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PALISADES REACTOR PRESSURE VESSEL NEUTRON FLUENCE EVALUATION

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Palisades Reactor Pressure Vessel Neutron Fluence Evaluation

Westinghouse Electric Company, LLC

WESTINGHOUSE NON-PROPRIETARY CLASS 3

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Palisades Reactor Pressure Vessel Neutron Fluence Evaluation

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF TABLES (CONTINUED)

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ANS	American Nuclear Society
ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials
Barn	Nuclear cross-section unit (1 barn = 10^{-24} cm^2)
BOC	Beginning of Cycle
BUGLE-96	Library of nuclear cross-section data (Reference 10)
CBMI	Clad-Base Metal Interface
DORT	Two-dimensional discrete ordinates transport code (Reference 9)
dpa	Displacements per atom
EFPD, EFPH, EFPS, or EFPY	Effective Full Power Days, Hours, Seconds, or Years
ENDF/B-VI	Evaluated Nuclear Data File, Section B, Version 6
EOC	End of Cycle
FERRET	Computer code for neutron spectrum unfolding (Reference 27)
FQE	First Quadrant Equivalent
LHR	Linear Heating Rate
LSA/C	Least Squares Adjusted / Calculation
LSA/M	Least Squares Adjusted / Measurement
M/C	Measurement / Calculation
MOC	Middle of Cycle
MDNBR	Minimum Departure from Nucleate Boiling Ratio
MWD/MTU	Megawatt-days per metric ton of uranium (measure of core burnup)
ORNL	Oak Ridge National Laboratory
PWR	Pressurized Water Reactor
RM	Radiometric Monitor
RPV	Reactor Pressure Vessel
SAND-II	Computer code for neutron spectrum unfolding (Reference 28)
TORT	Three-dimensional discrete ordinates transport code (Reference 9)
¼ T	A point one-quarter of the way through the thickness of the reactor vessel starting from the inner radius of the RPV base metal
¾ T	A point three-quarters of the way through the thickness of the reactor vessel starting from the inner radius of the RPV base metal

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ABSTRACT

This report describes updated radiation transport calculations and the evaluation of dosimetry sets that were irradiated at the Palisades Nuclear Power Plant during the first fourteen fuel cycles of operation in order to assess the Reactor Pressure Vessel (RPV) fast neutron fluence. This work is being performed as part of the Palisades Reactor Vessel Surveillance Program that was established to provide a measurement data base sufficient to qualify the analytical predictions of the in-vessel and ex-vessel dosimetry neutron exposure and support the methodology for the analytical prediction of the RPV neutron exposure and exposure gradients through the thickness of the RPV wall.

There are several prominent differences between the Palisades RPV neutron fluence evaluation presented in this report versus the proceeding evaluation that was documented in WCAP-14557, Rev 1[8]. These key differences are summarized below.

- Three additional operating cycles have occurred at Palisades since WCAP-14557 was published and one additional accelerated surveillance capsule dosimetry set has been added to the measurement data base that increases the plant-specific total to five in-vessel dosimetry sets in addition to the thirteen ex-vessel dosimetry sets.
- The geometric model that was applied in the discrete ordinates radiation transport calculations utilizes a "two-zone" core to accurately reflect known differences in the physical parameters between the radially inboard or "center" fuel assemblies versus the radially outboard or "peripheral" fuel assemblies. This modeling approach is important for plants that utilize low-leakage loading patterns since the center assemblies typically operate at an average relative power slightly greater than 1.0 and the peripheral assemblies operate at a considerably lower value. With less power being generated in the peripheral assemblies, less heat is transferred to the local water region resulting in a lower temperature rise; thus the water density of the peripheral assemblies is somewhat greater than the center assemblies. Hence, utilization of a two-zone core model should reduce the neutron fluence calculated at the Clad-Base Metal Interface (CBMI) of the RPV since the cooler water that surrounds the peripheral assemblies provides enhanced neutron shielding.
- Consumers Energy generated cycle-specific core radial power distributions with CASMO-4, whereas the previous Palisades fluence evaluation used CASMO-3. Since the changes that were incorporated into CASMO-4 are believed to model light water reactor fuel more accurately than CASMO-3, it is expected that a more accurate assessment of the calculated neutron fluence at the CBMI of the RPV will be made.
- In order to assess the fast neutron exposure axially along the RPV, a three-dimensional (3-D) flux solution was constructed using 2-D / 1-D synthesis techniques. The synthesis approach that was utilized adheres to the methodology described in Section 1.3.4 of DG-1053[32].
- The discrete ordinates radiation transport results documented in this report treat anisotropic scattering with a P_5 expansion of the BUGLE-96[10] cross-section library

and the angular discretization was modeled with an S_{16} order of angular quadrature. The results that were presented in WCAP14557[8] utilized a P_3 expansion of the BUGLE-93[36] cross-section library and S_{16} angular quadrature. The change to P_5 cross-sections was made to enhance the group flux solution determined via the transport calculations, in particular, for the analyses involving R,Z geometry. BUGLE-96 cross-sections were utilized in the analyses described in this report since this data set corrects known deficiencies which exist in the BUGLE-93 data.

EXECUTIVE SUMMARY

This report presents the Palisades Reactor Pressure Vessel Neutron Fluence Evaluation which incorporates both refined analytical models and additional dosimetry data. Significant updates to the DORT inputs include: (i) use of CASMO-4 for generation of cycle-specific neutron sources, (ii) construction of a "two-zone" core model, (iii) utilization of BUGLE-96 transport cross-sections, and (iv) implementation of a 3-D flux synthesis methodology to address concerns regarding the axial leakage effects on in-vessel and ex-vessel dosimetry[33]. All reactor cavity neutron dosimetry measurements obtained during Fuel Cycles 8, 9, and 10 / 11 along with the previous in-vessel surveillance capsule measurements from A240, W290, W290-9, and W110 have been reanalyzed. In addition, one new measurement set for accelerated capsule SA60-1 has been included in the evaluation. The data from the plant-specific reactor pressure vessel surveillance measurement program are integral to qualifying the analytical exposure predictions.

The Palisades reactor pressure vessel fast neutron exposure within the circumferential beltline region has peak fluences at the 15° (Reference 345°) and 75° (Reference 285°) azimuths in the first-quadrant equivalent quarter-core model (see Figures 3.1-1 through 3.1-6). However, the exposure to the axial welds at the 30° (Reference 330°) and 90° (Reference 270°) azimuths of the first-quadrant equivalent model is limiting with respect to the 10CFR50.61 Pressurized Thermal Shock Screening Criterion. Based on the close agreement among calculations and measurements, it is concluded that the DORT neutron transport calculations provide an accurate representation of the reactor vessel fast neutron fluence (E > 1.0 MeV). The following table lists the peak integrated RPV clad-base-metal-interface fluence one-foot below the core midplane at various azimuths for operation through Cycle 14.

Reference Azimuth	FQE Azimuth	Calculated $\Phi(E > 1.0\ MeV)$ Through EOC 14 [n/cm^2]
0° or 360°	0°	1.12e+19
345°	15°	1.56e+19
330°	30°	1.18e+19
315°	45°	7.39e+18
300°	60°	1.15e+19
285°	75°	1.56e+19
270°	90°	1.12e+19

All of the calculations and dosimetry evaluations presented in this report were based on the BUGLE-96[10] nuclear cross-section data derived from ENDF/B-VI and are intended to be consistent with the requirements of Draft Regulatory Guide DG-1053[32], "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence". The data provided here supersede all prior Palisades neutron fluence evaluations[1 through 8].

1 INTRODUCTION

On December 20, 1996, the NRC staff issued an interim Safety Evaluation Report (SER)[34] based on its review of the Consumers Energy Palisades RPV neutron fluence evaluation that was documented in Reference 8. It concluded that the calculated RPV neutron fluence was acceptable; however, application of a plant-specific bias, derived from a least-squares evaluation of the measurements, dosimetry cross-sections, and calculation, required further review. Subsequent discussions with the Staff focused on the statistical continuity of the measurement data and identifiable components of the analytical bias. A considerable effort in identifying physical factors of the analytical bias was undertaken and subsequently incorporated into the models to remove the biases. These included: (i) using CASMO-4 for the generation of cycle-specific neutron sources, (ii) construction of a "two-zone" core model, (iii) utilization of BUGLE-96 transport cross-sections, and (iv) implementation of a 3-D flux synthesis methodology to address concerns regarding the axial leakage effects on in-vessel and ex-vessel dosimetry measurements.[33] The plant-specific measurement database is then used to qualify the analytical predictions at the measurement locations in order to validate the analytical results at the RPV.

The in-vessel and ex-vessel neutron flux has been derived from measurements at several locations around the Palisades reactor pressure vessel using state-of-the-art dosimetry and industry standard radiation metrology techniques. This measured data is used to provide confidence in the accuracy of the calculated exposure parameters.

The Reactor Cavity Neutron Measurement Program[1-3] initiated at Palisades at the start of Fuel Cycle 8 was designed to enhance the long term (in-vessel) neutron exposure monitoring program already in existence at that time. Particular emphasis was focused on those portions of the reactor vessel which may experience radiation induced increases in the reference nil ductility transition temperature (RT_{NDT}) over the lifetime of the Palisades plant. When used in conjunction with dosimetry from internal surveillance capsules[4-7], and with the results of neutron transport calculations[8], the reactor cavity neutron dosimetry provides an extensive plant specific measurement data base that is used to qualify the analytical fluence results. In addition, the measured data also supports the methodology for the analytical prediction of exposure gradients through the thickness of the pressure vessel wall. Minimizing the uncertainty in the neutron exposure projections will, in turn, help to assure that the reactor can be operated in the least restrictive mode possible with respect to:

1 - 10CFR50 Appendix G pressure/temperature limit curves for normal heatup and cooldown of the reactor coolant system[31],

2 - Emergency Operating Procedure (EOP) pressure/temperature limit curves,

3 - Pressurized Thermal Shock (PTS) RT_{PTS} screening criteria, and

4 - Plant thermal margins (i.e., LHR and MDNBR operating margins).

Finally, an accurate prediction of the neutron exposure of the reactor vessel can provide a sound basis for license extension should operation of the plant beyond the current licensed lifetime prove to be desirable.

In the assessment of the state of embrittlement of light water reactor vessels, an accurate evaluation of the neutron exposure of the materials comprising the beltline region of the vessel is required. This exposure evaluation must, in general, include assessments not only at locations of maximum exposure at the inner diameter of the vessel, but also exposure estimates as a function of axial, azimuthal, and radial position throughout the vessel wall.

In order to satisfy the requirements of 10CFR50 Appendix G for the calculation of pressure/temperature limit curves for normal heatup and cooldown of the Reactor Coolant System, fast neutron exposure levels must be defined at depths within the vessel wall equal to 25 and 75 percent of the wall thickness for each of the materials comprising the beltline region. These locations are commonly referred to as the 1/4T and 3/4T positions in the vessel wall. The 1/4T exposure levels are also used in determining the upper shelf energy fracture toughness as specified in 10CFR50 Appendix G.

In the determination of values of RT_{PTS} for comparison with applicable pressurized thermal shock screening criteria for plates, circumferential welds, and axial welds, maximum neutron exposure levels experienced by each of the reactor vessel beltline region materials is required. These maximum exposure levels will occur at the vessel inner radius near the axial midplane of the core.

In the event that a probabilistic fracture mechanics evaluation of the reactor vessel is performed, or an evaluation of thermal annealing and subsequent material re-embrittlement is undertaken, a complete embrittlement profile is required for the entire volume of the reactor vessel beltline. The determination of this embrittlement profile would, in turn, necessitate the evaluation of neutron exposure gradients throughout the entire beltline region.

The methodology used to provide the neutron exposure evaluations for the Palisades reactor vessel is based on the underlying philosophy that, in order to minimize the uncertainties associated with vessel exposure projections, plant specific neutron transport calculations must be (i) compared to industry standard benchmark measurements, (ii) compared with industry wide power reactor data bases of surveillance capsule and reactor cavity dosimetry, and (iii) validated by plant specific surveillance capsule and reactor cavity dosimetry data bases.

In other words, a progression is made from purely analytical results benchmarked with experimental data of high fidelity to an approach that also utilizes industry and plant specific power reactor measurements. Agreement among the analytical and various measured results provides confidence that the analytical method is producing accurate knowledge regarding the neutron environment applicable to a specific reactor vessel.

With this overall methodology in mind, the Palisades Reactor Cavity Measurement Program was established with the objective of providing an accurate and reliable plant-specific measurement data base for comparison with analytical predictions of neutron exposure in order to support the methodology for predicting exposure gradients through the thickness of the pressure vessel wall.

This report provides the results of neutron dosimetry evaluations performed through the completion of Fuel Cycle 14. Fast neutron exposure in terms of fast neutron fluence (E > 1.0 MeV) and dpa is established for all measurement locations in the reactor cavity. Results of exposure evaluations from surveillance capsule dosimetry withdrawn at the end of Fuel Cycles 2, 5, and 10, as well as surveillance capsules irradiated during Fuel Cycles 9 and 12 / 13, and reactor cavity dosimetry results from Cycles 8, 9, and 10 / 11 are used to establish confidence in the calculated exposure of the reactor vessel from plant startup through the End-Of-Cycle (EOC) 14. Additionally, the calculated exposure rate at the pressure vessel for Fuel Cycle 15 is provided for use in extrapolating the fast neutron fluence.

All of the calculations and dosimetry evaluations presented in this report are intended to meet the requirements of Draft Regulatory Guide DG-1053[32], "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence", and the results are based on the BUGLE-96[10] nuclear cross-section data derived from ENDF/B-VI. Hence, the results provided in this report supersede all prior Palisades neutron fluence evaluations[1 through 8].

2 DESCRIPTION OF THE MEASUREMENT PROGRAM

2.1 Description of Reactor Cavity Dosimetry

To achieve the goals of the Reactor Cavity Neutron Measurement Program, comprehensive multiple foil sensor sets including radiometric monitors (RM) were installed at several locations in the reactor cavity to characterize the neutron energy spectra within the beltline region of the reactor pressure vessel. In addition, gradient chains were used in conjunction with the encapsulated sensors to complete the azimuthal and axial mapping of the neutron environment over the regions of interest.

Placement of the multiple foil sensor sets was such that spectra evaluations could be made at various azimuthal locations at an axial elevation representative of the mid-plane of the reactor core (see Figure 2.1-1). The intent here was to determine changes in spectra caused by varying amounts of water located between the core and the RPV. Due to the step shape of the reactor core, water thickness varies significantly as a function of azimuthal angle. Additional sensor sets were positioned opposite the bottom of the active core at an azimuthal angle of a longitudinal reactor pressure vessel weld (270°), at a particular azimuthal angle (290°) of an in-vessel surveillance capsule, and at a particular azimuthal angle (280°) of the peak azimuthal flux. Here the intent was to measure variations in neutron spectra over the core height. At each of the azimuthal locations selected for core midplane spectra measurements, gradient chains extended over the bottom half of the active fuel. Additional gradient chains were placed at symmetric locations in other quadrants to confirm symmetry of the neutron flux distribution. These additional gradient chains extended over nearly the full height of the active fuel (except for the bottom-most nine inches) and extended up past the reactor vessel support structure.

The sensor set deployment described in the preceding paragraphs is characteristic of the basic long term monitoring program designed to provide fast neutron exposure assessments for materials comprising the beltline region of the reactor vessel. The reactor cavity dosimetry program has been discontinued at Palisades since sufficient characterization of the ex-vessel axial and azimuthal flux has been obtained.

2.1.1 Sensor Placement in the Reactor Cavity

A detailed description of the reactor cavity dosimetry hardware and plant-specific installation can be found in References 1 through 3. However, the following information is provided in this report to orient the reader to the plant geometry and the specifics of the sensor sets.

The placement of the individual multiple foil sensor sets and gradient chains within the reactor cavity is illustrated in Figure 2.1-1. A plan view of the azimuthal locations of the strings of sensor sets is depicted in Figure 2.1-1 along with the azimuthal locations of the gradient chains. The strings were located at azimuthal positions of 270°, 280°, 290°, 300°, 315° and 330° relative to the core cardinal axis. The sensor strings were hung in the annular gap between the reactor pressure vessel insulation and the primary biological shield at a nominal radius of 108 inches relative to the core centerline using an aluminum support bar that was attached to the reactor cavity seal drip pan. It has subsequently been determined that the dosimetry support bar was skewed radially, i.e., the 270° end of the bar was closer to the reactor vessel than what was intended[6]; therefore, the first quadrant equivalent (FQE) azimuthal positions of the dosimetry are summarized below.

Reference Azimuth	Intended First Quadrant Equivalent	Bar Shifted Angle	Dosimeter Radius (inches)
270°	90°	84°	100.7
280°	80°	74°	101.6
290°	70°	64°	102.5
300°	60°	54°	103.5
315°	45°	39°	105.3
330°	30°	24°	107.6

The gradient chains, located at azimuthal positions of 30°, 90°, 150°, 210°, 260° and 340°, were also located in the annular gap between the reactor pressure vessel insulation and the primary biological shield at a nominal radius of 108 inches relative to the core centerline and were likewise supported from the reactor cavity seal drip pan.

2.1.2 Description of Irradiation Capsules

The sensor sets used to characterize the neutron spectra within the reactor cavity were retained in 3.87 inch x 1.00 inch x 0.50 inch rectangular aluminum 6061 capsules such as that shown in Figure 2.1-2. Each capsule included three compartments to hold the neutron sensors. The top compartment (position 1) contained the bare radiometric monitors, whereas, the two remaining compartments (positions 2 and 3) housed the cadmium shielded packages. The separation between positions 1 and 2 was such that cadmium shields inserted into position 2 did not introduce perturbations in the thermal flux in position 1. Aluminum 6061 was selected for the dosimeter capsules in order to minimize neutron flux perturbations at the sensor set locations as well as to limit the radiation levels associated with post-irradiation shipping and handling of the capsules. A summary of the contents of the multiple foil capsules used during each cycle of irradiation is provided in the appendices to this report.

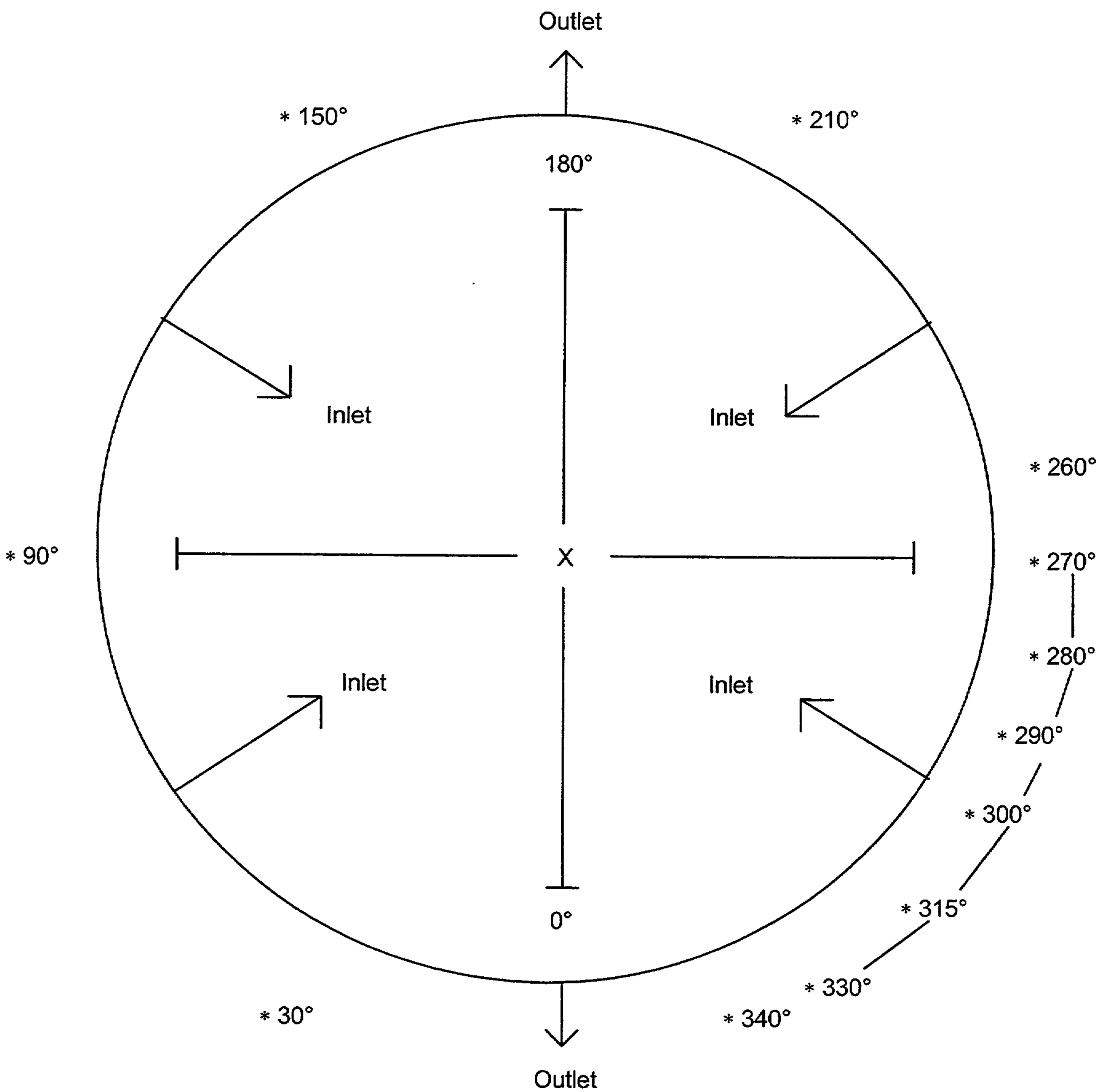
2.1.3 Description of Gradient Chains

Along with the multiple foil sensor sets placed at discrete locations within the reactor cavity, gradient chains were employed to obtain axial variations of fast neutron exposure along each of the twelve traverses. Subsequent to irradiation, these gradient chains were removed from the reactor cavity and segmented to provide neutron reaction rate measurements at six-inch to one-foot intervals over the height of the axial traverses. These gradient chains consisted of Type 304 stainless steel bead chain of 0.188 inch diameter.

When coupled with a chemical analysis, the stainless steel gradient chains yielded activation results for the $^{54}Fe(n,p)^{54}Mn$, $^{58}Ni(n,p)^{58}Co$, and $^{59}Co(n,\gamma)^{60}Co$ reactions. The high-purity iron, nickel, and cobalt-aluminum foils contained in the multiple foil sensor sets established a direct correlation with the measured reaction rates from the stainless steel chain and provided a check on the chemical analysis of the Type 304 stainless steel.

FIGURE 2.1-1

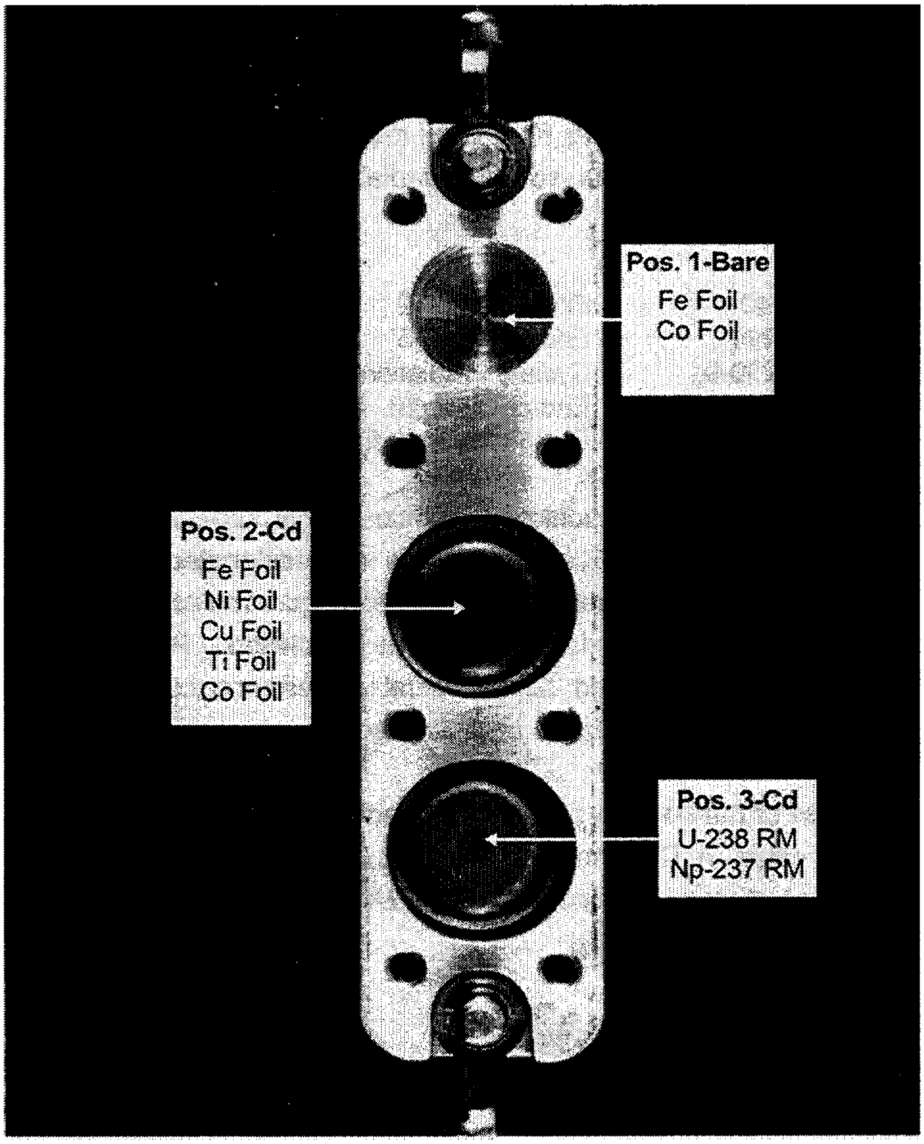
AZIMUTHAL LOCATION OF SENSOR STRINGS



NOTE: The dosimetry bar has been determined to be shifted by 6° clockwise relative to the position shown above.

Figure 2.1-2

IRRADIATION CAPSULE FOR REACTOR CAVITY SENSOR SETS (98.4 mm x 25.4 mm)



2.2 Description of Surveillance Capsule Dosimetry

During Palisades first 14 fuel cycles, five dosimetry or surveillance capsules were withdrawn from their positions; two from the outer surface of the core support barrel (denoted as "A" for accelerated capsules and "SA" for supplemental accelerated capsules) and three from the inner surface of the reactor pressure vessel (denoted as "W" for wall capsules). The neutron dosimetry contained within these capsules provides a position-dependent measure of the integrated exposure received by each capsule during its respective irradiation period; furthermore, it establishes continuity in measurements from initial reactor startup to the initiation of the Reactor Cavity Measurement Program. The specific irradiation and withdrawal dates of these five capsules were as follows:

Capsule A240	End of Cycle 2	12/71 - 01/78
Capsule W290	End of Cycle 5	12/71 - 08/83
Capsule W290-9	Cycle 9 Irradiation	03/91 - 02/92
Capsule W110	End of Cycle 10	12/71 - 06/93
Capsule SA60-1	Cycle 12-13 Irradiation	08/95 - 04/98

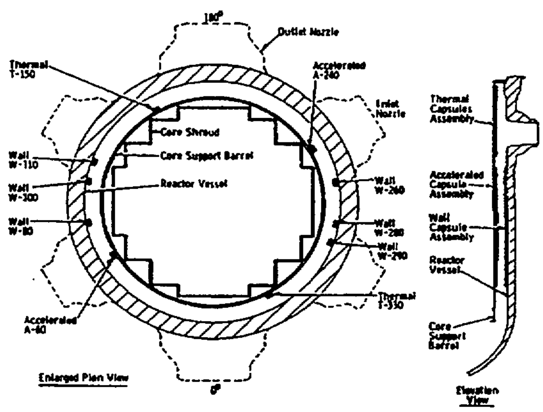
A wall capsule was installed for irradiation in Cycle 9 only and an accelerated capsule was installed for irradiation in Cycles 12 and 13; these are designated as W290-9 and SA60-1, respectively. These capsules had the same external configuration as all others except for minor design changes that were made to facilitate remote installation. Plan views of the Palisades reactor which show the original and supplemental surveillance capsule locations appear in Figure 2.2-1 and the in-vessel surveillance capsule assembly geometry is shown in Figure 2.2-2.

The type and location of the neutron sensors included in the materials surveillance program are described in some detail in References 4 through 7. Specific information pertinent to the individual sensor sets included in Capsules A240, W290, W290-9, W110, and SA60-1 is provided in the appendices to this report.

FIGURE 2.2-1

REACTOR VESSEL CROSS SECTION SHOWING SURVEILLANCE CAPSULE LOCATIONS

Reactor Vessel Cross Section Showing Location of Palisades
Original RVSP Capsules



Reactor Vessel Cross Section Showing Location of Palisades
Supplemental Surveillance Capsules

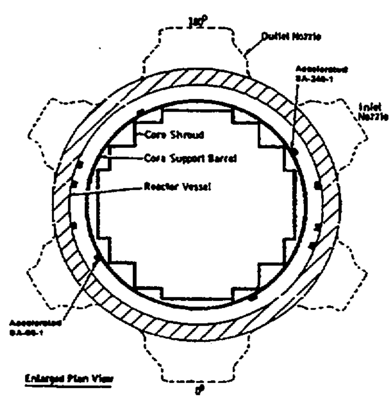
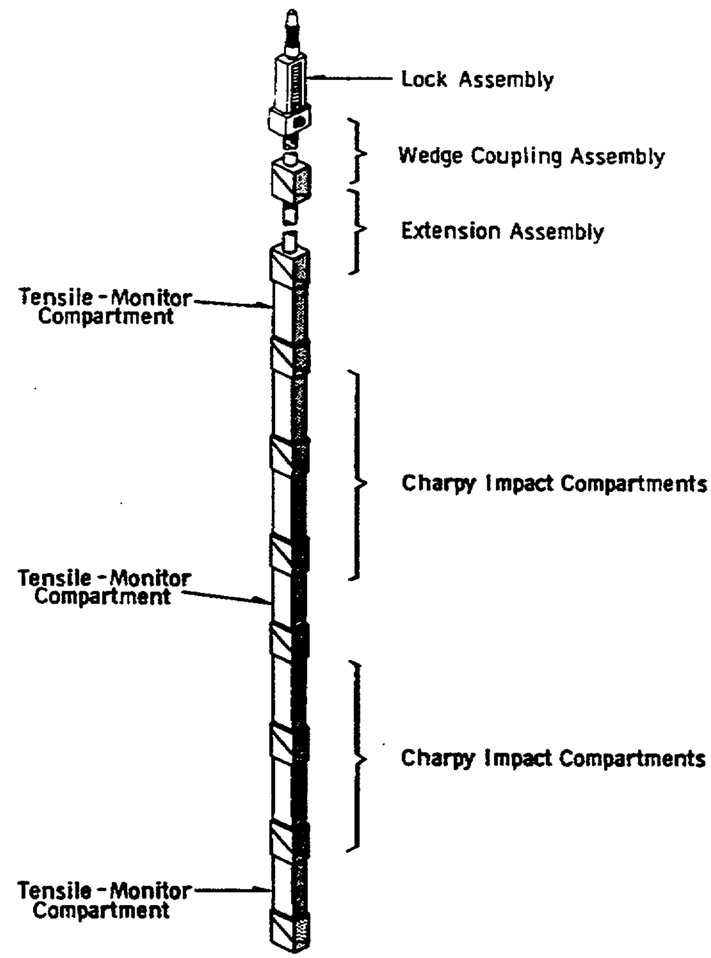


FIGURE 2.2-2

TYPICAL SURVEILLANCE CAPSULE



3 NEUTRON TRANSPORT AND DOSIMETRY EVALUATION METHODOLOGIES

As noted in Section 1 of this report, the exposure of the reactor vessel was determined using plant-specific neutron transport calculations and validated using plant-specific measurements from the reactor cavity and internal surveillance capsules. In this section, the neutron transport and dosimetry evaluation methodologies are discussed in conjunction with the synthesized three-dimensional (3-D) flux solution technique. In addition; the approach used to combine the calculations and measurements to produce the least squares adjusted vessel exposure is presented.

3.1 Neutron Transport Analysis Methods

Fast neutron exposure calculations for the reactor and reactor cavity were carried out using forward discrete ordinates neutron transport calculations in R-Θ, R-Z, and R geometries. The combination of results from these forward calculations were used to construct a three-dimensional (3-D) flux solution based on the following 2-D / 1-D synthesis formula:

$$\phi_g(r,\theta,z) = \phi_g(r,\theta) \times \frac{\phi_g(r,z)}{\phi_g(r)}$$

where

$\phi_g(r,\theta)$ = The group g transport solution in r,θ geometry for a representative axial plane, i.e., at the core midplane.

$\phi_g(r)$ and $\phi_g(r,z)$ = The one- and two-dimensional group g flux solutions whose ratio is used to determine a group-dependent axial shape factor.

This 3-D synthesis approach, which is described in Section 1.3.4 of DG-1053[32], assumes complete separability between the axial and azimuthal flux calculations. However, its use is justified since this synthesis procedure is generally more accurate in preserving the integral properties of the three-dimensional flux relative to other synthesis calculations, e.g., in typical pressure vessel fluence calculations, the synthesized flux is a good approximation to the actual 3-D flux distribution close to the core midplane.

Fuel-cycle specific core power distributions were used in the forward transport calculations to provide the energy distribution of neutrons for use as input to the neutron dosimetry evaluations as well as for use in relating measurement results to the actual exposure at key locations in the reactor vessel wall. In addition, they established the means to compute absolute exposure rate values thus providing a direct comparison with all dosimetry results obtained over the operating history of the reactor.

One important feature associated with the cycle-specific core power distributions that were used to support this neutron fluence evaluation is markedly different relative to the previous evaluation documented in WCAP-14557[8]. Specifically, the neutron source terms supporting the current analysis were determined using CASMO-4, while the corresponding data used to support WCAP-14557[8] were based on CASMO-3. CASMO-4 models light water reactor fuel more accurately than CASMO-3 as a result of the following model changes:

- Expanded resonance calculations to include Gadolinium (Gd) isotopes and additional Plutonium (Pu) isotopes
- New 2-D transport solution -- Method of Characteristics with heterogeneous geometry (CASMO-3 used homogenized cells)
- Expanded pin cell calculation to model Gd explicitly (Previously, Gd was modeled using MICBURN with its approximated fuel buffer region)
- Improved 2-D macrogroup calculation
- Expanded depletion chains for Gd and Erbium (Er)

Incorporating the cycle-specific data to derive neutron energy spectra distributions from the forward calculations provided the means to:

1 - Evaluate the neutron dosimetry from the reactor cavity and surveillance capsule locations.

2 - Enable a direct comparison of analytical prediction with measurement.

3 - Establish a mechanism for projecting the reactor vessel exposure as the design of each new fuel cycle evolves.

A plan view of the first quadrant equivalent reactor geometry at the core midplane elevation is shown in Figures 3.1-1 through 3.1-6. Figure 3.1-1 shows the model used for Cycles 1 through 7, Cycle 9, Cycle 13 and Cycle 14 which did not contain stainless steel shield pins in any of the core peripheral fuel assemblies. With respect to the remaining Palisades cycles, selected UO_2 fuel pins in the core periphery were intentionally replaced by stainless-steel pins in order to reduce the fast ($E > 1.0$ MeV) neutron fluence on the RPV. Hence, the associated R,Θ models for Cycle 8, Cycles 10 through 12, and Cycle 15, that include these shield pins are shown in Figures 3.1-2 through 3.1-6, respectively. With respect to Figure 3.1-6 which shows the R,Θ model for the Cycle 15 core design, it is noted that this cycle was used to determine projected neutron exposures incident on the reactor pressure vessel since future cycles are anticipated to closely resemble the Cycle 15 layout.

For the first quadrant equivalent sector that is depicted in Figures 3.1-1 through 3.1-6, the model shows explicit representations of the "two-zone" core and shield regions, the shroud (or baffle) region, the core bypass water, the core barrel, the inlet (or downcomer) water, the surveillance capsules, the pressure vessel cladding, the pressure vessel, the air between the pressure vessel and the mirror insulation, the insulation, the air in the reactor cavity, the liner for the primary biological shield, and approximately 7.5 inches of the biological shield. Specific information pertaining to the surveillance capsule modeling that is illustrated in these figures is summarized below.

- The surveillance capsule located on the core barrel outer radius at 60° was used to represent the A240 and SA60-1 accelerated capsules that were removed at the EOC 2 and EOC 13, respectively.
- The surveillance capsule adjacent to the reactor pressure vessel cladding at 70° was used to represent the W290, W290-9, and W110 wall capsules that were removed at the EOC 5, EOC 9, and EOC 10, respectively.
- The surveillance capsule adjacent to the reactor pressure vessel cladding at 80° was used to represent the W100 and W280 wall capsules that remain on standby for future dosimetry analyses.

A plan view of the R,Z reactor geometry is provided in Figure 3.1-7. This model was used to represent all of the Palisades fuel cycles considered in this analysis. One key feature of this model is that the total core is represented as a radius of an equivalent area cylinder; hence, the core former region is subsequently represented by a uniform thickness representing an average value. It is further noted that although Cycle 8, Cycles 10 through 12, and Cycle 15 contained stainless steel shield pins in selected peripheral fuel assemblies, these were not modeled in the R,Z (and R) forward transport calculations since: this was already considered in the aforementioned R,Θ forward runs; changes to the volume fractions of the core peripheral materials are homogenized in these calculations; and the results from the R,Z (and R) DORT runs were used to determine the axial flux distribution along the CBMI of the RPV.

The one-dimensional (R) forward transport calculations were simulated by using the R,Z spatial model where a single (1.0 centimeter) Z mesh was used to represent the height of the core and the neutron source was accordingly reduced by a factor that was equivalent to the R,Z model core height, i.e., 334.772 centimeters. As a result of these similarities, a plan view of this model is not shown. It is worthwhile mentioning, however, that all three geometric models utilize the same radial mesh boundaries since this simplifies retrieving results from the various forward transport calculations.

A description of a single surveillance capsule that may be attached to the core support barrel or the reactor vessel cladding is shown in Figure 3.1-8. From a neutronic standpoint, the inclusion of the surveillance capsules and associated support structures in the analytical model is significant. Since the presence of the capsules and structure has a marked impact on the magnitude of the local neutron flux as well as on the relative neutron energy spectra at dosimetry locations within the capsules, a meaningful comparison of measurement and calculation can be made only if these perturbation effects are properly accounted for in the analysis.

In contrast to the relatively massive stainless steel and carbon steel structures associated with the internal surveillance capsules, the small aluminum capsules used in the reactor cavity measurement program were designed to minimize perturbations in the neutron flux, and thus, provide free-field data at the measurement locations. Therefore, explicit modeling of these small capsules in the forward transport models was not required.

The forward transport calculations for the reactor model depicted in Figures 3.1-1 through 3.1-7 were carried out in R-Θ, R-Z, and R geometries using the DORT two-dimensional discrete ordinates transport theory code[9] and the BUGLE-96 cross-section library[10]. The BUGLE-96 library is a 47 neutron and 20 gamma ray energy group, ENDF/B-VI based, data set produced specifically for light water reactor applications. In these analyses, anisotropic scattering was treated with a P_5 expansion of the scattering cross-sections and the angular discretization was modeled with an S_{16} order of angular quadrature.

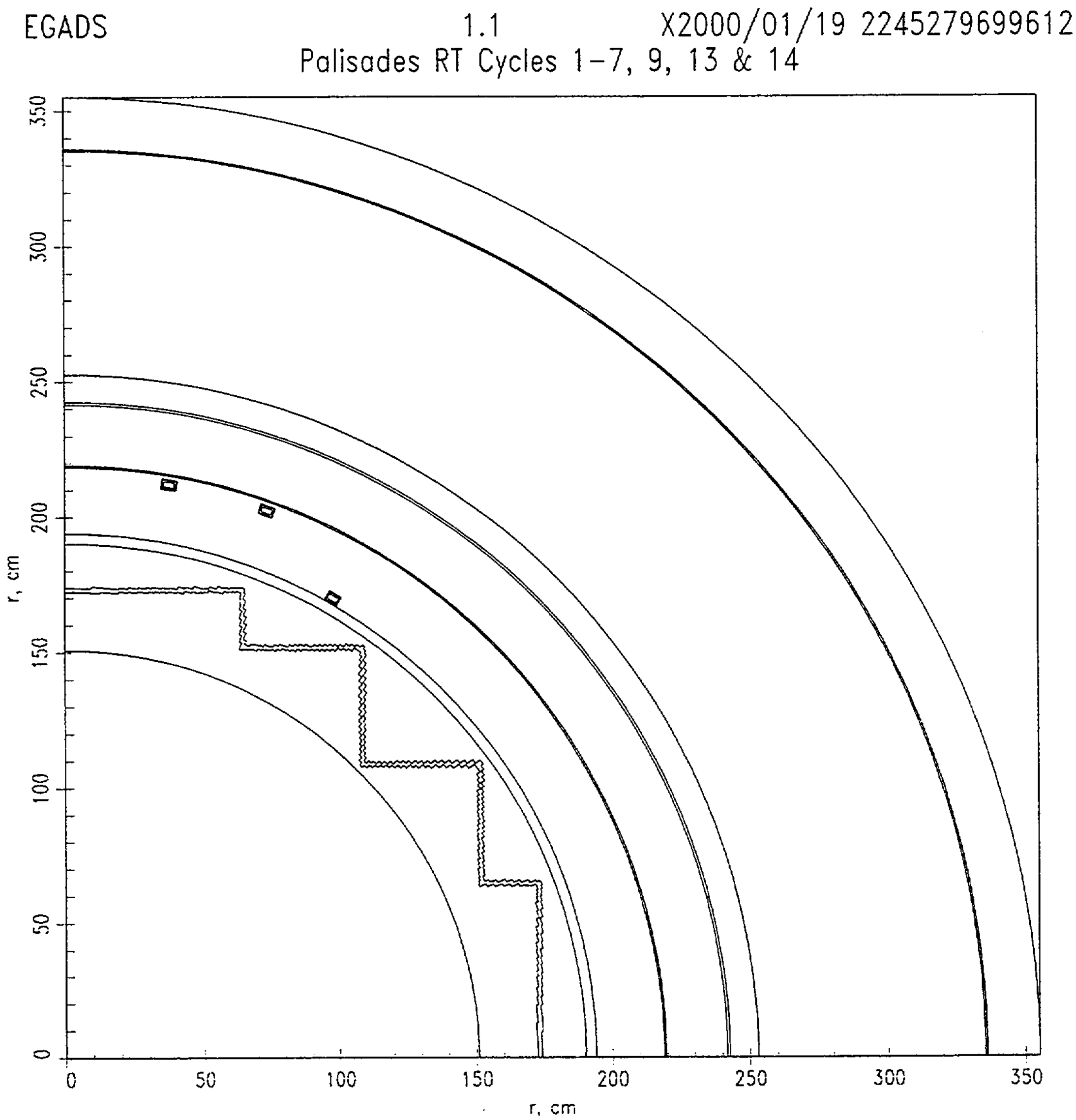
The forward calculations were normalized to a core midplane power density and for operation at a thermal power level of 2530 MWt. The axial and radial core power distributions utilized in the forward calculations were supplied by Consumers Energy[11]. The radial power distributions were supplied as pin-by-pin power distributions, initial enrichments, and cycle burnups for each fuel assembly in the quadrant. The neutron source was derived for each fuel pin and for each assembly using burnup dependent values of the fission neutron energy spectrum, neutrons per fission, and energy per fission evaluated at the mean assembly burnup value for each cycle. The source spectrum was calculated by determining the fraction of fissions occurring in each of the important uranium and plutonium isotopes for the mid-cycle burnup and calculating the resultant average fission spectrum using the BUGLE-96 values of ENDF/B-VI fission spectrum for each isotope.

The source from each fuel assembly was spatially located to take into account the varying gaps between fuel assemblies, and thus, represents the location of source from each fuel pin as accurately as possible. Details of the fuel assembly locations, core geometry, and other reactor parameters were taken from References 6, 8 and 11. The cycle-specific midplane coolant temperatures were determined using the thermal-hydraulic model in SIMULATE. This data, along with the cycle-specific bypass and core inlet temperatures, were provided in Reference 11.

The results of the DORT forward calculations are given in Section 6 of this report.

FIGURE 3.1-1

REACTOR GEOMETRY SHOWING A 90° R,Θ SECTOR FOR CYCLES 1 - 7, 9, 13 AND 14



NOTES:

(1) In the first quadrant equivalent figure shown above, the X axis represents 0° and the Y axis represents 90°.

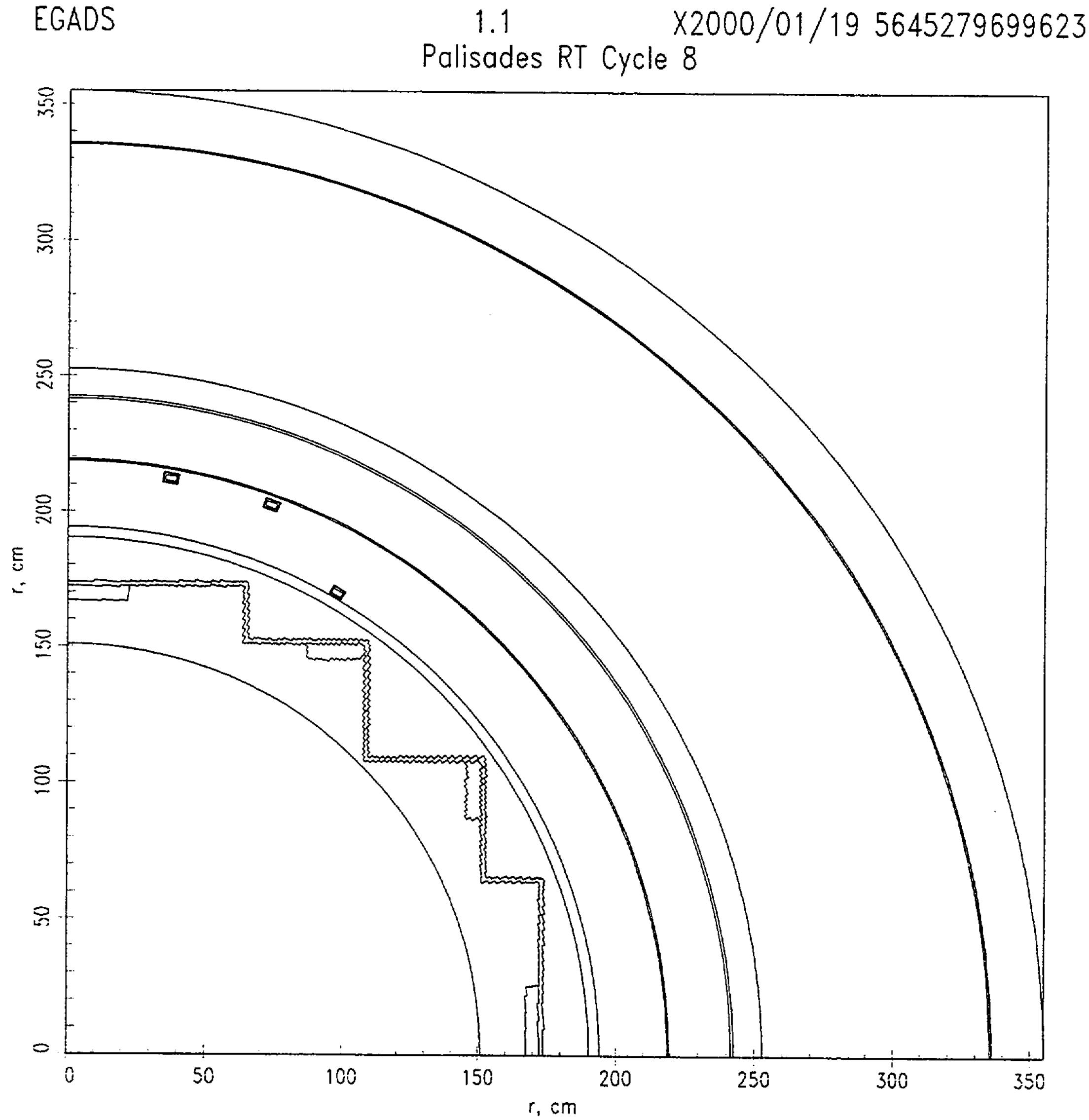
(2) The accelerated capsule shown at 60° in the figure above represents the A240 and SA60-1 capsules that were removed at the EOC 2 and EOC 13, respectively.

(3) The wall capsule shown at 70° in the figure above represents the W290, W290-9, and W110 capsules that were removed at the EOC 5, EOC 9, and EOC 10, respectively.

(4) The wall capsule shown at 80° in the figure above represents the W100 and W280 capsules that have not been removed, i.e., they are all on standby.

FIGURE 3.1-2

REACTOR GEOMETRY SHOWING A 90° R,Θ SECTOR FOR CYCLE 8



NOTES:

(1) In the first quadrant equivalent figure shown above, the X axis represents 0° and the Y axis represents 90°.

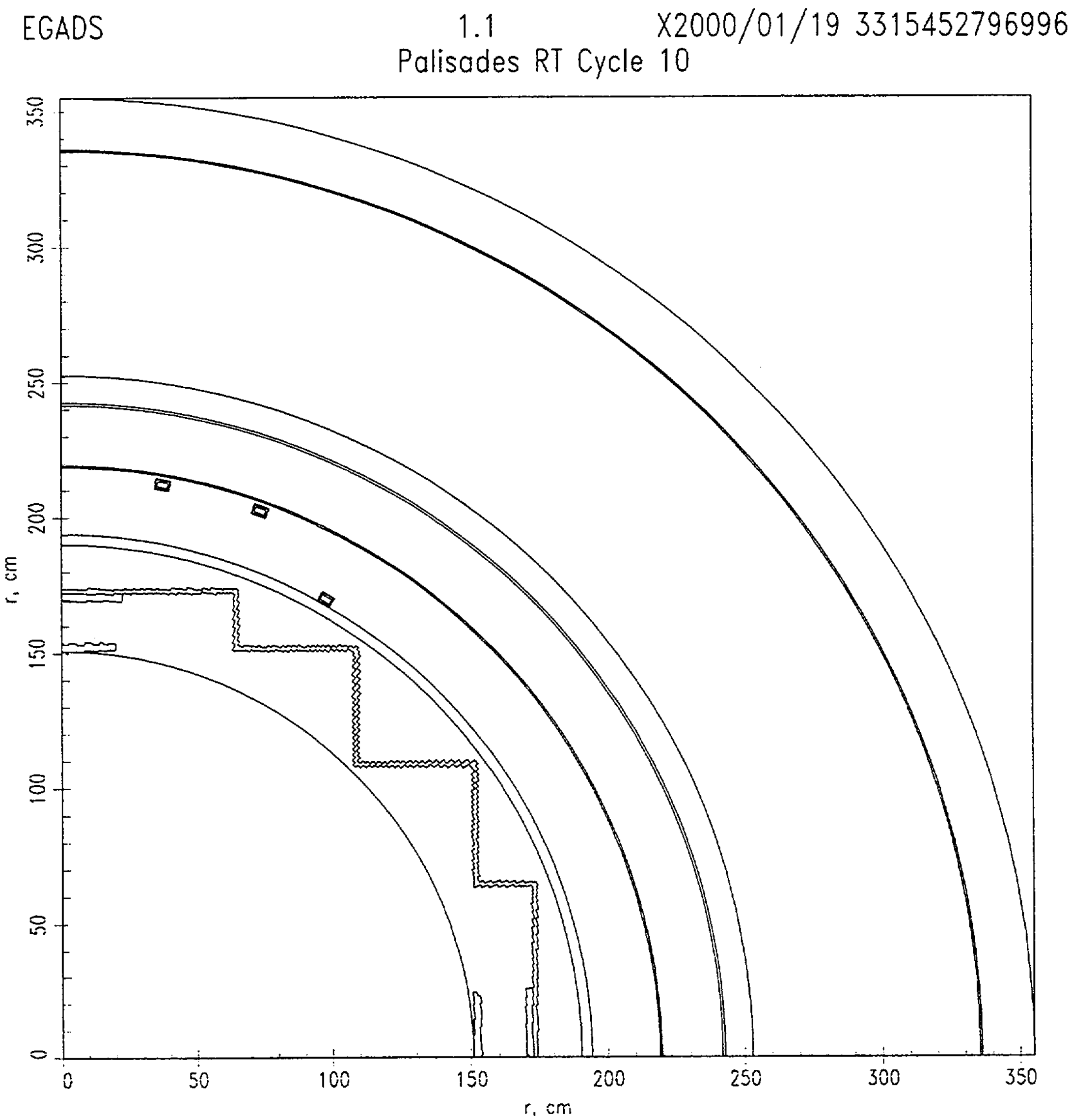
(2) The accelerated capsule shown at 60° in the figure above represents the A240 and SA60-1 capsules that were removed at the EOC 2 and EOC 13, respectively.

(3) The wall capsule shown at 70° in the figure above represents the W290, W290-9, and W110 capsules that were removed at the EOC 5, EOC 9, and EOC 10, respectively.

(4) The wall capsule shown at 80° in the figure above represents the W100 and W280 capsules that have not been removed, i.e., they are all on standby.

FIGURE 3.1-3

REACTOR GEOMETRY SHOWING A 90° R,Θ SECTOR FOR CYCLE 10



NOTES:

(1) In the first quadrant equivalent figure shown above, the X axis represents 0° and the Y axis represents 90°.

