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Proprietary Information – Withhold Under 10 CFR 2.390

10 CFR 50.46

April 8, 2020
NRC-20-0010

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

Fermi 2 Power Plant
NRC Docket No. 50-341
NRC License No. NPF-43

Subject: Submittal of Plant Specific Emergency Core Cooling System (ECCS) Evaluation Model Reanalysis

References: 1) DTE Letter to NRC, "Submittal of Plant Specific Emergency Core Cooling System (ECCS) Evaluation Model Reanalysis," NRC-17-0016, dated February 13, 2017 (ML17045A668)

2) DTE Letter to NRC, "Submittal of 2018 Safety Relief Valve Challenge Report, Main Steam Bypass Lines Report, and ECCS Cooling Performance Evaluation Model Changes or Errors Report," NRC-19-0018, dated April 18, 2019 (ML19108A384)

In accordance with 10 CFR 50.46(a)(3), DTE Electric Company (DTE) submits a reanalysis for the plant specific Emergency Core Cooling System (ECCS) evaluation for Fermi 2.

DTE submitted the previous reanalysis in Reference 1. Subsequently, in Reference 2, DTE identified no changes or errors in the ECCS cooling performance evaluation model since that submitted in Reference 1.

In support of GNF3 new fuel introduction General Electric – Hitachi (GEH) prepared a new analysis using TRACG-LOCA methodology. DTE has now adopted this new analysis and is therefore submitting it to establish a new Licensing Basis Peak Clad Temperature (LBPCT)

using the TRACG-LOCA methodology for the GE14 and GNF3 fuel types. A summary of the current model assessment and results is provided in Enclosure 1.

Enclosure 3 contains proprietary information as defined by 10 CFR 2.390. GEH, as the owner of the proprietary information, has executed the affidavit in Enclosure 2, which identifies that the enclosed proprietary information has been handled and classified as proprietary, is customarily held in confidence, and has been withheld from public disclosure. A non-proprietary version of the documentation in Enclosure 3 is provided in Enclosure 4.

No new commitments are made in this letter.

Should you have any questions or require additional information, please contact Ms. Margaret (Peg) Offerle, Manager – Nuclear Licensing, at (734) 586-5076.

Sincerely,

Peter Dietrich
Senior Vice President and Chief Nuclear Officer

Enclosures:
1) Current LOCA Model Assessment for GE14 & GNF3 Fuels
2) GEH Affidavit for NEDC-33919P
3) NEDC-33919P – PROPRIETARY
4) NEDO-33919 – NON-PROPRIETARY

cc:

NRC Project Manager
NRC Resident Office
Regional Administrator, Region III

Enclosure 1 to
NRC-20-0010

Fermi 2 NRC Docket No. 50-341
Operating License No. NPF-43

Current LOCA Model Assessment for GE14 & GNF3 Fuels

Plant Name:	Fermi 2
ECCS Evaluation Model:	TRACG-LOCA
New Analysis Approval Date:	March 20, 2020
Current Operating Cycle:	Refueling Outage Prior to Cycle 21

Analysis of Record

Evaluation Model:
1. NEDE-33005P-A, Rev. 2, "TRACG Application for Emergency Core Cooling Systems / Loss-of-Coolant-Accident Analysis for BWR/2-6," May 2018.
2. NEDC-33256P-A, NEDC-33257P-A, NEDC-33258P-A, Rev. 1, "The PRIME Model for Analysis of Fuel Rod Thermal-Mechanical Performance," September 2010.
3. NEDE-32176P, Rev. 4, "TRACG Model Description," January 2008.
4. NEDE-20566-P-A, "Analytical Model for Loss-of-Coolant Analysis in Accordance with 10CFR50 Appendix K," September 1986.

Calculation:
1. 005N1475-R1, "DTE Energy Enrico Fermi 2 TRACG ECCS Loss-of-Coolant Accident (LOCA) Analysis," dated November 2019.

Results:
- **Fuels Analyzed in Calculation:** GNF3 and GE14
- **Limiting Single Failure:** Division II Battery Power
- **Limiting Break Size and Location:** Small break in recirculation line
- **Licensing Basis PCT:** 1980°F for GE14 fuel and 2150°F for GNF3 fuel

Previous Analysis

- **Licensing Basis PCT from Previous Analysis of Record (NRC-17-0016):** 1980°F (GE14 only)

**Enclosure 2 to
NRC-20-0010**

**Fermi 2 NRC Docket No. 50-341
Operating License No. NPF-43**

GEH Affidavit for NEDC-33919P

GE-Hitachi Nuclear Energy Americas, LLC

AFFIDAVIT

I, Kent E. Halac, state as follows:

(1) I am a Senior Engineer, Regulatory Affairs, Global Nuclear Fuel – Americas, LLC ("GNF-A"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in GEH Report, NEDC-33919P, Revision 0*, DTE Energy Enrico Fermi Unit 2, TRACG ECCS Loss-of-Coolant Accident (LOCA) Analysis,* January 2020. The proprietary information in NEDC-33919P, Revision 0*,* is identified by a dotted underline within double square brackets. [[This sentence is an example.{3}]] GEH proprietary information in figures and large objects is identified with double square brackets before and after the object. In all cases, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F2.d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2.d 1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer–funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. above.

(5) To address the 10 CFR 2.390 (b) (4), the information sought to be withheld is being submitted to the NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) above, is classified as proprietary because it contains detailed GEH information regarding the TRACG-LOCA methodology used in the analysis of the GEH Boiling Water Reactor (BWR). Development of these methods, techniques, and information and their application for the design and analyses methodologies and processes was achieved at a significant cost to GEH.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH’s competitive position and foreclose or reduce the availability of profit–making opportunities. The fuel design and licensing methodology is part of GEH’s comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC–approved methods.

The research, development, engineering, analytical, and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 24th day of January 2020.

Kent E. Halac
Senior Engineer, Regulatory Affairs
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Enclosure 4 to
NRC-20-0010

Fermi 2 NRC Docket No. 50-341
Operating License No. NPF-43

NEDO-33919 – NON-PROPRIETARY
DTE Energy Enrico Fermi 2 TRACG ECCS Loss-of-Coolant Accident Analysis

GE Hitachi Nuclear Energy

NEDO-33919
Revision 0
January 2020

DTE Energy
Enrico Fermi Unit 2

TRACG ECCS
Loss-of-Coolant Accident (LOCA) Analysis

INFORMATION NOTICE

This is a non-proprietary version of NEDC-33919P Revision 0 which has the proprietary information removed. Portions of the document that have been removed are indicated by an open and closed double square bracket as shown here [[ ]].

IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

Please Read Carefully

The design, engineering, and other information contained in this document are furnished for the purpose of plant DTE Electric Company Fermi Unit 2 TRACG-LOCA Licensing Implementation. The use of this information by anyone other than DTE Fermi, or for any purpose other than that for which it is furnished by GEH is not authorized; and with respect to any unauthorized use, GEH makes no representation or warranty, express or implied, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document, or that its use may not infringe privately owned rights.

REVISION SUMMARY

Rev #	Section Modified	Revision Summary
0		Initial release

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SUMMARY

The GE Hitachi (GEH) TRACG-LOCA evaluation model (EM) is documented in Licensing Topical Report (LTR) NEDE-33005P-A, Revision 2. The United States Nuclear Regulatory Commission (NRC) approved the TRACG-LOCA EM to evaluate four out of the five licensing acceptance criteria for Emergency Core Cooling Systems (ECCS) specified in 10 CFR 50.46, for GEH boiling water reactor (BWR) types BWR/2 – BWR/6. In particular, for all specified loss-of-coolant accidents (LOCA), the EM must demonstrate with high probability and high confidence that: (1) the transient overall core peak cladding temperature (PCT) does not exceed 2200 °F, (2) the maximum local fuel cladding oxidation (MLO), as a fraction of the cladding that has been oxidized, is less than 17%, (3) the total fraction of fuel cladding oxidized in the core (CWO) is less than 1%, and (4) the fuel must remain in a coolable geometry. The TRACG-LOCA EM utilizes a best estimate plus uncertainty approach to establish that criteria (1) – (3) have all been met with at least a 95% probability with 95% confidence. The methodology then prescribes that meeting criteria (1) – (3) establishes that criteria (4) is also met. The fifth criteria, for long term core cooling, is not addressed by the TRACG-LOCA EM.

Most recently, the SAFER/PRIME-LOCA EM was used to establish the Fermi 2 licensing basis PCT, MLO, and CWO for the GE14 fuel product line in NEDC-33865P [9]. The licensing basis values for GE14 are superseded with the implementation of TRACG-LOCA.

The TRACG computer program utilizes more advanced two-phase flow modeling than SAFER. Additionally, TRACG allows for much greater model detail in the core and the vessel, as well as for modeling of piping attached to the exterior of the vessel. This model sophistication, combined with an extensive qualification basis, leads to the assertion that a nominal TRACG calculation of the LOCA transient represents a best estimate. The important uncertainties in models, plant parameters, and initial conditions are either accounted for by using bounding values or by randomly sampling from prescribed probability distributions in a large number of statistical analysis trials. For Fermi 2, the TRACG-LOCA EM results in limiting PCT results for small recirculation line breaks.

TRACG-LOCA models were developed for Fermi Unit 2. Using these models, nominal LOCA calculations, known as the break spectra, were performed for the GNF3 fuel product line to find the potentially limiting initial conditions, single failures, break locations, and break sizes. Statistical analyses, consisting of a large number of trials with randomly perturbed model and plant parameters and initial conditions, were then performed for the potentially limiting breaks. The results from the statistical analyses were used to determine the licensing basis PCT, MLO, and CWO for GE14 and GNF3.

For SAFER Fermi 2 LOCA analyses, the small recirculation line breaks for Division I DC Power Source (Div I Battery) failure were limiting. Similarly, the TRACG-LOCA licensing basis PCT is set by the small recirculation line break as well. TRACG-LOCA predictions show that Division II DC Power Source (Div II Battery) failure is the limiting failure. All licensing basis values are within prescribed limits.

1.0 INTRODUCTION

This report provides the results of the loss-of-coolant accident (LOCA) analysis performed by GE Hitachi Nuclear Energy (GEH) for plant Fermi Unit 2 (or Fermi 2). The analysis was performed using the TRACG-LOCA evaluation model (EM) approved by the United States Nuclear Regulatory Commission (NRC) ([5], [6]). This is the second application of TRACG-LOCA to a domestic jet pump plant boiling water reactor (BWR). The analysis was performed assuming a maximum core thermal power corresponding to the current licensed thermal power, plus power uncertainty, of 3,499 MW. The analysis considers all licensed initial power/flow conditions and 24-month cycle operation.

This LOCA analysis was performed in accordance with NRC requirements to demonstrate conformance with the ECCS acceptance criteria of 10 CFR 50.46. A key objective of the LOCA analysis is to provide assurance that the most limiting break size, break location and single failure combination has been considered. The TRACG-LOCA method described in Licensing Topical Report (LTR) NEDE-33005P-A, Revision 2 ([2]) is followed to satisfy these requirements.

The TRACG-LOCA EM process is demonstrated for a BWR/4 (jet pump plant similar to Fermi 2) in [2]. The process consists of two main parts. First, potentially limiting LOCA cases are determined by performing nominal best estimate calculations across the break spectra. Second, a statistical analysis is performed for each potentially limiting break. The statistical analysis consists of a large number of statistical trials for which the important model and plant parameters and initial conditions have been randomly perturbed according to specified probability distribution functions. The results of the statistical trials are then used to determine the peak cladding temperature (PCT), maximum local oxidation (MLO), and core wide oxidation (CWO) that represent the joint 95th percentile of the distribution with 95% confidence for each analyzed break. The licensing basis PCT, MLO, and CWO are then determined from the overall maxima from the statistical analyses.

2.0 DESCRIPTION OF MODELS

Two primary computer models were used to determine the LOCA response for plant Fermi 2 using the TRACG LOCA method. These models are PRIME ([3]) and TRACG ([4]).

2.1 PRIME

The PRIME model provides the parameters to initialize the fuel rod fission gas inventory and rod internal pressure at the onset of a postulated LOCA for input to TRACG. PRIME also provides the initial pellet-cladding gap conductance and other parameters used by TRACG to calculate the transient gap conductance.

2.2 TRACG

TRACG calculates the system response of the reactor and the detailed fuel rod heat transfer over a complete spectrum of hypothetical break sizes and locations. TRACG is compatible with the PRIME fuel rod model for gap conductance and fission gas release. A simplified form of the PRIME fuel thermal conductivity model is built into TRACG. TRACG calculates the core and vessel water levels, system pressure response, ECCS performance, and other thermal-hydraulic phenomena occurring in the reactor as a function of time. TRACG conservatively models the sources of heat in the core such as fission power, decay heat, and metal-water reaction. TRACG realistically models all regimes of heat transfer to calculate the transient cladding temperatures and oxidation.

3.0 ANALYSIS PROCEDURE

The procedure by which the TRACG-LOCA analysis was performed for plant Fermi 2 is based on the TRACG-LOCA LTR ([2]). The acceptance criteria are based on the United States Code of Federal Regulations (10 CFR 50.46 [1]).

