10 CFR 50.90

PECO NUCLEAR
A Unit of PECO Energy

PECO Energy Company
200 Exelon Way
Kennett Square, PA 19348

August 10, 2000

Docket No. 50-352

License No. NPF-39

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Subject: Limerick Generating Station, Unit 1
Technical Specifications Change Request No. 00-02-1
Changes to Reactor Pressure Vessel Pressure-Temperature Limits
Supplemental Information

References: (1) Letter from J. A. Hutton (PECO Energy Company) to U.S. Nuclear Regulatory Commission, Limerick Generating Station, Unit 1, Technical Specifications Change Request No. 00-02-1, "Changes to Reactor Pressure Vessel Pressure-Temperature Limits," dated May 15, 2000

(2) GE Nuclear Energy Report GE-NE-B11-00836-00-01 "Pressure-Temperature Curves for PECO Energy Company Limerick Unit 1" dated April 2000 (attachment to Reference 1 letter above)

(3) Letter #BJB-9710R1 from Betty J. Branlund to Bob McCall (PECO Energy), "Limerick Generating Station Unit 1 and 2 First Cycle Beltline Dosimeter Missing Data", GENE (San Jose), November 20, 1997 (retransmitted as Letter #BJB-0010 on July 12, 2000)

Dear Sir/Madam:

In the Reference 1 letter, PECO Energy Company (PECO Energy) requested changes to Appendix A of Facility Operating License No. NPF-39 for Limerick Generating Station (LGS), Unit 1. The proposed changes to LGS, Unit 1, Technical Specifications (TS) Figure 3.4.6.1-1, "Minimum Reactor Vessel Metal Temperature vs. Reactor Vessel Pressure," and associated changes to TS Bases Section 3/4.4.6, revise the pressure-temperature (P-T) limits by revising the heatup, cooldown and inservice test limitations

A001

for the Unit 1 Reactor Pressure Vessel (RPV) to a maximum of 32 Effective Full Power Years (EFPY).

The purpose of this letter is to request interim approval of the 32 EFPY P-T limits until the end of the current operating cycle (i.e., Cycle 9) for LGS Unit 1, currently scheduled for April 2002. In a teleconference between members of the NRC and PECO Energy on July 12, 2000, the NRC indicated that the neutron fluence used to develop the revised P-T limits did not reflect the guidance contained in Draft Regulatory Guide DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," dated September, 1999, and therefore, the NRC could not support approval of the new P-T limits out to 32 EFPY. During subsequent follow-up teleconferences with the NRC, PECO Energy requested interim approval of the P-T limits. Attachment 1 provides the revised "camera-ready" TS page for LGS Unit 1 TS Figure 3.4.6.1-1, "Minimum Reactor Vessel Metal Temperature vs. Reactor Vessel Pressure" which reflects the interim approval request.

During the July 12, 2000 teleconference, the NRC requested the following additional information: data to support the fluence value for Limerick Unit 1 specified in the Reference 2 report; the location of all of the surveillance capsules represented by the data in the Reference 3 letter; the identification of obstructions, if any, between the reactor core and the surveillance capsules identified in the Reference 3 letter; and the location of certain welds identified in the Reference 3 letter. Attachment 2 provides the requested additional information in support of this request for interim approval.

The attached information is being submitted under affirmation, and the required affidavit is enclosed. This supplement does not change the information supporting the finding of No Significant Hazards Consideration and information supporting the need not to perform an Environmental Assessment contained in the Reference 1 letter.

We request approval of this amendment prior to September 21, 2000, to ensure the validity of the P-T limitations and to support continued operation of LGS, Unit 1. If approved, we request that the changes become effective no later than September 21, 2000.

If you have any questions, please do not hesitate to contact us.

Sincerely,

D. B. Helker /FOR

James A. Hutton
Director - Licensing

Attachments

| | | |
|---|---|---|
| cc: | H. J. Miller, Administrator, Region I, USNRC | w/ Attachments |
| | A. L. Burritt, USNRC Senior Resident Inspector, LGS | " |
| | R. R. Janati, PA Bureau of Radiological Protection | w/o Attachments |

COMMONWEALTH OF PENNSYLVANIA :

: ss

COUNTY OF CHESTER :

J. W. Langenbach, being first duly sworn, deposes and says:

That he is Vice President of PECO Energy Company, the Applicant herein; that he has read the enclosed supplement to Technical Specifications Change Request No. 00-02-1, "Changes to Reactor Pressure Vessel Pressure-Temperature Limits," for Limerick Generating Station, Unit 1, Facility Operating License No. NPF-39, and knows the contents thereof; and that the statements and matters set forth therein are true and correct to the best of his knowledge, information and belief.

James W. Langenbach
Vice President

Subscribed and sworn to
before me this 9th day
of August, 2000.