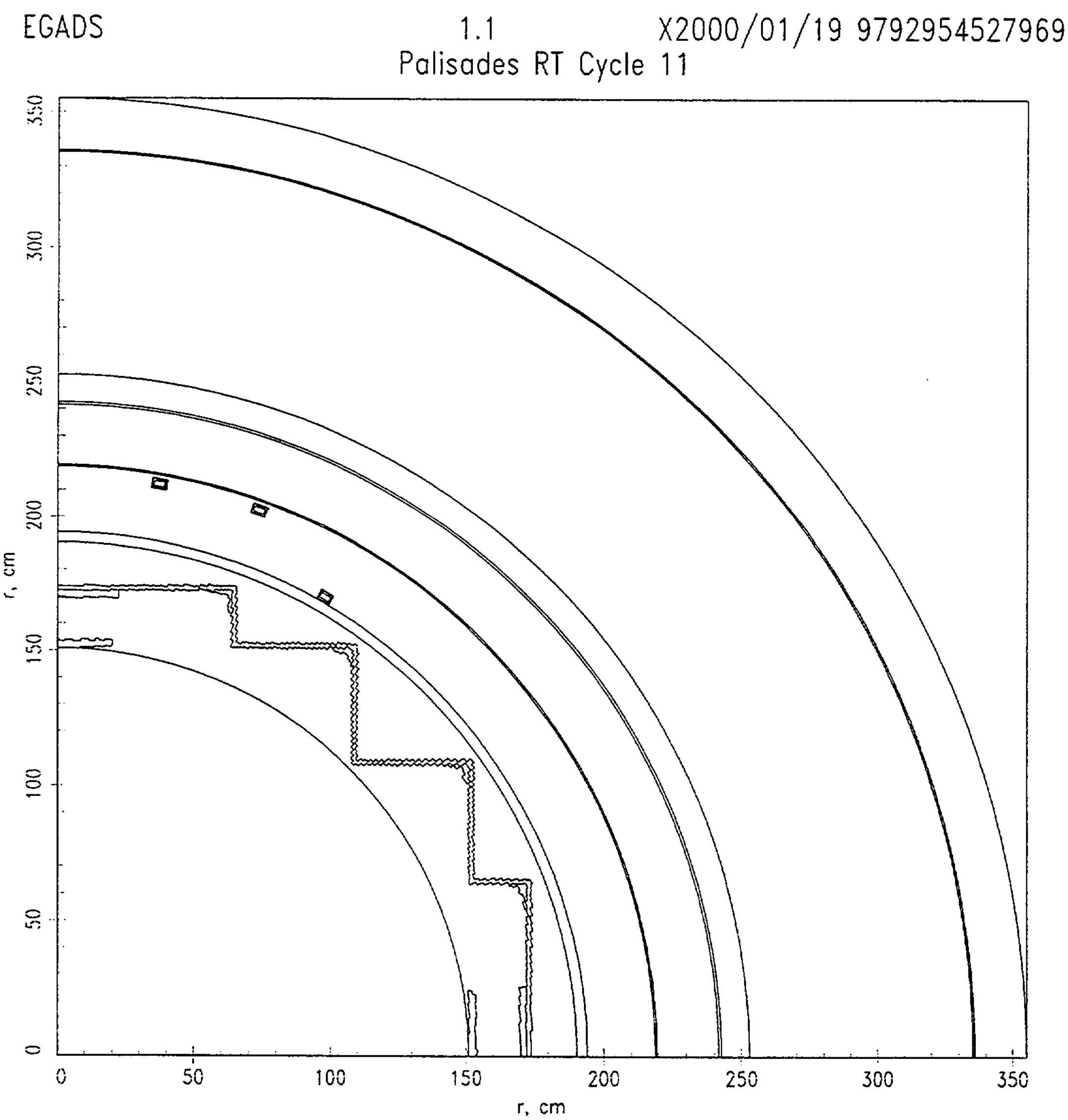
(2) The accelerated capsule shown at 60° in the figure above represents the A240 and SA60-1 capsules that were removed at the EOC 2 and EOC 13, respectively.

(3) The wall capsule shown at 70° in the figure above represents the W290, W290-9, and W110 capsules that were removed at the EOC 5, EOC 9, and EOC 10, respectively.

(4) The wall capsule shown at 80° in the figure above represents the W100 and W280 capsules that have not been removed, i.e., they are all on standby.

FIGURE 3.1-4

REACTOR GEOMETRY SHOWING A 90° R,Θ SECTOR FOR CYCLE 11



NOTES:

(1) In the first quadrant equivalent figure shown above, the X axis represents 0° and the Y axis represents 90°.

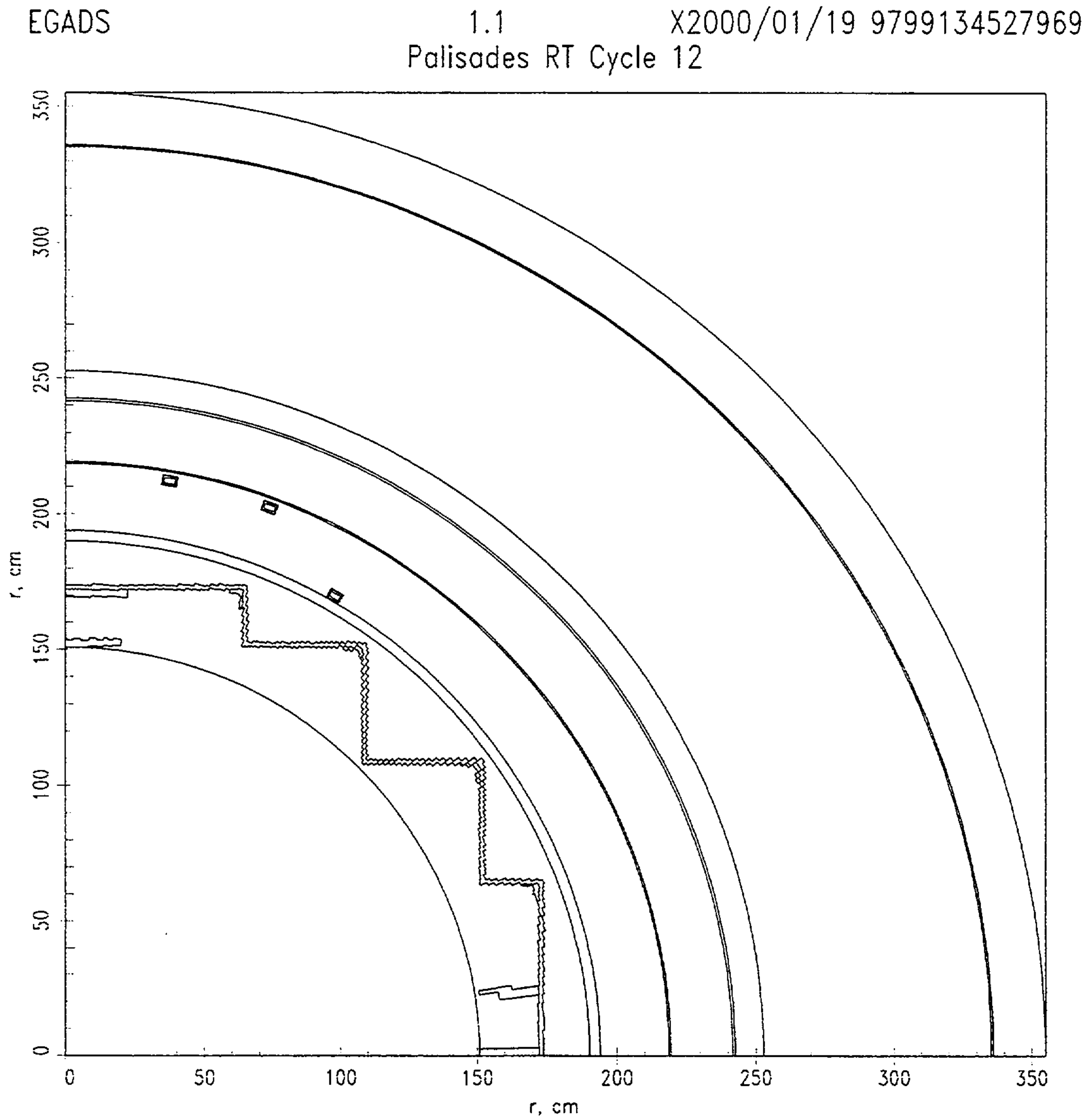
(2) The accelerated capsule shown at 60° in the figure above represents the A240 and SA60-1 capsules that were removed at the EOC 2 and EOC 13, respectively.

(3) The wall capsule shown at 70° in the figure above represents the W290, W290-9, and W110 capsules that were removed at the EOC 5, EOC 9, and EOC 10, respectively.

(4) The wall capsule shown at 80° in the figure above represents the W100 and W280 capsules that have not been removed, i.e., they are all on standby.

FIGURE 3.1-5

REACTOR GEOMETRY SHOWING A 90° R,Θ SECTOR FOR CYCLE 12



NOTES:

(1) In the first quadrant equivalent figure shown above, the X axis represents 0° and the Y axis represents 90°.

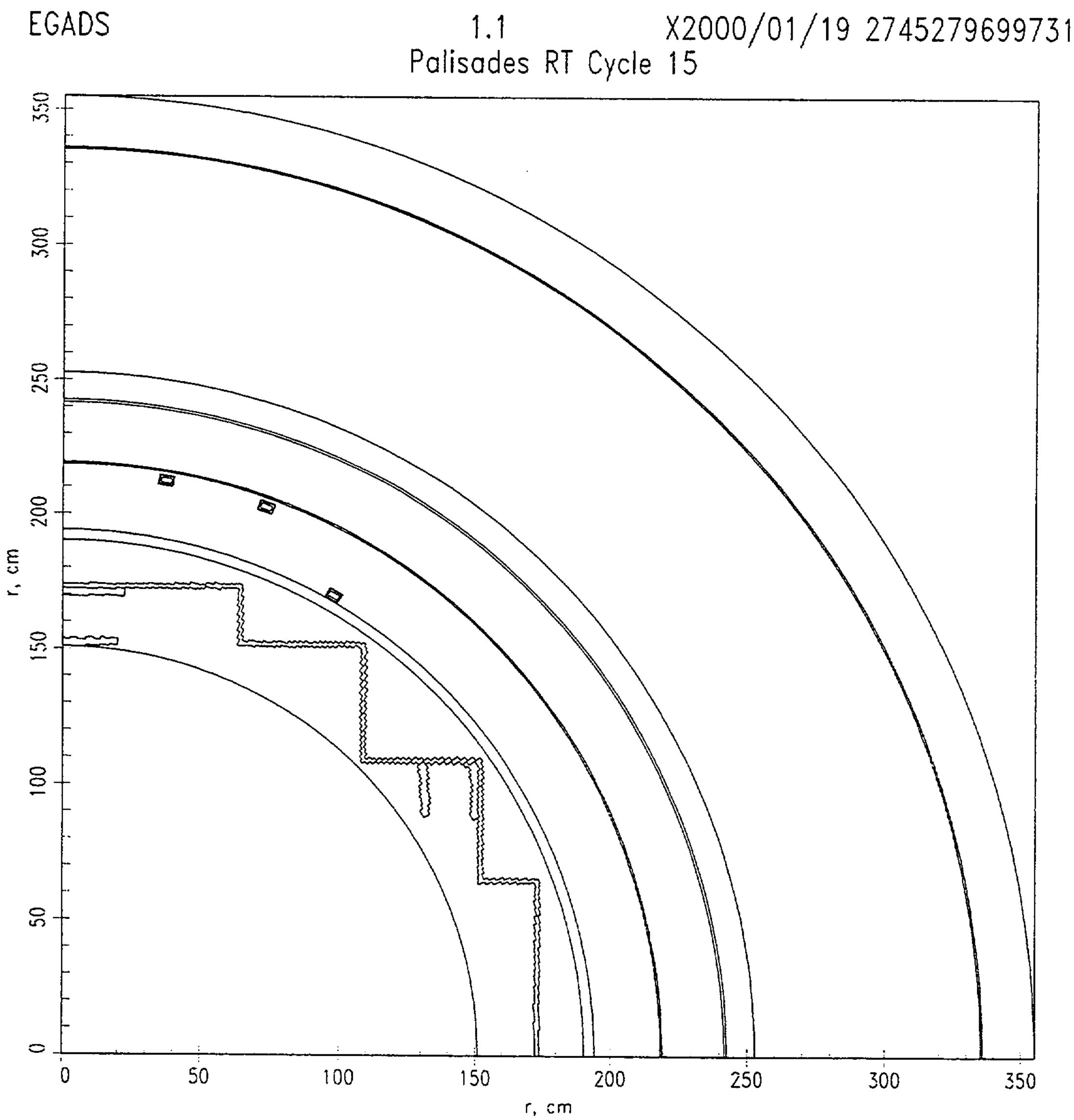
(2) The accelerated capsule shown at 60° in the figure above represents the A240 and SA60-1 capsules that were removed at the EOC 2 and EOC 13, respectively.

(3) The wall capsule shown at 70° in the figure above represents the W290, W290-9, and W110 capsules that were removed at the EOC 5, EOC 9, and EOC 10, respectively.

(4) The wall capsule shown at 80° in the figure above represents the W100 and W280 capsules that have not been removed, i.e., they are all on standby.

FIGURE 3.1-6

REACTOR GEOMETRY SHOWING A 90° R,Θ SECTOR FOR CYCLE 15



NOTES:

(1) In the first quadrant equivalent figure shown above, the X axis represents 0° and the Y axis represents 90°.

(2) The accelerated capsule shown at 60° in the figure above represents the A240 and SA60-1 capsules that were removed at the EOC 2 and EOC 13, respectively.

(3) The wall capsule shown at 70° in the figure above represents the W290, W290-9, and W110 capsules that were removed at the EOC 5, EOC 9, and EOC 10, respectively.

(4) The wall capsule shown at 80° in the figure above represents the W100 and W280 capsules that have not been removed, i.e., they are all on standby.

FIGURE 3.1-7

REACTOR GEOMETRY SHOWING THE R,Z CYLINDER FOR CYCLES 1 THROUGH 15

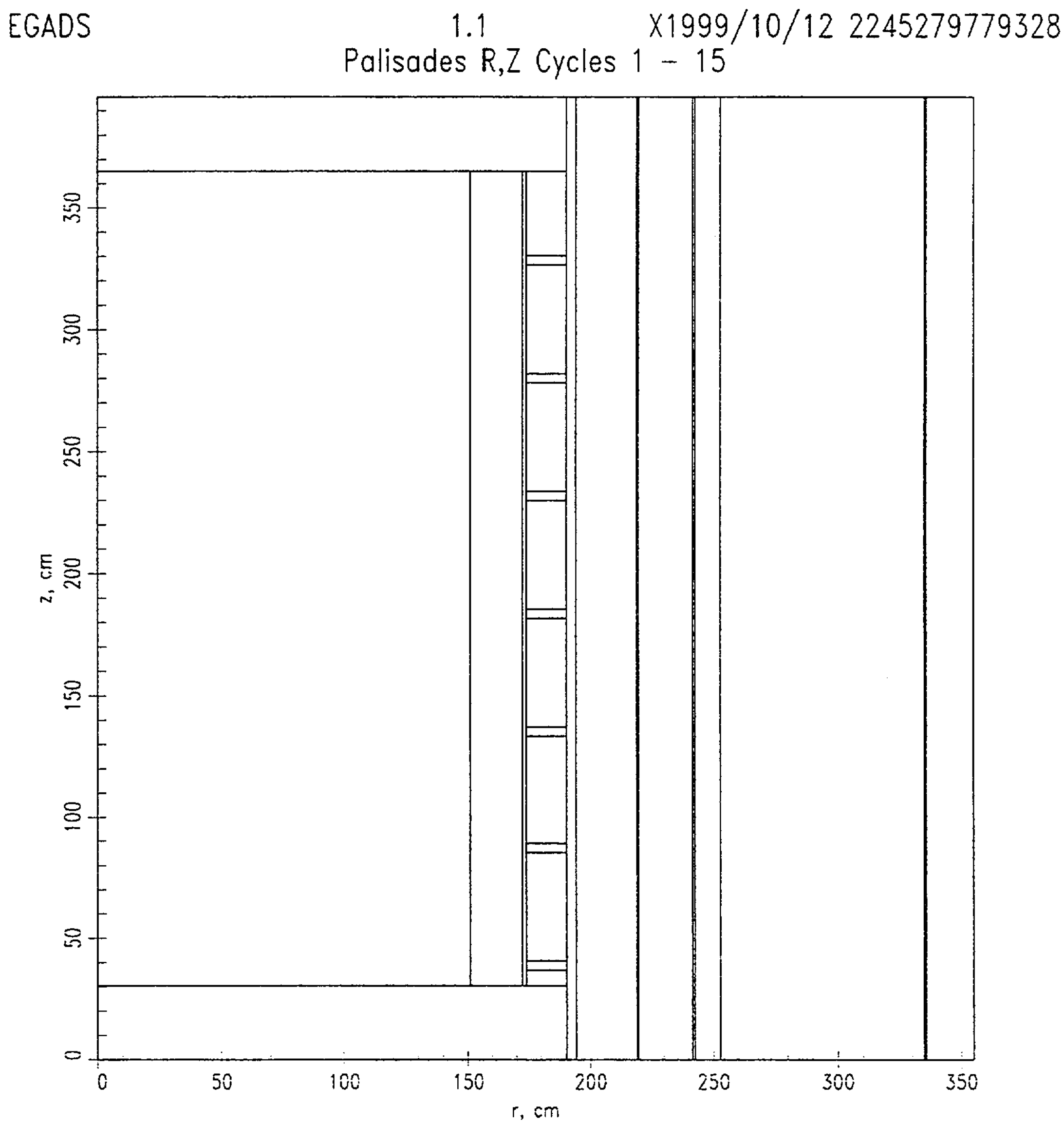
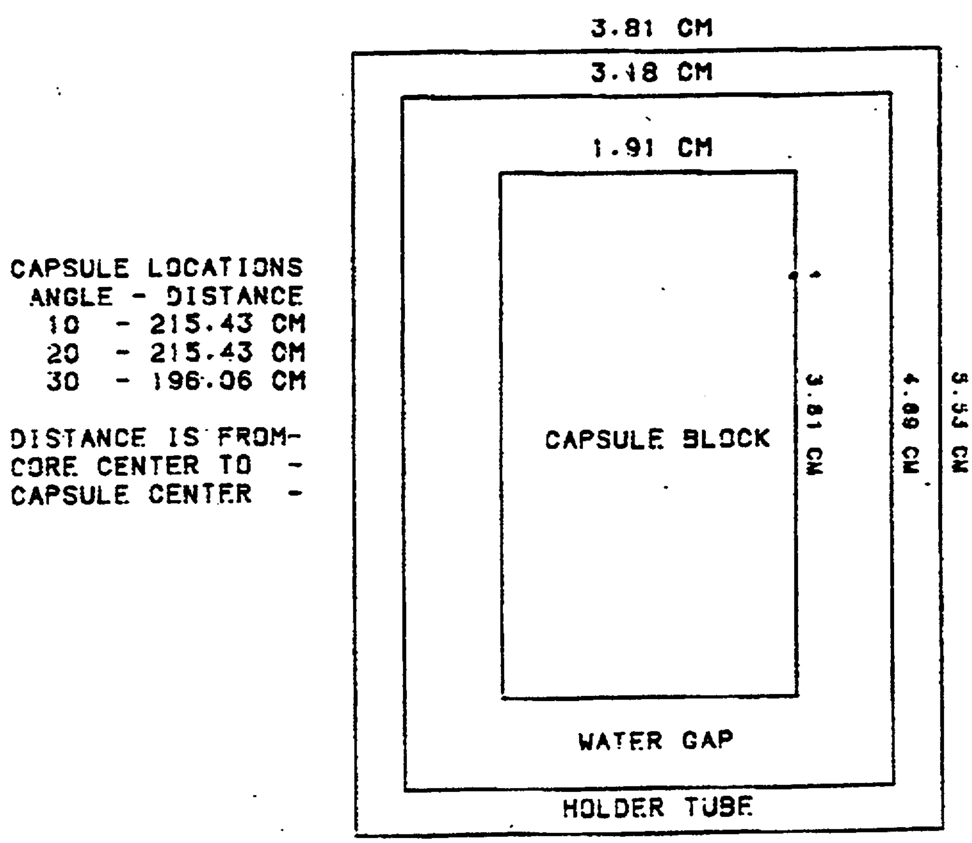


FIGURE 3.1-8

INTERNAL SURVEILLANCE CAPSULE GEOMETRY



3.2 Neutron Dosimetry Evaluation Methodology

The use of passive neutron sensors such as those included in the internal surveillance capsule and reactor cavity dosimetry sets does not yield a direct measure of the energy dependent neutron flux level at the measurement location. Rather, the activation or fission process is a measure of the integrated effect that the time- and energy-dependent neutron flux has on the target material over the course of the irradiation period. An accurate assessment of the average flux level, and hence, time integrated exposure (fluence) experienced by the sensors may be developed from the measurements only if the sensor characteristics and the parameters of the irradiation are well known. In particular, the following variables are of interest:

1 - The measured specific activity of each sensor,
2 - The physical characteristics of each sensor,
3 - The operating history of the reactor,
4 - The energy response of each sensor,
5 - The neutron energy spectrum at the sensor location.

In this section, the procedures used by Westinghouse to determine sensor-specific activities, to develop reaction rates for individual sensors from the measured specific activities and the operating history of the reactor, and the derivation of key fast neutron exposure parameters from the measured reaction rates are described.

For the most part, these procedures apply to all of the evaluations provided in this report. However, in the case of internal surveillance capsule A240, the specific activities of the multiple foil sensor set were determined from prior analysis performed by Battelle Columbus Laboratory[4]. In this case, the source of the measured specific activity data was referenced and the remainder of the data evaluation proceeded using the methodology described in this section.

3.2.1 Determination of Sensor Reaction Rates

Following irradiation, the multiple foil sensor sets from surveillance capsule and reactor cavity irradiations along with reactor cavity gradient chains were recovered and transported for evaluation. Analysis of all radiometric foils from Capsules W290, W290-9, and W110, as well as the gradient chains was performed at the Westinghouse Analytical Services Laboratory at the Waltz Mill Site. Capsule A240 was processed by Battelle Columbus Laboratory and Capsule SA60-1 was processed by BWX Technologies, Incorporated (Reference 35).

3.2.1.1 Radiometric Sensors

The specific activity of each of the radiometric sensors and gradient chain segments was determined using established ASTM procedures[12 through 25]. Following sample preparation and weighing, the specific activity of each sensor was determined by means of a lithium drifted germanium, Ge(Li), gamma spectrometer. In the case of the surveillance capsule and reactor cavity multiple foil sensor sets, these analyses were performed by direct counting of each of the individual foils or wires; or, as in the case of ^{238}U and ^{237}Np fission monitors from internal surveillance capsules, by direct counting preceded by dissolution and chemical separation of cesium from the sensor. For the stainless steel gradient chains used in the reactor cavity irradiations, individual sensors were obtained by cutting the chains into a series of segments to provide data points at six-inch to one-foot intervals. For the long gradient chains, the data points encompass an axial span from 4.5 feet below the core midplane to 8.0 feet above the core midplane. For the short gradient chains, which are attached to the support bar, the data points encompass an axial span from 5.5 feet below the core midplane to 0.5 feet above the core midplane.

The irradiation history of the reactor over the first ten operating cycles was obtained from NUREG-0020, "Licensed Operating Reactors Status Summary Report" and the irradiation history of Cycles 11 through 14 were supplied by Consumers Energy[26]. In particular, operating data were extracted from these reports on a monthly basis from reactor startup to the end of the current evaluation period. For the sensor sets utilized in surveillance capsule and reactor cavity irradiations, the half-lives of the product isotopes are long enough that a monthly histogram describing reactor operation has proven to be an adequate representation for use in radioactive decay corrections for the reactions of interest in the exposure evaluations.

Having the measured specific activities, the operating history of the reactor, and the physical characteristics of the sensors, reaction rates referenced to full power operation at 2530 MWt were determined from the following equation:

$$R = \frac{A}{N_0 \, F \, Y \sum_j \frac{P_j}{P_{ref}} \, C_j \, [1 - e^{-\lambda t_j}] \, e^{-\lambda t_d}}$$

where:

A	=	measured specific activity (dps/gm)
R	=	reaction rate averaged over the irradiation period and referenced to operation at a core power level of P_{ref} (rps/nucleus).
N_0	=	number of target element atoms per gram of sensor.
F	=	weight fraction of the target isotope in the sensor material.
Y	=	number of product atoms produced per reaction.
P_j	=	average core power level during irradiation period j (MW).
P_{ref}	=	maximum or reference core power level of the reactor (MW).
C_j	=	calculated ratio of $\phi(E > 1.0 \text{ MeV})$ during irradiation period j to the time weighted average $\phi(E > 1.0 \text{ MeV})$ over the entire irradiation period.

λ = decay constant of the product isotope (1/second).
t_j = length of irradiation period j (second).
t_d = decay time following irradiation period j (second).

and the summation is carried out over the total number of monthly intervals comprising the total irradiation period.

In the above equation, the ratio P_j/P_{ref} accounts for month-by-month variation of power level within a given fuel cycle. The ratio C_j is calculated for each fuel cycle using the forward transport methodology and accounts for the change in sensor reaction rates caused by variations in flux level due to changes in core power spatial distributions from fuel cycle to fuel cycle. For a single cycle irradiation, $C_j = 1.0$. However, for multiple cycle irradiations, particularly those employing low leakage fuel management, the additional C_j correction must be utilized.

3.2.1.2 Corrections to Reaction Rate Data

Prior to using the measured reaction rates in the least squares adjustment procedure discussed in Section 3.2.2 of this report, additional corrections were made to the ^{238}U foil measurements to account for the presence of ^{235}U impurities in the sensors as well as to adjust for the build-in of plutonium isotopes over the course of the irradiation. These corrections were location and fluence dependent and were derived from the data obtained from the forward transport calculations.

In addition to the corrections made for the presence of ^{235}U in the ^{238}U fission sensors, corrections were also made to both the ^{238}U and ^{237}Np sensor reaction rates to account for gamma ray induced fission reactions occurring over the course of the irradiation. These photo-fission corrections were, likewise, location dependent and were also based on the forward transport calculations described in Section 3.1.

3.2.2 Least Squares Adjustment Procedure

Values of key fast neutron exposure parameters were derived from the measured reaction rates using the FERRET least squares adjustment code[27]. The FERRET approach used the measured reaction rate data, sensor reaction cross-sections, and a calculated trial spectrum as input and proceeded to adjust the group fluxes from the trial spectrum to produce a best fit (in a least squares sense) to the measured reaction rate data. The "measured" exposure parameters along with the associated uncertainties were then obtained from the adjusted spectrum.

In the FERRET evaluations, a log-normal least squares algorithm weights both the trial values and the measured data in accordance with the assigned uncertainties and correlations. In general, the measured values f are linearly related to the flux ϕ by some response matrix A:

$$f_i^{(s,\alpha)} = \sum_g A_{ig}^{(s)} \phi_g^{(\alpha)}$$

where i indexes the measured values belonging to a single data set s, g designates the energy group, and α delineates spectra that may be simultaneously adjusted. For example,

$$R_i = \sum_g \sigma_{ig} \phi_g$$

relates a set of measured reaction rates R_i to a single spectrum ϕ_g by the multi-group reaction cross-section σ_{ig}. The log-normal approach automatically accounts for the physical constraint of positive fluxes, even with large assigned uncertainties.

In the least squares adjustment, the continuous quantities (i.e., neutron spectra and cross-sections) were approximated in a multi-group format consisting of 53-energy groups. The trial input spectrum was converted to the FERRET 53-group structure using the SAND-II code[28]. This procedure was carried out by first expanding the 47 group calculated spectrum into the SAND-II 620-group structure using a spline interpolation procedure in regions where group boundaries do not coincide. The 620-point spectrum was then re-collapsed into the group structure used in FERRET.

The sensor set reaction cross-sections, obtained from the ENDF/B-VI based SNLRML dosimetry library[29], were also collapsed into the 53 energy group structure using the SAND-II code. In this instance, the trial spectrum, as expanded to 620 groups, was employed as a weighting function in the cross-section collapsing procedure. Reaction cross-section uncertainties in the form of a 53×53 covariance matrix for each sensor reaction were also constructed from the information contained on the SNLRML dosimetry library. These matrices included energy group to energy group uncertainty correlations for each of the individual reactions. However, correlations between cross-sections for different sensor reactions were not included. The omission of this additional uncertainty information does not significantly impact the results of the adjustment.

Due to the importance of providing a trial spectrum that exhibits a relative energy distribution close to the actual spectrum at the sensor set locations, the neutron spectrum input to the FERRET evaluation was obtained from the plant-specific calculation for each dosimetry location. While the 53×53 group covariance matrices applicable to the sensor reaction cross-sections were developed from the cross-section data files, the covariance matrix for the input trial spectrum was constructed from the following relation:

$$M_{gg'} = R_n^2 + R_g R_{g'} P_{gg'}$$

where R_n specifies an overall fractional normalization uncertainty (i.e., complete correlation) for the set of values. The fractional uncertainties R_g specify additional random uncertainties for group g that are correlated with a correlation matrix given by:

$$P_{gg'} = [1-\theta]\, \delta_{gg'} + \theta\, e^{-H}$$

where:

$$H = \frac{(g-g')^2}{2\gamma^2}$$

The first term in the correlation matrix equation specifies purely random uncertainties, while the second term describes short-range correlations over a group range γ (θ specifies the strength of the latter term). The value of δ is 1 when $g = g'$ and is 0 otherwise. For the trial spectrum used in the current evaluations, a short range correlation of γ = 6 groups was used. This choice implies that neighboring groups are strongly correlated when θ is close to 1. Strong long range correlations (or anti-correlations) were justified based on information presented by R. E. Maerker[30]. Maerker's results are closely duplicated when γ = 6. For the integral reaction rate covariances, simple normalization and random uncertainties were combined as deduced from experimental uncertainties.

In performing the least squares adjustment with the FERRET code, the fast (E > 1.0 MeV) neutron flux spectra calculated at the center of the dosimetry location was input to the analyses. The specific assignment of uncertainties in the measured reaction rates and the input (trial) spectra used in the FERRET evaluations was as follows:

REACTION RATE UNCERTAINTY	
Activation Monitors	5%
Fission Monitors	10%
FLUX NORMALIZATION UNCERTAINTY	15%
FLUX GROUP UNCERTAINTIES	
(E > 0.0055 MeV)	15%
(0.68 eV < E < 0.0055 MeV)	29%
(E < 0.68 eV)	52%
SHORT-RANGE CORRELATION	
(E > 0.0055 MeV)	0.9
(0.68 eV < E < 0.0055 MeV)	0.5
(E < 0.68 eV)	0.5

FLUX GROUP CORRELATION RANGE	
(E > 0.0055 MeV)	6
(0.68 eV < E < 0.0055 MeV)	3
(E < 0.68 eV)	2

It should be noted that the 29% group uncertainty in the second range is made up of a 15% uncertainty with a 0.9 short range correlation and a range of 6, and a second part of magnitude 25% with a 0.5 correlation and a range of 3, i.e., $[(0.15)^2 + (0.25)^2]^{1/2}$. Similarly, the 52% group uncertainty in the third range is made up of a 15% uncertainty with a 0.9 short range correlation and a range of 6, and a second part of magnitude 50% with a 0.5 correlation and a range of 2, i.e., $[(0.15)^2 + (0.50)^2]^{1/2}$. Including the flux normalization uncertainty results in a total uncertainty of 21% for the groups in the upper energy range, 33% in the mid-energy range, and 54% in the lowest-energy range which encompasses the thermal-flux region.

These input uncertainty assignments were based on prior experience in using the FERRET least squares adjustment approach in the analysis of neutron dosimetry from surveillance capsule, reactor cavity, and benchmark irradiations. The values are liberal enough to permit adjustment of the input spectrum to fit the measured data for all practical applications.

4 NEUTRON DOSIMETRY EVALUATIONS

4.1 ANALYTICAL RESULTS AT THE MEASUREMENT LOCATIONS

As noted in Section 3 of this report, data from the cycle specific forward transport calculations were used in evaluating dosimetry from both reactor cavity and surveillance capsule irradiations as well as in relating the results of these evaluations to the neutron exposure of the reactor vessel wall. In this section, the key data extracted from the forward calculations are presented and their relevance to the dosimetry evaluations is discussed. This fluence methodology is consistent with the approved method specified in Reference 31.

4.1.1 Reactor Cavity Sensor Set Locations

Data from the Cycle 8, Cycle 9, and Cycles 10 / 11 specific forward calculations pertinent to reactor cavity sensor evaluations are provided in Tables 4.1-1 through 4.1-3. Specifically, the calculated neutron energy spectra are listed for the dosimetry locations at 24°, 39°, 54°, 64°, 74°, and 84° relative to the first quadrant equivalent (FQE) at the axial core midplane and at the radial locations in the reactor cavity corresponding to the dosimetry positions as described in Section 2.

Table 4.1-1 presents the four spectra used for the analysis of the Cycle 8 dosimetry. Table 4.1-2 presents the six spectra used for the analysis of the Cycle 9 dosimetry, and Table 4.1-3 presents the seven spectra used for the analysis of the Cycle 10 / 11 dosimetry. These data represent the trial spectra used as the starting guess in the FERRET least squares adjustment evaluations of the reactor cavity sensor sets. On a relative basis, these calculated energy distributions establish a baseline against which adjusted spectra may be compared.

4.1.2 Surveillance Capsule Locations

Data from the cycle-specific forward calculation pertinent to surveillance capsule evaluations are provided in Table 4.1-4.

In Table 4.1-4, the calculated neutron energy spectra at the geometric center of surveillance capsules located at 60° (also symmetric to the actual location of 240°) and radially at 196.055 cm and 70° (symmetric to the actual locations of 110° and 290°) and radially at 215.430 cm are listed.

TABLE 4.1-1

CALCULATED NEUTRON ENERGY SPECTRA
AT THE REACTOR CAVITY SENSOR SET LOCATIONS FOR CYCLE 8

Lower Energy (MeV)	Neutron Flux (n/cm^2-sec) Azimuthal Angle 74°	64°	64° Bottom	39°
1.42E+01	3.413E+05	2.773E+05	8.798E+04	2.020E+05
1.22E+01	9.604E+05	7.683E+05	2.432E+05	5.475E+05
1.00E+01	3.711E+06	2.906E+06	9.164E+05	2.007E+06
8.61E+00	6.779E+06	5.261E+06	1.664E+06	3.593E+06
7.41E+00	1.019E+07	7.778E+06	2.470E+06	5.222E+06
6.07E+00	2.154E+07	1.623E+07	5.167E+06	1.081E+07
4.97E+00	2.858E+07	2.145E+07	7.010E+06	1.432E+07
3.68E+00	4.880E+07	3.666E+07	1.242E+07	2.481E+07
3.01E+00	3.766E+07	2.859E+07	9.938E+06	1.958E+07
2.73E+00	2.971E+07	2.245E+07	7.811E+06	1.533E+07
2.47E+00	3.590E+07	2.749E+07	9.758E+06	1.911E+07
2.35E+00	2.444E+07	1.848E+07	6.483E+06	1.258E+07
2.23E+00	2.949E+07	2.212E+07	7.685E+06	1.475E+07
1.92E+00	8.109E+07	6.146E+07	2.158E+07	4.143E+07
1.65E+00	1.157E+08	8.771E+07	3.079E+07	5.865E+07
1.35E+00	1.946E+08	1.501E+08	5.404E+07	1.032E+08
1.00E+00	4.749E+08	3.691E+08	1.342E+08	2.538E+08
8.21E-01	4.682E+08	3.673E+08	1.342E+08	2.533E+08
7.43E-01	1.916E+08	1.591E+08	6.339E+07	1.227E+08
6.08E-01	1.064E+09	8.431E+08	3.133E+08	5.831E+08
4.98E-01	8.648E+08	7.088E+08	2.789E+08	5.251E+08
3.69E-01	9.299E+08	7.726E+08	3.076E+08	5.887E+08
2.98E-01	1.461E+09	1.202E+09	4.643E+08	8.801E+08

NOTE: The upper energy of group 1 is 17.33 MeV.

TABLE 4.1-1 (continued)

CALCULATED NEUTRON ENERGY SPECTRA
AT THE REACTOR CAVITY SENSOR SET LOCATIONS FOR CYCLE 8

Lower Energy (MeV)	Neutron Flux (n/cm^2-sec) Azimuthal Angle 74°	64°	64° Bottom	39°
1.83E-01	1.474E+09	1.287E+09	5.409E+08	1.057E+09
1.11E-01	1.570E+09	1.372E+09	5.732E+08	1.123E+09
6.74E-02	8.975E+08	8.023E+08	3.462E+08	6.823E+08
4.09E-02	6.030E+08	5.518E+08	2.470E+08	4.878E+08
3.18E-02	1.773E+08	1.672E+08	7.813E+07	1.545E+08
2.61E-02	8.729E+07	8.388E+07	3.978E+07	7.939E+07
2.42E-02	4.090E+08	3.458E+08	1.354E+08	2.605E+08
2.18E-02	2.511E+08	2.179E+08	8.979E+07	1.736E+08
1.50E-02	3.687E+08	3.396E+08	1.518E+08	3.016E+08
7.10E-03	4.484E+08	4.277E+08	2.020E+08	4.006E+08
3.36E-03	4.468E+08	4.237E+08	1.957E+08	3.930E+08
1.59E-03	3.661E+08	3.507E+08	1.649E+08	3.301E+08
4.54E-04	5.483E+08	5.266E+08	2.488E+08	4.974E+08
2.14E-04	2.586E+08	2.506E+08	1.190E+08	2.394E+08
1.01E-04	2.698E+08	2.605E+08	1.234E+08	2.476E+08
3.73E-05	3.295E+08	3.183E+08	1.506E+08	3.028E+08
1.07E-05	3.643E+08	3.525E+08	1.668E+08	3.363E+08
5.04E-06	1.926E+08	1.868E+08	8.860E+07	1.787E+08
1.86E-06	2.205E+08	2.149E+08	1.027E+08	2.070E+08
8.76E-07	1.422E+08	1.391E+08	6.680E+07	1.348E+08
4.14E-07	1.146E+08	1.127E+08	5.428E+07	1.100E+08
0.00	6.637E+08	6.551E+08	3.123E+08	6.445E+08

TABLE 4.1-2

CALCULATED NEUTRON ENERGY SPECTRA
AT THE REACTOR CAVITY SENSOR SET LOCATIONS FOR CYCLE 9

Lower Energy (MeV)	Neutron Flux (n/cm^2-sec) Azimuthal Angle 84°	84° Bottom	74°	64°	64° Bottom	39°
1.42E+01	2.802E+05	8.685E+04	2.809E+05	2.415E+05	7.698E+04	1.746E+05
1.22E+01	7.652E+05	2.363E+05	7.693E+05	6.582E+05	2.094E+05	4.670E+05
1.00E+01	2.851E+06	8.753E+05	2.886E+06	2.446E+06	7.756E+05	1.695E+06
8.61E+00	5.136E+06	1.579E+06	5.232E+06	4.413E+06	1.403E+06	3.037E+06
7.41E+00	7.531E+06	2.319E+06	7.729E+06	6.470E+06	2.066E+06	4.418E+06
6.07E+00	1.564E+07	4.820E+06	1.615E+07	1.343E+07	4.298E+06	9.164E+06
4.97E+00	2.048E+07	6.470E+06	2.117E+07	1.756E+07	5.771E+06	1.216E+07
3.68E+00	3.474E+07	1.136E+07	3.573E+07	2.968E+07	1.010E+07	2.106E+07
3.01E+00	2.702E+07	9.059E+06	2.756E+07	2.306E+07	8.048E+06	1.660E+07
2.73E+00	2.121E+07	7.117E+06	2.163E+07	1.804E+07	6.302E+06	1.299E+07
2.47E+00	2.597E+07	8.894E+06	2.622E+07	2.205E+07	7.853E+06	1.613E+07
2.35E+00	1.738E+07	5.883E+06	1.770E+07	1.478E+07	5.208E+06	1.066E+07
2.23E+00	2.078E+07	6.954E+06	2.124E+07	1.765E+07	6.155E+06	1.253E+07
1.92E+00	5.801E+07	1.960E+07	5.871E+07	4.904E+07	1.728E+07	3.504E+07
1.65E+00	8.279E+07	2.797E+07	8.358E+07	6.979E+07	2.459E+07	4.962E+07
1.35E+00	1.419E+08	4.919E+07	1.413E+08	1.192E+08	4.304E+07	8.684E+07
1.00E+00	3.509E+08	1.227E+08	3.456E+08	2.923E+08	1.065E+08	2.131E+08
8.21E-01	3.507E+08	1.233E+08	3.416E+08	2.902E+08	1.062E+08	2.123E+08
7.43E-01	1.515E+08	5.853E+07	1.427E+08	1.260E+08	5.025E+07	1.011E+08
6.08E-01	8.099E+08	2.894E+08	7.789E+08	6.645E+08	2.473E+08	4.873E+08
4.98E-01	6.784E+08	2.577E+08	6.402E+08	5.589E+08	2.201E+08	4.339E+08
3.69E-01	7.410E+08	2.859E+08	6.925E+08	6.098E+08	2.429E+08	4.841E+08
2.98E-01	1.162E+09	4.331E+08	1.084E+09	9.455E+08	3.653E+08	7.271E+08

NOTE: The upper energy of group 1 is 17.33 MeV.

TABLE 4.1-2 (continued)

CALCULATED NEUTRON ENERGY SPECTRA
AT THE REACTOR CAVITY SENSOR SET LOCATIONS FOR CYCLE 9

Neutron Flux (n/cm^2-sec)
Azimuthal Angle

Lower Energy (MeV)	84°	84° Bottom	74°	64°	64° Bottom	39°
1.83E-01	1.230E+09	5.044E+08	1.117E+09	1.015E+09	4.265E+08	8.585E+08
1.11E-01	1.315E+09	5.360E+08	1.190E+09	1.081E+09	4.516E+08	9.117E+08
6.74E-02	7.655E+08	3.238E+08	6.854E+08	6.326E+08	2.728E+08	5.510E+08
4.09E-02	5.241E+08	2.311E+08	4.642E+08	4.354E+08	1.948E+08	3.917E+08
3.18E-02	1.575E+08	7.303E+07	1.379E+08	1.320E+08	6.167E+07	1.234E+08
2.61E-02	7.889E+07	3.734E+07	6.840E+07	6.627E+07	3.141E+07	6.321E+07
2.42E-02	3.388E+08	1.282E+08	3.067E+08	2.712E+08	1.062E+08	2.133E+08
2.18E-02	2.109E+08	8.416E+07	1.897E+08	1.710E+08	7.042E+07	1.411E+08
1.50E-02	3.216E+08	1.418E+08	2.840E+08	2.674E+08	1.195E+08	2.418E+08
7.10E-03	4.022E+08	1.889E+08	3.498E+08	3.374E+08	1.593E+08	3.189E+08
3.36E-03	3.998E+08	1.835E+08	3.481E+08	3.343E+08	1.543E+08	3.131E+08
1.59E-03	3.294E+08	1.542E+08	2.860E+08	2.768E+08	1.300E+08	2.624E+08
4.54E-04	4.942E+08	2.324E+08	4.290E+08	4.155E+08	1.962E+08	3.953E+08
2.14E-04	2.345E+08	1.111E+08	2.029E+08	1.978E+08	9.388E+07	1.900E+08
1.01E-04	2.438E+08	1.151E+08	2.113E+08	2.056E+08	9.736E+07	1.966E+08
3.73E-05	2.977E+08	1.404E+08	2.583E+08	2.512E+08	1.188E+08	2.404E+08
1.07E-05	3.292E+08	1.553E+08	2.856E+08	2.782E+08	1.316E+08	2.668E+08
5.04E-06	1.741E+08	8.234E+07	1.510E+08	1.474E+08	6.988E+07	1.418E+08
1.86E-06	1.999E+08	9.527E+07	1.732E+08	1.696E+08	8.100E+07	1.641E+08
8.76E-07	1.291E+08	6.190E+07	1.118E+08	1.098E+08	5.271E+07	1.069E+08
4.14E-07	1.042E+08	5.018E+07	9.026E+07	8.895E+07	4.282E+07	8.716E+07
0.00E+00	6.037E+08	2.878E+08	5.229E+08	5.169E+08	2.463E+08	5.103E+08

TABLE 4.1-3

CALCULATED NEUTRON ENERGY SPECTRA
AT THE REACTOR CAVITY SENSOR SET LOCATIONS FOR CYCLES 10 / 11

Lower Energy (MeV)	Neutron Flux (n/cm^2-sec) Azimuthal Angle 84°	74°	74° Bottom	64°	54°	39°	24°
1.42E+01	1.974E+05	2.124E+05	6.832E+04	1.997E+05	1.702E+05	1.628E+05	1.884E+05
1.22E+01	5.322E+05	5.769E+05	1.851E+05	5.391E+05	4.546E+05	4.332E+05	5.088E+05
1.00E+01	1.953E+06	2.141E+06	6.839E+05	1.982E+06	1.650E+06	1.563E+06	1.870E+06
8.61E+00	3.501E+06	3.864E+06	1.236E+06	3.559E+06	2.953E+06	2.787E+06	3.357E+06
7.41E+00	5.081E+06	5.669E+06	1.819E+06	5.180E+06	4.285E+06	4.025E+06	4.887E+06
6.07E+00	1.046E+07	1.179E+07	3.786E+06	1.070E+07	8.861E+06	8.313E+06	1.011E+07
4.97E+00	1.355E+07	1.537E+07	5.055E+06	1.389E+07	1.161E+07	1.088E+07	1.314E+07
3.68E+00	2.272E+07	2.581E+07	8.773E+06	2.329E+07	1.975E+07	1.845E+07	2.194E+07
3.01E+00	1.763E+07	1.991E+07	6.931E+06	1.801E+07	1.539E+07	1.438E+07	1.690E+07
2.73E+00	1.377E+07	1.560E+07	5.432E+06	1.408E+07	1.203E+07	1.120E+07	1.319E+07
2.47E+00	1.686E+07	1.894E+07	6.722E+06	1.717E+07	1.478E+07	1.380E+07	1.607E+07
2.35E+00	1.125E+07	1.275E+07	4.475E+06	1.150E+07	9.821E+06	9.142E+06	1.076E+07
2.23E+00	1.340E+07	1.525E+07	5.302E+06	1.371E+07	1.162E+07	1.076E+07	1.276E+07
1.92E+00	3.744E+07	4.224E+07	1.482E+07	3.809E+07	3.238E+07	2.996E+07	3.522E+07
1.65E+00	5.328E+07	6.004E+07	2.106E+07	5.415E+07	4.592E+07	4.239E+07	4.999E+07
1.35E+00	9.121E+07	1.018E+08	3.657E+07	9.240E+07	7.923E+07	7.342E+07	8.531E+07
1.00E+00	2.250E+08	2.495E+08	9.036E+07	2.265E+08	1.940E+08	1.798E+08	2.066E+08
8.21E-01	2.242E+08	2.468E+08	8.979E+07	2.244E+08	1.925E+08	1.787E+08	2.037E+08
7.43E-01	9.768E+07	1.045E+08	4.143E+07	9.729E+07	8.714E+07	8.256E+07	9.085E+07
6.08E-01	5.158E+08	5.633E+08	2.081E+08	5.131E+08	4.403E+08	4.083E+08	4.599E+08
4.98E-01	4.343E+08	4.668E+08	1.824E+08	4.308E+08	3.796E+08	3.563E+08	3.924E+08
3.69E-01	4.756E+08	5.067E+08	2.005E+08	4.699E+08	4.191E+08	3.944E+08	4.288E+08
2.98E-01	7.404E+08	7.902E+08	3.029E+08	7.286E+08	6.394E+08	5.975E+08	6.536E+08

NOTE: The upper energy of group 1 is 17.33 MeV.

TABLE 4.1-3 (continued)

CALCULATED NEUTRON ENERGY SPECTRA
AT THE REACTOR CAVITY SENSOR SET LOCATIONS FOR CYCLES 10 / 11

Lower Energy (MeV)	Neutron Flux (n/cm^2-sec) Azimuthal Angle 84°	74°	74° Bottom	64°	54°	39°	24°
1.83E-01	7.930E+08	8.259E+08	3.448E+08	7.805E+08	7.176E+08	6.856E+08	7.269E+08
1.11E-01	8.471E+08	8.797E+08	3.650E+08	8.307E+08	7.626E+08	7.271E+08	7.674E+08
6.74E-02	4.951E+08	5.095E+08	2.185E+08	4.856E+08	4.531E+08	4.353E+08	4.541E+08
4.09E-02	3.405E+08	3.472E+08	1.546E+08	3.340E+08	3.168E+08	3.068E+08	3.163E+08
3.18E-02	1.028E+08	1.038E+08	4.830E+07	1.012E+08	9.782E+07	9.584E+07	9.792E+07
2.61E-02	5.162E+07	5.173E+07	2.445E+07	5.079E+07	4.967E+07	4.891E+07	4.956E+07
2.42E-02	2.157E+08	2.248E+08	8.725E+07	2.083E+08	1.850E+08	1.725E+08	1.827E+08
2.18E-02	1.349E+08	1.398E+08	5.704E+07	1.312E+08	1.190E+08	1.126E+08	1.185E+08
1.50E-02	2.084E+08	2.123E+08	9.440E+07	2.048E+08	1.947E+08	1.890E+08	1.948E+08
7.10E-03	2.628E+08	2.640E+08	1.241E+08	2.584E+08	2.512E+08	2.466E+08	2.500E+08
3.36E-03	2.610E+08	2.624E+08	1.207E+08	2.559E+08	2.478E+08	2.421E+08	2.449E+08
1.59E-03	2.156E+08	2.162E+08	1.012E+08	2.118E+08	2.064E+08	2.025E+08	2.043E+08
4.54E-04	3.236E+08	3.242E+08	1.525E+08	3.180E+08	3.104E+08	3.049E+08	3.073E+08
2.14E-04	1.538E+08	1.536E+08	7.269E+07	1.513E+08	1.484E+08	1.462E+08	1.469E+08
1.01E-04	1.599E+08	1.600E+08	7.551E+07	1.572E+08	1.539E+08	1.513E+08	1.521E+08
3.73E-05	1.954E+08	1.954E+08	9.212E+07	1.921E+08	1.881E+08	1.850E+08	1.859E+08
1.07E-05	2.161E+08	2.162E+08	1.019E+08	2.127E+08	2.085E+08	2.051E+08	2.061E+08
5.04E-06	1.143E+08	1.143E+08	5.403E+07	1.127E+08	1.106E+08	1.089E+08	1.096E+08
1.86E-06	1.314E+08	1.313E+08	6.250E+07	1.297E+08	1.276E+08	1.260E+08	1.266E+08
8.76E-07	8.491E+07	8.483E+07	4.058E+07	8.393E+07	8.284E+07	8.195E+07	8.247E+07
4.14E-07	6.862E+07	6.854E+07	3.290E+07	6.798E+07	6.732E+07	6.683E+07	6.739E+07
0.00E+00	3.975E+08	3.975E+08	1.888E+08	3.954E+08	3.927E+08	3.913E+08	3.948E+08

TABLE 4.1-4

CALCULATED NEUTRON ENERGY SPECTRA
AT THE SURVEILLANCE CAPSULE CENTER

Lower Energy (MeV)	Neutron Flux (n/cm^2-sec) Azimuthal Angle				
	A240	W290	W290-9	W110	SA60-1
1.42E+01	7.444E+07	1.976E+07	1.323E+07	1.837E+07	3.640E+07
1.22E+01	2.580E+08	6.287E+07	4.090E+07	5.820E+07	1.199E+08
1.00E+01	1.229E+09	2.640E+08	1.668E+08	2.435E+08	5.429E+08
8.61E+00	2.571E+09	5.145E+08	3.231E+08	4.742E+08	1.122E+09
7.41E+00	4.980E+09	9.031E+08	5.581E+08	8.310E+08	2.107E+09
6.07E+00	1.371E+10	2.389E+09	1.461E+09	2.196E+09	5.710E+09
4.97E+00	2.285E+10	3.564E+09	2.143E+09	3.271E+09	9.175E+09
3.68E+00	4.885E+10	6.458E+09	3.799E+09	5.916E+09	1.865E+10
3.01E+00	3.984E+10	4.482E+09	2.607E+09	4.103E+09	1.473E+10
2.73E+00	2.934E+10	3.178E+09	1.841E+09	2.909E+09	1.083E+10
2.47E+00	3.418E+10	3.560E+09	2.054E+09	3.258E+09	1.254E+10
2.35E+00	2.087E+10	2.183E+09	1.258E+09	1.997E+09	7.675E+09
2.23E+00	2.131E+10	2.158E+09	1.242E+09	1.975E+09	7.831E+09
1.92E+00	5.552E+10	5.328E+09	3.062E+09	4.874E+09	2.022E+10
1.65E+00	5.982E+10	5.334E+09	3.062E+09	4.880E+09	2.161E+10
1.35E+00	8.548E+10	7.125E+09	4.085E+09	6.519E+09	3.075E+10
1.00E+00	1.300E+11	9.600E+09	5.505E+09	8.783E+09	4.648E+10
8.21E-01	8.476E+10	5.872E+09	3.366E+09	5.373E+09	3.015E+10
7.43E-01	4.336E+10	3.116E+09	1.784E+09	2.851E+09	1.538E+10
6.08E-01	1.008E+11	6.849E+09	3.915E+09	6.264E+09	3.556E+10
4.98E-01	8.474E+10	5.572E+09	3.184E+09	5.096E+09	2.980E+10
3.69E-01	8.732E+10	6.141E+09	3.509E+09	5.616E+09	3.074E+10
2.98E-01	7.551E+10	5.118E+09	2.921E+09	4.679E+09	2.652E+10

NOTE: The upper energy of group 1 is 17.33 MeV.

