NOTE TO: DOCUMENT CONTROL DESK 3/17/00

From: William R. Jones, RES, 415-7558

RE: Attached Document for Inclusion in the Document Control System

This document was received from outside the agency. It is an old document which has had an updated "Forward." It came to me by express mail. It should be put into the current system and **made publicly available**.

The Research file code/category is **RES-1B-1**.

Please call me if there is a problem. **Thanks for your help**.

F03

Add: William
Jones
T10E-10

TECHNICAL REPORT
JCN W-6968-9

DRAFT REGULATORY GUIDE DG-1053

CALCULATIONAL AND DOSIMETRY METHODS FOR DETERMINING PRESSURE VESSEL NEUTRON FLUENCE

RESOLUTION OF COMMENTS DOCUMENT

John Carew

Department of Energy Sciences and Technology, Brookhaven National Laboratory
Upton, New York 11973-5000

BROOKHAVEN NATIONAL LABORATORY

Prepared for the U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Contract No. DE-AC02-98CH10886

TECHNICAL REPORT
JCN W-6968-9

DRAFT REGULATORY GUIDE DG-1053

CALCULATIONAL AND DOSIMETRY METHODS FOR DETERMINING PRESSURE VESSEL NEUTRON FLUENCE

RESOLUTION OF COMMENTS DOCUMENT

John Carew

Department of Energy Sciences and Technology, Brookhaven National Laboratory
Upton, New York 11973-5000

Prepared for the U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Contract No. DE-AC02-98CH10886

FOREWORD

This report was originally written in 1997 to document stakeholder comments on Draft Regulatory Guide DG-1053 (formerly Draft Regulatory Guide DG-1025). It also documented the basis for NRC resolution and disposition of these comments. The report addressed comments on both Draft Regulatory Guide DG-1025, issued September 1993, and on the subsequent update, Draft Regulatory Guide DG-1053, issued June 1966.

This document was initially intended as an internal NRC document and had not been previously released to the public. However, at the public meeting in September 1999, discussing the Draft Regulatory Guide, NRC stated that documentation of previous comment resolution would be provided to the public to assist stakeholders in reviewing the current version of the Draft Regulatory Guide and providing comments. Since this document had been prepared and conveyed the technical content of the previous comments and the bases for their disposition, it is being made publically available with a minimum of changes and associated effort. Minor changes have been made for clarity, conciseness, and consistency.

ACKNOWLEDGMENTS

The work documented in this report was performed under the auspices of the United States Nuclear Regulatory Commission (USNRC). It was funded by the Electrical, Materials, and Mechanical Engineering Branch of the Division of Engineering Technology, in the Office of Nuclear Regulatory Research, under JCN A-3954. The program was monitored at the USNRC by C. Fairbanks, whose support of this work is greatly appreciated. The authors are also grateful to Mike Mayfield of the Office of Nuclear Regulatory Research for many valuable discussions and contributions to this work.

Special thanks are also due to Mrs. B. A. Kponou, who helped prepare this report.

CONTENTS

RESOLUTION OF COMMENTS DOCUMENT

REGULATORY GUIDE DG-1053

I. INTRODUCTION

Draft Regulatory Guide DG-1053 , "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence,"dated June 1996, has been issued for public comment by the NRC Office of Nuclear Regulatory Research. The comments received by the NRC on Regulatory Guide DG-1053 (and the earlier version DG-1025, dated September 1993) are included in References 1-11, and have been reviewed and evaluated for possible inclusion in the guide. The evaluation was performed by a team of experts from the Brookhaven National Laboratory, National Institute of Standards and Technology, and Oak Ridge National Laboratory, lead by the NRC.

The comments include editorial changes, suggestions for reorganization to improve clarity, and recommendations to both relax and tighten requirements. The criteria used to evaluate the comments included: (1) consistency with the purpose and scope of the guide, (2) information included must be a significant part of the fluence determination, (3) consistency with presently accepted methods should be maintained, and (4) the level of detail should not be overly prescriptive and should allow sufficient freedom to apply the engineering judgement required to resolve unanticipated plant-specific problems. The response and decision for each comment are provided in this document. The response and decision for each comment, which reflect a team consensus, were recommended to the NRC.

The comments from each reviewer/organization and their resolution have been collected into a single section and are summarized in the following. For each comment, a brief comment summary together with the response and action decision is provided.

II. BALTIMORE GAS AND ELECTRIC

The following are the resolutions to the comments on DG-1025 provided by Baltimore Gas and Electric in Reference 1.

II.1.1 Comment ID: Reference-1, pg-1, second paragraph.

II.1.2 Comment: It is not clear how DG-1025[1] is to be applied when existing surveillance capsule dosimetry is analyzed and how this compares to the situation in which new dosimetry materials or configurations are analyzed.

II.1.3 Response: DG-1025 explains that, as capsule and cavity measurements become available, the new measurement results should be incorporated into the operating reactor measurements data base and used in the calculation-to-measurement comparisons. These comparisons should be used to update the calculational biases and uncertainties as necessary (DG-1025, pg-19, l-23).

DG-1025 states that comparisons of measurements and calculations should be performed for the specific reactor being analyzed or for reactors of similar design (DG-1025, pg-19, l-6). If the new configuration or materials are not of a similar design, the calculation-to-measurement comparisons should be used with reduced weight in determining the calculational bias and uncertainties.

II.1.4 Decision: No changes are required.

II.2.1 Comment ID: Reference-1, pg-1, second paragraph.

II.2.2 Comment: The DG needs process flow charts that clearly define: (1) what must be done in the analysis of each surveillance capsule; (2) what must be done to qualify/calibrate new dosimeters; and (3) what must be done to validate analytical models.

II.2.3 Response: Process flow charts have been added to describe the procedure for validating the calculational methodology and the procedure for qualifying new dosimeters. The logic and method for performing the detector response measurements are well documented in

[1]DG-1025 is the initial version of DG-1053.

Section-2.1.2 of DG-1025 and in the referenced standards. The method for determining the fluence from the measurements is also well described in Section-2.3 of DG-1025.

II.2.4 Decision: Selected Flow Diagrams have been added.

II.3.1 Comment ID: Reference-1, pg-2, first paragraph.

II.3.2 Comment: The trend curves of 10 CFR 50.61 and Regulatory Guide 1.99, Revision-2 provide estimates of the embrittlement of vessel materials at near end-of-life fluences and, therefore, absolute values of the vessel fluence are not required.

II.3.3 Response: The absolute value of the vessel fluence is required as input to these correlations in order to determine the vessel-specific state of the embrittlement.

II.3.4 Decision: No changes are required.

II.4.1 Comment ID: Reference-1, pg-2, second paragraph.

II.4.2 Comment: It is questionable that an immediate need exists to switch to ENDF/B-VI cross-sections for surveillance capsule and vessel fluence analysis. There is little iron between surveillance capsule coupons and the vessel wall; hence there should be little difference between embrittlement predictions made with ENDF/B-IV based fluences and trend curves, and those made with ENDF/B-VI based fluences and trend curves.

II.4.3 Response: The DG-1025 methodology requires an absolute calculation of the vessel fluences, rather than a simple extrapolation of the capsule fluence, and is therefore affected by the ENDF/B-IV-to-ENDFB-VI differences in the iron cross-sections of the iron regions between the core and the vessel (viz., core baffle, barrel and thermal shield). Therefore, DG-1025 recommends that the effect of the ENDF/B-IV-to-ENDF/B-VI cross-section change be evaluated and the fluence estimates updated when the effects are significant.

II.4.4 Decision: No changes are required.

II.5.1 Comment ID: Reference-1, pg-2, second paragraph.

II.5.2 Comment: The complete ENDF/B-VI based surveillance results must be used to revise the trend curves of 10 CFR 50.61 and Regulatory Guide 1.99, Revision 2 before ENDF/B-VI

fluence values are required for the calculation of pressurized thermal shock Reference temperatures (RT_{PTS}).

II.5.3 Response: The revision of the trend curves is outside the scope of DG-1025.

II.5.4 Decision: No change is required.

II.6.1 Comment ID: Reference-1, pg-2, third paragraph.

II.6.2 Comment: DG-1025 should provide guidance as to when vessel through-wall fluence calculations based on ENDF/B-VI cross-sections should take precedence over the displacement-per-atom-based attenuation correlation of Regulatory Guide 1.99, Revision 2.

II.6.3 Response: DG-1025 is not intended to replace Regulatory Guide 1.99, Revision 2 and additional clarification to this effect has been added to DG-1025 on pg-12, l-12.

II.6.4 Decision: Additional clarification has been added.

II.7.1 Comment ID: Reference-1, pg-2, third paragraph.

II.7.2 Comment: The benefits-analysis appears to credit the use of reduced uncertainties in determining RT_{PTS}. Currently, 10 CFR 50.61 specifies the use of the best estimate fluence and does not provide for reduction in uncertainties.

II.7.3 Response: When performing Probabilistic Risk Assessment (PRA) evaluations such as those described in Regulatory Guide 1.154, an explicit uncertainty term is required in addition to the best estimate fluence values. In this case it is permissible to use the fluence uncertainty determined per this guide. This clarification has been added to DG-1025 on pg-5, l-11.

II.7.4 Decision: Additional clarification has been added.

III. COMMENTS by R. GOLD

The following are the resolutions to the comments on DG-1025 provided by R. Gold in Reference 2.

III.1.1 Comment ID: Reference-2, pg-3.

III.1.2 Comment: The PCA comparisons indicate no better than a factor of two in vessel fluence prediction accuracy.

III.1.3 Response: Calculation-to-measurement comparisons made across the industry indicate that vessel fluence calculations made with the methodology of DG-1025 will result in a prediction accuracy of ~20% (e.g., Reference-35 of DG-1025).

III.1.4 Decision: No change is required.

III.2.1 Comment ID: Reference-2, pgs. 3-5.

III.2.2 Comment: The fluence calculation is sensitive to the modeling input assumptions and data. Consequently, the predicted fluence typically includes a substantial degree of uncertainty. The sources of uncertainty include: (1) the core power history and the assembly power distribution, (2) the basic cross-section data, (3) the fission spectrum, (4) the effects of the cross-section group structure on the modeling of the iron resonances and the calculation of the Np^{237} threshold reaction.

III.2.3 Response: DG-1025 identifies these and other sources of calculational uncertainty and requires an explicit uncertainty analysis in order to quantify the effects of the important calculational uncertainties.

III.2.4 Decision: No change is required.

III.3.1 Comment ID: Reference-2, pg-7.

III.3.2 Comment: The agreement with the benchmark measurement required by DG-1025 is necessary but not sufficient for qualification of the calculation methodology.

III.3.3 Response: DG-1025 recognizes that agreement with a benchmark measurement alone does not ensure an accurate calculation and, consequently, requires comparisons with three distinct benchmarks as well as an analytic uncertainty analysis.

III.3.4 Decision: No change is required.

III.4.1 Comment ID: Reference-2, pg-7.

III.4.2 Comment: The observed calculation-to-measurement bias may be due to a combination of several offsetting effects, rather than a single approximation. This will make the identification and elimination of the bias more difficult.

III.4.3 Response: In the case in which several substantial and offsetting approximations are made, the identification and elimination of the individual effects are more difficult. However, in this case the individual approximations made in the calculations should be evaluated in the analytic uncertainty analysis. While the application of the DG-1025 methodology becomes more difficult when many approximations are made, the methodology is still valid.

III.4.4 Decision: No change is necessary.

III.5.1 Comment ID: Reference-2, pg. 7.

III.5.2 Comment: The calculation-to-measurement bias determined for a specific benchmark may not be directly applicable to the vessel configuration being analyzed.

III.5.3 Response: DG-1025 recognizes that the observed bias may be dependent on the specific benchmark and, therefore, requires that three distinct benchmark comparisons be made. In addition, in order to minimize the possibility of introducing a bias that does not apply to the vessel being analyzed, it is required that one of these benchmarks be a plant of similar design.

III.5.4 Decision: No change is required.

III.6.1 Comment ID: Reference-2, pg-8.

III.6.2 Comment: The least-squares adjustment codes should be used for combining the measured and calculated results.

III.6.3 Response: DG-1025 allows, but does not require, the use of adjustment codes for the spectrum unfolding of the dosimetry measurements and for determining the calculational bias.

III.6.4 Decision: No change is required.

III.7.1 Comment ID: Reference-2, pg-8.

III.7.2 Comment: The fluence scale (i.e., the normalization) should be determined by measurement and the extrapolation to unmeasured locations of interest should be made using a calculation.

III.7.3 Response: Because of the limited number and accuracy of plant-specific fluence measurements, DG-1025 requires that the fluence prediction be made with an absolute or direct calculation which begins with a determination of the neutron source in the core and propagates the source to the vessel using a transport calculation. The measurements are used to validate and benchmark the calculation. In the case where the number and quality of the fluence measurements allow the determination of an accurate calculational bias, the bias may be applied directly to the predicted fluence.

III.7.4 Decision: No change is required.

IV. CONSUMERS POWER

The following are the resolutions to the comments on DG-1025 provided by Consumers Power in Reference 3.

IV.1.1 Comment ID: Comment-1.

IV.1.2 Comment: Since the accumulated exposure at the end of cycle is used to estimate the neutron source distribution, it may be more accurate to use the accumulated cycle energy distribution database.

IV.1.3 Response: DG-1025 recommends that the accumulated energy distribution (based on the operating power distribution) be used for determining the core neutron source. However, DG-1025 also allows the use of the exposure distribution to determine the core neutron source when it is a good approximation of the cycle-average assembly power distribution (DG-1025, pg-8, ls 17-24 and pg-9, ls 6-21). Therefore, this suggestion is already included in DG-1025.

IV.1.4 Decision: No change is required.

IV.2.1 Comment ID: Comment-2.

IV.2.2 Comment: DG-1025 allows the use of an (r,θ) and (r,z) synthesis to determine the three-dimensional vessel fluence distribution. It may be better to use the nodal axial peaking factor database as the axial correction factor, because it may be more adequate and conservative.

IV.2.3 Response: As suggested, Equation (2) of DG-1025 allows the use of the core nodal power distribution to determine the axial source shape of the peripheral fuel assemblies that have the greatest influence on the vessel location of interest. It is important to note, however, that this approximation neglects the flattening of the axial fluence shape as it propagates from the core to the vessel and (as indicated in DG-1025, pg-13, ls 14-22) may be nonconservative in certain situations. In order to provide a best-estimate calculation in these situations, DG-1025 also provides the Equation (3) synthesis approach which accounts for the change in the fluence axial shape between the core and the vessel. Therefore, this suggestion is already included in DG-1025.

IV.2.4 Decision: No change is required.

IV.3.1 Comment ID: Comment-3.

IV.3.2 Comment: If a licensee does not use this regulatory guide to determine the pressure vessel fluence, will the NRC evaluate the submittal against the requirements and guidance of DG-1025.

IV.3.3 Response: A licensee submittal that does not use the methodology provided in this guide will be evaluated on its own merits. However, DG-1025 identifies many of the important issues involved in vessel fluence analyses and it is expected that these would be addressed in the submittal.

IV.3.4 Decision: No change is required.

IV.4.1 Comment ID: Comment-4.

