fuel compositions in the reactor core region change continuously during an operating cycle due to changes in power level, fuel burnup, control rod movements, and changing moderator density levels (voids).
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Table 3-1
Summary of Material Compositions by Region for the Pilgrim Nuclear Power Station

Region	Material Composition
Reactor Core	^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, O_{fuel}, Zr, Water
Core Reflector	Water
Fuel Support Piece	Stainless Steel
Lower Tie Plate	Stainless Steel, Zr, Inconel
Top Guide	Stainless Steel
Upper Tie Plate	Stainless Steel, Zr, Inconel
Shroud	Stainless Steel
Shroud Repair Tie Rods (*)	Stainless Steel
Downcomer Region	Water
Jet Pump Riser and Mixer Flow Areas	Water
Jet Pump Riser and Mixer Metal	Stainless Steel
Surveillance Capsule Specimens	Carbon Steel
Reactor Pressure Vessel Clad	Stainless Steel
Reactor Pressure Vessel Wall	Carbon Steel
Cavity Regions	Air
Insulation Clad	Stainless Steel
Insulation	Stainless Steel, Aluminum, Air
Biological Shield Clad	Carbon Steel
Biological Shield	Reinforced Concrete

(*) The shroud repair tie rods were introduced into the reactor at the start of cycle 11.

3.3 Reactor Operating Data Inputs

An accurate evaluation of fluence in the reactor requires an accurate accounting of the reactor operating history. The primary reactor operating parameters that affect neutron fluence evaluations for BWR's include the reactor power level, core power distribution, core void fraction distribution (or equivalently, water density distribution), and fuel material distribution.

3.3.1 Power History Data

The reactor power history used in the Reactor component fluence evaluation was obtained from Entergy Nuclear Operations, Inc. for operating cycles 1 through 15 [6]. The power history data accounts for the Reactor shutdown periods. The shutdowns were primarily due to the refueling outages between cycles. Table 3-2 provides the accumulated effective full power years of power generation at the end of each cycle in this fluence evaluation.

Table 3-2
Number of State-point Data Files for Each Cycle in the Pilgrim Nuclear Power Station

Cycle Number	Number of State-Point Data Files	Rated Thermal Power MWt	Accumulated Effective Full Power Years (EFPY)
1	[[	1998	0.9
2		1998	1.7
3		1998	2.6
4		1998	4.2
5		1998	5.3
6		1998	6.7
7		1998	7.7
8		1998	9.1
9		1998	10.4
10		1998	11.8
11		1998	13.4
12		1998	15.3
13		1998	17.0
14		1998	18.8
15		2028	20.7
>15 (Projected)	]]	[[ ]]	54.0

[[

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3.3.2 Reactor State-Point Data

Reactor operating data for the Pilgrim Nuclear Power Station RPV fluence evaluation was provided as state-point data files by Entergy Nuclear Operations, Inc. [6]. The state-point files are generated by three-dimensional core simulator models and provide a best-available representation of the operating conditions of the unit over the lifetime of the Reactor. The data files include three-dimensional data arrays that describe the fuel materials, moderator materials, and the relative power distribution in the core region.

A separate neutron transport calculation was performed for each of the available state points. The calculated neutron flux for each state point was combined with the appropriate power history data described in Section 3.3.1 to calculate the neutron fluence in the reactor pressure vessel.

3.3.2.1 Beginning of Operation through Cycle 15 State Points

A total of [[ ]] state-point data files were used to represent the first fifteen operating cycles of the Pilgrim Nuclear Power Station. Table 3-2 shows the number of state points used for each cycle in this fluence evaluation. The rated thermal power output of the Reactor for operating cycles 1 through 14 is specified as 1998 MWt. For operating cycle 15 the rated thermal power output is specified as 2028 MWt due to a power up-rate at the beginning of cycle 15.

3.3.2.2 Projected Operation through End of Design Life State Points

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This analysis predicts fluence at the end of the last completed operating cycle at the time of the analysis and projects fluence to the end of the reactor licensed lifetime. With these two data points, it is common practice to use linear interpolation techniques to determine RPV and component fluence at any time in between. While the fluence at the end of the last completed operating cycle is based upon historical operating conditions, the projected fluence assumes an "equilibrium cycle" strategy. If future reactor cycles deviate from the equilibrium cycle, the use of linear interpolation techniques may produce inaccurate results. It is recommended that each new operating cycle be evaluated for potential impact on the projected fluence and that the fluence analysis be updated accordingly. Deviations from equilibrium cycle conditions can be incurred as the result of, for example, changes in core management strategies, power uprates, new fuel designs, and revised heat balances.

3.3.3 Core Loading Pattern

It is common in BWRs that more than one fuel assembly design will be loaded in the reactor core in any given operating cycle. For fluence evaluations, it is important to account for the fuel assembly designs that were loaded in the core in order to accurately represent the neutron source distribution at the core boundaries (i.e., peripheral fuel locations, the top fuel nodes, and the bottom fuel nodes).

Four different fuel assembly designs are used in the Reactor during cycles 1 through 15. Table 3-3 provides a summary of the fuel designs loaded in the reactor core for these operating cycles. The cycle core loading patterns provided by Entergy Nuclear Operations, Inc. are used to identify the fuel assembly designs in each cycle and their location in the core loading pattern. For each cycle, appropriate fuel assembly models are used to describe the reactor core region of the RAMA fluence model for the Reactor.