TABLE 4.1-4 (continued)

CALCULATED NEUTRON ENERGY SPECTRA
AT THE SURVEILLANCE CAPSULE CENTER

	Neutron Flux (n/cm^2-sec) Azimuthal Angle				
Lower Energy (MeV)	A240	W290	W290-9	W110	SA60-1
1.83E-01	1.161E+11	8.225E+09	4.689E+09	7.519E+09	4.069E+10
1.11E-01	1.026E+11	7.072E+09	4.022E+09	6.462E+09	3.587E+10
6.74E-02	7.750E+10	5.541E+09	3.149E+09	5.063E+09	2.706E+10
4.09E-02	6.834E+10	4.784E+09	2.719E+09	4.371E+09	2.384E+10
3.18E-02	2.668E+10	1.952E+09	1.110E+09	1.784E+09	9.299E+09
2.61E-02	1.363E+10	1.063E+09	6.049E+08	9.716E+08	4.748E+09
2.42E-02	2.073E+10	1.431E+09	8.137E+08	1.308E+09	7.233E+09
2.18E-02	1.289E+10	8.664E+08	4.920E+08	7.915E+08	4.492E+09
1.50E-02	3.859E+10	2.881E+09	1.637E+09	2.633E+09	1.343E+10
7.10E-03	7.456E+10	5.522E+09	3.137E+09	5.045E+09	2.596E+10
3.36E-03	7.707E+10	5.777E+09	3.282E+09	5.278E+09	2.682E+10
1.59E-03	7.281E+10	5.428E+09	3.084E+09	4.959E+09	2.532E+10
4.54E-04	1.234E+11	9.092E+09	5.163E+09	8.307E+09	4.283E+10
2.14E-04	6.885E+10	5.209E+09	2.957E+09	4.760E+09	2.388E+10
1.01E-04	7.494E+10	5.577E+09	3.165E+09	5.096E+09	2.598E+10
3.73E-05	9.929E+10	7.339E+09	4.163E+09	6.707E+09	3.437E+10
1.07E-05	1.235E+11	9.130E+09	5.177E+09	8.344E+09	4.270E+10
5.04E-06	7.221E+10	5.379E+09	3.049E+09	4.916E+09	2.493E+10
1.86E-06	9.537E+10	7.248E+09	4.107E+09	6.624E+09	3.290E+10
8.76E-07	6.918E+10	5.403E+09	3.060E+09	4.938E+09	2.384E+10
4.14E-07	5.981E+10	4.876E+09	2.761E+09	4.457E+09	2.060E+10
0.00E+00	6.331E+11	8.735E+10	4.918E+10	7.983E+10	2.176E+11

4.2 MEASURED REACTION RATES

4.2.1 In-Vessel Surveillance Capsules

In this section, the full power reaction rates of the five neutron sensor sets withdrawn from the Palisades reactor vessel are presented. The capsule designation, location within the reactor, and time of withdrawal of each of these dosimetry sets were as listed below.

Capsule ID	FQE Azimuthal Location	Withdrawal Time	Irradiation Time (EFPS)
A240	60°	EOC 2	7.156e+07
W290	70°	EOC 5	1.642e+08
W290-9*	70°	EOC 9	2.579e+07
W110	70°	EOC 10	3.138e+08
SA60-1**	60°	EOC13	7.145E+07

* Irradiated during Cycle 9 only.

** Irradiated during Cycles 12 and 13 only.

With the exception of Capsules A240 and SA60-1, radiometric counting of each of these capsule dosimetry data sets was accomplished by Westinghouse using the procedures discussed in Section 3 of this report. The measured specific activities are included in Appendix A to this report. Radiometric counting of the sensors from Capsule A240, on the other hand, was carried out by the Battelle Memorial Institute[4]. However, in this case, the measured specific activities were not reported. Radiometric counting of the sensors from Capsule SA60-1 was carried out by BWX Technologies, Incorporated[35].

The irradiation history of the Palisades reactor during the first 13 fuel cycles is also listed in Appendix A. The irradiation history was obtained from NUREG-0020[37], "Licensed Operating Reactors Status Summary Report," as supplemented by information obtained from Consumers Energy in Reference 26, for the applicable operating periods. In addition to the reactor power history, for the multiple cycle irradiations Capsules A240, W290, W110, and SA60-1, the flux level adjustment factors for each cycle are also tabulated in Appendix A. These adjustment factors were determined from the fuel cycle specific forward calculations described in Section 4.1 of this report.

Based on the irradiation history, the individual sensor characteristics, capsule gradient corrections, and the measured specific activities, reaction rates averaged over the appropriate irradiation periods and referenced to a core power level of 2530 MWt were computed for the sensor sets removed from Capsules W290, W290-9, W110, and SA60-1. In the case of Capsule A240, reaction rates were developed directly from the derived neutron flux and spectrum averaged reaction cross-sections reported in Reference 4. The computed reaction rates for the multiple foil sensor sets from each of the five internal surveillance capsules are provided in Table 4.2-1.

In regard to the data listed in Table 4.2-1, the fission rate measurements for the ^{238}U sensors include corrections for ^{235}U impurities, the build-in of plutonium isotopes during the long irradiations, and for the effects of photofission reactions. Likewise, the fission rate measurements for the ^{237}Np sensors include adjustments for photofission reactions occurring over the course of the respective irradiation periods.

4.2.2 Ex-Vessel Dosimetry

In this section, the full power reaction rates of all neutron sensor sets irradiated since the inception of the Reactor Cavity Measurement Program are presented. At Palisades the program was initiated prior to the startup of Cycle 8, and to date, has included measurement evaluations at the conclusion of Cycles 8, 9, 11. The evaluation of each of these sets of measured data was accomplished using a consistent approach based on the methodology discussed in Section 3, resulting in an accurate and reliable data base used to provide confidence that the calculated neutron exposure at the reactor vessel wall is an accurate prediction.

4.2.2.1 Cycle 8 Cavity Dosimetry

During the Cycle 8 irradiation, four multiple foil sensor sets, and ten stainless steel gradient chains were deployed in the reactor cavity. The capsule identifications associated with each of the multiple foil sensor sets mounted from the dosimetry support bar are listed below.

Reference		Bar	Capsule Identification	
Azimuth	FQE	Shifted Angle	Core Midplane	Core Bottom
270°	90°	84°	Not Recovered	Not Recovered
280°	80°	74°	B	
290°	70°	64°	D	E
300°	60°	54°	Not Recovered	
315°	45°	39°	G	
330°	30°	24°	Gradient Chain Only	

The contents of each of these irradiation capsules is specified in Appendix B to this report.

The irradiation history of the Palisades reactor during Cycle 8 is also listed in Appendix B. The irradiation history was obtained from NUREG-0020[37], "Licensed Operating Reactors Status Summary Report" for the applicable operating period. Based on this reactor operating history, the individual sensor characteristics, and the measured specific activities given in Appendix B, cycle average reaction rates referenced to a core power level of 2530 MWt were computed for each multiple foil sensor and gradient chain segment.

The computed reaction rates for the radiometric foil sensor sets irradiated during Cycle 8 are provided in Table 4.2-2. Corresponding reaction rate data from the ten stainless steel gradient chains are recorded in Tables 4.2-3 through 4.2-8 for the ^{54}Fe(n,p), ^{58}Ni(n,p), and ^{59}Co(n,γ) reactions, respectively.

In regard to the data listed in Table 4.2-2, the ^{54}Fe(n,p) reaction rates represent an average of the bare and cadmium covered measurements for each capsule. In addition, the fission rate measurements include corrections for ^{235}U impurities in the ^{238}U sensors as well as corrections for photofission reactions in both the ^{238}U and ^{237}Np sensors.

4.2.2.2 Cycle 9 Cavity Dosimetry

During the Cycle 9 irradiation, six multiple foil sensor sets, and ten stainless steel gradient chains were deployed in the reactor cavity. The capsule identifications associated with each of the multiple foil sensor sets mounted from the dosimetry support bar are listed below.

Reference		Bar	Capsule Identification	
Azimuth	FQE	Shifted Angle	Core Midplane	Core Bottom
270°	90°	84°	A[1]	C[1]
280°	80°	74°	J	
290°	70°	64°	K	L
300°	60°	54°	Mispositioned[2]	
315°	45°	39°	N	
330°	30°	24°	Gradient Chain Only	

1 Dosimetry Capsules A and C irradiated during Cycles 8 and 9 (Reference 6).

2 Mispositioned prior to Cycle 9 irradiation (Reference 6).

The contents of each of these irradiation capsules is specified in Appendix C to this report.

The irradiation history of the Palisades reactor during Cycle 9 is also listed in Appendix C. The irradiation history was obtained from NUREG-0020[37], "Licensed Operating Reactors Status Summary Report" for the applicable operating period. Based on this reactor operating history, the individual sensor characteristics, and the measured specific activities given in Appendix C, cycle average reaction rates referenced to a core power level of 2530 MWt were computed for each multiple foil sensor and gradient chain segment.

The computed reaction rates for the radiometric foil sensor sets irradiated during Cycle 9 are provided in Table 4.2-9. Corresponding reaction rate data from the ten stainless steel gradient chains are recorded in Tables 4.2-10 through 4.2-15 for the ^{54}Fe(n,p), ^{58}Ni(n,p), and ^{59}Co(n,γ) reactions, respectively.

In regard to the data listed in Table 4.2-9, the ^{54}Fe(n,p) reaction rates represent an average of the bare and cadmium covered measurements for each capsule. In addition, the fission rate measurements include corrections for ^{235}U impurities in the ^{238}U sensors as well as corrections for photofission reactions in both the ^{238}U and ^{237}Np sensors.

4.2.2.3 Cycle 10/11 Cavity Dosimetry

During the Cycles 10/11 irradiation, seven multiple foil sensor sets, and twelve stainless steel gradient chains were deployed in the reactor cavity. The capsule identifications associated with each of the multiple foil sensor sets mounted from the dosimetry support bar were as follows:

Reference Azimuth	FQE	Bar Shifted Angle	Capsule Identification Core Midplane	Capsule Identification Core Bottom
270°	90°	84°	O	
280°	80°	74°	P	Q
290°	70°	64°	R	
300°	60°	54°	S	
315°	45°	39°	T	
330°	30°	24°	U	

The contents of each of these irradiation capsules is specified in Appendix D to this report.

The irradiation history of the Palisades reactor during Cycles 10/11 is also listed in Appendix D. The irradiation history was obtained from NUREG-0020[37], "Licensed Operating Reactors Status Summary Report" for the applicable operating period. Based on this reactor operating history, the individual sensor characteristics, and the measured specific activities given in Appendix D, cycle average reaction rates referenced to a core power level of 2530 MWt were computed for each multiple foil sensor and gradient chain segment.

The computed reaction rates for the radiometric foil sensor sets irradiated during Cycles 10/11 are provided in Table 4.2-16. Corresponding reaction rate data from the twelve stainless steel gradient chains are recorded in Tables 4.2-17 through 4.2-22 for the ^{54}Fe(n,p), ^{58}Ni(n,p), and ^{59}Co(n,γ) reactions, respectively.

In regard to the data listed in Table 4.2-16, the ^{54}Fe(n,p) reaction rates represent an average of the bare and cadmium covered measurements for each capsule. In addition, the fission rate measurements include corrections for ^{235}U impurities in the ^{238}U sensors as well as corrections for photofission reactions in both the ^{238}U and ^{237}Np sensors.

TABLE 4.2-1

SUMMARY OF REACTION RATES DERIVED FROM MULTIPLE FOIL SENSOR SETS WITHDRAWN FROM INTERNAL SURVEILLANCE CAPSULES

	Reaction Rate (rps/nucleus)				
Reaction	A240	W290	W290-9	W110	SA60-1
$^{63}Cu\ (n,\alpha)\ ^{60}Co$ Cd	4.97E-16	9.46E-17	5.72E-17	8.85E-17	2.16E-16
$^{54}Fe\ (n,p)\ ^{54}Mn$	5.58E-14	7.52E-15	4.31E-15	7.09E-15	2.23E-14
$^{58}Ni\ (n,p)\ ^{58}Co$ Cd	6.99E-14	9.89E-15	5.78E-15	9.13E-15	3.04E-14
$^{46}Ti\ (n,p)\ ^{46}Sc$	9.65E-15	1.46E-15	9.29E-16	1.41E-15	3.86E-15
$^{238}U\ (n,f)\ ^{137}Cs$ Cd		2.52E-14	1.44E-14		9.88E-14
$^{237}Np\ (n,f)\ ^{137}Cs$ Cd			6.28E-14		
$^{59}Co\ (n,\gamma)\ ^{60}Co$			1.70E-12		
$^{59}Co\ (n,\gamma)\ ^{60}Co$ Cd			2.38E-13		

Note: Cd indicates that the sensor was cadmium covered

TABLE 4.2-2

SUMMARY OF REACTION RATES DERIVED FROM MULTIPLE FOIL SENSOR SETS
CYCLE 8 IRRADIATION

	Reaction Rate (rps/nucleus)			
Reaction	Capsule B (74°)	Capsule D (64°)	Capsule E (64°)	Capsule G (39°)
$^{63}Cu\ (n,\alpha)\ ^{60}Co$ Cd	9.76E-19	7.51E-19	1.99E-19	5.53E-19
$^{46}Ti\ (n,p)\ ^{46}Sc$	1.43E-17	1.10E-17	3.29E-18	7.76E-18
$^{54}Fe\ (n,p)\ ^{54}Mn$	7.48E-17	5.65E-17	1.76E-17	4.04E-17
$^{58}Ni\ (n,p)\ ^{58}Co$ Cd	1.04E-16	7.83E-17	2.58E-17	5.53E-17
$^{238}U\ (n,f)\ ^{137}Cs$ Cd	3.44E-16	2.53E-16		1.94E-16
$^{235}U\ (n,f)\ ^{137}Cs$ Cd	9.40E-14	8.87E-14		8.69E-14
$^{238}U\ (n,f)\ ^{137}Cs$ Cd[1]	4.02E-16	3.06E-16	8.95E-17	1.94E-16
$^{235}U\ (n,f)\ ^{137}Cs$ Cd[1]	8.10E-14	7.97E-14	4.63E-14	9.17E-14
$^{237}Np\ (n,f)\ ^{137}Cs$ Cd	6.64E-15	4.97E-15	1.64E-15	3.54E-15
$^{59}Co\ (n,\gamma)\ ^{60}Co$	4.64E-14	4.34E-14	2.59E-14	4.82E-14
$^{59}Co\ (n,\gamma)\ ^{60}Co$ Cd	3.08E-14	2.99E-14	1.75E-14	2.90E-14

Note: Cd indicates that the sensor was cadmium covered.

1 Paired Uranium Dosimeter (PUD) measurement

TABLE 4.2-3

^{54}Fe (n,p) ^{54}Mn REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLE 8 IRRADIATION

Feet from Midplane	Reaction Rate (rps/nucleus) 74°	64°	39°	24°
0.5	7.33E-17	5.37E-17	3.98E-17	5.58E-17
0.0				6.23E-17
-0.5	7.45E-17	5.47E-17	3.90E-17	5.91E-17
-1.0	7.45E-17	5.58E-17	3.90E-17	5.99E-17
-1.5	7.26E-17	5.47E-17	3.48E-17	5.29E-17
-2.0	7.00E-17	5.35E-17	3.67E-17	5.04E-17
-2.5	5.91E-17	5.04E-17	3.23E-17	4.72E-17
-3.0	5.68E-17	4.79E-17	3.17E-17	4.29E-17
-3.5	5.42E-17	4.67E-17	2.83E-17	3.55E-17
-4.0	3.96E-17	3.95E-17	2.47E-17	3.05E-17
-4.5	3.28E-17	3.32E-17	2.27E-17	2.17E-17
-5.0	2.20E-17	2.22E-17	1.61E-17	1.57E-17
-5.5	1.46E-17		1.19E-17	9.38E-18

TABLE 4.2-4

^{58}Ni (n,p) ^{58}Co REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLE 8 IRRADIATION

Feet from	Reaction Rate (rps/nucleus)			
Midplane	74°	64°	39°	24°
0.5	1.11E-16	8.34E-17	6.10E-17	8.69E-17
0.0				8.29E-17
-0.5	1.15E-16	8.06E-17	5.43E-17	8.98E-17
-1.0	1.08E-16	8.11E-17	5.25E-17	8.52E-17
-1.5	1.03E-16	8.40E-17	5.53E-17	8.00E-17
-2.0	9.95E-17	8.34E-17	5.42E-17	8.23E-17
-2.5	9.90E-17	8.00E-17	4.72E-17	7.48E-17
-3.0	8.57E-17	7.37E-17	4.74E-17	6.67E-17
-3.5	8.23E-17	7.02E-17	4.31E-17	5.58E-17
-4.0	6.85E-17	6.62E-17	4.10E-17	4.66E-17
-4.5	5.12E-17	5.13E-17	3.42E-17	3.11E-17
-5.0	3.41E-17	3.45E-17	2.56E-17	2.47E-17
-5.5	2.44E-17		2.09E-17	1.80E-17

TABLE 4.2-5

$^{59}Co\ (n,\gamma)\ ^{60}Co$ REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLE 8 IRRADIATION

Feet from Midplane	Reaction Rate (rps/nucleus) 74°	64°	39°	24°
0.5	5.15E-14	4.63E-14	5.20E-14	5.81E-14
0.0				5.81E-14
-0.5	5.15E-14	4.62E-14	5.25E-14	5.81E-14
-1.0	5.15E-14	4.63E-14	5.15E-14	5.66E-14
-1.5	5.04E-14	4.57E-14	5.15E-14	5.55E-14
-2.0	4.90E-14	4.54E-14	5.00E-14	5.35E-14
-2.5	4.76E-14	4.37E-14	4.86E-14	5.08E-14
-3.0	4.56E-14	4.33E-14	4.54E-14	4.78E-14
-3.5	4.40E-14	4.16E-14	4.41E-14	4.46E-14
-4.0	4.11E-14	3.93E-14	4.04E-14	4.09E-14
-4.5	3.50E-14	3.68E-14	3.76E-14	3.29E-14
-5.0	2.99E-14	2.95E-14	3.02E-14	2.81E-14
-5.5	2.75E-14		2.56E-14	2.59E-14

TABLE 4.2-6

^{54}Fe (n,p) ^{54}Mn REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLE 8 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	4.13E-18	4.23E-18	5.03E-18	2.78E-18	3.94E-18	3.32E-18	3.34E-18
7.5	5.36E-18	5.50E-18	5.26E-18	3.70E-18	5.98E-18	4.91E-18	4.86E-18
7.0	8.93E-18	8.55E-18	8.74E-18	7.13E-18	1.14E-17	6.68E-18	8.39E-18
6.5	1.35E-17	1.14E-17	1.32E-17	8.87E-18	1.09E-17	9.45E-18	9.74E-18
6.0	2.01E-17		1.72E-17	1.50E-17	1.61E-17	1.59E-17	1.57E-17
5.5	2.51E-17		2.56E-17	1.89E-17	2.44E-17	2.18E-17	2.17E-17
5.0	3.05E-17		3.16E-17	2.45E-17	2.91E-17	2.77E-17	2.71E-17
4.5	3.69E-17		3.63E-17	3.03E-17	3.21E-17	3.35E-17	3.20E-17
4.0	4.06E-17		4.25E-17	3.24E-17	3.70E-17	3.68E-17	3.54E-17
3.5	4.48E-17		4.63E-17	3.84E-17	4.43E-17	4.08E-17	4.12E-17
3.0	4.66E-17		5.06E-17	4.04E-17	4.34E-17	4.18E-17	4.18E-17
2.5	4.83E-17		5.19E-17	4.27E-17	4.51E-17	4.68E-17	4.49E-17
2.0	4.92E-17		5.28E-17	4.22E-17	4.70E-17	4.34E-17	4.42E-17
1.5	4.78E-17		5.26E-17	4.15E-17	4.65E-17	4.47E-17	4.42E-17
1.0	4.59E-17		4.92E-17	4.23E-17	4.89E-17	4.41E-17	4.51E-17
0.5	4.85E-17		5.07E-17	4.35E-17	4.72E-17	4.49E-17	4.52E-17
0.0	5.42E-17		5.33E-17	4.43E-17	4.93E-17	4.25E-17	4.54E-17
-0.5	5.12E-17		5.14E-17	4.40E-17	4.67E-17	4.68E-17	4.58E-17
-1.0	4.65E-17		5.12E-17	4.43E-17	4.74E-17	4.43E-17	4.53E-17
-1.5	4.71E-17		5.12E-17	4.18E-17	4.63E-17	4.45E-17	4.42E-17
-2.0	4.51E-17		5.28E-17	4.45E-17	4.51E-17	4.60E-17	4.52E-17
-2.5	4.52E-17		5.20E-17	4.27E-17	4.46E-17	4.18E-17	4.30E-17
-3.0	3.86E-17		4.70E-17	4.07E-17	4.00E-17	3.98E-17	4.01E-17
-3.5	4.27E-17		4.46E-17	3.89E-17	3.95E-17	4.02E-17	3.96E-17
-4.0	3.59E-17		3.95E-17	3.52E-17	3.64E-17	3.30E-17	3.49E-17
-4.5	2.94E-17		1.30E-17	2.81E-17	3.07E-17	2.71E-17	2.86E-17

TABLE 4.2-7

^{58}Ni (n,p) ^{58}Co REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLE 8 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	6.91E-18	7.83E-18	7.31E-18	5.55E-18	5.56E-18	5.33E-18	5.48E-18
7.5	9.49E-18	9.09E-18	1.34E-17	6.27E-18	1.01E-17	7.77E-18	8.04E-18
7.0	1.72E-17	1.35E-17	1.47E-17	1.12E-17	1.85E-17	1.11E-17	1.36E-17
6.5	2.20E-17	1.53E-17	2.03E-17	1.38E-17	1.88E-17	1.73E-17	1.66E-17
6.0	2.98E-17		3.19E-17	2.26E-17	2.60E-17	2.69E-17	2.51E-17
5.5	3.94E-17		4.18E-17	3.20E-17	3.65E-17	3.41E-17	3.42E-17
5.0	4.80E-17		4.85E-17	3.80E-17	4.56E-17	4.47E-17	4.28E-17
4.5	5.58E-17		5.87E-17	4.82E-17	5.87E-17	5.41E-17	5.37E-17
4.0	6.16E-17		6.16E-17	5.09E-17	6.21E-17	5.59E-17	5.63E-17
3.5	7.25E-17		6.62E-17	5.87E-17	6.50E-17	5.81E-17	6.06E-17
3.0	7.48E-17		7.14E-17	6.04E-17	6.96E-17	6.50E-17	6.50E-17
2.5	7.54E-17		7.60E-17	6.10E-17	6.85E-17	6.16E-17	6.37E-17
2.0	8.17E-17		7.71E-17	5.98E-17	7.42E-17	6.85E-17	6.75E-17
1.5	7.25E-17		7.71E-17	6.16E-17	6.96E-17	6.73E-17	6.62E-17
1.0	7.83E-17		7.77E-17	6.44E-17	6.79E-17	6.44E-17	6.56E-17
0.5	7.54E-17		7.83E-17	6.27E-17	6.96E-17	7.02E-17	6.75E-17
0.0	7.19E-17		7.42E-17	6.44E-17	7.60E-17	6.73E-17	6.92E-17
-0.5	7.48E-17		8.00E-17	6.56E-17	7.31E-17	6.85E-17	6.90E-17
-1.0	7.31E-17		8.06E-17	6.56E-17	6.56E-17	6.79E-17	6.64E-17
-1.5	6.79E-17		8.34E-17	7.14E-17	6.79E-17	7.31E-17	7.08E-17
-2.0	6.91E-17		8.17E-17	6.73E-17	7.02E-17	6.85E-17	6.87E-17
-2.5	7.25E-17		7.83E-17	6.79E-17	6.62E-17	6.27E-17	6.56E-17
-3.0	6.50E-17		7.19E-17	6.33E-17	6.85E-17	5.98E-17	6.39E-17
-3.5	6.16E-17		6.27E-17	5.73E-17	6.21E-17	5.75E-17	5.90E-17
-4.0	5.12E-17		6.04E-17	5.33E-17	5.51E-17	5.44E-17	5.43E-17
-4.5	4.21E-17		1.85E-17	4.74E-17	4.86E-17	4.64E-17	4.75E-17

TABLE 4.2-8

$^{59}Co(n,\gamma)^{60}Co$ REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLE 8 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	2.32E-14	1.75E-14	2.17E-14	1.55E-14	1.67E-14	2.14E-14	1.79E-14
7.5	2.54E-14	2.01E-14	2.37E-14	1.69E-14	1.93E-14	2.46E-14	2.02E-14
7.0	3.02E-14	2.19E-14	2.74E-14	2.00E-14	2.45E-14	2.84E-14	2.43E-14
6.5	3.25E-14	2.29E-14	2.86E-14	2.07E-14	2.45E-14	3.17E-14	2.56E-14
6.0	3.63E-14		3.33E-14	2.37E-14	2.67E-14	3.41E-14	2.82E-14
5.5	3.88E-14		3.48E-14	2.43E-14	2.83E-14	3.67E-14	2.98E-14
5.0	4.41E-14		3.86E-14	2.80E-14	3.11E-14	3.98E-14	3.30E-14
4.5	4.68E-14		4.17E-14	3.01E-14	3.33E-14	4.36E-14	3.57E-14
4.0	4.91E-14		4.47E-14	2.98E-14	3.53E-14	4.62E-14	3.71E-14
3.5	5.35E-14		4.59E-14	3.33E-14	3.76E-14	4.93E-14	4.01E-14
3.0	5.50E-14		4.96E-14	3.47E-14	3.97E-14	5.08E-14	4.17E-14
2.5	5.96E-14		5.09E-14	3.55E-14	4.11E-14	5.30E-14	4.32E-14
2.0	6.42E-14		5.45E-14	3.75E-14	4.27E-14	5.45E-14	4.49E-14
1.5	6.01E-14		5.66E-14	3.86E-14	4.41E-14	5.71E-14	4.66E-14
1.0	6.62E-14		5.71E-14	3.88E-14	4.52E-14	5.81E-14	4.74E-14
0.5	6.52E-14		6.01E-14	4.04E-14	4.62E-14	5.91E-14	4.86E-14
0.0	6.73E-14		6.11E-14	4.09E-14	4.67E-14	6.17E-14	4.97E-14
-0.5	6.83E-14		6.06E-14	4.05E-14	4.68E-14	6.11E-14	4.95E-14
-1.0	6.73E-14		6.22E-14	4.17E-14	4.65E-14	6.11E-14	4.98E-14
-1.5	6.67E-14		6.01E-14	4.04E-14	4.58E-14	6.01E-14	4.88E-14
-2.0	6.47E-14		6.06E-14	4.07E-14	4.53E-14	5.91E-14	4.84E-14
-2.5	6.22E-14		5.91E-14	3.99E-14	4.38E-14	5.66E-14	4.67E-14
-3.0	5.76E-14		5.55E-14	3.77E-14	4.30E-14	5.35E-14	4.47E-14
-3.5	5.55E-14		5.45E-14	3.65E-14	4.02E-14	5.10E-14	4.26E-14
-4.0	5.05E-14		5.01E-14	3.41E-14	3.82E-14	4.73E-14	3.99E-14
-4.5	4.66E-14		1.65E-14	3.05E-14	3.47E-14	4.29E-14	3.60E-14

TABLE 4.2-9

SUMMARY OF REACTION RATES DERIVED FROM MULTIPLE FOIL SENSOR SETS
CYCLE 9 IRRADIATION

	Reaction Rate (rps/nucleus)					
	Capsule A[1]	Capsule C[1]	Capsule J	Capsule K	Capsule L	Capsule N
Reaction	(84°)	(84°)	(74°)	(64°)	(64°)	(39°)
^{63}Cu (n,α) ^{60}Co Cd	7.42E-19	1.13E-19	7.06E-19	6.05E-19	1.69E-19	4.19E-19
^{46}Ti (n,p) ^{46}Sc	1.01E-17	1.71E-18	1.01E-17	8.51E-18	2.54E-18	5.79E-18
^{54}Fe (n,p) ^{54}Mn	5.39E-17	9.77E-18	5.18E-17	4.31E-17	1.36E-17	2.99E-17
^{58}Ni (n,p) ^{58}Co Cd	7.20E-17	1.37E-17	7.27E-17	6.14E-17	1.99E-17	4.20E-17
^{238}U (n,f) ^{137}Cs Cd	2.46E-16	5.64E-17	2.39E-16	2.34E-16	6.47E-17	1.35E-16
^{235}U (n,f) ^{137}Cs Cd	8.20E-14	4.19E-14	5.94E-14	4.84E-14	2.98E-14	6.22E-14
^{238}U (n,f) ^{137}Cs Cd[2]	3.26E-16	5.57E-17				
^{235}U (n,f) ^{137}Cs Cd[2]	7.01E-14	3.93E-14				
^{237}Np (n,f) ^{137}Cs Cd	4.37E-15	1.09E-15	3.92E-15	3.72E-15	1.16E-15	2.20E-15
^{59}Co (n,γ) ^{60}Co	4.31E-14	2.17E-14	3.57E-14	3.20E-14	1.92E-14	3.55E-14
^{59}Co (n,γ) ^{60}Co Cd	2.71E-14	1.50E-14	2.36E-14	2.28E-14	1.30E-14	2.23E-14

Note: Cd indicates that the sensor was cadmium covered.

1 Dosimetry capsules A and C irradiated during Cycles 8 and 9 (Reference 6).
2 Paired Uranium Dosimeter (PUD) measurement

TABLE 4.2-10

^{54}Fe (n,p) ^{54}Mn REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLE 9 IRRADIATION

Feet from	Reaction Rate (rps/nucleus)				
Midplane	84° [1]	74°	64°	39°	24°
0.5	4.76E-17	4.66E-17	3.96E-17	2.76E-17	3.95E-17
0.0					4.03E-17
-0.38		4.87E-17			
-0.5	4.63E-17	4.71E-17	4.05E-17	2.78E-17	3.87E-17
-1.0	4.55E-17	4.70E-17	3.81E-17	2.73E-17	3.96E-17
-1.5	4.43E-17	4.48E-17	3.98E-17	2.41E-17	3.84E-17
-2.0	3.78E-17	4.14E-17	3.69E-17	2.34E-17	3.75E-17
-2.5	3.54E-17	3.91E-17	3.49E-17	2.21E-17	3.46E-17
-3.0	2.86E-17	3.49E-17	3.20E-17	2.18E-17	3.24E-17
-3.5	2.70E-17	3.26E-17	3.00E-17	1.95E-17	2.90E-17
-4.0	2.59E-17	2.69E-17	2.80E-17	1.65E-17	2.50E-17
-4.5	1.58E-17	1.96E-17	2.29E-17	1.41E-17	2.00E-17
-5.0	1.11E-17	1.40E-17	1.60E-17	1.08E-17	1.34E-17
-5.5		1.07E-17		8.28E-18	1.05E-17

1 Dosimetry capsules A and C irradiated during Cycles 8 and 9 (Reference 6).

TABLE 4.2-11

^{58}Ni (n,p) ^{58}Co REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLE 9 IRRADIATION

Feet from	Reaction Rate (rps/nucleus)				
Midplane	84°[1]	74°	64°	39°	24°
0.5	6.66E-17	6.82E-17	5.61E-17	3.86E-17	5.63E-17
0.0					5.63E-17
-0.38		6.84E-17			
-0.5	6.50E-17	6.72E-17	5.69E-17	3.84E-17	5.54E-17
-1.0	6.32E-17	6.53E-17	5.67E-17	3.78E-17	5.50E-17
-1.5	5.79E-17	6.36E-17	5.54E-17	3.59E-17	5.48E-17
-2.0	5.72E-17	6.03E-17	5.35E-17	3.49E-17	5.33E-17
-2.5	5.04E-17	5.65E-17	5.16E-17	3.21E-17	5.04E-17
-3.0	4.17E-17	5.23E-17	4.87E-17	3.04E-17	4.70E-17
-3.5	3.71E-17	4.81E-17	4.60E-17	2.81E-17	4.30E-17
-4.0	3.39E-17	3.99E-17	4.05E-17	2.44E-17	3.74E-17
-4.5	2.33E-17	3.11E-17	3.46E-17	2.12E-17	3.09E-17
-5.0	1.68E-17	2.16E-17	2.35E-17	1.54E-17	2.05E-17
-5.5		1.59E-17		1.19E-17	1.49E-17

1 Dosimetry capsules A and C irradiated during Cycles 8 and 9 (Reference 6).

TABLE 4.2-12

$^{59}Co\ (n,\gamma)\ ^{60}Co$ REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLE 9 IRRADIATION

Feet from	Reaction Rate (rps/nucleus)				
Midplane	84°[1]	74°	64°	39°	24°
0.5	5.48E-14	3.38E-14	3.07E-14	3.40E-14	3.80E-14
0.0					3.76E-14
-0.38		3.41E-14			
-0.5	5.48E-14	3.39E-14	3.10E-14	3.43E-14	3.78E-14
-1.0	5.38E-14	3.36E-14	3.11E-14	3.38E-14	3.74E-14
-1.5	5.24E-14	3.30E-14	3.06E-14	3.34E-14	3.69E-14
-2.0	5.16E-14	3.22E-14	3.02E-14	3.26E-14	3.59E-14
-2.5	4.74E-14	3.15E-14	2.93E-14	3.16E-14	3.48E-14
-3.0	4.81E-14	3.03E-14	2.88E-14	3.03E-14	3.33E-14
-3.5	4.49E-14	2.87E-14	2.76E-14	2.89E-14	3.15E-14
-4.0	4.10E-14	2.72E-14	2.63E-14	2.70E-14	2.93E-14
-4.5	3.34E-14	2.36E-14	2.47E-14	2.48E-14	2.69E-14
-5.0	2.97E-14	1.99E-14	2.00E-14	1.91E-14	2.07E-14
-5.5		1.89E-14		1.67E-14	1.85E-14

1 Dosimetry capsules A and C irradiated during Cycles 8 and 9 (Reference 6).

TABLE 4.2-13

^{54}Fe (n,p) ^{54}Mn REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLE 9 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	2.76E-18	2.50E-18	2.72E-18	2.27E-18	2.33E-18		2.30E-18
7.5	4.27E-18	3.71E-18	3.88E-18	3.16E-18	3.57E-18		3.37E-18
7.0	7.14E-18	6.09E-18	5.29E-18	5.09E-18	5.79E-18		5.44E-18
6.5	1.08E-17	9.58E-18	9.33E-18	7.78E-18	8.73E-18		8.26E-18
6.0	1.55E-17	1.32E-17	1.36E-17	1.14E-17	1.14E-17		1.14E-17
5.5	2.03E-17	1.85E-17	1.83E-17	1.49E-17	1.55E-17		1.52E-17
5.0	2.46E-17	2.31E-17	2.41E-17	1.92E-17	1.94E-17		1.93E-17
4.5	2.95E-17	2.73E-17	2.86E-17	2.19E-17	2.42E-17		2.30E-17
4.0	3.16E-17	3.09E-17	3.24E-17	2.54E-17	2.60E-17		2.57E-17
3.5	3.55E-17	3.36E-17	3.46E-17	2.74E-17	2.82E-17		2.78E-17
3.0	3.71E-17	3.66E-17	3.62E-17	2.88E-17	2.97E-17		2.92E-17
2.5	3.83E-17	3.80E-17	3.64E-17	2.99E-17	3.24E-17		3.12E-17
2.0	3.84E-17	3.72E-17	3.81E-17	2.94E-17	3.28E-17		3.11E-17
1.5	3.89E-17	3.76E-17	3.81E-17	3.04E-17	3.46E-17		3.25E-17
1.0	4.01E-17	3.94E-17	3.89E-17	3.06E-17	3.23E-17		3.15E-17
0.5	3.97E-17	4.03E-17	3.83E-17	3.13E-17	3.32E-17		3.23E-17
0.0	4.02E-17	4.01E-17	4.02E-17	3.16E-17	3.37E-17		3.27E-17
-0.5	4.00E-17	4.01E-17	4.06E-17	3.18E-17	3.49E-17		3.33E-17
-1.0	4.00E-17	4.03E-17	4.12E-17	3.04E-17	3.50E-17		3.27E-17
-1.5	3.56E-17	4.09E-17	4.08E-17	3.14E-17	3.25E-17		3.20E-17
-2.0	3.47E-17	3.97E-17	3.96E-17	3.07E-17	3.31E-17		3.19E-17
-2.5	3.19E-17	3.73E-17	3.75E-17	3.02E-17	3.15E-17		3.09E-17
-3.0	3.20E-17	3.52E-17	3.52E-17	2.99E-17	3.02E-17		3.01E-17
-3.5	3.00E-17	3.33E-17	3.29E-17	2.60E-17	2.91E-17		2.75E-17
-4.0	2.66E-17	2.85E-17	2.82E-17	2.31E-17	2.51E-17		2.41E-17
-4.5	2.28E-17	2.42E-17	2.56E-17	2.04E-17	2.28E-17		2.16E-17

TABLE 4.2-14

^{58}Ni (n,p) ^{58}Co REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLE 9 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	4.56E-18	3.97E-18	4.37E-18	3.61E-18	3.67E-18		3.64E-18
7.5	7.47E-18	6.07E-18	6.53E-18	5.25E-18	5.21E-18		5.23E-18
7.0	1.07E-17	9.24E-18	9.72E-18	8.02E-18	8.75E-18		8.39E-18
6.5	1.55E-17	1.39E-17	1.45E-17	1.18E-17	1.26E-17		1.22E-17
6.0	2.18E-17	1.98E-17	2.07E-17	1.61E-17	1.75E-17		1.68E-17
5.5	2.90E-17	2.65E-17	2.73E-17	2.29E-17	2.41E-17		2.35E-17
5.0	3.63E-17	3.49E-17	3.53E-17	2.75E-17	2.98E-17		2.87E-17
4.5	4.30E-17	4.07E-17	4.18E-17	3.28E-17	3.55E-17		3.41E-17
4.0	4.77E-17	4.56E-17	4.64E-17	3.61E-17	3.80E-17		3.71E-17
3.5	5.14E-17	4.98E-17	5.04E-17	3.95E-17	4.37E-17		4.16E-17
3.0	5.40E-17	5.23E-17	5.29E-17	4.05E-17	4.60E-17		4.32E-17
2.5	5.44E-17	5.37E-17	5.42E-17	4.26E-17	4.77E-17		4.51E-17
2.0	5.44E-17	5.42E-17	5.54E-17	4.37E-17	4.79E-17		4.58E-17
1.5	5.56E-17	5.50E-17	5.63E-17	4.37E-17	4.83E-17		4.60E-17
1.0	5.65E-17	5.54E-17	5.61E-17	4.43E-17	4.83E-17		4.63E-17
0.5	5.63E-17	5.58E-17	5.63E-17	4.47E-17	4.95E-17		4.71E-17
0.0	5.54E-17	5.63E-17	5.73E-17	4.37E-17	4.98E-17		4.67E-17
-0.5	5.52E-17	5.67E-17	5.65E-17	4.45E-17	5.00E-17		4.72E-17
-1.0	5.48E-17	5.73E-17	5.73E-17	4.49E-17	4.91E-17		4.70E-17
-1.5	5.21E-17	5.73E-17	5.67E-17	4.49E-17	4.79E-17		4.64E-17
-2.0	5.04E-17	5.52E-17	5.67E-17	4.49E-17	4.72E-17		4.61E-17
-2.5	4.83E-17	5.27E-17	5.48E-17	4.41E-17	4.66E-17		4.53E-17
-3.0	4.53E-17	5.08E-17	5.16E-17	4.16E-17	4.47E-17		4.31E-17
-3.5	4.24E-17	4.70E-17	4.79E-17	3.80E-17	4.26E-17		4.03E-17
-4.0	3.84E-17	4.26E-17	4.22E-17	3.49E-17	3.82E-17		3.65E-17
-4.5	3.28E-17	3.61E-17	3.59E-17	2.94E-17	3.21E-17		3.08E-17

TABLE 4.2-15

$^{59}Co\ (n,\gamma)\ ^{60}Co$ REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLE 9 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	1.50E-14	1.51E-14	1.43E-14	1.37E-14	1.39E-14		1.38E-14
7.5	1.74E-14	1.70E-14	1.60E-14	1.57E-14	1.63E-14		1.60E-14
7.0	1.94E-14	1.88E-14	1.77E-14	1.73E-14	1.89E-14		1.81E-14
6.5	2.14E-14	2.07E-14	1.98E-14	1.88E-14	2.07E-14		1.97E-14
6.0	2.32E-14	2.24E-14	2.17E-14	2.02E-14	2.23E-14		2.12E-14
5.5	2.55E-14	2.41E-14	2.38E-14	2.21E-14	2.42E-14		2.31E-14
5.0	2.75E-14	2.58E-14	2.55E-14	2.39E-14	2.59E-14		2.49E-14
4.5	2.98E-14	2.75E-14	2.74E-14	2.55E-14	2.82E-14		2.69E-14
4.0	3.19E-14	2.89E-14	2.91E-14	2.69E-14	3.01E-14		2.85E-14
3.5	3.36E-14	3.02E-14	3.07E-14	2.82E-14	3.20E-14		3.01E-14
3.0	3.57E-14	3.16E-14	3.21E-14	2.94E-14	3.36E-14		3.15E-14
2.5	3.71E-14	3.27E-14	3.37E-14	3.04E-14	3.47E-14		3.25E-14
2.0	3.72E-14	3.38E-14	3.51E-14	3.14E-14	3.60E-14		3.37E-14
1.5	4.04E-14	3.45E-14	3.62E-14	3.25E-14	3.72E-14		3.49E-14
1.0	4.17E-14	3.55E-14	3.72E-14	3.32E-14	3.83E-14		3.57E-14
0.5	4.23E-14	3.62E-14	3.82E-14	3.42E-14	3.88E-14		3.65E-14
0.0	4.30E-14	3.63E-14	3.85E-14	3.43E-14	3.94E-14		3.69E-14
-0.5	4.30E-14	3.68E-14	3.90E-14	3.48E-14	3.98E-14		3.73E-14
-1.0	4.32E-14	3.65E-14	3.87E-14	3.47E-14	3.92E-14		3.70E-14
-1.5	4.26E-14	3.61E-14	3.85E-14	3.47E-14	3.85E-14		3.66E-14
-2.0	4.17E-14	3.54E-14	3.74E-14	3.44E-14	3.91E-14		3.67E-14
-2.5	3.99E-14	3.46E-14	3.65E-14	3.36E-14	3.76E-14		3.56E-14
-3.0	3.83E-14	3.31E-14	3.52E-14	3.24E-14	3.67E-14		3.46E-14
-3.5	3.60E-14	3.17E-14	3.35E-14	3.08E-14	3.48E-14		3.28E-14
-4.0	3.39E-14	2.99E-14	3.15E-14	2.89E-14	3.27E-14		3.08E-14
-4.5	3.02E-14	2.73E-14	2.87E-14	2.66E-14	3.01E-14		2.83E-14

TABLE 4.2-16

SUMMARY OF REACTION RATES DERIVED FROM MULTIPLE FOIL SENSOR SETS
CYCLES 10 / 11 IRRADIATION

	Reaction Rate (rps/nucleus)						
Reaction	Capsule O (84°)	Capsule P (74°)	Capsule Q (74°)	Capsule R (64°)	Capsule S (54°)	Capsule T (39°)	Capsule U (24°)
^{63}Cu (n,α) ^{60}Co Cd	5.19E-19	5.41E-19	1.30E-19	4.95E-19	4.16E-19	3.70E-19	4.49E-19
^{46}Ti (n,p) ^{46}Sc	6.85E-18	7.25E-18	1.84E-18	6.94E-18	5.49E-18	5.53E-18	6.40E-18
^{54}Fe (n,p) ^{54}Mn	3.63E-17	3.81E-17	9.79E-18	3.54E-17	2.84E-17	2.79E-17	3.26E-17
^{58}Ni (n,p) ^{58}Co Cd	5.00E-17	5.38E-17	1.42E-17	4.84E-17		3.92E-17	4.62E-17
^{238}U (n,f) ^{137}Cs Cd	2.18E-16	1.98E-16	4.73E-17	1.85E-16	1.52E-16	1.41E-16	1.87E-16
^{237}Np (n,f) ^{137}Cs Cd	2.56E-15	2.72E-15		2.60E-15	2.08E-15	1.99E-15	2.03E-15
^{59}Co (n,γ) ^{60}Co	2.84E-14	2.74E-14	1.53E-14	2.57E-14	2.54E-14	2.94E-14	3.09E-14
^{59}Co (n,γ) ^{60}Co Cd	1.83E-14	1.82E-14	1.03E-14	1.78E-14	1.81E-14	1.87E-14	1.93E-14

Note: Cd indicates that the sensor was cadmium covered.

TABLE 4.2-17

^{54}Fe (n,p) ^{54}Mn REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLES 10 / 11 IRRADIATION

Feet from	Reaction Rate (rps/nucleus)					
Midplane	84°	74°	64°	54°	39°	24°
0.5	3.45E-17	3.63E-17	3.10E-17	2.74E-17	2.59E-17	2.83E-17
-0.5	3.39E-17	3.47E-17	3.21E-17	2.68E-17	2.64E-17	3.03E-17
-1.5	2.93E-17	3.51E-17	3.25E-17	2.60E-17	2.39E-17	2.81E-17
-2.5	2.53E-17	3.01E-17	2.92E-17	2.65E-17	2.00E-17	2.86E-17
-3.5	1.93E-17	2.66E-17	2.55E-17	2.16E-17	1.78E-17	2.43E-17
-4.5	1.21E-17	1.72E-17	1.96E-17	1.73E-17	1.53E-17	1.79E-17
-5.5	5.99E-18	6.85E-18	1.06E-17	1.00E-17	7.48E-18	8.55E-18

TABLE 4.2-18

^{58}Ni (n,p) ^{58}Co REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLES 10 / 11 IRRADIATION

Feet from Midplane	Reaction Rate (rps/nucleus) 84°	74°	64°	54°	39°	24°
0.5	4.77E-17	5.25E-17	4.50E-17	3.95E-17	3.74E-17	4.09E-17
-0.5	4.65E-17	5.21E-17	4.54E-17	3.92E-17	3.54E-17	4.22E-17
-1.5	4.14E-17	4.93E-17	4.58E-17	3.80E-17	3.52E-17	4.16E-17
-2.5	3.87E-17	4.30E-17	4.17E-17	3.48E-17	3.26E-17	4.22E-17
-3.5	2.91E-17	3.94E-17	3.79E-17	3.24E-17	2.85E-17	3.73E-17
-4.5	1.79E-17	2.70E-17	3.01E-17	2.69E-17	2.34E-17	2.77E-17
-5.5	9.39E-18	1.07E-17	1.65E-17	1.47E-17	1.30E-17	1.38E-17

TABLE 4.2-19

$^{59}Co\ (n,\gamma)\ ^{60}Co$ REACTION RATES DERIVED FROM THE STAINLESS STEEL SHORT GRADIENT CHAINS - CYCLES 10 / 11 IRRADIATION

Feet from Midplane	Reaction Rate (rps/nucleus) 84°	74°	64°	54°	39°	24°
0.5	2.65E-14	2.46E-14	2.30E-14	2.32E-14	2.60E-14	2.75E-14
-0.5	2.58E-14	2.44E-14	2.32E-14	2.32E-14	2.60E-14	2.77E-14
-1.5	2.53E-14	2.41E-14	2.27E-14	2.25E-14	2.50E-14	2.72E-14
-2.5	2.36E-14	2.27E-14	2.20E-14	2.16E-14	2.39E-14	2.60E-14
-3.5	2.11E-14	2.11E-14	2.07E-14	2.01E-14	2.16E-14	2.32E-14
-4.5	1.60E-14	1.76E-14	1.85E-14	1.80E-14	1.87E-14	1.98E-14
-5.5	1.36E-14	1.35E-14	1.39E-14	1.32E-14	1.27E-14	1.41E-14

TABLE 4.2-20

^{54}Fe (n,p) ^{54}Mn REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLES 10 / 11 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	2.24E-18	1.92E-18	2.54E-18	1.74E-18	2.18E-18	1.97E-18	1.97E-18
7.5	2.49E-18	3.13E-18	3.60E-18	3.02E-18	3.21E-18	3.39E-18	3.20E-18
6.5	7.64E-18	7.10E-18	7.07E-18	7.70E-18	7.83E-18	6.85E-18	7.46E-18
5.5	1.42E-17	1.37E-17	1.30E-17	1.46E-17	1.54E-17	1.51E-17	1.50E-17
4.5	2.25E-17	2.07E-17	1.95E-17	2.09E-17	2.27E-17	2.26E-17	2.21E-17
3.5	2.67E-17	2.56E-17	2.46E-17	2.42E-17	2.59E-17	2.71E-17	2.57E-17
2.5	2.92E-17	2.62E-17	2.67E-17	2.73E-17	2.99E-17	2.69E-17	2.80E-17
1.5	3.09E-17	2.63E-17	2.66E-17	2.71E-17	2.82E-17	2.94E-17	2.82E-17
0.5	2.85E-17	2.77E-17	2.82E-17	2.62E-17	2.99E-17	2.96E-17	2.85E-17
0.0	2.94E-17	2.66E-17	2.91E-17	2.63E-17	2.93E-17	3.21E-17	2.92E-17
-0.5	2.85E-17	2.76E-17	2.85E-17	2.79E-17	2.86E-17	2.94E-17	2.86E-17
-1.5	2.82E-17	2.82E-17	2.79E-17	2.71E-17	2.80E-17	2.96E-17	2.82E-17
-2.5	2.63E-17	2.49E-17	2.69E-17	2.54E-17	2.73E-17	2.78E-17	2.68E-17
-3.5	2.34E-17	2.20E-17	2.40E-17	2.61E-17	2.45E-17	2.34E-17	2.46E-17
-4.5	1.83E-17	1.56E-17	2.02E-17	1.85E-17	1.83E-17	1.84E-17	1.84E-17

TABLE 4.2-21

^{58}Ni (n,p) ^{58}Co REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLES 10 / 11 IRRADIATION

Feet from Midplane	Reaction Rate (rps/nucleus) Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	3.16E-18	3.76E-18	3.65E-18	3.15E-18	3.71E-18	2.89E-18	3.25E-18
7.5	4.90E-18	5.05E-18	6.20E-18	5.17E-18	5.42E-18	5.55E-18	5.38E-18
6.5	1.08E-17	1.15E-17	1.21E-17	1.14E-17	1.28E-17	1.16E-17	1.19E-17
5.5	2.27E-17	2.07E-17	1.99E-17	2.24E-17	2.38E-17	2.35E-17	2.32E-17
4.5	3.43E-17	3.21E-17	3.09E-17	3.20E-17	3.33E-17	3.66E-17	3.40E-17
3.5	3.79E-17	3.91E-17	3.68E-17	3.80E-17	4.21E-17	4.08E-17	4.03E-17
2.5	4.47E-17	4.07E-17	4.03E-17	3.84E-17	4.21E-17	4.21E-17	4.09E-17
1.5	4.59E-17	4.11E-17	4.15E-17	3.99E-17	4.30E-17	4.26E-17	4.18E-17
0.5	4.27E-17	3.90E-17	4.15E-17	3.91E-17	4.26E-17	4.42E-17	4.20E-17
0.0	4.19E-17	4.03E-17	4.11E-17	3.99E-17	4.30E-17	4.38E-17	4.22E-17
-0.5	4.15E-17	4.07E-17	4.23E-17	4.07E-17	4.06E-17	4.34E-17	4.16E-17
-1.5	4.19E-17	4.19E-17	4.03E-17	3.86E-17	4.04E-17	4.26E-17	4.05E-17
-2.5	3.89E-17	3.80E-17	3.95E-17	4.06E-17	4.21E-17	4.17E-17	4.15E-17
-3.5	3.68E-17	3.34E-17	3.55E-17	3.73E-17	3.65E-17	3.51E-17	3.63E-17
-4.5	2.64E-17	2.60E-17	3.11E-17	2.78E-17	2.83E-17	2.88E-17	2.83E-17

TABLE 4.2-22

$^{59}Co\ (n,\gamma)\ ^{60}Co$ REACTION RATES DERIVED FROM THE STAINLESS STEEL LONG GRADIENT CHAINS - CYCLES 10 / 11 IRRADIATION

	Reaction Rate (rps/nucleus)						
Feet from Midplane	Ref. 90° FQE 90°	Ref. 260° FQE 80°	Ref. 340° FQE 20°	Ref. 30° FQE 30°	Ref. 150° FQE 30°	Ref. 210° FQE 30°	Average FQE 30°
8.0	1.08E-14	1.11E-14	1.00E-14	1.03E-14	1.09E-14	1.04E-14	1.06E-14
7.5	1.26E-14	1.25E-14	1.13E-14	1.19E-14	1.24E-14	1.20E-14	1.21E-14
6.5	1.55E-14	1.52E-14	1.43E-14	1.45E-14	1.57E-14	1.53E-14	1.51E-14
5.5	1.82E-14	1.76E-14	1.72E-14	1.69E-14	1.83E-14	1.79E-14	1.77E-14
4.5	2.11E-14	1.99E-14	2.01E-14	1.95E-14	2.14E-14	2.12E-14	2.07E-14
3.5	2.37E-14	2.21E-14	2.25E-14	2.19E-14	2.42E-14	2.35E-14	2.32E-14
2.5	2.63E-14	2.39E-14	2.47E-14	2.36E-14	2.62E-14	2.58E-14	2.52E-14
1.5	2.85E-14	2.51E-14	2.69E-14	2.48E-14	2.79E-14	2.75E-14	2.67E-14
0.5	2.97E-14	2.58E-14	2.83E-14	2.60E-14	2.92E-14	2.84E-14	2.79E-14
0.0	2.97E-14	2.60E-14	2.88E-14	2.65E-14	2.94E-14	2.87E-14	2.82E-14
-0.5	3.02E-14	2.65E-14	2.90E-14	2.65E-14	2.96E-14	2.89E-14	2.83E-14
-1.5	3.04E-14	2.58E-14	2.88E-14	2.67E-14	2.94E-14	2.84E-14	2.82E-14
-2.5	2.90E-14	2.48E-14	2.76E-14	2.55E-14	2.84E-14	2.72E-14	2.70E-14
-3.5	2.61E-14	2.28E-14	2.54E-14	2.37E-14	2.58E-14	2.48E-14	2.47E-14
-4.5	2.03E-14	1.94E-14	2.19E-14	2.04E-14	2.24E-14	2.07E-14	2.12E-14

4.3 LEAST SQUARES ADJUSTMENT

4.3.1 In-Vessel Surveillance Capsules

The results of the application of the least squares adjustment procedure to the five sets of surveillance capsule dosimetry are provided in Table 4.3-1 through 4.3-5. In these tables, the derived exposure experienced by the capsule along with data illustrating the fit of both the trial and adjusted spectra to the measurements are given. Also included in the tabulations are the 1σ uncertainties associated with each of the derived exposure rates.