Carol A. Walton
Notary Public

Notarial Seal
Carol A. Walton, Notary Public
Tredyffrin Twp., Chester County
My Commission Expires May 28, 2002
Member, Pennsylvania Association of Notaries

**ATTACHMENT 1**

LIMERICK GENERATING STATION
UNIT 1

DOCKET NO.
50-352

LICENSE NO.
NPF-39

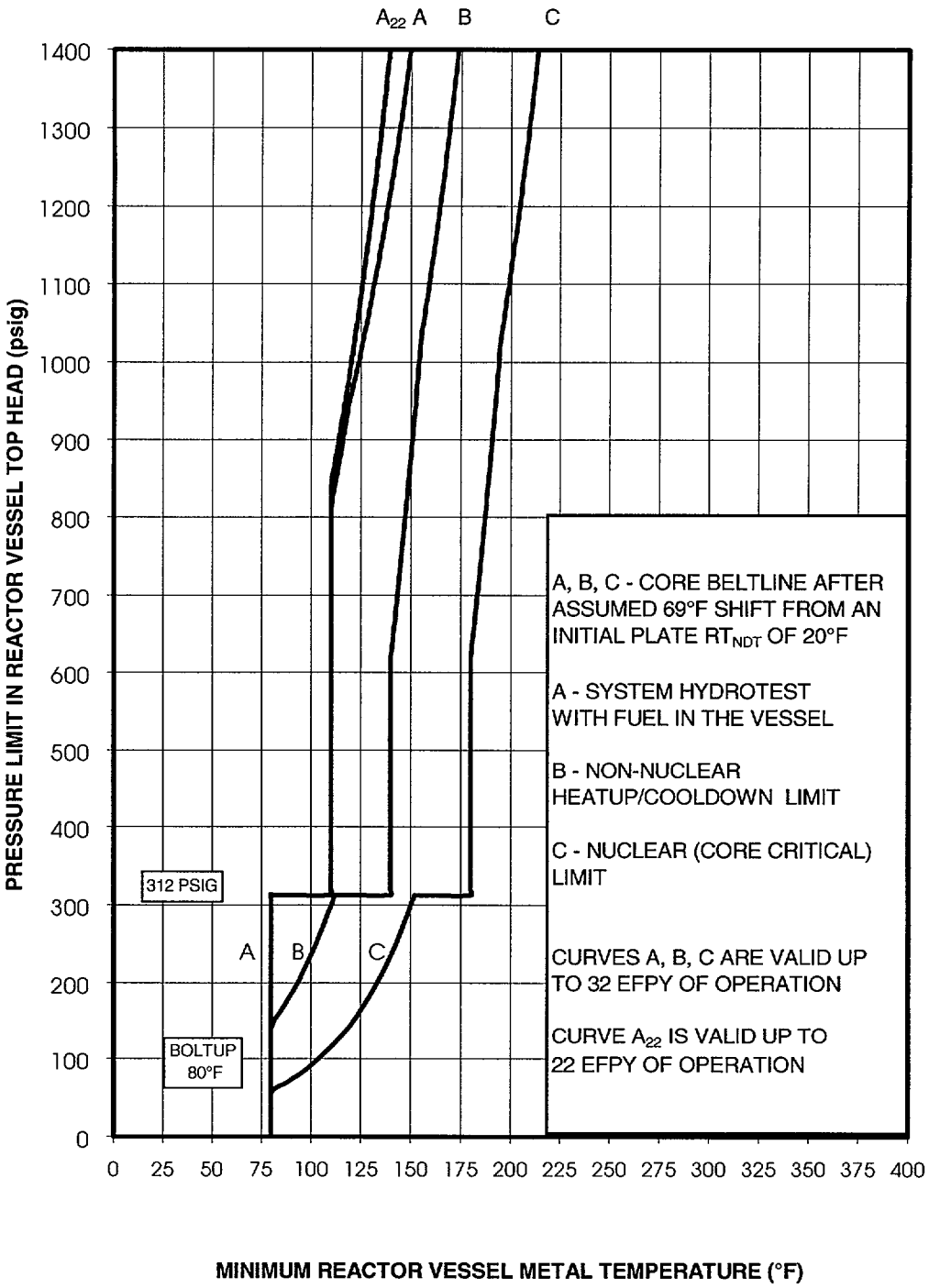
TECHNICAL SPECIFICATIONS CHANGE REQUEST
NO. 00-02-1

August 10, 2000

AFFECTED PAGES
(Camera-ready)

UNIT 1

3/4 4-20




Note: In accordance with NRC Safety Evaluation supporting Amendment No. ____, this Figure is valid through Cycle 9 Operation, currently scheduled to end in April 2002.