Table 3-3
Summary of the Pilgrim Nuclear Power Station Core Loading Pattern

Cycle	Number of General Electric (GE) 7x7 Fuel Assembly Designs	Number of General Electric (GE) 8x8 Fuel Assembly Designs	Number of General Electric (GE) 9x9 Fuel Assembly Designs	Number of General Electric (GE) 10x10 Fuel Assembly Designs	Dominant Peripheral Fuel Design in the RAMA Model
1	580	0	0	0	GE 7x7
2	560	20	0	0	GE 7x7
3	428	152	0	0	GE 7x7
4	0	580	0	0	GE 8x8
5	0	580	0	0	GE 8x8
6	0	580	0	0	GE 8x8
7	0	580	0	0	GE 8x8
8	0	580	0	0	GE 8x8
9	0	580	0	0	GE 8x8
10	0	580	0	0	GE 8x8
11	0	444	136	0	GE 8x8
12	0	236	344	0	GE 8x8
13	0	76	504	0	GE 8x8
14	0	0	436	144	GE 9x9
15	0	0	272	308	GE 9x9
>15	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]

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4
CALCULATION METHODOLOGY

The Reactor RPV fluence evaluation was performed using the RAMA Fluence Methodology software package [2]. The Methodology and the application of the Methodology to the Reactor are described in this section.

4.1 Description of the RAMA Fluence Methodology

The RAMA Fluence Methodology is a system of codes that is used to perform fluence evaluations in light water reactor components. The Methodology includes a transport code, model builder codes, a fluence calculator code, an uncertainty methodology, and a nuclear data library. The transport code, fluence calculator, and nuclear data library are the primary software components for calculating the neutron flux and fluence. The transport code uses a deterministic, three-dimensional, multigroup nuclear particle transport theory to perform the neutron flux calculations. The transport code couples the nuclear transport method with a general geometry modeling capability to provide a flexible and accurate tool for calculating fluxes in light water reactors. The fluence calculator uses reactor operating history information with isotopic production and decay data to estimate activation and fluence in the reactor components over the operating life of the reactor. The nuclear data library contains nuclear cross-section data and response functions that are needed in the flux, fluence, and reaction rate calculations. The cross sections and response functions are based on the BUGLE-96 nuclear data library [7]. The Methodology and procedures for its use are described in the following reports: Theory Manual [8] and Procedures Manual [9].

The primary inputs for the RAMA Fluence Methodology are mechanical design parameters and reactor operating history data. The mechanical design inputs are obtained from reactor design drawings (or vendor drawings) of the plant. The reactor operating history data is obtained from reactor core simulation calculations, system heat balance calculations, and daily operating logs that describe the operating conditions of the reactor.

The primary outputs from the RAMA Fluence Methodology calculations are neutron flux, neutron fluence, and uncertainty determinations. The RAMA transport code calculates the neutron flux distributions that are used in the determination of neutron fluence. Several transport calculations are typically performed over the operating life of the reactor in order to calculate neutron flux distributions that accurately characterize the operating history of the reactor. The post-processing code (RAFTER) is then used to calculate component fluence and nuclide activations using the neutron flux solutions from the transport calculations and daily operating history data for the plant. The fluence calculated by RAFTER may then be adjusted in accordance with the calculational bias to determine the best estimate fluence and uncertainty in accordance with the intent of U. S. Nuclear Regulatory Guide 1.190.

4.2 The RAMA Geometry Model for the Pilgrim Nuclear Power Station

The RAMA Fluence Methodology uses a flexible three-dimensional modeling technique to describe the reactor geometry. The geometry modeling technique is based on the Cartesian coordinate system in which the (x,y) coordinates describe an axial plane of the reactor system and the z-axis describes elevations of the reactor system.

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]] The pressure vessel has cladding on the wall inner surface. The biological shield has cladding on the inner and outer surfaces. The downcomer region includes representations for the jet pumps, surveillance capsules, and, from cycle 11 onward, shroud repair tie rods.

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Each of the components and regions that extend outward from the core region are modeled in their correct geometrical form. [[

]] The riser pipe is correctly situated on a curvilinear path between the centers of the mixer pipes.

[[

]] Downcomer water surrounds the capsule on all sides.

[[

]] The tie rods, springs, and stabilizers are surrounded by downcomer water on all sides.

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[[ ]] The 10 jet pump assemblies are positioned azimuthally at 30, 60, 90, 120, 150, 210, 240, 270, 300, and 330 degrees. [[

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4.3 RAMA Calculation Parameters

The RAMA transport code uses a three-dimensional deterministic transport method to calculate neutron flux distributions in reactor problems. [[

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The RAMA transport calculation also uses information from the RAMA nuclear data library to determine the scope of the flux calculation. This information includes a Legendre expansion of the scattering cross sections that is used in the treatment of anisotropy of the problem. [[

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The neutron flux is calculated using an iterative technique to obtain a converged solution for the problem. [[

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The impact of these calculation parameter selections on the RAMA fluence evaluation for the Pilgrim Nuclear Power Station is presented in Section 4.6.

4.4 RAMA Neutron Source Calculation

The neutron source for the RAMA transport calculation is calculated using the input relative power density factors for the different fuel regions and data from the RAMA nuclear data library.

The core neutron source is determined using the cycle-specific three-dimensional burnup distributions. [[

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4.5 RAMA Fission Spectra

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4.6 Parametric Sensitivity Analyses

Several sensitivity analyses were performed to evaluate the stability and accuracy of the RAMA transport calculation for the Pilgrim Nuclear Power Station model. [[

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5 SURVEILLANCE CAPSULE ACTIVATION AND FLUENCE RESULTS

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]] This section addresses the evaluation of the Pilgrim Nuclear Power Station surveillance capsule flux wires and the comparison to measurements. The flux wires were installed at the start of commercial operation and were removed at the end of cycle 4 after being irradiated for a total of 4.17 effective full power years (EFPY). [[

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6
REACTOR PRESSURE VESSEL UNCERTAINTY ANALYSIS

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7
CALCULATED NEUTRON FLUENCE FOR REACTOR PRESSURE VESSEL

The neutron fluence for the reactor pressure vessel at the inner vessel wall (0T) and at 1/4T is determined by the RAMA Fluence Methodology for two points in time: at the end of cycle 15 (EOC 15) and through the projected end of normal operating life at 54 EFPY. The results of the fluence evaluation for energy >1.0 MeV are presented in the tables that follow.