In regard to the comparisons listed in Tables 4.3-1 through 4.3-5, it should be noted that the columns labeled "Trial Calc." represent the calculated neutron flux (E > 1.0 MeV) from Table 4.1-4 averaged over the applicable irradiation periods (Cycles 1 and 2 for Capsule A240, Cycles 1 through 5 for Capsule W290, Cycle 9 for Capsule W290-9, Cycles 1 through 10 for Capsule W110, and Cycles 12 and 13 for Capsule SA60-1) as discussed in Section 3. Thus, the comparisons illustrated in Tables 4.3-1 through 4.3-5 indicate the degree to which the calculated neutron energy spectra matched the measured sensor data before and after adjustment. The comparisons of calculation-to-measured results are discussed in Section 5 of this report.

4.3.2 Ex-Vessel Dosimetry

4.3.2.1 Cycle 8 Cavity Dosimetry

The results of the application of the least squares adjustment procedure to the four sets of multiple foil measurements obtained from the Cycle 8 irradiation are provided in Tables 4.3-6 through 4.3-9. In these tables, the derived exposure experienced at each sensor set location along with data illustrating the fit of both the trial and adjusted spectra to the measurements are given. Also included in the tabulations are the 1σ uncertainties associated with each of the derived exposure rates.

In regard to the comparisons listed in Tables 4.3-6 through 4.3-9, it should be noted that the columns labeled "Trial Calc." represent the absolute calculated neutron flux (E > 1.0 MeV) from Table 4.1-1 averaged over the Cycle 8 irradiation period as discussed in Section 3. Thus, the comparisons illustrated in Tables 4.3-6 through 4.3-9 indicate the degree to which the calculated neutron energy spectra matched the measured data before and after adjustment. The comparisons of calculation-to-measured results are discussed in Section 5 of this report.

4.3.2.2 Cycle 9 Cavity Dosimetry

The results of the application of the least squares adjustment procedure to the six sets of multiple foil measurements obtained from the Cycle 9 irradiation are provided in Tables 4.3-10 through 4.3-15. In these tables, the derived exposure experienced at each sensor set location along with data illustrating the fit of both the trial and adjusted spectra to the measurements are given. Also included in the tabulations are the 1σ uncertainties associated with each of the derived exposure rates.

In regard to the comparisons listed in Tables 4.3-10 through 4.3-15, it should be noted that the columns labeled "Trial Calc." represent the absolute calculated neutron flux (E > 1.0 MeV) from Table 4.1-2 averaged over the Cycle 9 irradiation period as discussed in Section 3. Thus, the comparisons illustrated in Tables 4.3-10 through 4.3-15 indicate the degree to which the calculated neutron energy spectra matched the measured data before and after adjustment. The comparisons of calculation-to-measured results are discussed in Section 5 of this report.

4.3.2.3 Cycle 10/11 Cavity Dosimetry

The results of the application of the least squares adjustment procedure to the seven sets of multiple foil measurements obtained from the Cycles 10/11 irradiation are provided in Tables 4.3-16 through 4.3-22. In these tables, the derived exposure experienced at each sensor set location along with data illustrating the fit of both the trial and adjusted spectra to the measurements are given. Also included in the tabulations are the 1σ uncertainties associated with each of the derived exposure rates.

In regard to the comparisons listed in Tables 4.3-16 through 4.3-22, it should be noted that the columns labeled "Trial Calc." represent the calculated neutron flux (E > 1.0 MeV) from Table 4.1-3 averaged over the Cycles 10/11 irradiation period as discussed in Section 3. Thus, the comparisons illustrated in Tables 4.3-16 through 4.3-22 indicate the degree to which the calculated neutron energy spectra matched the measured data before and after adjustment. The comparisons of calculation-to-measured results are discussed in Section 5 of this report.

TABLE 4.3-1

DERIVED EXPOSURE RATES FROM SURVEILLANCE CAPSULE A240 DOSIMETRY
WITHDRAWN AT THE END OF FUEL CYCLE 2

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	5.71E+11	5.61E+11	7
ϕ(E > 0.1 MeV)	1.28E+12	1.25E+12	10
ϕ(E < 0.414 eV)	6.30E+11	6.46E+11	42
dpa/sec	8.24E-10	8.15E-10	7

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
SURVEILLANCE CAPSULE A240

	Reaction Rate (rps/nucleus)				Ratios	
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	4.97E-16	4.55E-16	4.99E-16	1.09	1.00	1.10
^{54}Fe (n,p)	5.58E-14	5.48E-14	5.68E-14	1.02	1.02	1.03
^{58}Ni (n,p) Cd	6.99E-14	7.33E-14	7.41E-14	0.95	1.06	1.01
^{46}Ti (n,p)	9.65E-15	7.95E-15	8.92E-15	1.21	0.92	1.12

TABLE 4.3-2

DERIVED EXPOSURE RATES FROM SURVEILLANCE CAPSULE W290 DOSIMETRY
WITHDRAWN AT THE END OF FUEL CYCLE 5

	Trial Value	Adjusted Value	1σ % Uncertainty
$\phi(E > 1.0$ MeV)	5.71E+10	5.64E+10	6
$\phi(E > 0.1$ MeV)	1.06E+11	1.04E+11	9
$\phi(E < 0.414$ eV)	8.72E+10	8.97E+10	43
dpa/sec	8.20E-11	8.17E-11	6

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
SURVEILLANCE CAPSULE W290

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	9.46E-17	8.24E-17	9.17E-17	1.15	0.97	1.11
^{54}Fe (n,p)	7.52E-15	7.56E-15	7.77E-15	0.99	1.03	1.03
^{58}Ni (n,p) Cd	9.89E-15	9.86E-15	1.01E-14	1.00	1.02	1.02
^{46}Ti (n,p)	1.46E-15	1.31E-15	1.42E-15	1.11	0.97	1.08
^{238}U (n,f) Cd	2.52E-14	2.56E-14	2.57E-14	0.98	1.02	1.00

TABLE 4.3-3

DERIVED EXPOSURE RATES FROM SURVEILLANCE CAPSULE W290-9 DOSIMETRY WITHDRAWN AT THE END OF FUEL CYCLE 9

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	3.32E+10	3.17E+10	5
ϕ(E > 0.1 MeV)	6.13E+10	5.74E+10	8
ϕ(E < 0.414 eV)	4.91E+10	5.93E+10	8
dpa/sec	4.78E-11	4.62E-11	5

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES SURVEILLANCE CAPSULE W290-9

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	5.72E-17	5.09E-17	5.60E-17	1.12	0.98	1.10
^{54}Fe (n,p)	4.31E-15	4.51E-15	4.54E-15	0.96	1.05	1.01
^{58}Ni (n,p) Cd	5.78E-15	5.87E-15	5.90E-15	0.98	1.02	1.01
^{46}Ti (n,p)	9.29E-16	7.99E-16	8.73E-16	1.16	0.94	1.09
^{238}U (n,f) Cd	1.44E-14	1.50E-14	1.47E-14	0.96	1.02	0.98
^{237}Np (n,f) Cd	6.28E-14	6.86E-14	6.40E-14	0.92	1.02	0.93
^{59}Co (n,γ)	1.70E-12	1.49E-12	1.69E-12	1.14	1.00	1.14
^{59}Co (n,γ) Cd	2.38E-13	3.07E-13	2.41E-13	0.77	1.01	0.78

TABLE 4.3-4

DERIVED EXPOSURE RATES FROM SURVEILLANCE CAPSULE W110 DOSIMETRY WITHDRAWN AT THE END OF FUEL CYCLE 10

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	5.23E+10	5.29E+10	6
ϕ(E > 0.1 MeV)	9.72E+10	9.73E+10	9
ϕ(E < 0.414 eV)	7.97E+10	8.31E+10	43
dpa/sec	7.51E-11	7.66E-11	6

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES SURVEILLANCE CAPSULE W110

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	8.85E-17	7.58E-17	8.62E-17	1.17	0.97	1.14
^{54}Fe (n,p)	7.09E-15	6.94E-15	7.31E-15	1.02	1.03	1.05
^{58}Ni (n,p) Cd	9.13E-15	9.04E-15	9.45E-15	1.01	1.03	1.04
^{46}Ti (n,p)	1.41E-15	1.21E-15	1.35E-15	1.17	0.96	1.12

TABLE 4.3-5

DERIVED EXPOSURE RATES FROM SURVEILLANCE CAPSULE SA60-1 DOSIMETRY WITHDRAWN AT THE END OF FUEL CYCLE 13

	Trial Value	Adjusted Value	1σ % Uncertainty
$\phi(E > 1.0\ MeV)$	2.10E+11	2.26E+11	6
$\phi(E > 0.1\ MeV)$	4.61E+11	4.91E+11	10
$\phi(E < 0.414\ eV)$	2.17E+11	2.30E+11	42
dpa/sec	3.03E-10	3.26E-10	6

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES SURVEILLANCE CAPSULE SA60-1

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
$^{63}Cu\ (n,\alpha)$ Cd	2.16E-16	1.92E-16	2.16E-16	1.13	1.00	1.13
^{54}Fe (n,p)	2.23E-14	2.13E-14	2.32E-14	1.05	1.04	1.09
^{58}Ni (n,p) Cd	3.04E-14	2.84E-14	3.10E-14	1.07	1.02	1.09
^{46}Ti (n,p)	3.86E-15	3.25E-15	3.70E-15	1.19	0.96	1.14
^{238}U (n,f) Cd	9.88E-14	8.55E-14	9.28E-14	1.15	0.94	1.09

TABLE 4.3-6

DERIVED EXPOSURE RATES FROM THE CAPSULE B DOSIMETRY EVALUATION
CYCLE 8 - 74° AZIMUTH - 280° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	1.17E+09	1.30E+09	6
ϕ(E > 0.1 MeV)	9.35E+09	1.05E+10	10
ϕ(E < 0.414 eV)	6.57E+08	6.23E+08	18
dpa/sec	3.31E-12	3.69E-12	8

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
74° AZIMUTH - 280° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	9.76E-19	8.97E-19	9.79E-19	1.09	1.00	1.09
^{46}Ti (n,p)	1.43E-17	1.25E-17	1.39E-17	1.14	0.97	1.11
^{54}Fe (n,p)	7.48E-17	6.93E-17	7.55E-17	1.08	1.01	1.09
^{58}Ni (n,p) Cd	1.04E-16	9.70E-17	1.06E-16	1.07	1.01	1.09
^{238}U (n,f) Cd	3.44E-16	3.52E-16	3.86E-16	0.98	1.13	1.10
^{235}U (n,f) Cd	9.40E-14	9.04E-14	9.23E-14	1.04	0.98	1.02
^{238}U (n,f) Cd[1]	4.02E-16	3.52E-16	3.86E-16	1.14	0.96	1.10
^{235}U (n,f) Cd[1]	8.10E-14	9.04E-14	9.23E-14	0.90	1.14	1.02
^{237}Np (n,f) Cd	6.64E-15	4.75E-15	5.93E-15	1.40	0.89	1.25
^{59}Co (n,γ)	4.64E-14	4.12E-14	4.65E-14	1.12	1.00	1.13
^{59}Co (n,γ) Cd	3.08E-14	2.44E-14	3.03E-14	1.26	0.98	1.24

1 Paired Uranium Dosimeter (PUD) measurement

TABLE 4.3-7

DERIVED EXPOSURE RATES FROM THE CAPSULE D DOSIMETRY EVALUATION
CYCLE 8 - 64° AZIMUTH - 290° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
φ(E > 1.0 MeV)	9.01E+08	9.78E+08	6
φ(E > 0.1 MeV)	7.76E+09	8.50E+09	10
φ(E < 0.414 eV)	6.49E+08	5.58E+08	19
dpa/sec	2.69E-12	2.94E-12	8

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
64° AZIMUTH - 290° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	7.51E-19	6.88E-19	7.54E-19	1.09	1.00	1.10
^{46}Ti (n,p)	1.10E-17	9.54E-18	1.06E-17	1.15	0.97	1.11
^{54}Fe (n,p)	5.65E-17	5.25E-17	5.69E-17	1.08	1.01	1.08
^{58}Ni (n,p) Cd	7.83E-17	7.36E-17	7.95E-17	1.06	1.01	1.08
^{238}U (n,f) Cd	2.53E-16	2.68E-16	2.90E-16	0.94	1.15	1.08
^{235}U (n,f) Cd	8.87E-14	8.56E-14	8.79E-14	1.04	0.99	1.03
^{238}U (n,f) Cd[1]	3.06E-16	2.68E-16	2.90E-16	1.14	0.95	1.08
^{235}U (n,f) Cd[1]	7.97E-14	8.56E-14	8.79E-14	0.93	1.10	1.03
^{237}Np (n,f) Cd	4.97E-15	3.77E-15	4.52E-15	1.32	0.91	1.20
^{59}Co (n,γ)	4.34E-14	4.02E-14	4.37E-14	1.08	1.01	1.09
^{59}Co (n,γ) Cd	2.99E-14	2.35E-14	2.93E-14	1.27	0.98	1.25

1 Paired Uranium Dosimeter (PUD) measurement

TABLE 4.3-8

DERIVED EXPOSURE RATES FROM THE CAPSULE E DOSIMETRY EVALUATION
CYCLE 8 - 64° AZIMUTH - 290° REFERENCE - CORE BOTTOM

	Trial Value	Adjusted Value	1σ % Uncertainty
φ(E > 1.0 MeV)	3.21E+08	3.38E+08	6
φ(E > 0.1 MeV)	3.06E+09	3.30E+09	11
φ(E < 0.414 eV)	3.09E+08	3.34E+08	18
dpa/sec	1.04E-12	1.11E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
64° AZIMUTH - 290° REFERENCE - CORE BOTTOM

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	1.99E-19	2.19E-19	2.11E-19	0.91	1.06	0.96
^{46}Ti (n,p)	3.29E-18	3.07E-18	3.13E-18	1.07	0.95	1.02
^{54}Fe (n,p)	1.76E-17	1.75E-17	1.77E-17	1.01	1.01	1.01
^{58}Ni (n,p) Cd	2.58E-17	2.47E-17	2.54E-17	1.04	0.99	1.03
^{238}U (n,f) Cd	8.95E-17	9.34E-17	9.70E-17	0.96	1.08	1.04
^{235}U (n,f) Cd	4.63E-14	3.96E-14	4.73E-14	1.17	1.02	1.19
^{237}Np (n,f) Cd	1.64E-15	1.41E-15	1.57E-15	1.16	0.96	1.12
^{59}Co (n,γ)	2.59E-14	1.91E-14	2.59E-14	1.36	1.00	1.36
^{59}Co (n,γ) Cd	1.75E-14	1.11E-14	1.72E-14	1.57	0.98	1.54

TABLE 4.3-9

DERIVED EXPOSURE RATES FROM THE CAPSULE G DOSIMETRY EVALUATION
CYCLE 8 - 39° AZIMUTH - 315° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	6.15E+08	6.86E+08	6
ϕ(E > 0.1 MeV)	5.88E+09	6.69E+09	10
ϕ(E < 0.414 eV)	6.38E+08	7.37E+08	16
dpa/sec	2.00E-12	2.27E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
39° AZIMUTH - 315° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	5.53E-19	4.67E-19	5.49E-19	1.18	0.99	1.18
^{46}Ti (n,p)	7.76E-18	6.43E-18	7.56E-18	1.21	0.97	1.18
^{54}Fe (n,p)	4.04E-17	3.55E-17	4.04E-17	1.14	1.00	1.14
^{58}Ni (n,p) Cd	5.53E-17	4.98E-17	5.62E-17	1.11	1.02	1.13
^{238}U (n,f) Cd	1.94E-16	1.82E-16	2.04E-16	1.06	1.05	1.12
^{235}U (n,f) Cd	8.69E-14	7.94E-14	9.08E-14	1.10	1.04	1.14
^{238}U (n,f) Cd[1]	1.94E-16	1.82E-16	2.04E-16	1.06	1.05	1.12
^{235}U (n,f) Cd[1]	9.17E-14	7.94E-14	9.08E-14	1.16	0.99	1.14
^{237}Np (n,f) Cd	3.54E-15	2.68E-15	3.26E-15	1.32	0.92	1.22
^{59}Co (n,γ)	4.82E-14	3.88E-14	4.81E-14	1.24	1.00	1.24
^{59}Co (n,γ) Cd	2.90E-14	2.24E-14	2.88E-14	1.30	0.99	1.29

1 Paired Uranium Dosimeter (PUD) measurement

TABLE 4.3-10

DERIVED EXPOSURE RATES FROM THE CAPSULE A[1] DOSIMETRY EVALUATION
CYCLE 9 - 84° AZIMUTH - 270° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
$\phi(E > 1.0\ MeV)$	8.55E+08	9.33E+08	6
$\phi(E > 0.1\ MeV)$	7.43E+09	8.05E+09	10
$\phi(E < 0.414\ eV)$	5.98E+08	6.18E+08	17
dpa/sec	2.57E-12	2.79E-12	8

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
84° AZIMUTH - 270° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
$^{63}Cu\ (n,\alpha)$ Cd	7.42E-19	6.68E-19	7.31E-19	1.11	0.99	1.09
$^{46}Ti\ (n,p)$	1.01E-17	9.19E-18	1.00E-17	1.10	0.99	1.09
$^{54}Fe\ (n,p)$	5.39E-17	5.01E-17	5.41E-17	1.08	1.01	1.08
$^{58}Ni\ (n,p)$ Cd	7.20E-17	7.01E-17	7.48E-17	1.03	1.04	1.07
$^{238}U\ (n,f)$ Cd	2.46E-16	2.55E-16	2.77E-16	0.97	1.13	1.09
$^{235}U\ (n,f)$ Cd	8.20E-14	8.02E-14	8.02E-14	1.02	0.98	1.00
$^{238}U\ (n,f)$ Cd[2]	3.26E-16	2.55E-16	2.77E-16	1.28	0.85	1.09
$^{235}U\ (n,f)$ Cd[2]	7.01E-14	8.02E-14	8.02E-14	0.87	1.14	1.00
$^{237}Np\ (n,f)$ Cd	4.37E-15	3.60E-15	4.13E-15	1.21	0.95	1.15
$^{59}Co\ (n,\gamma)$	4.31E-14	3.74E-14	4.30E-14	1.15	1.00	1.15
$^{59}Co\ (n,\gamma)$ Cd	2.71E-14	2.20E-14	2.67E-14	1.23	0.99	1.22

1 Dosimetry capsules A and C irradiated during Cycles 8 and 9.
2 Paired Uranium Dosimeter (PUD) measurement

TABLE 4.3-11

DERIVED EXPOSURE RATES FROM THE CAPSULE C[1] DOSIMETRY EVALUATION
CYCLE 9 - 84° AZIMUTH - 270° REFERENCE - CORE BOTTOM

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	2.93E+08	2.04E+08	6
ϕ(E > 0.1 MeV)	2.84E+09	2.34E+09	11
ϕ(E < 0.414 eV)	2.85E+08	2.61E+08	19
dpa/sec	9.61E-13	7.60E-13	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
84° AZIMUTH - 270° REFERENCE - CORE BOTTOM

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	1.13E-19	2.07E-19	1.18E-19	0.55	1.05	0.57
^{46}Ti (n,p)	1.71E-18	2.87E-18	1.69E-18	0.60	0.99	0.59
^{54}Fe (n,p)	9.77E-18	1.61E-17	9.77E-18	0.61	1.00	0.61
^{58}Ni (n,p) Cd	1.37E-17	2.28E-17	1.40E-17	0.60	1.02	0.61
^{238}U (n,f) Cd	5.64E-17	8.54E-17	5.64E-17	0.66	1.00	0.66
^{235}U (n,f) Cd	4.19E-14	3.69E-14	3.99E-14	1.14	0.95	1.08
^{238}U (n,f) Cd[2]	5.57E-17	8.54E-17	5.64E-17	0.65	1.01	0.66
^{235}U (n,f) Cd[2]	3.93E-14	3.69E-14	3.99E-14	1.06	1.02	1.08
^{237}Np (n,f) Cd	1.09E-15	1.30E-15	1.04E-15	0.84	0.96	0.80
^{59}Co (n,γ)	2.17E-14	1.77E-14	2.16E-14	1.22	1.00	1.22
^{59}Co (n,γ) Cd	1.50E-14	1.04E-14	1.48E-14	1.45	0.99	1.43

1 Dosimetry capsules A and C irradiated during Cycles 8 and 9.
2 Paired Uranium Dosimeter (PUD) measurement

TABLE 4.3-12

DERIVED EXPOSURE RATES FROM THE CAPSULE J DOSIMETRY EVALUATION CYCLE 9 - 74° AZIMUTH - 280° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
$\phi(E > 1.0\ MeV)$	8.53E+08	8.53E+08	6
$\phi(E > 0.1\ MeV)$	6.96E+09	6.92E+09	10
$\phi(E < 0.414\ eV)$	5.18E+08	4.78E+08	18
dpa/sec	2.45E-12	2.44E-12	8

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES 74° AZIMUTH - 280° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	7.06E-19	6.84E-19	7.08E-19	1.03	1.00	1.03
^{46}Ti (n,p)	1.01E-17	9.44E-18	9.84E-18	1.07	0.98	1.04
^{54}Fe (n,p)	5.18E-17	5.13E-17	5.22E-17	1.01	1.01	1.02
^{58}Ni (n,p) Cd	7.27E-17	7.17E-17	7.28E-17	1.01	1.00	1.02
^{238}U (n,f) Cd	2.39E-16	2.57E-16	2.58E-16	0.93	1.08	1.00
^{235}U (n,f) Cd	5.94E-14	7.03E-14	6.71E-14	0.84	1.13	0.95
^{237}Np (n,f) Cd	3.92E-15	3.49E-15	3.69E-15	1.13	0.94	1.06
^{59}Co (n,γ)	3.57E-14	3.24E-14	3.57E-14	1.10	1.00	1.10
^{59}Co (n,γ) Cd	2.36E-14	1.91E-14	2.32E-14	1.24	0.98	1.22

TABLE 4.3.13

DERIVED EXPOSURE RATES FROM THE CAPSULE K DOSIMETRY EVALUATION
CYCLE 9 - 64° AZIMUTH - 290° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	7.18E+08	7.58E+08	6
ϕ(E > 0.1 MeV)	6.12E+09	6.33E+09	10
ϕ(E < 0.414 eV)	5.12E+08	3.87E+08	19
dpa/sec	2.13E-12	2.21E-12	8

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
64° AZIMUTH - 290° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	6.05E-19	5.74E-19	6.00E-19	1.05	0.99	1.05
^{46}Ti (n,p)	8.51E-18	7.89E-18	8.31E-18	1.08	0.98	1.05
^{54}Fe (n,p)	4.31E-17	4.28E-17	4.44E-17	1.01	1.03	1.04
^{58}Ni (n,p) Cd	6.14E-17	5.99E-17	6.22E-17	1.03	1.01	1.04
^{238}U (n,f) Cd	2.34E-16	2.16E-16	2.26E-16	1.09	0.97	1.05
^{235}U (n,f) Cd	4.84E-14	6.75E-14	5.95E-14	0.72	1.23	0.88
^{237}Np (n,f) Cd	3.72E-15	2.99E-15	3.41E-15	1.24	0.92	1.14
^{59}Co (n,γ)	3.20E-14	3.17E-14	3.22E-14	1.01	1.01	1.02
^{59}Co (n,γ) Cd	2.28E-14	1.86E-14	2.21E-14	1.23	0.97	1.19

TABLE 4.3-14

DERIVED EXPOSURE RATES FROM THE CAPSULE L DOSIMETRY EVALUATION
CYCLE 9 - 64° AZIMUTH - 290° REFERENCE - CORE BOTTOM

	Trial Value	Adjusted Value	1σ % Uncertainty
φ(E > 1.0 MeV)	2.56E+08	2.46E+08	6
φ(E > 0.1 MeV)	2.42E+09	2.35E+09	11
φ(E < 0.414 eV)	2.44E+08	2.43E+08	18
dpa/sec	8.23E-13	7.98E-13	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
64° AZIMUTH - 290° REFERENCE - CORE BOTTOM

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	1.69E-19	1.84E-19	1.73E-19	0.92	1.03	0.94
^{46}Ti (n,p)	2.54E-18	2.56E-18	2.47E-18	0.99	0.97	0.97
^{54}Fe (n,p)	1.36E-17	1.43E-17	1.37E-17	0.95	1.01	0.95
^{58}Ni (n,p) Cd	1.99E-17	2.02E-17	1.95E-17	0.99	0.98	0.96
^{238}U (n,f) Cd	6.47E-17	7.52E-17	7.19E-17	0.86	1.11	0.96
^{235}U (n,f) Cd	2.98E-14	3.13E-14	3.25E-14	0.95	1.09	1.04
^{237}Np (n,f) Cd	1.16E-15	1.12E-15	1.12E-15	1.04	0.96	1.00
^{59}Co (n,γ)	1.92E-14	1.51E-14	1.91E-14	1.27	1.00	1.27
^{59}Co (n,γ) Cd	1.30E-14	8.79E-15	1.27E-14	1.48	0.98	1.45

TABLE 4.3-15

DERIVED EXPOSURE RATES FROM THE CAPSULE N DOSIMETRY EVALUATION
CYCLE 9 - 39° AZIMUTH - 315° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	5.19E+08	4.92E+08	6
ϕ(E > 0.1 MeV)	4.84E+09	4.62E+09	11
ϕ(E < 0.414 eV)	5.05E+08	5.11E+08	17
dpa/sec	1.65E-12	1.58E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
39° AZIMUTH - 315° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	4.19E-19	3.95E-19	4.16E-19	1.06	0.99	1.05
^{46}Ti (n,p)	5.79E-18	5.45E-18	5.68E-18	1.06	0.98	1.04
^{54}Fe (n,p)	2.99E-17	3.01E-17	3.01E-17	0.99	1.01	1.00
^{58}Ni (n,p) Cd	4.20E-17	4.22E-17	4.20E-17	1.00	1.00	1.00
^{238}U (n,f) Cd	1.35E-16	1.54E-16	1.49E-16	0.87	1.11	0.97
^{235}U (n,f) Cd	6.22E-14	6.33E-14	6.53E-14	0.98	1.05	1.03
^{237}Np (n,f) Cd	2.20E-15	2.24E-15	2.16E-15	0.98	0.98	0.96
^{59}Co (n,γ)	3.55E-14	3.08E-14	3.54E-14	1.15	1.00	1.15
^{59}Co (n,γ) Cd	2.23E-14	1.78E-14	2.21E-14	1.26	0.99	1.24

TABLE 4.3-16

DERIVED EXPOSURE RATES FROM THE CAPSULE O DOSIMETRY EVALUATION
CYCLE 10/11 - 84° AZIMUTH - 270° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	5.52E+08	6.30E+08	6
ϕ(E > 0.1 MeV)	4.77E+09	5.40E+09	11
ϕ(E < 0.414 eV)	3.94E+08	4.02E+08	18
dpa/sec	1.66E-12	1.88E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
84° AZIMUTH - 270° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	5.19E-19	4.52E-19	5.10E-19	1.15	0.98	1.13
^{46}Ti (n,p)	6.85E-18	6.16E-18	6.87E-18	1.11	1.00	1.12
^{54}Fe (n,p)	3.63E-17	3.31E-17	3.70E-17	1.10	1.02	1.12
^{58}Ni (n,p) Cd	5.00E-17	4.62E-17	5.14E-17	1.08	1.03	1.11
^{238}U (n,f) Cd	2.18E-16	1.65E-16	1.88E-16	1.32	0.87	1.14
^{237}Np (n,f) Cd	2.56E-15	2.31E-15	2.60E-15	1.11	1.02	1.13
^{59}Co (n,γ)	2.84E-14	2.45E-14	2.85E-14	1.16	1.00	1.16
^{59}Co (n,γ) Cd	1.83E-14	1.44E-14	1.82E-14	1.27	0.99	1.26

TABLE 4.3-17

DERIVED EXPOSURE RATES FROM THE CAPSULE P DOSIMETRY EVALUATION
CYCLE 10/11 - 74° AZIMUTH - 280° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	6.16E+08	6.43E+08	6
ϕ(E > 0.1 MeV)	5.09E+09	5.39E+09	11
ϕ(E < 0.414 eV)	3.94E+08	3.72E+08	18
dpa/sec	1.79E-12	1.89E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
74° AZIMUTH - 280° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)				Ratios	
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	5.41E-19	5.03E-19	5.34E-19	1.08	0.99	1.06
^{46}Ti (n,p)	7.25E-18	6.91E-18	7.24E-18	1.05	1.00	1.05
^{54}Fe (n,p)	3.81E-17	3.73E-17	3.87E-17	1.02	1.02	1.04
^{58}Ni (n,p) Cd	5.38E-17	5.20E-17	5.41E-17	1.03	1.01	1.04
^{238}U (n,f) Cd	1.98E-16	1.86E-16	1.94E-16	1.07	0.98	1.04
^{237}Np (n,f) Cd	2.72E-15	2.53E-15	2.69E-15	1.08	0.99	1.06
^{59}Co (n,γ)	2.74E-14	2.46E-14	2.75E-14	1.11	1.01	1.12
^{59}Co (n,γ) Cd	1.82E-14	1.44E-14	1.80E-14	1.26	0.99	1.25

TABLE 4.3-18

DERIVED EXPOSURE RATES FROM THE CAPSULE Q DOSIMETRY EVALUATION
CYCLE 10/11 - 74° AZIMUTH - 280° REFERENCE - CORE BOTTOM

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	2.19E+08	1.76E+08	7
ϕ(E > 0.1 MeV)	1.99E+09	1.72E+09	13
ϕ(E < 0.414 eV)	1.87E+08	1.94E+08	18
dpa/sec	6.84E-13	5.82E-13	11

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
74° AZIMUTH - 280° REFERENCE - CORE BOTTOM

	Reaction Rate (rps/nucleus)				Ratios	
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	1.30E-19	1.62E-19	1.32E-19	0.80	1.01	0.81
^{46}Ti (n,p)	1.84E-18	2.24E-18	1.82E-18	0.82	0.99	0.81
^{54}Fe (n,p)	9.79E-18	1.25E-17	9.93E-18	0.78	1.01	0.80
^{58}Ni (n,p) Cd	1.42E-17	1.75E-17	1.41E-17	0.81	0.99	0.80
^{238}U (n,f) Cd	4.73E-17	6.47E-17	5.16E-17	0.73	1.09	0.80
^{59}Co (n,γ)	1.53E-14	1.16E-14	1.53E-14	1.32	1.00	1.31
^{59}Co (n,γ) Cd	1.03E-14	6.82E-15	1.02E-14	1.51	0.99	1.49

TABLE 4.3-19

DERIVED EXPOSURE RATES FROM THE CAPSULE R DOSIMETRY EVALUATION
CYCLE 10/11 - 64° AZIMUTH - 290° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	5.58E+08	5.95E+08	6
ϕ(E > 0.1 MeV)	4.72E+09	5.09E+09	11
ϕ(E < 0.414 eV)	3.91E+08	3.34E+08	19
dpa/sec	1.65E-12	1.77E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
64° AZIMUTH - 290° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	4.95E-19	4.61E-19	4.94E-19	1.07	1.00	1.07
^{46}Ti (n,p)	6.94E-18	6.29E-18	6.79E-18	1.10	0.98	1.08
^{54}Fe (n,p)	3.54E-17	3.38E-17	3.58E-17	1.05	1.01	1.06
^{58}Ni (n,p) Cd	4.84E-17	4.71E-17	4.96E-17	1.03	1.03	1.05
^{238}U (n,f) Cd	1.85E-16	1.68E-16	1.79E-16	1.10	0.97	1.06
^{237}Np (n,f) Cd	2.60E-15	2.31E-15	2.54E-15	1.12	0.98	1.10
^{59}Co (n,γ)	2.57E-14	2.43E-14	2.60E-14	1.06	1.01	1.07
^{59}Co (n,γ) Cd	1.78E-14	1.42E-14	1.75E-14	1.25	0.99	1.24

TABLE 4.3-20

DERIVED EXPOSURE RATES FROM THE CAPSULE S DOSIMETRY EVALUATION
CYCLE 10/11 - 54° AZIMUTH - 300° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	4.77E+08	4.89E+08	7
ϕ(E > 0.1 MeV)	4.20E+09	4.36E+09	11
ϕ(E < 0.414 eV)	3.89E+08	3.15E+08	20
dpa/sec	1.45E-12	1.51E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
54° AZIMUTH - 300° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	4.16E-19	3.83E-19	4.08E-19	1.09	0.98	1.07
^{46}Ti (n,p)	5.49E-18	5.24E-18	5.49E-18	1.05	1.00	1.05
^{54}Fe (n,p)	2.84E-17	2.84E-17	2.92E-17	1.00	1.03	1.03
^{238}U (n,f) Cd	1.52E-16	1.43E-16	1.47E-16	1.06	0.97	1.03
^{237}Np (n,f) Cd	2.08E-15	2.00E-15	2.08E-15	1.04	1.00	1.04
^{59}Co (n,γ)	2.54E-14	2.39E-14	2.58E-14	1.06	1.01	1.08
^{59}Co (n,γ) Cd	1.81E-14	1.39E-14	1.78E-14	1.30	0.98	1.28

TABLE 4.3-21

DERIVED EXPOSURE RATES FROM THE CAPSULE T DOSIMETRY EVALUATION
CYCLE 10/11 - 39° AZIMUTH - 315° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
ϕ(E > 1.0 MeV)	4.42E+08	4.68E+08	6
ϕ(E > 0.1 MeV)	3.95E+09	4.19E+09	11
ϕ(E < 0.414 eV)	3.87E+08	4.21E+08	17
dpa/sec	1.37E-12	1.45E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
39° AZIMUTH - 315° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	3.70E-19	3.61E-19	3.79E-19	1.03	1.02	1.05
^{46}Ti (n,p)	5.53E-18	4.93E-18	5.33E-18	1.12	0.96	1.08
^{54}Fe (n,p)	2.79E-17	2.66E-17	2.82E-17	1.05	1.01	1.06
^{58}Ni (n,p) Cd	3.92E-17	3.72E-17	3.94E-17	1.05	1.00	1.06
^{238}U (n,f) Cd	1.41E-16	1.33E-16	1.41E-16	1.06	1.00	1.06
^{237}Np (n,f) Cd	1.99E-15	1.87E-15	1.99E-15	1.06	1.00	1.06
^{59}Co (n,γ)	2.94E-14	2.37E-14	2.94E-14	1.24	1.00	1.24
^{59}Co (n,γ) Cd	1.87E-14	1.37E-14	1.85E-14	1.37	0.99	1.35

TABLE 4.3-22

DERIVED EXPOSURE RATES FROM THE CAPSULE U DOSIMETRY EVALUATION
CYCLE 10/11 - 24° AZIMUTH - 330° REFERENCE - CORE MIDPLANE

	Trial Value	Adjusted Value	1σ % Uncertainty
$\phi(E > 1.0$ MeV)	5.15E+08	5.47E+08	6
$\phi(E > 0.1$ MeV)	4.32E+09	4.54E+09	11
$\phi(E < 0.414$ eV)	3.91E+08	4.47E+08	17
dpa/sec	1.52E-12	1.60E-12	9

COMPARISON OF MEASURED AND CALCULATED SENSOR REACTION RATES
24° AZIMUTH - 330° REFERENCE - CORE MIDPLANE

	Reaction Rate (rps/nucleus)			Ratios		
	Measured	Trial Calc.	Least Squares Adjusted	M/C	LSA/M	LSA/C
^{63}Cu (n,α) Cd	4.49E-19	4.35E-19	4.53E-19	1.03	1.01	1.04
^{46}Ti (n,p)	6.40E-18	5.94E-18	6.29E-18	1.08	0.98	1.06
^{54}Fe (n,p)	3.26E-17	3.18E-17	3.34E-17	1.03	1.02	1.05
^{58}Ni (n,p) Cd	4.62E-17	4.43E-17	4.66E-17	1.04	1.01	1.05
^{238}U (n,f) Cd	1.87E-16	1.57E-16	1.66E-16	1.19	0.89	1.06
^{237}Np (n,f) Cd	2.03E-15	2.11E-15	2.14E-15	0.96	1.05	1.01
^{59}Co (n,γ)	3.09E-14	2.38E-14	3.08E-14	1.30	1.00	1.29
^{59}Co (n,γ) Cd	1.93E-14	1.37E-14	1.91E-14	1.40	0.99	1.39

5 COMPARISONS OF CALCULATIONS WITH MEASUREMENTS

Direct comparisons of the transport calculations with the Palisades measurement data base were used to qualify the analytical results and identify biases that may exist due to the transport methodology, reactor modeling, and/or reactor operating characteristics over the respective irradiation period. In addition, these comparisons can reveal problems or inconsistencies among the measurements themselves.

In this section, comparisons of the measurement results from surveillance capsule and reactor cavity dosimetry with corresponding analytical predictions at the measurement locations are presented. These comparisons are provided on two levels. In the first instance, predictions of fast neutron exposure rates in terms of $\phi(E > 1.0 \text{ MeV})$, $\phi(E > 0.1 \text{ MeV})$, and dpa/sec are compared with the results of the FERRET least squares adjustment procedure. In the second case, calculations of individual sensor reaction rates are compared directly with the measured data from the counting laboratories. It is shown that these two levels of comparison yield consistent and similar results, indicating that the least squares adjustment methodology is producing accurate exposure results and that the analytical techniques properly account for attenuation through the geometry.

5.1 Comparison of Least Squares Adjustment Results with Calculation

In Table 5.1-1, comparisons of measured and calculated exposure rates for the five surveillance capsule dosimetry sets withdrawn to date as well as for the three cycles of reactor cavity midplane dosimetry sets irradiated during Cycles 8, 9, and 10/11 are given. In all cases, the calculated values were based on the fuel cycle specific exposure calculations averaged over the appropriate irradiation period.

5.2 Comparisons of Measured and Calculated Sensor Reaction Rates

In Table 5.2-1, measurement/calculation (M/C) ratios for each fast neutron sensor reaction rate from the surveillance capsule and reactor cavity irradiations are listed. This tabulation provides a direct comparison, on an absolute basis, of calculation and measurement prior to the application of the least squares adjustment procedure as represented in the FERRET evaluations.

5.3 Validity of the Analytical Results

The comparisons in Tables 5.1-1 and 5.2-1 show that in-vessel and ex-vessel measurement data validate, and are consistent with, the calculations. The direct comparison of the measured and calculated reaction rates in Table 5.2-1 do not account for response threshold nor spectrum coverage as would be determined in the least squares evaluation. However, it does provide adequate consideration to validate the analytical techniques. Based on these comparisons at the measurement locations, the analytical techniques are valid for the projection of the RPV neutron exposure.

TABLE 5.1-1

COMPARISON OF LEAST SQUARES ADJUSTED AND CALCULATED EXPOSURE RATES FROM SURVEILLANCE CAPSULE AND CAVITY DOSIMETRY IRRADIATIONS, CORE MIDPLANE ONLY

	$\phi(E > 1.0\ MeV)$ [n/cm^2-sec]		
	Calculated	**LSA**	**LSA/C**
Internal Capsules			
A240 (60°)	5.71E+11	5.61E+11	0.983
W290 (70°)	5.71E+10	5.64E+10	0.988
W290-9 (70°)	3.32E+10	3.17E+10	0.955
W110 (70°)	5.23E+10	5.29E+10	1.011
SA60-1 (60°)	2.10E+11	2.26E+11	1.078
84° Cavity			
Cycle 8			
Cycle 9	8.55E+08	9.33E+08	1.091
Cycle 10/11	5.52E+08	6.30E+08	1.142
74° Cavity			
Cycle 8	1.17E+09	1.30E+09	1.108
Cycle 9	8.53E+08	8.53E+08	0.999
Cycle 10/11	6.16E+08	6.43E+08	1.044
64° Cavity			
Cycle 8	9.01E+08	9.78E+08	1.086
Cycle 9	7.18E+08	7.58E+08	1.055
Cycle 10/11	5.58E+08	5.95E+08	1.065
54° Cavity			
Cycle 8			
Cycle 9			
Cycle 10/11	4.77E+08	4.89E+08	1.026
39° Cavity			
Cycle 8	6.15E+08	6.86E+08	1.116
Cycle 9	5.19E+08	4.92E+08	0.949
Cycle 10/11	4.42E+08	4.68E+08	1.058
24° Cavity			
Cycle 8			
Cycle 9			
Cycle 10/11	5.15E+08	5.47E+08	1.062

TABLE 5.1-1 (continued)

COMPARISON OF LEAST SQUARES ADJUSTED AND CALCULATED EXPOSURE RATES FROM SURVEILLANCE CAPSULE AND CAVITY DOSIMETRY IRRADIATIONS, CORE MIDPLANE ONLY

	ϕ(E > 0.1 MeV) [n/cm^2-sec]		
	Calculated	**LSA**	**LSA/C**
Internal Capsules			
A240 (60°)	1.28E+12	1.25E+12	0.972
W290 (70°)	1.06E+11	1.04E+11	0.981
W290-9 (70°)	6.13E+10	5.74E+10	0.937
W110 (70°)	9.72E+10	9.73E+10	1.001
SA60-1 (60°)	4.61E+11	4.91E+11	1.067
84° Cavity			
Cycle 8			
Cycle 9	7.43E+09	8.05E+09	1.083
Cycle 10/11	4.77E+09	5.40E+09	1.133
74° Cavity			
Cycle 8	9.35E+09	1.05E+10	1.120
Cycle 9	6.96E+09	6.92E+09	0.993
Cycle 10/11	5.09E+09	5.39E+09	1.058
64° Cavity			
Cycle 8	7.76E+09	8.50E+09	1.096
Cycle 9	6.12E+09	6.33E+09	1.033
Cycle 10/11	4.72E+09	5.09E+09	1.078
54° Cavity			
Cycle 8			
Cycle 9			
Cycle 10/11	4.20E+09	4.36E+09	1.039
39° Cavity			
Cycle 8	5.88E+09	6.69E+09	1.139
Cycle 9	4.84E+09	4.62E+09	0.956
Cycle 10/11	3.95E+09	4.19E+09	1.060
24° Cavity			
Cycle 8			
Cycle 9			
Cycle 10/11	4.32E+09	4.54E+09	1.050

TABLE 5.1-1 (continued)

COMPARISON OF LEAST SQUARES ADJUSTED AND CALCULATED EXPOSURE RATES FROM SURVEILLANCE CAPSULE AND CAVITY DOSIMETRY IRRADIATIONS, CORE MIDPLANE ONLY

Iron Displacements (dpa/sec)

	Calculated	LSA	LSA/C
Internal Capsules			
A240 (60°)	8.24E-10	8.15E-10	0.988
W290 (70°)	8.20E-11	8.17E-11	0.997
W290-9 (70°)	4.78E-11	4.62E-11	0.966
W110 (70°)	7.51E-11	7.66E-11	1.020
SA60-1 (60°)	3.03E-10	3.26E-10	1.077
84° Cavity			
Cycle 8			
Cycle 9	2.57E-12	2.79E-12	1.084
Cycle 10/11	1.66E-12	1.88E-12	1.134
74° Cavity			
Cycle 8	3.31E-12	3.69E-12	1.116
Cycle 9	2.45E-12	2.44E-12	0.996
Cycle 10/11	1.79E-12	1.89E-12	1.055
64° Cavity			
Cycle 8	2.69E-12	2.94E-12	1.092
Cycle 9	2.13E-12	2.21E-12	1.038
Cycle 10/11	1.65E-12	1.77E-12	1.075
54° Cavity			
Cycle 8			
Cycle 9			
Cycle 10/11	1.45E-12	1.51E-12	1.036
39° Cavity			
Cycle 8	2.00E-12	2.27E-12	1.135
Cycle 9	1.65E-12	1.58E-12	0.957
Cycle 10/11	1.37E-12	1.45E-12	1.060
24° Cavity			
Cycle 8			
Cycle 9			
Cycle 10/11	1.52E-12	1.60E-12	1.053

TABLE 5.2-1

COMPARISON OF MEASUREMENT AND CALCULATED NEUTRON SENSOR REACTION RATES FROM SURVEILLANCE CAPSULE AND CAVITY DOSIMETRY IRRADIATIONS, CORE MIDPLANE ONLY

	^{63}Cu (n,a)	^{46}Ti (n,p)	^{54}Fe (n,p)	^{58}Ni (n,p)	^{238}U (n,f)	^{237}Np (n,f)
Internal Capsules						
A240 (60°)	1.09	1.21	1.02	0.95		
W290 (70°)	1.15	1.11	0.99	1.00	0.98	
W290-9 (70°)	1.12	1.16	0.96	0.98	0.96	0.92
W110 (70°)	1.17	1.17	1.02	1.01		
SA60-1 (60°)	1.13	1.19	1.05	1.07	1.15	
84° Cavity						
Cycle 8						
Cycle 9	1.11	1.10	1.08	1.03	1.13[1]	1.21
Cycle 10/11	1.15	1.11	1.10	1.08	1.32	1.11
74° Cavity						
Cycle 8	1.09	1.14	1.08	1.07	1.06[1]	1.40
Cycle 9	1.03	1.07	1.01	1.01	0.93	1.13
Cycle 10/11	1.08	1.05	1.02	1.03	1.07	1.08
64° Cavity						
Cycle 8	1.09	1.15	1.08	1.06	1.04[1]	1.32
Cycle 9	1.05	1.08	1.01	1.03	1.09	1.24
Cycle 10/11	1.07	1.10	1.05	1.03	1.10	1.12
54° Cavity						
Cycle 8						
Cycle 9						
Cycle 10/11	1.09	1.05	1.00		1.06	1.04
39° Cavity						
Cycle 8	1.18	1.21	1.14	1.11	1.06[1]	1.32
Cycle 9	1.06	1.06	0.99	1.00	0.87	0.98
Cycle 10/11	1.03	1.12	1.05	1.05	1.06	1.06
24° Cavity						
Cycle 8						
Cycle 9						
Cycle 10/11	1.03	1.08	1.03	1.04	1.19	0.96
Average	1.10	1.12	1.04	1.03	1.07	1.14
Standard Dev. (1σ)	0.047	0.052	0.045	0.039	0.106	0.145

1 Indicated values are location / cycle-specific averages from the Paired Uranium Dosimeter measurements.

6 CALCULATED NEUTRON EXPOSURE OF THE REACTOR VESSEL

6.1 Exposure Distributions Within the Beltline Region

As noted in Section 3 of this report, data from the cycle specific forward transport calculations were used in evaluating dosimetry from both the reactor cavity and surveillance capsule irradiations as well as in relating the results of these evaluations to the neutron exposure of the reactor vessel wall. Section 4 presented the evaluation of the plant specific measurement database. The analytical models were validated in Section 5 by comparing the measurements to the calculation, thus qualifying the calculations at the reactor pressure vessel. In this section, the key data extracted from the forward calculations are presented at the reactor pressure vessel. This fluence methodology is consistent with the approved method specified in Reference 31.

Data from the forward calculations pertinent to the reactor vessel wall are provided in Tables 6.1-1 through 6.1-19.

In Tables 6.1-1 through 6.1-15, the calculated azimuthal distribution of exposure rates in terms of $\phi(E > 1.0\ \text{MeV})$, $\phi(E > 0.1\ \text{MeV})$, and dpa/sec are listed at approximately five degree intervals over the reactor geometry for Cycles 1 to 15, respectively. The data in these tables are applicable to the reactor vessel clad/base metal interface. Also given in these tables are the exposure rate ratios $[\phi(E > 0.1\ \text{MeV})]/[\phi(E > 1.0\ \text{MeV})]$ and $[\text{dpa/sec}]/[\phi(E > 1.0\ \text{MeV})]$ that provide an indication of the variation in neutron spectrum as a function of azimuthal angle at the reactor vessel inner radius.

The cycle-specific relative axial distributions of the fast ($E > 1.0$ MeV) neutron flux are provided in Table 6.1-16 along the reactor vessel clad/base metal interface. This data is provided in one-half to one-foot intervals from the axial core centerline of the R,Z and R DORT models that were described in Section 3.1 of this report (e.g., see Figure 3.1-7) and the data is normalized to the core-centerline value. It should also be recognized that the Table 6.1-16 data extends slightly beyond the axial dimension of the active fuel that was modeled, i.e., 131.8 inches or approximately ± 5.5 feet above and below the core-centerline position.

Radial gradient information for $\phi(E > 1.0\ \text{MeV})$, $\phi(E > 0.1\ \text{MeV})$, and dpa/sec is given in Tables 6.1-17, 6.1-18, and 6.1-19 for Cycle 15, respectively. These data are presented on a relative basis for each exposure parameter at the 0°, 15°, 30°, and 45° azimuthal locations from the R,Θ DORT model that was previously described in Section 3.1 of this report. The cycle-to-cycle variation is small such that the relative radial distributions for Cycle 15 is similar to the previous cycles; hence, this data can be used to calculate the exposure rate distributions through the reactor vessel wall. Exposure rate distributions within the vessel wall are obtained by normalizing the calculated exposure at the vessel inner radius to the gradient data given in Tables 6.1-17 through 6.1-19.

Calculated exposures for $\phi(E > 1.0\ MeV)$, $\phi(E > 0.1\ MeV)$, and iron atom displacement (dpa) resulting from irradiation during Palisades Cycles 1 through 14 are given in Tables 6.1-20, 6.1-21, and 6.1-22, respectively. The calculated results provided in these tables are given as a function of axial position (obtained from Table 6.1-16) and radial position (obtained from Tables 6.1-1 through 6.1-14) for exposures at the clad-base metal interface of the reactor pressure vessel.