IV.4.2 Comment: Does DG-1025 allow the use of more than 80 azimuthal nodes?

IV.4.3 Response: The wording in DG-1025 unintentionally implied that the number of azimuthal nodes was limited to 80. However, no limit was intended and the wording has been changed to allow more than 80 azimuthal nodes when necessary.

IV.4.4 Decision: The wording in DG-1025 has been changed (pg-9, l-29).

IV.5.1 Comment ID: Comment-5.

IV.5.2 Comment: In the modeling of the core geometry in the (r, θ) model, it is more important to approximate the assembly power to within ~0.5% than to represent the assembly area to within ~0.5%.

IV.5.3 Response: In the DG-1025 methodology, since the approximation is made in the (r,θ) representation of the square assembly geometry, the accuracy criterion is stated in terms of the actual quantity being approximated, i.e., to within ~0.5% in the assembly area. It should be noted, however, that since the total assembly power is assigned to the (r,θ) assembly area, the average source density in the assembly (r,θ) region is approximated to within ~0.5%.

IV.5.4 Decision: No change is required.

IV.6.1 Comment ID: Comment-6.

IV.6.2 Comment: When determining the peak vessel fluence the octant with the maximum fluence should be represented. When evaluating dosimetry the octant closest to the dosimetry should be represented.

IV.6.3 Response: The selection of the octant to be modeled when evaluating the dosimetry was not included in DG-1025 but has now been added.

IV.6.4 Decision: Additional clarification has been added (DG-1025, pg-9, l-27).

IV.7.1 Comment ID: Comment-7.

IV.7.2 Comment: The DG-1025 synthesis procedure of Equation (4) should be generalized to allow any axial shape.

IV.7.3 Response: The specific synthesis procedure defined by Equation (4) has been extensively tested and validated. The general prescription proposed in this comment has not been validated.

IV.7.4 Decision: No change is required.

IV.8.1 Comment ID: Comment-8.

IV.8.2 Comment: (a) On pg-15 (ls 21-24),[2] it is implied that the biases and uncertainties should be combined together.

(b) On pg-17 (ls 31-35), it is implied that an adjustment should be made if the uncertainty (not the algebraic sum or bias) is > 20%, in order to bring the agreement within this range.

IV.8.3 Response: (a) DG-1025 states that the systematic errors (or biases) should be combined algebraically, recognizing the sign of each contribution. These errors are systematic and affect the fluence prediction in a specific direction (i.e., increase or decrease the estimate). Consequently, when these errors (or biases) are applied the signs (or directions) must be recognized and they must be combined algebraically.

[2]The DG-1025 locations referenced in the Comment Sections of this report refer to locations in the DG-1025 draft dated September 1993 which was issued for public comment.

DG-1025 also states that the independent random uncertainties should be combined in a statistical or root-sum-of-the-squares fashion. The independent random uncertainties have no specific direction (i.e., an increase or decrease) associated with them, and they are combined without recognizing a specific sign.

DG-1025 does not suggest that the uncertainties and systematic errors (or biases) should be combined. The uncertainties are an indication of the accuracy of the fluence prediction and are typically quoted along with estimate, and the systematic error (or bias) is a correction that may be applied directly to the fluence prediction.

(b) The known systematic errors (or biases) should be applied to the fluence prediction in order to determine the best-estimate fluence value. In PTS applications, if the uncertainty in this best-estimate fluence (determined using the qualification procedures of Section-1.4) is > 20% then either the cause of this large uncertainty must be identified and the model corrected or a correction must be applied directly to the best-estimate value to bring the agreement within this range. DG-1025 does not suggest that the algebraic sum is to be compared with the 20% criteria.

IV.8.4 Decision: While no specific changes are required, the text on pg-21, ls 3-7 has been clarified.

IV.9.1 Comment ID: Comment-9.

IV.9.2 Comment: Additional explanation of the available calculational benchmark problem should be provided.

IV.9.3 Response: The calculational benchmark problem is described in detail in the Reference-27 report NUREG/CR-6115 (BNL NUREG-52395) which has been issued in draft form.

IV.9.4 Decision: No change is required.

IV.10.1 Comment ID: Comment-10.

IV.10.2 Comment: DG-1025 does not provide guidance on what the NRC considers as "sufficient quality and quantity" in the statement "when the measurement data is of sufficient quality and quantity, the comparisons to measurement may be used to determine any calculational bias and, if appropriate, adjust the fluence predictions."

IV.10.3 Response: The adequacy of the database for determining a bias in the calculations depends on the magnitude of the bias and is therefore problem dependent. For example, if the bias is small an accurate estimate of the bias will require either (1) a large number of reasonably accurate measurements or (2) a small number of very accurate measurements. It is not the purpose of DG-1025 to provide specific procedures for qualifying the measurement database. These procedures are well established and may be found in standard statistical references.

However, in order to provide some general guidance it has now been added that the measurement data should be of sufficient quality and quantity to allow a reliable estimate of the calculational bias and represent a statistically significant measurement database (pg-3, l-18).

IV.10.4 Decision: Additional clarification has been added (pg-3, l-18).

IV.11.1 Comment ID: Comment-11.

IV.11.2 Comment: The footnote should be clarified (pg-4, l-30).

IV.11.3 Response: The footnote is not necessary and has been deleted.

IV.11.4 Decision: The text has been modified.

IV.12.1 Comment ID: Comment-12.

IV.12.2 Comment: DG-1025 requires additional qualification for the use of the S_8 quadrature in the case of narrow cavities. However, wide cavities may also require additional qualification.

IV.12.3 Response: The streaming effects are the primary concern with the use of the S_8 quadrature in the cavity calculation. The S_8 quadrature has been shown to be adequate for the case of wide cavities, but for narrow cavities where streaming effects are more important and the S_8 quadrature may not provide adequate coverage and additional qualification is required.

IV.12.4 Decision: No change is required.

IV.13.1 Comment ID: Comment-13.

IV.13.2 Comment: A reference to an available multigroup ENDF/B-VI cross-section library should be added.

IV.13.3 Response: A reference to the recently released BUGLE-93 ENDF/B-VI cross-section library has been added to DG-1025 (pg-7, l-31).

IV.13.4 Decision: The reference has been added.

V. NUCLEAR MANAGEMENT AND RESOURCES COUNCIL

The following are the resolutions to the comments on DG-1025 provided by Nuclear Management and Resources Council in Reference 4.

V.1.1 Comment ID: Enclosure-2, Comment-1.

V.1.2 Comment: A NUREG report should be provided that includes: (1) a detailed example of the analysis of a PWR following the methods of DG-1025, (2) an example of the qualification of the methodology, (3) an example of the qualification of the dosimetry, and (4) the use of the best-estimate fluence in the calculation of RT_{PTS}.

V.1.3 Response: (a) The NUREG/CR-6115 report (Reference-27 in DG-1025), which has been issued in draft form, includes a detailed calculation of the vessel fluence for a typical PWR using the methods of DG-1025. The report defines a set of benchmark problems and provides the reference solutions. The NUREG/CR-6115 analysis includes the calculation of the vessel fluence as well as the response of a complete set of dosimeters.

(b) The plant analyzed is generic in the sense that it includes many important features that are generally not found in a single plant; for example, (1) a standard core loading, (2) a low-leakage core loading and (3) a partial-length-shield-assembly core loading are all included. Consequently, since the configuration analyzed does not correspond to an actual plant, dosimeter measurements are not available for benchmarking and methods qualification. However, References-2, 3, 4, 31, 35 and 36 of DG-1025 provide sufficient examples of the comparisons to measurement used in the methods qualification.

(c) The qualification of the dosimetry requires a periodic validation in a reference field and an uncertainty analysis of the dosimetry measurements. References 62 and 63 of DG-1025 provide the necessary guidance on the reference field validation. Additional guidance on the identification of the sources of measurement uncertainty has been added to DG-1025 (pg-25, l-28). This additional information together with the available ASTM standards provides sufficient guidance to perform the dosimeter uncertainty analysis.

(d) The use of the best-estimate fluence in the calculation of RT_{PTS} is sufficiently straightforward that the guidance provided in 10 CFR 50.61 and in Regulatory Guide 1.99,

Revision 2 is considered adequate, and additional guidance in a NUREG is neither needed nor appropriate.

V.1.4 Decision: The NUREG/CR-6115 report has been issued in draft form. The DG-1025 text has been revised to include additional guidance on the qualification of the dosimeter measurements (DG-1025, pg-25, l-28).

V.2.1 Comment ID: Enclosure-2, Comment-2.

V.2.2 Comment: DG-1025 should include less-prescriptive fluence methods for the situation in which a technical rationale indicates that the embrittlement limits cannot be exceeded

V.2.3 Response: Less prescriptive fluence methods can be developed for this situation, however, these methods are not presently available and will require a qualification and uncertainty evaluation before they can be recommended in DG-1025.

V.2.4 Decision: No change is required.

V.3.1 Comment ID: Enclosure-2, Comment-3.

V.3.2 Comment: DG-1025 should be made more user-friendly by using consistent terminology and the flow diagrams of Attachment-A. Also, guidelines on acceptable engineering judgement should be provided.

V.3.3 Response: The uncertainty and bias terminology has been clarified and made more consistent. The flow diagrams of Figures 1-3 describing: (1) the calculation methodology, (2) the methods qualification and (3) the measurement qualification procedures have also been added.

The detailed engineering judgement that is used in the application of DG-1025 is to a large extent application-specific and has been deliberately minimized in order to avoid making the guide overly prescriptive, and to allow the licensee the freedom necessary to optimize the application of the DG-1025 methods to his specific problem. Additional guidance on engineering judgement is considered outside the scope of the guide.

V.3.4 Decision: Selected changes in the text have been made, in order to make the terminology more consistent, and methods and qualification flow diagrams have been added.

V.4.1 Comment ID: Enclosure-2, Comment-4.

V.4.2 Comment: The estimates of the level of effort required to implement the methodology of the guide should be made more realistic.

V.4.3 Response: The estimates of the additional effort required to implement DG-1025 assume that the methods currently being used are close to state-of-the-art and include: (1) reliable and relatively complete plant data, (2) a standard multigroup cross-section library, (3) accepted computer codes, (4) a detailed plant model and (5) several benchmark comparisons (e.g., the ORNL PCA and plant-specific measurements). It is therefore expected that the modifications to the existing models will not be extensive and may only involve modifications to the source and the use of an ENDF/B-VI cross-section library. The qualification will require an uncertainty analysis, if not already included, and some updating of the benchmark comparisons necessitated by the changes in the models. These changes have been estimated to require ~15 staff weeks of effort. The additional licensee measurement costs assume that the dosimetry is currently being installed in the reactor, and does not apply to presently installed dosimetry. The additional tasks involve quality control, response corrections, calibration, uncertainty analysis, and documentation. The cost estimates assume that the measurement methods presently being used are close to state-of-the-art and experienced staff, familiar with the codes and methods presently being used, will be updating the methodology.

It is recognized that in cases where the current methods require extensive modifications to bring them to state-of-the-art, the effort to implement DG-1025 may exceed the estimates made in the Regulatory Analysis.

V.4.4 Decision: No change is required.

V.5.1 Comment ID: Enclosure-2, Comment-5.

V.5.2 Comment: The wording in DG-1025 appears to suggest a new uncertainty term in the calculation of RT_{PTS}.

V.5.3 Response: The wording has been changed to indicate that in 10 CFR 50.61 the uncertainty (e.g., from uncertainty in the fluence, chemistry factor, or shift correlation) has been included separately in the margin term.

V.5.4 Decision: The text has been changed (pg-3, l-1).

V.6.1 Comment ID: Enclosure-2, Comment-6.

V.6.2 Comment: Further technical basis should be provided to justify the need for the analytic uncertainty analysis.

V.6.3 Response: The analytic uncertainty analysis is required because the benchmarks alone typically do not provide an accurate indication of the prediction uncertainty. The simulator benchmarks are generally accurate measurements but do not represent the actual plant configuration. The plant measurements, on the other hand, represent the actual configuration but typically include substantial uncertainties. The calculational benchmarks provide accurate solutions and a good test of the modeling, computer codes and numerical procedures, but do not provide an indication of the plant as-built variability. The analytic uncertainty analysis, based on the actual plant configuration and estimates of the as-built variability and the modeling, code and numerical uncertainties, provides an independent indication of the fluence prediction uncertainty. In view of the limitations of the benchmark comparisons, the analytic uncertainty analysis is considered to be a required part of the qualification procedure.

V.6.4 Decision: No change is required.

V.7.1 Comment ID: Enclosure-2, Comment-7.

V.7.2 Comment: The DG-1025 text should be changed to relax the requirements that: (a) the fluence be based on an absolute fluence calculation, rather than a simple spatial extrapolation of the surveillance capsule measurements (pg-4, l-2) and (b) the calculation must be benchmarked to measurements for similar reactor geometries (pg-19, l-8).

V.7.3 Response: (a) Because of the limited number and accuracy of plant-specific fluence measurements, DG-1025 requires that the fluence prediction be made with an absolute or direct calculation which starts with a determination of the neutron source in the core and propagates the source to the vessel using a transport calculation. The measurements are used to validate and benchmark the calculation. In the case where the number and quality of the fluence measurements allow the determination of an accurate calculational bias, the bias may be applied directly to the predicted fluence.

(b) DG-1025 states that the benchmarking to measurements should be performed for the specific reactor being analyzed or a reactor of similar design. DG-1025 uses the word should rather than must to allow for situations where special circumstances (for example, when no reliable measurements are available) make it impossible to benchmark to the specific reactor or to a reactor of similar design. It is expected, however, that these situations will be very infrequent.

V.7.4 Decision: No change is required.

V.8.1 Comment ID: Enclosure-2, Comment-8.

V.8.2 Comment: (a) The use of the expressions uncertainty and bias should be checked for consistency with the definitions given or referenced in the guide.

(b) The definitions relating to uncertainty given in Footnote-1 should be removed and replaced with the definitions given in the ASTM Standard E-170.

(c) A simple and precise notation for the uncertainty parameters should be adopted.

(d) On pg-17, l-19, remove the word uncertainty.

(e) On pg-17, l-33, replace the word uncertainty with differences.

(f) On pg-17 l-23, replace the word uncertainty with precision.

(g) On pg-3, l-12, delete the statement implying that the calculational uncertainty is determined from the comparisons to measurement.

V.8.3 Response: (a) The use of these expressions in the guide has been reviewed and selected changes have been made (pg-3, l-22; pg-17, l-5; pg-17, l-6; pg-17, l-8; pg-17, l-19; pg-18, l-18; pg-20, l-30; pg-25, l-27; pg-25, l-32; pg-25, l-33).

(b) Footnote-1 has been removed and replaced with the Reference-1 and Reference-34 comprehensive uncertainty reports.

(c) A notation similar to that used in the Reference-4, Attachment-2 flow diagrams has been adopted in the DG-1025 flow diagrams and text (Figures 2-3; pg-18, l-17; pg-17, ls-4, 10; pg-20, ls-30, 32 and 33).

(d) The word uncertainty on pg-17, l-19 has been removed.

(e) The word uncertainty on pg-28, l-27 has been replaced with differences.

(f) The word uncertainty is consistent with the definitions being used in the guide.