Tables 7-1 and 7-4 report the >1.0 MeV fluence in the RPV shell and weld locations for the RPV beltline region. The location and identification of the RPV welds and shells are shown in Figure 3-2. It is observed that the fluence is greatest at the inner surface (0T) at the point closest to the edge of the core for all RPV welds and shells. The maximum fluence for the RPV welds is at the inner diameter of vertical welds 1-338 A and 1-338 C with a value of 1.14E+18 n/cm^2 at 54 EFPY. The maximum fluence for the RPV shells is at the lower intermediate shell with a value of 1.28E+18 n/cm^2 at 54 EFPY.

It was observed that the threshold fluence value of 1.00E+17 n/cm^2 was reached prior to the end of operating cycle 15 (20.7 EFPY) at the 0T and 1/4T thickness in a majority of the lower intermediate shell locations. Several locations in the lower shell exceed the threshold value, but no welds in the upper shell are expected to exceed 1.00E+17 n/cm^2 during the Reactor's design life. The elevation range over which the fluence value exceeds 1.00E+17 n/cm^2 is 512.13 cm (201.63 inches) to 929.95 cm (366.12 inches) for 54 EFPY.

Tables 7-5 and 7-6 present the fluence profiles for the RPV circumferential welds 1-344 and 3-339 B for energy >1.0 MeV at EOC 15 and 54 EFPY, respectively. The fluence values for the circumferential welds are determined from azimuth 0 to 45 degrees in one degree increments at the inner surface of the RPV wall (0T). In Tables 7-5 and 7-6 the peak fluence values are shown in bold text.

The fluence values for each RPV vertical weld in the RPV beltline region is determined for the entire height of the weld represented in the RAMA model. Fluence is calculated in one degree increments at the inner surface of the RPV wall. Tables 7-7 and 7-8 present the fluence profiles for vertical welds 1-338 A, 1-338 B and 1-338 C for energy >1.0 MeV at EOC 15 and 54 EFPY, espectively. In Tables 7-7 and 7-8 the peak fluence values are shown in bold text.

It was determined that the recirculation inlet (jet pump) nozzle, with a central axis elevation of 508 cm, was positioned within the bounds of the 1.0E+17 n/cm^2 threshold range. The peak fluence value is along the upper edge of the nozzle with a value of 1.30E+17 n/cm^2 for EOC 15 and 2.81E+17 n/cm^2 for 54 EFPY.

Table 7-1
Maximum >1.0 MeV Neutron Fluence in Pilgrim Nuclear Power Station RPV Shells at EOC 15 (20.7 EFPY)

Shell Location	Fluence (n/cm^2) 0T	Fluence (n/cm^2) 1/4T
Lower	4.87E+17	2.93E+17
Lower Intermediate	5.51E+17	3.63E+17
Upper	2.45E+15	1.71E+15

Table 7-2
Maximum >1.0 MeV Neutron Fluence in Pilgrim Nuclear Power Station RPV Welds at EOC 15 (20.7 EFPY)

Shell Location	Weld	Fluence (n/cm^2) 0T at weld	Fluence (n/cm^2) 1/4T at weld
Lower	2-338 A	2.93E+17	1.80E+17
	2-338 B	3.94E+17	2.41E+17
	2-338 C	2.99E+17	1.83E+17
	1-344 (Circumferential)	4.19E+17	2.74E+17
Lower Intermediate	1-338 A	4.96E+17	3.31E+17
	1-338 B	2.22E+17	1.50E+17
	1-338 C	4.96E+17	3.31E+17
	3-339 B (Circumferential)	2.45E+15	1.71E+15
Upper	2-339 A	2.06E+15	1.44E+15
	2-339 B	2.45E+15	1.71E+15
	2-339 C	2.36E+15	1.66E+15

Table 7-3
Maximum >1.0 MeV Neutron Fluence in Pilgrim Nuclear Power Station RPV Shells at 54 EFPY

Shell Location	Fluence (n/cm^2) 0T	Fluence (n/cm^2) 1/4T
Lower	1.01E+18	6.09E+17
Lower Intermediate	1.28E+18	8.40E+17
Upper	5.12E+15	3.59E+15

Table 7-4
Maximum >1.0 MeV Neutron Fluence in Pilgrim Nuclear Power Station RPV Welds at 54 EFPY

Shell Location	Weld	Fluence (n/cm^2) 0T at weld	Fluence (n/cm^2) 1/4T at weld
Lower	2-338 A	6.08E+17	3.74E+17
	2-338 B	8.17E+17	5.00E+17
	2-338 C	6.72E+17	4.11E+17
	1-344 (Circumferential)	8.69E+17	5.70E+17
Lower Intermediate	1-338 A	1.14E+18	7.63E+17
	1-338 B	5.17E+17	3.51E+17
	1-338 C	1.14E+18	7.63E+17
	3-339 B (Circumferential)	5.12E+15	3.59E+15
Upper	2-339 A	4.28E+15	3.02E+15
	2-339 B	5.12E+15	3.59E+15
	2-339 C	5.00E+15	3.52E+15

Table 7-5
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Circumferential Welds 1-344 and 3-339 B at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Azimuth (degrees)	Weld 1-344 Fluence (n/cm^2)	Weld 3-339 B Fluence (n/cm^2)
0	1.71E+17	1.94E+15
1	1.74E+17	1.97E+15
2	1.76E+17	2.01E+15
3	1.80E+17	2.03E+15
4	1.84E+17	2.06E+15
5	1.88E+17	2.07E+15
6	1.94E+17	2.07E+15
7	2.00E+17	2.07E+15
8	2.09E+17	2.08E+15
9	2.19E+17	2.11E+15
10	2.29E+17	2.13E+15
11	2.40E+17	2.14E+15
12	2.54E+17	2.17E+15
13	2.69E+17	2.20E+15
14	2.84E+17	2.22E+15
15	2.99E+17	2.25E+15
16	3.14E+17	2.28E+15
17	3.30E+17	2.30E+15
18	3.42E+17	2.33E+15
19	3.53E+17	2.36E+15
20	3.62E+17	2.37E+15
21	3.73E+17	2.38E+15
22	3.87E+17	2.38E+15
23	4.07E+17	2.42E+15
24	4.16E+17	2.44E+15
25	**4.19E+17**	**2.45E+15**
26	4.13E+17	2.45E+15
27	4.03E+17	2.43E+15
28	3.92E+17	2.41E+15
29	3.82E+17	2.41E+15