TABLE 6.1-1

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 1

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	3.13E+10	6.72E+10	4.81E-11	2.15	1.54E-21
5	3.33E+10	7.15E+10	5.12E-11	2.15	1.54E-21
10	3.82E+10	8.18E+10	5.84E-11	2.14	1.53E-21
15	4.14E+10	8.88E+10	6.31E-11	2.14	1.52E-21
20	3.74E+10	8.10E+10	5.71E-11	2.17	1.53E-21
25	3.20E+10	6.94E+10	4.92E-11	2.17	1.54E-21
30	3.22E+10	6.93E+10	4.93E-11	2.15	1.53E-21
35	3.05E+10	6.60E+10	4.65E-11	2.17	1.52E-21
40	2.37E+10	5.16E+10	3.64E-11	2.18	1.54E-21
45	1.96E+10	4.28E+10	3.05E-11	2.18	1.56E-21
50	2.37E+10	5.15E+10	3.64E-11	2.18	1.54E-21
55	3.04E+10	6.58E+10	4.63E-11	2.17	1.52E-21
60	3.15E+10	6.80E+10	4.82E-11	2.16	1.53E-21
65	3.17E+10	6.89E+10	4.87E-11	2.17	1.54E-21
70	3.52E+10	8.11E+10	5.42E-11	2.30	1.54E-21
75	4.15E+10	8.91E+10	6.32E-11	2.15	1.52E-21
80	3.60E+10	8.18E+10	5.53E-11	2.28	1.54E-21
85	3.33E+10	7.16E+10	5.12E-11	2.15	1.54E-21
90	3.13E+10	6.73E+10	4.81E-11	2.15	1.54E-21

TABLE 6.1-2

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 2

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	2.80E+10	6.02E+10	4.32E-11	2.15	1.54E-21
5	2.96E+10	6.35E+10	4.54E-11	2.15	1.54E-21
10	3.33E+10	7.15E+10	5.10E-11	2.14	1.53E-21
15	3.60E+10	7.72E+10	5.48E-11	2.15	1.52E-21
20	3.28E+10	7.12E+10	5.01E-11	2.17	1.53E-21
25	2.88E+10	6.23E+10	4.42E-11	2.17	1.54E-21
30	2.92E+10	6.29E+10	4.47E-11	2.15	1.53E-21
35	2.77E+10	6.00E+10	4.22E-11	2.17	1.52E-21
40	2.17E+10	4.72E+10	3.34E-11	2.18	1.54E-21
45	1.81E+10	3.95E+10	2.82E-11	2.18	1.56E-21
50	2.17E+10	4.72E+10	3.34E-11	2.17	1.54E-21
55	2.76E+10	5.98E+10	4.20E-11	2.17	1.52E-21
60	2.85E+10	6.16E+10	4.37E-11	2.16	1.53E-21
65	2.85E+10	6.19E+10	4.38E-11	2.17	1.54E-21
70	3.10E+10	7.14E+10	4.76E-11	2.30	1.54E-21
75	3.61E+10	7.75E+10	5.49E-11	2.15	1.52E-21
80	3.14E+10	7.15E+10	4.83E-11	2.28	1.54E-21
85	2.96E+10	6.36E+10	4.55E-11	2.15	1.54E-21
90	2.80E+10	6.03E+10	4.32E-11	2.15	1.54E-21

TABLE 6.1-3

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 3

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	3.78E+10	8.15E+10	5.82E-11	2.15	1.54E-21
5	4.03E+10	8.66E+10	6.18E-11	2.15	1.54E-21
10	4.61E+10	9.90E+10	7.04E-11	2.15	1.53E-21
15	5.00E+10	1.07E+11	7.60E-11	2.15	1.52E-21
20	4.49E+10	9.76E+10	6.85E-11	2.17	1.53E-21
25	3.81E+10	8.28E+10	5.85E-11	2.17	1.54E-21
30	3.78E+10	8.17E+10	5.78E-11	2.16	1.53E-21
35	3.56E+10	7.73E+10	5.42E-11	2.17	1.52E-21
40	2.76E+10	6.03E+10	4.25E-11	2.18	1.54E-21
45	2.29E+10	5.02E+10	3.56E-11	2.19	1.56E-21
50	2.76E+10	6.03E+10	4.25E-11	2.18	1.54E-21
55	3.54E+10	7.70E+10	5.39E-11	2.17	1.52E-21
60	3.70E+10	8.01E+10	5.66E-11	2.17	1.53E-21
65	3.78E+10	8.23E+10	5.81E-11	2.18	1.54E-21
70	4.24E+10	9.79E+10	6.51E-11	2.31	1.54E-21
75	5.01E+10	1.08E+11	7.63E-11	2.15	1.52E-21
80	4.34E+10	9.91E+10	6.68E-11	2.28	1.54E-21
85	4.03E+10	8.68E+10	6.19E-11	2.15	1.54E-21
90	3.79E+10	8.16E+10	5.83E-11	2.16	1.54E-21

TABLE 6.1-4

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 4

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	3.88E+10	8.38E+10	5.98E-11	2.16	1.54E-21
5	4.13E+10	8.89E+10	6.34E-11	2.15	1.54E-21
10	4.72E+10	1.02E+11	7.21E-11	2.15	1.53E-21
15	5.13E+10	1.11E+11	7.81E-11	2.15	1.52E-21
20	4.67E+10	1.02E+11	7.12E-11	2.18	1.53E-21
25	4.06E+10	8.84E+10	6.24E-11	2.18	1.54E-21
30	4.17E+10	9.01E+10	6.37E-11	2.16	1.53E-21
35	4.00E+10	8.69E+10	6.09E-11	2.17	1.52E-21
40	3.12E+10	6.82E+10	4.80E-11	2.18	1.54E-21
45	2.59E+10	5.66E+10	4.02E-11	2.19	1.55E-21
50	3.12E+10	6.82E+10	4.80E-11	2.18	1.54E-21
55	3.98E+10	8.66E+10	6.06E-11	2.17	1.52E-21
60	4.07E+10	8.83E+10	6.23E-11	2.17	1.53E-21
65	4.03E+10	8.78E+10	6.19E-11	2.18	1.54E-21
70	4.40E+10	1.02E+11	6.77E-11	2.31	1.54E-21
75	5.15E+10	1.11E+11	7.84E-11	2.16	1.52E-21
80	4.45E+10	1.02E+11	6.84E-11	2.29	1.54E-21
85	4.13E+10	8.91E+10	6.35E-11	2.16	1.54E-21
90	3.89E+10	8.39E+10	5.98E-11	2.16	1.54E-21

TABLE 6.1-5

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 5

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	3.64E+10	7.86E+10	5.61E-11	2.16	1.54E-21
5	3.90E+10	8.41E+10	5.99E-11	2.16	1.54E-21
10	4.53E+10	9.75E+10	6.93E-11	2.15	1.53E-21
15	4.99E+10	1.07E+11	7.59E-11	2.15	1.52E-21
20	4.57E+10	9.93E+10	6.97E-11	2.17	1.53E-21
25	3.97E+10	8.64E+10	6.10E-11	2.17	1.54E-21
30	4.03E+10	8.71E+10	6.16E-11	2.16	1.53E-21
35	3.84E+10	8.34E+10	5.84E-11	2.17	1.52E-21
40	2.99E+10	6.53E+10	4.60E-11	2.18	1.54E-21
45	2.48E+10	5.43E+10	3.86E-11	2.19	1.55E-21
50	2.99E+10	6.53E+10	4.60E-11	2.18	1.54E-21
55	3.82E+10	8.30E+10	5.82E-11	2.17	1.52E-21
60	3.94E+10	8.54E+10	6.03E-11	2.17	1.53E-21
65	3.93E+10	8.58E+10	6.05E-11	2.18	1.54E-21
70	4.30E+10	9.95E+10	6.62E-11	2.31	1.54E-21
75	5.01E+10	1.08E+11	7.62E-11	2.15	1.52E-21
80	4.27E+10	9.75E+10	6.57E-11	2.28	1.54E-21
85	3.90E+10	8.42E+10	6.00E-11	2.16	1.54E-21
90	3.64E+10	7.86E+10	5.61E-11	2.16	1.54E-21

TABLE 6.1-6

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 6

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	3.95E+10	8.52E+10	6.08E-11	2.15	1.54E-21
5	4.19E+10	9.01E+10	6.43E-11	2.15	1.54E-21
10	4.75E+10	1.02E+11	7.26E-11	2.15	1.53E-21
15	5.14E+10	1.11E+11	7.82E-11	2.15	1.52E-21
20	4.65E+10	1.01E+11	7.10E-11	2.18	1.53E-21
25	4.02E+10	8.74E+10	6.17E-11	2.18	1.54E-21
30	4.06E+10	8.77E+10	6.20E-11	2.16	1.53E-21
35	3.85E+10	8.37E+10	5.87E-11	2.17	1.52E-21
40	2.99E+10	6.54E+10	4.61E-11	2.18	1.54E-21
45	2.48E+10	5.43E+10	3.85E-11	2.19	1.55E-21
50	2.99E+10	6.54E+10	4.61E-11	2.18	1.54E-21
55	3.83E+10	8.34E+10	5.84E-11	2.17	1.52E-21
60	3.97E+10	8.60E+10	6.07E-11	2.17	1.53E-21
65	3.98E+10	8.68E+10	6.11E-11	2.18	1.54E-21
70	4.38E+10	1.01E+11	6.74E-11	2.31	1.54E-21
75	5.16E+10	1.11E+11	7.85E-11	2.16	1.52E-21
80	4.48E+10	1.02E+11	6.89E-11	2.28	1.54E-21
85	4.19E+10	9.03E+10	6.44E-11	2.16	1.54E-21
90	3.96E+10	8.53E+10	6.09E-11	2.16	1.54E-21

TABLE 6.1-7

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 7

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	3.73E+10	8.03E+10	5.73E-11	2.15	1.54E-21
5	3.95E+10	8.49E+10	6.06E-11	2.15	1.54E-21
10	4.48E+10	9.63E+10	6.85E-11	2.15	1.53E-21
15	4.84E+10	1.04E+11	7.36E-11	2.15	1.52E-21
20	4.38E+10	9.53E+10	6.69E-11	2.17	1.53E-21
25	3.80E+10	8.26E+10	5.83E-11	2.17	1.54E-21
30	3.85E+10	8.32E+10	5.89E-11	2.16	1.53E-21
35	3.66E+10	7.96E+10	5.58E-11	2.17	1.52E-21
40	2.86E+10	6.25E+10	4.40E-11	2.18	1.54E-21
45	2.38E+10	5.20E+10	3.70E-11	2.19	1.55E-21
50	2.86E+10	6.24E+10	4.40E-11	2.18	1.54E-21
55	3.64E+10	7.92E+10	5.55E-11	2.17	1.52E-21
60	3.76E+10	8.15E+10	5.76E-11	2.17	1.53E-21
65	3.76E+10	8.20E+10	5.78E-11	2.18	1.54E-21
70	4.13E+10	9.55E+10	6.35E-11	2.31	1.54E-21
75	4.85E+10	1.05E+11	7.39E-11	2.15	1.52E-21
80	4.22E+10	9.63E+10	6.49E-11	2.28	1.54E-21
85	3.95E+10	8.51E+10	6.07E-11	2.15	1.54E-21
90	3.73E+10	8.04E+10	5.74E-11	2.15	1.54E-21

TABLE 6.1-8

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 8

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.47E+10	3.23E+10	2.30E-11	2.20	1.57E-21
5	1.92E+10	4.19E+10	2.98E-11	2.18	1.55E-21
10	3.01E+10	6.46E+10	4.60E-11	2.14	1.53E-21
15	3.85E+10	8.22E+10	5.84E-11	2.13	1.51E-21
20	3.51E+10	7.56E+10	5.33E-11	2.15	1.52E-21
25	2.54E+10	5.48E+10	3.89E-11	2.16	1.53E-21
30	1.78E+10	3.86E+10	2.75E-11	2.17	1.55E-21
35	1.40E+10	3.06E+10	2.17E-11	2.18	1.55E-21
40	1.35E+10	2.89E+10	2.09E-11	2.14	1.55E-21
45	1.34E+10	2.84E+10	2.08E-11	2.12	1.55E-21
50	1.35E+10	2.89E+10	2.09E-11	2.14	1.55E-21
55	1.39E+10	3.03E+10	2.15E-11	2.19	1.55E-21
60	1.74E+10	3.79E+10	2.70E-11	2.18	1.55E-21
65	2.53E+10	5.46E+10	3.88E-11	2.16	1.54E-21
70	3.29E+10	7.56E+10	5.04E-11	2.30	1.53E-21
75	3.86E+10	8.25E+10	5.85E-11	2.14	1.52E-21
80	2.84E+10	6.46E+10	4.36E-11	2.28	1.54E-21
85	1.93E+10	4.21E+10	3.00E-11	2.18	1.55E-21
90	1.47E+10	3.23E+10	2.30E-11	2.20	1.57E-21

TABLE 6.1-9

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 9

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.72E+10	3.68E+10	2.66E-11	2.14	1.55E-21
5	1.89E+10	4.04E+10	2.91E-11	2.14	1.54E-21
10	2.29E+10	4.88E+10	3.51E-11	2.13	1.53E-21
15	2.59E+10	5.51E+10	3.94E-11	2.13	1.52E-21
20	2.39E+10	5.14E+10	3.65E-11	2.15	1.53E-21
25	2.00E+10	4.27E+10	3.07E-11	2.14	1.54E-21
30	1.72E+10	3.69E+10	2.65E-11	2.14	1.54E-21
35	1.43E+10	3.09E+10	2.20E-11	2.16	1.54E-21
40	1.12E+10	2.42E+10	1.73E-11	2.16	1.55E-21
45	9.78E+09	2.11E+10	1.53E-11	2.16	1.56E-21
50	1.12E+10	2.42E+10	1.73E-11	2.16	1.55E-21
55	1.42E+10	3.07E+10	2.18E-11	2.16	1.54E-21
60	1.68E+10	3.60E+10	2.58E-11	2.15	1.54E-21
65	1.98E+10	4.24E+10	3.04E-11	2.15	1.54E-21
70	2.23E+10	5.10E+10	3.43E-11	2.28	1.54E-21
75	2.58E+10	5.49E+10	3.93E-11	2.13	1.52E-21
80	2.14E+10	4.85E+10	3.30E-11	2.26	1.54E-21
85	1.88E+10	4.03E+10	2.90E-11	2.14	1.54E-21
90	1.71E+10	3.67E+10	2.65E-11	2.14	1.55E-21

TABLE 6.1-10

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 10

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.21E+10	2.61E+10	1.88E-11	2.15	1.55E-21
5	1.36E+10	2.91E+10	2.10E-11	2.14	1.54E-21
10	1.69E+10	3.59E+10	2.59E-11	2.13	1.53E-21
15	1.91E+10	4.06E+10	2.92E-11	2.13	1.53E-21
20	1.84E+10	3.93E+10	2.81E-11	2.14	1.53E-21
25	1.71E+10	3.64E+10	2.63E-11	2.13	1.54E-21
30	1.64E+10	3.49E+10	2.52E-11	2.13	1.53E-21
35	1.46E+10	3.13E+10	2.23E-11	2.15	1.53E-21
40	1.21E+10	2.59E+10	1.87E-11	2.15	1.55E-21
45	1.09E+10	2.33E+10	1.70E-11	2.14	1.56E-21
50	1.21E+10	2.60E+10	1.87E-11	2.15	1.55E-21
55	1.45E+10	3.12E+10	2.22E-11	2.15	1.53E-21
60	1.60E+10	3.42E+10	2.46E-11	2.14	1.54E-21
65	1.70E+10	3.63E+10	2.61E-11	2.13	1.54E-21
70	1.73E+10	3.93E+10	2.66E-11	2.28	1.54E-21
75	1.92E+10	4.09E+10	2.93E-11	2.13	1.53E-21
80	1.59E+10	3.61E+10	2.46E-11	2.26	1.54E-21
85	1.37E+10	2.93E+10	2.11E-11	2.14	1.54E-21
90	1.21E+10	2.61E+10	1.88E-11	2.15	1.55E-21

TABLE 6.1-11

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 11

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.06E+10	2.27E+10	1.64E-11	2.14	1.55E-21
5	1.17E+10	2.50E+10	1.81E-11	2.14	1.54E-21
10	1.41E+10	3.00E+10	2.16E-11	2.13	1.53E-21
15	1.55E+10	3.29E+10	2.37E-11	2.13	1.53E-21
20	1.43E+10	3.07E+10	2.19E-11	2.14	1.53E-21
25	1.30E+10	2.78E+10	2.00E-11	2.13	1.54E-21
30	1.25E+10	2.66E+10	1.92E-11	2.13	1.54E-21
35	1.10E+10	2.35E+10	1.68E-11	2.15	1.54E-21
40	9.04E+09	1.94E+10	1.40E-11	2.15	1.55E-21
45	8.23E+09	1.76E+10	1.28E-11	2.14	1.56E-21
50	9.19E+09	1.97E+10	1.42E-11	2.15	1.55E-21
55	1.12E+10	2.40E+10	1.71E-11	2.15	1.54E-21
60	1.26E+10	2.69E+10	1.94E-11	2.13	1.54E-21
65	1.37E+10	2.92E+10	2.11E-11	2.14	1.54E-21
70	1.47E+10	3.34E+10	2.26E-11	2.28	1.54E-21
75	1.71E+10	3.64E+10	2.61E-11	2.13	1.53E-21
80	1.44E+10	3.24E+10	2.21E-11	2.26	1.54E-21
85	1.23E+10	2.62E+10	1.89E-11	2.14	1.54E-21
90	1.08E+10	2.32E+10	1.68E-11	2.15	1.55E-21

TABLE 6.1-12

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 12

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.01E+10	2.16E+10	1.56E-11	2.14	1.55E-21
5	1.12E+10	2.40E+10	1.73E-11	2.14	1.55E-21
10	1.41E+10	3.00E+10	2.16E-11	2.13	1.53E-21
15	1.62E+10	3.44E+10	2.47E-11	2.13	1.53E-21
20	1.52E+10	3.26E+10	2.33E-11	2.14	1.53E-21
25	1.37E+10	2.91E+10	2.10E-11	2.13	1.54E-21
30	1.29E+10	2.75E+10	1.98E-11	2.13	1.54E-21
35	1.14E+10	2.44E+10	1.74E-11	2.15	1.54E-21
40	9.47E+09	2.03E+10	1.46E-11	2.14	1.55E-21
45	8.61E+09	1.83E+10	1.34E-11	2.13	1.56E-21
50	9.45E+09	2.02E+10	1.46E-11	2.14	1.55E-21
55	1.12E+10	2.40E+10	1.71E-11	2.15	1.53E-21
60	1.22E+10	2.59E+10	1.87E-11	2.13	1.54E-21
65	1.25E+10	2.66E+10	1.92E-11	2.13	1.54E-21
70	1.24E+10	2.82E+10	1.92E-11	2.28	1.54E-21
75	1.40E+10	2.97E+10	2.14E-11	2.13	1.53E-21
80	1.18E+10	2.67E+10	1.83E-11	2.26	1.54E-21
85	1.03E+10	2.21E+10	1.59E-11	2.14	1.55E-21
90	9.22E+09	1.98E+10	1.43E-11	2.15	1.55E-21

TABLE 6.1-13

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 13

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.42E+10	3.01E+10	2.18E-11	2.13	1.54E-21
5	1.47E+10	3.13E+10	2.27E-11	2.12	1.54E-21
10	1.60E+10	3.39E+10	2.45E-11	2.12	1.53E-21
15	1.63E+10	3.48E+10	2.50E-11	2.13	1.53E-21
20	1.45E+10	3.12E+10	2.23E-11	2.15	1.53E-21
25	1.26E+10	2.69E+10	1.93E-11	2.14	1.54E-21
30	1.17E+10	2.50E+10	1.80E-11	2.13	1.54E-21
35	1.04E+10	2.23E+10	1.59E-11	2.16	1.53E-21
40	8.44E+09	1.82E+10	1.31E-11	2.15	1.55E-21
45	7.48E+09	1.61E+10	1.17E-11	2.15	1.56E-21
50	8.42E+09	1.81E+10	1.30E-11	2.15	1.55E-21
55	1.03E+10	2.22E+10	1.58E-11	2.16	1.54E-21
60	1.16E+10	2.49E+10	1.79E-11	2.14	1.54E-21
65	1.30E+10	2.79E+10	2.00E-11	2.15	1.54E-21
70	1.46E+10	3.33E+10	2.25E-11	2.29	1.54E-21
75	1.77E+10	3.77E+10	2.70E-11	2.13	1.53E-21
80	1.61E+10	3.62E+10	2.47E-11	2.26	1.54E-21
85	1.55E+10	3.29E+10	2.38E-11	2.13	1.54E-21
90	1.47E+10	3.12E+10	2.26E-11	2.13	1.54E-21

TABLE 6.1-14

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 14

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.58E+10	3.37E+10	2.44E-11	2.13	1.54E-21
5	1.67E+10	3.55E+10	2.56E-11	2.13	1.54E-21
10	1.86E+10	3.95E+10	2.84E-11	2.13	1.53E-21
15	1.94E+10	4.13E+10	2.96E-11	2.13	1.53E-21
20	1.73E+10	3.72E+10	2.64E-11	2.15	1.53E-21
25	1.47E+10	3.15E+10	2.26E-11	2.15	1.54E-21
30	1.36E+10	2.90E+10	2.09E-11	2.14	1.54E-21
35	1.20E+10	2.58E+10	1.84E-11	2.16	1.53E-21
40	9.57E+09	2.07E+10	1.48E-11	2.16	1.55E-21
45	8.34E+09	1.80E+10	1.30E-11	2.15	1.56E-21
50	9.48E+09	2.04E+10	1.47E-11	2.16	1.55E-21
55	1.17E+10	2.53E+10	1.80E-11	2.16	1.53E-21
60	1.30E+10	2.79E+10	2.00E-11	2.14	1.54E-21
65	1.41E+10	3.04E+10	2.18E-11	2.15	1.54E-21
70	1.55E+10	3.55E+10	2.39E-11	2.29	1.54E-21
75	1.83E+10	3.91E+10	2.80E-11	2.13	1.53E-21
80	1.62E+10	3.67E+10	2.50E-11	2.26	1.54E-21
85	1.55E+10	3.31E+10	2.39E-11	2.13	1.54E-21
90	1.47E+10	3.14E+10	2.27E-11	2.13	1.54E-21

TABLE 6.1-15

AZIMUTHAL VARIATION OF NEUTRON FLUX AND DPA/SEC
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE
CYCLE 15

Theta (degrees)	E > 1.0 MeV Fast Flux (n/cm**2-sec)	E > 0.1 MeV Fast Flux (n/cm**2-sec)	Iron Atom Displacement Rate (dpa/sec)	Ratio of E > 0.1 MeV to E > 1.0 MeV	Ratio of dpa/sec to E > 1.0 MeV
0	1.35E+10	2.87E+10	2.08E-11	2.13	1.54E-21
5	1.42E+10	3.02E+10	2.18E-11	2.13	1.54E-21
10	1.58E+10	3.35E+10	2.42E-11	2.13	1.53E-21
15	1.68E+10	3.57E+10	2.56E-11	2.13	1.53E-21
20	1.53E+10	3.28E+10	2.34E-11	2.15	1.53E-21
25	1.28E+10	2.72E+10	1.96E-11	2.14	1.54E-21
30	1.06E+10	2.27E+10	1.63E-11	2.14	1.54E-21
35	8.65E+09	1.88E+10	1.34E-11	2.17	1.55E-21
40	7.68E+09	1.66E+10	1.19E-11	2.16	1.55E-21
45	7.96E+09	1.70E+10	1.24E-11	2.13	1.56E-21
50	9.73E+09	2.09E+10	1.50E-11	2.15	1.54E-21
55	1.21E+10	2.59E+10	1.85E-11	2.15	1.53E-21
60	1.31E+10	2.80E+10	2.01E-11	2.14	1.54E-21
65	1.37E+10	2.94E+10	2.11E-11	2.14	1.54E-21
70	1.42E+10	3.25E+10	2.19E-11	2.28	1.54E-21
75	1.55E+10	3.31E+10	2.37E-11	2.13	1.53E-21
80	1.21E+10	2.75E+10	1.87E-11	2.27	1.54E-21
85	9.86E+09	2.12E+10	1.53E-11	2.15	1.55E-21
90	8.55E+09	1.85E+10	1.33E-11	2.16	1.56E-21

TABLE 6.1-16

RELATIVE AXIAL DISTRIBUTION OF NEUTRON FLUX (E > 1.0 MeV)
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE*
CYCLES 1 through 15

Axial Distance from Core Centerline (feet)	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
6.0	0.128	0.148	0.140	0.142	0.143
5.5	0.281	0.321	0.303	0.308	0.309
5.0	0.464	0.523	0.493	0.499	0.502
4.0	0.774	0.837	0.793	0.797	0.802
3.0	0.922	0.965	0.927	0.925	0.929
2.0	0.991	1.010	0.989	0.983	0.986
1.0	0.975	0.981	0.974	0.970	0.971
0.0	1.000	1.000	1.000	1.000	1.000
-1.0	1.011	1.012	1.012	1.015	1.016
-2.0	0.991	1.000	0.995	1.000	1.004
-3.0	0.980	1.007	0.994	1.002	1.010
-4.0	0.814	0.864	0.847	0.862	0.870
-5.0	0.484	0.528	0.517	0.530	0.535
-5.5	0.262	0.289	0.283	0.291	0.293
-6.0	0.115	0.127	0.126	0.129	0.130

* Values are normalized at the core centerline.

TABLE 6.1-16 (continued)

RELATIVE AXIAL DISTRIBUTION OF NEUTRON FLUX (E > 1.0 MeV)
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE*
CYCLES 1 through 15

Axial Distance from Core Centerline (feet)	Cycle 6	Cycle 7	Cycle 8	Cycle 9	Cycle 10
6.0	0.136	0.143	0.151	0.156	0.153
5.5	0.295	0.309	0.326	0.332	0.327
5.0	0.482	0.503	0.526	0.528	0.525
4.0	0.781	0.805	0.823	0.802	0.813
3.0	0.915	0.932	0.942	0.918	0.936
2.0	0.980	0.987	0.994	0.980	0.995
1.0	0.970	0.971	0.975	0.972	0.978
0.0	1.000	1.000	1.000	1.000	1.000
-1.0	1.013	1.015	1.009	1.005	1.002
-2.0	0.994	1.002	0.988	0.974	0.972
-3.0	0.991	1.007	0.987	0.962	0.959
-4.0	0.843	0.867	0.851	0.832	0.821
-5.0	0.514	0.533	0.530	0.530	0.516
-5.5	0.281	0.292	0.294	0.299	0.289
-6.0	0.124	0.130	0.131	0.137	0.131

* Values are normalized at the core centerline.

TABLE 6.1-16 (continued)

RELATIVE AXIAL DISTRIBUTION OF NEUTRON FLUX (E > 1.0 MeV)
AT THE REACTOR VESSEL CLAD-BASE METAL INTERFACE*
CYCLES 1 through 15

Axial Distance from Core Centerline (feet)	Cycle 11	Cycle 12	Cycle 13	Cycle 14	Cycle 15
6.0	0.177	0.181	0.170	0.172	0.158
5.5	0.377	0.385	0.361	0.367	0.343
5.0	0.599	0.610	0.576	0.586	0.563
4.0	0.893	0.900	0.867	0.885	0.890
3.0	0.986	0.988	0.968	0.986	0.999
2.0	1.016	1.016	1.009	1.018	1.027
1.0	0.984	0.984	0.984	0.986	0.989
0.0	1.000	1.000	1.000	1.000	1.000
-1.0	1.002	0.999	0.995	0.999	0.998
-2.0	0.981	0.973	0.961	0.974	0.974
-3.0	0.989	0.978	0.951	0.975	0.976
-4.0	0.883	0.878	0.835	0.863	0.853
-5.0	0.574	0.576	0.539	0.557	0.532
-5.5	0.325	0.328	0.306	0.315	0.291
-6.0	0.148	0.151	0.140	0.144	0.129

* Values are normalized at the core centerline.

TABLE 6.1-17

RELATIVE RADIAL DISTRIBUTION OF NEUTRON FLUX (E > 1.0 MeV)
THROUGH THE REACTOR VESSEL WALL
CYCLE 15

Radius (centimeters)	Vessel Fraction	0 Degrees	15 Degrees	30 Degrees	45 Degrees
219.329	0.000	1.000	1.000	1.000	1.000
219.650	0.014	0.983	0.983	0.984	0.984
220.485	0.052	0.917	0.914	0.915	0.917
221.750	0.108	0.805	0.801	0.804	0.808
223.250	0.176	0.679	0.672	0.676	0.681
224.750	0.243	0.566	0.558	0.563	0.569
224.912	0.250	0.555	0.548	0.552	0.559
226.250	0.310	0.468	0.460	0.466	0.471
227.750	0.377	0.386	0.378	0.383	0.389
229.250	0.444	0.317	0.309	0.315	0.320
230.495	0.500	0.268	0.262	0.267	0.272
230.750	0.511	0.259	0.252	0.257	0.262
232.250	0.579	0.211	0.205	0.210	0.215
233.750	0.646	0.172	0.166	0.170	0.175
235.250	0.713	0.139	0.134	0.138	0.143
236.077	0.750	0.124	0.119	0.123	0.127
236.750	0.780	0.112	0.107	0.111	0.115
238.680	0.867	0.085	0.080	0.084	0.088
240.760	0.960	0.060	0.056	0.060	0.064
241.660	1.000	0.053	0.049	0.054	0.059

Base Metal Inner Radius =	219.329	cm
Base Metal 1/4 T =	224.912	cm
Base Metal 1/2 T =	230.495	cm
Base Metal 3/4 T =	236.077	cm
Base Metal Outer Radius =	241.660	cm

TABLE 6.1-18

RELATIVE RADIAL DISTRIBUTION OF NEUTRON FLUX (E > 0.1 MeV)
THROUGH THE REACTOR VESSEL WALL
CYCLE 15

Radius (centimeters)	Vessel Fraction	0 Degrees	15 Degrees	30 Degrees	45 Degrees
219.329	0.000	1.000	1.000	1.000	1.000
219.650	0.014	1.010	1.008	1.011	1.012
220.485	0.052	1.005	0.998	1.003	1.008
221.750	0.108	0.973	0.961	0.971	0.982
223.250	0.176	0.923	0.905	0.920	0.935
224.750	0.243	0.865	0.842	0.862	0.882
224.912	0.250	0.858	0.835	0.855	0.876
226.250	0.310	0.805	0.778	0.802	0.824
227.750	0.377	0.744	0.715	0.741	0.767
229.250	0.444	0.684	0.653	0.682	0.709
230.495	0.500	0.635	0.603	0.634	0.663
230.750	0.511	0.625	0.593	0.624	0.653
232.250	0.579	0.568	0.535	0.567	0.598
233.750	0.646	0.512	0.479	0.513	0.545
235.250	0.713	0.458	0.425	0.460	0.493
236.077	0.750	0.429	0.396	0.432	0.465
236.750	0.780	0.405	0.373	0.409	0.442
238.680	0.867	0.339	0.308	0.345	0.380
240.760	0.960	0.264	0.235	0.276	0.312
241.660	1.000	0.241	0.212	0.255	0.293

Base Metal Inner Radius =	219.329	cm
Base Metal 1/4 T =	224.912	cm
Base Metal 1/2 T =	230.495	cm
Base Metal 3/4 T =	236.077	cm
Base Metal Outer Radius =	241.660	cm

TABLE 6.1-19

RELATIVE RADIAL DISTRIBUTION OF IRON ATOM DISPLACEMENT RATE (dpa/sec) THROUGH THE REACTOR VESSEL WALL
CYCLE 15

Radius (centimeters)	Vessel Fraction	0 Degrees	15 Degrees	30 Degrees	45 Degrees
219.329	0.000	1.000	1.000	1.000	1.000
219.650	0.014	0.986	0.985	0.986	0.986
220.485	0.052	0.930	0.926	0.929	0.931
221.750	0.108	0.838	0.832	0.837	0.841
223.250	0.176	0.734	0.725	0.732	0.738
224.750	0.243	0.639	0.629	0.638	0.646
224.912	0.250	0.631	0.620	0.629	0.637
226.250	0.310	0.557	0.545	0.556	0.563
227.750	0.377	0.485	0.472	0.483	0.493
229.250	0.444	0.422	0.409	0.421	0.431
230.495	0.500	0.376	0.363	0.376	0.387
230.750	0.511	0.367	0.354	0.367	0.378
232.250	0.579	0.319	0.306	0.319	0.331
233.750	0.646	0.277	0.264	0.278	0.289
235.250	0.713	0.240	0.227	0.241	0.253
236.077	0.750	0.221	0.208	0.223	0.235
236.750	0.780	0.206	0.193	0.208	0.220
238.680	0.867	0.168	0.155	0.170	0.183
240.760	0.960	0.128	0.116	0.133	0.148
241.660	1.000	0.116	0.104	0.122	0.138

Base Metal Inner Radius =	219.329	cm
Base Metal 1/4 T =	224.912	cm
Base Metal 1/2 T =	230.495	cm
Base Metal 3/4 T =	236.077	cm
Base Metal Outer Radius =	241.660	cm

TABLE 6.1-20

SUMMARY OF CALCULATED FAST NEUTRON (E > 1.0 MeV) EXPOSURE PROJECTIONS FOR THE PALISADES REACTOR VESSEL CLAD-BASE METAL INTERFACE THROUGH CYCLE 14

Axial Distance from Core Centerline (feet)	0 Degrees	15 Degrees	30 Degrees	45 Degrees	60 Degrees	75 Degrees	90 Degrees
6.0	1.64E+18	2.28E+18	1.72E+18	1.08E+18	1.68E+18	2.28E+18	1.63E+18
5.5	3.53E+18	4.92E+18	3.72E+18	2.33E+18	3.63E+18	4.93E+18	3.51E+18
5.0	5.72E+18	7.97E+18	6.02E+18	3.78E+18	5.88E+18	7.98E+18	5.69E+18
4.0	9.04E+18	1.26E+19	9.52E+18	5.97E+18	9.29E+18	1.26E+19	9.00E+18
3.0	1.04E+19	1.45E+19	1.10E+19	6.87E+18	1.07E+19	1.45E+19	1.04E+19
2.0	1.10E+19	1.53E+19	1.16E+19	7.27E+18	1.13E+19	1.54E+19	1.10E+19
1.0	1.08E+19	1.51E+19	1.14E+19	7.13E+18	1.11E+19	1.51E+19	1.08E+19
0.0	1.11E+19	1.54E+19	1.17E+19	7.31E+18	1.14E+19	1.55E+19	1.10E+19
-1.0	1.12E+19	1.56E+19	1.18E+19	7.39E+18	1.15E+19	1.56E+19	1.12E+19
-2.0	1.10E+19	1.53E+19	1.16E+19	7.25E+18	1.13E+19	1.53E+19	1.10E+19
-3.0	1.10E+19	1.53E+19	1.16E+19	7.25E+18	1.13E+19	1.53E+19	1.10E+19
-4.0	9.46E+18	1.32E+19	9.96E+18	6.24E+18	9.73E+18	1.32E+19	9.42E+18
-5.0	5.86E+18	8.15E+18	6.17E+18	3.86E+18	6.02E+18	8.16E+18	5.83E+18
-5.5	3.23E+18	4.50E+18	3.41E+18	2.13E+18	3.33E+18	4.51E+18	3.22E+18
-6.0	1.44E+18	2.01E+18	1.52E+18	9.53E+17	1.48E+18	2.01E+18	1.44E+18

TABLE 6.1-21

SUMMARY OF CALCULATED FAST NEUTRON (E > 0.1 MeV) EXPOSURE PROJECTIONS FOR THE PALISADES REACTOR VESSEL CLAD-BASE METAL INTERFACE THROUGH CYCLE 14

Axial Distance from Core Centerline (feet)	0 Degrees	15 Degrees	30 Degrees	45 Degrees	60 Degrees	75 Degrees	90 Degrees
6.0	3.52E+18	4.89E+18	3.71E+18	2.35E+18	3.63E+18	4.90E+18	3.50E+18
5.5	7.60E+18	1.05E+19	8.00E+18	5.06E+18	7.84E+18	1.06E+19	7.56E+18
5.0	1.23E+19	1.71E+19	1.30E+19	8.20E+18	1.27E+19	1.71E+19	1.23E+19
4.0	1.95E+19	2.70E+19	2.05E+19	1.30E+19	2.01E+19	2.70E+19	1.94E+19
3.0	2.24E+19	3.11E+19	2.36E+19	1.49E+19	2.31E+19	3.12E+19	2.23E+19
2.0	2.37E+19	3.29E+19	2.50E+19	1.58E+19	2.45E+19	3.30E+19	2.36E+19
1.0	2.33E+19	3.23E+19	2.45E+19	1.55E+19	2.40E+19	3.23E+19	2.32E+19
0.0	2.39E+19	3.31E+19	2.51E+19	1.59E+19	2.46E+19	3.32E+19	2.38E+19
-1.0	2.41E+19	3.34E+19	2.54E+19	1.61E+19	2.49E+19	3.35E+19	2.40E+19
-2.0	2.37E+19	3.28E+19	2.49E+19	1.58E+19	2.44E+19	3.29E+19	2.36E+19
-3.0	2.37E+19	3.28E+19	2.49E+19	1.58E+19	2.44E+19	3.29E+19	2.36E+19
-4.0	2.04E+19	2.82E+19	2.14E+19	1.36E+19	2.10E+19	2.83E+19	2.03E+19
-5.0	1.26E+19	1.75E+19	1.33E+19	8.40E+18	1.30E+19	1.75E+19	1.26E+19
-5.5	6.96E+18	9.65E+18	7.33E+18	4.64E+18	7.18E+18	9.68E+18	6.93E+18
-6.0	3.10E+18	4.31E+18	3.27E+18	2.07E+18	3.21E+18	4.32E+18	3.09E+18

TABLE 6.1-22

SUMMARY OF CALCULATED IRON ATOM DISPLACEMENT (dpa) EXPOSURE PROJECTIONS FOR THE PALISADES REACTOR VESSEL CLAD-BASE METAL INTERFACE THROUGH CYCLE 14

Axial Distance from Core Centerline (feet)	0 Degrees	15 Degrees	30 Degrees	45 Degrees	60 Degrees	75 Degrees	90 Degrees
6.0	2.52E-03	3.47E-03	2.64E-03	1.68E-03	2.58E-03	3.48E-03	2.51E-03
5.5	5.44E-03	7.49E-03	5.69E-03	3.63E-03	5.57E-03	7.50E-03	5.42E-03
5.0	8.82E-03	1.21E-02	9.22E-03	5.87E-03	9.02E-03	1.21E-02	8.78E-03
4.0	1.39E-02	1.92E-02	1.46E-02	9.28E-03	1.43E-02	1.92E-02	1.39E-02
3.0	1.61E-02	2.21E-02	1.68E-02	1.07E-02	1.64E-02	2.21E-02	1.60E-02
2.0	1.70E-02	2.33E-02	1.78E-02	1.13E-02	1.74E-02	2.34E-02	1.69E-02
1.0	1.67E-02	2.29E-02	1.74E-02	1.11E-02	1.71E-02	2.30E-02	1.66E-02
0.0	1.71E-02	2.35E-02	1.79E-02	1.14E-02	1.75E-02	2.35E-02	1.70E-02
-1.0	1.73E-02	2.37E-02	1.81E-02	1.15E-02	1.77E-02	2.38E-02	1.72E-02
-2.0	1.70E-02	2.33E-02	1.77E-02	1.13E-02	1.73E-02	2.33E-02	1.69E-02
-3.0	1.70E-02	2.33E-02	1.77E-02	1.13E-02	1.73E-02	2.33E-02	1.69E-02
-4.0	1.46E-02	2.00E-02	1.53E-02	9.71E-03	1.49E-02	2.01E-02	1.45E-02
-5.0	9.03E-03	1.24E-02	9.45E-03	6.01E-03	9.24E-03	1.24E-02	8.99E-03
-5.5	4.99E-03	6.86E-03	5.22E-03	3.32E-03	5.10E-03	6.87E-03	4.96E-03
-6.0	2.23E-03	3.06E-03	2.33E-03	1.48E-03	2.28E-03	3.07E-03	2.22E-03

6.2 Uncertainty in the Calculated Neutron Exposure Levels

The uncertainty associated with the calculated neutron exposure of the Palisades reactor pressure vessel is based on the recommended approach provided in Draft Regulatory Guide DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence". In particular, the qualification of the methodology used in the Palisades reactor pressure vessel neutron exposure evaluations was carried out in the following four stages:

1 - Comparison of calculations with benchmark measurements from the Pool Critical Assembly (PCA) simulator at the Oak Ridge National Laboratory (ORNL).

2 - Comparison of calculations with surveillance capsule and reactor cavity measurements from the H. B. Robinson power reactor benchmark experiment.

3 - An analytical sensitivity study addressing the uncertainty components resulting from important input parameters applicable to the plant specific transport calculations used in the neutron exposure assessments.

4 - Comparisons of the calculations with all available dosimetry results from measurement programs carried out at the Palisades reactor.

The first phase of the methods qualification addressed the adequacy of basic transport calculation and dosimetry evaluation techniques and associated cross-sections. This phase, however, did not test the accuracy of commercial core neutron source calculations nor did it address uncertainties in operational and geometric variables that impact power reactor calculations. The second phase of the qualification addressed uncertainties that are primarily methods related and would tend to apply generically to all fast neutron exposure evaluations. The third phase of the qualification identified the potential uncertainties introduced into the overall evaluation due to calculational methods approximations as well as to a lack of knowledge relative to various plant specific input parameters. The overall calculational uncertainty is established from the results of these three phases of the methods qualification.

The comparison of the calculated results with the available plant specific dosimetry results was used solely to demonstrate the adequacy of the transport calculations and to confirm the uncertainty estimates associated with the analytical results. The comparison was used only as a check and was not used to bias the final results in any way.

The following summarizes the uncertainties associated with the Palisades neutron exposure evaluation:

PCA Benchmark Comparisons:	3%
H. B. Robinson Benchmark Comparisons:	3%

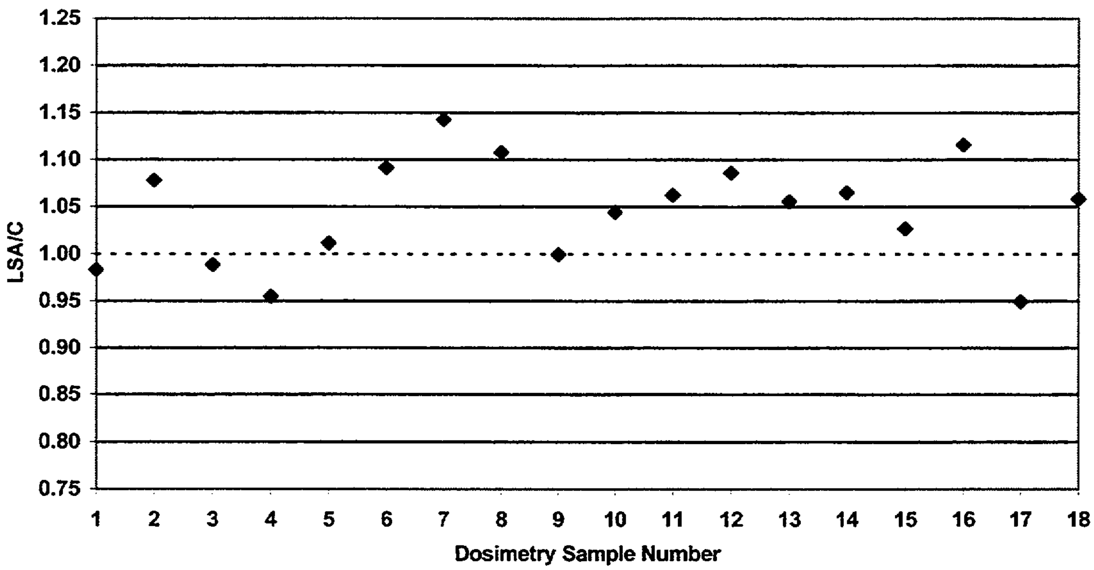
Analytical Sensitivity Studies:	
Core Source	10%
Water Temperature	3%
Vessel Inner Radius	3%
Cladding Thickness	1%
Internals Tolerances	2%
Numerical Procedures	5%
Other Factors:	5%

Combined in quadrature, the overall uncertainty in the Palisades calculated fluence is determined to be 14%.

The comparison of the Palisades calculations with the least squares adjusted neutron flux (E > 1.0 MeV) for five in-vessel and thirteen ex-vessel dosimetry evaluation points is illustrated in Figure 6.2-1. This comparison demonstrates that fifteen of the eighteen dosimetry evaluations produce results within 10% of the analytical predictions and all eighteen evaluations fall within 15% of the calculations. This comparison further shows that all of the dosimetry evaluations meet the DG-1053 requirement that all of the plant specific measurement data fall within ± 20% of the analytical prediction.

FIGURE 6.2-1

COMPARISON OF LSA RESULTS TO CALCULATION
FOR FAST NEUTRON FLUX (E > 1.0 MeV)



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APPENDIX A

SPECIFIC ACTIVITIES AND IRRADIATION HISTORY OF SENSORS FROM SURVEILLANCE CAPSULES A240, W290, W290-9, W110 AND SA60-1

In this appendix, the irradiation history and the measured specific activities of radiometric monitors irradiated in surveillance capsules A240, W290, W290-9, W110, and SA60-1 are provided.

The irradiation history of capsules withdrawn to date is as follows:

Cycle	Startup	Shutdown	Comment
1	12/31/71	12/20/75	
2	05/08/76	01/06/78	Capsule A240 Withdrawn
3	04/20/78	09/08/79	
4	05/24/80	08/29/81	
5	12/25/81	08/12/83	Capsule W290 Withdrawn
6	07/29/84	11/30/85	
7	03/02/86	08/08/88	
8	11/01/88	09/15/90	
9	03/10/91	02/06/92	Caps. W290-9 Installed/Withdrawn
10	04/18/92	06/05/93	Capsule W110 Withdrawn
11	11/06/93	05/22/95	
12	08/21/95	11/01/96	Capsule SA60-1 Installed
13	12/27/96	04/25/98	Capsule SA60-1 Withdrawn
14	06/07/98	10/15/99	

Reference Core Power = 2530 MWt

The monthly thermal generation applicable to the Palisades reactor is provided in addition to the specific activities of the sensors on the following pages.

Since the in-vessel surveillance capsules were irradiated for multiple fuel cycles, the flux adjustment factors, C_j, defined in Section 3.0 were employed in the reaction rate calculations for the individual sensor sets.

The quantity C_j is defined as the calculated ratio of $\phi(E > 1.0 \text{ MeV})$ during the irradiation period j to the time weighted average $\phi(E > 1.0 \text{ MeV})$ over the entire irradiation period. The values of C_j used in the evaluation of the Palisades surveillance capsules were as follows:

Flux Adjustment Factor C_j

Cycle	A 240	W 290	W 290-9	W 110	SA 60
1		0.895		0.978	
2		0.813		0.889	
3		1.091		1.192	
4		1.138		1.243	
5		1.118		1.222	
6				1.224	
7				1.171	
8				0.948	
9			1.00	0.632	
10				0.482	
11					
12					1.071
13					0.931
14					

TABLE A-1

IRRADIATION HISTORY OF PALISADES INTERNAL SURVEILLANCE CAPSULES

Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)
Dec-71	625	Apr-75	967872	Aug-78	1049064
Jan-72	155642	May-75	1334640	Sep-78	556008
Feb-72	16679	Jun-75	873360	Oct-78	1172520
Mar-72	247284	Jul-75	1116216	Nov-78	1683216
Apr-72	519993	Aug-75	749376	Dec-78	849192
May-72	0	Sep-75	977856	Jan-79	1801656
Jun-72	684662	Oct-75	1135152	Feb-79	1604952
Jul-72	669575	Nov-75	1212960	Mar-79	1785288
Aug-72	792640	Dec-75	537672	Apr-79	1371072
Sep-72	490476	Jan-76	0	May-79	590664
Oct-72	731045	Feb-76	0	Jun-79	1297416
Nov-72	552165	Mar-76	0	Jul-79	1702776
Dec-72	1071439	Apr-76	0	Aug-79	1570656
Jan-73	667608	May-76	569280	Sep-79	322368
Feb-73	0	Jun-76	1520760	Oct-79	0
Mar-73	1059289	Jul-76	1052469	Nov-79	0
Apr-73	1549797	Aug-76	1260240	Dec-79	0
May-73	983014	Sep-76	1449288	Jan-80	0
Jun-73	1578251	Oct-76	1207248	Feb-80	0
Jul-73	1534211	Nov-76	1080384	Mar-80	0
Aug-73	476077	Dec-76	1531608	Apr-80	0
Sep-73	0	Jan-77	1426488	May-80	161088
Oct-73	0	Feb-77	1428888	Jun-80	1600296
Nov-73	0	Mar-77	1507152	Jul-80	1182912
Dec-73	0	Apr-77	1454856	Aug-80	1335552
Jan-74	0	May-77	1024776	Sep-80	1328640
Feb-74	0	Jun-77	1596000	Oct-80	1663008
Mar-74	0	Jul-77	1554528	Nov-80	0
Apr-74	0	Aug-77	1122840	Dec-80	920760
May-74	0	Sep-77	1431480	Jan-81	1777944
Jun-74	0	Oct-77	1630296	Feb-81	1684176
Jul-74	0	Nov-77	1457736	Mar-81	1867008
Aug-74	0	Dec-77	1703640	Apr-81	1750200
Sep-74	0	Jan-78	270336	May-81	1641384
Oct-74	387048	Feb-78	0	Jun-81	1531584
Nov-74	8400	Mar-78	0	Jul-81	604440
Dec-74	0	Apr-78	381600	Aug-81	845688
Jan-75	0	May-78	947376	Sep-81	0
Feb-75	0	Jun-78	1245312	Oct-81	0
Mar-75	0	Jul-78	1288344	Nov-81	0

TABLE A-1 (continued)

IRRADIATION HISTORY OF PALISADES INTERNAL SURVEILLANCE CAPSULES

Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)
Dec-81	1104	Apr-85	1622592	Aug-88	444768
Jan-82	947952	May-85	1841352	Sep-88	0
Feb-82	168384	Jun-85	1708032	Oct-88	0
Mar-82	682224	Jul-85	1823376	Nov-88	29640
Apr-82	0	Aug-85	640848	Dec-88	454344
May-82	362304	Sep-85	1372872	Jan-89	1657920
Jun-82	1614336	Oct-85	1557216	Feb-89	0
Jul-82	581544	Nov-85	1744224	Mar-89	1248144
Aug-82	0	Dec-85	0	Apr-89	1392120
Sep-82	1558992	Jan-86	0	May-89	1499736
Oct-82	1669680	Feb-86	0	Jun-89	1457664
Nov-82	1802688	Mar-86	331392	Jul-89	1510872
Dec-82	1841424	Apr-86	1321872	Aug-89	1341864
Jan-83	1742448	May-86	1107336	Sep-89	1453344
Feb-83	1675200	Jun-86	0	Oct-89	504
Mar-83	1862568	Jul-86	0	Nov-89	0
Apr-83	1713816	Aug-86	0	Dec-89	502200
May-83	1688184	Sep-86	0	Jan-90	1372848
Jun-83	1761720	Oct-86	0	Feb-90	1352352
Jul-83	1735776	Nov-86	0	Mar-90	1378920
Aug-83	543720	Dec-86	0	Apr-90	741096
Sep-83	0	Jan-87	0	May-90	536208
Oct-83	0	Feb-87	0	Jun-90	1047984
Nov-83	0	Mar-87	0	Jul-90	1501584
Dec-83	0	Apr-87	951309	Aug-90	1501896
Jan-84	0	May-87	1454016	Sep-90	704184
Feb-84	0	Jun-87	1387536	Oct-90	0
Mar-84	0	Jul-87	875304	Nov-90	0
Apr-84	0	Aug-87	1410336	Dec-90	0
May-84	0	Sep-87	1566648	Jan-91	0
Jun-84	0	Oct-87	14832	Feb-91	0
Jul-84	9816	Nov-87	968160	Mar-91	480456
Aug-84	166704	Dec-87	197136	Apr-91	1809167
Sep-84	222792	Jan-88	204576	May-91	1885464
Oct-84	0	Feb-88	1484904	Jun-91	1818648
Nov-84	485160	Mar-88	1878312	Jul-91	1143408
Dec-84	1838256	Apr-88	1522344	Aug-91	1837560
Jan-85	1802520	May-88	1731336	Sep-91	1818984
Feb-85	1562424	Jun-88	1818696	Oct-91	1882521
Mar-85	1843632	Jul-88	1794168	Nov-91	1712592

TABLE A-1 (continued)

IRRADIATION HISTORY OF PALISADES INTERNAL SURVEILLANCE CAPSULES

Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)	Month	Thermal Generation (MW-hr)
Dec-91	1513368	Feb-94	1004688	Apr-96	1811246
Jan-92	1867224	Mar-94	0	May-96	1874811
Feb-92	357888	Apr-94	0	Jun-96	1750200
Mar-92	0	May-94	0	Jul-96	1694185
Apr-92	620112	Jun-94	666768	Aug-96	1874328
May-92	1878432	Jul-94	1874208	Sep-96	1813701
Jun-92	1819464	Aug-94	1874448	Oct-96	1877294
Jul-92	1392552	Sep-94	1812408	Nov-96	53755
Aug-92	1459272	Oct-94	1869960	Dec-96	169562
Sep-92	1260672	Nov-94	1813872	Jan-97	772562
Oct-92	1779079	Dec-94	1867368	Feb-97	860456
Nov-92	1326168	Jan-95	1874304	Mar-97	1868293
Dec-92	1880496	Feb-95	1655688	Apr-97	1809640
Jan-93	1879536	Mar-95	1871832	May-97	1875000
Feb-93	1698408	Apr-95	1811689	Jun-97	1814498
Mar-93	1880544	May-95	1170744	Jul-97	1875400
Apr-93	1688919	Jun-95	0	Aug-97	1875058
May-93	862632	Jul-95	0	Sep-97	1745398
Jun-93	237864	Aug-95	419871	Oct-97	891762
Jul-93	0	Sep-95	1588200	Nov-97	1813953
Aug-93	0	Oct-95	1863332	Dec-97	1874786
Sep-93	0	Nov-95	1814541	Jan-98	1873929
Oct-93	0	Dec-95	1757839	Feb-98	1434156
Nov-93	1242336	Jan-96	1010896	Mar-98	1806566
Dec-93	1876608	Feb-96	1755785	Apr-98	1393953
Jan-94	1844112	Mar-96	1802064	May-98	0

CHEMICAL ANALYSIS REPORT WESTINGHOUSE ANALYTICAL WALTZ MILL SITE — SYSTEMS

ANAL. SERV. REQUEST NO. 105 11552 page 1 of 2

ORIGINATOR: S.L. ANDERSON | DEPT. & OR: WIN 284-5165 | BAY 478 | FACILITY: MNC

APPROVAL SIGNATURE: C.A. Blackburn | DATE RECEIVED: 6-19-84 | DATE REPORTED: 7-25-84

METHOD	ANALYST	REFERENCE	METHOD	ANALYST	REFERENCE
γ spec.	CAB	File.			

RESULTS OF ANALYSIS

PALISADES DOSIMETERS.

ANAL SERV. LAB NO.	ORIGINATOR'S SAMPLE NO. Location.	Code	Dosimeter	Isotope	dps/g @ June 27, 1984 dps / mg wire
84-1747	1A 73°+	2T	Ti	Sc-46	1.1x10^5 110
-1748	↓	3I	FE	Mn-54	1.88x10^6 1880
-1750		6NC	Ni(Cd)	Co-58	3.06x10^6 3060
-1751		7CC	Cu(Cd)	Co-60	2.32x10^5 232
-1752		FE1	FE	Mn-54	1.77x10^6 1770
-1753		FE2	FE	↓	1.85x10^6 1850
-1754		FE3	FE		1.89x10^6 1890
-1755		FE4	FE		1.75x10^6 1750
-1756	↓	FE5	FE	↓	1.95x10^6 1950
-1758	1A41°	2T	Ti	Sc-46	1.06x10^5 106
-1759	↓	3I	FE	Mn-54	1.88x10^6 1880
-1761		6NC	Ni(Cd)	Co-58	3.05x10^6 3050
-1762		7CC	Cu(Cd)	Co-60	2.39x10^5 239
-1763	↓	FE1	FE	Mn-54	1.86x10^6 1860
-1764A	?	FE2	FE	↓	1.86x10^6 1860
-1764B	?	FE2	FE		1.66x10^6 1660
-1765	1A41°	FE3	FE		1.75x10^6 1750
-1766	↓	FE4	FE		1.91x10^6 1910
-1767	↓	FE5	FE	↓	1.66x10^6 1660
-1769	1A14*	2T	Ti	Sc-46	1.01x10^5 101
-1770	↓	3I	FE	Mn-54	1.39x10^6 1390
-1772		6NC	Ni(Cd)	Co-58	2.90x10^6 2900
-1773		7CC	Cu(Cd)	Co-60	2.07x10^5 207
-1774		FE1	FE	Mn-54	1.67x10^6 1670
-1776		FE3	FE	↓	1.57x10^6 1570
-1777		FE4	FE		1.74x10^6 1740
84-1778	↓	FE5	FE	↓	1.47x10^6 1470

106

CHEMICAL ANALYSIS REPORT | **WESTINGHOUSE ADVANCED ENERGY SYSTEMS ANALYTICAL LABORATORIES WALTZ MILL SITE** | ANAL. SERV. REQUEST: 11532. page 2

ORIGINATOR	DEPT. & GRP.	EXT.	ROOM NO.	FACILITY
S.L. ANDERSON				MNC

APPROVAL SIGNATURE	DATE RECEIVED	DATE REPORTED
C. A. Blackburn	6-19-84	7-25-84

METHOD	ANALYST	REFERENCE	METHOD	ANALYST	REFERENCE
γ spec.		LAB Book #07	page 40	LAB Book # 10	pages 30,31
U by mass spec	WRM	LAB Book # 15	page 136,137		
		MASS SPEC FILE	DATA3 / 11	532	

RESULTS OF ANALYSIS

ANAL. SERV. LAB. NO.	Location	Code Dosimeter		Cs-137 dps / mg U-238	dps/g @ June 27, 1984
84-1746	1 A 73°+	1 U	U-238 S	1054	1.05×10^6
-1749	"	5 U	U-238 (Cd)	556	5.56×10^5
-1757	1 A 41°	1 U	U-238	982	9.82×10^5
-1760	"	5 U		(Not Received From Hot Cells)	
-1768	1 A 14ˣ	1 U	U-238	840	8.40×10^5
-1771	"	5 U	U-238 (Cd)	536	5.36×10^5

CHEMICAL ANALYSIS REPORT	WESTINGHOUSE ADVANCED ENERGY SYSTEMS ANALYTICAL LABORATORIES WALTZ MILL SITE	ANAL. SERV. REQUEST NO. 11570

ORIGINATOR	DEPT. & GRP.	EXT.	ROOM NO.	FACILITY
S.L. ANDERSON			MNC.	

