

10 CFR 50.46

TMI-18-059

May 4, 2018

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

Three Mile Island Nuclear Station, Unit 1  
Renewed Facility Operating License No. DPR-50  
NRC Docket No. 50-289

Subject: 10 CFR 50.46 Annual Report

Reference: 1) Letter from James Barstow (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "10 CFR 50.46 Annual Report," dated May 5, 2017

The purpose of this letter is to submit the 10 CFR 50.46 reporting information for Three Mile Island Nuclear Station (TMI), Unit 1. The most recent annual 50.46 Report for TMI, Unit 1 (Reference 1), provided the cumulative Peak Cladding Temperature (PCT) errors for the most recent fuel designs.

Since the Reference 1 report was issued, a vendor notification of Emergency Core Cooling System (ECCS) model change applicable to TMI, Unit 1, has been issued. AREVA identified an update to the M5<sup>®</sup> swelling and rupture model (SRM) had the potential to impact TMI's SBLOCA and LBLOCA analysis. The analysis concluded that the estimated SBLOCA and LBLOCA PCT impact due to the M5<sup>®</sup> SRM update was 0°F.

Two attachments are included with this letter that provide the current TMI, Unit 1, 10 CFR 50.46 status. Attachment 1 ("Peak Cladding Temperature Rack-Up Sheets") provides updated information regarding the PCT for the limiting SBLOCA and LBLOCA analyses. Attachment 2 ("Assessment Notes") contains a detailed description for each change or error reported.

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No new regulatory commitments are established in this submittal.

If any additional information is needed, please contact Frank Mascitelli at (610) 765-5512.

Respectfully,



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David P. Helker  
Manager, Licensing & Regulatory Affairs  
Exelon Generation Company, LLC

Attachments: 1) Peak Cladding Temperature Rack-Up Sheets  
2) Assessment Notes

cc: USNRC Administrator, Region I  
USNRC Project Manager, TMI, Unit 1  
USNRC Senior Resident Inspector, TMI, Unit 1

**ATTACHMENT 1**

**10 CFR 50.46  
Acceptance Criteria for Emergency Core  
Cooling Systems for Light-Water Nuclear Power Reactors**

**Report of the Emergency Core Cooling System  
Evaluation Model Changes and Errors Assessments**

**Assessments as of May 4, 2018**

**Peak Cladding Temperature Rack-Up Sheets**

**TMI, Unit 1**

PLANT NAME: Three Mile Island Unit 1  
 ECCS EVALUATION MODEL: Small Break Loss of Coolant Accident (SBLOCA)  
 REPORT REVISION DATE: 05/04/2018  
 CURRENT OPERATING CYCLE: 22

**ANALYSIS OF RECORD (AOR)**

Evaluation Model: BWNT<sup>1</sup>  
 Calculation: AREVA NP, 86-9111507-000, August 2009 (Mark-B-HTP with Enhanced Once-Through Steam Generators (EOTSGs))  
 Fuel: Mark-B-HTP  
 Limiting Fuel Type: Mark-B-HTP  
 Limiting Single Failure: Loss of One Train of ECCS  
 Limiting Break Size and Location: 0.07 ft<sup>2</sup> Break in Cold Leg Pump Discharge Piping

Reference Peak Cladding Temperature (PCT) PCT = 1444.0°F

**MARGIN ALLOCATION**

**A. PRIOR LOSS OF COOLANT ACCIDENT (LOCA) MODEL ASSESSMENTS**

|  |              |
|--|--------------|
| Annual 10 CFR 50.46 Report dated May 16, 2007 (See Note 1)       | ΔPCT = 0 °F  |
| Annual 10 CFR 50.46 Report dated May 15, 2009 (See Note 3)       | ΔPCT = 0 °F  |
| Annual 10 CFR 50.46 Report dated May 14, 2010 (See Note 4)       | ΔPCT = 0 °F  |
| 30-Day 10 CFR 50.46 Report dated September 7, 2010 (See Note 5)  | ΔPCT = 225°F |
| Annual 10 CFR 50.46 Report dated May 13, 2011 (See Note 6)       | ΔPCT = 0 °F  |
| 30-Day 10 CFR 50.46 Report dated March 21, 2012 (See Note 7)     | ΔPCT = 0 °F  |
| Annual 10 CFR 50.46 Report dated May 11, 2012 (See Note 8)       | ΔPCT = 0 °F  |
| Annual 10 CFR 50.46 Report dated May 10, 2013 (See Note 9)       | ΔPCT = 0 °F  |
| Annual 10 CFR 50.46 Report dated May 9, 2014 (See Note 10)       | ΔPCT = 0 °F  |
| 30-Day 10 CFR 50.46 Report dated December 22, 2014 (See Note 11) | ΔPCT = 0°F   |
| Annual 10 CFR 50.46 Report dated May 8, 2015 (See Note 12)       | ΔPCT = 0°F   |
| Annual 10 CFR 50.46 Report dated May 6, 2016 (See Note 13)       | ΔPCT = 0°F   |
| Annual 10 CFR 50.46 Report dated May 5, 2017 (See Note 14)       | ΔPCT = 0°F   |