Table 7-5 (Continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Circumferential Welds 1-344 and 3-339 B at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Azimuth (degrees)	Weld 1-344 Fluence (n/cm^2)	Weld 3-339 B Fluence (n/cm^2)
30	3.70E+17	2.40E+15
31	3.58E+17	2.38E+15
32	3.43E+17	2.37E+15
33	3.31E+17	2.36E+15
34	3.21E+17	2.36E+15
35	3.12E+17	2.36E+15
36	3.03E+17	2.35E+15
37	2.92E+17	2.33E+15
38	2.81E+17	2.29E+15
39	2.73E+17	2.26E+15
40	2.67E+17	2.24E+15
41	2.61E+17	2.23E+15
42	2.59E+17	2.20E+15
43	2.58E+17	2.17E+15
44	2.54E+17	2.15E+15
45	2.50E+17	2.14E+15

Table 7-6
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Circumferential Welds 1-344 and 3-339 B at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Azimuth (degrees)	Weld 1-344 Fluence (n/cm^2)	Weld 3-339 B Fluence (n/cm^2)
0	3.59E+17	4.04E+15
1	3.63E+17	4.11E+15
2	3.68E+17	4.18E+15
3	3.75E+17	4.24E+15
4	3.84E+17	4.28E+15
5	3.92E+17	4.31E+15
6	4.04E+17	4.31E+15
7	4.18E+17	4.31E+15
8	4.37E+17	4.34E+15
9	4.57E+17	4.39E+15
10	4.78E+17	4.45E+15
11	5.00E+17	4.47E+15
12	5.28E+17	4.52E+15
13	5.58E+17	4.58E+15
14	5.88E+17	4.62E+15
15	6.19E+17	4.69E+15
16	6.51E+17	4.76E+15
17	6.85E+17	4.78E+15
18	7.10E+17	4.85E+15
19	7.33E+17	4.92E+15
20	7.52E+17	4.95E+15
21	7.74E+17	4.95E+15
22	8.01E+17	4.97E+15
23	8.41E+17	5.04E+15
24	8.61E+17	5.09E+15
25	**8.69E+17**	5.12E+15
26	8.59E+17	**5.12E+15**
27	8.41E+17	5.10E+15
28	8.21E+17	5.07E+15
29	8.02E+17	5.08E+15

Table 7-6 (Continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Circumferential Welds 1-344 and 3-339 B at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Azimuth (degrees)	Weld 1-344 Fluence (n/cm^2)	Weld 3-339 B Fluence (n/cm^2)
30	7.83E+17	5.06E+15
31	7.62E+17	5.03E+15
32	7.37E+17	5.03E+15
33	7.17E+17	5.01E+15
34	6.99E+17	5.00E+15
35	6.85E+17	5.01E+15
36	6.68E+17	4.99E+15
37	6.49E+17	4.94E+15
38	6.30E+17	4.85E+15
39	6.16E+17	4.76E+15
40	6.03E+17	4.66E+15
41	5.91E+17	4.58E+15
42	5.83E+17	4.49E+15
43	5.74E+17	4.40E+15
44	5.55E+17	4.32E+15
45	5.36E+17	4.25E+15

Table 7-7
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
616.92 (242.88)	3.70E+17	1.71E+17	3.70E+17
619.46 (243.88)	3.74E+17	1.73E+17	3.74E+17
622.00 (244.88)	3.77E+17	1.74E+17	3.77E+17
624.54 (245.88)	3.80E+17	1.75E+17	3.80E+17
627.08 (246.88)	3.83E+17	1.77E+17	3.83E+17
629.62 (247.88)	3.86E+17	1.78E+17	3.86E+17
632.16 (248.88)	3.90E+17	1.79E+17	3.90E+17
634.70 (249.88)	3.93E+17	1.81E+17	3.93E+17
637.24 (250.88)	3.96E+17	1.82E+17	3.96E+17
639.78 (251.88)	3.99E+17	1.84E+17	3.99E+17
642.32 (252.88)	4.02E+17	1.85E+17	4.02E+17
644.86 (253.88)	4.05E+17	1.86E+17	4.05E+17
647.40 (254.88)	4.08E+17	1.88E+17	4.08E+17
649.94 (255.88)	4.11E+17	1.89E+17	4.11E+17
652.48 (256.88)	4.14E+17	1.90E+17	4.14E+17
655.02 (257.88)	4.16E+17	1.91E+17	4.16E+17
657.56 (258.88)	4.19E+17	1.93E+17	4.19E+17
660.10 (259.88)	4.21E+17	1.94E+17	4.21E+17
662.64 (260.88)	4.24E+17	1.95E+17	4.24E+17
665.18 (261.88)	4.26E+17	1.96E+17	4.26E+17
667.72 (262.88)	4.29E+17	1.97E+17	4.29E+17
670.26 (263.88)	4.32E+17	1.98E+17	4.32E+17
672.80 (264.88)	4.34E+17	2.00E+17	4.34E+17

