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License Amendment Request for Measurement Uncertainty Recapture (MUR) Power Uprate

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SAFETY ANALYSIS REPORT
FOR
FERMI GENERATING STATION
UNIT 2
THERMAL POWER OPTIMIZATION

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Term	Definition
ABA	Amplitude Based Algorithm
AC	Alternating Current
ADS	Automatic Depressurization System
AL	Analytical Limit
ALARA	As Low As Reasonably Achievable
AOO	Anticipated Operational Occurrence
AP	Annulus Pressurization
APRM	Average Power Range Monitor
ARI	Alternate Rod Insertion
ART	Adjusted Reference Temperature
ARTS	Average Power Range Monitor, Rod Block Monitor, Technical Specifications Improvement Program
ASME	American Society of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
AV	Allowable Value
B&PV	Boiler and Pressure Vessel
BHP	Brake Horsepower
BIIT	Boron Injection Initiation Temperature
BOC	Beginning-of-Cycle
BOP	Balance-of-Plant
BSP	Backup Stability Protection
BWR	Boiling Water Reactor
BWRVIP	Boiling Water Reactor Vessel and Internals Project
CE	Combustion Engineering, Inc
CEOG	Combustion Engineering Owners Group
CF	Chemistry Factor
CFD	Condensate Filter Demineralizer
CFR	Code of Federal Regulation
CGCS	Combustible Gas Control System
CLTP	Current Licensed Thermal Power

Term	Definition
CLTR	NEDC-33004P-A, Constant Pressure Power Uprate
CMTR	Certified Material Test Report
CPPU	Constant Pressure Power Uprate
CPR	Critical Power Ratio
CRD	Control Rod Drive
CRDA	Control Rod Drop Accident
CRGT	Control Rod Guide Tube
CS	Core Spray
CSC	Containment Spray Cooling
CSS	Core Support Structure
CUF	Cumulative Usage Factor
DBA	Design Basis Accident
DC	Direct Current
DG	Diesel Generator
DIVOM	Delta Critical Power Ratio Over Initial Critical Power Ratio Versus Oscillation Magnitude
DW	Drywell
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EDGSW	Emergency Diesel Generator Service Water
EECW	Emergency Equipment Cooling Water
EESW	Emergency Equipment Service Water
EFPY	Effective Full Power Year
EHG	Electro-Hydraulic Governor
ELTR1	NEDC-32424P-A, Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate
ELTR2	NEDC-32523P-A, Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate
EOC	End-of-Cycle
EOOS	Equipment Out-Of-Service
EOP	Emergency Operating Procedure
EPG	Emergency Procedure Guideline

Term	Definition
EPU	Extended Power Uprate
EQ	Environmental Qualification
ESF	Engineered Safety Feature
ESW	Emergency Service Water
FAC	Flow-Accelerated Corrosion
FCV	Flow Control Valve
FFWTR	Final Feedwater Temperature Reduction
FHA	Fuel Handling Accident
FIV	Flow-Induced Vibration
FOA	Forced Oil and Air
FPCC	Fuel Pool Cooling and Cleanup
fps	Feet Per Second
FW	Feedwater
FWHOOS	Feedwater Heater(s) Out-Of-Service
GDC	General Design Criteria
GEH	GE-Hitachi Nuclear Energy Americas LLC
GL	Generic Letter
GRA	Growth Rate Algorithm
HCOM	Hot Channel Oscillation Magnitude
HELB	High Energy Line Break
HEPA	High Efficiency Particulate Air
HFCL	High Flow Control Line
HPCI	High Pressure Coolant Injection
HPCS	High Pressure Core Spray
HVAC	Heating, Ventilation and Air Conditioning
IASCC	Irradiation Assisted Stress Corrosion Cracking
ICF	Increased Core Flow
ICH&GT	In-Core Housing and Guide Tube
IORV	Inadvertent Opening of a Relief Valve
IRM	Intermediate Range Monitor
ISP	Integrated Surveillance Program

Term	Definition
JR	Jet Reaction
kA	Kilo-amp
ksi	Kips Per Square Inch
kV	Kilovolt
kW	Kilowatt
LAR	License Amendment Request
LCO	Limiting Conditions for Operation
LEFM	Leading Edge Flow Meter
LHGR	Linear Heat Generation Rate
LOCA	Loss-Of-Coolant Accident
LOOP	Loss Of Offsite Power
LPCI	Low Pressure Coolant Injection
LPRM	Local Power Range Monitor
LPSP	Low Power Setpoint
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCC	Motor Control Center
MCPR	Minimum Critical Power Ratio
MELB	Moderate Energy Line Break
MELLLA	Maximum Extended Load Line Limit Analysis
MeV	Million Electron Volts
MFWT	Minimum Feedwater Temperature
MGD	Million Gallons per Day
Mlb	Millions of Pounds
MOV	Motor Operated Valve
MS	Main Steam
MSF	Modified Shape Function
MSIV	Main Steam Isolation Valve
MSIVC	Main Steam Isolation Valve Closure
MSL	Main Steam Line
MSLB	Main Steam Line Break
MSR	Moisture Separator Reheater

Term	Definition
MTEB	Material Engineering Branch Technical Position
MVA	Million Volt Amps
MVAR	Megavolt Amperes Reactive
MWe	Megawatt-Electric
MWt	Megawatt-Thermal
NCL	Natural Circulation Line
NFWT	Nominal Feedwater Temperature
NPDES	National Pollutant Discharge Elimination System
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
NTSP	Nominal Trip Setpoint
NUMARC	Nuclear Utilities Management and Resources Council
NUREG	Nuclear Regulations (NRC Document)
ODFA	Oil Directed Forced Air
OLTP	Original Licensed Thermal Power
OLMCPR	Operating Limit Minimum Critical Power Ratio
OOS	Out-Of-Service
OPRM	Oscillation Power Range Monitor
PBDA	Period Based Detection Algorithm
PCS	Pressure Control System
PCT	Peak Clad Temperature
P/F	Power/Flow
P(F/E)	Probability of a Failure Event
PRA	Probabilistic Risk Assessment
PRFO	Pressure Regulator Failure Open
psi	Pounds Per Square Inch
psia	Pounds Per Square Inch – Absolute
psid	Pounds Per Square Inch – Differential
psig	Pounds Per Square Inch – Gauge
P-T	Pressure-Temperature

Term	Definition
RBCCW	Reactor Building Closed Cooling Water
RBM	Rod Block Monitor
RCIC	Reactor Core Isolation Cooling
RCPB	Reactor Coolant Pressure Boundary
RG	Regulatory Guide
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
RIPD	Reactor Internal Pressure Difference
RIS	Regulatory Issue Summary
RLB	Recirculation Line Break
RPT	Recirculation Pump Trip
RPV	Reactor Pressure Vessel
RRS	Reactor Recirculation System
RT_{NDT}	Reference Temperature of the Nil-Ductility Transition
RTP	Rated Thermal Power
RWCU	Reactor Water Cleanup
RWE	Rod Withdrawal Error
RWM	Rod Worth Minimizer
SAG	Severe Accident Guideline
SBO	Station Blackout
SBPCS	Steam Bypass Pressure Control System
SCCW	Supplemental Cooling Chilled Water
SDC	Shutdown Cooling
SER	Safety Evaluation Report
SFP	Spent Fuel Pool
SGTS	Standby Gas Treatment System
SHB	Shroud Head Bolt
SJAE	Steam Jet Air Ejector
SLCS	Standby Liquid Control System
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single-Loop Operation

Term	Definition
SP	Suppression Pool
SPC	Suppression Pool Cooling
SR	Surveillance Requirement
SRM	Source Range Monitor
SRP	Standard Review Plan
SRV	Safety Relief Valve
SRVDL	Safety Relief Valve Discharge Line
TBCCW	Turbine Building Closed Cooling Water
TBV	Turbine Bypass Valve
TCV	Turbine Control Valve
TFSP	Turbine First-Stage Pressure
T/G	Turbine-Generator
TIP	Traversing In-Core Probe
TLO	Two (Recirculation) Loop Operation
TLTR	NEDC-32938P-A, Thermal Power Optimization Licensing Topical Report
TPO	Thermal Power Optimization
TRC	Total Residual Chlorine
TS	Technical Specifications
TSAR	Thermal Power Optimization Safety Analysis Report
TSV	Turbine Stop Valve
UFSAR	Updated Final Safety Analysis Report
UHS	Ultimate Heat Sink
USE	Upper Shelf Energy
VWO	Valves Wide Open
W or Wd	Recirculation Drive Flow
WLI	Water Level Instrumentation

EXECUTIVE SUMMARY

This report summarizes the results of all significant safety evaluations performed that justify increasing the licensed thermal power at Fermi Generating Station Unit 2 (Fermi 2) to 3,486 MWt. The requested license power level is 1.64% above the current licensed thermal power (CLTP) level of 3,430 MWt.

This report follows the Nuclear Regulatory Commission (NRC) approved format and content for boiling water reactor (BWR) thermal power optimization (TPO) licensing reports documented in NEDC-32938P-A, "Generic Guidelines and Evaluations for General Electric Boiling Water Reactor Thermal Power Optimization," called "TLTR." Per the outline of the TPO safety analysis report (TSAR) in the TLTR Appendix A, every safety issue that should be addressed in a plant-specific TPO licensing report is addressed in this report. For issues that have been evaluated generically, this report references the appropriate evaluation and establishes that the evaluation is applicable to the plant.

Only previously NRC approved or industry-accepted methods were used for the analysis of accidents, transients, and special events. Therefore, because the safety analysis methods have been previously addressed, they are not addressed in this report. Also, event and analysis descriptions that are provided in other licensing documents or the Updated Final Safety Analysis Report (UFSAR) are not repeated. This report summarizes the results of the safety evaluations needed to justify a license amendment to allow for TPO operation.

The TLTR addresses power increases of up to 1.5% of CLTP, which will produce up to an approximately 2% increase in steam flow to the turbine-generator (T/G). The amount of power uprate (≤ 1.5%) contained in the TLTR was based on the expected reduction in power level uncertainty with the instrumentation technology available in 1999. The present instrumentation technology has evolved to where a power level uncertainty is reduced to as low as 0.3%, thereby supporting the evaluation of a power level increase of up to 1.7%. A higher steam flow is achieved by increasing the reactor power along the current rod and core flow control lines. A limited number of operating parameters are changed, some setpoints are adjusted and instruments are recalibrated. Plant procedures are revised, and tests similar to some of the original startup tests are performed.

Evaluations of the reactor, engineered safety features, power conversion, emergency power, support systems, environmental issues, design basis accidents (DBAs), and previous licensing evaluations were performed. This report demonstrates that Fermi 2 can safely operate at a power level of 3,486 MWt.

The following evaluations were conducted in accordance with the criteria of TLTR Appendix B:

All safety aspects of the plant that are affected by a 1.64% increase in the thermal power level were evaluated, including the nuclear steam supply system (NSSS) and balance-of-plant (BOP) systems.

Evaluations and reviews were based on licensing criteria, codes, and standards applicable to the plant at the time of the TSAR submittal. There is no change in the previously established licensing basis for the plant, except for the increased power level.

Evaluations and/or analyses were performed using NRC-approved or industry-accepted analysis methods for the UFSAR accidents, transients, and special events affected by TPO.

Evaluations and reviews of the NSSS systems and components, containment structures, and BOP systems and components show continued compliance to the codes and standards applicable to the current plant licensing basis (i.e., no change to comply with more recent codes and standards is proposed due to TPO).

NSSS components and systems were reviewed to confirm that they continue to comply with the functional and regulatory requirements specified in the UFSAR and/or applicable reload license.

Any modification to safety-related or non-safety related equipment will be implemented in accordance with 10 Code of Federal Regulation (CFR) 50.59.

All plant systems and components affected by an increased thermal power level were reviewed to ensure that there is no significant increase in challenges to the safety systems.

A review was performed to assure that the increased thermal power level continues to comply with the existing plant environmental regulations.

An assessment, as defined in 10 CFR 50.92(c), was performed to establish that no significant hazards consideration exists as a result of operation at the increased power level.

A review of the UFSAR and approved design changes ensures adequate evaluation of the licensing basis for the effect of TPO through the date of that evaluation.

The plant licensing requirements have been reviewed, and it is concluded that this TPO can be accommodated (1) without a significant increase in the probability or consequences of an accident previously evaluated, (2) without creating the possibility of a new or different kind of accident from any accident previously evaluated, and (3) without exceeding any existing regulatory limits applicable to the plant, which might cause a significant reduction in a margin of safety. Therefore, the requested TPO uprate does not involve a significant hazards consideration.

1.0 INTRODUCTION

1.1 OVERVIEW

This document addresses a TPO power uprate of 1.64% of the CLTP, consistent with the magnitude of the thermal power uncertainty reduction for the Fermi Generating Station Unit 2 (Fermi 2) plant. This will result in an increase in licensed thermal power from 3,430 MWt to 3,486 MWt and an expected increase in electrical power of approximately 22MWe.