(g) This statement is appropriate since the calculation-to-measurement benchmark comparisons will be used to estimate the calculational uncertainty.

V.8.4 Decision: Selected changes (indicated in Section-V.8.3) have been made to the text and flow diagrams.

V.9.1 Comment ID: Enclosure-2, Comment-9

V.9.2 Comment: The basis for the 20% limit on calculational uncertainty is not provided in DG-1025.

V.9.3 Response: The 20% limit on calculational uncertainty is based on the analysis supporting 10 CFR 50.61 and Regulatory Guide 1.99. The determination of this limit and the basis for this value is outside the scope of DG-1025.

V.9.4 Decision: No change is required.

V.10.1 Comment ID: Enclosure-2, Comment-1.

V.10.2 Comment: During the December 9, 1993 public meeting on DG-1025, the NRC indicated that it would be acceptable to use a calculational uncertainty less than 20% in certain situations (e.g., in a Regulatory Guide 1.154 analysis).

V.10.3 Response: DG-1025 has been revised to allow the use of the fluence uncertainty, estimated using the methods of DG-1025, in probabilistic risk analyses such as those described in Regulatory Guide 1.154 (pg-5, l-11). The NEI (Reference-5) version of the additional text provided under this comment has also been incorporated in DG-1025 (pg-4, ls 23-34).

V.10.4 Decision: The recommended changes have been incorporated.

V.11.1 Comment ID: Enclosure-2, Comment-11.

V.11.2 Comment: DG-1025 would be more precise if the term "measured data" was replaced with "as-built materials data."

V.11.3 Response: DG-1025 has been revised to use the term "as-built materials data" (pg-6, l-1).

V.11.4 Decision: The DG-1025 text has been revised.

V.12.1 Comment ID: Enclosure-2, Comment-12.

V.12.2 Comment: (a) Footnote-3 suggests that the effect of the ENDF/B-VI cross-sections is to increase the inner-wall (cavity) fluence by ~20% (35%) relative to ENDF/B-V. The actual increase is believed to be smaller.

(b) The fluence estimates should not require updating unless the effect of the cross-section change is significant.

V.12.3 Response: (a) The exact increase in the fluence depends on the specific configuration being analyzed, and the approximate sign " ~ " is included for this purpose. This statement is intended as a general note of caution and does not suggest that these values apply to a specific application. The text has been modified to further reduce the emphasis on the specific values (pg-6, l-32).

(b) The text has been changed to indicate that the fluence estimates only need to be updated if the effect of the reevaluated cross-sections is significant (pg-6, l-23 and pg-33, l-18).

V.12.4 Decision: The text has been changed.

V.13.1 Comment ID: Enclosure-2, Comment-13.

V.13.2 Comment: The term "core follow calculations" should be clarified.

V.13.3 Response: The text changes recommended in this comment have been adopted (pg-8, l-11).

V.13.4 Decision: The text has been changed.

V.14.1 Comment ID: Enclosure-2, Comment-14.

V.14.2 Comment: The recommendation of the use of fine-mesh quarter-core calculations for determining the core neutron source is too prescriptive.

V.14.3 Response: This recommendation has been expanded and adopted to allow either depletion calculations or measured data (pg-8, l-11).

V.14.4 Decision: The text has been changed.

V.15.1 Comment ID: Enclosure-2, Comment-15.

V.15.2 Comment: Does the reference to changes in isotopic fission fraction refer to Pu "burning"?

V.15.3 Response: The changes in isotopic fission fraction are a result of the build-up of Pu, and the text has been revised to indicate this (pg-9, l-9).

V.15.4 Decision: The text has been changed.

V.16.1 Comment ID: Enclosure-2, Comment-16.

V.16.2 Comment: (a) The statement on pg-28 appears to be a replacement for the fluence attenuation formula of Regulatory Guide 1.99.

(b) The discussion concerning the spectral lead factor in the text (pg-10, l-34) and in Table-1 (pg-28, l-8) appear to be inconsistent.

(c) The discussion on pg-10 , l-34 appears to suggest a direct adjustment of ΔRT_{NDT} rather than an adjustment of the fluence. Also, no basis is provided for the direct adjustment of ΔRT_{NDT}.

V.16.3 Response: (a) As recommended in the comment, DG-1025 has been revised to indicate that the spectral lead factor is not a replacement for Regulatory Guide 1.99 (pg-12, l-12).

(b) The referenced discussions in the text and in Table-1 have been revised and are now identical.

(c) The wording has been changed to indicate that the spectral lead factor adjustment is to be made to the fluence (pg-12, l-12).

V.16.4 Decision: Selected revisions have been made in the text.

V.17.1 Comment ID: Enclosure-2, Comment-17.

V.17.2 Comment: The extrapolation of the fluence from the surveillance capsule to the vessel inner-wall and vessel internal locations appears to be inconsistent with the DG-1025 requirement to perform absolute fluence calculations rather than extrapolations of surveillance capsule fluence measurements

V.17.3 Response: The extrapolation referred to on pg-10, l-34 is a result of the fact that the ΔRT_{NDT} measurements are made at the surveillance capsule locations and must be extrapolated to the locations of interest inside the vessel. Consequently, in the application of the ΔRT_{NDT} correlation, Regulatory Guide 1.99 requires an extrapolation of ΔRT_{NDT} and the fluence from the vessel inner-wall to the vessel internal locations. DG-1025 requires that the fluence at the vessel inner-wall be determined with an absolute fluence calculation. In addition, in order to account for spectrum changes between the inner-wall and vessel internal locations, DG-1025 requires that a fluence lead factor be applied to the fluence at the vessel internal locations. This lead factor has been included in the Regulatory Guide 1.99 (Equation (3)) attenuation formula and, therefore, is not required when this formula is used. However, when this attenuation formula is not used the spectral lead factor must be applied.

V.17.4 Decision: The DG-1025 text has been revised to further explain the application of the spectral lead factor (pg-12, l-8).

V.18.1 Comment ID: Enclosure-2, Comment-18.

V.18.2 Comment: The word "scattering" should be added between "inelastic" and "cross-section" (pg-13, l-15).

V.18.3 Response: The text has been revised to include this suggestion (pg-14, l-27).

V.18.4 Decision: The text has been changed.

V.19.1 Comment ID: Enclosure-2, Comment-19.

V.19.2 Comment: (a) The reference to "support structures" should be deleted since the scope of the guide includes pressure vessels not support structures (pg-13, l-15).

(b) The term "narrow cavities" should be eliminated.

(c) A general discussion of the effects of neutron streaming in the cavity should be provided.

(d) The guide requires the use of END/B-VI cross-sections and does not allow the use of a suitably benchmarked alternate set of cross-sections.

(e) It is not evident that the θ-weighted difference model is available in all discrete ordinates transport codes that could be applied to this problem. The reference to this model should therefore be deleted.

V.19.3 Response: (a) The reference to support structures has been removed (pg-14, l-23).

(b) The reference to narrow cavities has been eliminated.

(c) A general discussion of the effects of cavity streaming is outside the scope of the guide.

(d) DG-1025 has been revised to allow the use of properly benchmarked cross-section sets (pg-14, l-31).

(e) The θ-weighted model is available in the DORT computer code which is widely used for pressure vessel fluence analyses. It is therefore concluded that this is appropriate information to include in the guide.

V.19.4 Decision: Selected changes have been made in the guide.

V.20.1 Comment ID: Enclosure-2, Comment-20.

V.20.2 Comment: DG-1025 requires that the fluence calculational methods be validated against (1) an operating reactor benchmark, (2) a pressure vessel simulator benchmark, and (3) a calculational benchmark (pg-16, l-6). The requirement to validate against a calculational benchmark appears to be redundant to the other two benchmarks without commensurate improvement in increased safety or knowledge of the fluence.

V.20.3 Response: The simulator and operating reactor benchmark measurements are not sufficient by themselves to provide the reliable and complete validation required for these complex and highly sensitive fluence calculations. The simulator benchmarks typically do not provide a reliable representation of the operating reactor core/downcomer/vessel geometry and, although the operating reactor benchmarks provide a valid representation of the actual geometry and as-built variability, the operating reactor measurements generally are not sufficiently accurate to provide a complete benchmarking. It is therefore concluded that all three of the benchmarks are required for a complete and reliable methods qualification.

V.20.4 Decision: No change is required.

V.21.1 Comment ID: Enclosure-2, Comment-21.

V.21.2 Comment: (a) Sufficient detail has not been provided on the specific method to be used to combine the uncertainty estimates of (1) the analytic uncertainty analysis and (2) the uncertainty analysis based on the benchmark comparisons (pg-17, l-28).

(b) The guide does not indicate how the uncertainty results are to be used with the best-estimate fluence.

V.21.3 Response: (a) The method used to combine the uncertainty estimates depends on the details of the specific application. In order not to be overly prescriptive and allow the analyst the freedom to exercise engineering judgement, the details of the method have been intentionally not included in the guide. However, in response to this comment, an additional statement has been added indicating that a weighted-average that accounts for the reliability of the individual estimates may be used (pg-20, l-33).

(b) A statement has been added indicating that the bias B^c should be applied as a multiplicative correction to the calculated fluence to determine the best-estimate value, and the uncertainty σ^c should be used (when required) as the (one-sigma) uncertainty in the calculated best-estimate fluence (pg-20, l-33). Also, a flow diagram indicating the process for determining the overall calculational bias B^c and uncertainty σ^c has been added (Figure-2).

V.21.4 Decision: The text has been revised.

V.22.1 Comment ID: Enclosure-2, Comment-22.

V.22.2 Comment: Section C.2 should describe the dosimetry methods that will be used to qualify the calculation methods. It should not describe measurements that will be used to directly determine the fluence.

V.22.3 Response: The text has been revised to indicate that the dosimetry measurements are to be used for validating the calculations (pg-21, l-17).

V.22.4 Decision: The text has been revised.

V.23.1 Comment ID: Enclosure-2, Comment-23.

V.23.2 Comment: A distinction should be made between (1) the documentation that should be reported to the NRC and (2) the documentation that is only to be maintained in the licensees records.

V.23.3 Response: The information identified for reporting or documentation should be provided to the NRC in the documentation describing the licensee application of the DG-1025 methodology. This information is required (1) to allow a determination that the application of the methodology is valid and (2) to understand the results and their bases.

V.23.4 Decision: No change is required.

V.24.1 Comment ID: Enclosure-2, Comment-24.

V.24.2 Comment: DG-1025 is unclear on how the "upper tolerance limit" is to be used with the current rules and guidance documents (pg-17, l-35).

V.24.3 Response: There is no current requirement to use an upper tolerance limit with the calculated fluence. Consequently, the discussion on the upper tolerance limit has been removed from the text.

V.24.4 Decision: The text has been revised.

V.25.1 Comment ID: Enclosure-2, Comment-25.

V.25.2 Comment: DG-1025 states that the dosimetry measurement provides an independent estimate of the fluence. In fact, the dosimetry measurements require an additional cross-section to determine the fluence and, therefore, do not provide a direct estimate of the fluence.

V.25.3 Response: The text has been revised to indicate that the dosimetry measurements provide a direct estimate of the specific activities and isotopic production rates that are used to validate the neutron transport calculations and for surveillance capsule analyses (pg-21, l-16).

V.25.4 Decision: The text has been revised.

V.26.1 Comment ID: Enclosure-2, Comment-26.

V.26.2 Comment: (a) The documentation in Section-C.2 should only be for the licensees records and should not be a reporting requirement.

(b) It is unclear what is meant by a "complete analysis."

V.26.3 Response: (a) See the response in Section V.23.3.

(b) The expression "complete analysis" has been changed to "complete uncertainty assessment (pg-21, l-22)."

V.26.4 Decision: The text has been revised in response to Comment (b).

V.27.1 Comment ID: Enclosure-2, Comment-27.

V.27.2 Comment: (a) The guidance given in DG-1025 concerning the selection of dosimeter sets may at best be redundant with 10 CFR Part 50, Appendix H and at worst conflict with the requirements of Appendix H. This recommendation on dosimetry sets should be deleted.

(b) The selection of dosimetry sets is outside the scope of Section-C.2 on dosimetry measurements and should be deleted.

(c) Measurements for benchmarking calculations of the > 1-MeV and > 0.1-MeV fluence do not require thermal neutron dosimeters for determining the uncertainty.

(d) The sentences on pg-18, l-30 and pg-19, l-4 are redundant.

(e) The dosimeter set should provide adequate thresholds for benchmarking calculations above 1.0 MeV and 0.1 MeV.

V.27.3 Response: (a) The guidance provided in DG-1025 neither conflicts nor is redundant with Appendix H of 10 CFR Part 50.

(b) An accurate determination of the fluence requires that the selected dosimeter responses provide an adequate coverage of the energy spectrum. In Table-2, DG-1025 provides an example of an acceptable dosimeter set, and allows for the use of alternate dosimeter sets that provide equivalent spectrum coverage. This information is considered to be important guidance and should be included in DG-1025.

(c) Thermal neutron detectors will be required, when there is a significant contribution to the measurements from thermal reactions, to allow a reliable interpretation of the dosimeter measurements.

(d) These sentences are not redundant since the sentence on pg-19, l-4 introduces the new and important fact that alternate dosimeter sets which provide equivalent spectrum coverage are acceptable.

(e) The dosimeter set provided in DG-1025 is considered adequate for determining the > 1.0 and > 0.1 MeV fluence.

V.27.4 Decision: No changes are required.

V.28.1 Comment ID: Enclosure-2, Comment-28.

V.28.2 Comment: The isotopic production rate is an additional parameter that is used when comparing calculated and measured dosimeter responses. This parameter has been omitted and should be included as an acceptable dosimeter response.

V.28.3 Response: The DG-1025 text has been revised to include this additional dosimeter response (pg-24, l-2).

V.28.4 Decision: The text has been changed.

V.29.1 Comment ID: Enclosure-2, Comment-29.

V.29.2 Comment: DG-1025 requires that the ASTM fission yields be used. More accurate data are available and should be allowed.

V.29.3 Response: The text has been revised to allow the fission yield data from the ENDF library, ASTM Standards, or the validated job library (pg-24, l-20).

V.29.4 Decision: The text has been revised.

V.30.1 Comment ID: Enclosure-2, Comment-30.

V.30.2 Comment: DG-1025 requires that the dosimeter measurement system be periodically validated in a well-characterized neutron field. There are other means for validating the measurement system and the guide should allow the use of alternate methods.

V.30.3 Response: Validation in a reference or standard neutron field provides a reliable and accurate assessment of the dosimetry measurement. While alternate calibration methods are available these are generally not as reliable and are not recommended in the guide.

V.30.4 Decision: No changes are required.

V.31.1 Comment ID: Enclosure-2, Comment-31.

V.31.2 Comment: The following comments refer to Section-2.3 (pg-22).

(a) DG-1025 proposes to use the fast neutron fluence, reaction probabilities, or average reaction rates as the quantities to be compared in the calculation-to-measurement validation of the calculational methodology. This validation could also be based on comparisons of specific activities, total reactions, or other measured quantities.

(b) DG-1025 does not indicate how the average calculation-to-measurement (C/M) ratio is to be determined. The average C/M ratio should be determined as a suitably weighted average of the individual C/M values which accounts for the uncertainties in the measurement, spectral-average cross-section, and (optionally) the neutron spectrum.