3.1 Licensing Criteria

10 CFR 50.46 [1] prescribes the acceptance criteria for ECCS analyses. A summary of the criteria is provided below:

1. The calculated maximum fuel element cladding temperature shall not exceed 2200 °F.

   For Fermi 2 TRACG-LOCA, the [[ ]] from the statistical analysis must not exceed 2200 °F [[ ]].

2. The calculated total local oxidation shall not exceed 0.17 times the total cladding thickness before oxidation.

   For TRACG-LOCA, the local oxidation limit is 13% ([5]) of the total cladding thickness before oxidation. For Fermi 2 TRACG-LOCA, the [[ ]] from the statistical analysis must be less than 13%.

3. The calculated total amount of hydrogen generated from the chemical reaction of the cladding with water or steam must not exceed 0.01 times the hypothetical amount that would be generated if all the metal in the cladding cylinder surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react.

   For Fermi 2 TRACG-LOCA, the [[ ]] from the statistical analysis must be less than 1%.

4. Calculated changes in core geometry shall be such that the core remains amenable to cooling.

   For TRACG-LOCA, this criterion is considered to be satisfied if the first three criteria are satisfied.

5. After any calculated successful initial operation of ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

   The existing bases and compliance with this criterion are documented on page III-16 of Volume 2 of [7] and in [10], and are unchanged by application of TRACG-LOCA for Fermi 2. TRACG-LOCA calculations may not be used to address this criterion without further NRC review ([5]).

3.2 TRACG-LOCA Licensing Methodology

The TRACG-LOCA licensing methodology approved in [5] and [6] is an ECCS EM developed to analyze BWR LOCA in accordance with 10 CFR 50.46. TRACG-LOCA is a best estimate plus uncertainty type of EM. The analyses result in cycle-independent licensing basis peak cladding temperature (PCT), maximum local oxidation (MLO), and core wide oxidation (CWO) for each fuel product line to which it has been applied.

Potentially limiting break locations, initial conditions, and ECCS performance are determined using inputs that correspond to the “nominal” trial associated with the statistical analysis. In particular, any inputs that are perturbed for the statistical analysis are taken as the best estimate value, [[ ]] The calculations to determine the potentially limiting breaks are referred to as the break spectrum calculations, or “break spectra”.

Statistical analyses are performed for [[ ]] For purposes of TRACG-LOCA, a small break is a break for which the break area is less than approximately 0.1 ft^2 and a large break is a break for which the break area is greater than approximately 1.1 ft^2. An intermediate break is a break for which the break area is in between the small break and large break definitions. Statistical trials are constructed by randomly sampling from distributions representing uncertainties in important model parameters, initial conditions, and plant parameters. To achieve the tri-variate output acceptance criteria (PCT, MLO, CWO), either 124 or 181 statistical trials may be performed for each potentially limiting break. If 124 trials are chosen, then the first ranked result of each output attribute represents a joint 95/95 upper tolerance limit. Alternatively, the same joint upper tolerance limit may be established by performing 181 trials and rejecting two. The decision of the number of trials and which two trials to be rejected, if applicable, must be made prior to performing the statistical analysis. [[ ]]

3.3 TRACG-LOCA Methodology Limitations and Conditions

The limitations and conditions stipulated on the TRACG-LOCA EM in [5] and [6] are paraphrased and summarized in the below table, along with how each is met.

Table 3-1: TRACG-LOCA Limitations and Conditions

Limitation	Description	Resolution
1.1	Only applicable to GE BWR/2 – BWR/6.	Fermi Unit 2 is a GE BWR/4 plant.
1.2	TRACG-LOCA is approved for fuel designs through GNF2. TRACG-LOCA may also be used for *evolutionary* fuel designs by following the GESTAR-II process for new fuel introduction.	GNF3 is considered an evolutionary fuel design relative to GNF2 for purposes of the TRACG-LOCA application. There is no new underlying physics and no model changes are required to simulate GNF3 LOCA transients with TRACG. TRACG04P input allows for the specification and handling of [[ ]]
1.3	TRACG-LOCA may not be used to establish less restrictive operational constraints for fuel product lines from GNF competitors without NRC approval.	Not currently applicable to Fermi 2.
1.4	NRC recommends any applications outside the TRACG-LOCA approval basis be submitted as a standalone requested licensing action.	For Fermi 2, TRACG-LOCA is currently only applied as approved (*i.e.*, the analyses are performed in accordance with the LTR and only to establish the applicable licensing criteria indicated in Section 3.1).
1.5	TRACG-LOCA may not be applied for establishing compliance with the long term cooling criterion of 10 CFR 50.46(b)(5) without NRC approval.	TRACG-LOCA is not being used to establish the long term cooling basis for Fermi 2.
1.6	A revision or supplement to NEDE-33005, with subsequent NRC review and approval, would be required to apply TRACG-LOCA to establish compliance with pending changes to 10 CFR 50.46(c).	This work is based on the January 1, 2016 version of 10 CFR 50.46.
2.1	The TRACG-LOCA model must include at least [[ ]] CHAN component.	The Fermi 2 TRACG-LOCA models use [[ ]]
2.2	The TRACG-LOCA model must include [[ ]]	The Fermi 2 TRACG-LOCA models use [[ ]]

Table 3-1: TRACG-LOCA Limitations and Conditions

Limitation	Description	Resolution
2.3	The break spectrum analysis must be performed at the limiting break location and ECCS configuration. Further, the limiting break size must be captured using sufficient break size resolution in the spectra, based on critical flow uncertainty.	The break spectrum calculations were performed for Fermi 2 in such a way that the limiting break size and ECCS configuration could be determined, with break size resolution based on critical flow uncertainty.
2.4	Unless the treatment is specifically addressed in Chapter 6 of the LTR or the uncertainty is determined using an NRC-approved instrument setpoint methodology, the variability in important initial conditions and significant plant parameters must be modeled deterministically (*i.e.*, not statistically sampled) in their most pessimistic condition.	The variability in important initial conditions is treated consistent with Chapter 6 of the LTR [2]. The variability in significant plant parameters is treated by utilizing analytical values established through the Operating Parameters for Licensing, Form 4 (OPL-4). The analytical values are set to the most pessimistic condition, consistent with Chapter 6 of the LTR (see LTR Table 6.3-1 and Table 6.3-2).
2.5	Each application of TRACG-LOCA must establish and utilize the more limiting between loss of offsite power coincident with LOCA, or offsite power available.	[[ ]] for Fermi 2 TRACG-LOCA (see Section 4.7).
2.6	The core thermal power must be increased to account for the calorimetric uncertainty.	For Fermi 2, the licensed thermal power of 3488 MW is increased by the 0.32% calorimetric uncertainty for TRACG-LOCA. Thus, the analytical core thermal power is 3499 MW.
2.7	The Shumway Correlation (minimum stable film boiling temperature) is only approved for TRACG-LOCA.	This report is limited to the application of TRACG-LOCA to Fermi 2.
3.1	Errors in, and changes to, concurrent or upstream methods are subject to the reporting requirements of 10 CFR 50.46(a)(3), to the extent they impact TRACG-LOCA.	Each concurrent or upstream method change, or error is evaluated to determine if TRACG-LOCA is affected. If so, the 10 CFR 50.46 reporting requirements will be followed.
3.2	All upstream and concurrent methods must be used in TRACG-LOCA within their existing approval bases.	The TRACG-LOCA application for Fermi 2 is the second TRACG-LOCA application for GNF3 fuel. This application is within the existing approval bases for all upstream and concurrent methods.
4.1	Each potentially limiting break scenario must be statistically analyzed using either 124 trials with no rejections or 181 trials with two rejections.	For Fermi 2 TRACG-LOCA each potentially limiting break is statistically analyzed [[ ]]