This report follows the NRC-approved format and content for boiling water reactor (BWR) TPO licensing reports documented in NEDC-32938P-A, "Generic Guidelines and Evaluations for General Electric Boiling Water Reactor Thermal Power Optimization" (TLTR, Reference 1). Power uprates in GE BWRs of up to 120% of original licensed thermal power (OLTP) are based on the generic guidelines and approach defined in the Safety Evaluation Reports (SERs) provided in NEDC-32424P-A, "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," (ELTR1) (Reference 2) and NEDC-32523P-A, "Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate," (ELTR2) (Reference 3). Since their NRC approval, numerous extended power uprate (EPU) submittals have been based on these reports. The outline for the TSAR in TLTR Appendix A follows the same pattern as that used for the EPUs. All of the issues that should be addressed in a plant-specific TPO licensing report are included in this TSAR. For issues that have been evaluated generically, this report references the appropriate evaluation and establishes that it is applicable to Fermi 2.

BWR plants, as currently licensed, have safety systems and component capability for operation at least 1.5% above the CLTP level. The amount of power uprate (≤ 1.5%) contained in the TLTR was based on the expected reduction in power level uncertainty with the instrumentation technology available in 1999. The present instrumentation technology has evolved to where a power level uncertainty is reduced to as low as 0.3%, thereby supporting the evaluation of a power level increase of up to 1.7%. Several pressurized water reactor and BWR plants have already been authorized to increase their thermal power above the OLTP based on a reduction in the uncertainty in the determination of the power through improved feedwater (FW) flow rate measurements. When a previous uprate (other than a TPO) has been accomplished, the ≥ 102% safety analysis basis is reestablished above the uprated power level. Therefore, all GEH BWR plant designs have the capability to implement a TPO uprate, whether or not the plant has previously been uprated.

1.2 PURPOSE AND APPROACH

1.2.1 TPO Analysis Basis

Fermi 2 was originally licensed at 3,293 MWt. In Amendment 87 for Fermi 2, the NRC approved a 4.2% power uprate to 3,430 MWt which is the CLTP. The current safety analysis basis assumes, where required, that the reactor had been operating continuously at a power level at least 1.02 times the licensed power level. The analyses performed at 102% of CLTP remain applicable at the TPO rated thermal power (RTP), because the 2% factor from regulatory guide (RG) 1.49, "Power Levels of Nuclear Power Plants," is effectively reduced by the improvement in the FW flow measurements. Some analyses may be performed at TPO RTP, because the uncertainty factor is accounted for in the methods, or the additional 2% margin is not required (e.g., anticipated transient without scram (ATWS)). Detailed descriptions of the basis for the TPO analyses are provided in the subsequent sections of this report.

The TPO uprate is based on the evaluation of the improved FW flow rate measurement provided in Section 1.4. Figure 1-1 illustrates the TPO power/flow (P/F) operating map for the bounding analysis at 101.64% of CLTP for Fermi 2. The changes to the P/F operating map are consistent with the generic descriptions given in TLTR Section 5.2. The approach to achieve a higher thermal power level is to increase core flow along the established maximum extended load line limit analysis (MELLLA) rod lines. This strategy allows Fermi 2 to maintain most of the existing available core flow operational flexibility while assuring that low power-related issues (e.g., stability and ATWS instability) do not change because of the TPO uprate.

No increase in the previously licensed maximum core flow limit is associated with the TPO uprate. When end of full power reactivity condition (all-rods-out) is reached, end-of-cycle (EOC) coastdown may be used to extend the power generation period. Previously licensed performance improvement features are presented in Section 1.3.2.

With respect to absolute thermal power and flow, there is no change in the extent of the single-loop operation (SLO) domain as a result of the TPO uprate. Therefore, the SLO domain is not provided. For Fermi 2 the maximum analyzed reactor core thermal power for SLO remains at the technical specification (TS) limit of 2,305 MWt.

The TPO uprate is accomplished with no increase in the nominal vessel dome pressure. This minimizes the effect of uprating on reactor thermal duty, evaluations of environmental conditions, and minimizes changes to instrument setpoints related to system pressure. Satisfactory reactor pressure control capability is maintained by evaluating the steam flow margin available at the turbine inlet. This operational aspect of the TPO uprate will be demonstrated by performing controller testing as described in Section 10.4. The TPO uprate does not affect the pressure control function of the turbine bypass valves (TBVs).

1.2.2 Margins

The TPO analysis basis ensures that the power-dependent instrument error margin identified in RG 1.49 is maintained. NRC-approved or industry-accepted computer codes and calculation techniques are used in the safety analyses for the TPO uprate. A list of the NSSS computer codes used in the evaluations is provided in Table 1-1. Computer codes used in previous analyses (i.e., analyses at 102% of CLTP) are not listed. Similarly, factors and margins specified by the application of design code rules are maintained, as are other margin-assuring acceptance criteria used to judge the acceptability of the plant.

1.2.3 Scope of Evaluations

The scope of the evaluations is discussed in TLTR Appendix B. Tables B-1 through B-3 identify those analyses that are bounded by current analyses, those that are not significantly affected, and those that require updating. The disposition of the evaluations as defined by Tables B-1 through B-3 is applicable to Fermi 2. This TSAR includes all of the evaluations for the plant-specific application. Many of the evaluations are supported by generic reference, some supported by rational considerations of the process differences, and some plant-specific analyses are provided.

The scope of the evaluations is summarized in the following sections:

2.0 Reactor Core and Fuel Performance

Overall heat balance and power-flow operating map information are provided. Key core performance parameters are confirmed for each fuel cycle, and will continue to be evaluated and documented for each fuel cycle.

3.0 Reactor Coolant and Connected Systems

Evaluations of the NSSS components and systems are performed at the TPO conditions. These evaluations confirm the acceptability of the TPO changes in process variables in the NSSS.

4.0 Engineered Safety Features

The effects of TPO changes on the containment, emergency core cooling systems (ECCS), standby gas treatment system (SGTS), and other engineered safety features (ESFs) are evaluated for key events. The evaluations include the containment responses during limiting abnormal events, loss-of-coolant accident (LOCA), and safety relief valve (SRV) containment dynamic loads.

5.0 Instrumentation and Control

The instrumentation and control signal ranges and analytical limits (ALs) for setpoints are evaluated to establish the effects of TPO changes in process parameters. If required, analyses are performed to determine the need for setpoint changes for various functions. In general, setpoints are changed only to maintain adequate operating margins between plant operating parameters and trip values.

6.0 Electrical Power and Auxiliary Systems

Evaluations are performed to establish the operational capability of the plant electrical power and distribution systems and auxiliary systems to ensure that they are capable of supporting safe plant operation at the TPO RTP level.

7.0 Power Conversion Systems

Evaluations are performed to establish the operational capability of various (non-safety) BOP systems and components to ensure that they are capable of delivering the increased TPO power output.

8.0 Radwaste and Radiation Sources

The liquid and gaseous waste management systems are evaluated at TPO conditions to show that applicable release limits continue to be met during operation at the TPO RTP level. The radiological consequences are evaluated to show that applicable regulations are met for TPO including the effect on source terms, on-site doses, and off-site doses during normal operation.

9.0 Reactor Safety Performance Evaluations

[[

]] The standard reload analyses consider the plant conditions for the cycle of interest.

10.0 Other Evaluations

High energy line break (HELB) and environmental qualification (EQ) evaluations are performed at bounding conditions for the TPO range to show the continued operability of plant equipment under TPO conditions. The probabilistic risk assessment (PRA) will not be updated, because the change in plant risk from the subject power uprate is insignificant. This conclusion is supported by NRC Regulatory Issue Summary (RIS) 2002-03 (Reference 4). In response to feedback received during the public workshop held on August 23, 2001, the Staff wrote, "The NRC has generically determined that measurement uncertainty recapture power uprates have an insignificant effect on plant risk. Therefore, no risk information is requested to support such applications."

1.2.4 Exceptions to the TLTR

No exceptions are requested to the TLTR because this evaluation follows the protocol as approved by the NRC.

1.2.5 Concurrent Changes Unrelated to TPO

No concurrent changes unrelated to TPO are included in this evaluation because there are no other pending license amendments.

1.3 TPO PLANT OPERATING CONDITIONS

1.3.1 Reactor Heat Balance

The reactor heat balance diagrams at TPO conditions are presented in Figures 1-2 and 1-3. Figure 1-2 is the reactor heat balance for the bounding analysis at 101.7% of CLTP and Figure 1-3 is the reactor heat balance for the requested 101.64% of CLTP.

The small changes in thermal-hydraulic parameters for the TPO are identified in Table 1-2. These parameters are generated for TPO by performing reactor heat balances that relate the reactor thermal-hydraulic parameters to the increased plant FW and steam flow conditions. Input from Fermi 2 operation is considered to match expected TPO uprate conditions.

1.3.2 Reactor Performance Improvement Features

The following performance improvement and equipment out-of-service (EOOS) features currently licensed at Fermi 2 are acceptable at the TPO RTP level:

Performance Improvement Feature
SLO
Increased Core Flow (ICF) (105.0% of rated)
Average power range monitor (APRM), Rod block monitor (RBM), TS improvement program (ARTS) / MELLLA (83% of rated core flow at TPO RTP)
Final FW temperature reduction (FFWTR), -50°F
FW heater(s) out-of-service (FWHOOS), -50°F
SRV 4 valves out-of-service (OOS)/Automatic depressurization system (ADS) 1 valve OOS
TBV OOS
Moisture separator reheater (MSR) OOS

1.4 BASIS FOR TPO UPRATE

The safety analyses in this report are based on a total thermal power measurement uncertainty of 0.355%. This will bound the actual power level requested. The detailed basis value is provided in separate documentation, which addresses the improved FW flow measurement accuracy using the Cameron leading edge flow meter (LEFM) check-plus system.

1.5 SUMMARY AND CONCLUSIONS

This evaluation has investigated a TPO uprate to 101.64% of CLTP. The strategy for achieving higher power is to increase core flow along the established MELLLA rod lines. The plant licensing criteria have been reviewed (Table 1-3) to demonstrate how the TPO uprate can be accommodated without a significant increase in the probability or consequences of an accident previously evaluated, without creating the possibility of a new or different kind of accident from any accident previously evaluated, and without exceeding any existing regulatory limits or design allowable limits applicable to the plant which might cause a reduction in a margin of safety. The TPO uprate described herein involves no significant hazards consideration.

Table 1-1 Computer Codes for TPO Analyses

Task	Computer Code*	Version or Revision	NRC Approved	Comments
Reactor Heat Balance	ISCOR	09	Y (1)	NEDE-24011-P Rev. 0 SER
ATWS	ODYN STEMP PANACEA	10 04 11	Y (3) Y(2)	NEDE-24154P-A Supp. 1, Vol. 4 NEDE-30130-P-A
Reactor Core and Fuel Performance	ISCOR	09	Y(1)	NEDE-24011-P Rev. 0 SER
Reactor Internal Pressure Differences (RIPDs)	ISCOR	09	Y(1)	NEDE-24011-P Rev. 0 SER
Thermal-Hydraulic Stability	PANACEA ISCOR TRACG ODYSY	11 09 04 05	Y(2) Y(1) N(4) Y	NEDE-30130-P-A NEDE-24011-P Rev. 0 SER NEDO-32465-A NEDE-33213P-A

* The application of these codes to the Fermi 2 TPO analyses complies with the limitations, restrictions, and conditions specified in the approving NRC SER where applicable for each code.

Notes:

(1) The ISCOR code is not approved by name. However, the SER supporting approval of NEDE-24011-P Revision 0 by the May 12, 1978 letter from D.G. Eisenhut (NRC) to R. Gridley (GE) finds the models and methods acceptable, and mentions the use of a digital computer code. The referenced digital computer code is ISCOR. The use of ISCOR to provide core thermal-hydraulic information in RIPDs, Transient, ATWS, Stability, Reactor Core and Fuel Performance, and LOCA applications is consistent with the approved models and methods.

(2) The physics code, PANACEA, provides inputs to the transient code ODYN. The improvements to PANACEA that were documented in NEDE-30130-P-A were incorporated into ODYN by way of Amendment 11 of GESTAR II (NEDE-24011-P-A). The use of TGBLA Version 06 and PANACEA Version 11 in this application was initiated following approval of Amendment 26 of GESTAR II by letter from S.A. Richards (NRC) to G.A. Watford (GE) Subject: "Amendment 26 to GE Licensing Topical Report NEDE-24011-P-A, GESTAR II Implementing Improved GE Steady-State Methods," (TAC NO. MA6481), November 10, 1999.