(c) DG-1025 should allow the analyst to correct for known biases in the spectrum calculation or the cross-sections.

(d) DG-1025 should allow an individual detector measurement to be discarded or given reduced weight when it gives spurious results.

(e) The guide should state that "if, after checking and eliminating errors and systematic bias, the measurement-to-calculation agreement is outside the expected range, it must be suspected that an unknown error or bias is present and further information is required to identify the source of the error or bias."

V.31.3 Response: (a) The text has been expanded to include specific activities and total reactions (pg-28, l-3). The use of "other measured quantities" in the validation is considered to be insufficiently defined to be used in the guide.

(b) Additional text has been added to indicate that (1) the average C/M ratio should be determined as a suitably weighted average of the individual C/M values and (2) as a

minimum, the uncertainty in the measurement, spectral-average cross-section, and (optionally) the neutron spectrum should be considered in determining the weighting (pg-28, l-8).

(c) The text has been modified to allow corrections for known biases in the spectrum calculation or the cross-sections (pg-28, l-13).

(d) DG-1025 does allow individual detector measurements to be discarded or given reduced weight when they give spurious results (pg-28, l-13).

(e) This statement does not provide any significant new information and is not considered appropriate for the guide.

V.31.4 Decision: Selected additions have been made to the text to respond to these comments.

V.32.1 Comment ID: Enclosure-2, Comment-32.

V.32.2 Comment: The guide should not require the reporting of the detector measurements and associated corrections. This information should only be included in the licensees files.

V.32.3 Response: This information should be reported since it is required (1) to allow a determination that the application of the methodology is valid and (2) to understand the results and their bases.

V.32.4 Decision: No change is required.

V.33.1 Comment ID: Enclosure-2, Comment-33.

V.33.2 Comment: (a) The guide should state that in order to validate the calculations, evaluations must be performed to estimate the bias and uncertainty associated with the measured response for each dosimeter type. Also, the bias and uncertainty must be included in the documentation of the results.

(b) There are several different methods available for estimating the measurement bias and uncertainty and the guide should not restrict the licensee to any specific method.

V.33.3 Response: (a) The text has been revised to include this comment (pg-25, l-19).

(b) The guide does not specify the specific method to be used but just requires that the measurement bias and uncertainties be reported.

V.33.4 Decision: Selected revisions in the text have been made.

V.34.1 Comment ID: Enclosure-2, Comment-34.

V.34.2 Comment: A topical report for licensee reference should be sufficient for describing the calculation and uncertainty methodologies.

V.34.3 Response: The text has been revised to indicate that a topical report providing the details of the fluence methodology should be sufficient for compliance with the guide (pg.-30, l-12).

V.34.4 Decision: The text has been revised to include this comment.

V.35.1 Comment ID: Enclosure-2, Comment-35.

V.35.2 Comment: DG-1025 requires that the multigroup fluences be reported. The reporting of these fluences will increase the cost of the analysis and the volume of the report, without any commensurate benefit.

V.35.3 Response: The multigroup fluences are required (1) to allow a determination that the application of the methodology is valid and (2) to understand the results and their bases. These fluences should be reported.

V.35.4 Decision: No change is required.

V.36.1 Comment ID: Enclosure-2, Comment-36.

V.36.2 Comment: Since the fluences are inferred from the measurements using an effective cross-section rather than by a direct measurement there should not be a requirement to report them.

V.36.3 Response: The DG-1025 text initially required that fluence comparisons be reported. In response to this comment, the text has been revised to recognize that the validation comparisons can be made using reaction rates or other responses (as described in Regulatory Position 2.3). However, whatever response is used in the validation comparisons, both the measured and calculated values must be reported (pg-31, l-19).

V.36.4 Decision: The text has been revised in response to this comment.

V.37.1 Comment ID: Enclosure-2, Comment-37.

V.37.2 Comment: (a) The isotope Niobium-93 should be added to the recommended list of dosimeters.

(b) Add the ASTM E1297-89 Standard as a reference on pg-39.

(c) The Table-2 listing of dosimeters is considered to prescriptive.

V.37.3 Response: (a) Niobium-93 has been added to Table-2 (pg-37, l-1).

(b) The ASTM E1297-89 Standard has been referenced (Table-2).

(c) The dosimeter set given in Table-2 is an example of an acceptable set. Alternate dosimeter sets may be used if they provide adequate spectral coverage.

V.37.4 Decision: Selected changes have been made to the text.

V.38.1 Comment ID: Enclosure-2, Comment-38.

V.38.2 Comment: NUREG/CR-6115 should be issued for comment prior to finalizing DG-1025.

V.38.3 Response: NUREG/CR-6115 has been released in draft form.

V.38.4 Decision: The Benchmark Problem Report has been released in draft form.

V.39.1 Comment ID: Enclosure-2, Comment-39.

V.39.2 Comment: Several of the referenced standards have more recent editions.

V.39.3 Response: The list of references has been updated to include the most recent editions of the referenced standards.

V.39.4 Decision: The guide has been modified in response to this comment.

V.40.1 Comment ID: Enclosure-2, Comment-40.

V.40.2 Comment: (a) Using the methods of DG-1025 a licensee, with a pressure vessel near the PTS screening criteria of 10 CFR 50.61, may be able to demonstrate a reduced fluence uncertainty and a considerable degree of conservatism in the calculated fluence. In order

to take advantage of this improved fluence prediction, the 10 CFR 50.61 Rule should be revised to allow the margin term to be reduced when the fluence uncertainty is less than the 20% included in the PTS Rule.

(b) Plants with a greater margin to the PTS screening criteria can tolerate a larger fluence uncertainty and more approximate methods should be acceptable for performing these fluence calculations.

(c) Any benefit resulting from the reduction of fluence values should be deleted from the cost-benefit analysis.

V.40.3 Response: (a) The specific value of the fluence uncertainty used in 10 CFR 50.61 is outside the scope of this guide. However, the PTS Rule is presently being reevaluated and any changes required in DG-1053 to insure consistency with this rule will be made when this reevaluation is completed.

(b) More approximate methods can be used in this situation, however, their acceptance will be determined on a case-by-case basis.

(c) No benefit was taken in the cost-benefit analysis for reduced fluence values.

V.40.4 Decision: No change is required.

V.41.1 Comment ID: Reference-4, pg-3, first paragraph.

V.41.2 Comment: The regulatory guide scope should be clarified to specifically state situations where simpler fluence estimation methods are warranted and acceptable.

V.41.3 Response: A statement has been added recognizing that, in situations where the embrittlement is not significant and there is a large margin to the RT_{NDT} limits, more approximate methods for determining the vessel fluence may be appropriate. It is also noted, however, that these methods must be qualified.

V.41.4 Decision: Additional clarification has been added (pg-1, l-33).

V.42.1 Comment ID: Comment-42.

V.42.2 Comment: Figure-3 of Reference-4 describes the determination and application of a plant-specific bias factor BF_{ps}. This Figure should be included in the guide.

V.42.3 Response: In the DG-1025 methodology, the calculational bias is determined as described in Regulatory Position 1.4.3. This determination can result in a plant-specific bias if the calculations of the dosimetry measurements for the specific plant indicate a bias. However, in most cases it is expected that the number and quality of the plant-specific measurements will not be sufficient to make a reliable estimate of this bias. Therefore, in order to avoid misapplication of the guide, the Figure-3 description of the plant-specific bias factor BF_{ps} is not included in the guide. (It is understood, however, that a plant-specific bias factor BF_{ps} may be used if there is sufficient measurement data to make an accurate estimate of a plant-specific bias factor.)

V.42.4 Decision: No change is required.

VI. B&W NUCLEAR TECHNOLOGIES

The following are the resolutions to the comments provided by B&W Nuclear Technologies in Reference 6.

VI.1.1 Comment ID: Comment-1.

VI.1.2 Comment: Reference-6 makes some initial general remarks explaining the detailed comments that follow.

VI.1.3 Response: No response is required.

VI.1.4 Decision: No change is required.

VI.2.1 Comment ID: Comment-2.

VI.2.2 Comment: Reference-6 then makes a general observation identifying the "key statements" in the guide.

VI.2.3 Response: No response is required.

VI.2.4 Decision: No change is required.

VI.3.1 Comment ID: Comment-3.

VI.3.2 Comment: (a) A topical report should be sufficient for documenting the licensee methods.

(b) The guide does not indicate the purpose of subsequent measurements, once the methods have been verified.

VI.3.3 Response: (a) See Response V.34.3.

(b) The guide has been modified to indicate that, as capsule and cavity measurements become available, these measurements should be incorporated into the operating reactor measurements data base and the calculational uncertainties and biases updated as necessary (pg-19, l-23).

VI.3.4 Decision: The text has been revised.

VI.4.1 Comment ID: Comment-4.

VI.4.2 Comment: The title of Section C.2 should be "Dosimetry Measurement Methods" rather than "Neutron Fluence Measurement Methods."

VI.4.3 Response: The purpose of the measurements is to validate the calculation of the neutron fluence and, in view of the material presented, the selected title is considered more appropriate.

VI.4.4 Decision: No change is required.

VI.5.1 Comment ID: Comment-5.

VI.5.2 Comment: The expression "reference nil-ductility temperature" should be replaced with the expression, "reference temperature for nil-ductility transition."

VI.5.3 Response: The text has been revised to include this suggestion (pg-1, l-20).

VI.5.4 Decision: The text has been revised.

VI.6.1 Comment ID: Comment-6.

VI.6.2 Comment: The expression "fluence measurements" should be replaced with the expression "dosimetry measurements."

VI.6.3 Response: The reference to "fluence measurements" is considered more appropriate in this context.

VI.6.4 Decision: No change is required.

VI.7.1 Comment ID: Comment-7.

VI.7.2 Comment: The methods in the guide do not cover the entire damage fluence spectrum and, consequently, the word "entire" should be removed (pg-3, l-2).

VI.7.3 Response: The word "entire" has been removed (pg-3, l-7).

VI.7.4 Decision: The text has been revised.

VI.8.1 Comment ID: Comment-8.

VI.8.2 Comment: The phrase "best-estimate" should be used when the concept of an "absolute" fluence calculation is introduced.

VI.8.3 Response: In order to maintain the emphasis on "absolute" and in the interest of clarity, the concept of "best-estimate" will not also be included in this sentence.

VI.8.4 Decision: No change is required.

VI.9.1 Comment ID: Comment-9.

VI.9.2 Comment: The wording on pg-4 (ls 7-9) is unclear.

VI.9.3 Response: The wording has been revised (pg-4, l-23).

VI.9.4 Decision: The text has been revised.

VI.10.1 Comment ID: Comment-10.

VI.10.2 Comment: (a) The basis for the 20% calculational uncertainty required in PTS calculations should be provided.

(b) It is not evident whether the 20% uncertainty includes both calculation and measurement uncertainty (pg-4, l-8).

VI.10.3 Response: (a) See Response-V.9.3.

(b) The text has been revised to indicate that the 20% uncertainty is on the calculation and the reference to benchmark measurements has been removed from the sentence.

VI.10.4 Decision: Selected changes have been made to the text.

VI.11.1 Comment ID: Comment-11.

VI.11.2 Comment: The guide does not indicate how the "as-built plant-specific dimensions and materials" data will be obtained (pg-4, l-26).

VI.11.3 Response: While it is recognized that in certain cases this data may not be available or very difficult to obtain, the pressure vessel fluence should be determined with the best available data. In order to recognize the possibility that this data may not be available, the phrase "to the extent possible" has been added to the text (pg-5, l-30). The as-built plant-specific data is typically provided in plant drawings and documents, however, general instructions on how to obtain this data is outside the scope of the guide.

VI.11.4 Decision: Selected changes have been made.

VI.12.1 Comment ID: Comment-12.

VI.12.2 Comment: The use of the terms "multigroup master library" and "multigroup job library" is confusing (pg-6, ls 4 and 18).

VI.12.3 Response: Additional text has been added to clarify the difference between these libraries (pg-7, ls 5, 7 and 22).

VI.12.4 Decision: Selected changes have been made.

VI.13.1 Comment ID: Comment-13.

VI.13.2 Comment: (a) The guide requires that the ENDF/B cross-sections be collapsed. This is too prescriptive.

(b) The guide states that the "master" library may be collapsed to a "job" library. This collapse should be a requirement.

(c) The guide states that the adequacy of the collapse of the master library, to determine the job library, may be validated by comparing calculations performed with the job library and the master library. This validation should be a requirement.

(d) It should be noted that additional qualification of the job library will be provided by the benchmark comparisons.

VI.13.3 Response: (a) Since the ENDF/B cross-sections are not in multigroup form they must be collapsed to be used in the discrete ordinates code.

(b) The text has been changed to require that the vessel fluence calculations be performed with a job library that has been determined by collapsing the master library (pg-7, l-17).

(c) The text has been changed to require that the collapse of the master library be validated by comparing calculations performed with the master library and the job library (pg-7, l-24).

(d) The text has been modified to indicate that, in addition to the validation of the collapsing, additional qualification of the job library is provided by the benchmark comparisons of Regulatory Position 1.4.2 (pg-7, l-28).

VI.13.4 Decision: Selected changes have been made to the text.

VI.14.1 Comment ID: Comment-14.

VI.14.2 Comment: The "prescribed" accuracy requirements are not defined in the guide (pg-6, l-1).

VI.14.3 Response: The term "prescribed" has been removed from the text (pg-7, l-3).

VI.14.4 Decision: The text has been revised.

VI.15.1 Comment ID: Comment-15.

VI.15.2 Comment: The term "fixed" source is not necessary (pg-7, l-2).

VI.15.3 Response: The term "fixed" has been removed from the text (pg-8, l-2).

VI.15.4 Decision: The text has been revised.

VI.16.1 Comment ID: Comment-16.

VI.16.2 Comment: The core power distribution design calculations and the on-line power distribution measurements are not based on qualified methodologies. It is, therefore, not clear how the fluence methodology can be qualified using an unqualified source distribution (pg-7, l-5).

VI.16.3 Response: The core power distribution calculations and measurements are performed with qualified methodologies. It is recognized that in some cases this qualification may not include the peripheral assemblies since these typically are not close to the fuel design limits. However, the qualification of the fluence methodology only requires that the procedures described in Regulatory Position 1.4 be performed. This qualification does not require that the core neutron source distribution be determined with a qualified methodology, but only that a reliable estimate of the uncertainty in the source distribution can be determined. This source uncertainty is then included in the analytic uncertainty analysis, which is part of the qualification of the fluence methodology.

VI.16.4 Decision: No changes are required.

VI.17.1 Comment ID: Comment-17.

VI.17.2 Comment: The description of the core-follow calculations is too detailed (pg-7, l-7).

VI.17.3 Response: The unnecessary detail has been removed from the text (pg-8, l-11).

VI.17.4 Decision: The text has been changed.

VI.18.1 Comment ID: Comment-18.

VI.18.2 Comment: The power and source distribution in the peripheral fuel assemblies are not typically included in the uncertainty analysis performed for the process computer fuel (peaking and DNBR) limits evaluation (pg-7, l-9). Consequently, the source distribution uncertainties may not be available and will have to be determined. In addition, it is recommended that the NRC upgrade the procedure for quantifying the power distribution uncertainties to include the peripheral fuel assemblies.