Table 3-1: TRACG-LOCA Limitations and Conditions

Limitation	Description	Resolution
4.2	The statistical analysis sample size and rejection strategy must be determined in advance.	For Fermi 2 TRACG-LOCA, the use of [[ ]] prior to performing any statistical analysis.
4.3	No rejections are allowed for a sample size of 124. Two rejections are allowed for a sample size of 181.	For Fermi 2 TRACG-LOCA each potentially limiting break is statistically analyzed [[ ]]
4.4	If the sample size of 181 is chosen, the rejection strategy must be chosen in advance of the statistical analysis.	For Fermi 2 TRACG-LOCA, the use of [[ ]] prior to performing any statistical analysis.
4.5	Once the potentially limiting breaks are determined and the statistical analysis is applied, GEH must document the characteristics of any unacceptable results, and what changes were made to produce acceptable results.	All statistical analysis results for Fermi 2 TRACG-LOCA are acceptable.
4.6	With the exception of major design changes, resampling is not permitted for re-analysis.	A set of statistical samples for Fermi 2 has been generated for TRACG-LOCA. The appropriate set will be used for any hypothetical re-analysis, with the possible exception of major design changes.
5	The maximum acceptable ECR when using the Cathcart-Pawel oxidation correlation is 13%.	The Fermi 2 TRACG-LOCA ECR (MLO) licensing limit is 13%.
6	In license amendment requests to implement expanded operating domains, for which the ECCS LOCA analysis is based on TRACG-LOCA, the requesting licensee shall include documentation of the supporting ECCS-LOCA analysis in the license amendment request.	Not currently applicable to Fermi 2 TRACG-LOCA.
7.1	For TRACG-LOCA applications to BWR/3-6, the TRACG [[ ]]	For Fermi 2 TRACG-LOCA, the [[ ]]
7.2	The axial power shape for the [[ ]] components must be demonstrated as bounding for each cycle.	For Fermi 2 TRACG-LOCA, the assumed axial power shape [[ ]] is expected to be bounding. A cycle specific check is required.

Table 3-1: TRACG-LOCA Limitations and Conditions

Limitation	Description	Resolution
N/A	GEH must confirm that the built-in TRACG exposure to irradiation time conversion is bounding for each application of TRACG-LOCA.	[[ ]]
N/A	GEH must confirm the sensitivity of the results to initial dome pressure and downcomer water level on a plant-specific basis.	Sensitivity studies were performed. Fermi 2 TRACG-LOCA PCT results [[ ]]
N/A	Sensitivity studies must be performed for each TRACG-LOCA application to determine the limiting axial power shape.	A study was performed for Fermi 2 that determined that [[ ]]

4.0 INPUT TO ANALYSIS

The significant input parameters to the Fermi 2 LOCA analysis are presented in Table 4-1, Table 4-2, and Table 4-3. Chapter 6 of [2] describes the important initial conditions and plant parameters used for input.

4.1 Plant Inputs

The significant plant inputs to establish the Fermi 2 LOCA analysis initial conditions are presented in Table 4-1.

The treatment of initial total core power and core flow are described in Section 6.2.1 of [2]. Additionally, Limitation 2.6 of [5] specifies that the calorimetric power uncertainty must be added to the core thermal power. The calorimetric power uncertainty has been added to the core thermal power for Fermi 2 analysis, as shown in Table 4-1. The range of core flows considered are based on the licensed power-flow map and are typically expressed as a percentage of rated.

The treatment of initial feedwater temperature is described in Section 6.2.2 of [2] and confirmed in Section 5.5.1 of [5].

The treatment of initial steam dome pressure and initial downcomer water level are described in Section 6.2.3 and 6.2.4, respectively, of [2]. Section 5.5.1 of [5] indicates that sensitivities to these inputs must be confirmed for each plant application. For Fermi 2 LOCA analysis, a sensitivity analysis was performed to determine the proper initial dome pressure and downcomer water level. The sensitivity analysis results showed that the nominal initial values listed in Table 4-1 are appropriate for Fermi 2 TRACG LOCA analysis.

4.2 Fuel Parameters

The modeled bundle power distribution is prescribed in Section 6.2.5 of [2] and confirmed in Section 5.3 of [5]. Additionally, Limitation 2.2 of [5] specifies that a minimum of [[ ]] be included in the core model.

The TRACG-LOCA analyses were performed with hot bundles modeled as indicated in Table 4-4 and Table 4-5. The hot bundle modeling is based on the fuel MAPLHGR limits as a function of exposure given in Table 4-2 and Table 4-3 (the limits are the piecewise linear connection of the tabulated points). For GE14 fuel, there are [[ ]] modeled as shown in Table 4-4 [[ ]] For GNF3 fuel, there are [[ ]] modeled as shown in Table 4-5 [[ ]]

4.3 ECCS Parameters

The treatment of ECCS parameters is prescribed in Section 6.3 of [2]. In particular, Table 6.3-1 of [2] specifies analytical limits be applied for certain parameters, while nominal inputs are sufficient for others. Other important plant parameters are summarized in Table 6.3-2 of [2]. Limitation 2.4 of [5] essentially requires that analytical limits be applied to these parameters (as opposed to statistical sampling).

The key ECCS performance inputs for Fermi 2 TRACG-LOCA analysis are summarized in Table 4-6.