(3) The STEMP code uses fundamental mass and energy conservation laws to calculate the suppression pool (SP) heatup. The use of STEMP was noted in NEDE-24222, "Assessment of BWR Mitigation of ATWS," Volume I & II (NUREG-0460 Alternate No. 3) December 1, 1979. The code has been used in ATWS applications since that time. There is no formal NRC review and approval of STEMP.

(4) TRACG02 has been approved in NEDO-32465-A by the USNRC for the stability Delta Critical Power Ratio (CPR) over Initial CPR Versus Oscillation Magnitude (DIVOM) analysis. The CLTP stability analysis is based on TRACG04, which has been shown to provide essentially the same or more conservative results in DIVOM applications as the previous version, TRACG02.

Table 1-2 Thermal-Hydraulic Parameters at TPO Uprate Conditions

Parameter	CLTP	TPO RTP (101.7% of CLTP)	Revised TPO RTP (101.64% of CLTP)
Thermal Power (MWt) (Percent of Current Licensed Power)	3430 100.0	3488 101.7	3486 101.64
Steam Flow (Mlb/hr) (Percent of Current Rated)	14.86 100.0	15.15 102.0	15.14 101.9
FW Flow (Mlb/hr) (Percent of Current Rated)	14.83 100.0	15.12 102.0	15.11 101.9
Dome Pressure (psia)	1045	1045	1045
Dome Temperature (°F)	550.0	550.0	550.0
FW Temperature (°F)	424.5	426.5	426.5
Full Power Core Flow Range (Mlb/hr) (Percent of Current Rated)	81.0 to 105.0 (81.0 to 105.0)	83.1 to 105.0 (83.1 to 105.0)	83.0 to 105.0 (83.0 to 105.0)

Table 1-3 Summary of Effect of TPO Uprate on Licensing Criteria

Key Licensing Criteria	Effect of 1.64% Thermal Power Increase	Explanation of Effect
LOCA challenges to fuel (10 CFR 50, Appendix K)	No effect, current 10 CFR 50.46, or LOCA, analyses for the Fermi 2 revised plant have been performed at 117% of CLTP, exceeding Appendix K requirements.	Pre-TPO LOCA analysis for GE14 fuel bounds the 1.64% TPO uprate.
Change of Operating Limit Minimum Critical Power Ratio (MCPR)	Negligible increase.	The operating limit MCPR (OLMCPR) changes are expected to be within the normal cycle-to-cycle variation.
Challenges to reactor pressure vessel (RPV) overpressure	There is no increase in nominal operating pressure for the Fermi 2 TPO uprate.	Evaluations and analyses for the CLTP have been performed at 102% of CLTP to demonstrate that the reactor vessel conformed to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code and plant TS requirements.
Primary containment pressure during a LOCA	No increase in peak containment pressure.	The current containment evaluations were performed at 102% of CLTP.
Pool temperature during a LOCA	No increase in peak pool temperature.	The current containment analyses have been performed at 102% of CLTP.
Offsite Radiation Release, DBAs	No increase (remains within 10 CFR 100 or 10 CFR 50.67 limits).	Previous analysis bounds TPO operation. No vessel pressure increase.
Onsite Radiation Dose, normal operation	Approximately 1.64% increase, must remain within 10 CFR 20.	Slightly higher inventory of radionuclides in steam/FW flow.
Equipment Qualification	TPO uprate does not increase the nominal vessel dome pressure, there is a very small effect on pressure and temperature conditions experienced by equipment during normal operation and accident conditions	Resulting environmental conditions are bounded by the existing environmental parameters specified for use in the EQ program.
Fracture Toughness, 10 CFR 50, Appendix G	No adverse effect (not exceeding regulatory requirements) on the reactor vessel fracture toughness	Fermi 2 was evaluated for a fluence that bounds the required value for operation at TPO conditions
Stability	The oscillation power range monitor (OPRM) trip-enabled region is confirmed for nominal FW temperature (NFWT) and minimum FW temperature (MFWT) operations based on the demonstration backup stability protection (BSP) regions for NFWT and MFWT.	The BSP regions are confirmed or expanded on a cycle-specific basis. TPO operation is justified for plant operation with stability BSP regions.
ATWS peak vessel pressure	Remains within ASME Service Level C limit.	Response to ATWS event at TPO is acceptable.
Vessel and NSSS equipment design pressure	No change.	Comply with existing ASME Code stress limits of all categories.

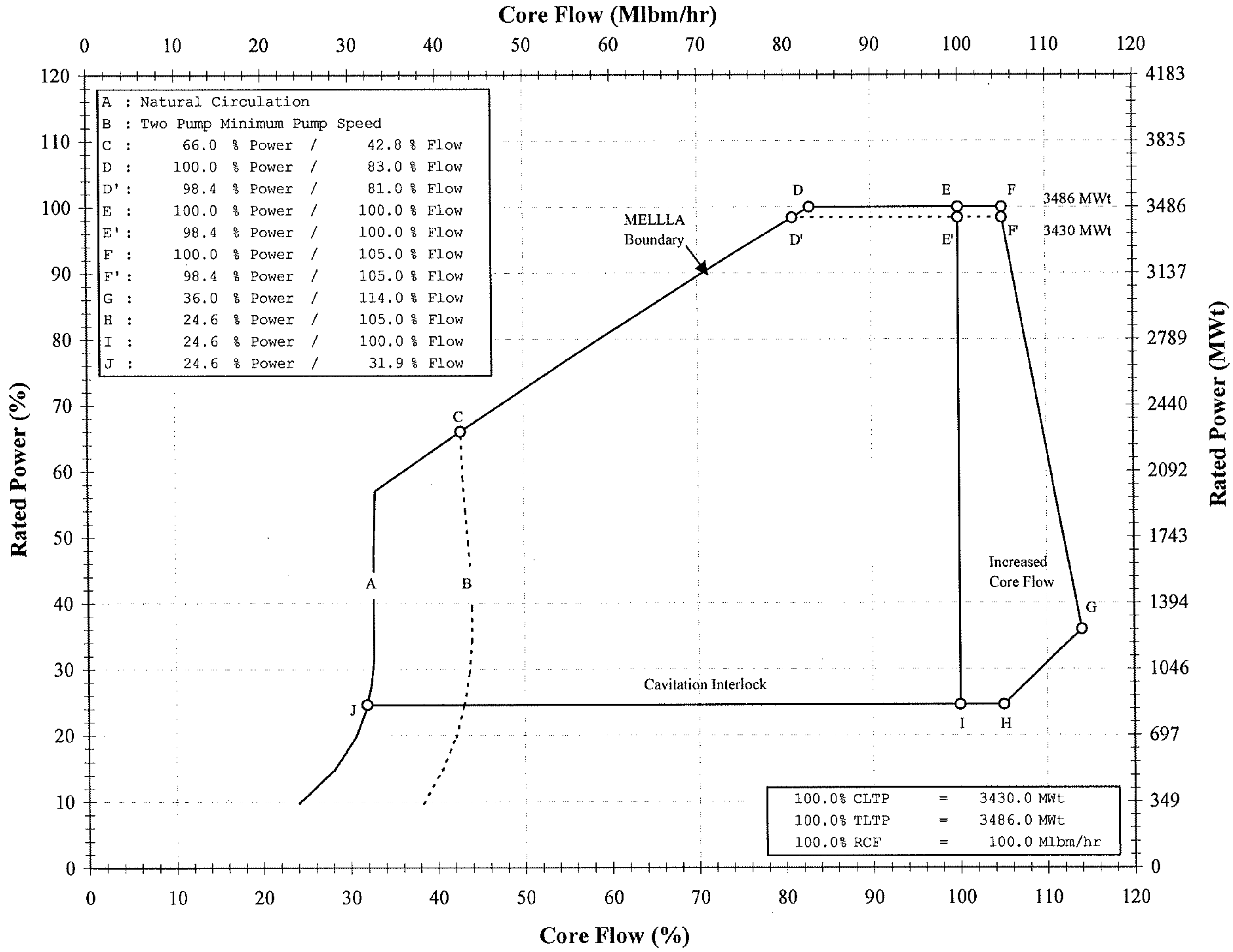
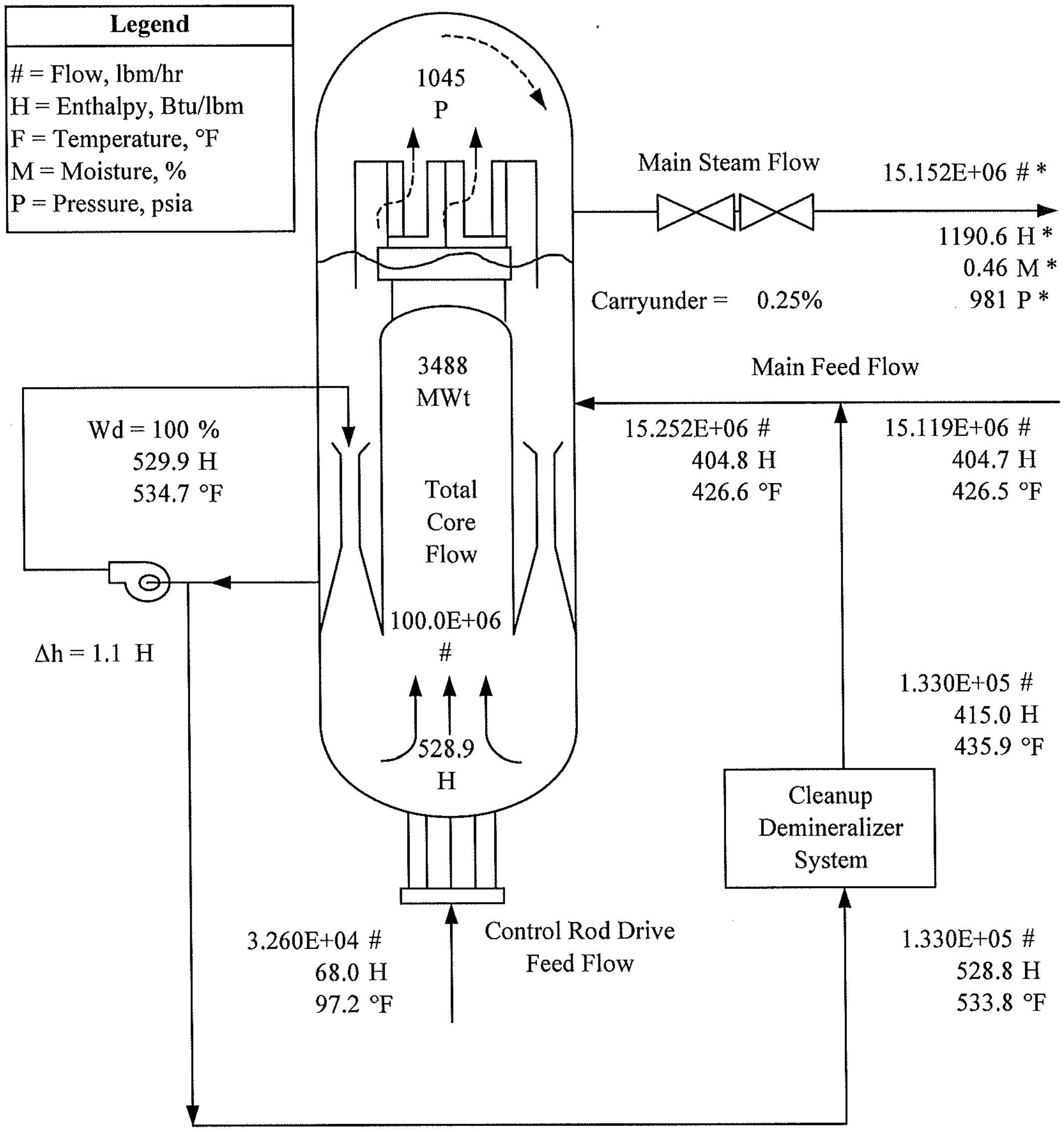