Table 7-7 (Continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
675.34 (265.88)	4.37E+17	2.01E+17	4.37E+17
677.88 (266.88)	4.40E+17	2.02E+17	4.40E+17
680.42 (267.88)	4.42E+17	2.03E+17	4.42E+17
682.96 (268.88)	4.44E+17	2.04E+17	4.44E+17
685.50 (269.88)	4.46E+17	2.05E+17	4.46E+17
688.04 (270.88)	4.49E+17	2.05E+17	4.49E+17
690.58 (271.88)	4.51E+17	2.06E+17	4.51E+17
693.12 (272.88)	4.52E+17	2.07E+17	4.52E+17
695.66 (273.88)	4.52E+17	2.08E+17	4.52E+17
698.20 (274.88)	4.53E+17	2.09E+17	4.53E+17
700.74 (275.88)	4.53E+17	2.10E+17	4.53E+17
703.28 (276.88)	4.53E+17	2.10E+17	4.53E+17
705.82 (277.88)	4.53E+17	2.11E+17	4.53E+17
708.36 (278.88)	4.53E+17	2.12E+17	4.53E+17
710.90 (279.88)	4.53E+17	2.13E+17	4.53E+17
713.44 (280.88)	4.54E+17	2.14E+17	4.54E+17
715.98 (281.88)	4.54E+17	2.15E+17	4.54E+17
718.52 (282.88)	4.54E+17	2.15E+17	4.54E+17
721.06 (283.88)	4.55E+17	2.16E+17	4.55E+17
723.60 (284.88)	4.57E+17	2.17E+17	4.57E+17
726.14 (285.88)	4.58E+17	2.17E+17	4.58E+17
728.68 (286.88)	4.60E+17	2.18E+17	4.60E+17
731.22 (287.88)	4.62E+17	2.18E+17	4.62E+17

Table 7-7 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
733.76 (288.88)	4.64E+17	2.19E+17	4.64E+17
736.30 (289.88)	4.68E+17	2.19E+17	4.68E+17
738.84 (290.88)	4.73E+17	2.20E+17	4.73E+17
741.38 (291.88)	4.78E+17	2.20E+17	4.78E+17
743.92 (292.88)	4.83E+17	2.20E+17	4.83E+17
746.46 (293.88)	4.88E+17	2.21E+17	4.88E+17
749.00 (294.88)	4.93E+17	2.21E+17	4.93E+17
751.54 (295.88)	4.94E+17	2.21E+17	4.94E+17
754.08 (296.88)	4.94E+17	2.21E+17	4.94E+17
756.62 (297.88)	4.95E+17	2.21E+17	4.95E+17
759.16 (298.88)	4.95E+17	2.22E+17	4.95E+17
761.70 (299.88)	4.96E+17	**2.22E+17**	4.96E+17
764.24 (300.88)	4.96E+17	2.22E+17	4.96E+17
766.78 (301.88)	4.96E+17	2.22E+17	4.96E+17
769.32 (302.88)	4.96E+17	2.21E+17	4.96E+17
771.86 (303.88)	4.96E+17	2.21E+17	4.96E+17
774.40 (304.88)	4.96E+17	2.21E+17	4.96E+17
776.94 (305.88)	**4.96E+17**	2.21E+17	**4.96E+17**
779.48 (306.88)	4.94E+17	2.21E+17	4.94E+17
782.02 (307.88)	4.93E+17	2.20E+17	4.93E+17
784.56 (308.88)	4.91E+17	2.20E+17	4.91E+17
787.10 (309.88)	4.89E+17	2.19E+17	4.89E+17
789.64 (310.88)	4.87E+17	2.19E+17	4.87E+17

Table 7-7 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
792.18 (311.88)	4.83E+17	2.18E+17	4.83E+17
794.72 (312.88)	4.78E+17	2.17E+17	4.78E+17
797.26 (313.88)	4.72E+17	2.16E+17	4.72E+17
799.80 (314.88)	4.67E+17	2.15E+17	4.67E+17
802.34 (315.88)	4.61E+17	2.14E+17	4.61E+17
804.88 (316.88)	4.56E+17	2.13E+17	4.56E+17
807.42 (317.88)	4.50E+17	2.12E+17	4.50E+17
809.96 (318.88)	4.43E+17	2.10E+17	4.43E+17
812.50 (319.88)	4.36E+17	2.08E+17	4.36E+17
815.04 (320.88)	4.30E+17	2.07E+17	4.30E+17
817.58 (321.88)	4.24E+17	2.05E+17	4.24E+17
820.12 (322.88)	4.18E+17	2.03E+17	4.18E+17
822.66 (323.88)	4.12E+17	2.01E+17	4.12E+17
825.20 (324.88)	4.06E+17	1.98E+17	4.06E+17
827.74 (325.88)	4.00E+17	1.96E+17	4.00E+17
830.28 (326.88)	3.94E+17	1.93E+17	3.94E+17
832.82 (327.88)	3.89E+17	1.91E+17	3.89E+17
835.36 (328.88)	3.81E+17	1.88E+17	3.81E+17
837.90 (329.88)	3.73E+17	1.84E+17	3.73E+17
840.44 (330.88)	3.66E+17	1.81E+17	3.66E+17
842.98 (331.88)	3.58E+17	1.78E+17	3.58E+17
845.52 (332.88)	3.51E+17	1.75E+17	3.51E+17
848.06 (333.88)	3.43E+17	1.71E+17	3.43E+17

