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AmerGen SM

An Exelon/British Energy Company

10 CFR 50.90
10 CFR 50.12

August 2, 2001
5928-01-20210

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Dear Sir or Madam:

SUBJECT: THREE MILE ISLAND, UNIT 1 (TMI UNIT 1)
OPERATING LICENSE No. DPR-50
DOCKET No. 50-289
ADDITIONAL INFORMATION – REQUEST FOR EXEMPTION TO 10 CFR 50.44; 10 CFR 50, APPENDIX A, GENERAL DESIGN CRITERIA 41; AND 10 CFR 50, APPENDIX E, SECTION VI; AND LICENSE AMENDMENT REQUEST NO. 292 PERTAINING TO THE HYDROGEN CONTROL SYSTEMS

The purpose of this letter is to submit additional information regarding the exemption request and license change associated with AmerGen License Amendment Request No. 292. As requested verbally by the NRC on July 13, 2001, Enclosure 1 provides the AmerGen Calculation No. C-1101-202-E620-427, which calculates the weight of zirconium in the TMI Unit 1 core for determining hydrogen generation by metal-water reaction.

If any additional information is needed, please contact Bob Knight at (717) 948-8554.

Very truly yours,

George Gellrich Jr

Mark E. Warner
Vice President, TMI Unit 1

MEW/mrk

Enclosure: 1) AmerGen Calculation No. C-1101-01-202-E620-427, "Weight Of Zirconium In TMI-1 Core For Determining Hydrogen Generation By Metal-Water Reaction," Revision 0

A001

cc: H. J. Miller, Administrator, USNRC Region I
T. G. Colburn, USNRC Senior Project Manager, TMI Unit 1
J. D. Orr, USNRC Senior Resident Inspector, TMI Unit 1
D. Allard, Director, Bureau of Radiation Protection – PA Department of Environmental Resources
Chairman, Board of County Commissioners of Dauphin County
Chairman, Board of Supervisors of Londonderry Township
File No. 00075

AMERGEN ENERGY COMPANY, LLC

THREE MILE ISLAND, UNIT 1

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Operating License No. DPR-50
Docket No. 50-289
ADDITIONAL INFORMATION – REQUEST FOR EXEMPTION TO 10 CFR 50.44; 10 CFR 50, APPENDIX A, GENERAL DESIGN CRITERIA 41; AND 10 CFR 50, APPENDIX E, SECTION VI AND LICENSE AMENDMENT REQUEST NO. 292 PERTAINING TO THE HYDROGEN CONTROL SYSTEMS

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COMMONWEALTH OF PENNSYLVANIA )

) SS:

COUNTY OF DAUPHIN )

This additional information is submitted in support of Licensee's request to change the Technical Specifications for Three Mile Island, Unit 1 (TMI Unit 1). All statements contained in this submittal have been reviewed, and all such statements made and matters set forth therein are true and correct to the best of my knowledge.

AmerGen Energy Company, LLC

By: Gene Gellrich for Mark Warner
Vice President, TMI Unit 1

Sworn and Subscribed to before me
this 2nd day of August 2001.

Suzanne C. Mikolaich
Notary Public

Notarial Seal
Suzanne C. Mikolaich, Notary Public
Londonderry Twp., Dauphin County
My Commission Expires Nov. 22, 2003
Member, Pennsylvania Association of Notaries

# ENCLOSURE 1

**ADDITIONAL INFORMATION - REQUEST FOR EXEMPTION TO 10 CFR 50.44; 10 CFR 50, APPENDIX A, GENERAL DESIGN CRITERIA 41; AND 10 CFR 50, APPENDIX E, SECTION VI AND LICENSE AMENDMENT REQUEST NO. 292 PERTAINING TO THE HYDROGEN CONTROL SYSTEMS**

**AMERGEN CALCULATION NO. C-1101-01-202-E620-427, "WEIGHT OF ZIRCONIUM IN TMI-1 CORE FOR DETERMINING HYDROGEN GENERATION BY METAL-WATER REACTION," REVISION 0**