4.4 Analyzed Operating Statepoints

See Section 4.1 for a discussion of the requirements for initial core power, core flow, and feedwater temperature. Based on these requirements, calculations are performed for the following power-flow-feedwater temperature initial conditions:

A) CLTP – current licensed thermal power plus uncertainty, rated core flow, rated normal feedwater temperature
B) MELLLA – current licensed thermal power plus uncertainty, MELLLA core flow, rated normal feedwater temperature
C) ICF – current licensed thermal power plus uncertainty, ICF core flow, rated normal feedwater temperature
D) FWTR – current licensed thermal power plus uncertainty, rated core flow, reduced feedwater temperature
E) SLO – analytical core thermal power of 2313 MW (66.1% of 3499 MW), 48% core flow, normal feedwater temperature (adjusted for reduced power)

The particular core flow corresponding to MELLLA and ICF are given in the OPL-4 [8].

4.5 Single Failure

Based on the OPL-5 form in [8], Table 4-7 shows the various combinations of Automatic Depressurization System (ADS), High Pressure Coolant Injection (HPCI) System, Low Pressure Core Spray (LPCS) System and Low Pressure Coolant Injection (LPCI) System which are credited for standard ECCS LOCA analysis. In performing the ECCS performance analysis with TRACG-LOCA, GEH assumes that no postulated single active component failure will result in less than the minimum combinations of systems remaining, as shown in Table 4-7.

Only the first three single failures in Table 4-7 are necessary for the standard LOCA analysis in Section 5.0, which are Div I Battery, Div II Battery and LPCI Injection Valve. The other three single failures in Table 4-7, which are DG, HPCI and One ADS Valve, result in more ECCS systems than at least one of the first three single failures and, therefore, are not considered in the calculations in Section 5.0.

4.6 Break Locations and Break Sizes

Based on [2], core spray line (CSL), feedwater line (FWL), recirculation suction line (RSL), recirculation discharge line (RDL), reactor water cleanup (RWCU) line outside containment and main steam line breaks are considered. Break sizes ranging from the minimum size that meets the definition of a LOCA ([1]) to 200% of the largest applicable pipe cross-sectional area are considered. Where appropriate, a DEGB is modeled either in addition to or instead of a 200% area split break.

Core spray line break sizes from approximately [[ ]] to 200% of the cross-sectional flow area of a 12” core spray pipe are modeled.

Feedwater line break sizes from approximately [[ ]] to 200% of the cross-sectional flow area of a 20” feedwater pipe are modeled.

Main steam line outside containment break sizes from approximately [[ ]] to 200% of the cross-sectional flow area of the TRACG-LOCA model combined steam line downstream of the equalizing header are modeled. A DEGB of a main steam line upstream of the flow limiter is also modeled.

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Recirculation discharge line break sizes from approximately [[ ]] to 200% of the cross-sectional area of the 28” recirculation pump discharge pipe are modeled. In this case, both a 200% area split break and a DEGB are modeled.

Recirculation suction line break sizes from approximately [[ ]] to 200% of the cross-sectional area of the 28” recirculation pump suction pipe are modeled. In this case, both a 200% area split break and a DEGB are modeled.

Also, a flow path is modeled from [[
]]

4.7 Offsite Power Condition

In the TRACG-LOCA modeling, the loss of offsite power is analyzed by [[
]] Additionally, low pressure ECCS cannot start until after power is available from the emergency diesel generators.

For all potentially limiting breaks inside containment, the high drywell pressure trip, [[

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Table 4-1: Key Plant Initial Conditions [8]

Plant Initial Condition	Value
Maximum core thermal power, including uncertainty allowance (MW)	3499
Rated core flow (Mlb_m/hr)	100
Rated normal feedwater temperature (°F)	426.5
Reduced feedwater temperature (°F) analytical value	376.5
Nominal vessel steam dome pressure (psia)	1045
Nominal downcomer water level (inches above vessel zero)	563.5

Table 4-2: GE14 MAPLHGR Limits

Exposure (MWd/MTU)	MAPLHGR (kW/ft)
0	12.82
16000	12.82
21100	12.82
63500	8.0
70000	5.0

Table 4-3: GNF3 MAPLHGR Limits

Exposure (MWd/MTU)	MAPLHGR (kW/ft)
0	14.36
10000	13.78
23400	13.01
45000	10.75
63500	8.00
70000	6.00

Table 4-4: Modeled GE14 Hot Bundles

Power Shape	Exposure (GWd/MTU)	MAPLHGR (kW/ft)	ICPR or (APF)	R-factor
[[				
				]]

Table 4-5: Modeled GNF3 Hot Bundles

Power Shape	Exposure (GWd/MTU)	MAPLHGR (kW/ft)	ICPR or (APF)	R-factor
[[				
				]]

Table 4-6: Key ECCS Parameters [8]

Variable	Units	Analysis Value
1. Emergency Diesel Generators (EDG)		
a. Start signal on loss of offsite power?	yes/no	yes
b. Start signal on low-low-low level (level 1)?	yes/no	yes
c. Start signal on high drywell pressure?	yes/no	yes
d. Delay time from start signal to bus at rated voltage	seconds	25.0
2. Low Pressure Coolant Injection (LPCI) System		
a. Start signal on low-low-low level (level 1)?	yes/no	yes
b. Start signal on high drywell pressure?	yes/no	yes
c. Delay time from LPCI pump start to pump at rated speed	seconds	5.0
d. Maximum vessel to drywell pressure difference for which flow may be delivered to the vessel	psid	264
e. Minimum flow rate delivered to the vessel from two LPCI pumps at a vessel to drywell pressure difference of 20 psid	gpm	21850
f. Minimum flow rate delivered to the vessel from three LPCI pumps at a vessel to drywell pressure difference of 20 psid	gpm	26260
g. Minimum flow rate delivered to the vessel from four LPCI pumps at a vessel to drywell pressure difference of 20 psid	gpm	27625
h. Vessel pressure below which injection valves may open	psig	350
i. Injection valve open stroke time	seconds	30
j. Vessel pressure below which recirculation discharge valves may close	psig	870
k. Recirculation discharge valve close stroke time	seconds	45
l. LPCI temperature	°F	120
m. Minimum detectable break size for LPCI loop selection logic	ft^2	0.15
3. Core Spray (CS) System		
a. Start signal on low-low-low level (level 1)?	yes/no	yes
b. Start signal on high drywell pressure?	yes/no	yes
c. Delay time from CS pump start to pump at rated speed	seconds	8.0
d. Maximum vessel to drywell pressure difference for which flow may be delivered to the vessel	psid	280
e. Minimum flow rate delivered to the vessel from 1 CS pump at a vessel to drywell pressure difference of 100 psid	gpm	5625
f. Minimum flow rate delivered to the vessel from 1 CS pump at a vessel to drywell pressure difference of 0 psid	gpm	7013

Table 4-6: Key ECCS Parameters [8]