Table 7-7 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
850.60 (334.88)	3.38E+17	1.66E+17	3.38E+17
853.14 (335.88)	3.33E+17	1.61E+17	3.33E+17
855.68 (336.88)	3.28E+17	1.56E+17	3.28E+17
858.22 (337.88)	3.23E+17	1.51E+17	3.23E+17
860.76 (338.88)	3.18E+17	1.46E+17	3.18E+17
863.30 (339.88)	3.13E+17	1.41E+17	3.13E+17
865.84 (340.88)	3.07E+17	1.36E+17	3.07E+17
868.38 (341.88)	3.02E+17	1.30E+17	3.02E+17
870.92 (342.88)	2.97E+17	1.25E+17	2.97E+17
873.46 (343.88)	2.92E+17	1.20E+17	2.92E+17
876.00 (344.88)	2.87E+17	1.15E+17	2.87E+17
878.54 (345.88)	2.73E+17	1.09E+17	2.73E+17
881.08 (346.88)	2.59E+17	1.02E+17	2.59E+17
883.62 (347.88)	2.45E+17	9.61E+16	2.45E+17
886.16 (348.88)	2.33E+17	9.04E+16	2.33E+17
888.70 (349.88)	2.21E+17	8.51E+16	2.21E+17
891.24 (350.88)	2.07E+17	7.92E+16	2.07E+17
893.78 (351.88)	1.89E+17	7.24E+16	1.89E+17
896.32 (352.88)	1.73E+17	6.62E+16	1.73E+17
898.86 (353.88)	1.58E+17	6.05E+16	1.58E+17
901.40 (354.88)	1.44E+17	5.53E+16	1.44E+17
903.94 (355.88)	1.32E+17	5.05E+16	1.32E+17
906.48 (356.88)	1.19E+17	4.56E+16	1.19E+17

Table 7-7 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
909.02 (357.88)	1.07E+17	4.11E+16	1.07E+17
911.56 (358.88)	9.60E+16	3.70E+16	9.60E+16
914.10 (359.88)	8.63E+16	3.34E+16	8.63E+16
916.64 (360.88)	7.75E+16	3.01E+16	7.75E+16
919.18 (361.88)	6.95E+16	2.71E+16	6.95E+16
921.72 (362.88)	6.17E+16	2.45E+16	6.17E+16
924.26 (363.88)	5.47E+16	2.22E+16	5.47E+16
926.80 (364.88)	4.85E+16	2.01E+16	4.85E+16
929.34 (365.88)	4.30E+16	1.81E+16	4.30E+16
931.88 (366.88)	3.82E+16	1.64E+16	3.82E+16
934.42 (367.88)	3.44E+16	1.52E+16	3.44E+16
936.96 (368.88)	3.13E+16	1.42E+16	3.13E+16
939.50 (369.88)	2.84E+16	1.32E+16	2.84E+16
942.04 (370.88)	2.59E+16	1.23E+16	2.59E+16
944.58 (371.88)	2.35E+16	1.15E+16	2.35E+16
947.12 (372.88)	2.14E+16	1.08E+16	2.14E+16
949.66 (373.88)	1.97E+16	1.03E+16	1.97E+16
952.20 (374.88)	1.82E+16	9.79E+15	1.82E+16
954.74 (375.88)	1.67E+16	9.33E+15	1.67E+16
957.28 (376.88)	1.54E+16	8.89E+15	1.54E+16
959.82 (377.88)	1.42E+16	8.48E+15	1.42E+16
962.36 (378.88)	1.31E+16	8.08E+15	1.31E+16
964.90 (379.88)	1.22E+16	7.69E+15	1.22E+16

Table 7-7 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at EOC 15 (20.7 EFPY)

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
967.44 (380.88)	1.13E+16	7.33E+15	1.13E+16
969.98 (381.88)	1.04E+16	6.98E+15	1.04E+16
972.52 (382.88)	9.68E+15	6.65E+15	9.68E+15
975.06 (383.88)	8.97E+15	6.34E+15	8.97E+15
977.60 (384.88)	8.31E+15	5.99E+15	8.31E+15
980.14 (385.88)	7.70E+15	5.66E+15	7.70E+15
982.68 (386.88)	7.13E+15	5.35E+15	7.13E+15
985.22 (387.88)	6.61E+15	5.05E+15	6.61E+15
987.76 (388.88)	6.13E+15	4.78E+15	6.13E+15
990.30 (389.88)	5.64E+15	4.46E+15	5.64E+15
992.84 (390.88)	5.11E+15	4.07E+15	5.11E+15
995.38 (391.88)	4.64E+15	3.71E+15	4.64E+15
997.92 (392.88)	4.21E+15	3.38E+15	4.21E+15
1000.46 (393.88)	3.82E+15	3.08E+15	3.82E+15
1003.00 (394.88)	3.47E+15	2.81E+15	3.47E+15
1005.54 (395.88)	3.09E+15	2.51E+15	3.09E+15
1008.08 (396.88)	2.74E+15	2.22E+15	2.74E+15
1010.62 (397.88)	2.43E+15	1.96E+15	2.43E+15
1010.92 (398.00)	2.40E+15	1.94E+15	2.40E+15

Table 7-8
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
616.92 (242.88)	7.83E+17	3.59E+17	7.83E+17
619.46 (243.88)	7.90E+17	3.62E+17	7.90E+17
622.00 (244.88)	7.97E+17	3.65E+17	7.97E+17
624.54 (245.88)	8.04E+17	3.68E+17	8.04E+17
627.08 (246.88)	8.11E+17	3.72E+17	8.11E+17
629.62 (247.88)	8.18E+17	3.75E+17	8.18E+17
632.16 (248.88)	8.25E+17	3.78E+17	8.25E+17
634.70 (249.88)	8.32E+17	3.81E+17	8.32E+17
637.24 (250.88)	8.39E+17	3.85E+17	8.39E+17
639.78 (251.88)	8.46E+17	3.88E+17	8.46E+17
642.32 (252.88)	8.53E+17	3.92E+17	8.53E+17
644.86 (253.88)	8.61E+17	3.95E+17	8.61E+17
647.40 (254.88)	8.68E+17	3.98E+17	8.68E+17
649.94 (255.88)	8.75E+17	4.02E+17	8.75E+17
652.48 (256.88)	8.81E+17	4.05E+17	8.81E+17
655.02 (257.88)	8.87E+17	4.09E+17	8.87E+17
657.56 (258.88)	8.93E+17	4.12E+17	8.93E+17
660.10 (259.88)	9.00E+17	4.15E+17	9.00E+17
662.64 (260.88)	9.06E+17	4.19E+17	9.06E+17
665.18 (261.88)	9.13E+17	4.22E+17	9.13E+17
667.72 (262.88)	9.19E+17	4.25E+17	9.19E+17
670.26 (263.88)	9.26E+17	4.28E+17	9.26E+17
672.80 (264.88)	9.33E+17	4.31E+17	9.33E+17