**NET PCT** **PCT= 1669.0°F**

**B. CURRENT LOCA MODEL ASSESSMENTS**

|   |                |
|---|----------------|
| M5 <sup>®</sup> Swelling and Rupture Model Update (See Note 15) | ΔPCT = 0°F     |
| Total PCT change from current assessments                       | Σ ΔPCT = 0°F   |
| Cumulative PCT change from current assessments                  | Σ  ΔPCT  = 0°F |

**NET PCT** **PCT= 1669.0°F**

<sup>1</sup> The BWNT EM is based on RELAP5/MOD2-B&W.

PLANT NAME: Three Mile Island Unit 1  
 ECCS EVALUATION MODEL: Large Break Loss of Coolant Accident (LBLOCA)  
 REPORT REVISION DATE: 05/04/2018  
 CURRENT OPERATING CYCLE: 22

**ANALYSIS OF RECORD (AOR)**

Evaluation Model: BWNT<sup>2</sup>  
 Calculation: AREVA NP, 86-9111507-000, August 2009 (Mark-B-HTP with EOTSGs)  
 Fuel: Mark-B-HTP  
 Limiting Fuel Type: Mark-B-HTP  
 Limiting Single Failure: Loss of One Train of ECCS  
 Limiting Break Size and Location: Guillotine Break in Cold Leg Pump Discharge Piping

Reference Peak Cladding Temperature (PCT) PCT = 1890°F

**MARGIN ALLOCATION**

**A. PRIOR LOCA MODEL ASSESSMENTS**

|  |                            |
|--|----------------------------|
| Annual 10 CFR 50.46 Report dated May 16, 2007 (See Note 1)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 15, 2008 (See Note 2)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 15, 2009 (See Note 3)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 14, 2010 (See Note 4)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 13, 2011 (See Note 6)       | $\Delta PCT = 0^\circ F$   |
| 30-Day 10 CFR 50.46 Report dated March 21, 2012 (See Note 7)     | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 11, 2012 (See Note 8)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 10, 2013 (See Note 9)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 9, 2014 (See Note 10)       | $\Delta PCT = 0^\circ F$   |
| 30-Day 10 CFR 50.46 Report dated December 22, 2014 (See Note 11) | $\Delta PCT = +18^\circ F$ |
| Annual 10 CFR 50.46 Report dated May 8, 2015 (See Note 12)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 6, 2016 (See Note 13)       | $\Delta PCT = 0^\circ F$   |
| Annual 10 CFR 50.46 Report dated May 5, 2017 (See Note 14)       | $\Delta PCT = 0^\circ F$   |

**NET PCT PCT= 1908.0°F**

**B. CURRENT LOCA MODEL ASSESSMENTS**

|   |                                   |
|---|-----------------------------------|
| M5 <sup>®</sup> Swelling and Rupture Model Update (See Note 15) | $\Delta PCT = 0^\circ F$          |
| Total PCT change from current assessments                       | $\Sigma \Delta PCT = 0^\circ F$   |
| Cumulative PCT change from current assessments                  | $\Sigma  \Delta PCT  = 0^\circ F$ |

**NET PCT PCT= 1908.0°F**

<sup>2</sup> The BWNT EM is based on RELAP5/MOD2-B&W.

**ATTACHMENT 2**

**10 CFR 50.46  
Acceptance Criteria for Emergency Core  
Cooling Systems for Light-Water Nuclear Power Reactors**

**Report of the Emergency Core Cooling System  
Evaluation Model Changes and Errors Assessments**

**Assessments as of May 4, 2018**

**Peak Cladding Temperature Rack-Up Sheets**

**TMI, Unit 1**

**Assessment Notes**

#### 1. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 16, 2007 reported an evaluation for a LOCA model change which resulted in a 0 °F PCT change. The reported evaluation considered the effect on the containment pressure response for LOCA due to GSI-191 related reactor building sump screen replacement. The evaluation resulted in 0 °F impact for LBLOCA and SBLOCA PCTs.

#### 2. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 15, 2008 reported an evaluation for LOCA model change which resulted in a 0 °F PCT change. Reported change included the impact of an energy deposition factor error which resulted in a LBLOCA PCT impact of 0 °F.

#### 3. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 15, 2009 reported no evaluations or PCT penalties for either SBLOCA or LBLOCA.

#### 4. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 14, 2010 reported a change to the reference PCT value for LBLOCA due to the final discharge of all Mark-B9 fuel.