MINIMUM REACTOR VESSEL METAL TEMPERATURE VS. REACTOR VESSEL PRESSURE
FIGURE 3.4.6.1-1

**ATTACHMENT 2**

LIMERICK GENERATING STATION
UNIT 1

DOCKET NO.
50-352

LICENSE NO.
NPF-39

TECHNICAL SPECIFICATIONS CHANGE REQUEST
NO. 00-02-1

August 10, 2000

"Changes to Reactor Pressure Vessel Pressure-Temperature Limits"

Supplemental Information Supporting Changes (GE Nuclear Energy letter B13-00836-00-LT06 dated August 9, 2000)

g

*GE Nuclear Energy*

Engineering and Licensing Consulting Services
175 Curtner Avenue M/C 747
San Jose, CA 95125
(408) 925-5945

**B13-00836-00-LT06**
**August 9, 2000**

**TO:** **Steve Leshnoff**

**FROM:** **Lori J. Tilly (original signed)**

**SUBJECT:** **Limerick Generating Station Unit 1 and 2**
**Response to NRC Request for Additional Information**

**REFERENCE:**
1) **Letter from D. W. Diefenderfer to G. M. Zaimis, " Limerick Generating Station Unit 1 Belt Line Dosimeter," GE-NEBO, San Jose, CA, July 15, 1987.**
2) **L.J. Tilly, GE-NE-B11-00836-00-01, Rev. 0, "Pressure-Temperature Curves for PECO Energy Company Limerick Unit 1", GENE (San Jose), April 2000**
3) **Lurie, D. and Moore, R.H., "Applying Statistics", U.S. Nuclear Regulatory Commission, NUREG-1475, February 1994**
4) **Letter #BJB-9710R1 from Betty J. Branlund to Bob McCall (PECO Energy), "Limerick Generating Station Unit 1 and 2 First Cycle Beltline Dosimeter Missing Data", GENE (San Jose), November 20, 1997 (retransmitted as Letter #BJB-0010 on July 12, 2000)**

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## Executive Summary

The Reference 2 report provides pressure-temperature (P-T) curves using updated methodology (Code Cases N-588 and N-640) which are based upon the same fluence as the currently licensed P-T curves. The NRC has requested information in order to better understand the determination of fluence since Limerick Unit 1 and Unit 2 do not have dosimetry data or a fluence calculation using current methodology.

**The revised Table 1 demonstrates that the flux used to determine the predicted capsule fluence for Limerick Units 1 and 2 ($1.6 \times 10^9$ n/cm$^2$-s) contains conservatism of 18% above the measured average of 19 data points with a 95/95 confidence factor of 2.8$\sigma$ ($1.36 \times 10^9$ n/cm$^2$-s).**

**Calculations were performed to determine the impact of fluence on the P-T curves at various EFPYs for Limerick Unit 1. As Table A demonstrates, there is a significant margin between the fluence and the resultant beltline required temperature (i.e., $6.0 \times 10^{17}$ n/cm$^2$ and 18°F, respectively) used for the 32 EFPY P-T curves and for the 17 EFPY P-T curves. It is also shown that the Limerick Unit 1 P-T curves for all EFPYs up to and including 26 EFPY, are not limited by the fluence and are, in fact, limited by the feedwater nozzle discontinuity within the upper vessel curve. Consequently, the 32 EFPY P-T curves add only an additional 6°F to the non-beltline limited upper vessel curve. Hence, applying the 32 EFPY P-T curves [2] to Limerick Unit 1 for operation up to 17 EFPY contains an additional conservatism of 6°F on the non-beltline curve and 18°F on the beltline curve.**

Table 2 provides the surveillance capsule and first cycle dosimeter azimuthal locations for the plants referenced in Table 1.

Table 3 and Figure 1 provide the corresponding obstructions between the capsules and the reactor core. In the case of all of the plants referenced in Table 1, the only obstruction is the 10 inch Schedule 30 Jet Pump Riser Pipe.

Table 4 provides the location of the welds in the Limerick Unit 1 reactor pressure vessel as clarification of the information contained in Table 4-3 of [2].

**Introduction and Background**

A letter was provided to PECO Energy in 1997 [4] discussing the baseline fluence evaluation for both Limerick Units. This information was discussed in a telecon which included the NRC, PECO Energy and GENE on 7/12/00. For convenience, the original text of the 1997 letter is included within this letter (denoted by *Beginning of Original Text* and *End of Original Text*) in addition to the responses to the NRC requested information and other items requested by PECO Energy. The specific information requested follows:

(a) azimuthal location of the surveillance capsules and first cycle dosimeters contained in Table 1 of this letter (which is also part of the original letter),
(b) definition of any obstructions between the reactor core and the surveillance capsules or dosimeters, and
(c) definition of the location of the welds listed in Table 4-3 of [2].

PECO Energy has also requested a normality test of the data presented in Table 1 and the application of a correction factor due to the small sample size. Therefore, the Table 1 in this letter differs from the 1997 letter with respect to the Measured Data Average Plus (factor) Sigma as discussed in the text of this letter. Additionally, PECO Energy requested a discussion of the margin contained in the 32 EFPY P-T curves with respect to

application for a lower EFPY, and clarification as to why three (3) initial $RT_{NDT}$ values changed during the P-T curve evaluation.