VI.18.3 Response: The qualification of the fluence methodology involves an analytic uncertainty analysis which requires that the various sources of uncertainty be identified and quantified. It is expected that uncertainty estimates for several of the input variables may not be available, and additional work will be required to determine the uncertainties in these input parameters. The upgrade of the procedure used to qualify the core power distribution to include the peripheral fuel assemblies is outside the scope of this guide.

VI.18.4 Decision: No change is required.

VI.19.1 Comment ID: Comment-19.

VI.19.2 Comment: The source distribution should be determined as the product of the neutron yield and fission rate distribution (pg-7, l-11).

VI.19.3 Response: While this is implied in the guide, to improve the clarity this statement has been added (pg-9, l-6).

VI.19.4 Decision: The text has been revised to include this comment.

VI.20.1 Comment ID: Comment-20.

VI.20.2 Comment: The "generic" power distribution must be compared to a "qualified" measured power distribution (pg-7, l-24).

VI.20.3 Response: The specification of the quality level of the measured power distribution is outside the scope of the guide.

VI.20.4 Decision: No change is required.

VI.21.1 Comment ID: Comment-21.

VI.21.2 Comment: (a) The concept that the mesh must be quantitatively verified needs to be included for both the r-mesh and the θ-mesh (pg-8, l-14).

(b) The two references to Reference-20 are redundant and one of these should be removed (pg-8, l-24).

VI.21.3 Response: (a) The guide states specific mesh accuracy criteria for representing the peripheral fuel assembly areas and pin-power gradients (pg-9, l-31). In addition, as part of the methodology qualification, specific sensitivity calculations are required to estimate the error introduced by the mesh selection (pg-16, l-19).

(b) Each of these references to Reference-20 is made for a different purpose.

VI.21.4 Decision: No change is required.

VI.22.1 Comment ID: Comment-22.

VI.22.2 Comment: The statement that if DORT (r,z) and (r) calculations are used to determine an axial correction factor, the source specification may be less stringent (pg-8, l-29) is unclear.

VI.22.3 Response: The text has been modified to indicate that, since the (r,z) and (r) fluences enter as a ratio in the correction factor (see Equation (4)), the source specification may be less stringent if consistent sources are used in both the (r,z) and (r) calculations (pg-10, l-7).

VI.22.4 Decision: The text has been modified.

VI.23.1 Comment ID: Comment-23.

VI.23.2 Comment: The reference to "two-dimensional" discrete ordinates transport calculations should be deleted (pg-9, l-3).

VI.23.3 Response: While it is recognized that three-dimensional transport codes are available, the three dimensional codes are generally not used. However, in Regulatory Position 1.3.2 concerning synthesis procedures, it is noted that when strong axial or azimuthal heterogeneities are present three-dimensional calculations should be considered (pg-14, l-15).

VI.23.4 Decision: No change is required.

VI.24.1 Comment ID: Comment-24.

VI.24.2 Comment: The statement that the "adequacy of the capsule representation and mesh must be demonstrated using sensitivity calculations" is unclear as to how the adequacy is to be demonstrated and what criteria are to be used.

VI.24.3 Response: The mesh sensitivity calculations are described in Regulatory Position 1.4.1, and a reference to this Section has been added to the text (pg-12, l-3).

VI.24.4 Decision: The text has been modified.

VI.25.1 Comment ID: Comment-25.

VI.25.2 Comment: Same as Comment-V.17.2.

VI.25.3 Response: See Response-V.17.3.

VI.25.4 Decision: See Decision-V.17.4.

VI.26.1 Comment ID: Comment-26.

VI.26.2 Comment: (a) The guidance provided on the use of assembly importance factors does not indicate that the pin-wise source distribution in the peripheral assemblies should be included in the determination of these factors (pg-11, l-3).

(b) No guidance is provided for the validation of these importance factor calculations.

VI.26.3 Response: (a) Additional text has been added to indicate that the pin-wise source distribution should be included in the determination of the assembly importance factors (pg-12, l-18).

(b) The methodology qualification procedures are described in Regulatory Position 1.4 and apply independent of the specific details of the application (pg-15, l-20).

VI.26.4 Decision: No change is required.

VI.27.1 Comment ID: Comment-27.

VI.27.2 Comment: The Equation (1) synthesis prescription is too specific and should be expanded to allow similar but different synthesis methods (pg-11, l-21).

VI.27.3 Response: The Equation (1) synthesis prescription has been validated and is known to provide an accurate fluence estimate. Since the synthesis methods are approximate, any alternate method that is used will require additional validation.

VI.27.4 Decision: No change is required.

VI.28.1 Comment ID: Comment-28.

VI.28.2 Comment: The total source per unit volume in the (r,z) and (r) problems should be identical.

VI.28.3 Response: The validated Equation (1) synthesis procedure does not require that the total source per unit volume in the (r,z) and (r) problems be identical. However, the guide allows this selection provided that the source per unit height for both the (r,θ) and the (r) models are identical (pg-13, l-11).

VI.28.4 Decision: No change is required.

VI.29.1 Comment ID: Comment-29.

VI.29.2 Comment: (a) If the fluence shape flattens as it moves from the core to the vessel, the relative maximum will decrease and the minimum will increase (pg-12, l-12). It is not clear how this will result in an overprediction (underprediction) of the vessel maximum (minimum).

(b) A statement should be added to indicate that the synthesis method should be validated (pg-12, l-12).

VI.29.3 Response: a) This will result in an overprediction (underprediction) of the vessel maximum (minimum) since the core axial power distribution (which is used to represent the fluence shape in the application of Equation (2)) will be more peaked than the actual vessel fluence shape and result in larger (smaller) fluences at the maximum (minimum) locations.

b) The qualification of the complete methodology (including the synthesis approach) is to be carried out using the procedures described in Regulatory Position 1.4.

VI.29.4 Decision: No change is required.

VI.30.1 Comment ID: Comment-30.

VI.30.2 Comment: The discussion concerning the conservatism of Equation (2) may not be valid for double-peaked axial power shapes (pg-12, l-25).

VI.30.3 Response: While the discussion is generally valid in practice, a qualification to typical axial power shapes has been added to the text (pg-13, l-19).

VI.30.4 Decision: The text has been modified.

VI.31.1 Comment ID: Comment-31.

VI.31.2 Comment: a) Same as Comments-V.19.2 b), c) and d).

VI.31.3 Response: a) See Responses-V.19.3 b), c) and d).

VI.31.4 Decision: a) See Decisions-V.19.4 b), c) and d).

VI.32.1 Comment ID: Comment-32.

VI.32.2 Comment: The concept (on pg-14, l-1) of extrapolating the fluence measurements appears to contradict the DG-1025 requirement to perform absolute fluence calculations, rather than a simple extrapolation of the measurements.

VI.32.3 Response: The DG-1025 requirement to perform absolute fluence calculations applies to the calculation of fluence for use in the determination of vessel embrittlement. The referenced measurement extrapolation (pg-14, l-1) is only introduced to allow comparison of three independent estimates of the inner-wall fluence for the purpose of assessment and

validation. This three-way comparison will allow an assessment of both the calculations and measurements.

VI.32.4 Decision: No change is required.

VI.33.1 Comment ID: Comment-33.

VI.33.2 Comment: Same as Comment-V.20.2.

VI.33.3 Response: See Response-V.20.3.

VI.33.4 Decision: See Decision-V.20.3.

VI.34.1 Comment ID: Comment-34.

VI.34.2 Comment: The validation of the calculational methodology should be based on comparisons of activities and/or production rates.

VI.34.3 Response: Additional text has been included to explicitly identify the measured activities and production rates for use in the benchmarking (pg-21, l-17; pg-24, l-4; pg-28, l-3).

VI.34.4 Decision: The text has been modified.

VI.35.1 Comment ID: Comment-35.

VI.35.2 Comment: The word "should" in the statement, "Any adjustments made to the calculations should be justified and reported," is not strong enough and should be replaced by the word must.

VI.35.3 Response: The text has been changed from should to must.

VI.35.4 Decision: The text has been modified.

VI.36.1 Comment ID: Comment-36.

VI.36.2 Comment: The surveillance capsule data provides information that can be used to determine the fluence but does not (by itself) determine the fluence. The word "fluence" should be removed from l-17, pg-16.

VI.36.3 Response: This use of the word "fluence" has been removed from the text at this point.

VI.36.4 Decision: The text has been modified.

VI.37.1 Comment ID: Comment-37.

VI.37.2 Comment: The material on pg-17 between ls 8-25 actually relates to Subsection-1.4.2 rather than Subsection-1.4.2.3.

VI.37.3 Response: This material has been moved to Subsection-1.4.2 (pg-18, l-2).

VI.37.4 Decision: The text has been modified.

VI.38.1 Comment ID: Comment-38.

VI.38.2 Comment: The statement that "the differences between the calculations and measurements should be consistent with the combined uncertainty estimates for the calculations and measurements" is unclear (pg-17, l-14).

VI.38.3 Response: An additional statement has been added to the text noting that the uncertainties in both the calculations and measurements contribute to the observed calculation-to measurement differences (pg-18, l-9).

VI.38.4 Decision: The text has been modified.

VI.39.1 Comment ID: Comment-39.

VI.39.2 Comment: The phrase "the calculated and measured reaction rates" (on pg-17, l-16) should be replaced by "the calculated reaction rates."

VI.39.3 Response: This change has been incorporated into the text (pg-18, l-11).

VI.39.4 Decision: The text has been revised.

VI.40.1 Comment ID: Comment-40.

VI.40.2 Comment: The guide states that the calculations and measurements should agree to within about 20% for in-vessel surveillance capsules and 30% for cavity capsules, and deviations outside these limits must be investigated. These typical (20% and 30%) calculation-to-measurement differences should not be considered limits.

VI.40.3 The text has been changed and the word "limits" has been removed (pg-18, l-14).

VI.40.4 Decision: The text has been changed.

VI.41.1 Comment ID: Comment-41.

VI.41.2 Comment: The Section-2 material appears to concern dosimetry measurement methods. The title of this section should be changed from "Fluence Measurement Methods" to "Dosimetry Measurement Methods."

VI.41.3 Response: The present title is considered more consistent with the material and purpose of this section, and the relationship between this section and the previous section in the guide.

VI.41.4 Decision: No change is required.

VI.42.1 Comment ID: Comment-42.

VI.42.2 Comment: Same as Comment-V.25.2.

VI.42.3 Response: See Response-V.25.3

VI.42.4 Decision: See Decision-V.25.4.

VI.43.1 Comment ID: Comment-43.

VI.43.2 Comment: Same as Comment-V.26.2.

VI.43.3 Response: See Response-V.26.3.

VI.43.4 Decision: See Decision-V.26.4.

VI.44.1 Comment ID: Comment-44.

VI.44.2 Comment: Same as Comment-V.27.2.

VI.44.3 Response: See Response-V.27.3.

VI.44.4 Decision: See Decision-V.27.4.

VI.45.1 Comment ID: Comment-45.

VI.45.2 Comment: Same as Comment-V.27.2 c).

VI.45.3 Response: See Response-V.27.3 c).

VI.45.4 Decision: See Decision V.27.4 c).

VI.46.1 Comment ID: Comment-46.

VI.46.2 Comment: Same as Comment-V.27.2 d).

VI.46.3 Response: See Response-V.27.3 d).

VI.46.4 Decision: See Decision-V.27.4 d).

VI.47.1 Comment ID: Comment-47.

VI.47.2 Comment: Same as Comment-V.28.2

VI.47.3 Response: See Response-V.28.3.

VI.47.4 Decision: See Decision-V.28.4.

VI.48.1 Comment ID: Comment-48.

VI.48.2 Comment: Same as Comment-V.29.2.

VI.48.3 Response: See Response-V.29.3.

VI.48.4 Decision: See Decision-V.29.4.

VI.49.1 Comment ID: Comment-49.

VI.49.2 Comment: Same as Comment-V.32.2.

VI.49.3 Response: See Response-V.32.3.

VI.49.4 Decision: See Decision-V.32.4.

VI.50.1 Comment ID: Comment-50.

VI.50.2 Comment: Same as Comment-V.33.2.

VI.50.3 Response: See Response-V.33.3.

VI.50.4 Decision: See Decision-V.33.4.

VI.51.1 Comment ID: Comment-51.

VI.51.2 Comment: a) The guide should indicate that the dosimeter measurements used to benchmark the fluence calculations must meet the requirements of Quality Assurance Program.

b) The requirement to validate the dosimeter measurements in a standard or reference field is too prescriptive.

VI.51.3 Response: a) The guide has been modified to indicate that the dosimeter measurements must satisfy the requirements of a QA program (pg-26, l-4).

b) Periodic validation must be performed every few years in order to ensure that the measurement system has not become unreliable due to loss in equipment calibration, personnel changes, changes in procedures, or other changes that could affect the measurement system accuracy. This requirement is important since there is a significant possibility that the dosimeter measurement system will degrade with time, and the measurement accuracy determined by the initial qualification will no longer be valid.

VI.51.4 Decision: a) The text has been modified to incorporate this comment.

b) No change is required.

VI.52.1 Comment ID: Comment-52.

VI.52.2 Comment: The following comments refer to Section-2.2 on the validation of the dosimeter measurements in the reference field (pg-21, l-14).

a) The reference field fluence and standard deviation must be validated.

b) The reference field fluence should not be biased.

c) The standard deviation in the reference fluence must not include any "correlative dependence."

d) The normality (or lack of normality) of the reference field standard deviation should be certified and documented.

e) The number of dosimeters should be large enough to provide a statistically significant sample of each dosimeter type.

f) Detailed procedures should be provided for applying the bias, observed in the measurement validation, to the dosimeter measurements.

VI.52.3 Response: a) It is understood that the reference (or standard field) fluence and standard deviation are validated and documented.

b) The documented reference field fluence includes some (typically small) measurement error and, therefore, will include some (relatively small) bias.

c) The reference field fluence standard deviation may have some dependence on the measurement variables. If this dependence is known, it can be accounted for in the dosimetry uncertainty analysis. It is expected that, since the reference field standard deviation is relatively small, the effect of this dependence should be insignificant. The treatment of the dependence of the reference fluence standard deviation on the measurement variables is considered outside the scope of this guide.

d) The treatment of the distribution (normal or otherwise) of the standard deviation of the reference field is considered outside the scope of this guide. The reference field and its uncertainty are provided in the reference field documentation.

e) The specification of the number of samples used in the measurement validation will depend on the measurement system, and is considered overly prescriptive and detailed for inclusion in the guide.

f) The specification of special procedures for applying the observed bias to the dosimeter measurements is considered overly prescriptive and is outside the scope of DG-1025.

VI.52.4 Decision: No change is required.

VI.53.1 Comment ID: Comment-53.

VI.53.2 Comment: The following comment refers to Section-2.2 on the validation of the dosimeter measurements in the reference field (pg-21). The guide should allow for alternate methods of validating the dosimeter measurements, other than the reference field validation required in DG-1025.

VI.53.3 Response: The reference field validation required in the guide is considered acceptable, and other methods of validating the dosimeter measurements will be reviewed on a case-by-case basis.