Also identified in this report was a new SBLOCA analysis, implemented beginning with the Cycle 18 operation. This SBLOCA analysis was evaluated with the mixed core of Mark-B12 and Mark-B-HTP and a new PCT of 1444°F was calculated for the limiting Mark-B-HTP fuel type, which bounds the Mark-B12 fuel type. This analysis also includes consideration of the effect of reduced EDW wetting associated with the Enhanced Once-Through Steam Generators (EOTSGs).

#### 5. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated September 7, 2010 reported an evaluation for the SBLOCA analysis due to a non-bounding axial power shape from middle-of-cycle to end-of-cycle conditions. This resulted in a PCT increase of 225°F. The large break LOCA is not affected in this report.

#### 6. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 13, 2011 reported no evaluations or PCT penalties for either SBLOCA or LBLOCA.

#### 7. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated March 21, 2012 reported two changes to the TMI LOCA model. One consisted of an error in the ECCS Bypass Calculation that affected the LBLOCA analysis. The second change consisted of correcting the Upper Plenum Column Weldment Model which affected both the SBLOCA and LBLOCA analysis. The results of both of these changes were a 0°F PCT impact for both SBLOCA and LBLOCA.

#### 8. Prior LOCA Model Assessment

With the Cycle 19 reload, all Mark-B12 fuel types were discharged from the core. Currently, the limiting fuel type is Mark-B-HTP for both SBLOCA and LBLOCA. The limiting PCT for LBLOCA has been updated to 1890°F in accordance with our referenced calculation (86-9111507-000). All previous PCT assessments that are not applicable to Mark-B-HTP fuel have been removed.

The 10 CFR 50.46 report dated May 11, 2012 reported no evaluations or PCT penalties for either SBLOCA or LBLOCA.

#### 9. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 10, 2013 reported no evaluations or PCT penalties for either SBLOCA or LBLOCA.

#### 10. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 9, 2014 reported no evaluations or PCT penalties for either SBLOCA or LBLOCA.

#### 11. Prior LOCA Model Assessment

The 30-day 10 CFR 50.46 report dated December 22, 2014 reported a significant error due to thermal conductivity degradation (TCD) based on insufficient LOCA fuel temperature inputs in TACO-3/GDTACO computer codes. Correction of the TCD modeling in TACO-3/GDTACO results in a conservative increase of 393F in peak cladding temperature (PCT) for LBLOCA. The SBLOCA analyses are not sensitive to initial fuel temperature and therefore have an estimated PCT impact of 0°F.

Additionally, TMI has implemented a 2 kw/ft penalty to LHR limits in Cycle 20 (10/20/14). The penalty has been applied through more restrictive operational imbalance limits and results in a reduction of PCT by 375°F for LBLOCA.

The overall cumulative impact for the error and the design input change is 0°F for SBLOCA and 18°F for LBLOCA.

#### 12. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 8, 2015 reported no evaluations or PCT penalties for either SBLOCA or LBLOCA.

#### 13. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 6, 2016 reported the reactor coolant system (RCS) flow rate used in the TMI Unit 1 SBLOCA analysis (106.5% of design flow) is inconsistent with the RCS flow rate used in the departure-from-nucleate (DNB) analysis (104.5% of design flow). Additionally, a lower RCS flow rate was used in the LBLOCA analysis (102% of design flow) than that in the at-power minimum DNB analysis (104.5% of design flow). LOCA analyses are performed using the AREVA LOCA evaluation model (EM) BAW-10192P-A, which is the



applicable LOCA EM for TMI Unit 1, and are required to use the RCS flow rate that is used in the at-power minimum DNB analysis. The SBLOCA and LBLOCA RCS flow rate inconsistency assessments were estimated to be a 0 °F PCT impact.

#### 14. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated May 5, 2017 reported no evaluations or PCT penalties for either SBLOCA or LBLOCA.

#### 15. Current LOCA Model Assessment

On August 7, 2017, AREVA identified an update to the M5<sup>®</sup> swelling and rupture model (SRM) had the potential to impact TMI's SBLOCA and LBLOCA analysis.

M5<sup>®</sup> SRM is used in several of AREVA LOCA methodologies and since approval of the M5<sup>®</sup> SRM in the M5<sup>®</sup> Licensing Topical Report, BAW-10227, Rev. 1 (P)(A) by the NRC in the early 2000s, additional M5<sup>®</sup> cladding rupture test data was obtained. Following the same approach as the original model, an updated M5<sup>®</sup> SRM was developed to consider the new test data. The model changes do not change the predicted occurrence or conditions at the time of rupture, but would impact the post-rupture cladding characteristics for certain rupture temperatures.

The estimated SBLOCA and LBLOCA PCT impact due to the M5<sup>®</sup> SRM update was 0°F.