The information contained in the original Table 1 has been refined to include 95/95 confidence as defined by NUREG-1475 [3], and as a result of methods used to determine the normality of the data set as discussed below. This caused the flux value of $1.1 \times 10^9$ n/cm$^2$-s for "Measured Data Average Plus 2σ" to be revised to $1.36 \times 10^9$ n/cm$^2$-s, which represents "Measured Data Average Plus **2.8σ**". Specific calculated values are defined below using natural log, with the final flux value transformed to n/cm$^2$-s. Figure 2 provides descriptive statistics of the data contained in Table 1 and demonstrates the normality of the data set.

| | |
|---|---|
| Natural Log Mean of Table 1 Data | 20.2896 |
| Natural Log Standard Deviation of Table 1 Data | 0.2642 |
| Natural Log Mean + 2.8σ where 2.8 derived from [3] | 21.0294 |
| Mean + 2.8σ (transformed to flux) | $1.36 \times 10^9$ n/cm$^2$-s |

In performing the task to create the new P-T curves, initial $RT_{NDT}$ information changed from that previously reported in the FSAR due to a detailed review of the Certified Material Test Report (CMTR) data.

*(Beginning of Original Text)*
In 1987 the Reference 1 report addressed the concern of the missing first cycle flux wire dosimeters for Limerick Unit 1. The purpose of this letter is to update the 1987 letter, include the concern that first cycle flux wires are unavailable for Limerick Units 1 and 2, and provide further information regarding the baseline fluence evaluation. This letter addresses the influence of the unavailable flux wire data on the existing P -T curves particularly in light of the power rerate condition. Finally, compliance with 10CFR50 Appendix H and ASTM E185 including the concern of saturation of the flux wires as discussed in ASTM E185-82 is considered.

**Summary**

The wire test results would be used to confirm that the predicted peak ID surface fluence ($1.7 \times 10^{18}$ n/cm$^2$) used to develop the pre-rerate P-T curves was conservative (note that a fluence of $1.7 \times 10^{18}$ n/cm$^2$ corresponds to a flux of $1.7 \times 10^9$ n/cm$^2$-sec). GE has reviewed the flux wire data collected to-date for numerous BWRs with a 251" vessel ID and 764 fuel bundles and determined that a flux of $1.7 \times 10^9$ n/cm$^2$-sec is conservative. In addition, sufficient data from similar plants exists to address the concern of flux wire saturation. Therefore, the station can be confident that the P-T curves developed using the predicted flux of $1.7 \times 10^9$ n/cm$^2$-sec for rated power and $1.9 \times 10^9$ n/cm$^2$-sec for rerated power are conservative.

**Baseline Predicted Flux and Fluence**

The baseline flux was determined using a generic one dimensional Sn calculation in 1983 for BWR/4&5s with a 251" vessel ID and 764 fuel bundles. The calculated peak vessel ID surface flux at energies greater than 1MeV is 8.5 x $10^8$n/cm$^2$-sec. A safety factor of 2.0 was conservatively applied to establish a baseline predicted flux and end-of-life (EOL) fluence (flux = 1.7 x $10^9$n/cm$^2$- sec and EOL fluence = 1.7 x $10^{18}$n/cm$^2$). Since the lead factors (ratio of capsule flux to vessel ID surface flux) for plants of this size and fuel configuration range between 0.94 and 1.01, then this flux corresponds to a capsule flux of ~1.6 x $10^9$n/cm$^2$- sec (i.e., 1.7 x $10^9$n/cm$^2$- sec*0.94).

Note that in the Reference 1 letter, the predicted flux for some plants was reported to be 1.3 x $10^9$n/cm$^2$-sec. This flux was determined from the same one dimensional Sn calculation, but using a safety factor of 1.5 instead of 2.0. The flux of 1.1 x $10^9$n/cm$^2$-sec corresponds to the 1/4T flux.

**Comparison of Predicted to Measured Data**

Table 1 shows nineteen flux measurements taken between 1978 and 1996; ten measurements were from first cycle dosimeters, while the remaining nine were from capsules withdrawn between 6 and 9 EFPY. The population represents BWR 4 and 5 plants with 764 bundles and a thermal power rating of 3293 and 3323 MWth for the BWR/4 and 5, respectively. The average value of that data is 6.7 x $10^8$n/cm$^2$- sec and the standard deviation is 1.9 x $10^8$n/cm$^2$- sec. Therefore, the predicted flux used to develop the Limerick 1 and 2 P-T curves is well above two standard deviations of the measured data (i.e., 6.7 x $10^8$n/cm$^2$- sec + 2(1.9 x $10^8$n/cm$^2$- sec) = 1.1 x $10^9$n/cm$^2$- sec, measured compared to 1.6 x $10^9$n/cm$^2$- sec, predicted capsule flux). There is a factor of approximately 1.5 between the measured data with two standard deviations and the value used to develop the P-T curves. Also, the predicted capsule flux is 34% greater than the largest measured value (i.e., 1.2 x $10^9$n/cm$^2$- sec * 1.34 = 1.6 x $10^9$n/cm$^2$- sec). Therefore, the P-T curves are conservative.