VI.53.4 Decision: No change is required.

VI.54.1 Comment ID: Comment-54.

VI.54.2 Comment: Footnote-7 (pg-22, l-32) is not required if the changes suggested in Comments VI.52 and VI.53 are incorporated.

VI.54.3 Response: The changes suggested in Comments VI.52 and VI.53 have not been included and, therefore, Footnote-7 is not being deleted.

VI.54.4 Decision: No change is required.

VI.55.1 Comment ID: Comment-55.

VI.55.2 Comment: The following comments refer to Section-2.3 (pg-22).

a) Same as Comment-V.31.2.

b) This section describes both the fluence determined from detector measurements and the directly measured quantities, such as reaction probabilities, and their use in the benchmarking of the fluence calculations. The title of this section should be changed to "Calculational Uncertainty Determination from Dosimeter Measurements."

VI.55.3 Response: a) See Response-V.31.3.

b) The primary purpose of this section is to describe the determination of the fluence from the measurements and, consequently, the present title is considered the most appropriate.

VI.55.4 Decision: a) See Decision-VI.31.4.

b) No change is required.

VI.56.1 Comment ID: Comment-56.

VI.56.2 Comment: Same as Comment-V.20.2

VI.56.3 Response: See Response-V.20.3.

VI.56.4 Decision: See Decision-V.20.4.

VI.57.1 Comment ID: Comment-57.

VI.57.2 Comment: DG-1025 should indicate (pg-24, l-23) that a topical report presenting the details of the fluence methodology should be satisfactory for compliance with the guide. Subsequent analyses by the licensee to update the vessel fluence biases and uncertainties may be reported as 50.59 reports, for "information only."

VI.57.3 Response: The guide has been revised to include this comment (pg-28, l-7).

VI.57.4 Decision: The text has been revised.

VI.58.1 Comment ID: Comment-58.

VI.58.2 Comment: Same as Comment-V.35.2.

VI.58.3 Response: See Response-V.35.3.

VI.58.4 Decision: See Decision-V.35.4.

VI.59.1 Comment ID: Comment-59.

VI.59.2 Comment: The reporting requirement, in the case that an adjustment is made to the calculated result, should be changed from should to must.

VI.59.3 Response: This reporting requirement has been changed from should to must (pg-28, l-29).

VI.59.4 Decision: The text has been modified.

VI.60.1 Comment ID: Comment-60.

VI.60.2 Comment: Same as Comment-V.36.2

VI.60.3 Response: See Response-V.36.3.

VI.60.4 Decision: See Decision-V.36.4.

VII. NUCLEAR ENERGY INSTITUTE

The comments provided by the Nuclear Energy Institute (NEI) in Reference-5 are in the form of a redraft of DG-1025. In order to respond to these comments, the NEI redraft was reviewed and the substantive differences relative to DG-1025 identified. The evaluation of these differences is given in the following.

VII.1.1 Comment ID: Comment-1.

VII.1.2 Comment: DG-1025 requires that the vessel fluence be determined by an "absolute" fluence calculation in which the transport of the core neutron source is calculated from the core out to the vessel and cavity, rather than a simple spatial extrapolation of the fluence measurements (pg-3). This requirement has been eliminated from the redraft.

VII.1.3 Response: The typical surveillance capsule measurements are not considered sufficiently accurate by themselves, or with a multiplicative lead factor to account for the spatial extrapolation, to make the necessary high confidence estimate of the fluence and vessel embrittlement. Consequently, DG-1025 uses the surveillance measurement data (together with the pressure vessel simulator measurements and calculational benchmarks) indirectly as a benchmark of the absolute fluence calculation.

VII.1.4 Decision: No change is required.

VII.2.1 Comment ID: Comment-2.

VII.2.2 Comment: DG-1025 provides a Summary Table-1 which identifies the specific requirements of the guide (pg-24). This table is not included in the Reference-5 redraft.

VII.2.3 Response: Table-1 will simplify the application of DG-1025 and should be included.

VII.2.4 Decision: No change is required.

VII.3.1 Comment ID: Comment-3.

VII.3.2 Comment: DG-1025 states that the latest version of the Evaluated Nuclear Data File (ENDF/B) should be used for determining nuclear material reaction cross-sections. It also states that cross-sections, based on earlier or equivalent nuclear data sets that have been thoroughly benchmarked, are also acceptable (pg-5). The Reference-5 redraft does not make

any recommendation concerning the version of ENDF/B nuclear data to be used in the fluence calculations.

VII.3.3 Response: Because of the strong fluence attenuation and resulting sensitivity of the fluence predictions to the material nuclear cross-section data, the selection of the cross-section data set is a critical decision in performing the vessel fluence calculations. Consequently, the guide makes a recommendation concerning this selection but allows the use of alternate cross-section sets if appropriately benchmarked. See also Response-V.19.3.

VII.3.4 Decision: No change is required.

VII.4.1 Comment ID: Comment-4.

VII.4.2 Comment: DG-1025 includes a description of the collapsing of the nuclear cross-section data from the fine group ($\geq$ 100 group) master library representation to the broad-group ($\leq$ 50 group) job library representation (pg-5). The Reference-5 redraft does not include this information.

VII.4.3 Response: It is expected that in certain applications the available broad-group job libraries will not be adequate and new plant or problem-specific job libraries will be required. DG-1025 provides guidance on the collapsing of the fine-group library to insure an accurate fluence prediction.

VII.4.4 Decision: No change is required.

VII.5.1 Comment ID: Comment-5.

VII.5.2 Comment: DG-1025 recommends that a weighted-difference model should be used in performing the transport calculation in order to avoid negative fluxes and to improve the convergence of the calculation (pg-10). The Reference-5 redraft does not include this recommendation.

VII.5.3 Response: While this recommendation is somewhat detailed, it is considered important guidance since in certain applications it can prevent calculational errors which are difficult to identify. See also Response-V.19.3(e).

VII.5.4 Decision: No change is required.

VII.6.1 Comment ID: Comment-6.

VII.6.2 Comment: DG-1025 states that the cavity fluence calculations can be used to determine the fluence accumulated by the support structures (pg-13, l-10). This statement has been deleted in the Reference-5 redraft.

VII.6.3 Response: The determination of the support structure fluence is outside the scope of the guide and this statement has been removed from DG-1025 (pg-14, l-22). See also Response-V.19.3.

VII.6.4 Decision: The text has been revised.

VII.7.1 Comment ID: Comment-7.

VII.7.2 Comment: Same as Comment-V.20.2.

VII.7.3 Response: See Response-V.20.3.

VII.7.4 Decision: See Decision-V-20.4.

VII.8.1 Comment ID: Comment-8.

VII.8.2 Comment: The guide states that the operating reactor surveillance capsule measurements should be for the specific reactor being evaluated or a reactor of similar design (pg-16, l-16). In the Reference-5 redraft, this requirement has been changed from should to must.

VII.8.3 Response: The guide expects that the measurements will be of the same or a similar design, unless specific requirements (such as the unavailability of measurement data) make this impossible. The overall qualification, including an operating reactor benchmark (possibly of a different design), a pressure vessel simulator benchmark, and a calculational benchmark, is considered sufficient to provide an adequate test of the methodology and allow the application to a plant for which the operating reactor benchmark is not for the same or a similar design.

VII.8.4 Decision: No change is required.

VII.9.1 Comment ID: Comment-9.

VII.9.2 Comment: Same as Comment-V.27.2 a), b), and e).

VII.9.3 Response: See Response-V.27.3 a), b), and e).

VII.9.4 Decision: See Decision-V.27.4 a), b), and e).

VII.10.1 Comment ID: Comment-10.

VII.10.2 Comment: Same as Comment-V.51.2.

VII.10.3 Response: See Response-V.51.3.

VII.10.4 Decision: See decision-V.51.4.

VII.11.1 Comment ID: Comment-11.

VII.11.2 Comment: a) The Reference-5 redraft eliminates the DG-1025 requirement (pg-21, l-15) to validate the dosimeter measurements in a well-characterized reference or standard neutron field, and allows validation of the measurements using "suitable reference standards such as radioactive sources."

b) The description of the reference-field validation procedure has been eliminated in the Reference-5 redraft.

VII.11.3 Response: a) The validation using standards such as radioactive sources is not considered of sufficient quality and reliability to provide the validation of the dosimeter measurements required for vessel fluence determination. The radioactive sources allow an assessment of the radioactivity counting but do not provide an indication of the overall accuracy of the measurement system (including assumed dosimeter cross-section, determination of the reaction rate, dosimeter perturbations, etc.).

b) The DG-1025 description of the reference-field validation procedure (pg-21, l-21) is provided to ensure an accurate and reliable measurement and is considered important guidance.

VII.11.4 Decision: No change is required.

VII.12.1 Comment ID: Comment-12.

VII.12.2 Comment: Same as Comment-V.31.2.

VII.12.3 Response: See Response-V.31.3.

VII.12.4 Decision: See Decision-V.31.4.

VII.13.1 Comment ID: Comment-13.

VII.13.2 Comment: Same as Comment-V.35.2.

VII.13.3 Response: See Response-V.35.3.

VII.13.4 Decision: See Decision-V.35.4.

VII.14.1 Comment ID: Comment-14.

VII.14.2 Comment: Same as Comment-V.36.2.

VII.14.3 Response: See Response-V.36.3.

VII.14.4 Decision: See Decision-V.36.4.

VII.15.1 Comment ID: Comment-15.

VII.15.2 Comment: Same as Comment-V.10.2.

VII.15.3 Response: See Response-V.10.3.

VII.15.4 Decision: See Decision-V.10.4.

VII.16.1 Comment ID: Comment-16.

VII.16.2 Comment: The guide should indicate that, when fluence determinations are required by existing regulations, the fluence calculations should be reported according to the applicable regulations.

VII.16.3 Response: The existing regulations do not provide guidance on the requirements for reporting the fluence calculations.

VII.16.4 Decision: No change is required.

VIII. NUCLEAR ENERGY INSTITUTE

The Nuclear Energy Institute (NEI) provided a set of comments on the initial Draft DG-1025 in Reference-5 and the resolution of these comments are included in Section-VII. NEI provided a second set of comments on the subsequent version DG-1053 in Reference-7 and these are included in this section.

VIII.1.1 Comment ID: Comment-1.

VIII.1.2 Comment: Same as Comment-V.5.4.

VIII.1.3 Response: Same as Response-V.5.4.

VIII.1.4 Decision: See Decision-V.5.4.

VIII.2.1 Comment ID: Comment-2.

VIII.2.2 Comment: Threshold criteria should be established and included in the guide to define when the rigorous methods of DG-1053 are required and when more approximate methods may be used.

VIII.2.3 Response: Establishing specific threshold criteria is considered out the scope of the guide.

VIII.2.4 Decision: No change is required.

VIII.3.1 Comment ID: Comment-3.

VIII.3.2 Comment: DG-1053 states that the public comments were received and "resolved." NEI believes that several of the NEI comments have been dispositioned by the NRC but have not necessarily been resolved with the commentor.

VIII.3.3 Response: The NRC intends to fully resolve all the comments. However, in certain cases, the NRC may not agree with the comment and the comment proposal may not be adopted.

VIII.3.4 Decision: No change is required.

VIII.4.1 Comment ID: Comment-4.

VIII.4.2 Comment:. Same as Comment-V.4.1.

VIII.4.3 Response: Same as Response-V.4.3.

VIII.4.4 Decision: See Decision-V.4.4.

VIII.5.1 Comment ID: Comment-5.

VIII.5.2 Comment: a) An independent estimate of the overall calculational uncertainty is a costly evaluation; b) The suggested weighting process is arbitrary.

VIII.5.3 Response: a) The need for estimating the overall calculational uncertainty results from the PTS Rule (10CFR 50.61) requirement that the vessel fluence be calculated to within 20%. The analytic uncertainty analysis and benchmark comparisons provide independent estimates of the calculational uncertainty. The analytic uncertainty analysis is simple and does not require a large effort. The benchmarking comparisons can be limited to a relatively small set of measurements and do not have to be excessive. b) The optimum weighting depends on the specific application and has been purposely not specified in the Guide in order to allow the analyst the freedom to select the best weighting.

VIII.5.4 Decision: No change is required

VIII.6.1 Comment ID: Comment-6.

VIII.6.2 Comment: An additional item should be added indicating that the analysis also includes preparation of the basic nuclear cross sections.

VIII.6.3 Response: The DG-1053 analysis does not include the preparation of the basic nuclear data. As indicated in the Guide, the preparation of the multi-group library is included in the Step-3 analysis.

VIII.6.4 Decision: No change is required.

VIII.7.1 Comment ID: Comment-7.

VIII.7.2 Comment: NUREG-4183, "Pressurized Thermal Shock Evaluation of the H. B. Robinson, Unit-2 Nuclear Power Plant," states that the uncertainty value is 30%, rather than the 20% value of DG-1053.

VIII.7.3 Response: The 20% uncertainty is a requirement of 10 CFR 50.61. The larger 30% uncertainty estimate of NUREG-4183 applies to the specific methods and their application in NUREG-4183, and does not necessarily have to satisfy the requirements of 10 CFR 50.61.

VIII.7.4 Decision: No change required.

VIII.8.1 Comment ID: Comment-8.

VIII.8.2 Comment: The Guide should provide specific instructions for determining conservative estimates of the uncertainty in the material compositions and dimensions, used in modeling the core/vessel configuration, when plant-specific data is not available.

VIII.8.3 Response: Providing this level of detail is considered to be overly prescriptive and has been purposely not included in the Guide. In a given application, the necessary degree of conservatism depends on the specific information available on this modeling input. For example, in cases where material compositions are available for very similar materials, or where vessel thickness measurements are available but are limited, a large amount of conservatism may not be required.

VIII.8.4 Decision: No change required.

VIII.9.1 Comment ID: Comment-9.

VIII.9.2 Comment: The Guide states that the latest version of the ENDF/B Evaluated Nuclear Data File should be used if possible. However, while cross section sets based on the latest version of the ENDF/B nuclear data file are available, the Guide allows the use of earlier nuclear data sets (e.g., References 7-11).

VIII.9.3 Response: While it is expected that the latest version of the ENDF/B Evaluated Nuclear Data File will be used, the Guide recognizes that circumstances exist that may prevent the application of the latest nuclear data. Therefore, with appropriate benchmarking (as described in Regulatory Position 1.4) the Guide allows the use of earlier nuclear data sets.

VIII.9.4 Decision: No change is required.

VIII.10.1 Comment ID: Comment-10.

VIII.10.2 Comment: The Guide requires that when the nuclear data changes, the effect of these changes on the fluence methodology should be evaluated to determine if there is a significant effect on the fluence predictions. The determination of the effect of the changes in the nuclear data will require a full implementation of the revised nuclear data and a rebenchmarking of the methodology. This is a costly evaluation.

VIII.10.3 Response: The Guide does not require a complete new implementation and benchmarking of the methodology to evaluate the effect of the nuclear data changes. The evaluation will depend on the specific nuclear data changes made, and in most cases a relatively simple stand- alone analysis can be performed to determine the impact and whether a full implementation is required.

VIII.10.4 Decision: No change is required.