Table 7-8 (Continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
675.34 (265.88)	9.39E+17	4.34E+17	9.39E+17
677.88 (266.88)	9.46E+17	4.37E+17	9.46E+17
680.42 (267.88)	9.52E+17	4.40E+17	9.52E+17
682.96 (268.88)	9.59E+17	4.43E+17	9.59E+17
685.50 (269.88)	9.65E+17	4.46E+17	9.65E+17
688.04 (270.88)	9.71E+17	4.49E+17	9.71E+17
690.58 (271.88)	9.77E+17	4.52E+17	9.77E+17
693.12 (272.88)	9.82E+17	4.54E+17	9.82E+17
695.66 (273.88)	9.84E+17	4.57E+17	9.84E+17
698.20 (274.88)	9.85E+17	4.60E+17	9.85E+17
700.74 (275.88)	9.87E+17	4.62E+17	9.87E+17
703.28 (276.88)	9.89E+17	4.65E+17	9.89E+17
705.82 (277.88)	9.91E+17	4.67E+17	9.91E+17
708.36 (278.88)	9.93E+17	4.70E+17	9.93E+17
710.90 (279.88)	9.96E+17	4.73E+17	9.96E+17
713.44 (280.88)	9.99E+17	4.76E+17	9.99E+17
715.98 (281.88)	1.00E+18	4.78E+17	1.00E+18
718.52 (282.88)	1.00E+18	4.81E+17	1.00E+18
721.06 (283.88)	1.01E+18	4.84E+17	1.01E+18
723.60 (284.88)	1.01E+18	4.86E+17	1.01E+18
726.14 (285.88)	1.02E+18	4.88E+17	1.02E+18
728.68 (286.88)	1.02E+18	4.91E+17	1.02E+18
731.22 (287.88)	1.03E+18	4.93E+17	1.03E+18

Table 7-8 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
733.76 (288.88)	1.04E+18	4.95E+17	1.04E+18
736.30 (289.88)	1.05E+18	4.97E+17	1.05E+18
738.84 (290.88)	1.06E+18	4.99E+17	1.06E+18
741.38 (291.88)	1.07E+18	5.00E+17	1.07E+18
743.92 (292.88)	1.08E+18	5.02E+17	1.08E+18
746.46 (293.88)	1.10E+18	5.04E+17	1.10E+18
749.00 (294.88)	1.11E+18	5.05E+17	1.11E+18
751.54 (295.88)	1.11E+18	5.07E+17	1.11E+18
754.08 (296.88)	1.12E+18	5.08E+17	1.12E+18
756.62 (297.88)	1.12E+18	5.09E+17	1.12E+18
759.16 (298.88)	1.12E+18	5.11E+17	1.12E+18
761.70 (299.88)	1.13E+18	5.12E+17	1.13E+18
764.24 (300.88)	1.13E+18	5.13E+17	1.13E+18
766.78 (301.88)	1.13E+18	5.14E+17	1.13E+18
769.32 (302.88)	1.14E+18	5.15E+17	1.14E+18
771.86 (303.88)	1.14E+18	5.16E+17	1.14E+18
774.40 (304.88)	1.14E+18	5.16E+17	1.14E+18
776.94 (305.88)	**1.14E+18**	5.17E+17	**1.14E+18**
779.48 (306.88)	1.14E+18	**5.17E+17**	1.14E+18
782.02 (307.88)	1.14E+18	5.17E+17	1.14E+18
784.56 (308.88)	1.14E+18	5.17E+17	1.14E+18
787.10 (309.88)	1.14E+18	5.17E+17	1.14E+18
789.64 (310.88)	1.13E+18	5.17E+17	1.13E+18

Table 7-8 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
792.18 (311.88)	1.13E+18	5.17E+17	1.13E+18
794.72 (312.88)	1.12E+18	5.16E+17	1.12E+18
797.26 (313.88)	1.11E+18	5.14E+17	1.11E+18
799.80 (314.88)	1.10E+18	5.13E+17	1.10E+18
802.34 (315.88)	1.08E+18	5.12E+17	1.08E+18
804.88 (316.88)	1.07E+18	5.11E+17	1.07E+18
807.42 (317.88)	1.06E+18	5.08E+17	1.06E+18
809.96 (318.88)	1.05E+18	5.05E+17	1.05E+18
812.50 (319.88)	1.03E+18	5.02E+17	1.03E+18
815.04 (320.88)	1.02E+18	4.99E+17	1.02E+18
817.58 (321.88)	1.01E+18	4.96E+17	1.01E+18
820.12 (322.88)	9.96E+17	4.92E+17	9.96E+17
822.66 (323.88)	9.83E+17	4.87E+17	9.83E+17
825.20 (324.88)	9.71E+17	4.81E+17	9.71E+17
827.74 (325.88)	9.58E+17	4.76E+17	9.58E+17
830.28 (326.88)	9.46E+17	4.71E+17	9.46E+17
832.82 (327.88)	9.33E+17	4.66E+17	9.33E+17
835.36 (328.88)	9.16E+17	4.58E+17	9.16E+17
837.90 (329.88)	8.96E+17	4.50E+17	8.96E+17
840.44 (330.88)	8.77E+17	4.42E+17	8.77E+17
842.98 (331.88)	8.58E+17	4.34E+17	8.58E+17
845.52 (332.88)	8.40E+17	4.26E+17	8.40E+17
848.06 (333.88)	8.22E+17	4.18E+17	8.22E+17