Variable	Units	Analysis Value
g. Vessel pressure below which injection valve may open	psig	350
h. Injection valve open stroke time	seconds	15
i. Core spray temperature	°F	120
4. Automatic Depressurization System (ADS)		
a. Number of ADS valves credited		4
b. ADS timer starts on low-low-low level (level 1) AND high drywell pressure?	yes/no	yes
c. ADS timer starts on low-low-low level (level 1) plus the bypass timer delay?	yes/no	yes
d. Bypass timer delay time	seconds	480
e. ADS timer delay time	seconds	120
f. Require low pressure ECCS ready for ADS actuation?	yes/no	yes
5. High Pressure Coolant Injection (HPCI)		
a. Start signal on low-low level (level 2)?	yes/no	yes
b. Start signal on high drywell pressure?	yes/no	yes
c. Delay time from initiating signal to pump at rated flow	seconds	60.0
d. Maximum vessel pressure for which flow may be delivered to the vessel	psia	1135
e. Minimum vessel pressure for which flow may be delivered to the vessel	psia	165
f. Minimum flow over pressure range in Items d and e	gpm	5000
g. Minimum steam flow rate from the vessel at a vessel pressure of 1135 psia	lbm/hr	173500
h. Minimum steam flow rate from the vessel at a vessel pressure of 165 psia	lbm/hr	75000
i. HPCI liquid temperature	°F	120

Table 4-7: Fermi 2 Standard ECCS LOCA Analysis Single Failures [8]

Assumed Failure	Remaining systems for LOCA Analysis (1)
Division I DC Power Source (Div I Battery)	HPCI, 2 LPCI, 1 LPCS [1]
Division II DC Power Source (Div II Battery)	4 ADS, 2 LPCI, 1 LPCS
LPCI Injection Valve	4 ADS, HPCI, 2 LPCS
Diesel Generator (DG)	4 ADS, HPCI, 2 LPCI, 1 LPCS
HPCI	4 ADS, 4 LPCI, 2 LPCS
One ADS Valve	4 ADS, HPCI, 4 LPCI, 2 LPCS

(1) Consistent with historical notation, ‘1 LPCS’ implies one LPCS subsystem is modeled, which is actually comprised of two CS pumps. Likewise, ‘2 LPCS’ implies two LPCS subsystems are modeled, which are comprised of a total of four CS pumps.

[1] For feedwater line breaks, 3 SRVs are available for operators to manually depressurize the vessel for this single failure [8]. 3 SRVs and 4 SRVs were used in the analysis.

5.0 LOCA ANALYSIS RESULTS

The plant Fermi Unit 2 standard TRACG-LOCA break spectrum and statistical analysis results are described in Section 5.1 and Section 5.2.

5.1 Break Spectrum Calculations

Calculations were performed to determine all potentially limiting initial conditions, single failures, break locations, and break size combinations. All calculations were performed for [[

]] All break spectra were calculated with an initial dome pressure of 1045 psia.

As discussed in Section 4.5, the analyses in this section were only conducted [[

]] Several break sizes are selected for all off-rated conditions.

The minimum detectable break size for the loop selection logic assumed in the analysis is 0.15 ft^2 [8] , as shown in Table 4-6. The loop selection logic is assumed to choose the intact loop for break sizes larger than 0.15 ft^2. The loop selection logic is assumed to choose the broken loop for break sizes smaller than 0.15 ft^2.

5.1.1 Div I Battery Failure

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The affect of the off-rated conditions (MELLLA, ICF, FWTR and SLO) on the break spectra of the RSL and RDL are shown in Figure 5-2, and Figure 5-3, respectively. The affect of the off-rated condition (MELLLA) on the break spectra of the FWL breaks is shown in Figure 5-4, in which the results for both Div I Battery failure and Div II Battery failure are included.

As shown in Figure 5-2, Figure 5-3, and Figure 5-4, [[

]] Note that the MAPLHGR multiplier of 90% at SLO is used.

The highest nominal PCT results for each break type of interest are given in Table 5-1. Note that [[

]]

5.1.2 Div II Battery Failure

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The affect of the off-rated conditions (MELLLA, ICF, FWTR and SLO) on the break spectra of the RSL and RDL are shown in Figure 5-6 and Figure 5-7, respectively. The affect of the off-rated condition (MELLLA) on the break spectra of the FWL breaks is shown in Figure 5-4.

As shown Figure 5-6, Figure 5-7, and Figure 5-4, [[

]] Note that the MAPLHGR multiplier of 90% at SLO is used.

The highest nominal PCT results for each break type of interest are given in Table 5-1.

5.1.3 LPCI Injection Valve Failure

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The highest nominal PCT results for each break type of interest are given in Table 5-1.

5.2 Statistical Analyses

Based on the break spectra calculations, potentially limiting breaks were chosen for statistical analysis. [[

]] The results of the statistical analyses are shown in Table 5-2 and Table 5-3, with the overall maximum PCT, MLO, and CWO for each fuel type in bold. All results are within the licensing limits.

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It is further noted that even though [[

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The licensing basis PCT, MLO, and CWO are determined for each fuel type by rounding up the limiting results to the nearest 5 °F for PCT, 0.5% for MLO, and 0.01% for CWO. The licensing basis results are summarized in Table 5-4.

5.3 Revision 1 OPL-4/5 - Level 3 Change Affect

The analyses presented in Sections 5.1 and 5.2 used the Revision 0 OPL-4/5 Level 3 scram analytical limit of 535.01 inches above vessel zero. [[

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5.4 Revision 2 OPL-4/5 – LPCI and CS Minimum Flow Bypass Valve Setpoint

The analyses presented in Sections 5.1 and 5.2 used the Revision 1 OPL-4/5 LPCI and CS minimum flow bypass valve setpoints, which are 3000 gpm and 775 gpm for LPCI and CS, respectively. In the Revision 2 OPL-4/5 [8], these two setpoint values are changed to 6900 gpm and 2700 gpm for LPCI and CS, respectively.