VIII.11.1 Comment ID: Comment-11.

VIII.11.2 Comment: The term "atypical application" is vague. An example or two of atypical applications should be provided.

VIII.11.3 Response: The Guide states here that the cross section libraries were designed for LWR pressure vessel fluence calculations. It is understood that this includes the typical core/vessel configuration materials and geometries. An example of an atypical application is the calculation of the thermal flux.

VIII.11.4 Decision: The text has been modified to include this example.

VIII.12.1 Comment ID: Comment-12.

VIII.12.2 Comment: The Guide provides detailed methods for calculating the fluence and qualifying the methodology. However, no requirements are imposed on the qualification of the codes used to calculate the core neutron source.

VIII.12.3 Response: In practice, the codes presently used to calculate the core neutron source in LWRS are complex physics codes which have been approved by the NRC. The approval of these codes is focused primarily on the in-board fuel assemblies which are generally the thermally limiting fuel assemblies. In addition, while the uncertainty of

the neutron source of the in-board fuel assemblies is generally well known, there are typically a minimum of measurements made for the out-board assemblies. Nevertheless, the uncertainty of the source in these assemblies is required and must be estimated. The uncertainty in these out-board sources is clearly larger than for the in-board assemblies and can be estimated using: (1) calculation-to-measurement power distribution comparisons for full-core maps, especially the difference between central and peripheral locations, (2) assembly-wise calculation-to-measurement axial power distribution comparisons and (3) available comparisons between the approved core calculation and more detailed neutronics calculations for the peripheral fuel assemblies. Also, see Response VI.16.3.

VIII.12.4 Decision No change is required.

VIII.13.1 Comment ID: Comment-13.

VIII.13.2 Comment: When the Guide states that a referenced method "may" be used it should state that "the referenced method is an example of a method that may be used."

VIII.13.3 Response: The text will be changed to indicate that the Reference 16 and 17 lattice methods are examples of the methods that may be used.

VIII.13.4 Decision: The text has been revised.

VIII.14.1 Comment ID: Comment-14.

VIII.14.2 Comment: It is not appropriate to give an upper bound on the number of mesh.

VIII.14.3 Response: The text will be changed so that only a lower limit on the number of mesh is provided.

VIII.14.4 Decision: The text will be changed.

VIII.15.1 Comment ID: Comment-15.

VIII.15.2 Comment: The Guide recommends three intervals per inch, however, the mean neutron path-length is large for >1 MeV neutrons and only two mesh intervals per inch are necessary.

VIII.15.3 Response: Analyses of a large set of benchmark problems and measurements have demonstrated that three intervals per inch provide the necessary accuracy. Additional calculations and verification are required to demonstrate that two mesh per inch are adequate over the required range of applications. This additional verification is outside the scope of the present Guide.

VIII.15.4 Decision: No change is necessary.

VIII.16.1 Comment ID: Comment-16.

VIII.16.2 Comment: The Guide states that "many" of the numerical issues may be evaluated with one-dimensional analyses. However, except for the cross sections, most issues require two-dimensional analyses. The word "many" should be replaced by "some."

VIII.16.3 Response: The comment is valid and the text will be revised.

VIII.16.4 Decision: The text has been revised.

VIII.17.1 Comment ID: Comment-17.

VIII.17.2 Comment: The reference for the statement on p.-14, l-31 (beginning, "In addition....") does not provide the basis for the statement.

VIII.17.3 Response: The reference should be to Reference-5 rather than Reference-6.

VIII.17.4 Decision: The text has been corrected.

VIII.18.1 Comment ID: Comment-18.

VIII.18.2 Comment: If dpa is an acceptable method for extrapolating material damage from the vessel surface to vessel internal locations this should be indicated.

VIII.18.3 Response: The damage attenuation function included in Regulatory Guide 1.99 is based on dpa and is acceptable.

VIII.18.4 Decision: The text has been revised.

VIII.19.1 Comment ID: Comment-19.

VIII.19.2 Comment: The vessel fluence calculations are also sensitive to the cross section data and this data should be added to the list of important input variables.

VIII.19.3 Response: The cross sections will be added to the list of important input variables.

VIII.19.4 Decision: The text has been revised.

VIII.20.1 Comment ID: Comment-20.

VIII.20.2 Comment: The analytic sensitivity analysis cannot determine accuracy but can only determine precision.

VIII.20.3 Response: When all sources of uncertainty are identified, and they are evaluated and propagated through the calculation, the analytic uncertainty analysis provides a valid estimate of the calculational accuracy.

VIII.20.4 Decision: No change is required.

VIII.21.1 Comment ID: Comment-21.

VIII.21.2 Comment: The analytic uncertainty analysis does not appear to provide a method for determining systematic biases.

VIII.21.3 Response: In the analytic uncertainty analysis, the known sources of systematic bias are identified. The magnitude and sign of each bias are determined and then propagated through the calculation. When these individual bias components are combined they provide a valid estimate of the overall known calculational bias. An example of a known systematic calculational bias would be the case where it is discovered, after the calculations have been completed, that the coolant temperature has been systematically overestimated resulting in an overprediction or bias in the vessel fluence.

VIII.21.4 Decision: No change is required.

VIII.22.1 Comment ID: Comment-22.

VIII.22.2 Comment: The fluence benchmark requirement at the vessel T/4 and 3T/4 locations is not necessary since the fluence at these locations may be obtained by an extrapolation of the fluence at the vessel surface.

VIII.22.3 Response: The benchmark at the vessel internal locations provides the validation of the fluence attenuation through thick regions of steel. This is important since the fluence is required at these internal locations and since the core barrel and thermal shield, which have a substantial effect on the vessel fluence, typically have similar compositions.

VIII.22.4 Decision: No change is required.

VIII.23.1 Comment ID: Comment-23.

VIII.23.2 Comment: The calculational benchmark comparisons in which the methods used in the benchmark calculation and those used in the licensee calculation are similar do not provide a verification of the method.

VIII.23.3 Response: While it is recognized that the comparison of the licensee and reference solutions to calculation benchmarks (such as the NUREG/CR-6115 Benchmark Problem) will not identify input errors in assumed operating conditions or component geometry and composition, these comparisons will identify a large class of potential input, numerical, modeling and output processing errors. In view of the importance of the vessel fluence prediction and the complexity of these calculations, the calculational benchmarks are considered necessary for a complete qualification of the calculation methods.

VIII.23.4 Decision: No change is required.

VIII.24.1 Comment ID: Comment-24.

VIII.24.2 Comment: The statement that typical capsule and cavity measurements include relatively large uncertainties is not valid for the vendor laboratories.

VIII.24.3 Response: The statement has been removed.

VIII.24.4 Decision: The text has been revised.

VIII.25.1 Comment ID: Comment-25.

VIII.25.2 Comment: The Guide states that plant-specific biases should not be used unless sufficient reliable measurement data are available. The word "sufficient" is not required.

VIII.25.3 Response: The measured data should not be used to determine the calculational bias unless there is a sufficient number of data to make a statistically meaningful estimate.

VIII.25.4 Decision: No change is required.

VIII.26.1 Comment ID: Comment-26.

VIII.26.2 Comment: The Guide states that as measurements become available, they should be incorporated into the operating reactor measurements data base and the calculational biases and uncertainties should be updated as necessary. It is not possible to determine if the biases and uncertainties need to be updated without performing a complete new reanalysis of the entire measurement data base.

VIII.26.3 Response: If the new measurements are a significant fraction of the existing data-base and the new data differs substantially from the existing data, it can be concluded that the present biases and uncertainties will need to be updated. The determination of the biases and uncertainties does not require a complete new reanalysis of the entire data-base but only requires a determination of the statistical properties (i.e., mean values and standard deviations) of the updated data-base (which includes the new measurement data).

VIII.26.4 Decision: No change is required.

VIII.27.1 Comment ID: Comment-27.

VIII.27.2 Comment: The determination of the overall fluence calculational bias and uncertainty by combining the results of the analytic uncertainty analysis and the benchmark analysis may result in "double counting" of the uncertainties.

VIII.27.3 Response: In the "weighted average" suggested by the Guide, the weighting is normalized so that double counting does not occur when the results are combined.

VIII.27.4 Decision: No change is required.

VIII.28.1 Comment ID: Comment-28.

VIII.28.2 Comment: In the case that the overall calculation uncertainty is greater than 20%, the Guide states that the model must be adjusted or a correction must be applied to the calculated fluence. In the latter case, the fluence determined is not a best-estimate fluence and the best-estimate subscript in Equation-5 should be eliminated.

VIII.28.3 Response: The best-estimate subscript in Equation-5 has been eliminated.

VIII.28.4 Decision: The text has been changed.

VIII.29.1 Comment ID: Comment-29.

VIII.29.2 Comment: Most BWR surveillance capsules include only Cu, Fe and Ni dosimeters. This requirement appears to exclude certain BWR dosimetry from meeting the requirements of this Guide.

VIII.29.3 Response: The text has been changed from "must" to "should."

VIII.29.4 Decision: The text has been changed.

VIII.30.1 Comment ID: Comment-30.

VIII.30.2 Comment: The recent Davis-Besse Benchmark analysis included 306 dosimeters and required a 475 page report to document the uncertainty requested in DG-1053. In view of the large expense in documenting these uncertainty results and the fact that the NRC has the authority to perform an audit of the analysis, the requirement to document the dosimeter measurement uncertainty should be eliminated.

VIII.30.3 Response: While the referenced benchmarking analysis may include a large number of dosimeters, the number of unique dosimeter types is typically small (~ five). It is expected, therefore, that the uncertainty analyses for the dosimeters of a given type will all be identical (or very similar) and may be presented in a single uncertainty table.

It is not the intent of the Guide to subject the respondents to submitting voluminous documents of supporting material. In order to clarify the regulatory position, the following change has been made to page 23. The word "identifies," in line 26, has been replaced with the word "summarizes."

VIII.30.4 Decision: The text has been changed.

VIII.31.1 Comment ID: Comment-31.

VIII.31.2 Comment: Measurement techniques will be validated as part of the initial benchmarking. The laboratories performing these measurements have valid quality assurance programs that consider procedures, equipment and personnel. In the past, the dosimetry measurement uncertainties have not shown any increase with time. Since each fluence measurement will include a comparison with calculation which will identify any increase in measurement uncertainties and since no changes are expected, it is not cost-effective to perform periodic validation of the dosimeter techniques.

VIII.31.3 Response: The comparison to calculation does not provide a reliable means for identifying a measurement bias because of the difficulty in determining whether the calculation or measurement is biased. Also, it is well known that the fluence calculations and measurements are not in very good agreement (i.e., to within ~10%) and that part of this difference may very well be due to biases in the measurements. While the laboratories are required to have quality assurance programs (by Appendix B, 10 CFR Part 50), it is believed that because of the importance of these measurements and to ensure that systematic biases do not enter into the fluence prediction periodic validation measurements should be performed.

VIII.31.4 Decision: No change is required.

VIII.32.1 Comment ID: Comment-32.

VIII.32.2 Comment: Reporting the C/E ratios for the individual dosimeters in the validation process is not necessary since they do not support the calculation-based fluence methodology.

VIII.32.3 Response: The C/Es determined in the validation process provide a quantitative evaluation of the accuracy of the dosimetry measurement techniques. Since these measurement techniques are employed in determining the measurement data used in benchmarking the fluence predictions, they are considered critical to the fluence methodology and its qualification and should be reported.

VIII.32.4 Decision: No change is required.

VIII.33.1 Comment ID: Comment-33.

VIII.33.2 Comment: The discussion concerning the NRC LWR Surveillance Dosimetry Improvement Program (LWR-SDIP) is not necessary.

VIII.33.3 Response: In order to make this discussion more useful, specific references to the series of vessel dosimetry experiments, analyses and inter-laboratory comparisons that were carried out under the NRC LWR Surveillance Dosimetry Improvement Program (LWR-SDIP) have been added.

VIII.33.4 Decision: The text has been revised.

VIII.34.1 Comment ID: Comment-34.

VIII.34.2 Comment: The best-estimate fluence is discussed in Sections 1 and 2 but is not included in the Section 3 reporting requirements.

VIII.34.3 Response: In the case that the calculational uncertainty is greater than 20% and less than 30% (after any model adjustment), the reported Equation-5 fluence is actually not a best-estimate fluence. Consequently, the Section 3.3 reporting requirement is for the vessel inner wall integral fluence.

VIII.34.4 Decision: No change is required.

VIII.35.1 Comment ID: Comment-35.

VIII.35.2 Comment: Reporting of the multi-group fluences is not cost-effective since the calculation of RT_{PTS} does not require these fluences.

VIII.35.3 Response: The multi-group fluences are a standard result of the calculations and are used in determining the > 1-MeV fluence and the RT_{PTS}. These multi-group fluences allow an additional simple verification of the fluence calculation and should be reported.

VIII.35.4 Decision: No change is required.

VIII.36.1 Comment ID: Comment-36.

VIII.36.2 Comment: The qualification of the calculational methods using the > 1-MeV fluence is an obsolete and outdated approach when compared to the approach in which reaction rates from each dosimeter are compared.

VIII.36.3 Response: The Guide allows either of these approaches to be used in the methods qualification. In fact, since the >1-MeV fluence and the reaction rate for a given dosimeter only differ by a cross section ratio, the dosimeter reaction rate comparison gives the same percent M/C difference as the fluence comparison.

VIII.36.4 Decision: No change is required.

VIII.37.1 Comment ID: Comment-37.

VIII.37.2 Comment: The dosimeter "thermal shield" may be confused with the thermal shield component between the vessel and the core barrel.

VIII.37.3 Response: Additional clarification has been added to the text to describe the dosimeter thermal shield used to suppress the thermal-neutron component of the dosimeter response.

VIII.37.4 Decision: The text has been revised.

VIII.38.1 Comment ID: Comment-38.

VIII.38.2 Comment: The Figure-1 description identifies DOT as the transport code. Several other transport codes are available and a note should be added to indicate that DOT is only being used as an example.

VIII.38.3 Response: The figure has been modified to indicate that DOT is only used as an example of a transport code.

VIII.38.4 Decision: The text has been modified.

IX. COMMENTS by E. P. LIPPINCOTT

The following are the resolutions to the comments on DG-1053 provided by E. P. Lippincott in Reference 8.

IX.1.1 Comment ID: Comment-1.

IX.1.2 Comment: The calculation-to-measurement comparisons can only be used to confirm that uncertainty estimates are reasonable.

IX.1.3 Response: The Guide requires that the overall calculational uncertainty be based on a weighted combination of (1) the uncertainty determined by the analytic analysis and (2) the uncertainty determined by the calculation-to-measurement comparisons. The Guide suggests that the combination be a weighted average which accounts for the reliability of each uncertainty estimate. The Guide recognizes that, for example, in the case where only a few calculation-to-measurement comparisons are available, the resulting uncertainty estimate typically will not be as reliable as the analytic uncertainty estimate. Consequently, in this case the uncertainty estimate based on the calculation-to-measurement comparisons would receive reduced weighting.

IX.1.4 Decision: No change is required.

IX.2.1 Comment ID: Comment-2.