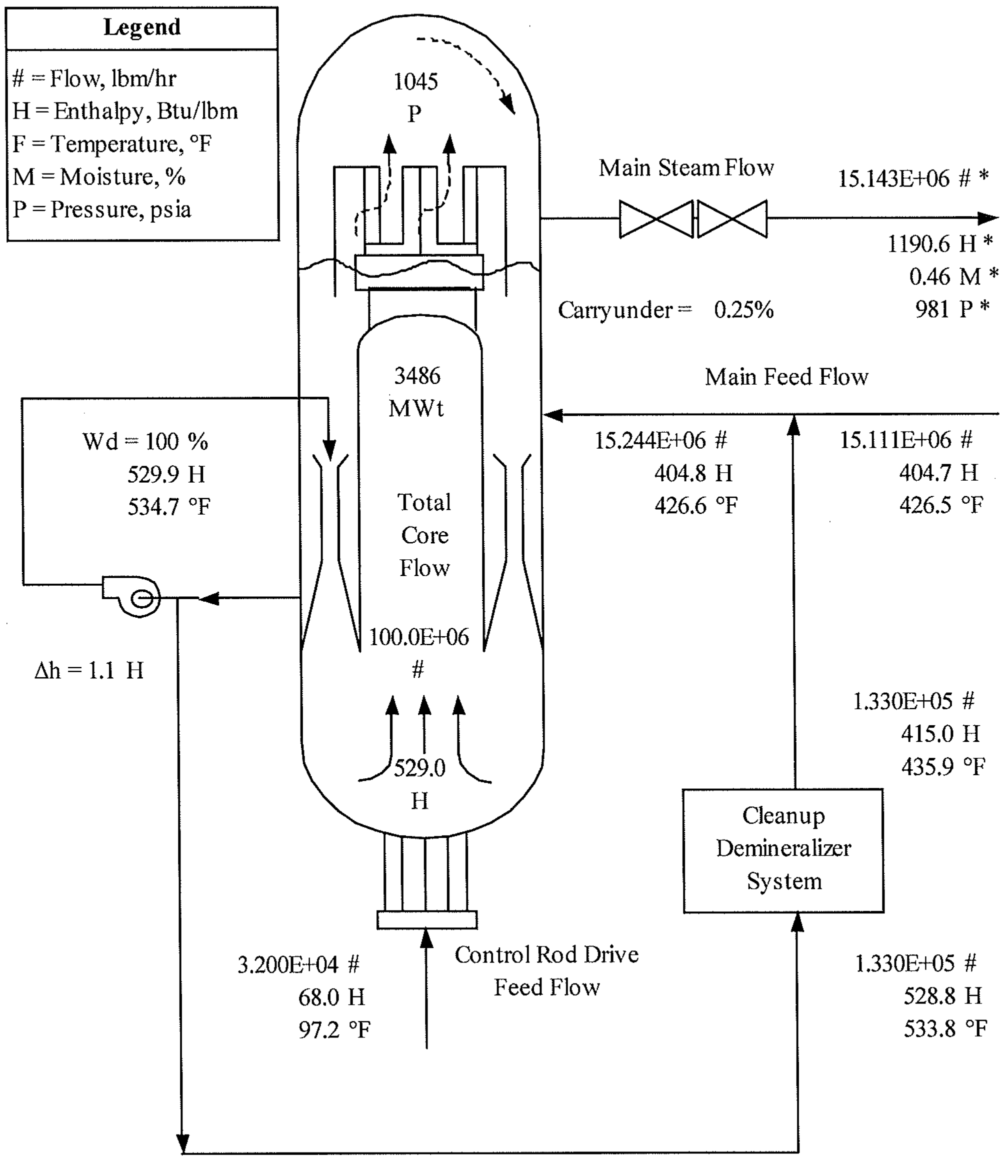
Figure 1-1 Power/Flow Map for the TPO (101.64% of CLTP)



*Conditions at upstream side of TSV

Core Thermal Power	3488.0
Pump Heating	10.6
Cleanup Losses	-4.4
Other System Losses	-1.2
Turbine Cycle Use	3493.0 MWt

Figure 1-2 Reactor Heat Balance – TPO Power (101.7% of CLTP), 100% Core Flow



*Conditions at upstream side of TSV

Core Thermal Power	3486.0
Pump Heating	10.6
Cleanup Losses	-4.4
Other System Losses	-1.2
Turbine Cycle Use	3491.0 MWt

Figure 1-3 Reactor Heat Balance – Revised TPO Power (101.64% of CLTP), 100% Core Flow

2.0 REACTOR CORE AND FUEL PERFORMANCE

2.1 FUEL DESIGN AND OPERATION

At the TPO RTP conditions, all fuel and core design limits are met by the deployment of fuel enrichment and burnable poison, control rod pattern management, and core flow adjustments. New fuel designs are not needed for the TPO to ensure safety. However, revised loading patterns, slightly larger batch sizes, and potentially new fuel designs may be used to provide additional operating flexibility and maintain fuel cycle length. NRC-approved limits for burn-up on the fuel are not exceeded. Therefore, the reactor core and fuel design is adequate for TPO operation.

The initial TPO cycle at Fermi 2 will be loaded with fresh and previously irradiated GE14 fuel assemblies.

2.2 THERMAL LIMITS ASSESSMENT

Operating thermal limits ensure that regulatory and/or safety limits are not exceeded for a range of postulated events (e.g., transients, LOCA). This section addresses the effects of TPO on thermal limits. Cycle-specific core configurations, which are evaluated for each reload, confirm TPO RTP capability and establish or confirm cycle-specific limits.

The historical 25% of RTP value for the TS Safety Limit, some thermal limits monitoring limiting conditions for operation (LCOs) thresholds, and some surveillance requirements (SRs) thresholds are based on [[

]] The historical 25% RTP value is a conservative basis, as described in the plant TS, [[

]] Therefore, the Safety Limit percent RTP basis, the thermal limit monitoring LCOs, and SR percent RTP thresholds remain at 25% RTP for the TPO uprate.

2.2.1 Safety Limit MCPR

The safety limit minimum critical power ratio (SLMCPR) is dependent upon the nominal average power level and the uncertainty in its measurement. Consistent with approved practice, a revised SLMCPR is calculated for the first TPO fuel cycle and confirmed for each subsequent cycle. The historical uncertainty allowance and calculational methods are discussed in TLTR Section 5.7.2.1.

2.2.2 MCPR Operating Limit

TLTR Appendix E shows that the changes in the OLMCPR for a TPO uprate [[

]] Because the cycle-specific SLMCPR is also defined, the actual required OLMCPR can be established. This ensures an adequate fuel thermal margin for TPO uprate operation.

2.2.3 MAPLHGR and Maximum LHGR Operating Limits

The maximum average planar linear heat generation rate (MAPLHGR) and maximum linear heat generation rate (LHGR) limits are maintained as described in TLTR Section 5.7.2.2. No significant change results due to TPO operation. The LHGR limits are fuel dependent and are not affected by the TPO. The ECCS performance is addressed in Section 4.3.

2.3 Reactivity Characteristics

All minimum shutdown margin requirements apply to cold shutdown conditions and are maintained without change. Checks of cold shutdown margin based on standby liquid control system (SLCS) boron injection capability and shutdown using control rods with the most reactive control rod stuck out are made for each reload. The TPO uprate has no significant effect on these conditions; the shutdown margin is confirmed in the reload core design.

Operation at the TPO RTP could result in a minor decrease in the hot excess reactivity during the cycle. This loss of reactivity does not affect safety and does not affect the ability to manage the power distribution through the cycle to achieve the target power level. However, the lower hot excess reactivity can result in achieving an earlier all-rods-out condition. Through fuel cycle redesign, sufficient excess reactivity can be obtained to match the desired cycle length.

2.4 Thermal Hydraulic Stability

2.4.1 Stability Option III

Fermi 2 has implemented the stability long-term solution Option III (References 5 and 6). The Option III solution combines closely spaced local power range monitor (LPRM) detectors into "cells" to effectively detect either core-wide or regional (local) modes of reactor instability. These cells are termed OPRM cells and are configured to provide local area coverage with multiple channels. Plants implementing Option III have hardware to combine the LPRM signals and to evaluate the cell signals with instability detection algorithms. The period based detection algorithm (PBDA) is the only algorithm credited in the Option III licensing basis (Reference 6). Two defense-in-depth algorithms, referred to as the amplitude based algorithm (ABA) and the growth rate algorithm (GRA), offer a higher degree of assurance that fuel failure will not occur as a consequence of stability-related oscillations. Because the OPRM hardware does not change, the hot channel oscillation magnitude (HCOM) portion of the Option III calculation (Reference 7) is not affected by TPO and does not need to be recalculated.

The Option III OPRM trip-enabled region has been defined as the region (≤ 60% rated core flow and ≥ 28% of CLTP) where the OPRM system is fully armed. For TPO, the Option III OPRM trip-enabled region is rescaled to maintain the same absolute P/F region boundaries. The BSP evaluation, described in Section 2.4.2, shows that the generic Option III OPRM trip-enabled region is adequate. The OPRM trip-enabled region is shown in Figure 2-1.

Because the rated core flow does not change, the 60% recirculation drive flow boundary is not rescaled (It should be noted that 60% recirculation drive flow bounds 60% core flow). The 28% of CLTP boundary changes by the following equation:

TPO Region Boundary = 28% CLTP * (100% ÷ TPO (% CLTP))

Thus, for a 101.64% of CLTP TPO:

TPO Region Boundary = 28% CLTP * (100% ÷101.64%) = 27.5% TPO

Stability Option III provides SLMCPR protection by generating a reactor scram if a reactor instability, which exceeds the specified trip setpoints, is detected. The demonstration setpoint is determined per the current NRC-approved methodology. The Option III stability reload licensing basis calculates the OLMCPR required to protect the SLMCPR for both steady-state and transient stability events as specified in the Option III methodology (Reference 6). These OLMCPRs are calculated for a range of OPRM setpoints for TPO operation. Selection of an appropriate instrument setpoint is then based upon the OLMCPR required to provide adequate SLMCPR protection. This determination relies on the DIVOM curve to determine an OPRM Amplitude Setpoint that protects the SLMCPR during an anticipated instability event (Reference 8). A DIVOM analysis is performed and used in Option III OPRM amplitude setpoint demonstration.

As demonstrated in Table 2-1, with an estimated OLMCPR of 1.35 and an estimated SLMCPR of 1.08, an OPRM amplitude setpoint of 1.12 with an ORPM Successive Confirmation Count Setpoint of 14 (Reference 6) is the highest setpoint that may be used without stability setting the OLMCPR. The actual setpoint will be established in accordance with Fermi 2 TS at each reload. These demonstration results are based on a power level of 101.7% CLTP, which is applicable for a power level of 101.64% CLTP.

Therefore, TPO operation is justified for plant operation with stability Option III.

2.4.2 Stability Backup Stability Protection

Fermi 2 has implemented the BSP methodology (Reference 9) as the stability backup solution should the OPRM system be declared inoperable.

The BSP regions consist of two regions, I-Scram and II-Controlled Entry. The base BSP scram region and the base BSP controlled entry region are defined by state points on the high flow control line (HFCL) and on the natural circulation line (NCL) in accordance with Reference 9. The bounding plant-specific BSP region state points must enclose the corresponding base BSP region state points on the HFCL and on the NCL. If a calculated BSP region state point is located inside the corresponding base BSP region state point, then it must be replaced by the corresponding base BSP region state point. If a calculated BSP region state point is located outside the corresponding base BSP region state point, this point is acceptable for use. That is, the selected points will result in the largest, or most conservative, region sizes. The proposed BSP Scram and Controlled Entry Region boundaries are constructed by connecting the corresponding bounding state points on the HFCL and the NCL using a shape function. The modified shape function (MSF) (Reference 10) is applied to these analyses.

The demonstration BSP regions for both the NFWT and the MFWT operations are shown in Table 2-2 and Figure 2-2, and Table 2-3 and Figure 2-3, respectively. The OPRM trip-enabled region is confirmed for NFWT and MFWT operations based on the demonstration BSP regions for NFWT and MFWT. These demonstration results are based on a power level of 101.7% CLTP, which is applicable for a power level of 101.64% CLTP.

The BSP regions are confirmed or expanded on a cycle-specific basis.

Therefore, TPO operation is justified for plant operation with stability BSP regions.

2.5 Reactivity Control

The generic discussion in TLTR Sections 5.6.3 and Appendix J.2.3.3 applies to Fermi 2. The control rod drive (CRD) and CRD hydraulic systems and supporting equipment are not affected by the TPO uprate and no further evaluation of CRD performance is necessary.