**Consideration of Power Rerate**

For power rerate the original fluence (1.7 x $10^{18}$n/cm$^2$) was assumed to increase proportional to the increase in power. To be conservative, it was assumed that the power increased from the first day of commercial operation rather than when the power rerate was implemented. Therefore, for the proposed 10% power rerate the fluence was increased by 10% to 1.9 x $10^{18}$n/cm$^2$. Since Limerick Units 1 and 2 are licensed for 5% power rerate (from 3293 MWth to 3458 MWth), the fluence used to develop the P-T curves for power rerate are additionally conservative.

**10CFR50 Appendix H and ASTM E185**

The material surveillance program for both Limerick Units 1 and 2 are designed to meet the intent of ASTM E185-73. There are no requirements with ASTM E185-73 to include

first cycle dosimetry. 10CFR50 Appendix H permits the use of revisions of ASTM E185 up to and including the 1982 version. In ASTM E185-82, although there are no specific requirements for first cycle dosimetry, article 7.3.3 states that separate dosimeter capsules should also be used to monitor radiation conditions independent of the specimen capsules if it is expected that the withdrawal schedule will otherwise result in saturation of the dosimeter activities.

The surveillance capsules for Limerick Units 1 and 2 contain iron and copper wires. The iron wire isotope, Mn-54, has a half-life of 312.5 days. The copper isotope is Co-60, has a half-life of 5.27 years. GE experience with these types of wires, pulled after 10 years of operation has shown that, while the iron wires reached a saturated condition after 4 or 5 years, consistent results with the "non-saturated" copper wires are achieved as long as an accurate daily power history is known. Extending the copper wire dosimetry to a saturated (or nearly saturated) condition is covered in ASTM E261-90, paragraph 9.5, which is referenced from the copper wire dosimetry method, ASTM E523-87. Paragraph 9.5 authorizes the use of the power history in the saturation condition, which will allow measurement of any saturated wire beyond the time of saturation (i.e., ~ 3 years for the iron wire and ~15 years for the copper wire). Based on these methods, saturation is not an issue for Unit 1 and 2 dosimetry. Therefore, there is no requirement nor recommendation for first cycle flux data based on 10CFR50 Appendix H, ASTM E185-73, and ASTM E185-82.

**Conclusion**

The data from similar plants demonstrate there is sufficient conservatism in the predicted fluence for both rated and rerated power. Conservatism in the fluence assures that the P-T curves are not impacted by the fact that the first cycle flux wire data is unavailable for both Limerick Units 1 and 2.
*(End of Original Text)*

**July 2000 NRC Request for Additional Information**

As stated above, the NRC requested three additional items. These items include: (a) the azimuthal location of the surveillance capsules and first cycle dosimeters for the data reported for the plants contained in Table 1, (b) any obstructions between the reactor core and the capsules and dosimeters for the plants contained in Table 1, and (c) the location of the welds listed in Table 4-3 of [2]. Table 2 contains the information requested in item (a), Table 3 contains the information requested in item (b), and Table 4 contains the information requested in item (c). Figure 1 provides a typical arrangement of the reactor core, surveillance capsule, and obstructions.

PECO Energy also requested an explanation for the change in initial $RT_{NDT}$ for the top head and vessel flange, feedwater nozzle, and the limiting weld in the Limerick Unit 1 reactor pressure vessel. All changes occurred as a result of a detailed review of Certified Material Test Report (CMTR) data.

**Discussion of Revisions to Table 1**

At PECO Energy's request, the data provided in Table 1 has been plotted to present the distribution in the data set to demonstrate that it represents a normal distribution, i.e., the P-value is greater than 0.05. In order to demonstrate the normality of this data set, the flux values transformed to natural log. The statistical methods were applied to the natural log values, deriving a P-value of 0.533. The larger the P-value, the greater the confidence that the null hypothesis is true. Since the P-value, 0.533, is much greater than 0.05, the assumption that the distribution is normal is accepted. Figure 2 demonstrates the attributes of the data.

In addition, due to the small sample size of the data set, a correction factor has been determined and applied. This factor of 2.8 was determined using statistical methods provided in NUREG-1475 [3] methods which include 95/95 confidence. As can be seen in Table 1, the Measured Data Average plus 2.8$\sigma$ (where 2.8 is the factor from [3]), while equivalent to the Maximum Measured Value, is still significantly lower than the Predicted ID Surface Flux with a Safety Factor of 2.0.

**Discussion of Margin Inherent in Proposed P-T Curves**

Using the proposed 32 EFPY P-T curves as provided in [2] for operation of Limerick Unit 1 up to approximately 17 EFPY provides additional margin. The following table provides the required hydrotest temperature at an assumed hydrotest pressure of 1100 psig.