IX.2.2 Comment: In the case of highly reliable measurements the DG-1053 methodology reduces to a simple extrapolation of the measurements which appears to contradict the definition of the "absolute" fluence calculation given on p.-4. Can this statement be clarified?

IX.2.3 Response: In this case, the DG-1053 methodology does reduce to a simple extrapolation of the measurements. However, the case cited is considered extremely unlikely and does not require changing the Guide.

IX.2.4 Decision: No change is required.

IX.3.1 Comment ID: Comment-3.

IX.3.2 Comment: There are several techniques that could be used to simplify the analytic uncertainty analysis. These include: (1) use of precalculated estimates of uncertainty for

effects that are small (< 20%) and that have been evaluated for similar applications (2) use of precalculated upper bounds for the various known uncertainty contributors (mesh density, angular mesh, etc.) and (3) use of upper uncertainty bounds, which would be considerably less than 20%, when the geometry is well known.

IX.3.3 Response: The use of precalculated uncertainty data and bounds assumes the referenced values are both correct and applicable. However, the uncertainty contributions depend on (1) the selection of calculational options (mesh density, angular quadrature, etc.) (2) the specific plant configuration (existence of a thermal shield, vessel diameter, etc.) and (3) the specific application (limiting fluence location, BWR versus PWR, etc.).

In view of the difficulty in determining a set of generic bounding uncertainty components, the evaluation/implementation of this approach is outside the scope of the Guide.

It should also be recognized that since the Guide only requires the evaluation of the "significant" uncertainties, the minor uncertainties may be approximated by using precalculated uncertainty values.

IX.3.4 Decision: No change is required.

IX.4.1 Comment ID: Comment-4.

IX.4.2 Comment: (a) The benchmarking requirements of Section 1.4.2 appear to be conflicting. For example: (i) Line-10 states that the calculational methods "must" be validated by comparison with measurement and calculational benchmarks, while Line-11 states that they "should" be validated and (ii) Section 1.4.2.1 uses "should" while Sections 1.4.2.2 and 1.4.2.3 use "may."

(b) While the calculation of the calculational benchmarks may be useful for methods qualification, it will accomplish this only if a sufficient assortment of cases is calculated. Usually, this calculation may not be necessary for methods that meet the standards of this Guide. If left in the Guide, it is suggested that the calculational benchmark be voluntary.

IX.4.3 Response: (a) The resolution is as follows; (i) The "should" in Line-11 has been changed to "must," (ii) The "should" in Section 1.4.2.1 has been changed to "must," and the "may"

in Sections 1.4.2.2 and 1.4.2.3 is used to allow the analyst the freedom to use similar or equivalent measurement and calculation benchmarks, and will not be changed.

(b) While the calculational benchmark problems are not exhaustive, they are considered sufficiently complex to provide the needed level of methods testing and qualification. It is assumed that the methods of DG-1053 will be used and the objective, in part, of the calculational benchmark is to validate the implementation of the methods. In view of the importance of the vessel fluence calculation and the complexity of the analysis and modeling, it is considered essential that the benchmark calculation be performed.

IX.4.4 Decision: No change is required.

IX.5.1 Comment ID: Comment-5.

IX.5.2 Comment: Same as Comment VIII.24.2

IX.5.3 Response: Same as Response-VIII.24.3.

IX.5.4 Decision: Same as Decision-VIII.24.4.

IX.6.1 Comment ID: Comment-6.

IX.6.2 Comment: The statement on p.-19, l-22 concerning the "independent calculation of the benchmark" is unclear.

IX.6.3 Response: Additional text has been added to explain this statement.

IX.6.4 Decision: The text has been revised.

X. COMMENTS BY M. MAHGEREFTEH

The following are the resolutions to the comments on DG-1053 provided by M. Mahgerefteh in Reference 9.

X.1.1 Comment ID: Comment-1.

X.1.2 Comment: Some of the references in DG-1053 refer back to very old documents. Some of these documents have been updated and revised. The Guide should make reference to the more recent documents on the subject.

X.1.3 Response: The suggested references have been added.

X.1.4 Decision: The Guide has been revised to include recent references.

X.2.1 Comment ID: Comment-2.

X.2.2 Comment: DG-1053 includes operating reactors for benchmark qualification, however, the recent Davis-Besse Benchmark Report is not referenced.

X.2.3 Response: The Davis Besse Benchmark Report is proprietary and is not generally available.

X.2.4 Decision: No change is required.

X.3.1 Comment ID: Comment-3.

X.3.2 Comment: Same as Comment-VIII.12.2.

X.3.3 Response: Same as Response-VIII.12.3.

X.3.4 Decision: No change is required.

XI. ELECTRIC POWER RESEARCH INSTITUTE

The following are the resolutions to the comments on DG-1053 provided by Electric Power Research Institute in Reference 10.

XI.1.1 Comment ID: Comment-1.

XI.1.2 Comment: The Guide could be modified to separate topics pertaining to "analysis provisions" and "modeling" provisions. Specifically, the sections discussing the discrete-ordinates method could be presented after the analysis sections. This revision would allow the Guide to be easily updated when the new RAMA (non-discrete-ordinates) method presently being developed becomes available.

XI.1.3 Response: It is not practical at this time to introduce a major rewrite in the Guide to accommodate a method that is still being developed and will require extensive benchmarking, application in a licensing analysis, and NRC review and approval.

XI.1.4 Decision: No change is required.

XI.2.1 Comment ID: Comment-2.

XI.2.2 Comment: The introductory sentence for Section 1.1.2.2 limits the discussion to discrete-ordinates calculations and may be easily generalized to all multi-group transport calculations.

XI.2.3 Response: The text has been revised to eliminate the unnecessary reference to the discrete-ordinates methods.

XI.2.4 Decision: The text has been revised.

XI.3.1 Comment ID: Comment-3.

XI.3.2 Comment: In order to make the Guide more generically applicable to alternate modeling approaches, Lines 16-37 of Section-1.2 should be used in a new section.

XI.3.3 Response: Same as Response-XI.1.3

XI.3.4 Decision: No change is required.

XI.4.1 Comment ID: Comment-4.

XI.4.2 Comment: The Guide states that an octant-symmetric representation is acceptable for the octant-symmetric fuel-loading patterns typically employed in LWRs. However, in some BWRs the positioning of the jet-pumps is only quadrant-symmetric.

XI.4.3 Response: The text has been changed to indicate that for BWRs a quadrant symmetric model is required when the jet-pump positioning is quadrant-symmetric.

XI.4.4 Decision: The text has been changed.

XI.5.1 Comment ID: Comment-5.

XI.5.2 Comment: a) An introduction should be included that recommends three-dimensional transport methods. b) The use of "bootstrap" models should be limited to situations where computer resources prevent the use of single-geometry models.

XI.5.3 Response: a) Three-dimensional transport methods (except for synthesis methods) have had very limited (if any) application to LWR pressure vessel fluence licensing analyses. Consequently, for this version of the Guide, the inclusion of general three-dimensional transport methods is not considered appropriate. b) The bootstrap approach is considered an acceptable method and is not restricted to just those situations which are computer-resource limited.

XI.5.4 Decision: No change is required

XI.6.1 Comment ID: Comment-6.

XI.6.2 Comment: Section 1.3.1 should be modified to allow the extension of the Guide to include general three-dimensional transport methods.

XI.6.3 Response: Same as Response-XI.1.3.

XI.6.4 Decision: No change is required.

XI.7.1 Comment ID: Comment-7.

XI.7.2 Comment: The Introduction to Section 1.3.2 should indicate that the synthesis method can be used when two-dimensional calculations are employed and three-dimensional effects are important.

XI.7.3 Response: The text has been modified to include this statement.

XI.7.4 Decision: The text has been modified.

XI.8.1 Comment ID: Comment-8.

XI.8.2 Comment: Section 1.3.3 should be used to form a new section in order to separate the discussion of the discrete-ordinates transport method and allow the extension of the Guide to include general three-dimensional transport calculations.

XI.8.3 Response: Same as Response-XI.1.3.

XI.8.4 Decision: No change is required.

XII. COMMENTS BY A. HAGHIGHAT

The following are the resolutions to the comments on DG-1053 provided by A. Haghighat in Reference 11.

XII.1.1 Comment ID: Comment-1.

XII.1.2 Comment: The subscript on RT_{PTS} on p.-1, l-30 is incorrect.

XII.1.3 Response: The subscript has been changed.

XII.1.4 Decision: The text has been revised.

XII.2.1 Comment ID: Comment-2.

XII.2.2 Comment: The suggested multi-group cross section libraries include the following approximations: (1) The libraries use an ad-hoc spectrum to collapse the cross section data (2) The spectrum used to collapse the cross section data does not include the effect of the thermal shield and (3) there is an uncertainty introduced by the treatment of the vessel self-shielding.

XII.2.3 Response: The simplifications made in collapsing the cross section data to form the multi-group libraries are typical approximations made in generating these type of libraries. As stated in the Guide, these libraries are acceptable if the methodology has been qualified against benchmark measurements and calculations.

XII.2.4 Decision: No change is required.

XII.3.1 Comment ID: Comment-3.

XII.3.2 Comment: It is not appropriate for the Guide to specify a maximum number of energy groups in the cross section library.

XII.3.3 Response: The implied maximum number of energy-groups has been eliminated from the text.

XII.3.4 Decision: The text has been revised.

XII.4.1 Comment ID: Comment-4.

XII.4.2 Comment: The statement that the libraries include macroscopic cross sections for isotopic data is misleading.

XII.4.3 Response: The statement has been changed to indicate that the macroscopic cross sections are for relevant mixtures.

XII.4.4 Decision: The text has been revised.

XII.5.1 Comment ID: Comment-5.

XII.5.2 Comment: A reference should be provided to support the statement that at least a P-3 Legendre expansion should be used for the scattering cross section.

XII.5.3 Response: An additional reference has been added to support the P-3 expansion requirement.

XII.5.4 Decision: The Guide has been revised.

XII.6.1 Comment ID: Comment-6.

XII.6.2 Comment: An additional reference should be added to Section 1.2 for describing the source preparation.

XII.6.3 Response: An additional reference has been added to describe the source preparation.

XII.6.4 Decision: The Guide has been revised.

XII.7.1 Comment ID: Comment-7.

XII.7.2 Comment: A parenthesis is missing on p.-9, l-28.

XII.7.3 Response: The parenthesis has been added.

XII.7.4 Decision: The text has been revised.

XII.8.1 Comment ID: Comment-8.

XII.8.2 Comment: The Guide should not place a limit on the number of spatial mesh.

XII.8.3 Response: The Guide has been modified to eliminate the implied limit on the number of spatial mesh.

XII.8.4 Decision: The text has been revised.

XII.9.1 Comment ID: Comment-9.

XII.9.2 Comment: On p.-10, in Footnote-6, a reference to the directional Θ-weighted scheme could be included.

XII.9.3 Response: A reference to the Θ-weighted scheme has been included.

XII.9.4 Decision: The Guide has been revised to include the suggested reference.

XII.10.1 Comment ID: Comment-10.

XII.10.2 Comment: The recent reference on the calculational numerics should be added.

XII.10.3 Response: The reference has been added.

XII.10.4 Decision: The Guide has been revised.

XII.11.1 Comment ID: Comment-11.

XII.11.2 Comment: Same as Comment-VIII.16.2.

XII.11.3 Response: Same as Response-VIII.16.3.

XII.11.4 Decision: Same as Decision-VIII.16.4.

XII.12.1 Comment ID: Comment-12.

XII.12.2 Comment: Same as Comment-VIII.17.2.

XII.12.3 Response: Same as Response-VIII.17.2.

XII.12.4 Decision: Same as Decision-VIII.17.4.

XII.13.1 Comment ID: Comment-13.

XII.13.2 Comment: Same as Comment-VIII.19.2.

XII.13.3 Response: Same as Response-VIII.19.3.

XII.13.4 Decision: Same as Decision-VIII.19.4.

XII.14.1 Comment ID: Comment-14.

XII.14.2 Comment: The 20% and 30% uncertainties on p.-20 require references.

XII.14.3 Response: The 20% uncertainty value is the accuracy criteria of 10 CFR 50.61 and a reference is provided at the point it was first introduced on p.-4. The 30% uncertainty value is a limit for the applicability of the methods of this Guide and is not the result of a referenceable calculation.

XII.14.4 Decision: No change is required.

XII.15.1 Comment ID: Comment-15.

XII.15.2 Comment: Same as Comment-VIII.37.2.

XII.15.3 Response: Same as Response-VIII.37.3.

XII.15.4 Decision: Same as Decision-VIII.37.4.

XII.16.1 Comment ID: Comment-16.

XII.16.2 Comment: Please replace Reference-28 with the more recent versions of this work by the same authors.

XII.16.3 Response: The more recent references have been added.

XII.16.4 Decision: The Guide has been revised.

XII.17.1 Comment ID: Comment-17.

XII.17.2 Comment: As a general comment, the Guide does not reference the most recent published work.

XII.17.3 Response: This latest revision to the Guide includes most of the recently suggested references.

XII.17.4 Decision: The Guide has been revised.

REFERENCES

1. "Comments on Draft Regulatory Guides DG-1023, 'Evaluation of Reactor Pressure Vessels with Charpy Upper-Shelf Energy Less than 50 Ft-Lb,' and DG-1025, 'Calculational and Dosimetry Methods for Determining Pressure Vessel Fluence,' " Letter, R.E. Denton (BG&E) to USNRC, dated January 31, 1994.

2. "Neutron Fluence Determination for Light Water Reactor Pressure Vessels," Letter, R. Gold to USNRC, dated December 23, 1993.

3. "Draft Regulatory Guide DG-1025 Calculational and Dosimetry Methods for Determining Pressure Vessel Fluence," Letter, G. H. Goralski (CP) to USNRC, dated November 17, 1993.

4. "Industry Comments on Draft Regulatory Guides DG-1025, 'Evaluation of Reactor Pressure Vessels with Charpy Upper-Shelf Energy Less than 50 Ft-Lb,' and DG-1025, 'Calculational and Dosimetry Methods for Determining Pressure Vessel Fluence,' " Letter, W. H. Rasin (NUMARC) to USNRC, dated January 28, 1994.

5. "Recommended Redraft of DG-1025, 'Calculational and Dosimetry Methods for Determining Pressure Vessel Fluence,' " Letter, W. H. Rasin (NEI) to USNRC, dated April 12, 1994.

6. "Regulatory Guide DG-1025 'Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence,' " Letter, J. H. Taylor (B&W) to USNRC, dated January 21, 1994.

7. "Project Number: 689," Letter, Thomas E. Tipton (NEI) to Michael E. Mayfield (USNRC), dated August 30, 1996.

8. "Comments on the Draft Regulatory Guide DG-1053," Letter, E. P. Lippincott (EPL) to C. Fairbanks (USNRC), dated August 8, 1996.

9. "Comments on the Draft Regulatory Guide DG-1053," Letter, Moussa Mahgerefteh (GPU) to USNRC, dated July 30, 1996.

10. "Comments on Draft Regulatory Guide DG-1053," Letter, Kathleen S. Ramp (EPRI) to Michael E. Mayfield (USNRC), dated September 6, 1996.

11. "Comments on DG-1053," Letter, Alireza Haghighat (PSU) to USNRC, dated July 19, 1996.