APPROVAL SIGNATURE	DATE RECEIVED	DATE REPORTED
C. A. Blackburn	7-17-84	7-25-84

METHOD	ANALYST	REFERENCE	METHOD	ANALYST	REFERENCE
GAMMA SPEC.	CAB.	F-LE.			

RESULTS OF ANALYSIS

ORIGINATOR'S SAMPLE NO.	13 C		RS	
ANAL. SERV. LAB. NO.	84-1918			
ISOTOPE	dps/mg. on June 27, 1984			
Mn-54	0.002			
Co-60	0.061			

PALISADES SAMPLE 13C.

RSAC PAL 775

Westinghouse Electric Corporation
Advanced Programs - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14629

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering and Analysis
Westinghouse Electric Corporation

Received: 4/1/92
Reported: 4/15/92

[RESULTS OF ANALYSIS]

Block# 1A7F

Palisades In-vessel Dosimetry

Originator ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *		2 sigma
Co-Al (Cd-V)	92-1148	Co-Al	Co-60	2.48E+03	+/-	3.2E+01
U (Cd-V)	92-1149	U	Zr-95	1.36E+03	+/-	1.8E+01
U (Cd-V)	92-1149	U	Ru-103	1.47E+03	+/-	1.9E+01
U (Cd-V)	92-1149	U	Cs-137	4.16E+01	+/-	4.6E+00
Ti (Bare)	92-1150	Ti	Sc-46	6.78E+02	+/-	1.0E+01
Fe (Bare)	92-1151	Fe	Mn-54	1.24E+03	+/-	8.9E+00
Co-Al (Bare)	92-1152	Co-Al	Co-60	1.75E+04	+/-	1.4E+02
U (V)	92-1153	U	Zr-95	1.26E+03	+/-	1.1E+01
U (V)	92-1153	U	Ru-103	1.40E+03	+/-	1.2E+01
U (V)	92-1153	U	Cs-137	4.48E+01	+/-	3.2E+00
Ni (Cd-V)	92-1154	Ni	Co-58	2.84E+04	+/-	1.4E+02
Cu (Cd-V)	92-1155	Cu	Co-60	3.83E+01	+/-	7.0E-01
Np (Cd-V)	92-1156	Np	Zr-95	5.83E+03	+/-	8.8E+01
Np (Cd-V)	92-1156	Np	Ru-103	4.98E+03	+/-	7.2E+01
Np (Cd-V)	92-1156	Np	Cs-137	1.90E+01	+/-	2.6E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
1) All dosimeter material was analyzed after removal from Cadmium and Vanadium encapsulation

AL File: 14629
References: Lab.Book# 56 page 16.
Procedures: A-524.
Analyst: WTF,FRC,MRK.

Approved: Mark Kanwhal

RSACPAL775

Westinghouse Electric Corporation
Advanced Programs - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14629

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering and Analysis
Westinghouse Electric Corporation

Received: 4/1/92
Reported: 4/15/92

[RESULTS OF ANALYSIS]

Block# 1A4F

Palisades In-vessel Dosimetry

Originator ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *		2 sigma
Co-Al (Cd-V)	92-1139	Co-Al	Co-60	2.52E+03	+/-	3.2E+01
U (Cd-V)	92-1140	U	Zr-95	1.35E+03	+/-	1.5E+01
U (Cd-V)	92-1140	U	Ru-103	1.38E+03	+/-	1.2E+01
U (Cd-V)	92-1140	U	Cs-137	4.79E+01	+/-	4.6E+00
Ti (Bare)	92-1141	Ti	Sc-46	6.97E+02	+/-	5.1E+00
Fe (Bare)	92-1142	Fe	Mn-54	1.28E+03	+/-	9.1E+00
Co-Al (Bare)	92-1143	Co-Al	Co-60	1.77E+04	+/-	2.4E+02
U (V)	92-1144	U	Zr-95	1.25E+03	+/-	1.3E+01
U (V)	92-1144	U	Ru-103	1.28E+03	+/-	1.1E+01
U (V)	92-1144	U	Cs-137	4.31E+01	+/-	3.9E+00
Ni (Cd-V)	92-1145	Ni	Co-58	2.74E+04	+/-	1.2E+02
Cu (Cd-V)	92-1146	Cu	Co-60	3.88E+01	+/-	5.5E-01
Np (Cd-V)	92-1147	Np	Zr-95	5.80E+03	+/-	8.7E+01
Np (Cd-V)	92-1147	Np	Ru-103	5.27E+00	+/-	9.4E+01
Np (Cd-V)	92-1147	Np	Cs-137	1.59E+02	+/-	2.3E+01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
1) All dosimeter material was analyzed after removal from Cadmium and Vanadium encapsulation

AL File: 14629
References: Lab.Book# 56 page 16.
Procedures: A-524.
Analyst: WTF,FRC,MRK.

Approved: [signature]

RSAC PAL775

Westinghouse Electric Corporation
Advanced Programs - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14629

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering and Analysis
Westinghouse Electric Corporation

Received: 4/1/92
Reported: 4/15/92

[RESULTS OF ANALYSIS]

Block# 1AIF

Palisades In-vessel Dosimetry

Originator ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *		2 sigma
Co-Al (Cd-V)	92-1130	Co-Al	Co-60	2.48E+03	+/-	2.3E+01
U (Cd-V)	92-1131	U	Zr-95	1.20E+03	+/-	2.0E+01
U (Cd-V)	92-1131	U	Ru-103	1.31E+03	+/-	1.3E+01
U (Cd-V)	92-1131	U	Cs-137	3.39E+01	+/-	3.3E+00
Ti (Bare)	92-1132	Ti	Sc-46	6.28E+02	+/-	6.7E+00
Fe (Bare)	92-1133	Fe	Mn-54	1.12E+03	+/-	4.4E+00
Co-Al (Bare)	92-1134	Co-Al	Co-60	1.82E+04	+/-	1.9E+02
U (V)	92-1135	U	Zr-95	1.19E+03	+/-	1.7E+01
U (V)	92-1135	U	Ru-103	1.38E+03	+/-	1.4E+01
U (V)	92-1135	U	Cs-137	4.34E+01	+/-	4.2E+00
Ni (Cd-V)	92-1136	Ni	Co-58	2.71E+04	+/-	1.2E+02
Cu (Cd-V)	92-1137	Cu	Co-60	3.59E+01	+/-	6.0E-01
Np (Cd-V)	92-1138	Np	Zr-95	5.59E+03	+/-	7.4E+01
Np (Cd-V)	92-1138	Np	Ru-103	4.92E+03	+/-	4.5E+01
Np (Cd-V)	92-1138	Np	Cs-137	1.77E+02	+/-	1.7E+01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
1) All dosimeter material was analyzed after removal from Cadmium and Vanadium encapsulation

AL File: 14629
References: Lab.Book# 56 page 16.
Procedures: A-524.
Analyst: WTF,FRC,MRK.

Approved: [signature]

Westinghouse Electric Corporation
Chemistry & Materials Technology - Analytical L:boratory
Waltz Mill Site

REPORT Request# 15214

Originator: Ed Terek (W)NTD
Structural Reliability & Plant Life Optimization
Westinghouse Electric Corporation

Received: 10/11/93
Reported: 1/11/94

[RESULTS OF ANALYSIS]

Dosimetry: Pallisades In-vessel Dosimetry

Originator ID	Lab Sample #	Dosimeter Material	Nuclide	(October 12, 1993) dps/mg	+/-	2 sigma
#1414 TOP						
U-238(1 ring)	93-4192	U-238	Zr-95	7.09E+02	+/-	3.0E+00
			Ru-103	3.26E+02	+/-	2.9E+00
			Cs-137	1.23E+03	+/-	2.4E+00
Ti (2 rings)	93-4193	Ti	Sc-46	1.98E+02	+/-	2.7E+00
Fe (4 rings)	93-4194	Fe	Mn-54	1.34E+03	+/-	1.2E+01
U-238 (Cd) (5 rings)	93-4195	U-238	Zr-95	6.95E+01	+/-	1.5E+00
			Ru-103	3.46E+01	+/-	1.3E+00
			Cs-137	1.30E+02	+/-	1.0E+00
Ni (Cd) (6 rings)	93-4196	Ni	Co-58	7.01E+03	+/-	6.6E+01
Cu (Cd) (7 rings)	93-4197	Cu	Co-60	2.22E+02	+/-	2.7E+00
Glass Sulphur	93-4198	S	NA	NA		
Fe (1 ring)t	93-4199	Fe	Mn-54	1.31E+03	+/-	1.5E+01
Fe (2 rings)t	93-4200	Fe	Mn-54	1.31E+03	+/-	1.5E+01
Fe (3 rings)t	93-4201	Fe	Mn-54	1.28E+03	+/-	1.5E+01
Fe (4 rings)t	93-4202	Fe	Mn-54	1.39E+03	+/-	1.6E+01
Fe (5 rings)t	93-4203	Fe	Mn-54	1.22E+03	+/-	1.4E+01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
Combustion Engineering Capsule Design
"t" denotes thin rings

Procedures:A-512,A-513,A-524
Analyst:WTF,FRC,MRK
Page 1

Approved: Mark Korchak

Westinghouse Electric Corporation
Chemistry & Materials Technology - Analytical Laboratory
Waltz Mill Site

REPORT Request# 15214

Originator: Ed Terek (W)NTD
Structural Reliability & Plant Life Optimization
Westinghouse Electric Corporation

Received: 10/11/93
Reported: 1/11/94

[RESULTS OF ANALYSIS]

Dosimetry: Pallisades In-vessel Dosimetry W-110

Originator ID	Lab Sample #	Dosimeter Material	Nuclide	(October 12, 1993) dps/mg	+/-	2 sigma
#1441 MID						
U-238(1 ring)	93-4204	U-238	Zr-95	6.69E+02	+/-	7.0E+00
			Ru-103	3.06E+02	+/-	7.6E+00
			Cs-137	1.30E+03	+/-	5.9E+00
Ti (2 rings)	93-4205	Ti	Sc-46	1.99E+02	+/-	2.8E+00
Fe (3 rings)	93-4206	Fe	Mn-54	1.41E+03	+/-	1.2E+01
U-238 (Cd) (5 rings)	93-4208	U-238	Zr-95	7.49E+01	+/-	5.6E-01
			Ru-103	3.49E+01	+/-	5.6E-01
			Cs-137	1.60E+02	+/-	4.6E-01
Ni (Cd) (6 rings)	93-4209	Ni	Co-58	7.11E+03	+/-	6.7E+01
Cu (Cd) (7 rings)	93-4210	Cu	Co-60	2.58E+02	+/-	3.1E+00
Glass Sulphur	93-4208	S	NA	NA		
Fe (1 ring)t	93-4211	Fe	Mn-54	1.42E+03	+/-	1.5E+01
Fe (2 rings)t	93-4212	Fe	Mn-54	1.42E+03	+/-	1.5E+01
Fe (3 rings)t	93-4213	Fe	Mn-54	1.40E+03	+/-	1.5E+01
Fe (4 rings)t	93-4214	Fe	Mn-54	1.51E+03	+/-	1.6E+01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
Combustion Engineering Capsule Design
"t" denotes thin rings

Procedures:A-512,A-513,A-524
Analyst:WTF,FRC,MRK
Page 2

Approved: [signature]

Westinghouse Electric Corporation
Chemistry & Materials Technology - Analytical Laboratory
Waltz Mill Site

REPORT Request# 15214

Originator: Ed Terek (W)NTD
Structural Reliability & Plant Life Optimization
Westinghouse Electric Corporation

Received: 10/11/93
Reported: 1/11/94

[RESULTS OF ANALYSIS]

Dosimetry: Pallisades In-vessel Dosimetry

Originator ID	Lab Sample #	Dosimeter Material	Nuclide	(October 12, 1993) dps/mg	+/-	2 sigma
#1473						
U-238(1 ring)	93-4215	U-238	Zr-95	7.53E+02	+/-	1.2E+01
			Ru-103	3.55E+02	+/-	1.1E+01
			Cs-137	1.41E+03	+/-	8.2E+00
Ti (2 rings)	93-4216	Ti	Sc-46	1.98E+02	+/-	2.7E+00
Fe (3 rings)	93-4217	Fe	Mn-54	1.37E+03	+/-	1.2E+01
U-238 (Cd) (5 rings)	93-4218	U-238	Zr-95	7.97E+01	+/-	2.1E+00
			Ru-103	3.69E+01	+/-	1.8E+00
			Cs-137	1.65E+02	+/-	1.4E+00
Ni (Cd) (6 rings)	93-4219	Ni	Co-58	7.02E+03	+/-	6.6E+01
Cu (Cd) (7 rings)	93-4220	Cu	Co-60	2.50E+02	+/-	3.1E+00
Glass Sulphur	93-4221	S	NA	NA		
Fe (1 ring)t	93-4222	Fe	Mn-54	1.42E+03	+/-	1.5E+01
Fe (2 rings)t	93-4223	Fe	Mn-54	1.41E+03	+/-	1.5E+01
Fe (3 rings)t	93-4224	Fe	Mn-54	1.38E+03	+/-	1.5E+01
Fe (4 rings)t	93-4225	Fe	Mn-54	1.53E+03	+/-	1.6E+01
Fe (5 rings)t	93-4226	Fe	Mn-54	1.31E+03	+/-	1.5E+01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
Combustion Engineering Capsule Design
"t" denotes thin rings

Procedures:A-512,A-513,A-524
Analyst:WTF,FRC,MRK
Page 3

Approved:

BAW-2341, Revision 1
May 1999

Test Results of Capsule SA-60-1
Consumers Energy
Palisades Nuclear Plant

-- Reactor Vessel Material Surveillance Program --

by

M. J. DeVan

FTI Document No. 77-2341-01
(See Section 7 for document signatures.)

Prepared for

Consumers Energy

Prepared by

Framatome Technologies, Inc.
3315 Old Forest Road
P. O. Box 10935
Lynchburg, Virginia 24506-0935

FRAMATOME TECHNOLOGIES

5.0 Dosimeter Measurements

5.1. Introduction

Three dosimeter sets were located in blocks that were installed in top, middle, and bottom positions of the Capsule SA-60-1 assembly. Each dosimeter set consisted of dosimeters made up of shielded and unshielded cobalt/aluminum and uranium dosimeters, shielded copper, nickel, and neptunium dosimeters, and unshielded iron and titanium dosimeters. The dosimeters were stored in vials identified by labels consisting of the position of the dosimeter holder block within the capsule assembly and the location from where the dosimeters where recovered.

5.2. Dosimeter Preparation

Vials were prepared for the dosimeters by labeling them with identifications that indicated their types and positions in the holder blocks. For example, the one top block shielded cobalt/aluminum dosimeter was labeled Palisades T (or TOP) Sh Co/Al. The analyte nuclides were verified during gamma scanning.

The dosimeter wires were washed in reagent grade acetone and blotted dry with a laboratory towel. Each dosimeter wire was then measured with a certified micrometer caliper and weighed on a certified analytical balance. Each wire was then mounted in the center of a PetriSlide™ with double-sided tape.

5.3. Quantitative Gamma Spectrometry

Several of the dosimeters, placed in the PetriSlide™, were given a 300 second preliminary count on the 31% PGT gamma spectrometer. This provided information to best judge the distance at which to count the dosimeter to obtain a minimum of 10,000 counts in the photopeak of interest while keeping the counter dead time below 15%. It also provided qualitative identification of the dosimeters. This identification was made from the presence of the gamma rays in Table 5-1. The spectra were used to confirm the identities of the dosimeters.

The spectra were then measured quantitatively at the appropriate counting positions and for the appropriate count times determined from the preliminary counts.

5.4. Dosimeter Specific Activities

The associated elemental weight fractions of the dosimeters and the isotopic fractions of the target nuclides are listed in Table 5-2. The isotopic fractions of the target nuclides were obtained from the CRC Handbook of Chemistry and Physics, 63rd Edition.[17]

The dosimeter specific activities were calculated by dividing the corrected activity of the analyte nuclide by the target nuclide mass, and the results are shown in Table 5-3.

The shielded uranium dosimeter identified as "Palisades, SA-60-1 161T Sh U" is considered to be invalid since this dosimeter has a bright shiny color and a non-wire shape. This non-wire shape was different from the other shielded uranium dosimeters removed from the other capsule locations (i.e., compartments 164T and 167T). Photographs of the shielded uranium dosimeters removed from compartments 161T and 164T are shown in Figure 5-1.

Table 5-1. Quantifying Gamma Rays

Dosimeter	Analyte
Iron	^{54}Mn @ 834 keV from ^{54}Fe
Co/Al	^{60}Co @ 1332 keV from ^{59}Co
Nickel	^{58}Co @ 811 keV from ^{58}Ni
Titanium	^{46}Sc@ 1121 keV from ^{46}Ti
Copper	^{60}Co @ 1332 keV from ^{63}Cu, very low activity compared to Co wires, wire has coppery color
^{237}Np	^{137}Cs @ 662 keV
^{238}U	^{137}Cs @ 662 keV

Table 5-2. Isotopic Fractions and Weight Fractions of Target Nuclides

Dosimeter	Target Nuclide	Isotopic Fraction of Target	Weight Fraction of Target Element
Iron	^{54}Fe	0.0570	0.999704
Cobalt	^{59}Co	1.0	0.0102
Nickel	^{58}Ni	0.6739	0.99997
Titanium	^{46}Ti	0.0793	0.99793
Copper	^{63}Cu	0.6850	0.99998
Neptunium-237	^{237}Np	1.0	Determined from ^{233}Pa
Uranium-238	^{238}U	1.0	1

Table 5-3. Specific Activities for Palisades Capsule SA-60-1 Dosimetry

Dosimeter Identification	Shielded (Yes/No)	Target Nuclide	Analyte Nuclide	Specific Activity (μCi/gm Target)	% Error (%)
Palisades, SA-60-1 161T Sh Co	Yes	Co-59	Co-60	3.638E+04	7.51
Palisades, SA-60-1 161T Co	No	Co-59	Co-60	1.065E+05	6.93
Palisades, SA-60-1 164T Sh Co	Yes	Co-59	Co-60	3.760E+04	6.58
Palisades, SA-60-1 164T Co	No	Co-59	Co-60	9.600E+04	6.70
Palisades, SA-60-1 167T Sh Co	Yes	Co-59	Co-60	3.489E+04	6.64
Palisades, SA-60-1 167T Co	No	Co-59	Co-60	9.682E+04	6.75
Palisades, SA-60-1 161T Sh Cu	Yes	Cu-63	Co-60	14.07	5.24
Palisades, SA-60-1 164T Sh Cu	Yes	Cu-63	Co-60	13.87	5.25
Palisades, SA-60-1 167T Sh Cu	Yes	Cu-63	Co-60	13.79	5.24
Palisades, SA-60-1 161T Sh Ni	Yes	Ni-58	Co-58	7458	5.24
Palisades, SA-60-1 164T Sh Ni	Yes	Ni-58	Co-58	7184	5.24
Palisades, SA-60-1 167T Sh Ni	Yes	Ni-58	Co-58	7238	5.24
Palisades, SA-60-1 161T Fe	No	Fe-54	Mn-54	4921	5.68
Palisades, SA-60-1 164T Fe	No	Fe-54	Mn-54	4886	5.77
Palisades, SA-60-1 167T Fe	No	Fe-54	Mn-54	4970	5.68
Palisades, SA-60-1 161T Ti	No	Ti-46	Sc-46	1165	5.89
Palisades, SA-60-1 164T Ti	No	Ti-46	Sc-46	1173	6.33
Palisades, SA-60-1 167T Ti	No	Ti-46	Sc-46	1168	6.12
Palisades, SA-60-1 161T Sh U	Yes	U-238	Cs-137	NA	—
Palisades, SA-60-1 161T U	No	U-238	Cs-137	27.81	8.11
Palisades, SA-60-1 164T Sh U	Yes	U-238	Cs-137	22.71	8.13
Palisades, SA-60-1 164T U	No	U-238	Cs-137	NA*	NA*
Palisades, SA-60-1 167T Sh U	Yes	U-238	Cs-137	22.41	8.11
Palisades, SA-60-1 167T U	No	U-238	Cs-137	27.97	8.07
Palisades, SA-60-1 161T Sh Np	Yes	Np-237	Cs-137	145.7	8.08
Palisades, SA-60-1 164T Sh Np	Yes	Np-237	Cs-137	2263*	8.16*
Palisades, SA-60-1 167T Sh Np	Yes	Np-237	Cs-137	765.3*	8.16*

*Data were not available due to the fact that only a small amount of the dosimeter was recovered and the uncertainty of the dosimeter weight measurement was high (see Reference 18).

APPENDIX B

SPECIFIC ACTIVITIES AND IRRADIATION HISTORY OF REACTOR CAVITY SENSOR SETS - CYCLE 8

In this appendix, the irradiation history and the measured specific activities of radiometric monitors irradiated in the reactor cavity during Cycle 8 are provided.

The irradiation history of Cycle 8 was as follows:

Cycle	Startup	Shutdown	Comment
8	11/01/88	09/15/90	

Reference Core Power = 2530 MWt

The monthly thermal generation applicable to the Palisades reactor is provided in addition to the specific activities of the sensors on the following pages.

TABLE B-1

IRRADIATION HISTORY OF REACTOR CAVITY SENSOR SETS

Cycle 8

Date	Thermal Generation MW-hr
Sep-88	0
Oct-88	0
Nov-88	29640
Dec-88	454344
Jan-89	1657920
Feb-89	0
Mar-89	1248144
Apr-89	1392120
May-89	1499736
Jun-89	1457664
Jul-89	1510872
Aug-89	1341864
Sep-89	1453344
Oct-89	504
Nov-89	0
Dec-89	502200
Jan-90	1372848
Feb-90	1352352
Mar-90	1378920
Apr-90	741096
May-90	536208
Jun-90	1047984
Jul-90	1501584
Aug-90	1501896
Sep-90	704184

TABLE B-2

CONTENTS OF MULTIPLE FOIL SENSOR SETS
CYCLE 8 IRRADIATION

Capsule ID/ Position	Bare or Cd Shielded	Radiometric Monitor Foil ID Fe	Ni	Cu	Ti	Nb	Co	^{238}U (nat)	^{238}U (dep)	NBS PUD	^{237}Np
A-1	B	A	-	-	-	-	A	-	-	-	-
A-2	Cd	K	A	BA	AK	BA	K	AA	BG	-	-
A-3	Cd	-	-	-	-	-	-	-	-	11N1	8
B-1	B	B	-	-	-	-	B	-	-	-	-
B-2	Cd	L	B	BB	AL	BB	L	AB	BH	-	-
B-3	Cd	-	-	-	-	-	-	-	-	12N2	9
C-1	B	C	-	-	-	-	C	-	-	-	-
C-2	Cd	M	C	BC	AM	BC	M	AC	BI	-	-
C-3	Cd	-	-	-	-	-	-	-	-	13N3	10
D-1	B	D	-	-	-	-	D	-	-	-	-
D-2	Cd	N	D	BD	AN	BD	N	AD	BJ	-	-
D-3	Cd	-	-	-	-	-	-	-	-	14N4	11
E-1	B	E	-	-	-	-	E	-	-	-	-
E-2	Cd	O	E	BE	AO	BE	O	AE	AL	-	-
E-3	Cd	-	-	-	-	-	-	-	-	15N5	12
F-1	B	F	-	-	-	-	F	-	-	-	-
F-2	Cd	P	F	BF	AP	BF	P	AF	AM	-	-
F-3	Cd	-	-	-	-	-	-	-	-	16N6	13
G-1	B	G	-	-	-	-	G	-	-	-	-
G-2	Cd	R	G	BG	AR	BG	R	AG	U	-	-
G-3	Cd	-	-	-	-	-	-	-	-	17N7	14

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: A.H.Fero (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 12/21/90

[RESULTS OF ANALYSIS]
Palisades Cycle 8 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 12/12/90) dps/mg *		2 sigma
B	90-1857	Fe	Mn-54	17.43	+/-	0.19
L	90-1858	Fe	Mn-54	17.23	+/-	0.19
D	90-1870	Fe	Mn-54	13.20	+/-	0.16
N	90-1871	Fe	Mn-54	12.97	+/-	0.14
E	90-1883	Fe	Mn-54	4.28	+/-	0.07
O	90-1884	Fe	Mn-54	3.89	+/-	0.05
G	90-1896	Fe	Mn-54	9.36	+/-	0.07
R	90-1897	Fe	Mn-54	9.35	+/-	0.07
B	90-1859	Ni	Co-58	201.10	+/-	1.43
D	90-1872	Ni	Co-58	151.20	+/-	1.76
E	90-1885	Ni	Co-58	49.72	+/-	0.55
G	90-1898	Ni	Co-58	106.70	+/-	1.49
BB	90-1860	Cu	Co-60	0.745	+/-	0.010
BD	90-1873	Cu	Co-60	0.573	+/-	0.003
BE	90-1886	Cu	Co-60	0.152	+/-	0.003
BG	90-1899	Cu	Co-60	0.422	+/-	0.010
AL	90-1861	Ti	Sc-46	4.57	+/-	0.07
AN	90-1874	Ti	Sc-46	3.50	+/-	0.03
AO	90-1887	Ti	Sc-46	1.05	+/-	0.01
AR	90-1900	Ti	Sc-46	2.48	+/-	0.02
B	90-1863	AlCo	Co-60	270.7	+/-	4.1
L	90-1864	AlCo	Co-60	179.7	+/-	3.2
D	90-1876	AlCo	Co-60	253.4	+/-	4.2
N	90-1877	AlCo	Co-60	174.7	+/-	3.4
E	90-1889	AlCo	Co-60	151.5	+/-	3.3
O	90-1890	AlCo	Co-60	101.9	+/-	2.0
G	90-1902	AlCo	Co-60	281.4	+/-	2.8
R	90-1903	AlCo	Co-60	169.6	+/-	2.3

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 35 page 298 - 300
Procedures: A-524.
Analyst: WTF, CAB.

Approved: C.A. Blackburn 12-21-90

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT Request# 14175

TO: A.H.Fero (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 12/20/90

[RESULTS OF ANALYSIS]

Palisades Cycle 8 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 12/12/90) dps/mg *		2 sigma
AB	90-1865	U(2)	Zr-95	41.60	+/-	0.07
BH	90-1866	U(2)	Zr-95	12.40	+/-	0.10
12	90-1867	U(1)	Zr-95	12.17	+/-	0.05
N2	90-1868	U(2)	Zr-95	40.21	+/-	0.07
AD	90-1878	U(2)	Zr-95	36.71	+/-	0.19
BJ	90-1879	U(2)	Zr-95	9.75	+/-	0.10
14	90-1880	U(1)	Zr-95	9.75	+/-	0.05
N4	90-1881	U(2)	Zr-95	36.62	+/-	0.21
AE	90-1891	U(2)	Sample lost during inspection			
AL	90-1892	U(2)	Zr-95	3.78	+/-	0.05
15	90-1893	U(1)	Zr-95	3.22	+/-	0.04
N5	90-1894	U(2)	Zr-95	19.02	+/-	0.10
AG	90-1904	U(2)	Zr-95	34.40	+/-	0.17
U	90-1905	U(2)	Zr-95	7.48	+/-	0.06
17	90-1906	U(1)	Zr-95	6.19	+/-	0.05
N7	90-1907	U(2)	Zr-95	35.87	+/-	0.18
AB	90-1865	U(2)	Ru-103	17.49	+/-	0.04
BH	90-1866	U(2)	Ru-103	8.64	+/-	0.07
12	90-1867	U(1)	Ru-103	8.88	+/-	0.04
N2	90-1868	U(2)	Ru-103	16.92	+/-	0.04
AD	90-1878	U(2)	Ru-103	14.80	+/-	0.11
BJ	90-1879	U(2)	Ru-103	6.78	+/-	0.06
14	90-1880	U(1)	Ru-103	6.95	+/-	0.03
N4	90-1881	U(2)	Ru-103	14.82	+/-	0.13
AE	90-1891	U(2)	Sample lost during inspection			
AL	90-1892	U(2)	Ru-103	2.46	+/-	0.03
15	90-1893	U(1)	Ru-103	2.29	+/-	0.02
N5	90-1894	U(2)	Ru-103	6.97	+/-	0.06
AG	90-1904	U(2)	Ru-103	13.03	+/-	0.09
U	90-1905	U(2)	Ru-103	4.86	+/-	0.04
17	90-1906	U(1)	Ru-103	4.39	+/-	0.03
N7	90-1907	U(2)	Ru-103	13.45	+/-	0.13

Remarks: * The U foils turned to a powder during irradiation. Oxide form unknown.
U(1) For the PUD depleted foils (#12,#14,#15,#17), the foils were counted unopened, and the results calculated using the Net U3O8 weight supplied by A.Fero.
U(2) For all other U foils, the foils were opened and the recovered powder weighed. The results were calculated using the recovered powder weight.

AL File: 14175. References: Lab.Book# 35 page 298 - 300
Procedures: A-524.
Analyst: WTF, CAB.

Approved: C.A. Blackburn 12-20-90

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: A.H.Fero (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 12/20/90

Palisades Cycle 8 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 12/12/90) dps/mg *		2 sigma
AB	90-1865	U(2)	Cs-137	3.700	+/-	0.021
BH	90-1866	U(2)	Cs-137	1.300	+/-	0.031
12	90-1867	U(1)	Cs-137	1.272	+/-	0.019
N2	90-1868	U(2)	Cs-137	3.572	+/-	0.021
AD	90-1878	U(2)	Cs-137	3.237	+/-	0.060
BJ	90-1879	U(2)	Cs-137	0.975	+/-	0.027
14	90-1880	U(1)	Cs-137	0.981	+/-	0.017
N4	90-1881	U(2)	Cs-137	3.192	+/-	0.059
AE	90-1891	U(2)	Sample lost during inspection			
AL	90-1892	U(2)	Cs-137	0.346	+/-	0.014
15	90-1893	U(1)	Cs-137	0.303	+/-	0.013
N5	90-1894	U(2)	Cs-137	1.537	+/-	0.029
AG	90-1904	U(2)	Cs-137	2.980	+/-	0.053
U	90-1905	U(2)	Cs-137	0.764	+/-	0.018
17	90-1906	U(1)	Cs-137	0.651	+/-	0.016
N7	90-1907	U(2)	Cs-137	3.105	+/-	0.072

Remarks: * The U foils turned to a powder during irradiation. Oxide form unknown.
U(1) For the PUD depleted foils (#12,#14,#15,#17), the foils were counted unopened, and the results calculated using the Net U308 weight supplied by A.Fero.
U(2) For all other U foils, the foils were opened and the recovered powder weighed. The results were calculated using the recovered powder weight.
AL File: 14175. References: Lab.Book# 35 page 298 - 300
Procedures: A-524.
Analyst: WTF, CAB.

Approved: C.A. Blackburn 12-20-90

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: A.H.Fero (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 12/20/90

[RESULTS OF ANALYSIS]

Palisades Cycle 8 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 12/12/90) dps/mg *		2 sigma
9	90-1869	Np-237	Zr-95	238.8	+/-	1.4
11	90-1882	Np-237	Zr-95	175.0	+/-	1.5
12	90-1895	Np-237	Zr-95	60.3	+/-	1.1
14	90-1908	Np-237	Zr-95	129.6	+/-	1.3
9	90-1869	Np-237	Ru-103	144.2	+/-	0.9
11	90-1882	Np-237	Ru-103	106.4	+/-	1.4
12	90-1895	Np-237	Ru-103	39.5	+/-	0.8
14	90-1908	Np-237	Ru-103	79.8	+/-	1.2
9	90-1869	Np-237	Cs-137	24.01	+/-	0.47
11	90-1882	Np-237	Cs-137	17.97	+/-	0.77
12	90-1895	Np-237	Cs-137	5.94	+/-	0.40
14	90-1908	Np-237	Cs-137	12.82	+/-	0.61

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175. References: Lab.Book# 35 page 298 - 300
Procedures: A-524.
Analyst: WIF, CAB.

Approved: C. A. Blackburn 12-20-90

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 4/3/91

[RESULTS OF ANALYSIS]

(10 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 280 deg.
Bead Chain Tag ID: 280 deg.

Feet from Midplane	Lab Sample#	dps/mg of chain @ 12/12/90 — Mn-54 dps/mg	2 sigma	Co-58 dps/mg	2 sigma	Co-60 dps/mg	2 sigma
+0.5	90-1915A	1.14E+01 +/-	7.0E-01	1.92E+01 +/-	1.0E+00	1.01E+02 +/-	9.9E-01
-0.5	90-1915B	1.16E+01 +/-	5.9E-01	1.99E+01 +/-	1.3E+00	1.01E+02 +/-	7.7E-01
-1.0	90-1915C	1.16E+01 +/-	7.0E-01	1.88E+01 +/-	9.1E-01	1.01E+02 +/-	9.1E-01
-1.5	90-1915D	1.13E+01 +/-	6.0E-01	1.79E+01 +/-	1.3E+00	9.90E+01 +/-	7.7E-01
-2.0	90-1915E	1.09E+01 +/-	6.5E-01	1.73E+01 +/-	8.6E-01	9.62E+01 +/-	8.9E-01
-2.5	90-1915F	9.19E+00 +/-	5.5E-01	1.72E+01 +/-	1.2E+00	9.34E+01 +/-	7.4E-01
-3.0	90-1915G	8.84E+00 +/-	5.0E-01	1.49E+01 +/-	7.0E-01	8.95E+01 +/-	7.2E-01
-3.5	90-1915H	8.44E+00 +/-	6.5E-01	1.43E+01 +/-	1.1E+00	8.63E+01 +/-	7.1E-01
-4.0	90-1915I	6.17E+00 +/-	3.9E-01	1.19E+01 +/-	7.0E-01	8.07E+01 +/-	6.8E-01
-4.5	90-1915J	5.10E+00 +/-	3.8E-01	8.90E+00 +/-	7.3E-01	6.87E+01 +/-	4.1E-01
-5.0	90-1915K	3.43E+00 +/-	3.4E-01	5.92E+00 +/-	5.2E-01	5.86E+01 +/-	5.8E-01
-5.5	90-1915L	2.27E+00 +/-	1.9E-01	4.24E+00 +/-	4.3E-01	5.39E+01 +/-	2.7E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 4/3/91

[RESULTS OF ANALYSIS]

(20 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 290 deg.
Bead Chain Tag ID: 290 deg.

Feet from Midplane	Lab Sample#	[<—— dps/mg of chain @ 12/12/90 Mn-54 dps/mg	2 sigma	Co-58 dps/mg	2 sigma	Co-60 dps/mg ——>]	2 sigma
+0.5	90-1916A	8.36E+00 +/-	5.2E-01	1.45E+01 +/-	7.4E-01	9.08E+01 +/-	7.3E-01
-0.5	90-1916B	8.52E+00 +/-	3.1E-01	1.40E+01 +/-	6.7E-01	9.06E+01 +/-	4.1E-01
-1.0	90-1916C	8.68E+00 +/-	5.8E-01	1.41E+01 +/-	6.6E-01	9.09E+01 +/-	7.2E-01
-1.5	90-1916D	8.52E+00 +/-	3.2E-01	1.46E+01 +/-	7.4E-01	8.96E+01 +/-	4.2E-01
-2.0	90-1916E	8.32E+00 +/-	5.0E-01	1.45E+01 +/-	7.3E-01	8.90E+01 +/-	7.1E-01
-2.5	90-1916F	7.84E+00 +/-	5.3E-01	1.39E+01 +/-	1.1E+00	8.57E+01 +/-	7.2E-01
-3.0	90-1916G	7.46E+00 +/-	3.0E-01	1.28E+01 +/-	4.5E-01	8.49E+01 +/-	4.9E-01
-3.5	90-1916H	7.26E+00 +/-	5.8E-01	1.22E+01 +/-	1.2E+00	8.16E+01 +/-	7.0E-01
-4.0	90-1916I	6.15E+00 +/-	4.9E-01	1.15E+01 +/-	1.1E+00	7.72E+01 +/-	6.8E-01
-4.5	90-1916J	5.17E+00 +/-	2.8E-01	8.91E+00 +/-	4.0E-01	7.23E+01 +/-	4.6E-01
-5.0	90-1916K	3.45E+00 +/-	2.2E-01	5.99E+00 +/-	2.9E-01	5.79E+01 +/-	3.3E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

90 ✓

Westinghouse Electric Corporation RSAC PAL 671
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 4/3/91

[RESULTS OF ANALYSIS]

(45 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 315 deg.
Bead Chain Tag ID: 315 deg.

Feet from Midplane	Lab Sample#	Mn-54 dps/mg		Mn-54 2 sigma	Co-58 dps/mg		Co-58 2 sigma	Co-60 dps/mg		Co-60 2 sigma
		[<— dps/mg of chain @ 12/12/90 —>]								
+0.5	90-1918A	6.19E+00	+/-	5.6E-01	1.06E+01	+/-	1.1E+00	1.02E+02	+/-	7.8E-01
-0.5	90-1918B	6.07E+00	+/-	5.4E-01	9.43E+00	+/-	1.1E+00	1.03E+02	+/-	7.7E-01
-1.0	90-1918C	6.07E+00	+/-	6.1E-01	9.12E+00	+/-	1.2E+00	1.01E+02	+/-	8.7E-01
-1.5	90-1918D	5.42E+00	+/-	4.8E-01	9.61E+00	+/-	1.1E+00	1.01E+02	+/-	7.8E-01
-2.0	90-1918E	5.71E+00	+/-	3.2E-01	9.42E+00	+/-	4.7E-01	9.81E+01	+/-	5.3E-01
-2.5	90-1918F	5.03E+00	+/-	5.2E-01	8.21E+00	+/-	1.1E+00	9.54E+01	+/-	7.5E-01
-3.0	90-1918G	4.93E+00	+/-	4.1E-01	8.23E+00	+/-	7.9E-01	8.91E+01	+/-	5.3E-01
-3.5	90-1916H	4.40E+00	+/-	2.9E-01	7.49E+00	+/-	4.2E-01	8.66E+01	+/-	5.0E-01
-4.0	90-1916I	3.84E+00	+/-	3.3E-01	7.13E+00	+/-	7.3E-01	7.92E+01	+/-	4.4E-01
-4.5	90-1916J	3.53E+00	+/-	2.9E-01	5.94E+00	+/-	3.6E-01	7.38E+01	+/-	4.6E-01
-5.0	90-1916K	2.50E+00	+/-	2.6E-01	4.44E+00	+/-	3.2E-01	5.92E+01	+/-	4.1E-01
-5.5	90-1916L	1.85E+00	+/-	1.9E-01	3.64E+00	+/-	5.0E-01	5.02E+01	+/-	3.1E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 3/13/91

[RESULTS OF ANALYSIS]

(15 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 330 deg.
Bead Chain Tag ID: 330 deg.

Feet from Midplane	Lab Sample#	[<— dps/mg of chain @ 12/12/90 Mn-54 dps/mg	2 sigma	Co-58 dps/mg	2 sigma	Co-60 dps/mg —>]	2 sigma
+0.5	90-1919A	8.69E+00 +/-	5.7E-01	1.51E+01 +/-	1.2E+00	1.14E+02 +/-	8.2E-01
0.0	90-1919B	9.69E+00 +/-	6.6E-01	1.44E+01 +/-	1.0E+00	1.14E+02 +/-	8.3E-01
-0.5	90-1919C	9.19E+00 +/-	5.8E-01	1.56E+01 +/-	1.1E+00	1.14E+02 +/-	8.2E-01
-1.0	90-1919D	9.32E+00 +/-	6.1E-01	1.48E+01 +/-	1.0E+00	1.11E+02 +/-	8.1E-01
-1.5	90-1919E	8.24E+00 +/-	5.3E-01	1.39E+01 +/-	1.1E+00	1.09E+02 +/-	8.0E-01
-2.0	90-1919F	7.85E+00 +/-	5.4E-01	1.43E+01 +/-	1.0E+00	1.05E+02 +/-	7.9E-01
-2.5	90-1919G	7.34E+00 +/-	3.3E-01	1.30E+01 +/-	6.5E-01	9.96E+01 +/-	4.9E-01
-3.0	90-1919H	6.68E+00 +/-	3.5E-01	1.16E+01 +/-	6.9E-01	9.38E+01 +/-	5.5E-01
-3.5	90-1919I	5.52E+00 +/-	3.3E-01	9.69E+00 +/-	7.0E-01	8.75E+01 +/-	5.2E-01
-4.0	90-1919J	4.74E+00 +/-	3.9E-01	8.09E+00 +/-	5.9E-01	8.03E+01 +/-	5.0E-01
-4.5	90-1919K	3.37E+00 +/-	2.7E-01	5.40E+00 +/-	5.0E-01	6.45E+01 +/-	4.5E-01
-5.0	90-1919L	2.44E+00 +/-	2.6E-01	4.30E+00 +/-	5.0E-01	5.52E+01 +/-	4.1E-01
-5.5	90-1919M	1.46E+00 +/-	2.5E-01	3.12E+00 +/-	4.2E-01	5.08E+01 +/-	4.0E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

RSAC PAL 6/1

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 4/2/91

(30 DEG.)

[RESULTS OF ANALYSIS]

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 30 deg.
Bead Chain Tag ID: (30).

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<— dps/mg of chain @ 12/12/90 —>]					
+8.0	90-1909A	4.32E-01 +/-	1.2E-01	9.65E-01 +/-	3.0E-01	3.05E+01 +/-	2.3E-01
+7.5	90-1909B	5.75E-01 +/-	1.1E-01	1.09E+00 +/-	2.4E-01	3.31E+01 +/-	1.7E-01
+7.0	90-1909C	1.11E+00 +/-	1.5E-01	1.94E+00 +/-	3.5E-01	3.92E+01 +/-	2.6E-01
+6.5	90-1909D	1.38E+00 +/-	1.4E-01	2.40E+00 +/-	2.9E-01	4.06E+01 +/-	1.8E-01
+6.0	90-1909E	2.33E+00 +/-	2.0E-01	3.92E+00 +/-	3.9E-01	4.65E+01 +/-	2.9E-01
+5.5	90-1909F	2.94E+00 +/-	1.6E-01	5.56E+00 +/-	3.5E-01	4.77E+01 +/-	2.0E-01
+5.0	90-1909G	3.81E+00 +/-	2.2E-01	6.61E+00 +/-	4.5E-01	5.50E+01 +/-	3.2E-01
+4.5	90-1909H	4.72E+00 +/-	2.3E-01	8.38E+00 +/-	4.9E-01	5.90E+01 +/-	3.3E-01
+4.0	90-1909I	5.04E+00 +/-	2.0E-01	8.84E+00 +/-	3.9E-01	5.85E+01 +/-	2.2E-01
+3.5	90-1909J	5.98E+00 +/-	2.9E-01	1.02E+01 +/-	5.6E-01	6.53E+01 +/-	3.4E-01
+3.0	90-1909K	6.28E+00 +/-	3.2E-01	1.05E+01 +/-	5.2E-01	6.80E+01 +/-	3.5E-01
+2.5	90-1909L	6.64E+00 +/-	3.5E-01	1.06E+01 +/-	8.0E-01	6.97E+01 +/-	4.0E-01
+2.0	90-1909M	6.57E+00 +/-	3.1E-01	1.04E+01 +/-	5.6E-01	7.36E+01 +/-	3.7E-01
+1.5	90-1909N	6.46E+00 +/-	3.1E-01	1.07E+01 +/-	5.3E-01	7.58E+01 +/-	3.7E-01
+1.0	90-1909O	6.59E+00 +/-	3.6E-01	1.12E+01 +/-	7.6E-01	7.61E+01 +/-	4.1E-01
+0.5	90-1909P	6.77E+00 +/-	2.8E-01	1.09E+01 +/-	5.5E-01	7.93E+01 +/-	3.8E-01
0.0	90-1909Q	6.89E+00 +/-	2.8E-01	1.12E+01 +/-	6.0E-01	8.02E+01 +/-	3.8E-01
-0.5	90-1909R	6.84E+00 +/-	3.7E-01	1.14E+01 +/-	9.0E-01	7.94E+01 +/-	4.5E-01
-1.0	90-1909S	6.90E+00 +/-	2.7E-01	1.14E+01 +/-	5.9E-01	8.18E+01 +/-	3.8E-01
-1.5	90-1909T	6.50E+00 +/-	3.5E-01	1.24E+01 +/-	8.4E-01	7.93E+01 +/-	4.3E-01
-2.0	90-1909U	6.93E+00 +/-	2.8E-01	1.17E+01 +/-	5.8E-01	7.98E+01 +/-	3.8E-01
-2.5	90-1909V	6.64E+00 +/-	2.8E-01	1.18E+01 +/-	6.4E-01	7.83E+01 +/-	3.8E-01
-3.0	90-1909W	6.33E+00 +/-	3.7E-01	1.10E+01 +/-	7.5E-01	7.40E+01 +/-	4.1E-01
-3.5	90-1909X	6.06E+00 +/-	2.7E-01	9.96E+00 +/-	5.3E-01	7.17E+01 +/-	3.6E-01
-4.0	90-1909Y	5.47E+00 +/-	2.6E-01	9.27E+00 +/-	4.7E-01	6.70E+01 +/-	3.5E-01
-4.5	90-1909Z	4.38E+00 +/-	3.2E-01	8.24E+00 +/-	7.7E-01	5.98E+01 +/-	3.7E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: Bertram Menichetti

RSAC ... 71

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 4/2/91

[RESULTS OF ANALYSIS]

(0 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 90 deg.
Bead Chain Tag ID: (90).

Feet from Midplane	Lab Sample#	[<— dps/mg of chain @ 12/12/90 —>] Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+8.0	90-1910A	6.42E-01 +/-	7.6E-02	1.20E+00 +/-	1.4E-01	4.55E+01 +/-	1.9E-01
+7.5	90-1910B	8.34E-01 +/-	8.2E-02	1.65E+00 +/-	1.8E-01	4.99E+01 +/-	1.2E-01
+7.0	90-1910C	1.39E+00 +/-	2.1E-01	2.98E+00 +/-	4.1E-01	5.93E+01 +/-	3.3E-01
+6.5	90-1910D	2.10E+00 +/-	2.7E-01	3.83E+00 +/-	5.4E-01	6.38E+01 +/-	3.9E-01
+6.0	90-1910E	3.12E+00 +/-	2.4E-01	5.18E+00 +/-	4.3E-01	7.13E+01 +/-	3.3E-01
+5.5	90-1910F	3.90E+00 +/-	3.4E-01	6.85E+00 +/-	6.8E-01	7.62E+01 +/-	4.2E-01
+5.0	90-1910G	4.74E+00 +/-	2.4E-01	8.35E+00 +/-	4.9E-01	8.65E+01 +/-	5.1E-01
+4.5	90-1910H	5.74E+00 +/-	2.5E-01	9.69E+00 +/-	5.3E-01	9.18E+01 +/-	3.8E-01
+4.0	90-1910I	6.32E+00 +/-	3.7E-01	1.07E+01 +/-	7.7E-01	9.63E+01 +/-	4.7E-01
+3.5	90-1910J	6.97E+00 +/-	4.9E-01	1.26E+01 +/-	1.0E+00	1.05E+02 +/-	7.2E-01
+3.0	90-1910K	7.25E+00 +/-	4.1E-01	1.30E+01 +/-	8.9E-01	1.08E+02 +/-	5.0E-01
+2.5	90-1910L	7.52E+00 +/-	5.2E-01	1.31E+01 +/-	1.1E+00	1.17E+02 +/-	7.5E-01
+2.0	90-1910M	7.65E+00 +/-	5.6E-01	1.42E+01 +/-	1.4E+00	1.26E+02 +/-	7.8E-01
+1.5	90-1910N	7.44E+00 +/-	4.3E-01	1.26E+01 +/-	9.0E-01	1.18E+02 +/-	5.3E-01
+1.0	90-1910O	7.15E+00 +/-	5.5E-01	1.36E+01 +/-	1.0E+00	1.30E+02 +/-	7.9E-01
+0.5	90-1910P	7.55E+00 +/-	4.5E-01	1.31E+01 +/-	9.3E-01	1.28E+02 +/-	5.4E-01
0.0	90-1910Q	8.43E+00 +/-	6.0E-01	1.25E+01 +/-	1.1E+00	1.32E+02 +/-	8.0E-01
-0.5	90-1910R	7.96E+00 +/-	5.5E-01	1.30E+01 +/-	1.2E+00	1.34E+02 +/-	8.1E-01
-1.0	90-1910S	7.24E+00 +/-	4.6E-01	1.27E+01 +/-	1.1E+00	1.32E+02 +/-	8.1E-01
-1.5	90-1910T	7.33E+00 +/-	5.4E-01	1.18E+01 +/-	1.1E+00	1.31E+02 +/-	8.0E-01
-2.0	90-1910U	7.02E+00 +/-	5.4E-01	1.20E+01 +/-	1.2E+00	1.27E+02 +/-	7.9E-01
-2.5	90-1910V	7.04E+00 +/-	5.3E-01	1.26E+01 +/-	1.3E+00	1.22E+02 +/-	7.7E-01
-3.0	90-1910W	6.01E+00 +/-	3.8E-01	1.13E+01 +/-	9.9E-01	1.13E+02 +/-	5.2E-01
-3.5	90-1910X	6.64E+00 +/-	5.5E-01	1.07E+01 +/-	9.9E-01	1.09E+02 +/-	7.2E-01
-4.0	90-1910Y	5.58E+00 +/-	4.1E-01	8.90E+00 +/-	8.4E-01	9.91E+01 +/-	4.9E-01
-4.5	90-1910Z	4.57E+00 +/-	4.8E-01	7.31E+00 +/-	9.8E-01	9.15E+01 +/-	6.7E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

RSAC [illegible] 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 3/13/91

[RESULTS OF ANALYSIS]

(30 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 150 deg.
Bead Chain Tag ID: (NONE).

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<— dps/mg of chain @ 12/12/90 —>]					
+8.0	90-1911A	6.13E-01 +/-	1.3E-01	9.66E-01 +/-	2.3E-01	3.28E+01 +/-	2.2E-01
+7.5	90-1911B	9.30E-01 +/-	1.5E-01	1.75E+00 +/-	2.8E-01	3.78E+01 +/-	2.4E-01
+7.0	90-1911C	1.77E+00 +/-	1.8E-01	3.22E+00 +/-	3.1E-01	4.81E+01 +/-	2.7E-01
+6.5	90-1911D	1.70E+00 +/-	1.7E-01	3.27E+00 +/-	2.8E-01	4.81E+01 +/-	2.7E-01
+6.0	90-1911E	2.50E+00 +/-	1.6E-01	4.51E+00 +/-	3.5E-01	5.24E+01 +/-	2.8E-01
+5.5	90-1911F	3.80E+00 +/-	3.0E-01	6.34E+00 +/-	5.9E-01	5.56E+01 +/-	3.8E-01
+5.0	90-1911G	4.53E+00 +/-	2.5E-01	7.93E+00 +/-	3.9E-01	6.11E+01 +/-	3.0E-01
+4.5	90-1911H	4.99E+00 +/-	4.4E-01	1.02E+01 +/-	7.5E-01	6.54E+01 +/-	5.0E-01
+4.0	90-1911I	5.76E+00 +/-	4.3E-01	1.08E+01 +/-	8.2E-01	6.93E+01 +/-	5.1E-01
+3.5	90-1911J	6.89E+00 +/-	4.5E-01	1.13E+01 +/-	8.5E-01	7.38E+01 +/-	5.3E-01
+3.0	90-1911K	6.75E+00 +/-	4.8E-01	1.21E+01 +/-	8.3E-01	7.79E+01 +/-	5.5E-01
+2.5	90-1911L	7.02E+00 +/-	4.7E-01	1.19E+01 +/-	7.4E-01	8.07E+01 +/-	5.5E-01
+2.0	90-1911M	7.32E+00 +/-	4.6E-01	1.29E+01 +/-	9.5E-01	8.37E+01 +/-	5.6E-01
+1.5	90-1911N	7.23E+00 +/-	4.9E-01	1.21E+01 +/-	8.3E-01	8.66E+01 +/-	5.9E-01
+1.0	90-1911O	7.61E+00 +/-	5.4E-01	1.18E+01 +/-	8.5E-01	8.88E+01 +/-	5.8E-01
+0.5	90-1911P	7.35E+00 +/-	5.0E-01	1.21E+01 +/-	9.4E-01	9.06E+01 +/-	5.8E-01
0.0	90-1911Q	7.67E+00 +/-	5.6E-01	1.32E+01 +/-	1.1E+00	9.16E+01 +/-	5.9E-01
-0.5	90-1911R	7.26E+00 +/-	4.3E-01	1.27E+01 +/-	1.0E+00	9.19E+01 +/-	5.9E-01
-1.0	90-1911S	7.38E+00 +/-	5.0E-01	1.14E+01 +/-	9.1E-01	9.13E+01 +/-	5.9E-01
-1.5	90-1911T	7.20E+00 +/-	4.9E-01	1.18E+01 +/-	8.6E-01	8.98E+01 +/-	5.8E-01
-2.0	90-1911U	7.02E+00 +/-	4.7E-01	1.22E+01 +/-	8.9E-01	8.89E+01 +/-	5.8E-01
-2.5	90-1911V	6.94E+00 +/-	5.1E-01	1.15E+01 +/-	7.9E-01	8.59E+01 +/-	5.7E-01
-3.0	90-1911W	6.22E+00 +/-	3.7E-01	1.19E+01 +/-	8.0E-01	8.43E+01 +/-	5.1E-01
-3.5	90-1911X	6.15E+00 +/-	5.0E-01	1.08E+01 +/-	8.1E-01	7.89E+01 +/-	5.5E-01
-4.0	90-1911Y	5.67E+00 +/-	3.2E-01	9.58E+00 +/-	5.8E-01	7.49E+01 +/-	4.8E-01
-4.5	90-1911Z	4.78E+00 +/-	4.0E-01	8.45E+00 +/-	8.2E-01	6.80E+01 +/-	5.1E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REVISED @
REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 5/13/91

[RESULTS OF ANALYSIS]

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 210 deg.
Bead Chain Tag ID: 210 deg.