Table 2-1 OPRM Setpoint Versus OLMCPR for Fermi 2 TPO Demonstration

OPRM Amplitude Setpoint	Fermi 2 TPO	
	OLMCPR (2 Recirculation Pump Trip (RPT))	OLMCPR (Steady State)
1.05	1.189	1.201
1.06	1.215	1.227
1.07	1.242	1.254
1.08	1.270	1.282
1.09	1.301	1.314
1.10	1.318	1.331
1.11	1.333	1.346
1.12	1.347	1.360
1.13	1.359	1.373
1.14	1.371	1.385
1.15	1.383	1.396
Acceptance Criteria	**Rated Power OLMCPR**	**Off-Rated OLMCPR at 45% Flow**

Table 2-2 Demonstration BSP Region Intercepts for Nominal Feedwater Temperature

Region Boundary Intercept	% TPO Power	% Core Flow
Scram Region (Region I) Boundary Intercept on HFCL		
A1	66.7	43.6
Scram Region (Region I) Boundary Intercept on NCL		
B1	47.3	32.7
Controlled Entry Region (Region II) Boundary Intercept on HFCL		
A2 Base	72.4	50.0
Controlled Entry Region (Region II) Boundary Intercept on NCL		
B2 Base	33.1	32.7

Table 2-3 Demonstration BSP Region Intercepts for Minimum Feedwater Temperature

Region Boundary Intercept	% TPO Power	% Core Flow
Scram Region (Region I) Boundary Intercept on HFCL		
A1	71.7	49.2
Scram Region (Region I) Boundary Intercept on NCL		
B1	42.4	32.7
Controlled Entry Region (Region II) Boundary Intercept on HFCL		
A2	77.7	56.1
Controlled Entry Region (Region II) Boundary Intercept on NCL		
B2 Base	33.1	32.7

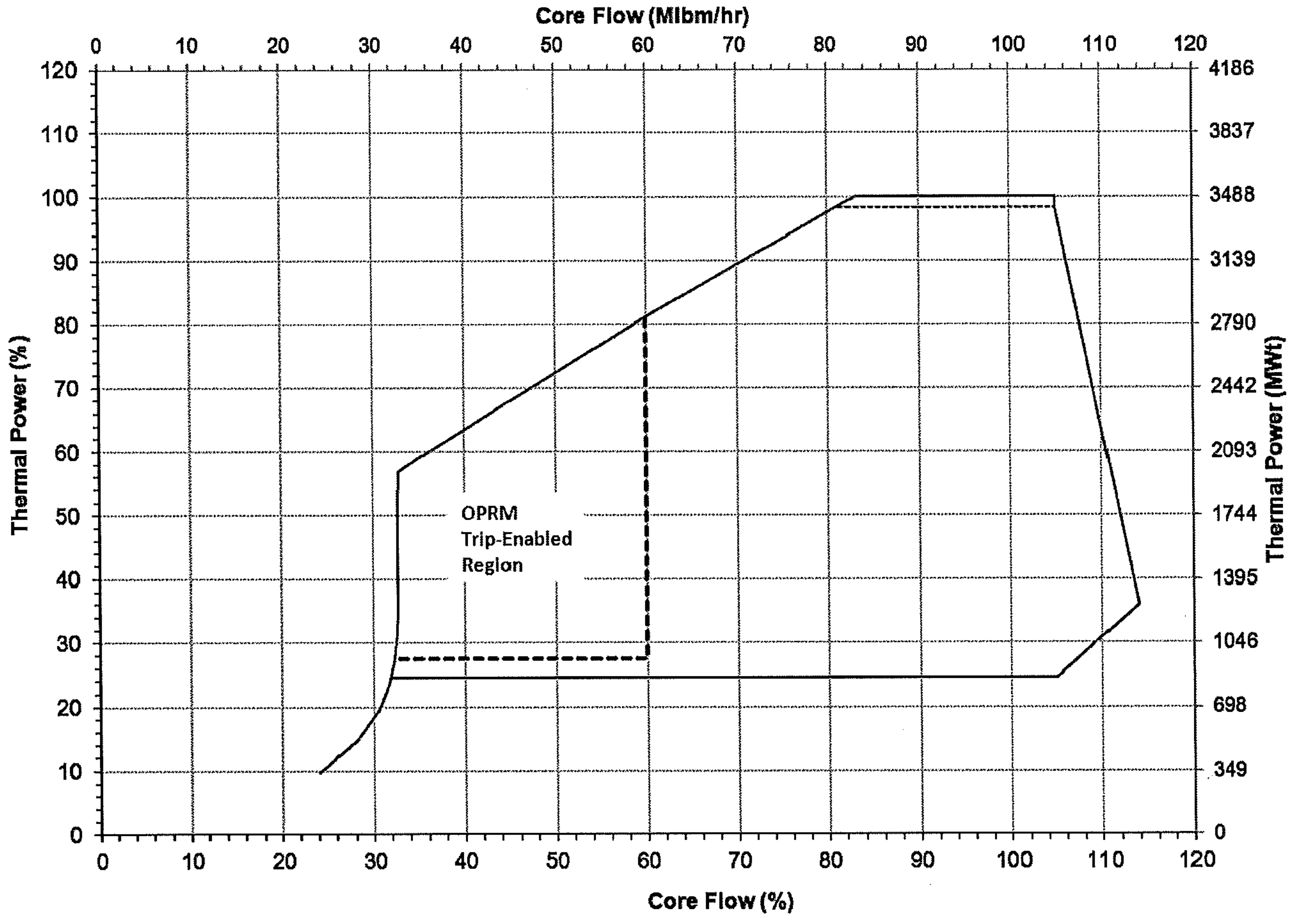


Figure 2-1 Illustration of OPRM Trip-Enabled Region

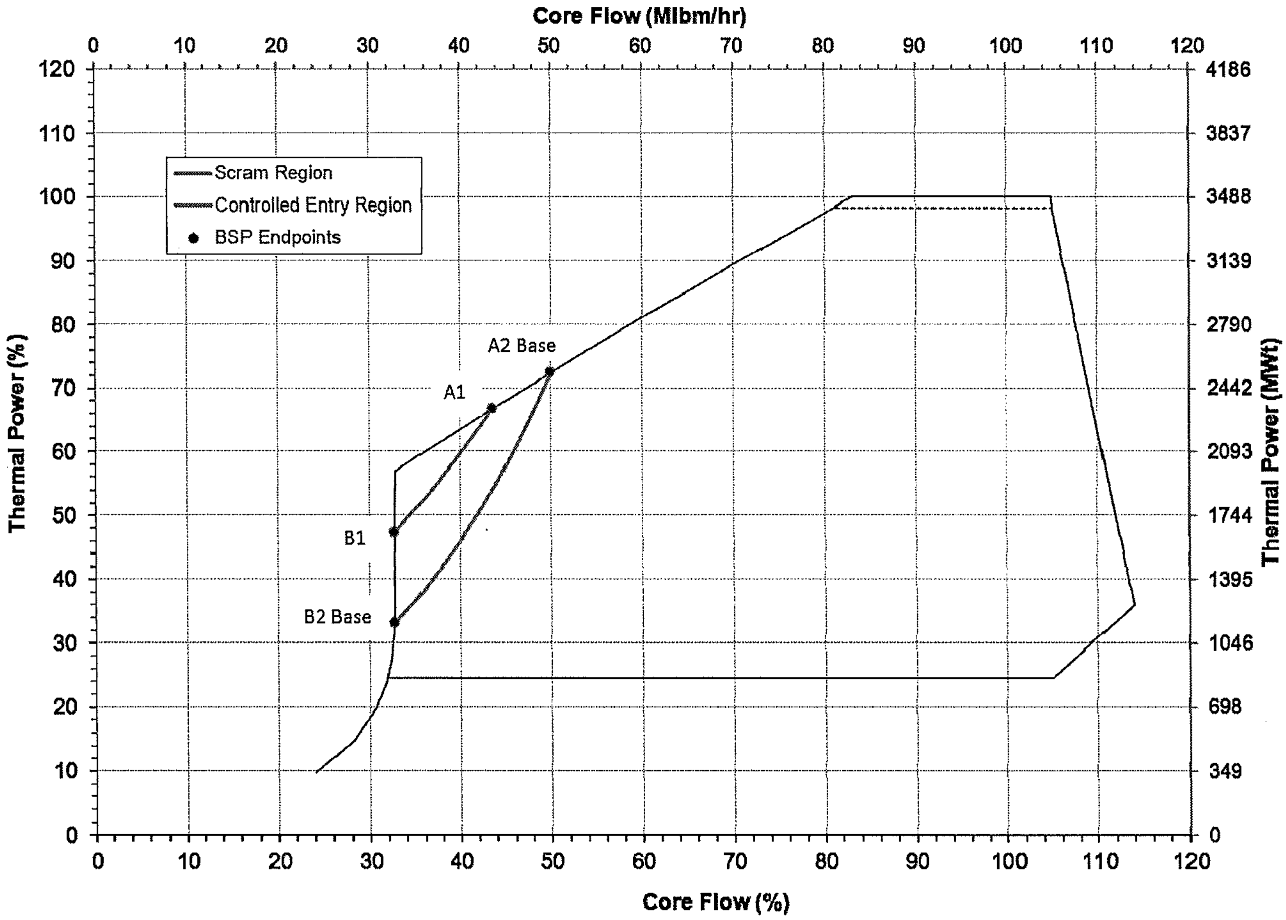


Figure 2-2 Demonstration BSP Regions for Nominal Feedwater Temperature

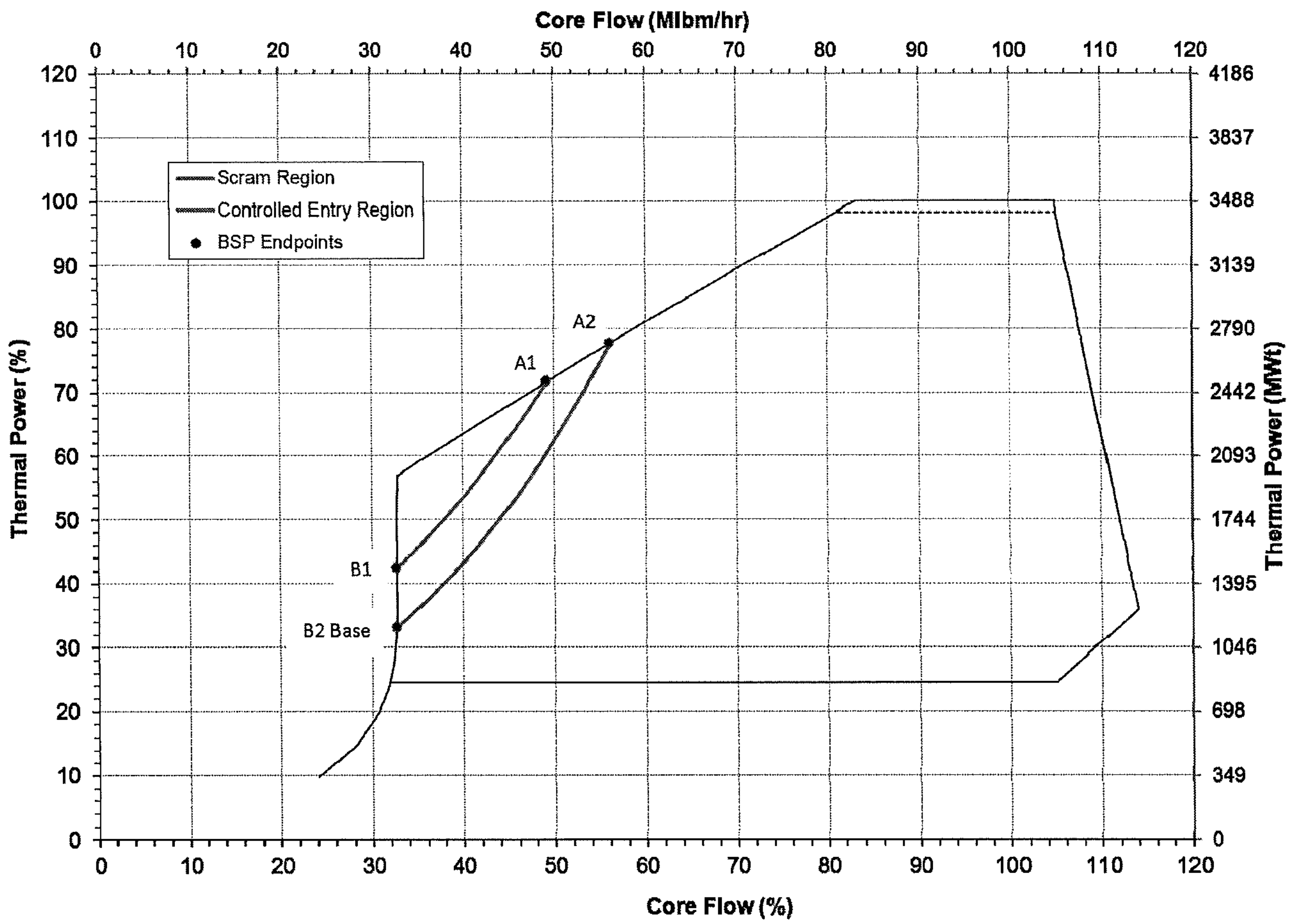


Figure 2-3 Demonstration BSP Regions for Minimum Feedwater Temperature

3.0 REACTOR COOLANT AND CONNECTED SYSTEMS

3.1 NUCLEAR SYSTEM PRESSURE RELIEF / OVERPRESSURE PROTECTION

The pressure relief system prevents over-pressurization of the nuclear system during abnormal operational transients. The SRVs along with other functions provide this protection. Evaluations and analyses for the CLTP have been performed at 102% of CLTP to demonstrate that the reactor vessel conformed to ASME B&PV Code and plant TS requirements. There is no increase in nominal operating pressure for the Fermi 2 TPO uprate. There are no changes in the SRV setpoints or valve OOS options. There is no change in the methodology or the limiting overpressure event. Therefore, the generic evaluation contained in the TLTR is applicable.