Table A

| EFPY | 1/4T Fluence (n/cm$^2$) | Shift (°F) | Beltline (Fluence) Required Temperature (°F) | Limiting Required Temperature (°F) | Limiting Curve |
|---|---|---|---|---|---|
| 32 | 1.3e18 | 69 | 131.6 | 131.6 | Beltline |
| 26 | 1.1e18 | 63 | 125.6 | 125.6 | Upper Vessel and Beltline |
| 22 | 9.0e17 | 58 | 120.6 | 125.6 | Upper Vessel |
| 17 | 7.0e17 | 51 | 113.6 | 125.6 | Upper Vessel |
| 11.5 (current) | 4.7e17 | 41 | 110.0* | 125.6 | Upper Vessel |

*limited by 10CFR50 Appendix G requirement (based on $RT_{NDT}$ +90°F)

As Table A demonstrates, there is a significant margin between the fluence and the resultant beltline required temperature (i.e., 6.0 x $10^{17}$ n/cm$^2$ and 18°F, respectively) used for the 32 EFPY P-T curves and for the 17 EFPY P-T curves. It is also shown that the

Limerick Unit 1 P-T curves for all EFPYs up to and including 26 EFPY, are not limited by the fluence and are, in fact, limited by the feedwater nozzle discontinuity within the upper vessel curve. Consequently, the 32 EFPY P-T curves add only an additional 6°F to the non-beltline limited upper vessel curve. Hence, applying the 32 EFPY P-T curves [2] to Limerick Unit 1 for operation up to 17 EFPY contains an additional conservatism of 6°F on the non-beltline curve and 18°F on the beltline curve. From another perspective, it can be seen that regardless of the EFPY associated with the fluence, Limerick Unit 1 would have to achieve a fluence of $1.1 \times 10^{18}$ n/cm$^2$ before fluence has any effect on the limiting P-T curve requirements. The data in Table 1 demonstrates that, for plants of similar configuration, the fluence used for Limerick Units 1 and 2 is conservative. Additional conservatism is unnecessary due to the fact that fluence is not an issue below 26 EFPY.

**Table 1**
**Flux Wire Measurements from 251" Vessel ID BWR/4&5's**
**With 764 Fuel Bundles**

| Plant ID | Measured Capsule Flux ($N/cm^2$-s) |
|---|---|
| **First Cycle Measurements at Capsule Location** | |
| P | 7.9E+8 |
| J | 8.2E+8 |
| Y | 1.2E+9 |
| AM | 1.0E+9 |
| AW | 6.3E+8 |
| AX | 4.7E+8 |
| AZ | 5.0E+8 |
| AK | 4.8E+8 |
| AH | 4.9E+8 |
| AY | 6.2E+8 |
| **Surveillance Capsule Flux Measurements** | |
| P | 7.50E+08 |
| J | 6.80E+08 |
| Y | 5.90E+08 |
| AW | 6.60E+08 |
| AT | 6.70E+08 |
| AX | 4.41E+08 |
| AZ | 5.22E+08 |
| AK | 6.85E+08 |
| AY | 7.49E+08 |
| Minimum | **4.4E+08** |
| Maximum | **1.2E+09** |
| Average | **Discussed in Text** |
| Standard Deviation | **Discussed in Text** |

| **251" Vessel ID BWR/4&5's With 764 Fuel Bundles** | **Flux ($N/cm^2$-s)** |
|---|---|
| **Predicted ID surface Flux with Safety Factor of 2.0** | **1.7E+09** |
| **Predicted Capsule Flux (ID surface flux * capsule lead factor) (1.7E+09 * 0.94)** | **1.6E+09** |
| **Measured Data Average plus 2.8σ*** | **1.36E+09** |
| **Maximum Measured Value** | **1.2E+09** |

*** 2.8σ derived from NUREG-1475, "Applying Statistics" due to sample size**

**Table 2**

**Surveillance Capsule and First Cycle Dosimeter Locations**

| Plant Code | Capsule Azimuth (°) | First Cycle Dosimeter Azimuth (°) |
|---|---|---|
| P | 120 | 30 |
| J | 30 | 30 |
| Y | 30 | 30 |
| AM | (1) | 30 |
| AW | 30 | 30 |
| AT | 30 | (2) |
| AX | 300 | 30 |
| AZ | 300 | 30 |
| AK | 300 | 30 |
| AH | (1) | 30 |
| AY | 30 | 30 |

(1) Capsules have not been removed for these plants
(2) Data point not included in statistical evaluation

**Table 3**

**Location of Surveillance Capsules/Dosimeters and Corresponding Obstructions**

| Plant | BWR Type | ID (inches) | Number of Fuel Bundles | Azimuth of Specimen Holder Brackets (°) | Specimen Holder Bracket Azimuth Corresponds to a Jet Pump Riser (N2 Nozzle) Azimuth? |
|---|---|---|---|---|---|
| P | 4 | 251 | 764 | 30, 120, 300 | Yes |
| J | 4 | 251 | 764 | 30, 120, 300 | Yes |
| Y | 4 | 251 | 764 | 30, 120, 300 | Yes |
| AM | 4 | 251 | 764 | 30, 120, 300 | Yes |
| AW | 4 | 251 | 764 | 30, 120, 300 | Yes |
| AT | 4 | 251 | 764 | 30, 120, 300 | Yes |
| AX | 5 | 251 | 764 | 30, 120, 300 | Yes |
| AZ | 5 | 251 | 764 | 30, 120, 300 | Yes |
| AK | 5 | 251 | 764 | 30, 120, 300 | Yes |
| AH | 4 | 251 | 764 | 30, 120, 300 | Yes |
| AY | 4 | 251 | 764 | 30, 120, 300 | Yes |