		[<— dps/mg of chain @ 12/12/90 —>]					
		Mn-54		Co-58		Co-60	
Feet from Midplane	Lab Sample#	dps/mg	2 sigma	dps/mg	2 sigma	dps/mg	2 sigma
+8.0	90-1912A	5.16E-01 +/-	1.0E-01	9.26E-01 +/-	1.3E-01	4.20E+01 +/-	1.9E-01
+7.5	90-1912B	7.64E-01 +/-	1.0E-01	1.35E+00 +/-	1.5E-01	4.83E+01 +/-	2.1E-01
+7.0	90-1912C	1.04E+00 +/-	1.9E-01	1.93E+00 +/-	4.2E-01	5.57E+01 +/-	4.2E-01
+6.5	90-1912D	1.47E+00 +/-	2.4E-01	3.00E+00 +/-	4.6E-01	6.22E+01 +/-	4.4E-01
+6.0	90-1912E	2.48E+00 +/-	2.7E-01	4.68E+00 +/-	5.1E-01	6.70E+01 +/-	4.5E-01
+5.5	90-1912F	3.39E+00 +/-	2.9E-01	5.92E+00 +/-	5.5E-01	7.21E+01 +/-	4.3E-01
+5.0	90-1912G	4.31E+00 +/-	3.4E-01	7.77E+00 +/-	6.4E-01	7.82E+01 +/-	4.9E-01
+4.5	90-1912H	5.22E+00 +/-	3.7E-01	9.40E+00 +/-	6.7E-01	8.56E+01 +/-	5.1E-01
+4.0	90-1912I	5.73E+00 +/-	6.4E-01	9.71E+00 +/-	7.8E-01	9.06E+01 +/-	5.6E-01
+3.5	90-1912J	6.35E+00 +/-	3.6E-01	1.04E+01 +/-	6.8E-01	9.68E+01 +/-	5.5E-01
+3.0	90-1912K	6.50E+00 +/-	4.9E-01	1.13E+01 +/-	8.8E-01	9.97E+01 +/-	6.3E-01
+2.5	90-1912L	7.28E+00 +/-	5.0E-01	1.07E+01 +/-	9.4E-01	1.04E+02 +/-	6.4E-01
+2.0	90-1912M	6.76E+00 +/-	4.8E-01	1.19E+01 +/-	9.1E-01	1.07E+02 +/-	6.4E-01
+1.5	90-1912N	6.96E+00 +/-	5.2E-01	1.17E+01 +/-	9.3E-01	1.12E+02 +/-	6.5E-01
+1.0	90-1912O	6.86E+00 +/-	5.0E-01	1.12E+01 +/-	9.5E-01	1.14E+02 +/-	6.7E-01
+0.5	90-1912P	6.98E+00 +/-	5.5E-01	1.22E+01 +/-	9.4E-01	1.16E+02 +/-	6.8E-01
0.0	90-1912Q	6.62E+00 +/-	6.4E-01	1.17E+01 +/-	1.4E+00	1.21E+02 +/-	1.1E+00
-0.5	90-1912R	7.29E+00 +/-	7.2E-01	1.19E+01 +/-	1.1E+00	1.20E+02 +/-	1.1E+00
-1.0	90-1912S	6.89E+00 +/-	6.9E-01	1.18E+01 +/-	1.3E+00	1.20E+02 +/-	1.1E+00
-1.5	90-1912T	6.92E+00 +/-	7.2E-01	1.27E+01 +/-	1.3E+00	1.18E+02 +/-	1.1E+00
-2.0	90-1912U	7.16E+00 +/-	8.0E-01	1.19E+01 +/-	1.3E+00	1.16E+02 +/-	1.1E+00
-2.5	90-1912V	6.51E+00 +/-	6.9E-01	1.09E+01 +/-	1.2E+00	1.11E+02 +/-	1.0E+00
-3.0	90-1912W	6.19E+00 +/-	4.1E-01	1.04E+01 +/-	7.1E-01	1.05E+02 +/-	5.7E-01
@ -3.5	90-1912X	6.26E+00 +/-	4.4E-01	9.99E+00 +/-	7.2E-01	1.00E+02 +/-	5.6E-01
-4.0	90-1912Y	5.14E+00 +/-	3.4E-01	9.45E+00 +/-	7.0E-01	9.28E+01 +/-	5.4E-01
-4.5	90-1912Z	4.21E+00 +/-	3.3E-01	8.06E+00 +/-	6.3E-01	8.42E+01 +/-	5.1E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
@ Sample #90-1912-X: Corrected Co-60 value.

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 3/13/91

[RESULTS OF ANALYSIS]

(10 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 260 deg.
Bead Chain Tag ID: (NONE)

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<—— dps/mg of chain @ 12/12/90					——>]
+8.0	90-1913A	6.58E-01	+/- 1.6E-01	1.36E+00	+/- 3.0E-01	3.44E+01	+/- 3.2E-01
+7.5	90-1913B	8.56E-01	+/- 1.0E-01	1.58E+00	+/- 2.3E-01	3.94E+01	+/- 2.1E-01
+7.0	90-1913C	1.33E+00	+/- 2.1E-01	2.34E+00	+/- 4.3E-01	4.29E+01	+/- 3.6E-01
+6.5	90-1913D	1.77E+00	+/- 2.0E-01	2.65E+00	+/- 3.9E-01	4.49E+01	+/- 3.6E-01
+6.0	90-1913E	8.96E-01	+/- 2.0E-01	2.25E+00	+/- 4.1E-01	4.09E+01	+/- 3.5E-01
+5.5	90-1913F	5.38E-01	+/- 1.8E-01	1.35E+00	+/- 3.3E-01	3.68E+01	+/- 3.3E-01
+5.0	90-1913G	5.42E-01	+/- 1.5E-01	9.06E-01	+/- 2.9E-01	3.10E+01	+/- 2.1E-01
+4.5	90-1913H	4.69E-01	+/- 1.4E-01	5.91E-01	+/- 2.3E-01	2.77E+01	+/- 2.0E-01
+4.0	90-1913I	2.73E-01	+/- 7.5E-02	4.49E-01	+/- 1.6E-01	2.63E+01	+/- 1.7E-01
+3.5	90-1913J	1.74E-01	+/- 9.4E-02	5.05E-01	+/- 2.1E-01	2.15E+01	+/- 1.7E-01
+3.0	90-1913K	1.68E-01	+/- 7.8E-02	4.23E-01	+/- 1.5E-01	2.06E+01	+/- 1.5E-01
+2.5	90-1913L	1.93E-01	+/- 8.7E-02	2.08E-01	+/- 1.7E-01	1.69E+01	+/- 1.5E-01
+2.0	90-1913M	1.27E-01	+/- 8.9E-02	2.88E-01	+/- 1.8E-01	1.51E+01	+/- 1.8E-01
+1.5	90-1913N	1.32E-01	+/- 6.0E-02	ND		1.25E+01	+/- 1.3E-01
+1.0	90-1913O	ND		ND		1.06E+01	+/- 1.2E-01
+0.5	90-1913P	ND		ND		8.97E+00	+/- 1.1E-01
0.0	90-1913Q	ND		ND		8.03E+00	+/- 1.1E-01
-0.5	90-1913R	ND		ND		7.07E+00	+/- 9.9E-02
-1.0	90-1913S	ND		8.13E-02	+/- 5.2E-02	7.00E+00	+/- 8.7E-02
-1.5	90-1913T	5.91E-02	+/- 3.6E-02	ND		6.31E+00	+/- 8.4E-02
-2.0	90-1913U	ND		ND		5.87E+00	+/- 8.1E-02
-2.5	90-1913V	ND		ND		5.42E+00	+/- 7.7E-02
-3.0	90-1913W	ND		ND		5.22E+00	+/- 7.6E-02
-3.5	90-1913X	ND		ND		4.83E+00	+/- 7.3E-02
-4.0	90-1913Y	ND		ND		4.44E+00	+/- 7.0E-02
-4.5	90-1913Z	ND		ND		4.28E+00	+/- 6.9E-02

ND- Not Detected

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

RSAC PAL 671

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT — Request# 14175

TO: E.P.Lippincott (W)Energy Center - East (4-17)

Received: 9/27/90
Reported: 4/2/91

[RESULTS OF ANALYSIS]

(20 DEG.)

Palisades Cycle 8 Reactor Cavity Dosimetry

Azimuth: 340 deg.
Bead Chain Tag ID: (150).

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		dps/mg of chain @ 12/12/90					
+8.0	90-1920A	7.82E-01 +/-	1.5E-01	1.27E+00 +/-	3.0E-01	4.25E+01 +/-	2.6E-01
+7.5	90-1920B	8.18E-01 +/-	2.3E-01	2.32E+00 +/-	5.2E-01	4.65E+01 +/-	3.3E-01
+7.0	90-1920C	1.36E+00 +/-	1.6E-01	2.55E+00 +/-	3.7E-01	5.38E+01 +/-	2.9E-01
+6.5	90-1920D	2.05E+00 +/-	1.6E-01	3.53E+00 +/-	3.5E-01	5.62E+01 +/-	2.2E-01
+6.0	90-1920E	2.68E+00 +/-	2.0E-01	5.55E+00 +/-	4.7E-01	6.53E+01 +/-	3.2E-01
+5.5	90-1920F	3.98E+00 +/-	2.3E-01	7.26E+00 +/-	4.7E-01	6.82E+01 +/-	3.3E-01
+5.0	90-1920G	4.92E+00 +/-	3.2E-01	8.42E+00 +/-	7.6E-01	7.57E+01 +/-	4.2E-01
+4.5	90-1920H	5.65E+00 +/-	2.6E-01	1.02E+01 +/-	5.8E-01	8.19E+01 +/-	3.6E-01
+4.0	90-1920I	6.61E+00 +/-	4.5E-01	1.07E+01 +/-	8.8E-01	8.78E+01 +/-	6.6E-01
+3.5	90-1920J	7.20E+00 +/-	4.0E-01	1.15E+01 +/-	7.4E-01	9.01E+01 +/-	4.7E-01
+3.0	90-1920K	7.88E+00 +/-	5.1E-01	1.24E+01 +/-	1.0E+00	9.73E+01 +/-	6.9E-01
+2.5	90-1920L	8.08E+00 +/-	4.7E-01	1.32E+01 +/-	8.6E-01	9.98E+01 +/-	4.9E-01
+2.0	90-1920M	8.21E+00 +/-	4.9E-01	1.34E+01 +/-	1.1E+00	1.07E+02 +/-	7.2E-01
+1.5	90-1920N	8.18E+00 +/-	5.2E-01	1.34E+01 +/-	1.1E+00	1.11E+02 +/-	7.4E-01
+1.0	90-1920O	7.65E+00 +/-	4.0E-01	1.35E+01 +/-	9.5E-01	1.12E+02 +/-	5.2E-01
+0.5	90-1920P	7.89E+00 +/-	5.4E-01	1.36E+01 +/-	1.2E+00	1.18E+02 +/-	7.6E-01
0.0	90-1920Q	8.29E+00 +/-	4.6E-01	1.29E+01 +/-	1.1E+00	1.20E+02 +/-	7.6E-01
-0.5	90-1920R	8.00E+00 +/-	4.8E-01	1.39E+01 +/-	8.9E-01	1.19E+02 +/-	5.3E-01
-1.0	90-1920S	7.96E+00 +/-	5.4E-01	1.40E+01 +/-	1.2E+00	1.22E+02 +/-	7.7E-01
-1.5	90-1920T	7.96E+00 +/-	4.1E-01	1.45E+01 +/-	8.9E-01	1.18E+02 +/-	5.3E-01
-2.0	90-1920U	8.22E+00 +/-	6.0E-01	1.42E+01 +/-	1.2E+00	1.19E+02 +/-	7.7E-01
-2.5	90-1920V	8.09E+00 +/-	5.2E-01	1.36E+01 +/-	1.1E+00	1.16E+02 +/-	7.5E-01
-3.0	90-1920W	7.31E+00 +/-	4.6E-01	1.25E+01 +/-	9.9E-01	1.09E+02 +/-	5.3E-01
-3.5	90-1920X	6.94E+00 +/-	5.1E-01	1.09E+01 +/-	9.5E-01	1.07E+02 +/-	7.2E-01
-4.0	90-1920Y	6.14E+00 +/-	2.9E-01	1.05E+01 +/-	6.0E-01	9.83E+01 +/-	4.3E-01
-4.5	90-1920Z	2.02E+00 +/-	1.5E-01	3.22E+00 +/-	2.7E-01	3.24E+01 +/-	1.7E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14175
References: Lab.Book# 49 pages 3-20.
Procedures: A-524.
Analyst: WTF,TK.

Approved: [signature]

KSAU . AL 6/1

WESTINGHOUSE ELECTRIC CORPORATION
NUCLEAR & ADVANCED TECHNOLOGY DIVISION
AES ANALYTICAL LABORATORY
WALTZ MILL SITE

ARNOLD FERO		AL REQUEST	14175
W NATD, RADIATION ENGINEERING	W284-4891	Receipt Date	May 20, 1991
		Report Date	May 24, 1991

MATERIAL DESCRIPTION
PALISADES CAVITY DOSIMETRY ...... CHAINS

Al Serv. #	Chain Identification Azimuth	ID Tag	ANALYSIS ... WEIGHT PERCENT (%) ... Fe	Ni	Co
91- 1909 S	30o	30	64.4	8.74	0.126
1910 S	90o	90	67.7	9.10	0.187
1911 K	~~none~~ 150°	none	66.7	9.06	0.131
1912 B	210o	210	66.5	8.65	0.179
1915 D	280o	280	70.6	8.81	0.176
1916 D	290o	290	68.3	9.20	0.174
1918 C	315o	315	67.3	8.68	0.164
1919 M	330o	330	68.7	9.35	0.164
1920 Z	340o	150	68.4	9.41	0.186
	Average chain value		67.2	9.00	0.165
	1 sigma		±1.7	±0.29	±0.022
NBS 1154		Certified	64.3	12.26	0.101
		Measured	61.6	11.77	0.099
NBS 160b		Certified	65.1	10.25	0.12
		Measured	66.1	10.25	0.1198
ICPS measurement at 2 sigma deviation			± 2.6	± 0.56	± 0.016

Method of Analysis	Operator	File
Metals ICPS	RMck	AL14175

Approved by [signature]
Lawrence Kardos, Sr Scientist

APPENDIX C

SPECIFIC ACTIVITIES AND IRRADIATION HISTORY OF REACTOR CAVITY SENSOR SETS - CYCLE 9

In this appendix, the irradiation history and the measured specific activities of radiometric monitors irradiated in the reactor cavity during Cycle 9 are provided.

The irradiation history of Cycle 9 was as follows:

Cycle	Startup	Shutdown	Comment
9	03/10/91	02/06/92	

Reference Core Power = 2530 MWt

The monthly thermal generation applicable to the Palisades reactor is provided in addition to the specific activities of the sensors on the following pages.

TABLE C-1

IRRADIATION HISTORY OF REACTOR CAVITY SENSOR SETS

Cycle 9

Date	Thermal Generation MW-hr
Oct-90	0
Nov-90	0
Dec-90	0
Jan-91	0
Feb-91	0
Mar-91	480456
Apr-91	1809167
May-91	1885464
Jun-91	1818648
Jul-91	1143408
Aug-91	1837560
Sep-91	1818984
Oct-91	1882521
Nov-91	1712592
Dec-91	1513368
Jan-92	1867224
Feb-92	357888

TABLE C-2

CONTENTS OF MULTIPLE FOIL SENSOR SETS
CYCLE 9 IRRADIATION

Capsule ID/ Position	Bare or Cd Shielded	Radiometric Monitor Foil ID									
		Fe	Ni	Cu	Ti	Nb	Co	^{238}U (nat)	^{238}U (dep)	NBS PUD	^{237}Np
A-1	B	A	-	-	-	-	A	-	-	-	-
A-2	Cd	K	A	BA	AK	BA	K	AA	BG	-	-
A-3	Cd	-	-	-	-	-	-	-	-	11N1	8
C-1	B	C	-	-	-	-	C	-	-	-	-
C-2	Cd	M	C	BC	AM	BC	M	AC	BI	-	-
C-3	Cd	-	-	-	-	-	-	-	-	13N3	10
F-1	B	F	-	-	-	-	F	-	-	-	-
F-2	Cd	P	F	BF	AP	BF	P	AF	AM	-	-
F-3	Cd	-	-	-	-	-	-	-	-	16N6	13
J-1	B	C	-	-	-	-	O	-	-	-	-
J-2	Cd	M	O	AO	BE	AC	AO	C	C	-	-
J-3	Cd	-	-	-	-	-	-	-	-	-	16
K-1	B	D	-	-	-	-	P	-	-	-	-
K-2	Cd	N	P	AP	BF	AD	AP	D	D	-	-
K-3	Cd	-	-	-	-	-	-	-	-	-	17
L-1	B	E	-	-	-	-	R	-	-	-	-
L-2	Cd	O	R	AR	BG	AE	AR	E	E	-	-
L-3	Cd	-	-	-	-	-	-	-	-	-	18
N-1	B	G	-	-	-	-	T	-	-	-	-
N-2	Cd	R	T	AT	BI	AG	AT	G	U	-	-
N-3	Cd	-	-	-	-	-	-	-	-	-	20

RSAC PAL 115

Westinghouse Electric Corporation
Advanced Programs - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14601

TO: A.H.Fero (W)Energy Center - East (4-17)

Received: 3/3/92
Reported: 3/6/92

[RESULTS OF ANALYSIS]
Palisades Cycle 9 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *		2 sigma
A	92-725	Co-Al	Co-60	4.27E+02	+/-	3.9E+00
K	92-726	Co-Al	Co-60	2.69E+02	+/-	3.4E+00
C	92-738	Co-Al	Co-60	2.15E+02	+/-	3.0E+00
M	92-739	Co-Al	Co-60	1.49E+02	+/-	2.5E+00
F	92-751	Co-Al	Co-60	3.14E+02	+/-	3.7E+00
P	92-752	Co-Al	Co-60	2.16E+02	+/-	3.1E+00
O	92-764	Co-Al	Co-60	1.77E+02	+/-	2.7E+00
AO	92-765	Co-Al	Co-60	1.17E+02	+/-	1.6E+00
P	92-777	Co-Al	Co-60	1.58E+02	+/-	1.8E+00
AP	92-778	Co-Al	Co-60	1.13E+02	+/-	1.6E+00
R	92-790	Co-Al	Co-60	9.50E+01	+/-	1.4E+00
AR	92-791	Co-Al	Co-60	6.43E+01	+/-	1.2E+00
T	92-803	Co-Al	Co-60	1.76E+02	+/-	2.0E+00
AT	92-804	Co-Al	Co-60	1.11E+02	+/-	1.6E+00
AK	92-723	Ti	Sc-46	6.73E+00	+/-	7.2E-02
AM	92-736	Ti	Sc-46	1.14E+00	+/-	1.7E-02
AP	92-749	Ti	Sc-46	2.07E+00	+/-	2.6E-02
BE	92-762	Ti	Sc-46	7.24E+00	+/-	7.5E-02
BF	92-775	Ti	Sc-46	6.12E+00	+/-	7.0E-02
BG	92-788	Ti	Sc-46	1.82E+00	+/-	2.7E-02
BI	92-801	Ti	Sc-46	4.16E+00	+/-	4.1E-02

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14601
References: Lab.Book# 49 pages 300-301,LB #51 page 32..
Procedures: A-524.
Analyst: WIF,FRC,MRK.

Approved: Mark Kowalski

RSAC PAL 775

Westinghouse Electric Corporation
Advanced Programs - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14601

TO: A.H.Fero (W)Energy Center - East (4-17)

Received: 3/3/92
Reported: 3/6/92

[RESULTS OF ANALYSIS]
Palisades Cycle 9 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *		2 sigma
A	92-719	Fe	Mn-54	1.91E+01	+/-	1.5E-01
K	92-720	Fe	Mn-54	1.84E+01	+/-	1.4E-01
C	92-732	Fe	Mn-54	3.59E+00	+/-	8.0E-02
M	92-733	Fe	Mn-54	3.22E+00	+/-	6.4E-02
F	92-745	Fe	Mn-54	7.72E+00	+/-	7.0E-02
P	92-746	Fe	Mn-54	7.51E+00	+/-	6.5E-02
C	92-758	Fe	Mn-54	1.48E+01	+/-	9.8E-02
M	92-759	Fe	Mn-54	1.44E+01	+/-	1.3E-01
D	92-771	Fe	Mn-54	1.22E+01	+/-	1.3E-01
N	92-772	Fe	Mn-54	1.21E+01	+/-	1.2E-01
E	92-784	Fe	Mn-54	3.95E+00	+/-	8.2E-02
O	92-785	Fe	Mn-54	3.69E+00	+/-	7.1E-02
G	92-797	Fe	Mn-54	8.58E+00	+/-	1.2E-01
R	92-798	Fe	Mn-54	8.22E+00	+/-	1.0E-01
A	92-721	Ni	Co-58	3.16E+02	+/-	2.0E+00
C	92-734	Ni	Co-58	6.02E+01	+/-	8.7E-01
F	92-747	Ni	Co-58	1.04E+02	+/-	1.1E+00
O	92-760	Ni	Co-58	3.48E+02	+/-	2.1E+00
P	92-773	Ni	Co-58	2.94E+02	+/-	1.9E+00
R	92-786	Ni	Co-58	9.52E+01	+/-	1.0E+00
T	92-799	Ni	Co-58	2.01E+02	+/-	1.6E+00
BA	92-722	Cu	Co-60	9.62E-01	+/-	1.5E-02
BC	92-735	Cu	Co-60	1.46E-01	+/-	4.5E-03
BF	92-748	Cu	Co-60	4.86E-01	+/-	7.6E-03
AO	92-761	Cu	Co-60	4.65E-01	+/-	7.6E-03
AP	92-774	Cu	Co-60	3.99E-01	+/-	7.0E-03
AR	92-787	Cu	Co-60	1.11E-01	+/-	2.9E-03
AT	92-800	Cu	Co-60	2.76E-01	+/-	6.0E-03

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14601
References: Lab.Book# 49 pages 300-301,LB #51 page 32..
Procedures: A-524.
Analyst: WIF,FRC,MRK.

Approved: Mark Kowchak

RSAC PAL 775

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT — Request# 14601

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/9/92

[RESULTS OF ANALYSIS]

Palisades Cycle 9 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *		2 sigma
8	92-731	Np-237	Zr-95	3.28E+02	+/-	2.6E+00
10	92-744	Np-237	Zr-95	7.95E+01	+/-	1.6E+00
13	92-757	Np-237	Zr-95	1.24E+02	+/-	1.7E+00
16	92-768	Np-237	Zr-95	3.65E+02	+/-	2.9E+00
17	92-781	Np-237	Zr-95	2.82E+02	+/-	2.7E+00
18	92-794	Np-237	Zr-95	1.17E+02	+/-	1.3E+00
20	92-807	Np-237	Zr-95	2.13E+02	+/-	6.0E+00
8	92-731	Np-237	Ru-103	3.08E+02	+/-	2.2E+00
10	92-744	Np-237	Ru-103	8.40E+01	+/-	1.1E+00
13	92-757	Np-237	Ru-103	1.16E+02	+/-	1.5E+00
16	92-768	Np-237	Ru-103	3.42E+02	+/-	2.4E+00
17	92-781	Np-237	Ru-103	2.86E+02	+/-	1.8E+00
18	92-794	Np-237	Ru-103	1.13E+02	+/-	1.1E+00
20	92-807	Np-237	Ru-103	2.22E+02	+/-	4.2E+00
8	92-731	Np-237	Cs-137	2.81E+01	+/-	1.2E+00
10	92-744	Np-237	Cs-137	7.03E+00	+/-	6.1E-01
13	92-757	Np-237	Cs-137	1.57E+01	+/-	8.8E-01
16	92-768	Np-237	Cs-137	1.15E+01	+/-	1.0E+00
17	92-781	Np-237	Cs-137	1.09E+01	+/-	9.0E-01
18	92-794	Np-237	Cs-137	3.40E+00	+/-	4.7E-01
20	92-807	Np-237	Cs-137	6.45E+00	+/-	1.5E+00

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14601
References: Lab.Book# 49 pages 300-301,LB #51 page 32.. —
Procedures: A-524.
Analyst: WTF,FRC,MRK.

Approved: [signature]

RSAC PAL 775

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14601

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

Palisades Cycle 9 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *		2 sigma
AA	92-727	U (nat)	Zr-95	6.22E+01	+/-	1.5E-01
BG	92-728	U (dep)	Zr-95	2.01E+01	+/-	9.9E-02
I1	92-729	U (dep)	Zr-95	2.10E+01	+/-	1.9E-01
N1	92-730	U (nat)	Zr-95	6.18E+01	+/-	2.5E-01
AC	92-740	U (nat)	Zr-95	3.32E+01	+/-	7.7E-02
BI	92-741	U (dep)	Zr-95	5.66E+00	+/-	8.8E-02
I3	92-742	U (dep)	Zr-95	4.76E+00	+/-	9.1E-02
N3	92-743	U (nat)	Zr-95	3.15E+01	+/-	2.1E-01
AF	92-753	U (nat)	Zr-95	3.67E+01	+/-	9.2E-02
AM	92-754	U (dep)	Zr-95	7.43E+00	+/-	6.8E-02
I6	92-755	U (dep)	Zr-95	6.63E+00	+/-	4.3E-02
N6	92-756	U (nat)	Zr-95	3.48E+01	+/-	8.8E-02
C	92-766	U (nat)	Zr-95	6.66E+01	+/-	1.5E-01
C	92-767	U (dep)	Zr-95	2.32E+01	+/-	1.3E-01
D	92-779	U (nat)	Zr-95	6.11E+01	+/-	3.3E-01
D	92-780	U (dep)	Zr-95	2.21E+01	+/-	1.2E-01
E	92-792	U (nat)	Zr-95	3.50E+01	+/-	1.9E-01
E	92-793	U (dep)	Zr-95	7.33E+00	+/-	6.8E-02
G	92-805	U (nat)	Zr-95	1.62E+02	+/-	9.0E-01
U	92-806	U (dep)	Zr-95	1.42E+01	+/-	9.7E-02

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14601
References: Lab.Book# 49 pages 261-265; 300-301: LB #51 page 32
Procedures: A-524.
Analyst: WTF,FRC,MRK,TRK

Approved: Mark Kowalski

RSAC PAL 775

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14601

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

Palisades Cycle 9 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *	2 sigma
AA	92-727	U (nat)	Ru-103	4.37E+01 +/-	9.1E-02
BG	92-728	U (dep)	Ru-103	2.08E+01 +/-	9.9E-02
11	92-729	U (dep)	Ru-103	2.20E+01 +/-	1.6E-01
N1	92-730	U (nat)	Ru-103	4.26E+01 +/-	1.6E-01
AC	92-740	U (nat)	Ru-103	1.73E+01 +/-	5.8E-02
BI	92-741	U (dep)	Ru-103	5.12E+00 +/-	7.0E-02
13	92-742	U (dep)	Ru-103	4.70E+00 +/-	7.8E-02
N3	92-743	U (nat)	Ru-103	1.63E+01 +/-	1.6E-01
AF	92-753	U (nat)	Ru-103	2.12E+01 +/-	7.0E-02
AM	92-754	U (dep)	Ru-103	6.91E+00 +/-	4.7E-02
16	92-755	U (dep)	Ru-103	7.19E+00 +/-	3.8E-02
N6	92-756	U (nat)	Ru-103	1.96E+01 +/-	6.7E-02
C	92-766	U (nat)	Ru-103	4.70E+01 +/-	9.5E-02
C	92-767	U (dep)	Ru-103	2.31E+01 +/-	1.1E-01
D	92-779	U (nat)	Ru-103	4.17E+01 +/-	2.1E-01
D	92-780	U (dep)	Ru-103	1.94E+01 +/-	8.0E-02
E	92-792	U (nat)	Ru-103	1.96E+01 +/-	1.4E-01
E	92-793	U (dep)	Ru-103	6.87E+00 +/-	5.8E-02
G	92-805	U (nat)	Ru-103	1.02E+02 +/-	5.7E-01
U	92-806	U (dep)	Ru-103	1.29E+01 +/-	6.8E-02

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14601
References: Lab.Book# 49 pages 261-265; 300-301: LB #51 page 32.
Procedures: A-524.
Analyst: WTF,FRC,MRK,TRK

Approved: Mark Kurochak

RSAC PAL775

Westinghouse Electric Corporation
Advanced Energy Systems - Analytical Laboratory
Waltz Mill Site

REPORT

Request# 14601

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

Palisades Cycle 9 Reactor Cavity Dosimetry

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) dps/mg *	2 sigma
AA	92-727	U (nat)	Cs-137	5.42E+00 +/-	5.3E-02
BG	92-728	U (dep)	Cs-137	1.68E+00 +/-	5.0E-02
11	92-729	U (dep)	Cs-137	1.84E+00 +/-	8.2E-02
N1	92-730	U (nat)	Cs-137	5.36E+00 +/-	8.8E-02
AC	92-740	U (nat)	Cs-137	2.32E+00 +/-	3.0E-02
BI	92-741	U (dep)	Cs-137	4.17E-01 +/-	3.0E-02
13	92-742	U (dep)	Cs-137	3.46E-01 +/-	4.2E-02
N3	92-743	U (nat)	Cs-137	2.19E+00 +/-	8.5E-02
AF	92-753	U (nat)	Cs-137	3.61E+00 +/-	3.9E-02
AM	92-754	U (dep)	Cs-137	8.97E-01 +/-	3.1E-02
16	92-755	U (dep)	Cs-137	9.21E-01 +/-	2.0E-02
N6	92-756	U (nat)	Cs-137	3.57E+00 +/-	3.7E-02
C	92-766	U (nat)	Cs-137	2.21E+00 +/-	4.8E-02
C	92-767	U (dep)	Cs-137	7.35E-01 +/-	3.8E-02
D	92-779	U (nat)	Cs-137	1.92E+00 +/-	9.8E-02
D	92-780	U (dep)	Cs-137	7.16E-01 +/-	3.8E-02
E	92-792	U (nat)	Cs-137	9.48E-01 +/-	6.5E-02
E	92-793	U (dep)	Cs-137	2.10E-01 +/-	2.4E-02
G	92-805	U (nat)	Cs-137	5.16E+00 +/-	2.69E-01
U	92-806	U (dep)	Cs-137	4.67E-01 +/-	3.54E-02

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 14601
References: Lab.Book# 49 pages 261-265; 300-301: LB #51 page 32.
Procedures: A-524.
Analyst: WTF,FRC,MRK,TRK

Approved: [signature]

24117Z

RSAC PAL775

Westinghouse Electric Corporation
Advanced Programs - Analytical Laboratory
Waltz Mill Site

REPORT
REVISION

Request# 14175

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 9/27/90
Reported: 12/16/92

[RESULTS OF ANALYSIS]

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 12/12/90) Bq/mg *		2 sigma
BB	90-1862	Nb-93(Cd)	Nb-93m	8.09E+01	+/-	3.7E+00
BD	90-1875	Nb-93(Cd)	Nb-93m	5.60E+01	+/-	3.1E+00
BE	90-1888	Nb-93(Cd)	Nb-93m	1.67E+01	+/-	1.7E+00
BG	90-1901	Nb-93(Cd)	Nb-93m	3.85E+01	+/-	2.6E+00

Remarks: * Results are in units of Bq/(mg of Dosimeter Material).
Nb-93m half-life: 5890 days

AL File: Request# 14175
References: Lab.Book# 51 page 61
Procedures: OI-Nb
Analyst: WTF,FRC,MRK

Approved: Mark Kaurhan

RSAC PAL775

Westinghouse Electric Corporation
Advanced Programs - Analytical Laboratory
Waltz Mill Site

REPORT
REVISION

Request# 14601

TO: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/4/92
Reported: 12/17/92

[RESULTS OF ANALYSIS]

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 3/4/92) Bq/mg *		2 sigma
BA	92-724	Nb-93(Cd)	Nb-93m	1.28E+02	+/-	4.6E+00
BC	92-737	Nb-93(Cd)	Nb-93m	2.50E+01	+/-	2.1E+00
BF	92-750	Nb-93(Cd)	Nb-93m	5.58E+01	+/-	3.1E+00
AC	92-763	Nb-93(Cd)	Nb-93m	4.37E+01	+/-	2.8E+00
AD	92-776	Nb-93(Cd)	Nb-93m	4.55E+01	+/-	2.9E+00
AE	92-789	Nb-93(Cd)	Nb-93m	1.59E+01	+/-	1.8E+00
AG	92-802	Nb-93(Cd)	Nb-93m	2.87E+01	+/-	2.3E+00

Remarks: * Results are in units of Bq/(mg of Dosimeter Material).
Nb-93m half-life: 5890 days

AL File: Request# 14601
References: Lab.Book# 51 page 61
Procedures: OI-Nb
Analyst: WTF,FRC,MRK

Approved: Mark Kurzhals

RSAC PAL775

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-1 270 Degrees

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		dps/mg of chain @ 3/4/92					
+0.5	92-712A	1.18E+01	+/- 7.1E-01	2.91E+01	+/- 8.9E-01	1.54E+02	+/- 9.8E-01
-0.5	92-712C	1.15E+01	+/- 7.0E-01	2.84E+01	+/- 8.6E-01	1.54E+02	+/- 9.8E-01
-1.0	92-712D	1.13E+01	+/- 7.4E-01	2.76E+01	+/- 8.6E-01	1.51E+02	+/- 9.7E-01
-1.5	92-712E	1.10E+01	+/- 7.6E-01	2.53E+01	+/- 8.6E-01	1.47E+02	+/- 9.7E-01
-2.0	92-712F	9.39E+00	+/- 6.1E-01	2.50E+01	+/- 8.4E-01	1.45E+02	+/- 9.5E-01
-2.5	92-712G	8.79E+00	+/- 7.1E-01	2.20E+01	+/- 8.4E-01	1.33E+02	+/- 1.2E+00
-3.0	92-712H	7.09E+00	+/- 6.1E-01	1.82E+01	+/- 7.2E-01	1.35E+02	+/- 9.2E-01
-3.5	92-712I	6.70E+00	+/- 6.6E-01	1.62E+01	+/- 7.4E-01	1.26E+02	+/- 8.7E-01
-4.0	92-712J	6.42E+00	+/- 6.8E-01	1.48E+01	+/- 7.2E-01	1.15E+02	+/- 8.4E-01
-4.5	92-712K	3.93E+00	+/- 4.7E-01	1.02E+01	+/- 5.6E-01	9.38E+01	+/- 7.6E-01
-5.0	92-712L	2.76E+00	+/- 4.2E-01	7.33E+00	+/- 5.4E-01	8.33E+01	+/- 7.2E-01

Remarks: *Results are in units of dps /(mg of Dosimeter Material)

AL File: 14601
References: Lab Book# 49 pages 261-265; 300-301; Lab Book#51 page 32
Procedures: A-524.
Analyst: WTF, TRK, MRK, FRC

Approved: Mark Yavorkah

RSAC PAL 112

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: Arnold Fero
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/9/92

[RESULTS OF ANALYSIS]

PALLISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 280 Degrees

Feet from Midplane	Lab Sample#	dps/mg of chain @ 3/4/92: Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+0.5	92-713A	9.33E+00	+/- 2.8E-01	3.25E+01	+/- 3.7E-01	4.83E+01	+/- 3.1E-01
-0.38	92-713X	9.75E+00	+/- 3.1E-01	3.26E+01	+/- 4.1E-01	4.86E+01	+/- 3.3E-01
-0.5	92-713C	9.43E+00	+/- 2.8E-01	3.20E+01	+/- 3.6E-01	4.84E+01	+/- 3.1E-01
-1.0	92-713D	9.41E+00	+/- 2.8E-01	3.11E+01	+/- 3.6E-01	4.79E+01	+/- 3.1E-01
-1.5	92-713E	8.97E+00	+/- 2.7E-01	3.03E+01	+/- 3.5E-01	4.71E+01	+/- 3.0E-01
-2.0	92-713F	8.29E+00	+/- 2.7E-01	2.87E+01	+/- 3.4E-01	4.60E+01	+/- 3.0E-01
-2.5	92-713G	7.84E+00	+/- 2.6E-01	2.69E+01	+/- 3.3E-01	4.49E+01	+/- 2.9E-01
-3.0	92-713H	7.00E+00	+/- 2.4E-01	2.49E+01	+/- 3.2E-01	4.32E+01	+/- 2.9E-01
-3.5	92-713I	6.53E+00	+/- 2.5E-01	2.29E+01	+/- 3.1E-01	4.10E+01	+/- 3.8E-01
-4.0	92-713J	5.38E+00	+/- 2.1E-01	1.90E+01	+/- 2.9E-01	3.88E+01	+/- 3.7E-01
-4.5	92-713K	3.93E+00	+/- 1.8E-01	1.48E+01	+/- 2.6E-01	3.37E+01	+/- 2.5E-01
-5.0	92-713L	2.81E+00	+/- 1.9E-01	1.03E+01	+/- 2.3E-01	2.84E+01	+/- 2.3E-01
-5.5	92-713M	2.15E+00	+/- 1.7E-01	7.58E+00	+/- 2.1E-01	2.69E+01	+/- 2.2E-01

Remarks:

AL File: 14601
References: Lab Book#49 pages 262-265; Lab Book#51 page 32
Procedures: A-524.
Analyst: WTF, TRK, MRK, FRC

Approved: [signature]

RSAC PAL 775

Westinghouse Advanced Energy Systems
REPORT Analytical Laboratory - Waltz Mill Site Request# 14601

Originator: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 290 Degrees

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		dps/mg of chain @ 3/4/92					
+0.5	92-714A	7.93E+00 +/-	2.7E-01	2.67E+01 +/-	3.4E-01	4.38E+01 +/-	2.9E-01
-0.5	92-714C	8.12E+00 +/-	3.3E-01	2.71E+01 +/-	4.3E-01	4.43E+01 +/-	3.6E-01
-1.0	92-714D	7.64E+00 +/-	3.3E-01	2.70E+01 +/-	4.3E-01	4.44E+01 +/-	3.7E-01
-1.5	92-714E	7.98E+00 +/-	3.4E-01	2.64E+01 +/-	4.3E-01	4.37E+01 +/-	3.6E-01
-2.0	92-714F	7.39E+00 +/-	3.0E-01	2.55E+01 +/-	4.1E-01	4.31E+01 +/-	3.6E-01
-2.5	92-714G	6.99E+00 +/-	3.2E-01	2.46E+01 +/-	4.2E-01	4.18E+01 +/-	3.5E-01
-3.0	92-714H	6.42E+00 +/-	2.9E-01	2.32E+01 +/-	4.0E-01	4.11E+01 +/-	3.5E-01
-3.5	92-714I	6.01E+00 +/-	2.4E-01	2.19E+01 +/-	3.2E-01	3.94E+01 +/-	2.8E-01
-4.0	92-714J	5.61E+00 +/-	2.4E-01	1.93E+01 +/-	3.0E-01	3.75E+01 +/-	2.7E-01
-4.5	92-714K	4.58E+00 +/-	2.1E-01	1.65E+01 +/-	2.8E-01	3.52E+01 +/-	2.6E-01
-5.0	92-714L	3.20E+00 +/-	1.8E-01	1.12E+01 +/-	2.5E-01	2.85E+01 +/-	2.3E-01

Remarks: *Results are in units of dps /(mg of Dosimeter Material)

AL File: 14601
References: Lab Book# 49 pages 261-265; 300-301; Lab Book#51 page 32
Procedures: A-524.
Analyst: WTF, TRK, MRK, FRC

Approved: Mark Kanwchak

ANALYTICAL

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-1 300 Degrees

Feet from Midplane	Lab Sample#	dps/mg of chain @ 3/4/92 Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+0.5	92-715A	5.38E+00 +/-	5.1E-01	1.33E+01 +/-	6.5E-01	1.18E+02 +/-	8.5E-01
-0.5	92-715C	4.68E+00 +/-	5.5E-01	7.21E+00 +/-	6.1E-01	1.07E+02 +/-	8.0E-01
-1.0	92-715D	3.73E+00 +/-	5.5E-01	5.10E+00 +/-	5.8E-01	1.05E+02 +/-	7.9E-01
-1.5	92-715E	3.49E+00 +/-	5.3E-01	3.10E+00 +/-	5.0E-01	1.03E+02 +/-	7.9E-01
-2.0	92-715F	2.52E+00 +/-	4.6E-01	2.50E+00 +/-	5.0E-01	1.00E+02 +/-	7.8E-01
-2.5	92-715G	2.46E+00 +/-	4.5E-01	1.75E+00 +/-	3.8E-01	9.62E+01 +/-	7.6E-01
-3.0	92-715H	2.13E+00 +/-	4.6E-01	1.13E+00 +/-	3.0E-01	9.23E+01 +/-	7.5E-01
-3.5	92-715I	2.10E+00 +/-	4.7E-01	1.20E+00 +/-	4.1E-01	8.82E+01 +/-	7.3E-01
-4.0	92-715J	2.13E+00 +/-	4.9E-01	7.81E-01 +/-	3.0E-01	8.40E+01 +/-	7.1E-01
-4.5	92-715K	1.65E+00 +/-	2.5E-01	8.00E-01 +/-	2.0E-01	7.84E+01 +/-	3.9E-01
-5.0	92-715L	1.32E+00 +/-	3.2E-01	6.05E-01 +/-	2.9E-01	6.89E+01 +/-	6.5E-01
-5.5	92-715M	8.33E-01 +/-	3.3E-01	7.42E-01 +/-	2.9E-01	5.97E+01 +/-	6.0E-01

Remarks: *Results are in units of dps /(mg of Dosimeter Material)

AL File: 14601
References: Lab Book# 49 pages 261-265; 300-301; Lab Book#51 page 32
Procedures: A-524.
Analyst: WTF, TRK, MRK, FRC

Approved: Mark Kaurhak

RSAC PAL 775

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 315 Degrees

Feet from Midplane	Lab Sample#	Mn-54 dps/mg (dps/mg of chain @ 3/4/92)		Mn-54 2 sigma	Co-58 dps/mg		Co-58 2 sigma	Co-60 dps/mg		Co-60 2 sigma
+0.5	92-716A	5.52E+00	+/-	2.4E-01	1.84E+01	+/-	3.2E-01	4.85E+01	+/-	3.0E-01
-0.5	92-716C	5.58E+00	+/-	2.5E-01	1.83E+01	+/-	3.2E-01	4.89E+01	+/-	3.1E-01
-1.0	92-716D	5.46E+00	+/-	2.5E-01	1.80E+01	+/-	3.1E-01	4.83E+01	+/-	3.1E-01
-1.5	92-716E	4.82E+00	+/-	2.1E-01	1.71E+01	+/-	3.1E-01	4.77E+01	+/-	3.0E-01
-2.0	92-716F	4.68E+00	+/-	2.4E-01	1.66E+01	+/-	3.2E-01	4.65E+01	+/-	3.0E-01
-2.5	92-716G	4.42E+00	+/-	2.3E-01	1.53E+01	+/-	3.0E-01	4.51E+01	+/-	2.9E-01
-3.0	92-716H	4.37E+00	+/-	2.3E-01	1.45E+01	+/-	2.9E-01	4.33E+01	+/-	2.9E-01
-3.5	92-716I	3.90E+00	+/-	2.4E-01	1.34E+01	+/-	2.9E-01	4.12E+01	+/-	2.8E-01
-4.0	92-716J	3.30E+00	+/-	2.1E-01	1.16E+01	+/-	2.7E-01	3.85E+01	+/-	2.7E-01
-4.5	92-716K	2.82E+00	+/-	2.0E-01	1.01E+01	+/-	2.6E-01	3.54E+01	+/-	2.6E-01
-5.0	92-716L	2.16E+00	+/-	1.8E-01	7.35E+00	+/-	2.2E-01	2.72E+01	+/-	2.3E-01
-5.5	92-716M	1.66E+00	+/-	1.8E-01	5.67E+00	+/-	2.0E-01	2.38E+01	+/-	2.1E-01

Remarks: * Results are in units dps /(mg of Dosimeter Material)

AL File: 14601
References: Lab Book#49 pages 261-272; 300-301; Lab Book#51 page 32
Procedures: A-524.
Analyst: WTF, TRK, MRK, FRC

Approved: [signature]

RSAC PAL775

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/16/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 330 degrees

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<--------------	dps/mg of chain	@ 3/4/92			-------------->]
+0.5	92-717A	7.92E+00	+/- 5.4E-01	2.68E+01	+/- 6.3E-01	5.43E+01	+/- 5.6E-01
0.0	92-717B	8.07E+00	+/- 2.9E-01	2.68E+01	+/- 3.7E-01	5.36E+01	+/- 3.2E-01
-0.5	92-717C	7.76E+00	+/- 2.8E-01	2.64E+01	+/- 3.6E-01	5.39E+01	+/- 3.2E-01
-1.0	92-717D	7.93E+00	+/- 2.7E-01	2.62E+01	+/- 3.6E-01	5.34E+01	+/- 3.2E-01
-1.5	92-717E	7.69E+00	+/- 2.8E-01	2.61E+01	+/- 3.7E-01	5.26E+01	+/- 3.2E-01
-2.0	92-717F	7.51E+00	+/- 2.8E-01	2.54E+01	+/- 3.4E-01	5.13E+01	+/- 3.1E-01
-2.5	92-717G	6.93E+00	+/- 2.6E-01	2.40E+01	+/- 3.4E-01	4.97E+01	+/- 3.1E-01
-3.0	92-717H	6.49E+00	+/- 2.5E-01	2.24E+01	+/- 3.4E-01	4.75E+01	+/- 3.0E-01
-3.5	92-717I	5.82E+00	+/- 2.4E-01	2.05E+01	+/- 3.2E-01	4.49E+01	+/- 2.9E-01
-4.0	92-717J	5.01E+00	+/- 2.2E-01	1.78E+01	+/- 2.8E-01	4.18E+01	+/- 2.6E-01
-4.5	92-717K	4.01E+00	+/- 2.1E-01	1.47E+01	+/- 2.8E-01	3.84E+01	+/- 2.7E-01
-5.0	92-717L	2.68E+00	+/- 1.7E-01	9.75E+00	+/- 2.4E-01	2.96E+01	+/- 2.4E-01
-5.5	92-717M	2.11E+00	+/- 1.7E-01	7.11E+00	+/- 2.1E-01	2.64E+01	+/- 2.2E-01

Remarks: * Results are in units dps /(mg of Dosimeter Material)

AL File: 14601
References: Lab Book#49 pages 261-272; 300-301; Lab Book#51 page 32
Procedures: A-524.
Analyst: WTF, TRK, MRK, FRC

Approved: [signature]

RSAC PAL 775

REPORT — Westinghouse Advanced Energy Systems, Analytical Laboratory - Waltz Mill Site — Request# 14601

Originator: A.H.Fero (W)Energy Center - East (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/17/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 30 Degrees

Feet from Midplane	Lab Sample#	Mn-54 dps/mg (dps/mg of chain @ 3/4/92)	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+8.0	92-707A	4.54E-01	+/- 7.0E-02	1.72E+00	+/- 9.8E-02	1.96E+01	+/- 1.2E-01
+7.5	92-707B	6.33E-01	+/- 9.6E-02	2.50E+00	+/- 1.4E-01	2.24E+01	+/- 1.6E-01
+7.0	92-707C	1.02E+00	+/- 1.1E-01	3.82E+00	+/- 1.5E-01	2.47E+01	+/- 1.7E-01
+6.5	92-707D	1.56E+00	+/- 1.3E-01	5.63E+00	+/- 1.6E-01	2.68E+01	+/- 1.8E-01
+6.0	92-707E	2.29E+00	+/- 1.9E-01	7.69E+00	+/- 2.3E-01	2.88E+01	+/- 2.3E-01
+5.5	92-707F	2.98E+00	+/- 2.0E-01	1.09E+01	+/- 2.5E-01	3.15E+01	+/- 2.5E-01
+5.0	92-707G	3.84E+00	+/- 2.3E-01	1.31E+01	+/- 2.8E-01	3.41E+01	+/- 2.6E-01
+4.5	92-707H	4.38E+00	+/- 2.2E-01	1.56E+01	+/- 2.8E-01	3.64E+01	+/- 2.6E-01
+4.0	92-707I	5.09E+00	+/- 2.4E-01	1.72E+01	+/- 3.0E-01	3.84E+01	+/- 2.7E-01
+3.5	92-707J	5.48E+00	+/- 2.4E-01	1.88E+01	+/- 3.0E-01	4.02E+01	+/- 2.8E-01
+3.0	92-707K	5.77E+00	+/- 2.3E-01	1.93E+01	+/- 3.1E-01	4.20E+01	+/- 2.8E-01
+2.5	92-707L	6.00E+00	+/- 2.5E-01	2.03E+01	+/- 3.3E-01	4.34E+01	+/- 2.9E-01
+2.0	92-707M	5.89E+00	+/- 2.7E-01	2.08E+01	+/- 3.4E-01	4.48E+01	+/- 2.9E-01
+1.5	92-707N	6.10E+00	+/- 2.7E-01	2.08E+01	+/- 3.4E-01	4.64E+01	+/- 3.0E-01
+1.0	92-707O	6.14E+00	+/- 2.7E-01	2.11E+01	+/- 3.4E-01	4.74E+01	+/- 3.0E-01
+0.5	92-707P	6.28E+00	+/- 2.5E-01	2.13E+01	+/- 3.4E-01	4.88E+01	+/- 3.0E-01
0.0	92-707Q	6.33E+00	+/- 2.7E-01	2.08E+01	+/- 3.4E-01	4.90E+01	+/- 3.1E-01
-0.5	92-707R	6.37E+00	+/- 2.8E-01	2.12E+01	+/- 3.5E-01	4.97E+01	+/- 3.1E-01
-1.0	92-707S	6.09E+00	+/- 2.6E-01	2.14E+01	+/- 3.4E-01	4.95E+01	+/- 3.1E-01
-1.5	92-707T	6.30E+00	+/- 2.6E-01	2.14E+01	+/- 3.5E-01	4.95E+01	+/- 3.1E-01
-2.0	92-707U	6.16E+00	+/- 2.6E-01	2.14E+01	+/- 3.5E-01	4.91E+01	+/- 3.1E-01
-2.5	92-707V	6.06E+00	+/- 2.7E-01	2.10E+01	+/- 3.5E-01	4.79E+01	+/- 3.0E-01
-3.0	92-707W	6.00E+00	+/- 2.5E-01	1.98E+01	+/- 3.4E-01	4.63E+01	+/- 3.0E-01
-3.5	92-707X	5.21E+00	+/- 2.4E-01	1.81E+01	+/- 3.1E-01	4.40E+01	+/- 2.9E-01
-4.0	92-707Y	4.62E+00	+/- 2.4E-01	1.66E+01	+/- 3.0E-01	4.13E+01	+/- 2.8E-01
-4.5	92-707Z	4.08E+00	+/- 2.3E-01	1.40E+01	+/- 3.0E-01	3.79E+01	+/- 2.7E-01

Remarks:

AL File: 14601
References: Lab Book#49 pages 259-271.
Procedures: A-524.
Analyst: WTF, TRK, MRK

Approved: Mark Kowthal

RSAC PAL775

REPORT	Westinghouse Advanced Energy Systems Analytical Laboratory - Waltz Mill Site	Request# I4601

Originator: A.H.Fero (W)Energy Center (4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/18/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 90 Degrees

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<--------------	dps/mg of chain @ 3/4/92			-------------->]	
+8.0	92-708A	5.52E-01 +/-	1.2E-01	2.17E+00 +/-	1.7E-01	2.14E+01 +/-	2.0E-01
+7.5	92-708B	8.56E-01 +/-	1.4E-01	3.56E+00 +/-	1.8E-01	2.49E+01 +/-	2.2E-01
+7.0	92-708C	1.43E+00 +/-	1.6E-01	5.09E+00 +/-	2.1E-01	2.77E+01 +/-	2.3E-01
+6.5	92-708D	2.16E+00 +/-	1.9E-01	7.36E+00 +/-	2.2E-01	3.05E+01 +/-	2.4E-01
+6.0	92-708E	3.11E+00 +/-	2.1E-01	1.04E+01 +/-	2.5E-01	3.31E+01 +/-	2.5E-01
+5.5	92-708F	4.06E+00 +/-	2.2E-01	1.38E+01 +/-	2.7E-01	3.64E+01 +/-	2.6E-01
+5.0	92-708G	4.93E+00 +/-	2.4E-01	1.73E+01 +/-	3.1E-01	3.93E+01 +/-	2.7E-01
+4.5	92-708H	5.91E+00 +/-	2.4E-01	2.05E+01 +/-	3.3E-01	4.25E+01 +/-	2.9E-01
+4.0	92-708I	6.33E+00 +/-	2.6E-01	2.27E+01 +/-	3.5E-01	4.55E+01 +/-	3.0E-01
+3.5	92-708J	7.11E+00 +/-	2.6E-01	2.45E+01 +/-	3.6E-01	4.80E+01 +/-	3.1E-01
+3.0	92-708K	7.43E+00 +/-	2.9E-01	2.57E+01 +/-	3.7E-01	5.10E+01 +/-	3.1E-01
+2.5	92-708L	7.68E+00 +/-	2.8E-01	2.59E+01 +/-	3.7E-01	5.30E+01 +/-	3.2E-01
+2.0	92-708M	7.70E+00 +/-	2.8E-01	2.59E+01 +/-	3.8E-01	5.31E+01 +/-	3.2E-01
+1.5	92-708N	7.79E+00 +/-	3.0E-01	2.65E+01 +/-	3.9E-01	5.76E+01 +/-	3.3E-01
+1.0	92-708O	8.04E+00 +/-	5.3E-01	2.69E+01 +/-	6.9E-01	5.95E+01 +/-	6.0E-01
+0.5	92-708P	7.96E+00 +/-	5.3E-01	2.68E+01 +/-	6.8E-01	6.04E+01 +/-	6.0E-01
0	92-708Q	8.05E+00 +/-	5.5E-01	2.64E+01 +/-	6.9E-01	6.13E+01 +/-	6.0E-01
-0.5	92-708R	8.01E+00 +/-	5.3E-01	2.63E+01 +/-	7.0E-01	6.13E+01 +/-	6.2E-01
-1.0	92-708S	8.02E+00 +/-	5.6E-01	2.61E+01 +/-	6.9E-01	6.16E+01 +/-	6.0E-01
-1.5	92-708T	7.13E+00 +/-	4.8E-01	2.48E+01 +/-	6.7E-01	6.08E+01 +/-	6.0E-01
-2.0	92-708U	6.96E+00 +/-	5.0E-01	2.40E+01 +/-	7.0E-01	5.95E+01 +/-	6.0E-01
-2.5	92-708V	6.40E+00 +/-	2.9E-01	2.30E+01 +/-	3.7E-01	5.69E+01 +/-	3.3E-01
-3.0	92-708W	6.42E+00 +/-	3.8E-01	2.16E+01 +/-	5.0E-01	5.46E+01 +/-	4.5E-01
-3.5	92-708X	6.01E+00 +/-	2.8E-01	2.02E+01 +/-	3.5E-01	5.14E+01 +/-	3.2E-01
-4.0	92-708Y	5.33E+00 +/-	2.8E-01	1.83E+01 +/-	3.5E-01	4.84E+01 +/-	3.1E-01
-4.5	92-708Z	4.57E+00 +/-	2.5E-01	1.56E+01 +/-	3.1E-01	4.31E+01 +/-	2.9E-01