As discussed in the Resolution Notes Items 7 and 8 of Revision 2 OPL-4/5 [8], the LPCI or CS flow rates with minimum flow bypass valve open are higher than the LPCI or CS flow rates specified for TRACG LOCA analysis in this report. Therefore, it is concluded [[

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Table 5-1: GNF3 Break Spectrum Calculation Highest PCT Results for Each Break Type of Interest

Break Location and Size	**Initial Condition, Break Size (ft^2)** **PCT (°F) / MLO (%)**
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Table 5-1: GNF3 Break Spectrum Calculation Highest PCT Results for Each Break Type of Interest (Continued)

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Table 5-2: GNF3 Statistical Analysis Results

Case[2]	PCT (°F)	MLO (%)	CWO (%)
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			]]

Table 5-3: GE14 Statistical Analysis Results

Case[2]	PCT (°F)	MLO (%)	CWO (%)
[[			
			]]

Table 5-4: Fermi 2 TRACG-LOCA Licensing Basis Results

Fuel Product Line	PCT (°F)	MLO (%)	CWO (%)
GNF3	2150	9.5	0.02
GE14	1980	6.0	0.02

2 [[ ]]

[[

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Figure 5-1: Fermi 2 GNF3 Break Spectra Results for CLTP Initial Conditions for Div I Battery Failure

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Figure 5-2: Fermi 2 GNF3 Recirculation Suction Line Break Spectra Results for Various Initial Conditions at Div I Battery Failure

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Figure 5-3: Fermi 2 GNF3 Recirculation Discharge Line Break Spectra Results for Various Initial Conditions at Div I Battery Failure

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Figure 5-4: Fermi 2 GNF3 Feedwater Line Break Spectra Results for Various Initial Conditions

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Figure 5-5: Fermi 2 GNF3 Break Spectra Results for CLTP Initial Conditions for Div II Battery Failure

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Figure 5-6: Fermi 2 GNF3 Recirculation Suction Line Break Spectra Results for Various Initial Conditions at Div II Battery Failure

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Figure 5-7: Fermi 2 GNF3 Recirculation Discharge Line Break Spectra Results for Various Initial Conditions at Div II Battery Failure

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Figure 5-8: Fermi 2 GNF3 Break Spectra Results for CLTP Initial Conditions for LPCI Injection Valve Failure

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Figure 5-9: L3 Update Affect on GNF3 Break Spectra Results for CLTP Initial Conditions for Div II Battery Failure

6.0 CONCLUSIONS

The licensing basis PCT, MLO, and CWO are all acceptable compared to the 10 CFR 50.46 and TRACG-LOCA LTR prescribed licensing limits of < 2200 °F, < 13%, and < 1%, respectively. For convenience, the licensing basis values for each applicable fuel product line are repeated here.

Fermi Unit 2 TRACG-LOCA Licensing Basis Results

Fuel Product Line	PCT (°F)	MLO (%)	CWO (%)
GNF3	2150	9.5	0.02
GE14	1980	6.0	0.02

The fuel MAPLHGR limits as a function of fuel exposure are provided in Table 4-2 and Table 4-3 for GE14 and GNF3, respectively. These limits are applicable to all Fermi 2 operation conditions, except for the SLO, for which a MAPLHGR multiplier of 90% applies.

The results in this report are also applicable to the Fermi 2 24-month cycle operation.

7.0 ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Explanation
ADS	Automatic Depressurization System
APF	Axial Peaking Factor – the ratio of the highest power axial node power divided by the axial averaged node power
AVZ	Above Vessel Zero
BAF	Bottom of Active Fuel
BWR	Boiling Water Reactor
BWR/n	GEH BWR type ‘n’. BWR/2 is an early, external recirculation loop design. BWR/3-BWR/6 utilize jet pumps for recirculation. Fermi Unit 2 is of the BWR/4 plant type.
CFR	Code of Federal Regulations
CHAN	TRACG channel component used to model one or more fuel bundles
CLTP	Current Licensed Thermal Power – used to refer to the 3499 MW core thermal power and 100% of rated core flow at rated feedwater temperature initial condition for Fermi 2 TRACG-LOCA
CPR	Critical Power Ratio – the ratio of the critical power to the current bundle power. The critical power is the power for which boiling transition (dryout) would be expected to occur for all other bundle conditions (inlet temperature, inlet mass flow rate, exit pressure, and axial power shape) held constant.
CS	Core Spray (synonymous with LPCS for Fermi 2)
CSL	Core Spray Line – normally used in reference to a split break in a core spray line inside containment
CWO	Core Wide Oxidation
DEGB	Double-Ended Guillotine Break
DG	Diesel Generator
Div	Division
DTE	DTE Energy
ECCS	Emergency Core Cooling System

Acronym or Abbreviation	Explanation
ECR	Equivalent Cladding Reacted (synonymous with MLO)
EDG	Emergency Diesel Generator
EM	Evaluation Model – TRACG-LOCA is a GEH LOCA EM
FW	Feedwater
FWL	Feedwater Line – normally used in reference to a split break in a feedwater line inside containment
FWTR	Feedwater Temperature Reduction – used to refer to the 3499 MW core thermal power and 100% of rated core flow with feedwater temperature 50 °F below normal for Fermi 2 TRACG-LOCA
GE14	A particular GNF fuel product line.
GEH	GE Hitachi Nuclear Energy
GNF	Global Nuclear Fuel
GNF3	A particular GNF fuel product line that is evolutionary in design relative to the GNF2 product line
GWd/MTU	Nuclear fuel exposure units of Gigawatt-days per metric ton of Uranium
HPCI	High Pressure Coolant Injection
ICF	Increased Core Flow – used to refer to the 3499 MW core thermal power and 105% of rated core flow at rated feedwater temperature initial condition for Fermi 2 TRACG-LOCA
ICPR	Initial Critical Power Ratio – the bundle CPR at the beginning of the transient
LHGR	Nuclear fuel linear heat generation rate, based on the heat transferred from the surface of the fuel rod(s)
LOCA	Loss-Of-Coolant Accident (defined in 10 CFR 50.46)
LOOP	Loss Of Offsite Power
LPCI	Low Pressure Coolant Injection
LPCS	Low Pressure Core Spray
LTR	Licensing Topical Report

Acronym or Abbreviation	Explanation
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate. The APLHGR is the average LHGR over all fuel rods in a discrete axial node. The MAPLHGR is the maximum APLHGR over all axial nodes of a fuel bundle.
MELLLA	Maximum Extended Load Line Limit Analysis – used to refer to the 3499 MW core thermal power and 83.1% of rated core flow at rated feedwater temperature initial condition for Fermi 2 TRACG-LOCA
MLO	Maximum Local Oxidation (synonymous with ECR)
MSL	Main Steam Line – normally used in reference to either a split break in the main steam line outside containment, or a DEGB in the steam line inside containment
MWd/MTU	Nuclear fuel exposure units of Megawatt-days per metric ton of Uranium
NRC	United States Nuclear Regulatory Commission
OPA	Offsite Power Available
OPL	Operating Parameters for Licensing. The OPL-4 and OPL-5 forms provide LOCA analysis design inputs.
PCT	Peak Cladding Temperature
PR	Problem Report
PRIME	Engineering Computer Program for fuel thermal-mechanical calculations
R-factor	A factor input to the [[ ]]
RDL	Recirculation Discharge Line – normally used in reference to either a split break or DEGB in the recirculation pump discharge line
RFWT	Reduced Feedwater Temperature – this is a synonym for FWTR for purposes of Fermi 2 TRACG-LOCA
RSL	Recirculation Suction Line – normally used in reference to either a split break or DEGB in the recirculation pump suction line
RWCU	Reactor Water Cleanup
SAFER	Engineering Computer Program for BWR LOCA analysis. This program is part of the GEH SAFER/PRIME-LOCA EM.