**AmerGen**

# CALCULATION COVER SHEET
(Ref. EP-006T)

| Subject: | Calculation No. | Rev. No. | System Nos. | Sheet |
|---|---|---|---|---|
| **Weight of Zirconium in TMI-1 Core for Determining Hydrogen Generation by Metal-Water Reaction** | **C-1101-202-E620-427** | **0** | **202** | 1 of 6 |

1. Is this calculation within the scope of the Operational Quality Assurance Plan? (IF **YES,** a verification is required.) ☒ Yes ☐ No

2. Does this calculation contain assumptions / design inputs that require confirmation? (If **YES,** provide CAP or appropriate configuration control number(s)) (e.g., ECD, PFU, MD, PCR, etc.) _____ ☐ Yes ☒ No

3. Does this calculation require revision to any existing documents? (If yes, provide CAP or appropriate configuration control number(s)) _____ ☐ Yes ☒ No

4. Is this calculation performed as a design basis calculation? (If **YES,** identify design basis parameters.) (See Section 3.3) ☐ Yes ☒ No

Parameter: _____

_____

| Referenced Calculations, Safety Evaluations and Technical Reports (See Section 4.2.3.5) | Rev. No. |
|---|---|
| | |

Comments:

**APPROVALS**

| | |
|---|---|
| **Originator** R. Jaffa Robert Jaffa | **Date** 7-9-01 |
| **Verification Engineer/Reviewer** M. Mahgerefteh Mowafak Mahgerefteh | **Date** 7/9/01 |
| **Section Manager** R. Tropasso R Tropasso | **Date** 7/10/01 |
| **Other Verification Engineer/Reviewer** | **Date** |
| **Other Verification Engineer/Reviewer** | **Date** |

| AmerGen | CALCULATION SHEET (Ref. EP-006T) | | | |
|---|---|---|---|---|
| Subject: **Weight of Zirconium in TMI-1 Core for Determining Hydrogen Generation by Metal-Water Reaction** | **Calculation No.** C-1101-202-E620-427 | **Rev. No** 0 | **System Nos.** 202 | **Sheet** 2 |

## 1.0 PROBLEM STATEMENT

The weight of zirconium in the TMI-1 core is determined for the current operating cycle (Cycle 13) and for future cycles containing a full core of the Mark-B12 fuel design with M5 cladding. Only the zirconium in cladding surrounding the active fuel region is considered, since the purpose of the zirconium weight is a reference for determining the amount of hydrogen generated due to the zirconium metal-water reaction. The maximum amount of hydrogen generated for these core configurations is also determined and compared to the value contained in TMI-1 UFSAR Section 6.5.3.2.a.

## 2.0 SUMMARY OF RESULTS

As of Cycle 13, a bounding value for the weight of zirconium in the TMI-1 core is 41,200 lbs. This weight is based only on the volume of cladding surrounding the active fuel region. Other sources of zirconium in the core (e.g., cladding surrounding the fuel rod plenum, fuel rod end caps, guide tubes and spacer grids) are not included.

The introduction of the Mark-B12 fuel design with M5 cladding into Cycle 14 will reduce the weight of zirconium in the core due to a thinner clad thickness. A bounding value for the weight of zirconium in the TMI-1 core for a full core of Mk-B12 fuel is 39,400 lbs.

The maximum amount of hydrogen generated for the two core configurations examined is 17,500 scf which is bounded by the value of 20,000 scf contained in TMI-1 UFSAR Section 6.5.3.2.a.

## 3.0 REFERENCES


3.1 Framatome Doc. 51-1269121-02, "Fuel Design Licensing Report - TMI-1 Cycle 13," June 17, 1999.

3.2 Framatome Doc. BAW-2388, "Three Mile Island Unit 1 Cycle 14 Reload Report," June 2001.

3.3 USNRC Regulatory Guide 1.7, Rev. 2, "Control of Combustible Gas Concentrations in Containment Following a Loss-of-Colant Accident," November 1978.