**Table 4**

**Location of Welds in the Limerick Unit 1 Reactor Pressure Vessel[1]**

| Weld Identifier | Weld Direction | Weld Location |
|---|---|---|
| AA[2] | Circumferential | Bottom Head Torus to Shell Ring #1 |
| AB[2] | Circumferential | Shell Ring #1 to Shell Ring #2 |
| AC[2] | Circumferential | Shell Ring #2 to Shell Ring #3 |
| AD[2] | Circumferential | Shell Ring #3 to Shell Ring #4 |
| AE[2] | Circumferential | Shell Ring #4 to Shell Ring #5 |
| AF | Circumferential | Shell Ring #5 to Shell Flange |
| AG | Circumferential | Head Flange to Top Head Torus |
| AH | Circumferential | Top Head Torus to Top Head Dollar Plate |
| AJ | Circumferential | Bottom Head Torus to Bottom Head Dollar Plate |
| BA, BB, BC | Vertical | Shell Ring #1 |
| BD, BE, BF | Vertical | Shell Ring #2 |
| BG, BH, BJ | Vertical | Shell Ring #3 |
| BK, BM | Vertical | Shell Ring #4 |
| BN, BP | Vertical | Shell Ring #5 |
| DA, DB, DC, DD, DE, DF | Vertical | Bottom Head Torus |
| DG | N/A | Bottom Head Dollar Plate |
| DH, DJ, DK, DM, DN, DP | Vertical | Top Head Torus |
| LPCI | N/A | LPCI Nozzle |

(1) as presented in Table 4-3 of GE-NE-B11-00836-00-01, Revision 0, "Pressure Temperature Curves for PECO Energy Company Limerick Unit 1", April 2000, General Electric Company, San Jose, CA
(2) Field Girth Welds