Acronym or Abbreviation	Explanation
SAFER/PRIME-LOCA	GE Hitachi Nuclear Energy BWR LOCA EM that utilizes the SAFER computer program. This was originally the SAFER/GESTR-LOCA EM, which used the GESTR-LOCA fuel thermal-mechanical modeling. The name change reflects the replacement of GESTR by PRIME for GEH fuel thermal-mechanical modeling.
SFIE	Steam Flow Induced Error
SLO	Single Loop Operation – used to refer to the 2313 MW core thermal power and 48% of rated core flow with one operating recirculation pump initial condition for Fermi 2 TRACG-LOCA
SRV	Safety / Relief Valve
TAF	Top of Active Fuel
TRACG	Engineering Computer Program for BWR analysis
TRACG-LOCA	GE Hitachi Nuclear Energy BWR LOCA EM that utilizes the TRACG computer program

8.0 REFERENCES

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9.0 APPENDIX A – EXAMPLE TRANSIENT SEQUENCE OF EVENTS AND PLOTS

The sequence of events and key parameters are presented for the LOCA types of interest. For each type, one particular nominal case (i.e., from the break spectra) is chosen for more detailed description. The success of the ECCS in mitigating the large breaks is primarily based on how rapidly the LPCS and LPCI flow can be delivered to the reactor.

The following cases are selected from the Section 5.0 licensing LOCA analysis.

9.1 Small Recirculation Suction Line Break

The GNF3 [[ ]] recirculation suction line break, initiated from the MELLLA condition for Div II Battery failure, is presented as an example (see Table 9-1 and Figure 9-1 through Figure 9-9). Results from a small recirculation discharge line break are very similar.

9.2 Intermediate Recirculation Suction Line Break

The GNF3 [[ ]] recirculation suction line break, initiated from the MELLLA condition for Div I Battery failure, is presented as an example (see Table 9-2 and Figure 9-10 through Figure 9-18). Results from an intermediate recirculation discharge line break are very similar.

9.3 Intermediate Recirculation Suction Line Break

The GNF3 [[ ]] recirculation suction line break, initiated from the CLTP condition for Div II Battery failure, is presented as an example (see Table 9-3 and Figure 9-19 through Figure 9-27). Results from an intermediate recirculation discharge line break are very similar.

9.4 Recirculation Discharge Line DEGB

The GNF3 recirculation discharge DEGB, initiated from the CLTP condition for Div II Battery failure, is presented as an example (see Table 9-4 and Figure 9-28 through Figure 9-36). Results from other large recirculation suction and discharge line breaks are similar.

Table 9-1: Sequence of Events, Fermi 2 GNF3 Nominal [[ ]] Recirculation Suction Line Break, MELLLA, Div II Battery

Event(s)	TRACG Transient Time (s)
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Table 9-2: Sequence of Events, Fermi 2 GNF3 Nominal [[ ]] Recirculation Suction Line Break, MELLLA, Div I Battery

Event(s)	TRACG Transient Time (s)
[[	
	]]

Table 9-3: Sequence of Events, Fermi 2 GNF3 Nominal [[ ]] Recirculation Suction Line Break, CLTP, Div II Battery

Event(s)	TRACG Transient Time (s)
[[	
	]]

Table 9-4: Sequence of Events, Fermi 2 GNF3 Nominal DEGB Recirculation Discharge Line Break, CLTP, Div II Battery

Event(s)	TRACG Transient Time (s)
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[[

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Figure 9-1: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – Break Mass Flow Rate

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Figure 9-2: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – Reactor Pressure

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Figure 9-3: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – Downcomer Water Level

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Figure 9-4: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – Central Core (Bypass and Upper Plenum) Water Level

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Figure 9-5: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – Vessel Steam Flow Rate

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Figure 9-6: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – Overall Core PCT

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Figure 9-7: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – Total Core Spray Mass Flow Rate

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Figure 9-8: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – LPCI Mass Flow Rate to Broken Loop

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Figure 9-9: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div II Battery Failure – HPCI Mass Flow Rate

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Figure 9-10: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure– Break Mass Flow Rate

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Figure 9-11: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure–Reactor Pressure

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Figure 9-12: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure–Downcomer Water Level

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Figure 9-13: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure–Central Core (Bypass and Upper Plenum) Water Level

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Figure 9-14: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure– Vessel Steam Flow Rate

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Figure 9-15: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure– Overall Core PCT

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Figure 9-16: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure– Total Core Spray Mass Flow Rate

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Figure 9-17: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure–LPCI Mass Flow Rate to Intact Recirculation Loop

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Figure 9-18: Fermi 2 GNF3 Nominal [[ ]] RSL Break for MELLLA Initial Conditions for Div I Battery Failure– HPCI Mass Flow Rate

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Figure 9-19: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure–Break Mass Flow Rate

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Figure 9-20: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure–Reactor Pressure

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Figure 9-21: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure–Downcomer Water Level

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Figure 9-22: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure– Central Core (Bypass and Upper Plenum) Water Level

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Figure 9-23: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure–Vessel Steam Flow Rate

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Figure 9-24: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure–Overall Core PCT

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Figure 9-25: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure– Total Core Spray Mass Flow Rate

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Figure 9-26: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure–LPCI Mass Flow Rate to Intact Recirculation Loop

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Figure 9-27: Fermi 2 GNF3 Nominal [[ ]] RSL Break for CLTP Initial Conditions for Div II Battery Failure–HPCI Mass Flow Rate

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Figure 9-28: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – Break Mass Flow Rate

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Figure 9-29: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – Reactor Pressure

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Figure 9-30: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – Downcomer Water Level

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Figure 9-31: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – Central Core (Bypass and Upper Plenum) Water Level

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Figure 9-32: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – Vessel Steam Flow Rate

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Figure 9-33: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – Overall Core PCT

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Figure 9-34: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – Total Core Spray Mass Flow Rate

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Figure 9-35: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – LPCI Mass Flow Rate to Intact Recirculation Loop

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Figure 9-36: Fermi 2 GNF3 Nominal DEGB RDL Break for CLTP Initial Conditions for Div II Battery Failure – HPCI Mass Flow Rate