Remarks:

AL File: 14601
References: Lab Book#49 pages 259-271.
Procedures: A-524.
Analyst: WTF, TRK, MRK

Approved: [signature]

RSAC PAL775

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: A.H.Fero (W)Energy Center (E 4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/20/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 150 Degrees

Feet from Midplane	Lab Sample#	[<-------------- dps/mg of chain @ 3/4/92 -------------->] Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+8.0	92-709A	4.67E-01 +/-	1.3E-01	1.75E+00 +/-	1.6E-01	1.99E+01 +/-	1.9E-01
+7.5	92-709B	7.16E-01 +/-	1.3E-01	2.48E+00 +/-	1.8E-01	2.32E+01 +/-	2.1E-01
+7.0	92-709C	1.16E+00 +/-	1.6E-01	4.17E+00 +/-	2.2E-01	2.69E+01 +/-	2.2E-01
+6.5	92-709D	1.75E+00 +/-	1.7E-01	5.98E+00 +/-	2.4E-01	2.95E+01 +/-	2.4E-01
+6.0	92-709E	2.29E+00 +/-	2.1E-01	8.35E+00 +/-	2.5E-01	3.18E+01 +/-	2.5E-01
+5.5	92-709F	3.11E+00 +/-	2.2E-01	1.15E+01 +/-	2.8E-01	3.45E+01 +/-	2.6E-01
+5.0	92-709G	3.89E+00 +/-	2.1E-01	1.42E+01 +/-	3.0E-01	3.70E+01 +/-	2.7E-01
+4.5	92-709H	4.84E+00 +/-	2.5E-01	1.69E+01 +/-	3.1E-01	4.03E+01 +/-	2.8E-01
+4.0	92-709I	5.21E+00 +/-	2.4E-01	1.81E+01 +/-	3.3E-01	4.30E+01 +/-	2.9E-01
+3.5	92-709J	5.66E+00 +/-	2.3E-01	2.08E+01 +/-	3.5E-01	4.56E+01 +/-	3.0E-01
+3.0	92-709K	5.95E+00 +/-	2.6E-01	2.19E+01 +/-	3.6E-01	4.79E+01 +/-	3.0E-01
+2.5	92-709L	6.50E+00 +/-	2.4E-01	2.27E+01 +/-	3.6E-01	4.95E+01 +/-	3.1E-01
+2.0	92-709M	6.57E+00 +/-	2.6E-01	2.28E+01 +/-	3.7E-01	5.14E+01 +/-	3.2E-01
+1.5	92-709N	6.94E+00 +/-	2.9E-01	2.30E+01 +/-	3.8E-01	5.31E+01 +/-	3.2E-01
+1.0	92-709O	6.48E+00 +/-	2.6E-01	2.30E+01 +/-	3.8E-01	5.46E+01 +/-	3.3E-01
+0.5	92-709P	6.66E+00 +/-	2.9E-01	2.36E+01 +/-	3.9E-01	5.54E+01 +/-	3.3E-01
0.0	92-709Q	6.76E+00 +/-	2.8E-01	2.37E+01 +/-	3.8E-01	5.63E+01 +/-	3.3E-01
-0.5	92-709R	6.99E+00 +/-	2.8E-01	2.38E+01 +/-	3.8E-01	5.68E+01 +/-	3.3E-01
-1.0	92-709S	7.01E+00 +/-	2.9E-01	2.34E+01 +/-	3.7E-01	5.60E+01 +/-	3.3E-01
-1.5	92-709T	6.52E+00 +/-	2.7E-01	2.28E+01 +/-	3.8E-01	5.50E+01 +/-	3.3E-01
-2.0	92-709U	6.63E+00 +/-	2.7E-01	2.25E+01 +/-	3.8E-01	5.58E+01 +/-	3.3E-01
-2.5	92-709V	6.31E+00 +/-	2.7E-01	2.22E+01 +/-	3.7E-01	5.36E+01 +/-	3.2E-01
-3.0	92-709W	6.06E+00 +/-	2.8E-01	2.13E+01 +/-	3.7E-01	5.24E+01 +/-	3.2E-01
-3.5	92-709X	5.83E+00 +/-	2.5E-01	2.03E+01 +/-	3.5E-01	4.96E+01 +/-	3.1E-01
-4.0	92-709Y	5.02E+00 +/-	2.4E-01	1.82E+01 +/-	3.4E-01	4.67E+01 +/-	3.0E-01
-4.5	92-709Z	4.57E+00 +/-	2.5E-01	1.53E+01 +/-	3.2E-01	4.30E+01 +/-	2.9E-01

Remarks:

AL File: 14601
References: Lab Book#49 pages 261-265; Lab Book#51 page 32
Procedures: A-524.
Analyst: WTF, TRK, MRK, FRC

Approved: [signature]

RSAC PAL775

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: A.H.Fero (W)Energy Center (E 4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/23/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 260 Degrees

Feet from Midplane	Lab Sample#	dps/mg of chain @ 3/4/92 — Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+8.0	92-711A	5.01E-01 +/-	1.1E-01	1.89E+00 +/-	1.6E-01	2.16E+01 +/-	2.0E-01
+7.5	92-711B	7.43E-01 +/-	1.4E-01	2.89E+00 +/-	1.9E-01	2.42E+01 +/-	2.1E-01
+7.0	92-711C	1.22E+00 +/-	1.6E-01	4.40E+00 +/-	2.1E-01	2.68E+01 +/-	2.2E-01
+6.5	92-711D	1.92E+00 +/-	1.9E-01	6.63E+00 +/-	2.4E-01	2.95E+01 +/-	2.4E-01
+6.0	92-711E	2.65E+00 +/-	2.2E-01	9.44E+00 +/-	2.7E-01	3.19E+01 +/-	2.5E-01
+5.5	92-711F	3.70E+00 +/-	2.3E-01	1.26E+01 +/-	2.9E-01	3.44E+01 +/-	2.6E-01
+5.0	92-711G	4.62E+00 +/-	2.4E-01	1.66E+01 +/-	3.1E-01	3.68E+01 +/-	2.7E-01
+4.5	92-711H	5.47E+00 +/-	2.3E-01	1.94E+01 +/-	3.2E-01	3.93E+01 +/-	2.7E-01
+4.0	92-711I	6.20E+00 +/-	2.6E-01	2.17E+01 +/-	3.4E-01	4.12E+01 +/-	2.8E-01
+3.5	92-711J	6.73E+00 +/-	2.5E-01	2.37E+01 +/-	3.5E-01	4.31E+01 +/-	2.9E-01
-3.0	92-711K	7.34E+00 +/-	2.7E-01	2.49E+01 +/-	3.7E-01	4.51E+01 +/-	2.9E-01
+2.5	92-711L	7.62E+00 +/-	2.6E-01	2.56E+01 +/-	3.8E-01	4.66E+01 +/-	3.0E-01
+2.0	92-711M	7.46E+00 +/-	2.7E-01	2.58E+01 +/-	3.7E-01	4.82E+01 +/-	3.1E-01
+1.5	92-711N	7.53E+00 +/-	2.9E-01	2.62E+01 +/-	3.8E-01	4.93E+01 +/-	3.1E-01
+1.0	92-711O	7.90E+00 +/-	2.9E-01	2.64E+01 +/-	3.8E-01	5.07E+01 +/-	3.1E-01
+0.5	92-711P	8.08E+00 +/-	2.8E-01	2.66E+01 +/-	3.9E-01	5.16E+01 +/-	3.2E-01
0	92-711Q	8.04E+00 +/-	3.0E-01	2.68E+01 +/-	4.0E-01	5.18E+01 +/-	3.2E-01
-0.5	92-711R	8.04E+00 +/-	2.4E-01	2.70E+01 +/-	3.6E-01	5.25E+01 +/-	2.9E-01
-1.0	92-711S	8.07E+00 +/-	3.0E-01	2.73E+01 +/-	3.8E-01	5.21E+01 +/-	3.2E-01
-1.5	92-711T	8.20E+00 +/-	3.0E-01	2.73E+01 +/-	3.9E-01	5.15E+01 +/-	3.2E-01
-2.0	92-711U	7.96E+00 +/-	2.9E-01	2.63E+01 +/-	3.9E-01	5.05E+01 +/-	3.1E-01
-2.5	92-711V	7.47E+00 +/-	2.8E-01	2.51E+01 +/-	3.8E-01	4.94E+01 +/-	3.1E-01
-3.0	92-711W	7.05E+00 +/-	2.8E-01	2.42E+01 +/-	3.8E-01	4.73E+01 +/-	3.0E-01
-3.5	92-711X	6.68E+00 +/-	2.7E-01	2.24E+01 +/-	3.5E-01	4.53E+01 +/-	3.0E-01
-4.0	92-711Y	5.72E+00 +/-	2.5E-01	2.03E+01 +/-	3.5E-01	4.27E+01 +/-	2.8E-01
-4.5	92-711Z	4.84E+00 +/-	2.4E-01	1.72E+01 +/-	3.3E-01	3.89E+01 +/-	2.7E-01

Remarks:

AL File: 14601
References: Lab Book#49 pages 259-271.
Procedures: A-524.
Analyst: WTF, TRK, MRK

Approved: Mark Kurchak

RSAC PAL775

REPORT

Westinghouse Advanced Energy Systems
Analytical Laboratory - Waltz Mill Site

Request# 14601

Originator: A.H.Fero (W)Energy Center (E 4-17)
Radiation Engineering & Analysis
Westinghouse Electric Corporation

Received: 3/3/92
Reported: 3/25/92

[RESULTS OF ANALYSIS]

PALISADES CYCLE 9 REACTOR CAVITY DOSIMETRY

Bead Chain Tag ID: S-2 340 Degrees

Feet from Midplane	Lab Sample#	Mn-54 dps/mg		Mn-54 2 sigma	Co-58 dps/mg		Co-58 2 sigma	Co-60 dps/mg		Co-60 2 sigma
		dps/mg of chain @ 3/4/92								
+8.0	92-718A	5.44E-01	+/-	6.9E-02	2.08E+00	+/-	1.1E-01	2.04E+01	+/-	1.2E-01
+7.5	92-718B	7.77E-01	+/-	7.4E-02	3.11E+00	+/-	1.2E-01	2.29E+01	+/-	1.3E-01
+7.0	92-718C	1.06E+00	+/-	1.2E-01	4.63E+00	+/-	2.1E-01	2.53E+01	+/-	2.2E-01
+6.5	92-718D	1.87E+00	+/-	1.6E-01	6.90E+00	+/-	2.5E-01	2.82E+01	+/-	2.3E-01
+6.0	92-718E	2.72E+00	+/-	2.1E-01	9.86E+00	+/-	2.6E-01	3.09E+01	+/-	2.4E-01
+5.5	92-718F	3.67E+00	+/-	2.1E-01	1.30E+01	+/-	3.0E-01	3.40E+01	+/-	2.5E-01
+5.0	92-718G	4.83E+00	+/-	2.3E-01	1.68E+01	+/-	3.3E-01	3.64E+01	+/-	2.7E-01
+4.5	92-718H	5.73E+00	+/-	2.4E-01	1.99E+01	+/-	3.4E-01	3.91E+01	+/-	2.7E-01
+4.0	92-718I	6.50E+00	+/-	2.5E-01	2.21E+01	+/-	3.6E-01	4.15E+01	+/-	2.8E-01
+3.5	92-718J	6.94E+00	+/-	2.6E-01	2.40E+01	+/-	3.6E-01	4.38E+01	+/-	2.9E-01
+3.0	92-718K	7.25E+00	+/-	2.7E-01	2.52E+01	+/-	3.8E-01	4.58E+01	+/-	2.9E-01
+2.5	92-718L	7.30E+00	+/-	2.7E-01	2.58E+01	+/-	3.8E-01	4.81E+01	+/-	3.1E-01
+2.0	92-718M	7.63E+00	+/-	2.6E-01	2.64E+01	+/-	3.6E-01	5.01E+01	+/-	2.9E-01
+1.5	92-718N	7.64E+00	+/-	2.8E-01	2.68E+01	+/-	4.0E-01	5.16E+01	+/-	3.2E-01
+1.0	92-718O	7.79E+00	+/-	3.0E-01	2.67E+01	+/-	4.0E-01	5.31E+01	+/-	3.2E-01
+0.5	92-718P	7.68E+00	+/-	3.0E-01	2.68E+01	+/-	4.1E-01	5.45E+01	+/-	3.3E-01
0	92-718Q	8.05E+00	+/-	3.1E-01	2.73E+01	+/-	4.1E-01	5.49E+01	+/-	3.3E-01
-0.5	92-718R	8.14E+00	+/-	2.9E-01	2.69E+01	+/-	4.2E-01	5.56E+01	+/-	3.3E-01
-1.0	92-718S	8.26E+00	+/-	3.0E-01	2.73E+01	+/-	4.1E-01	5.53E+01	+/-	3.3E-01
-1.5	92-718T	8.18E+00	+/-	2.9E-01	2.70E+01	+/-	4.2E-01	5.50E+01	+/-	3.3E-01
-2.0	92-718U	7.93E+00	+/-	2.9E-01	2.70E+01	+/-	4.1E-01	5.34E+01	+/-	3.2E-01
-2.5	92-718V	7.52E+00	+/-	2.9E-01	2.61E+01	+/-	4.1E-01	5.21E+01	+/-	3.2E-01
-3.0	92-718W	7.06E+00	+/-	2.8E-01	2.46E+01	+/-	3.9E-01	5.03E+01	+/-	3.1E-01
-3.5	92-718X	6.59E+00	+/-	2.6E-01	2.28E+01	+/-	3.7E-01	4.78E+01	+/-	3.0E-01
-4.0	92-718Y	5.66E+00	+/-	2.5E-01	2.01E+01	+/-	3.6E-01	4.49E+01	+/-	2.9E-01
-4.5	92-718Z	5.13E+00	+/-	2.3E-01	1.71E+01	+/-	3.4E-01	4.09E+01	+/-	2.8E-01

Remarks:

AL File: 14601
References: Lab Book#49 pages 259-271.
Procedures: A-524.
Analyst: WTF, TRK, MRK

Approved: Mark Kanrhah

RSAC PAL 775

WESTINGHOUSE ELECTRIC CORPORATION
NUCLEAR & ADVANCED TECHNOLOGY DIVISION
AES ANALYTICAL LABORATORY
WALTZ MILL SITE

ARNIE FERRO M. Kawchek AL REQUEST 14601

W NATD Energy Center Receipt March 13, 1992
W284-4891 msE417 Report March 17, 1992

MATERIAL DESCRIPTION
STAINLESS STEEL DOSIMETRY REACTOR CHAIN BEADS

Al Serv. #	W NATD Identification CHAIN	LOCATION	WEIGHT PERCENT (%) Fe	Ni	Co		
92- 707	S-2	30o	71.67	9.729	0.1345		
92- 708	S-2	90o	71.36	9.781	0.1387		
92- 709	S-2	150o	72.07	9.873	0.1430		
92- 711	S-2	260o	71.16	9.581	0.1384		
92- 712	S-~~2~~ 1	270o	70.88	9.768	0.1745		*
92- 713	S-2	280o	72.13	9.887	0.1430		
92- 714	S-2	290o	69.13	10.184	0.1385		
92- 715	S-~~2~~ 1	300o	71.97	10.234	0.1784		*
92- 716	S-2	315o	70.73	10.112	0.1404		
92- 717	S-2	330o	72.93	10.402	0.1417		
92- 718	S-2	340o	70.01	9.986	0.1363		
		aver	71.28	9.958	0.1394	0.1461	*
		std dev	±1.07	±0.250	±0.0029	±0.0152	*
		%RSD	1.5%	2.5%	2.0%	10.4%	*

* two cobalt values significantly different than group, calculated average with and without * values.

			Fe	Ni	Co
NIST 121d SS Control		certified	68.23	11.17	0.10
	aver	measured	69.67	11.463	0.0959
		± std dev	±0.92	±0.270	±0.0011
		% RSD	1.3%	2.4%	1.2%

S-2 210o received empty bag, no sample (92-710)

Method of Analysis Operator File
Metals ICPS RMcK AL 14601

Approved by [signature]
Lawrence Kardos, Sr Scientist

APPENDIX D

SPECIFIC ACTIVITIES AND IRRADIATION HISTORY OF REACTOR CAVITY SENSOR SETS - CYCLES 10 and 11

In this appendix, the irradiation history and the measured specific activities of radiometric monitors irradiated in the reactor cavity during Cycles 10 and 11 are provided.

The irradiation history of Cycles 10 and 11 were as follows:

Cycle	Startup	Shutdown	Comment
10	04/18/92	06/05/93	
11	11/06/93	05/22/95	

Reference Core Power = 2530 MWt

The monthly thermal generation applicable to the Palisades reactor is provided in addition to the specific activities of the sensors on the following pages.

TABLE D-1

IRRADIATION HISTORY OF REACTOR CAVITY SENSOR SETS

Cycle 10		Cycle 11	
Date	Thermal Generation MW-hr	Date	Thermal Generation MW-hr
Mar-92	0	Jul-93	0
Apr-92	620112	Aug-93	0
May-92	1878432	Sep-93	0
Jun-92	1819464	Oct-93	0
Jul-92	1392552	Nov-93	1242336
Aug-92	1459272	Dec-93	1876608
Sep-92	1260672	Jan-94	1844112
Oct-92	1779079	Feb-94	1004688
Nov-92	1326168	Mar-94	0
Dec-92	1880496	Apr-94	0
Jan-93	1879536	May-94	0
Feb-93	1698408	Jun-94	666768
Mar-93	1880544	Jul-94	1874208
Apr-93	1688919	Aug-94	1874448
May-93	862632	Sep-94	1812408
Jun-93	237864	Oct-94	1869960
		Nov-94	1813872
		Dec-94	1867368
		Jan-95	1874304
		Feb-95	1655688
		Mar-95	1871832
		Apr-95	1811689
		May-95	1170744

TABLE D-2

CONTENTS OF MULTIPLE FOIL SENSOR SETS
CYCLES 10/11 IRRADIATION

Capsule ID/ Position	Bare or Cd Shielded	Radiometric Monitor Foil ID Fe	Ni	Cu	Ti	Nb	Co	^{238}U	^{237}Np
O-1	B	D	-	-	-	-	A	-	-
O-2	Cd	N	AN	AN	BD	AN	N	-	-
O-3	Cd	-	-	-	-	-	-	1	1
P-1	B	E	-	-	-	-	B	-	-
P-2	Cd	O	AO	AO	BE	AO	O	-	-
P-3	Cd	-	-	-	-	-	-	2	2
Q-1	B	F	-	-	-	-	C	-	-
Q-2	Cd	P	AP	AP	BF	AP	P	-	-
Q-3	Cd	-	-	-	-	-	-	3	-
R-1	B	G	-	-	-	-	D	-	-
R-2	Cd	R	AR	AR	BG	AR	R	-	-
R-3	Cd	-	-	-	-	-	-	4	3
S-1	B	H	-	-	-	-	E	-	-
S-2	Cd	S	AS	AS	BH	AS	S	-	-
S-3	Cd	-	-	-	-	-	-	5	4
T-1	B	I	-	-	-	-	F	-	-
T-2	Cd	T	AT	AT	BI	AT	T	-	-
T-3	Cd	-	-	-	-	-	-	6	5
U-1	B	J	-	-	-	-	G	-	-
U-2	Cd	U	AU	AU	BJ	AU	U	-	-
U-3	Cd	-	-	-	-	-	-	7	6

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/24/95

[RESULTS OF ANALYSIS]
Palisades Reactor Cavity Dosimetry - Cycle 10

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 8/15/95) dps/mg *		2 sigma
D	95-1495	Fe	Mn-54	1.29E+01	+/-	1.2E-01
N	95-1496	Fe	Mn-54	1.24E+01	+/-	1.2E-01
E	95-1505	Fe	Mn-54	1.34E+01	+/-	1.6E-01
O	95-1506	Fe	Mn-54	1.30E+01	+/-	1.5E-01
F	95-1515	Fe	Mn-54	3.62E+00	+/-	8.5E-02
P	95-1516	Fe	Mn-54	3.31E+00	+/-	8.2E-02
G	95-1524	Fe	Mn-54	1.22E+01	+/-	1.5E-01
R	95-1525	Fe	Mn-54	1.19E+01	+/-	1.4E-01
H	95-1534	Fe	Mn-54	9.48E+00	+/-	1.4E-01
S	95-1535	Fe	Mn-54	9.64E+00	+/-	1.3E-01
I	95-1544	Fe	Mn-54	9.43E+00	+/-	1.4E-01
T	95-1545	Fe	Mn-54	9.19E+00	+/-	1.3E-01
J	95-1554	Fe	Mn-54	1.11E+01	+/-	1.5E-01
U	95-1555	Fe	Mn-54	1.08E+01	+/-	1.4E-01
A	95-1501	AlCo	Co-60	3.16E+02	+/-	4.6E+00
N	95-1502	AlCo	Co-60	2.04E+02	+/-	3.6E+00
B	95-1511	AlCo	Co-60	3.04E+02	+/-	4.5E+00
O	95-1512	AlCo	Co-60	2.02E+02	+/-	3.7E+00
C	95-1521	AlCo	Co-60	1.71E+02	+/-	3.3E+00
P	95-1522	AlCo	Co-60	1.15E+02	+/-	2.7E+00
D	95-1530	AlCo	Co-60	2.85E+02	+/-	4.2E+00
R	95-1531	AlCo	Co-60	1.97E+02	+/-	3.5E+00
E	95-1540	AlCo	Co-60	2.81E+02	+/-	4.1E+00
S	95-1541	AlCo	Co-60	2.00E+02	+/-	3.5E+00
F	95-1550	AlCo	Co-60	3.25E+02	+/-	4.4E+00
T	95-1551	AlCo	Co-60	2.06E+02	+/-	3.5E+00
G	95-1560	AlCo	Co-60	3.41E+02	+/-	4.5E+00
U	95-1561	AlCo	Co-60	2.13E+02	+/-	3.6E+00

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: [signature]

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/24/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 8/15/95) dps/mg *		2 sigma
BD	95-1499	Ti	Sc-46	3.08E+00	+/-	8.8E-02
BE	95-1509	Ti	Sc-46	3.23E+00	+/-	8.9E-02
BF	95-1519	Ti	Sc-46	8.49E-01	+/-	4.3E-02
BG	95-1528	Ti	Sc-46	3.01E+00	+/-	8.5E-02
BH	95-1538	Ti	Sc-46	2.34E+00	+/-	7.5E-02
BI	95-1548	Ti	Sc-46	2.33E+00	+/-	7.6E-02
BJ	95-1558	Ti	Sc-46	2.72E+00	+/-	8.2E-02
AN	95-1497	Ni	C0-58	1.35E+02	+/-	1.7E+00
AO	95-1507	Ni	C0-58	1.44E+02	+/-	1.7E+00
AP	95-1517	Ni	C0-58	3.94E+01	+/-	9.0E-01
AR	95-1526	Ni	C0-58	1.26E+02	+/-	1.6E+00
AS	95-1536	Ni	C0-58	1.99E+02	+/-	2.0E+00
AT	95-1546	Ni	C0-58	9.92E+01	+/-	1.4E+00
AU	95-1556	Ni	C0-58	1.18E+02	+/-	1.6E+00
AN	95-1498	Cu	C0-60	7.67E-01	+/-	2.0E-02
AO	95-1508	Cu	C0-60	7.98E-01	+/-	2.1E-02
AP	95-1518	Cu	C0-60	1.93E-01	+/-	1.0E-02
AR	95-1527	Cu	C0-60	7.28E-01	+/-	1.9E-02
AS	95-1537	Cu	C0-60	6.10E-01	+/-	1.8E-02
AT	95-1547	Cu	C0-60	5.43E-01	+/-	1.7E-02
AU	95-1557	Cu	C0-60	6.59E-01	+/-	1.9E-02

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: [signature]

REPORT	Westinghouse Electric Corporation Chemistry Operations Technology & Analysis Waltz Mill Site	Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/24/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 8/15/95) dps/mg *		2 sigma
1	95-1503	UO2	Cs-137	1.55E+00	+/-	2.3E-01
2	95-1513	UO2	Cs-137	1.41E+00	+/-	2.2E-01
3	95-1523	UO2	Cs-137	3.38E-01	+/-	1.3E-01
4	95-1532	UO2	Cs-137	1.32E+00	+/-	1.6E-01
5	95-1542	UO2	Cs-137	1.09E+00	+/-	1.8E-01
6	95-1552	UO2	Cs-137	1.01E+00	+/-	1.6E-01
7	95-1562	UO2	Cs-137	1.33E+00	+/-	2.9E-01
1	95-1503	UO2	Ru-103	5.73E+00	+/-	3.6E-01
2	95-1513	UO2	Ru-103	5.78E+00	+/-	3.9E-01
3	95-1523	UO2	Ru-103	1.74E+00	+/-	1.6E-01
4	95-1532	UO2	Ru-103	5.37E+00	+/-	2.8E-01
5	95-1542	UO2	Ru-103	4.14E+00	+/-	2.9E-01
6	95-1552	UO2	Ru-103	3.96E+00	+/-	2.3E-01
7	95-1562	UO2	Ru-103	4.94E+00	+/-	3.9E-01
1	95-1503	UO2	Zr-95	7.60E+00	+/-	5.2E-01
2	95-1513	UO2	Zr-95	8.16E+00	+/-	6.0E-01
3	95-1523	UO2	Zr-95	2.32E+00	+/-	2.5E-01
4	95-1532	UO2	Zr-95	7.81E+00	+/-	4.5E-01
5	95-1542	UO2	Zr-95	5.75E+00	+/-	4.2E-01
6	95-1552	UO2	Zr-95	5.87E+00	+/-	3.8E-01
7	95-1562	UO2	Zr-95	6.07E+00	+/-	5.7E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: [signature]

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/24/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10

Foil ID	Lab Sample#	Dosimeter Material	Nuclide	(@ 8/15/95) dps/mg *		2 sigma
1	95-1504	NpO2	Cs-137	1.92E+01	+/-	2.1E+00
2	95-1514	NpO2	Cs-137	2.04E+01	+/-	1.8E+00
3	95-1533	NpO2	Cs-137	1.95E+01	+/-	1.7E+00
4	95-1543	NpO2	Cs-137	1.56E+01	+/-	1.4E+00
5	95-1553	NpO2	Cs-137	1.49E+01	+/-	1.9E+00
6	95-1563	NpO2	Cs-137	1.52E+01	+/-	1.6E+00
1	95-1504	NpO2	Ru-103	7.48E+01	+/-	3.6E+00
2	95-1514	NpO2	Ru-103	7.54E+01	+/-	3.2E+00
3	95-1533	NpO2	Ru-103	6.76E+01	+/-	3.4E+00
4	95-1543	NpO2	Ru-103	5.62E+01	+/-	2.7E+00
5	95-1553	NpO2	Ru-103	5.29E+01	+/-	3.0E+00
6	95-1563	NpO2	Ru-103	6.26E+01	+/-	3.0E+00
1	95-1504	NpO2	Zr-95	1.20E+02	+/-	5.0E+00
2	95-1514	NpO2	Zr-95	1.26E+02	+/-	5.0E+00
3	95-1533	NpO2	Zr-95	1.11E+02	+/-	4.7E+00
4	95-1543	NpO2	Zr-95	9.55E+01	+/-	4.5E+00
5	95-1553	NpO2	Zr-95	9.13E+01	+/-	4.7E+00
6	95-1563	NpO2	Zr-95	1.05E+02	+/-	4.6E+00

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: [signature]

REVISED
REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 11/27/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10

Bead Chain Tag ID: 270 deg.

Feet from Midplane	Lab Sample#	dps/mg of chain @ 8/15/95 Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+0.5	95-1488-A	8.40E+00	+/- 4.9E-01	1.21E+01	+/- 5.4E-01	1.10E+02	+/- 1.1E+00
-0.5	95-1488-B	8.27E+00	+/- 5.1E-01	1.18E+01	+/- 5.9E-01	1.07E+02	+/- 1.1E+00
-1.5	95-1488-C	7.15E+00	+/- 4.3E-01	1.05E+01	+/- 5.0E-01	1.05E+02	+/- 1.1E+00
-2.5	95-1488-D	6.17E+00	+/- 4.4E-01	9.82E+00	+/- 4.9E+00	9.79E+01	+/- 9.4E-01
-3.5	95-1488-E	4.70E+00	+/- 3.8E-01	7.39E+00	+/- 4.9E-01	8.76E+01	+/- 8.9E-01
-4.5	95-1488-F	2.96E+00	+/- 3.1E-01	4.54E+00	+/- 3.5E-01	6.64E+01	+/- 7.7E-01
-5.5	95-1488-G	1.46E+00	+/- 1.5E-01	2.38E+00	+/- 1.6E-01	5.64E+01	+/- 4.1E-01

Bead Chain Tag ID: 280 deg.

Feet from Midplane	Lab Sample#	dps/mg of chain @ 8/15/95 Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+0.5	95-1489-A	8.81E+00	+/- 4.8E-01	1.32E+01	+/- 5.3E-01	1.02E+02	+/- 9.6E-01
-0.5	95-1489-B	8.42E+00	+/- 4.9E-01	1.31E+01	+/- 6.0E-01	1.01E+02	+/- 9.7E-01
-1.5	95-1489-C	8.52E+00	+/- 6.1E-01	1.24E+01	+/- 5.6E-01	9.99E+01	+/- 9.8E-01
-2.5	95-1489-D	7.30E+00	+/- 5.3E-01	1.08E+01	+/- 5.7E-01	9.40E+01	+/- 9.4E-01
-3.5	95-1489-E	6.44E+00	+/- 4.7E-01	9.89E+00	+/- 4.7E-01	8.74E+01	+/- 8.9E-01
-4.5	95-1489-F	4.17E+00	+/- 2.1E-01	6.79E+00	+/- 2.4E-01	7.27E+01	+/- 4.6E-01
-5.73	95-1489-G	1.66E+00	+/- 1.7E-01	2.69E+00	+/- 1.8E-01	5.57E+01	+/- 4.0E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
* Correction of Co-58: 95-1489-F

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: L. F. Becker for 11/27/95

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/28/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10

Bead Chain Tag ID: 290 deg.

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<--------------- dps/mg of chain @ 8/15/95 --------------->]					
+0.5	95-1490-A	7.39E+00 +/-	4.7E-01	1.10E+01 +/-	5.3E-01	9.48E+01 +/-	9.4E-01
-0.5	95-1490-B	7.65E+00 +/-	4.6E-01	1.11E+01 +/-	5.3E-01	9.58E+01 +/-	9.3E-01
-1.5	95-1490-C	7.73E+00 +/-	4.8E+00	1.12E+01 +/-	5.1E-01	9.38E+01 +/-	9.3E-01
-2.5	95-1490-D	6.95E+00 +/-	4.6E-01	1.02E+01 +/-	5.4E-01	9.09E+01 +/-	9.1E-01
-3.5	95-1490-E	6.07E+00 +/-	4.9E-01	9.26E+00 +/-	5.0E-01	8.53E+01 +/-	8.8E-01
-4.5	95-1490-F	4.66E+00 +/-	2.5E-01	7.36E+00 +/-	2.9E-01	7.64E+01 +/-	4.8E-01
-5.5	95-1490-G	2.52E+00 +/-	2.0E-01	4.04E+00 +/-	2.0E-01	5.74E+01 +/-	4.1E-01

Bead Chain Tag ID: 300 deg.

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<--------------- dps/mg of chain @ 8/15/95 --------------->]					
+0.5	95-1491-A	6.46E+00 +/-	4.3E-01	9.48E+00 +/-	4.9E-01	9.54E+01 +/-	9.3E-01
-0.5	95-1491-B	6.30E+00 +/-	4.1E-01	9.42E+00 +/-	4.6E-01	9.57E+01 +/-	9.3E-01
-1.5	95-1491-C	6.11E+00 +/-	3.9E-01	9.13E+00 +/-	4.7E-01	9.28E+01 +/-	9.2E-01
-2.5	95-1491-D	6.23E+00 +/-	4.8E-01	8.35E+00 +/-	4.5E-01	8.90E+01 +/-	9.1E-01
-3.5	95-1491-E	5.09E+00 +/-	2.1E-01	7.78E+00 +/-	2.6E-01	8.29E+01 +/-	4.9E-01
-4.5	95-1491-F	4.06E+00 +/-	2.1E-01	6.46E+00 +/-	2.4E-01	7.39E+01 +/-	4.6E-01
-5.5	95-1491-G	2.36E+00 +/-	1.8E-01	3.52E+00 +/-	1.8E-01	5.42E+01 +/-	4.0E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved:

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/28/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10

Bead Chain Tag ID: 315 deg.

Feet from Midplane	Lab Sample#	[<---- dps/mg of chain @ 8/15/95					---->]
		Mn-54		Co-58		Co-60	
		dps/mg	2 sigma	dps/mg	2 sigma	dps/mg	2 sigma
+0.5	95-1492-A	6.05E+00 +/-	6.2E-01	8.90E+00 +/-	6.5E-01	1.07E+02 +/-	1.0E+00
-0.5	95-1492-B	6.18E+00 +/-	5.2E-01	8.41E+00 +/-	5.5E-01	1.07E+02 +/-	1.0E+00
-1.5	95-1492-C	5.59E+00 +/-	5.4E-01	8.37E+00 +/-	6.4E-01	1.03E+02 +/-	1.0E+00
-2.5	95-1492-D	4.68E+00 +/-	5.1E-01	7.75E+00 +/-	5.5E-01	9.83E+01 +/-	9.9E-01
-3.5	95-1492-E	4.17E+00 +/-	3.0E-01	6.78E+00 +/-	3.9E-01	8.90E+01 +/-	6.0E-01
-4.5	95-1492-F	3.57E+00 +/-	2.9E-01	5.56E+00 +/-	3.5E-01	7.68E+01 +/-	5.5E-01
-5.5	95-1492-G	1.75E+00 +/-	1.8E-01	3.09E+00 +/-	2.4E-01	5.23E+01 +/-	4.1E-01

Bead Chain Tag ID: 330 deg.

Feet from Midplane	Lab Sample#	[<---- dps/mg of chain @ 8/15/95					---->]
		Mn-54		Co-58		Co-60	
		dps/mg	2 sigma	dps/mg	2 sigma	dps/mg	2 sigma
+0.5	95-1493-A	6.66E+00 +/-	6.3E-01	9.80E+00 +/-	6.6E-01	1.13E+02 +/-	1.1E+00
-0.5	95-1493-B	7.11E+00 +/-	5.8E-01	1.01E+01 +/-	7.3E-01	1.14E+02 +/-	1.1E+00
-1.5	95-1493-C	6.61E+00 +/-	5.7E-01	9.97E+00 +/-	6.7E-01	1.12E+02 +/-	1.1E+00
-2.5	95-1493-D	6.72E+00 +/-	4.4E-01	1.01E+01 +/-	5.6E-01	1.07E+02 +/-	9.9E-01
-3.5	95-1493-E	5.70E+00 +/-	4.0E-01	8.94E+00 +/-	5.3E-01	9.56E+01 +/-	9.3E-01
-4.5	95-1493-F	4.20E+00 +/-	2.1E-01	6.63E+00 +/-	2.3E-01	8.13E+01 +/-	4.9E-01
-5.5	95-1493-G	2.01E+00 +/-	1.6E-01	3.31E+00 +/-	2.1E-01	5.79E+01 +/-	4.1E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: [signature]

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/30/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10 / Cycle 11

Bead Chain Tag ID: 30 deg.

Feet from Midplane	Lab Sample#	dps/mg of chain @ 8/15/95 — Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+8.0	95-1483-A	4.10E-01 +/-	1.2E-01	7.56E-01 +/-	1.6E-01	4.25E+01 +/-	3.5E-01
+7.5	95-1483-B	7.09E-01 +/-	1.5E-01	1.24E+00 +/-	1.7E-01	4.89E+01 +/-	3.8E-01
+6.5	95-1483-C	1.81E+00 +/-	2.1E-01	2.72E+00 +/-	1.8E-01	5.95E+01 +/-	4.2E-01
+5.5	95-1483-D	3.42E+00 +/-	2.3E-01	5.36E+00 +/-	2.6E-01	6.97E+01 +/-	4.6E-01
+4.5	95-1483-E	4.91E+00 +/-	3.6E-01	7.66E+00 +/-	4.0E-01	8.04E+01 +/-	8.6E-01
+3.5	95-1483-F	5.68E+00 +/-	3.9E-01	9.11E+00 +/-	4.6E-01	9.01E+01 +/-	9.1E-01
+2.5	95-1483-G	6.42E+00 +/-	4.6E-01	9.20E+00 +/-	4.4E-01	9.70E+01 +/-	9.4E-01
+1.5	95-1483-H	6.36E+00 +/-	4.3E-01	9.57E+00 +/-	4.8E-01	1.02E+02 +/-	9.7E-01
+0.5	95-1483-I	6.15E+00 +/-	4.2E-01	9.37E+00 +/-	4.7E-01	1.07E+02 +/-	9.9E-01
0.0	95-1483-J	6.18E+00 +/-	4.5E-01	9.56E+00 +/-	5.4E-01	1.09E+02 +/-	1.0E+00
-0.5	95-1483-K	6.57E+00 +/-	4.2E-01	9.76E+00 +/-	4.7E-01	1.09E+02 +/-	1.0E+00
-1.5	95-1483-L	6.36E+00 +/-	4.4E-01	9.26E+00 +/-	5.0E-01	1.10E+02 +/-	1.0E+00
-2.5	95-1483-M	5.96E+00 +/-	4.0E-01	9.73E+00 +/-	5.8E-01	1.05E+02 +/-	9.9E-01
-3.5	95-1483-N	6.14E+00 +/-	5.0E-01	8.95E+00 +/-	5.8E-01	9.76E+01 +/-	9.5E-01
-4.5	95-1483-O	4.35E+00 +/-	4.3E-01	6.67E+00 +/-	4.5E-01	8.38E+01 +/-	8.8E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: Mark Kowrhal

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

REPORT

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/30/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10 / Cycle 11

Bead Chain Tag ID: 90 deg.

Feet from Midplane	Lab Sample#	[<------ dps/mg of chain @ 8/15/95 ------>] Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+8.0	95-1484-A	5.44E-01 +/-	1.2E-01	7.98E-01 +/-	1.5E-01	4.46E+01 +/-	3.6E-01
+7.5	95-1484-B	6.07E-01 +/-	1.4E-01	1.24E+00 +/-	1.7E-01	5.21E+01 +/-	3.9E-01
+6.5	95-1484-C	1.86E+00 +/-	1.9E-01	2.73E+00 +/-	2.1E-01	6.41E+01 +/-	4.4E-01
+5.5	95-1484-D	3.46E+00 +/-	2.1E-01	5.74E+00 +/-	3.0E-01	7.53E+01 +/-	4.8E-01
+4.5	95-1484-E	5.48E+00 +/-	4.4E-01	8.67E+00 +/-	6.1E-01	8.75E+01 +/-	9.1E-01
+3.5	95-1484-F	6.50E+00 +/-	5.2E-01	9.58E+00 +/-	6.4E-01	9.83E+01 +/-	9.7E-01
+2.5	95-1484-G	7.10E+00 +/-	5.8E-01	1.13E+01 +/-	7.0E-01	1.09E+02 +/-	1.0E+00
+1.5	95-1484-H	7.52E+00 +/-	6.3E-01	1.16E+01 +/-	6.9E-01	1.18E+02 +/-	1.1E+00
+0.5	95-1484-I	6.93E+00 +/-	5.7E-01	1.08E+01 +/-	6.4E-01	1.23E+02 +/-	1.1E+00
0.0	95-1484-J	7.16E+00 +/-	6.0E-01	1.06E+01 +/-	7.2E-01	1.23E+02 +/-	1.1E+00
-0.5	95-1484-K	6.94E+00 +/-	6.3E-01	1.05E+01 +/-	6.7E-01	1.25E+02 +/-	1.1E+00
-1.5	95-1484-L	6.86E+00 +/-	4.4E-01	1.06E+01 +/-	6.1E-01	1.26E+02 +/-	1.1E+00
-2.5	95-1484-M	6.40E+00 +/-	5.1E-01	9.84E+00 +/-	5.4E-01	1.20E+02 +/-	1.1E+00
-3.5	95-1484-N	5.70E+00 +/-	4.9E-01	9.30E+00 +/-	5.1E-01	1.08E+02 +/-	1.0E+00
-4.5	95-1484-O	4.45E+00 +/-	3.6E-01	6.68E+00 +/-	4.6E-01	8.43E+01 +/-	8.7E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved:

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/30/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10 / Cycle 11

Bead Chain Tag ID: 340 deg.

Feet from Midplane	Lab Sample#	dps/mg of chain @ 8/15/95 — Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
+8.0	95-1494-A	6.10E-01	+/- 1.1E-01	9.07E-01	+/- 1.4E-01	4.15E+01	+/- 3.4E-01
+7.5	95-1494-B	8.66E-01	+/- 1.3E-01	1.54E+00	+/- 1.8E-01	4.68E+01	+/- 3.7E-01
+6.5	95-1494-C	1.70E+00	+/- 1.8E-01	3.01E+00	+/- 1.7E-01	5.89E+01	+/- 4.1E-01
+5.5	95-1494-D	3.13E+00	+/- 1.9E-01	4.94E+00	+/- 2.1E-01	7.09E+01	+/- 4.5E-01
+4.5	95-1494-E	4.70E+00	+/- 2.2E-01	7.67E+00	+/- 2.7E-01	8.29E+01	+/- 4.9E-01
+3.5	95-1494-F	5.91E+00	+/- 4.3E-01	9.13E+00	+/- 4.4E-01	9.31E+01	+/- 9.2E-01
+2.5	95-1494-G	6.42E+00	+/- 3.3E-01	1.00E+01	+/- 4.0E-01	1.02E+02	+/- 7.3E-01
+1.5	95-1494-H	6.41E+00	+/- 4.5E-01	1.03E+01	+/- 5.5E-01	1.11E+02	+/- 1.0E+00
+0.5	95-1494-I	6.79E+00	+/- 4.5E-01	1.03E+01	+/- 5.6E-01	1.17E+02	+/- 1.0E+00
0.0	95-1494-J	7.01E+00	+/- 5.0E-01	1.02E+01	+/- 5.1E-01	1.19E+02	+/- 1.0E+00
-0.5	95-1494-K	6.85E+00	+/- 4.8E-01	1.05E+01	+/- 5.3E-01	1.20E+02	+/- 1.0E+00
-1.5	95-1494-L	6.71E+00	+/- 4.8E-01	1.00E+01	+/- 5.3E-01	1.19E+02	+/- 1.1E+00
-2.5	95-1494-M	6.46E+00	+/- 4.5E-01	9.82E+00	+/- 5.2E-01	1.14E+02	+/- 1.0E+00
-3.5	95-1494-N	5.77E+00	+/- 5.1E-01	8.81E+00	+/- 4.9E-01	1.05E+02	+/- 8.9E-01
-4.5	95-1494-O	4.85E+00	+/- 4.8E-01	7.73E+00	+/- 5.3E-01	9.05E+01	+/- 9.2E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: [signature]

Westinghouse Electric Corporation
REPORT — Chemistry Operations Technology & Analysis — Request# 15753
Waltz Mill Site

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/31/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10 / Cycle 11

Bead Chain Tag ID: 150 deg.

Feet from Midplane	Lab Sample#	[<------ dps/mg of chain @ 8/15/95					------>]
		Mn-54		Co-58		Co-60	
		dps/mg	2 sigma	dps/mg	2 sigma	dps/mg	2 sigma
+8.0	95-1485-A	5.12E-01 +/-	1.3E-01	8.88E-01 +/-	1.5E-01	4.49E+01 +/-	3.6E-01
+7.5	95-1485-B	7.54E-01 +/-	1.2E-01	1.30E+00 +/-	1.5E-01	5.11E+01 +/-	3.9E-01
+6.5	95-1485-C	1.84E+00 +/-	1.5E-01	3.06E+00 +/-	2.2E-01	6.46E+01 +/-	4.3E-01
+5.5	95-1485-D	3.61E+00 +/-	2.1E-01	5.71E+00 +/-	2.5E-01	7.55E+01 +/-	4.7E-01
+4.5	95-1485-E	5.34E+00 +/-	4.6E-01	7.99E+00 +/-	5.1E-01	8.80E+01 +/-	9.0E-01
+3.5	95-1485-F	6.08E+00 +/-	4.1E-01	1.01E+01 +/-	5.4E-01	9.96E+01 +/-	9.5E-01
+2.5	95-1485-G	7.03E+00 +/-	4.7E-01	1.01E+01 +/-	6.1E-01	1.08E+02 +/-	1.0E+00
+1.5	95-1485-H	6.62E+00 +/-	4.6E-01	1.03E+01 +/-	5.8E-01	1.15E+02 +/-	1.0E+00
+0.5	95-1485-I	7.03E+00 +/-	4.3E-01	1.02E+01 +/-	5.9E-01	1.20E+02 +/-	1.1E+00
0.0	95-1485-J	6.88E+00 +/-	5.7E-01	1.03E+01 +/-	5.8E-01	1.21E+02 +/-	1.1E+00
-0.5	95-1485-K	6.72E+00 +/-	5.2E-01	9.72E+00 +/-	5.8E-01	1.22E+02 +/-	1.1E+00
-1.5	95-1485-L	6.59E+00 +/-	5.3E-01	9.69E+00 +/-	5.7E-01	1.21E+02 +/-	1.1E+00
-2.5	95-1485-M	6.41E+00 +/-	5.3E-01	1.01E+01 +/-	6.6E-01	1.17E+02 +/-	1.1E+00
-3.5	95-1485-N	5.75E+00 +/-	5.3E-01	8.75E+00 +/-	5.7E-01	1.06E+02 +/-	1.0E+00
-4.5	95-1485-O	4.29E+00 +/-	5.3E-01	6.77E+00 +/-	6.1E-01	9.24E+01 +/-	9.4E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: M. Kandel

REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 8/31/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10 / Cycle 11

Bead Chain Tag ID: 210 deg.

Feet from Midplane	Lab Sample#	Mn-54 dps/mg	Mn-54 2 sigma	Co-58 dps/mg	Co-58 2 sigma	Co-60 dps/mg	Co-60 2 sigma
		[<---------------- dps/mg of chain @ 8/15/95 ---------------->]					
+8.0	95-1486-A	4.64E-01 +/-	1.5E-01	6.92E-01 +/-	1.4E-01	4.29E+01 +/-	3.6E-01
+7.5	95-1486-B	7.97E-01 +/-	1.7E-01	1.33E+00 +/-	1.7E-01	4.95E+01 +/-	3.9E-01
+6.5	95-1486-C	1.61E+00 +/-	2.0E-01	2.78E+00 +/-	2.3E-01	6.30E+01 +/-	4.4E-01
+5.5	95-1486-D	3.56E+00 +/-	2.0E-01	5.64E+00 +/-	2.7E-01	7.36E+01 +/-	4.6E-01
+4.5	95-1486-E	5.31E+00 +/-	4.0E-01	8.78E+00 +/-	5.1E-01	8.73E+01 +/-	8.9E-01
+3.5	95-1486-F	6.38E+00 +/-	4.2E-01	9.78E+00 +/-	4.9E-01	9.68E+01 +/-	9.5E-01
+2.5	95-1486-G	6.33E+00 +/-	4.4E-01	1.01E+01 +/-	5.0E-01	1.08E+02 +/-	9.8E-01
+1.5	95-1486-H	6.92E+00 +/-	4.7E-01	1.02E+01 +/-	5.8E-01	1.13E+02 +/-	1.0E+00
+0.5	95-1486-I	6.95E+00 +/-	5.3E-01	1.06E+01 +/-	6.2E-01	1.17E+02 +/-	1.0E+00
0.0	95-1486-J	7.55E+00 +/-	5.8E-01	1.05E+01 +/-	6.6E-01	1.18E+02 +/-	1.0E+00
-0.5	95-1486-K	6.90E+00 +/-	5.8E-01	1.04E+01 +/-	6.7E-01	1.19E+02 +/-	1.1E+00
-1.5	95-1486-L	6.96E+00 +/-	6.2E-01	1.02E+01 +/-	7.3E-01	1.17E+02 +/-	1.0E+00
-2.5	95-1486-M	6.54E+00 +/-	4.9E-01	1.00E+01 +/-	5.4E-01	1.12E+02 +/-	1.0E+00
-3.5	95-1486-N	5.49E+00 +/-	3.8E-01	8.42E+00 +/-	4.6E-01	1.02E+02 +/-	9.6E-01
-4.5	95-1486-O	4.32E+00 +/-	4.0E-01	6.91E+00 +/-	4.8E-01	8.51E+01 +/-	8.8E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: [signature]

REVISED REPORT

Westinghouse Electric Corporation
Chemistry Operations Technology & Analysis
Waltz Mill Site

Request# 15753

Originator: J. Perock (W)NTD, Energy Center (4-36)

Received: 6/29/95
Reported: 10/3/95

[RESULTS OF ANALYSIS]

Palisades Reactor Cavity Dosimetry - Cycle 10 / Cycle 11

Bead Chain Tag ID: 260 deg.

Feet from Midplane	Lab Sample#	[<---- dps/mg of chain @ 8/15/95 Mn-54 dps/mg	2 sigma	Co-58 dps/mg	2 sigma	Co-60 dps/mg ---->]	2 sigma
+8.0	95-1487-A	4.70E-01 +/-	1.4E-01	9.61E-01 +/-	1.7E-01	4.62E+01 +/-	3.7E-01
+7.5	95-1487-B	7.68E-01 +/-	1.3E-01	1.29E+00 +/-	1.7E-01	5.18E+01 +/-	3.9E-01
+6.5	95-1487-C	1.74E+00 +/-	1.9E-01	2.95E+00 +/-	2.3E-01	6.30E+01 +/-	4.3E-01
+5.5	95-1487-D	3.36E+00 +/-	1.8E-01	5.30E+00 +/-	2.2E-01	7.32E+01 +/-	4.7E-01
+4.5	95-1487-E	5.08E+00 +/-	4.6E-01	8.21E+00 +/-	5.4E-01	8.26E+01 +/-	8.8E-01
+3.5	95-1487-F	6.28E+00 +/-	5.0E-01	9.99E+00 +/-	5.4E-01	9.18E+01 +/-	9.3E-01
+2.5	95-1487-G	6.43E+00 +/-	4.7E-01	1.04E+01 +/-	5.5E-01	9.93E+01 +/-	9.7E-01
+1.5	95-1487-H	6.45E+00 +/-	4.7E-01	1.05E+01 +/-	6.7E-01	1.04E+02 +/-	9.9E-01
+0.5	95-1487-I	6.78E+00 +/-	5.7E-01	9.96E+00 +/-	6.6E-01	1.07E+02 +/-	1.0E+00
0.0	95-1487-J	6.52E+00 +/-	5.8E-01	1.03E+01 +/-	6.7E-01	1.08E+02 +/-	1.0E+00
-0.5	95-1487-K	6.77E+00 +/-	6.1E-01	1.04E+01 +/-	6.7E-01	1.10E+02 +/-	1.0E+00
-1.5	95-1487-L	6.90E+00 +/-	5.8E-01	1.07E+01 +/-	6.9E-01	1.07E+02 +/-	1.0E+00
-2.5	95-1487-M	6.11E+00 +/-	6.3E-01	9.72E+00 +/-	6.9E-01	1.03E+02 +/-	1.0E+00
-3.5	95-1487-N	5.40E+00 +/-	4.6E-01	8.54E+00 +/-	6.2E-01	9.44E+01 +/-	9.7E-01
-4.5	95-1487-O	3.82E+00 +/-	4.7E-01	6.64E+00 +/-	5.2E-01	8.04E+01 +/-	9.0E-01

Remarks: * Results are in units of dps/(mg of Dosimeter Material).
* Corrections of Co-58: 95-1487-J and 95-1487-L.

AL File: 15753
Procedures: A-524
Analyst: WTF

Approved: M. Kornhol

Customer	John Perock	AL Request #	15753

W NTD, Energy Center
win (8) 284-5788
fax (8) 284-4697

Receipt Date	JUN.29,1995
Report Date	DEC.11,1995

Nuclear Plant	Palisades - cycle #10	
Material Description	Stainless steel	Dosimetry Reactor Chain Beads

AL Service #	W NTD Identification Chain	Location	Weight Percent (%) Fe	Ni	Co
95- 1483	S-3	30	69.82	9.44	0.18
1484	S-3	90	69.83	9.43	0.18
1485	S-3	150	69.83	9.45	0.18
1486	S-3	210	71.49	9.45	0.18
1487	S-3	260	69.59	9.51	0.19
1488	S-3	270	69.97	9.28	0.18
1489	S-3	280	69.89	9.40	0.17
1490	S-3	290	69.91	9.37	0.18
1491	S-3	300	70.05	9.29	0.18
1492	S-3	315	69.83	9.38	0.18
1493	S-3	330	70.13	9.25	0.18
1494	S-3	340	70.03	9.39	0.18
		Average	70.03	9.39	0.18
		std dev	0.48	0.08	0.00
		% RSD	0.69	0.84	2.37

Method of Analysis		Operator	File
Metals	ICPS	R.W.MCKINNY	15753

Approved by *Lawrence Becker*
Lawrence Becker