The analysis for each fuel reload, which is current practice, confirms the capability of the system to meet the ASME design criteria.

3.2 REACTOR VESSEL

The RPV structure and support components form a pressure boundary to contain reactor coolant and moderator, and form a boundary against leakage of radioactive materials into the drywell (DW). The RPV also provides structural support for the reactor core and internals.

3.2.1 Fracture Toughness

Section 5.5.1.5 of the TLTR (Reference 1) describes the RPV fracture toughness evaluation process. RPV embrittlement is caused by neutron exposure of the wall adjacent to the core including the regions above and below the core that experience fluence ≥ 1.0E+17 n/cm^2. This region is defined as the "beltline" region. Operation at TPO conditions results in a higher neutron flux, which increases the integrated fluence over the period of plant license. Fermi 2 was evaluated for a fluence that bounds the required value for operation at TPO conditions.

Fermi 2 TPO was evaluated at the bounding power conditions at 115% of CLTP, which bounds TPO conditions at 101.7% of CLTP. The bounding power conditions were used to conservatively evaluate the vessel against the requirements of 10 CFR 50, Appendix G (References 11 and 12). The results of these evaluations indicate that:

a) The 32 effective full power year (EFPY) shift is increased, and consequently, requires a change in the adjusted reference temperature (ART), which is the initial reference temperature of the nil-ductility transition (RT_{NDT}) plus the shift. These values are provided in Table 3-1.

b) The beltline material RT_{NDT} remains below the 200°F screening criteria as defined in Reference 13. These values are provided in Table 3-1.

c) The upper shelf energy (USE), given in Table 3-2, remains greater than 50 ft-lbs, thereby demonstrating compliance with 10 CFR 50 Appendix G (References 11 and 12). The minimum USE for the Fermi 2 beltline materials is 54 ft-lb for 32 EFPY. The initial transverse USE for the SA508 Class 1 (SA508-1) forging of the N16 water level instrumentation (WLI) nozzle was obtained from the available purchase records and 95/95 confidence methods as defined in NUREG-1475 (Reference 14). Note that the WLI weld material is Inconel, which does not require a fracture toughness evaluation.

d) The fluence used in developing the pressure-temperature (P-T) curves was conservatively based upon operation at 3430 MWt for 12.04 EFPY and 3952 MWt for 19.96 EFPY. The current ART values for the beltline plates and welds remain bounding for TPO.

e) The N16 WLI nozzle P-T curve is bounded by the currently licensed 24 EFPY P-T curves (Reference 15) only for up to 21 EFPY. This issue also affects current operation of Fermi 2. As such, resolution of this issue is being pursued in a separate license amendment request (LAR).

f) The 32 EFPY beltline circumferential weld material RT_{NDT} remains bounded by the requirements of Generic Letter (GL) 98-05 (Reference 16). This comparison is provided in Table 3-3.

g) The surveillance program consisted of three capsules, two of which are still in the RPV, that have been in the reactor vessel since plant startup. Fermi 2 is participating in the BWR Vessel and Internals Project (BWRVIP) Integrated Surveillance Program (ISP) and will comply with the requirements of that program.

The maximum normal operating dome pressure for TPO is unchanged from that for current power operation. Therefore, the hydrostatic and leakage test pressures and associated temperatures are acceptable for the TPO. Because the vessel is still in compliance with regulatory requirements, operation with TPO does not have an adverse effect (not exceeding regulatory requirements) on the reactor vessel fracture toughness.

3.2.2 Reactor Vessel Structural Evaluation

[[

[illegible]	[illegible]

[illegible]

]]

High and low pressure seal leak detection nozzles were not considered to be pressure boundary components at the time that the OLTP evaluation was performed, and have not been evaluated for TPO.

The effect of TPO was evaluated to ensure that the reactor vessel components continue to comply with the structural requirements of the governing ASME B&PV Code of record. For the components under consideration, the 1968 Code with Addenda to and including summer 1969, which is the code of construction, was used as the governing code of record.

However, if a component's design has been modified and/or re-evaluated, the governing code, for that component, was the code used in the stress analysis of the modified component.

The following components [[
]] have been modified since the original construction:

- The FW Nozzle was modified and the governing code for the evaluation / modification is the ASME Boiler and Pressure Vessel Code, Section III, 1974 Edition with Addenda through summer 1976.

Typically, new stresses are determined by scaling the "original" stresses based on the constant pressure power uprate (CPPU) conditions (pressure, temperature and flow). The analyses were performed for the design, the normal and upset, and the emergency and faulted conditions. If there is an increase in annulus pressurization (AP), jet reaction (JR), pipe restraint or fuel lift loads, the changes are considered in the analysis of the components affected for normal, upset, emergency and faulted conditions.

3.2.2.1 Design Conditions

Because there are no changes in the design conditions due to CPPU, the design stresses are unchanged and the Code requirements are met.

3.2.2.2 Normal and Upset Conditions

The reactor coolant temperature and flows (except core flow, FW flow, recirculation flow, and main steam (MS) flow) at TPO conditions are only slightly changed from those at current rated conditions. Evaluations were performed at conditions that bound the change in operating conditions. The evaluation type is mainly reconciliation of the stresses and usage factors to reflect TPO conditions. A primary plus secondary stress analysis was performed showing TPO stresses still meet the requirements of the ASME Code, Section III. Lastly, the fatigue usage was evaluated for the limiting location of components with a [[ ]] The Fermi 2 fatigue analysis results for the limiting components are provided in Table 3-4. The Fermi 2 analysis results for a 40-year CPPU show that all components meet their ASME Code requirements.

For the FW nozzle blend radius location, in addition to a stress and fatigue analysis, a fracture mechanics analysis was reviewed in accordance with the ASME Code and NUREG-0619 (Reference 17). Crack growth was found to be within the requirements of Reference 17, covering the nozzle blend radius region.

3.2.2.3 Emergency and Faulted Conditions

The stresses due to emergency and faulted conditions are based on loads such as peak dome pressure design limits. These loads remain unchanged and bound the TPO values. Therefore, code requirements are met for all RPV components.

3.3 REACTOR INTERNALS

The reactor internals include core support structure (CSS) and non-core support structure (non-CSS) components.

3.3.1 Reactor Internal Pressure Difference

The RIPDs are affected more by the maximum licensed core flow rate than by the power level. The maximum licensed core flow rate is not changed for the TPO uprate. The effect due to the changes in loads for both Normal and Upset conditions is reported in Section 3.3.2. The normal and upset evaluations of RIPDs for the TPO uprate slightly increase. The emergency and faulted evaluations of RIPDs for the TPO uprate are bounded by the current analyses that conservatively assumed an initial power level of 102% of CLTP.

Minimum fuel bundle lift margins and maximum control rod guide tube (CRGT) lift forces are calculated at the Faulted condition to demonstrate that fuel bundles would not lift under the worst conditions. The current analysis conservatively assumed of 102% of CLTP and 105% core flow, which bounds the TPO. The fuel lift margins for the normal and upset conditions at the TPO RTP decrease slightly from CLTP. The CRGT lift forces for the normal and upset conditions at the TPO RTP increase slightly from CLTP. The fuel lift margins and CRGT lift forces at normal and upset conditions are bounded by Emergency and Faulted conditions. The effect due to the changes in minimum fuel lift margins and maximum CRGT lift forces is reported in Section 3.3.2.

Acoustic and flow-induced loads on jet pump, core shroud and shroud support due to recirculation line break (RLB) are bounded by the current analyses that conservatively assumed an initial power level of 102% of CLTP.

3.3.2 Reactor Internals Structural Evaluation

The reactor internals consist of the CSS components and non-CSS components. The reactor internals are not ASME Code components; however, the requirements of the ASME Code are used as guidelines in their design/analysis. The evaluations/stress reconciliation in support of the TPO was performed consistent with the design basis analysis of the reactor internals. The reactor internals evaluated are:

Core Support Structure Components

- Shroud
- Core plate
- Top guide
- CRD housing
- CRGT
- Orificed fuel support
- Fuel channel

Non-Core Support Structure Components

- FW sparger
- Jet pump
- CS line and sparger
- Access hole cover
- Shroud head and steam separator assembly
- In-core housing and guide tube (ICH&GT)
- Core differential pressure and standby liquid control line
- Jet pump instrument penetration seal
- Steam dryer

The original configurations of the reactor internals are considered in the TPO evaluation unless a component has undergone permanent structural modifications, in which case, the modified configuration is used as the basis for the evaluation.

The reactor internals were evaluated for structural integrity due to load changes associated with the TPO condition. The loads considered in the evaluation of the reactor internals include RIPDs, dead weight, seismic, AP/JR loads, acoustic loads due to RLB LOCA, hydraulic flow, and thermal loads, as applicable.

The structural integrity evaluation of the reactor internals was performed based on the design basis conditions at a power level of 120% OLTP. All applicable TPO-based loads for the normal, upset, emergency, and faulted conditions are bounded by the design basis loads, or remain unaffected with respect to the design basis conditions. The normal, upset, emergency, and faulted condition stresses for TPO are within the corresponding design basis ASME allowable stress limits. The stress results are shown in Table 3-5. Based on the qualitative assessment, it is concluded that the reactor internals remain qualified for operation under TPO conditions.

The steam dryer will experience a slight increase in the pressure loading during normal operation due to the increased steam flow velocities through the system. Operating experience for this dryer design in plants similar to Fermi 2 has shown that the dryer will maintain structural integrity when operated at the Fermi 2 TPO conditions. The upset and faulted condition pressure loads at the Fermi 2 TPO conditions remain within the dryer design basis.

3.3.3 Steam Separator and Dryer Performance

The steam separator and dryer performance evaluation is described in TLTR Section 5.5.1.6. As described in the TLTR, no additional evaluation of the steam separator and dryer performance is necessary unless the plant has been previously uprated by more than 5% above the original licensed power level. Because Fermi 2 has implemented a stretch power uprate of 4.2% of the original licensed power level, the generic evaluation in the TLTR is applicable and no further evaluation is needed.

For Fermi 2, the TPO performance of the steam dryer and separator was evaluated. The results of the evaluation demonstrated that the steam dryer/separator performance remains acceptable (i.e., moisture content ≤ 0.10 wt. %) at TPO conditions. TPO results in an increase in the amount of saturated steam generated in the reactor core. For constant core flow, this results in an increase in the separator inlet quality, an increase in the steam dryer face velocity and a decrease in the water level inside the dryer skirt. These factors, in addition to the radial power distribution, affect the steam dryer and separator performance. However, the net effect of these changes does not result in exceeding the acceptable moisture content of ≤ 0.10 wt. % leaving the steam dryer.

3.4 Piping and Piping Components Flow-Induced Vibration

The process for the reactor vessel internals vibration assessment is described in TLTR Section 5.5.1.3. An evaluation determined the effects of flow-induced vibration (FIV) on the reactor internals at 105% rated core flow and TPO RTP of 101.7%. The vibration levels for the TPO conditions were estimated from measured vibration data during startup testing of the NRC designated prototype plant (Browns Ferry Unit 1) and during other tests. The expected vibration levels were compared with established vibration acceptance limits. The following components were evaluated for the TPO uprate:

Component(s)	Process Parameter(s)	TPO Evaluation
Shroud Shroud Head and Separator	Steam flow at TPO RTP is about 2% greater than CLTP.	Slight increase in FIV. Extrapolation of measured data shows stresses are within limits.
Jet Pumps	The increase in jet pump flow at TPO is negligible based on no change in core flow and a minor increase in core dP (<0.1 psi).	No change.
Jet Pump Sensing Lines	Resonance at vane passing frequency	No resonance at vane passing frequency at TPO.
FW Sparger	FW flow at TPO RTP is about 2% greater than CLTP.	Slight increase in FIV. The maximum stresses are within limits.
CRGT and In-Core Guide Tubes	Core flow at TPO is unchanged from CLTP.	No change.

The calculations for the TPO uprate conditions indicate that vibrations of all safety-related reactor internal components are within the GEH acceptance criteria. The analysis is conservative for the following reasons:

- The GEH criteria of 10,000 psi peak stress intensity is much more conservative than the ASME allowable peak stress intensity of 13,600 psi for service cycles $\geq 10^{11}$.
- Conservatively, the peak responses of the applicable modes are absolute summed.

- Although the maximum vibration stress amplitude of each mode is used in the absolute sum process, the maximum vibration modal amplitude actually differs with time.

Therefore, it is concluded that the FIV for all evaluated components remain within the acceptance limits.