3.4 USNRC Standard Review Plan 6.2.5, Rev. 2, "Combustible Gas Control in Containment," July 1981.

3.5 Metals Handbook, Tenth Edition, Volume 2, Properties and Selection: Nonferrous Alloys and Special-Purpose Materials. ASM International. Pp. 666.

| AmerGen | CALCULATION SHEET (Ref. EP-006T) | | | |
|---|---|---|---|---|
| Subject: **Weight of Zirconium in TMI-1 Core for Determining Hydrogen Generation by Metal-Water Reaction** | **Calculation No.** C-1101-202-E620-427 | **Rev. No** 0 | **System Nos.** 202 | **Sheet** 3 |

4.0 ASSUMPTIONS

4.1 An active fuel height of 141.8" is assumed for all Mark-B fuel in the Cycle 13 core This will result in a larger weight of zirconium in the core which is conservative relative to the amount of hydrogen generated by the zirc metal-water reaction.

4.2 Non-zirconium alloying elements are ignored in calculating the weight of zirconium in Zr-4 and M5 cladding. The cladding is assumed to be 100% zirconium. This will result in a larger weight of zirconium in the core which is conservative relative to the amount of hydrogen generated by the zirc metal-water reaction.

4.3 Only the zirconium in the cladding surrounding the active fuel region is considered. Other sources of zirconium in the core (e.g., cladding surrounding the fuel rod plenum, fuel rod end caps, guide tubes and spacer grids) are not included per Reference 3.3.

5.0 DESIGN INPUTS

5.1 TMI-1 Cycle 13 Mark-B Fuel Dimensions [Ref. 3.1]:

| | |
|---|---|
| Active Fuel Length | 141.8" |
| Cladding ID | 0.377" |
| Cladding OD | 0.430" |
| Number of fuel rods | 208 |

5.2 Mark-B12 Fuel Dimensions [Ref. 3.2]:

| | |
|---|---|
| Active Fuel Length | 143.0" |
| Cladding ID | 0.380" |
| Cladding OD | 0.430" |
| Number of fuel rods | 208 |

5.3 Number of assemblies in TMI-1 core 177 FA

5.4 Density of pure reactor grade zirconium 6,500 $kg/m^3$ (or 405.7 $lb/ft^3$) [Ref. 3.5]

5.5 5% of zirconium cladding material undergoes the metal-water reaction per Ref. 3.3 and 10 CFR 50.46.

5.6 One pound of reacted zirconium yields 8.4866 scf of hydrogen per Ref. 3.4.

| AmerGen | CALCULATION SHEET (Ref. EP-006T) | | | |
|---|---|---|---|---|
| Subject: **Weight of Zirconium in TMI-1 Core for Determining Hydrogen Generation by Metal-Water Reaction** | **Calculation No.** C-1101-202-E620-427 | **Rev. No** 0 | **System Nos.** 202 | **Sheet** 4 |

6.0 OVERALL APPROACH AND METHODOLOGY

The volume of zirconium for the two core configurations is calculated using design inputs 5.1 – 5.3 and used to determine the weight of zirconium using design input 5.4. The amount of hydrogen generated by the zirconium metal-water reaction is determined using the larger of the two zirconium weights and design inputs 5.5 – 5.6.

7.0 CALCULATIONS

7.1 Weight of Zirconium in Current Cycle 13 Core

Volume = 177 (FA) * 208 (fuel rods/FA) * 141.8/12 (ft/rod) * Π/4 * $[(0.430/12)^2 - (0.377/12)^2]$ $(ft^2)$

= 101.487 $ft^3$

Weight = volume * density of zirconium

= 101.487 $(ft^3)$ * 405.7 $(lb/ft^3)$

= 41,177.4 lbs. ~ 41,200 lbs.

7.2 Weight of Zirconium in Full Core of Mark-B12 Fuel

Volume = 177 (FA) * 208 (fuel rods/FA) * 143.0/12 (ft/rod) * Π/4 * $[(0.430/12)^2 - (0.380/12)^2]$ $(ft^2)$

= 96.911 $ft^3$

Weight = volume * density of zirconium

= 96.911 $(ft^3)$ * 405.7 $(lb/ft^3)$

= 39,321.0 lbs. ~ 39,400 lbs.