Table 7-8 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
850.60 (334.88)	8.07E+17	4.04E+17	8.07E+17
853.14 (335.88)	7.92E+17	3.91E+17	7.92E+17
855.68 (336.88)	7.77E+17	3.78E+17	7.77E+17
858.22 (337.88)	7.63E+17	3.66E+17	7.63E+17
860.76 (338.88)	7.49E+17	3.54E+17	7.49E+17
863.30 (339.88)	7.35E+17	3.41E+17	7.35E+17
865.84 (340.88)	7.21E+17	3.27E+17	7.21E+17
868.38 (341.88)	7.07E+17	3.14E+17	7.07E+17
870.92 (342.88)	6.94E+17	3.01E+17	6.94E+17
873.46 (343.88)	6.81E+17	2.88E+17	6.81E+17
876.00 (344.88)	6.68E+17	2.76E+17	6.68E+17
878.54 (345.88)	6.33E+17	2.60E+17	6.33E+17
881.08 (346.88)	5.99E+17	2.44E+17	5.99E+17
883.62 (347.88)	5.66E+17	2.29E+17	5.66E+17
886.16 (348.88)	5.36E+17	2.15E+17	5.36E+17
888.70 (349.88)	5.07E+17	2.02E+17	5.07E+17
891.24 (350.88)	4.73E+17	1.87E+17	4.73E+17
893.78 (351.88)	4.30E+17	1.71E+17	4.30E+17
896.32 (352.88)	3.92E+17	1.55E+17	3.92E+17
898.86 (353.88)	3.56E+17	1.41E+17	3.56E+17
901.40 (354.88)	3.24E+17	1.29E+17	3.24E+17
903.94 (355.88)	2.95E+17	1.17E+17	2.95E+17
906.48 (356.88)	2.65E+17	1.05E+17	2.65E+17

Table 7-8 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
909.02 (357.88)	2.37E+17	9.45E+16	2.37E+17
911.56 (358.88)	2.12E+17	8.48E+16	2.12E+17
914.10 (359.88)	1.90E+17	7.61E+16	1.90E+17
916.64 (360.88)	1.70E+17	6.83E+16	1.70E+17
919.18 (361.88)	1.51E+17	6.13E+16	1.51E+17
921.72 (362.88)	1.34E+17	5.51E+16	1.34E+17
924.26 (363.88)	1.18E+17	4.95E+16	1.18E+17
926.80 (364.88)	1.04E+17	4.45E+16	1.04E+17
929.34 (365.88)	9.16E+16	4.00E+16	9.16E+16
931.88 (366.88)	8.08E+16	3.59E+16	8.08E+16
934.42 (367.88)	7.25E+16	3.30E+16	7.25E+16
936.96 (368.88)	6.58E+16	3.07E+16	6.58E+16
939.50 (369.88)	5.97E+16	2.85E+16	5.97E+16
942.04 (370.88)	5.41E+16	2.66E+16	5.41E+16
944.58 (371.88)	4.91E+16	2.47E+16	4.91E+16
947.12 (372.88)	4.45E+16	2.30E+16	4.45E+16
949.66 (373.88)	4.10E+16	2.18E+16	4.10E+16
952.20 (374.88)	3.77E+16	2.07E+16	3.77E+16
954.74 (375.88)	3.47E+16	1.97E+16	3.47E+16
957.28 (376.88)	3.19E+16	1.87E+16	3.19E+16
959.82 (377.88)	2.94E+16	1.78E+16	2.94E+16
962.36 (378.88)	2.71E+16	1.69E+16	2.71E+16
964.90 (379.88)	2.51E+16	1.60E+16	2.51E+16

Table 7-8 (continued)
Neutron Fluence Profile for Pilgrim Nuclear Power Station RPV Vertical Welds 1-338 A, 1-338 B, and 1-338 C at the Inner Surface for Energy >1.0 MeV at 54 EFPY

Elevation cm and (in)	Weld 1-338 A Fluence (n/cm^2)	Weld 1-338 B Fluence (n/cm^2)	Weld 1-338 C Fluence (n/cm^2)
967.44 (380.88)	2.33E+16	1.53E+16	2.33E+16
969.98 (381.88)	2.16E+16	1.45E+16	2.16E+16
972.52 (382.88)	2.00E+16	1.38E+16	2.00E+16
975.06 (383.88)	1.85E+16	1.31E+16	1.85E+16
977.60 (384.88)	1.72E+16	1.24E+16	1.72E+16
980.14 (385.88)	1.59E+16	1.17E+16	1.59E+16
982.68 (386.88)	1.48E+16	1.11E+16	1.48E+16
985.22 (387.88)	1.37E+16	1.05E+16	1.37E+16
987.76 (388.88)	1.27E+16	9.87E+15	1.27E+16
990.30 (389.88)	1.17E+16	9.22E+15	1.17E+16
992.84 (390.88)	1.07E+16	8.41E+15	1.07E+16
995.38 (391.88)	9.68E+15	7.67E+15	9.68E+15
997.92 (392.88)	8.80E+15	7.00E+15	8.80E+15
1000.46 (393.88)	8.00E+15	6.39E+15	8.00E+15
1003.00 (394.88)	7.27E+15	5.83E+15	7.27E+15
1005.54 (395.88)	6.50E+15	5.21E+15	6.50E+15
1008.08 (396.88)	5.77E+15	4.62E+15	5.77E+15
1010.62 (397.88)	5.13E+15	4.10E+15	5.13E+15
1010.92 (398.00)	5.06E+15	4.04E+15	5.06E+15

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A
CYCLE 4 SURVEILLANCE CAPSULE EVALUATION

This appendix addresses the results of the evaluation of the Pilgrim Nuclear Power Station cycle 4 surveillance capsule results. [[

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A.1 Comparison of Predicted Activation to Plant-Specific Measurements

Three copper, three iron, and three nickel flux wires were irradiated in the Pilgrim Nuclear Power Station surveillance capsule during the first four cycles of operation. Activation measurements were performed following irradiation for the following reactions [10]: $^{63}Cu(n,\alpha)^{60}Co$, $^{54}Fe(n,p)^{54}Mn$, and $^{58}Ni(n,p)^{58}Co$. [[

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