The safety-related MS and FW piping have minor increased flow rates or flow velocities resulting from the TPO uprate. The MS and FW piping experience increased vibration levels, approximately proportional to the increase in the square of the flow velocities and also in proportion to any increase in fluid density. The change in fluid density for TPO conditions, as a result of about 2°F increase in temperature, is insignificant. The MS and FW piping vibration is expected to increase only about 15% above OLTP, or 4% above CLTP. The MS and FW piping FIV test program, during initial plant startup, showed that vibration levels were within acceptance criteria and operating experience shows that there are no existing vibration problems in MS and FW piping at CLTP operating conditions. Therefore, the MS and FW piping vibration will remain within acceptable limits under TPO. Analytical evaluations have shown that the safety-related piping components and thermowells in the recirculation piping system, and non-safety related sample probes, and thermowells in FW system are structurally adequate for the TPO condition.

3.5 PIPING EVALUATION

3.5.1 Reactor Coolant Pressure Boundary Piping

The methods used for the piping and pipe support evaluations are described in TLTR Appendix K. These approaches are identical to those used in the evaluation of previous BWR power uprates of up to 20% power. The effect of the TPO uprate with no nominal vessel dome pressure increase is negligible for the reactor coolant pressure boundary (RCPB) portion of all piping except for portions of the FW lines, MS lines, and piping connected to the FW and MS lines. Table 3-6 summarizes the evaluation of the piping inside containment.

For the MS and FW lines, supports, and connected lines, the methodologies as described in TLTR Section 5.5.2 and Appendix K were used to determine the percent increases in applicable ASME Code stresses, displacements, CUF, and pipe interface component loads (including supports) as a function of percentage increase in pressure (where applicable), temperature, and flow due to TPO conditions. As necessary, the percentage increases were applied to the highest calculated stresses, displacements, and the CUF at applicable piping system node points to conservatively determine the maximum TPO calculated stresses, displacements and usage factors. This approach is conservative because the TPO does not affect weight and all building filtered loads (i.e., seismic loads are not affected by the TPO). The factors were also applied to nozzle load, support loads, penetration loads, valves, pumps, heat exchangers and anchors so that these components could be evaluated for acceptability, where required. No new computer codes were used or new assumptions introduced for this evaluation.

MS and Attached Piping System Evaluation

The MS piping system (inside containment) was evaluated for compliance with the ASME code stress criteria, and for the effects of thermal displacements on the piping snubbers, hangers, and struts. Piping interfaces with RPV nozzles, penetrations, flanges and valves were also evaluated.

Pipe Stresses

The evaluation shows that the increase in flow associated with the TPO uprate does not result in load limits being exceeded for the MS piping system or for the RPV nozzles. The current licensing basis design analyses have sufficient design margin between calculated stresses and ASME Code allowable limits to justify operation at the TPO uprate conditions. The temperature of the MS piping (inside containment) is unchanged for the TPO.

The design adequacy evaluation results show that the requirements of ASME, Section III, Subsection NB/ND (as applicable) requirements are satisfied for the evaluated piping systems. Therefore, the TPO does not have an adverse effect on the MS piping design.

Pipe Supports

The current licensing basis MS piping was reviewed for the effects of transient loading on the piping snubbers, hangers, struts, and pipe whip restraints. A review of the increases in MS flow associated with the TPO uprate indicates that piping load changes do not result in any load limit being exceeded.

Erosion / Corrosion

The carbon steel MS piping can be affected by flow-accelerated corrosion (FAC). FAC is affected by changes in fluid velocity, temperature and moisture content. Fermi 2 has an established FAC monitoring program for monitoring pipe wall thinning in single and two-phase high-energy carbon steel piping. The variation in velocity, temperature, and moisture content resulting from the TPO uprate are minor changes to parameters affecting FAC. The FAC monitoring program includes the use of a predictive method to calculate wall thinning of components susceptible to FAC. For TPO, the evaluation of predicted wall thinning of the MS and attached piping indicates minimal effect. Table 3-7 provides a description of the lines modeled and analyzed for TPO conditions.

No significant changes to piping inspection scope are required to ensure adequate margin for the changing process conditions. The continuing inspection program will take into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. This program provides assurance that the TPO uprate has no adverse effect on high-energy piping systems potentially susceptible to pipe wall thinning due to FAC.

FW Piping System Evaluation

The current licensing basis FW piping system (inside containment) reports were reviewed for compliance with the ASME Section III Code stress criteria, and for the effects of thermal expansion displacements on the piping snubbers, hangers, and struts. Piping interfaces with RPV nozzles, penetrations, and valves were also evaluated.

Pipe Stresses

A review of the change in temperature, pressure, and flow associated with the TPO uprate indicates that piping load changes do not result in load limits being exceeded for the FW piping system or for RPV nozzles. The current licensing basis design analyses have adequate design margin between calculated stresses and ASME Code allowable limits to justify operation at the TPO uprate conditions.

The design adequacy evaluation shows that the requirements of ASME, Section III, Subsection NB/NC/ND-3600 requirements remain satisfied. Therefore, the TPO does not have an adverse effect on the FW piping design.

Pipe Supports

The TPO does not affect the FW piping snubbers, hangers, and struts. A review of the increase in FW temperature and flow associated with the TPO indicates that piping load changes do not result in any load limit being exceeded at the TPO uprate conditions.

FW temperature increases by 2°F above the 424.5°F (CLTP) value. The change in temperature has negligible effect on thermal expansion clearances or pipe support travel range limits. Therefore, the existing qualified system expansion test results adequately represent TPO uprated conditions.

Erosion / Corrosion

The carbon steel FW piping can be affected by FAC. FAC in the FW piping is affected by changes in fluid velocity and temperature. Fermi 2 has an established program for monitoring pipe wall thinning in single and two-phase high-energy carbon steel piping. The variation in velocity and temperature resulting from the TPO uprate are minor changes to parameters affecting FAC. The FAC monitoring program includes the use of a predictive method to calculate wall thinning of components susceptible to FAC. For TPO, the evaluation of predicted wall thinning of the FW piping system indicates minimal effect. Table 3-7 provides a description of the lines modeled and analyzed for TPO conditions.

No significant changes to piping inspection scope is required to ensure adequate margin exists for the changing process conditions. The continuing inspection program will take into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. This program provides assurance that the TPO uprate has no adverse effect on high energy piping systems potentially susceptible to pipe wall thinning due to FAC.

3.5.2 Balance-of-Plant Piping Evaluation

This section addresses the adequacy of the BOP piping design (outside of the RCPB) for operation at the TPO conditions. The evaluation of the BOP piping and supports was performed in a manner similar to the evaluation of RCPB piping systems and supports (Section 3.5.1). The piping systems evaluated are as follows:

(1) MS (outside containment) including turbine bypass piping

(2) Main steam isolation valve (MSIV) drain lines (outside containment)

(3) Extraction steam, heater/ MSR vents and drains

(4) FW (outside containment) and condensate

(5) Reactor water cleanup (RWCU) (outside containment)

(6) Residual heat removal (RHR, outside containment)

(7) RHR service water (RHRSW, outside containment)

(8) CS (outside containment) - Pump suction / Pump discharge

(9) High pressure coolant injection (HPCI, outside containment)

(10) Reactor core isolation cooling (RCIC, outside containment)

(11) SLCS (outside containment)

(12) CRD

(13) Emergency equipment service water (EESW)

(14) Emergency equipment cooling water (EECW)

(15) Reactor Building closed cooling water (RBCCW)/Turbine Building closed cooling water (TBCCW)

(16) Spent fuel cooling

(17) SRV quenchers and supports

(18) Standby gas treatment

(19) Offgas piping

(20) Torus attached piping including ECCS suction strainers

(21) Exhaust hood spray piping

(22) Stator cooling water

(23) Diesel generator (DG) service water

(24) General service water including supplemental cooling chilled water (SCCW)

The following piping systems have no change in operating conditions between CLTP and TPO, and therefore are acceptable to TPO.

(1) RWCU (outside containment)

(2) RHRSW(outside containment)

(3) HPCI (outside containment)

(4) RCIC (outside containment)

(5) SLCS (outside containment)

(6) CRD

(7) EESW

(8) EECW

(9) RBCCW/TBCCW

(10) Spent fuel cooling

(11) Exhaust hood spray piping

(12) Stator cooling water

(13) DG service water

(14) General service water including SCCW

(15) MSIV drain lines

(16) Condensate from main condenser to drain coolers

(17) MS (outside containment)

The following piping systems have temperature increases less than 2°F due to the power increases anticipated for TPO; however the piping stresses have an insignificant increase and remain acceptable for TPO.

(1) RHR (outside containment)

(2) CS (outside containment) – Pump suction/Pump discharge

(3) SRV quenchers and supports

(4) Torus attached piping including ECCS suction strainers

(5) Standby gas treatment

(6) Extraction steam, heater/MSR vents and drains

(7) FW from drain coolers to No.6 FW heater

(8) Turbine bypass piping

The following piping system has temperature increases less than 1%, and flow rate increases less than 2% due to the power increases anticipated for TPO; the piping stresses have an insignificant increase and remain acceptable for TPO by engineering judgment:

(1) Offgas piping

The following piping systems have temperature increases of greater than 2°F and/or flow rate increases greater than 1% due to the power increases anticipated for TPO. These systems were reanalyzed at TPO conditions and the piping was found to be acceptable.

(1) FW from No.6 FW heater to containment

Pipe Supports

For those piping systems that have no change in operating conditions between CLTP and TPO, all the pipe support loads remain unchanged.

For those piping systems that have temperature increases less than 2°F due to the power increases anticipated for TPO, pipe support loads will experience a small increase in the thermal load. However, when considering the combination with other loads that are not affected by the TPO uprate (e.g., deadweight), the combined support load increase is insignificant and remains acceptable.

The offgas piping system has temperature increases less than 1%, and flow rate increases less than 2% due to the power increases anticipated for TPO; the piping support loads have an insignificant increase and remain acceptable for TPO by engineering judgment.

For those piping systems with increased operating temperatures and/or flow rates due to TPO (e.g., FW), the reanalysis described above showed that changes to thermal expansion stresses are small and acceptable. Pipe support loads will experience a small increase in the thermal load (< 1%). However, when considering the combination with other loads that are not affected by the TPO uprate (e.g., deadweight) the combined support load increase is insignificant.

Therefore, all supports, branch piping and equipment are acceptable for TPO.

For the MS system piping outside containment, the turbine stop valve (TSV) closure transient was reviewed against conditions that bound operations under TPO as part of the MS system piping analysis described above. Available stress and support load margins are adequate to accommodate the increase in loading associated with this fluid transient.

For the FW system piping outside containment, changes to fluid transient loading such as for feed pump trip are small. The station design for fluid transients was reviewed and no changes are required for TPO.

Note that the LEFM spool piece has been installed at Fermi 2. Revised stress and support load analysis for this change has been completed.

Erosion / Corrosion

The integrity of high-energy piping systems is assured by proper design in accordance with the applicable codes and standards. Piping thickness of carbon steel components can be affected by FAC. Fermi 2 has an established program for monitoring pipe wall thinning in single phase and two-phase high-energy carbon steel piping. FAC rates may be influenced by changes in fluid velocity, temperature, and moisture content. The FAC monitoring program includes the use of a predictive method to calculate wall thinning of components susceptible to FAC. For TPO, the evaluation of predicted wall thinning of the BOP piping indicates minimal effect. Table 3-7 provides a description of the lines modeled and analyzed for TPO conditions.

Operation at the TPO RTP results in some changes to parameters affecting FAC in those systems associated with the turbine cycle (e.g., condensate, FW, MS). The evaluation of and inspection for FAC in BOP systems is addressed by compliance with GL 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning." The plant FAC program currently monitors the affected systems. Continued monitoring of the systems provides confidence in the integrity of susceptible high-energy piping systems. Appropriate changes to piping inspection will be implemented to ensure adequate margin exists for those systems with changing process conditions. This action takes into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. This program provides assurance that the TPO has no adverse effect on high-energy piping systems potentially susceptible to pipe wall thinning due to FAC.

3.6 REACTOR RECIRCULATION SYSTEM

The reactor recirculation system (RRS) evaluation process is described in TLTR Section 5.6.2. The TPO uprate has a minor effect on the RRS and its components. The TPO uprate does not require an increase in the maximum core flow. No significant reduction of the maximum flow capability occurs due to the TPO uprate because of the small increase in core pressure drop (< 1 psi). The effect on pump net positive suction head (NPSH) at TPO conditions is negligible. An evaluation has confirmed that no significant increase in RRS vibration occurs from the TPO operating conditions.

The cavitation protection interlock for the recirculation pumps and jet pumps is expressed in terms of FW flow. This interlock is based on sub-cooling and thus is a function of absolute FW flow rate and FW temperature at less than full thermal power operating conditions. Therefore, the interlock is not changed by TPO.