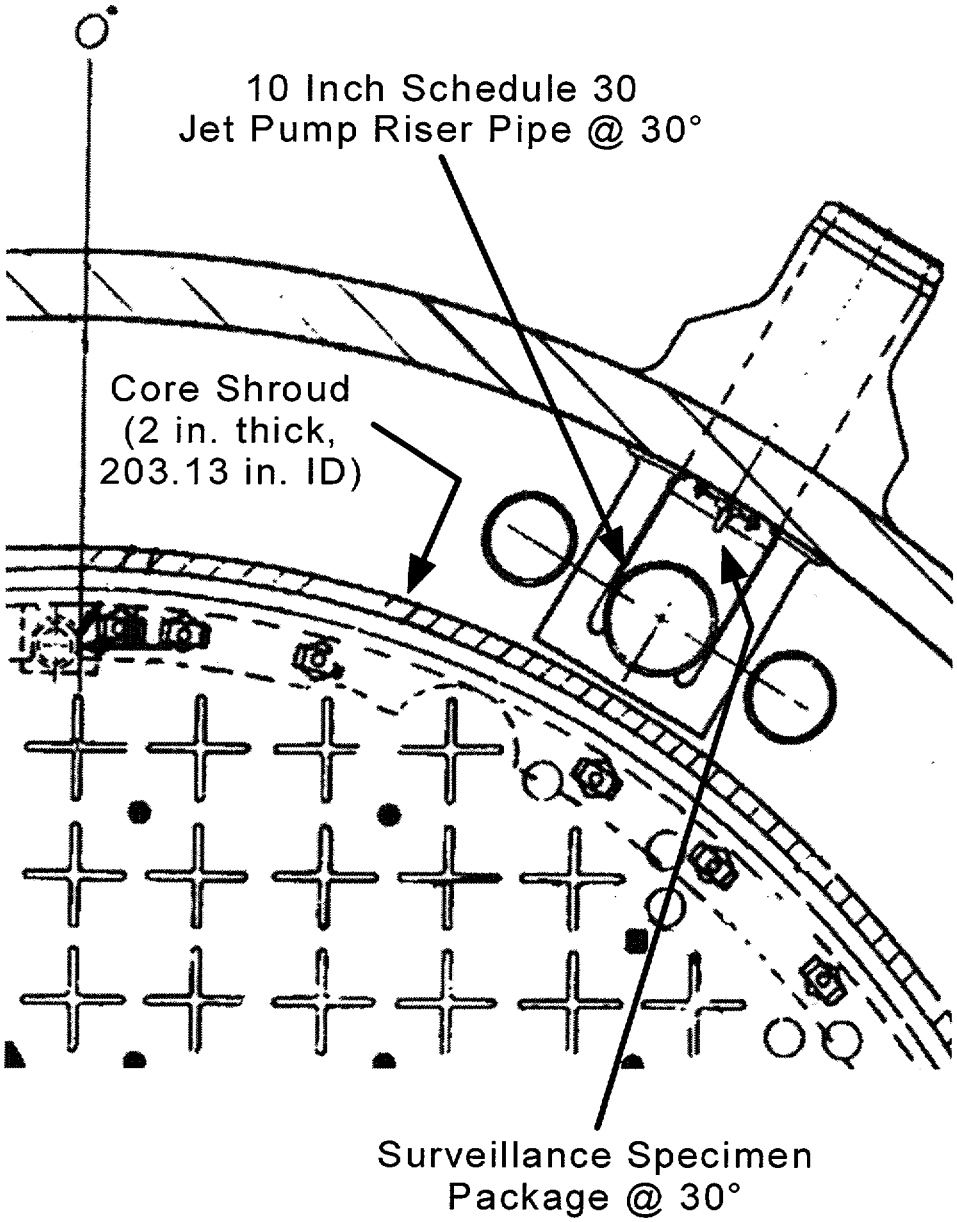
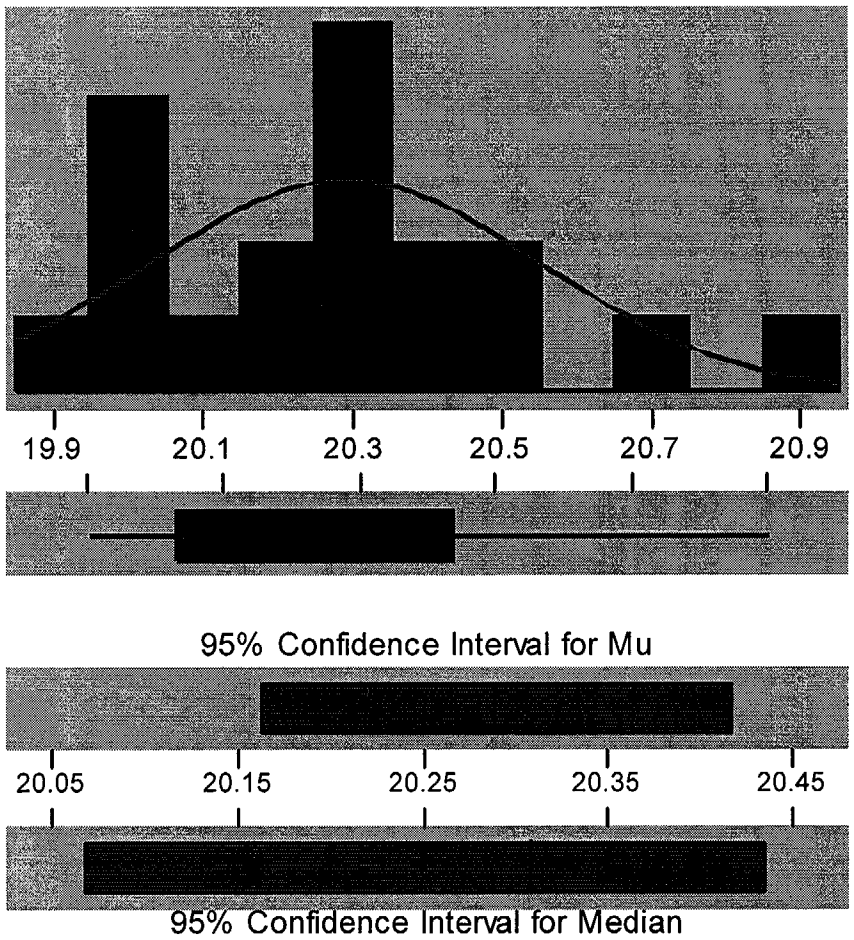



**Figure 1**

**Typical 251" BWR 4/5 Arrangement at 30° Azimuth for Plants Contained in Table 1 (also applicable to 120° and 300° azimuths)**

# Descriptive Statistics




## Variable: ln flux

Anderson-Darling Normality Test

| | |
|---|---|
| A-Squared: | 0.306 |
| P-Value: | 0.533 |
| Mean | 20.2896 |
| StDev | 0.2642 |
| Variance | 6.98E-02 |
| Skewness | 0.588690 |
| Kurtosis | 0.225173 |
| N | 19 |
| Minimum | 19.9046 |
| 1st Quartile | 20.0301 |
| Median | 20.3078 |
| 3rd Quartile | 20.4356 |
| Maximum | 20.9056 |

95% Confidence Interval for Mu

| | |
|---|---|
| 20.1622 | 20.4169 |

95% Confidence Interval for Sigma

| | |
|---|---|
| 0.1997 | 0.3908 |

95% Confidence Interval for Median

| | |
|---|---|
| 20.0673 | 20.4344 |

**Figure 2**
**Flux Data Normality Test**