7.3 Amount of Hydrogen Generated by Zirconium Metal-Water Reaction

Hydrogen (scf) = (Maximum weight of zirconium from 7.1 and 7.2) * (fraction of material reacted) * (8.4866 scf H per lb. Zr reacted)

= 41,200 (lbs. Zr) * 0.05 * 8.4866 (scf H/lb Zr)

= 17,482 scf ~ 17,500 scf

| AmerGen | CALCULATION VERIFICATION CHECKLIST (Ref. EP-006T) | | | |
|---|---|---|---|---|
| **Subject:** Weight of Zirconium in TMI-1 Core for Determining Hydrogen Generation by Metal-Water Reaction | **Calculation No.** C-1101-202-E620-427 | **Rev. No.** 0 | **System Nos.** 202 | **Sheet:** 5 |

**Place an "X" in the applicable box (Yes, No, N/A) for each item.**

A **"NO"** response may indicate that the design or verification is incomplete and may require a CAP to be assigned by the responsible Section Manager. The Section Manager shall review each **"NO"** response to determine if the **"NO"** response requires further investigation.

A "N/A" (Not Applicable) response does **not** require any further action by the Verification Engineer.

The Verification Summary (Exhibit 6A) may be used to outline the Verification Engineer's work or to document comments that are deemed appropriate by the Verification Engineer.

| ITEMS | Review Check Design Compliance | | |
|---|---|---|---|
| | Yes | No | N/A |
| 1. **Design Input and Data** – Were the inputs correctly selected, referenced (latest revision) and incorporated into the calculation? | ☑ | ☐ | ☐ |
| 2. **Assumptions** – Are assumptions necessary to perform the calculation adequately described and reasonable? | ☑ | ☐ | ☐ |
| 3. **Regulatory Requirements** – Are the applicable codes and standards and regulatory requirements, including issue and addenda, properly identified and their requirements met? | ☑ | ☐ | ☐ |
| 4. **Construction and Operating Experience** – Has applicable construction and operating experience been considered? | ☑ | ☐ | ☐ |
| 5. **Interfaces** – Have the design interface requirements been satisfied? | ☐ | ☐ | ☑ |
| 6. **Methods** –Is the appropriate calculation method used? | ☑ | ☐ | ☐ |
| 7. **Output** – Is the output reasonable compared to the inputs? | ☑ | ☐ | ☐ |
| 8. **Acceptance Criteria** – Are the acceptance criteria incorporated in the calculation sufficient to allow verification that the design requirements have been satisfactorily accomplished? | ☑ | ☐ | ☐ |
| 9. **Radiation Exposure** – Has the calculation properly considered radiation exposure to the public and plant personnel? | ☐ | ☐ | ☑ |
| 10. **Mathematical Accuracy** – Is the calculation mathematically correct? | ☑ | ☐ | ☐ |

**Comments:**

**AmerGen**

# CALCULATION VERIFICATION PLAN/SUMMARY SHEET

(Ref. EP-006T)

| Subject: | Calculation No. | Rev. No. | System Nos. | Sheet: |
|---|---|---|---|---|
| Weight of Zirconium in TMI-1 Core for Determining Hydrogen Generation by Metal-Water Reaction | C-1101-202-E620-427 | 0 | 202 | 6 of 6 |

## PLAN

**Scope of Verification:**
**TMI-1 Cycle 14 Final Cycle Design including NEMOXS, SHUF and NEMO input/output verification**

| Item No. | Method/Depth of Verification Required | Req'd. Comp. Date |
|---|---|---|
| | (Check Applicable Boxes)<br>Design Review ☒ Alternate Calculation ☐ Qualification Test ☐<br>Other ☐ (Specify below) | |
| 1 | Verify input assumptions are conservative and design inputs are correct. | 7/9/2001 |
| 2 | Verify accuracy of calculation results. | |

**Assigned Verification Engineer** M. Mahgerefteh

**Other Verification Engineer**

## SUMMARY

**Summary of verification scope, methods, results and conclusions:**

The input assumptions wer reviewed and are verifred to be correct and conservative for the purpose of this calculation. Also, all variable and data used for this calculation were checked and verified to be refrenced accurately. Furthermore, all calculation were checked and are correct.

**Based on this evaluation, the calculation is verified to be acceptable.**

**APPROVALS (Sign)**

| | |
|---|---|
| **Assigned Verification Engineer** | **Date** 7/9/01 |
| **Other Verification Engineer** | **Date** |

Use Additional Sheets if Necessary