3.7 MAIN STEAM LINE FLOW RESTRICTORS

The generic evaluation provided in TLTR Appendix J.2.3.7 is applicable to Fermi 2. The requirements for the MS line (MSL) flow restrictors remain unchanged for TPO uprate conditions. No change in steam line break flow rate occurs because the operating pressure is unchanged. All safety and operational aspects of the MSL flow restrictors are within previous evaluations.

3.8 MAIN STEAM ISOLATION VALVES

The generic evaluation provided in TLTR Appendix J.2.3.7 is applicable to Fermi 2. The requirements for the MSIVs remain unchanged for TPO uprate conditions. All safety and operational aspects of the MSIVs are within previous evaluations.

3.9 REACTOR CORE ISOLATION COOLING

The RCIC system provides inventory makeup to the reactor vessel when the vessel is isolated from the normal high pressure makeup systems. The generic evaluation provided in TLTR Section 5.6.7 is applicable to Fermi 2. The TPO uprate does not affect the RCIC system operation, initiation, or capability requirements.

3.10 RESIDUAL HEAT REMOVAL SYSTEM

The RHR system is designed to restore and maintain the coolant inventory in the reactor vessel and to remove sensible and decay heat from the primary system and containment following reactor shutdown for both normal and post-accident conditions. The RHR system is designed to function in several operating modes. The generic evaluation provided in TLTR Sections 5.6.4 and Appendices J.2.3.1 and J.2.3.13 are applicable to Fermi 2.

Table 3-8 summarizes the effect of the TPO on the design basis of the RHR system.

The ability of the RHR system to perform required safety functions is demonstrated with analyses based on 102% of CLTP. Therefore, all safety aspects of the RHR system are within previous evaluations. The requirements for the RHR system remain unchanged for TPO uprate conditions.

3.11 REACTOR WATER CLEANUP SYSTEM

The generic evaluation of the RWCU system provided in TLTR Sections 5.6.6 and J.2.3.4 is applicable to Fermi 2. The performance requirements of the RWCU system are negligibly affected by TPO uprate. There is no significant effect on operating temperature and pressure conditions in the high pressure portion of the system. Steady power level changes for much larger power uprates have shown no effect on reactor water chemistry and the performance of the RWCU system. Power transients are the primary source of challenge to the system, so safety and operational aspects of water chemistry performance are not affected by the TPO.

Table 3-1 Adjusted Reference Temperatures 40-Year License (32 EFPY)

Lower-Intermediate Shell Plates, Axial Welds

Thickness in inches = 6.125

32 EFPY Peak I.D. fluence = 9.68E+17 n/cm^2

32 EFPY Peak ¼ T fluence = 6.70E+17 n/cm^2

Water Level Instrumentation Nozzle

Thickness in inches = 6.125

32 EFPY Peak I.D. fluence = 1.65E+17 n/cm^2

32 EFPY Peak ¼ T fluence = 1.14E+17 n/cm^2

Lower Shell Plates and Axial Welds & Lower to Lower-Intermediate Girth Weld

Thickness in inches = 7.125

Axial Distribution Factor at Elevation of Girth Weld = 0.64

32 EFPY Peak I.D. fluence = 6.23E+17 n/cm^2

32 EFPY Peak ¼ T fluence = 4.06E+17 n/cm^2

Component	Heat or Heat/Lot	%Cu	%Ni	CF	Adjusted CF(1)	Initial RT_{NDT} °F	¼ T Fluence n/cm^2	32 EFPY ΔRT_{NDT}	σ_I	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART °F
PLANT SPECIFIC CHEMISTRIES													
PLATES:													
Lower Shell													
G3706-1	C4540-2	0.08	0.62	51		-10	4.06E+17	13	0	7	13	27	17
G3706-2	C4560-1	0.11	0.57	74		-10	4.06E+17	19	0	10	19	38	28
G3706-3	C4554-1	0.12	0.56	82		-10	4.06E+17	21	0	11	21	43	33
Lower-Intermediate Shell													
G3703-5	C4564-1	0.09	0.55	58		-10	6.70E+17	20	0	10	20	40	30
G3705-1	B8614-1	0.12	0.61	83		-20	6.70E+17	28	0	14	28	57	37
G3705-2	C4574-2	0.10	0.55	65		-16	6.70E+17	22	0	11	22	44	28
G3705-3	C4568-2	0.12	0.61	83		-12	6.70E+17	28	0	14	28	57	45
WELDS:													
Lower Shell Axial													
2-307 A, B, C	Tandem 13253, 12008 1092 Lot 3833	0.26	0.87	224		-44	4.06E+17	59	0	28	56	115	71
Lower Intermediate Shell Axial													
15-308 A, B, C, D	33A277, 124 Lot 3878	0.32	0.50	188.5		-50	6.70E+17	64	0	28	56	120	70
Lower to Lower-Intermediate Girth													
I-313	10137, 0091 Lot 3999	0.23	1.00	236		-50	4.06E+17	62	0	28	56	118	68

Table 3-1 Adjusted Reference Temperatures 40-Year License (32 EFPY) (Continued)

Component	Heat or Heat/Lot	%Cu	%Ni	CF	Adjusted CF[1]	Initial RT_{NDT} °F	¼ T Fluence n/cm²	32 EFPY ΔRT_{NDT}	σ_I	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART °F
NOZZLES:													
N16 (Water Level Instrumentation)[3]	2127273	[[				30	1.14E+17	[[					63
N16 (Water Level Instrumentation)[3]	6397860					30	1.14E+17					]]	63
N16 (Water Level Instrumentation) Weld[2]	Inconel												
INTEGRATED SURVEILLANCE PROGRAM[4]:													
BWRVIP-135 R1													
Plate	[[												45
Weld												]]	76

Notes:

(1) Adjusted Chemistry Factor (CF) calculated per RG 1.99 (Reference 13), Position 2.1.

(2) The N16 WLI nozzle weld material is Inconel, according to Fermi 2 Welding Material Records. Because it is Inconel, it does not require a fracture toughness evaluation.

(3) WLI nozzle forging heat numbers are from the Fermi 2 certified material test reports (CMTRs). While the WLI nozzle forging is SA508-1, WLI nozzle weld is Inconel, which does not require a fracture toughness evaluation. [[

]] The initial RT_{NDT} value is 10°F (temperature at which Charpy tests were performed for the WLI nozzle forging heats, given in the Fermi 2 CMTRs + 20°F based on Material Engineering Branch Technical Position (MTEB) 5-2, Position 1.1 (Item 4).

(4) Procedures defined in RG 1.99 (Reference 13) are applied to determine the ART considering the ISP.

(5) [[

]]

Table 3-2 Fermi 2 Upper Shelf Energy 40-Year License (32 EFPY)

Location	Heat	Initial Unirradiated Longitudinal USE	Initial Unirradiated Transverse USE(1)	% Cu	32 EFPY ¼ T Fluence (n/cm^2)	% Decrease USE (2)	32 EFPY USE (3)
PLATES:							
Lower Shell and Lower to Lower-Intermediate Girth Weld							
G3706-1	C4540-2	145	94.3	0.08	4.06E+17	8	87
G3706-2	C4560-1	156	101.4	0.11	4.06E+17	10	91
G3706-3	C4554-1	132	85.8	0.12	4.06E+17	10.5	77
Lower Intermediate Shell							
G3703-5	C4564-1	115	74.8	0.09	6.70E+17	9.5	68
G3705-1	B8614-1	130	84.5	0.12	6.70E+17	11.5	75
G3705-2	C4574-2	120	78	0.10	6.70E+17	10.5	70
G3705-3	C4568-2	119	77.4	0.12	6.70E+17	11.5	68
WELDS:							
Vertical Weld							
2-307 A, B, C	Tandem 13253, 12008, 1092 Lot 3833	N/A	119	0.26	4.06E+17	19.5	96
2-307 A, B, C (4)	Tandem 13253, 12008, 1092 Lot 3833	N/A	119	0.26	4.06E+17	31.5	82
15-308 A, B, C, D	33A277, 124 Lot 3878	N/A	94	0.32	6.70E+17	25	71
15-308 A, B, C, D (4)	33A277, 124 Lot 3878	N/A	94	0.32	6.70E+17	36	60
Girth							
1-313	10137, 0091 Lot 3999	N/A	108	0.23	4.06E+17	18	89
1-313(4)	10137, 0091 Lot 3999	N/A	108	0.23	4.06E+17	32	73
NOZZLES:							
N16 (Water Level Instrumentation)(7)	2127273	N/A	62.1	[[	1.14E+17	13.5	54
N16 (Water Level Instrumentation)(7)	6397860	N/A	62.1	]]	1.14E+17	13.5	54
N16 Weld	Inconel						

Table 3-2 Fermi 2 Upper Shelf Energy 40-Year License (32 EFPY) (Continued)

Location	Heat	Initial Unirradiated Longitudinal USE	Initial Unirradiated Transverse USE(1)	% Cu	32 EFPY ¼ T Fluence (n/cm²)	% Decrease USE (2)	32 EFPY USE (3)
INTEGRATED SURVEILLANCE PROGRAM:							
BWRVIP-135 R1							
Plate	[[		[[				120
Weld(4)	]]					]]	82

Notes:

(1) Transverse USE for plate materials obtained using 65% of the longitudinal USE and values obtained from NEDC-33133P, Table F-1 (Reference 15).

(2) Values obtained from Figure 2 of RG 1.99, Revision 2 (Reference 13) for 32 EFPY 1/4T fluence of 6.7×10^{17} n/cm^2 for Lower Intermediate Shell and Vertical Weld materials and a 32 EFPY 1/4T fluence of 4.1×10^{17} n/cm^2 for Lower Shell and Lower to Lower-Intermediate Girth Weld.

(3) 32 EFPY Transverse USE = Initial Transverse USE * {1 - (% Decrease USE / 100)}.

(4) RG 1.99 Position 2.2 applied to the weld materials.

(5) [[ ]]

(6) [[

]]

(7) While the WLI nozzle forging is SA508-1, the WLI nozzle weld is Inconel, which does not require a fracture toughness evaluation.

Table 3-3 Fermi 2 Circumferential Weld Inspection Relief 40-Year License (32 EFPY)

Parameter	NRC Limiting Plant Specific Analysis at 32 EFPY (Circ Welds)(4)	NRC Limiting Plant Specific Analysis at 32 EFPY (Circ Welds) (5)	Parameters at TPO Fermi Unit 2 32 EFPY
	(CE RPV)(6)	(CE RPV)(6)	(CE RPV)(6)
Cu%	0.13	0.183	0.23
Ni%	0.71	0.704	1.00
CF	151.7	172.2	236
End of Life Inside Diameter Fluence, (10^{19} n/cm^2)	0.20	0.20	0.06
$RT_{NDT(U)}$(°F)	0	0	-50
ΔRT_{NDT} w/o Margin (°F)(1)	86.4	98.1	77.4
Mean RT_{NDT} (°F)	86.4	98.1	27.4
P(F/E) NRC (2)	2.81E-05	6.34E-05	(3)

Notes:

(1) $\Delta RT_{NDT} = CF * f^{(0.28 - 0.10 \log f)}$

(2) P(F/E) stands for "Probability of a failure event."

(3) Although a conditional failure probability has not been calculated, the fact that the Fermi 2 mean RT_{NDT} value at the end of license is less than the 32 EFPY values provided by the NRC leads to the conclusion that the Fermi 2 RPV conditional failure probability is bounded by the NRC analysis, consistent with the requirements defined in GL 98-05 (Reference 16).

(4) Chemistry information reported in BWRVIP-05 (Reference 19).

(5) Chemistry information reported in Combustion Engineering Owners Group (CEOG) report (Reference 19).

(6) Combustion Engineering (CE) RPV.

Table 3-4 Fermi 2 P + Q Stresses & CUFs of Limiting Components

Component	P + Q Stress (ksi)			CUF[(1)]		
	Current	TPO	Allowable (ASME Code Limit)	Current	TPO	Allow.
FW Nozzle (N6)						
Node A	68.7 / 28.3[(3)]	73.0 / 30.1[(3)]	53.1	$0.581_{(s)} + 0.000_{(r)} = 0.581_{(t)}$	$0.774_{(s)} + 0.000_{(r)} = 0.774_{(t)}$	1.0
Node B/C	69.3 /18.7[(3)]	70.6 / 19.1[(3)]	58.8	$0.825_{(s)} + 0.108_{(r)} = 0.933_{(t)}$	$0.905_{(s)} + 0.078_{(r)} = 0.983_{(t)}$	1.0
Node D	45.8	46.7	58.8	$0.006_{(s)} + 0.659_{(r)} = 0.764_{(t)}$	$0.006_{(s)} + 0.126_{(r)} = 0.132_{(t)}$	1.0
Node E	57.9 / 47.9[(3)]	59.0 / 48.9[(3)]	53.1	$0.498_{(s)} + 0.007_{(r)} = 0.505_{(t)}$	$0.624_{(s)} + 0.000_{(r)} = 0.624_{(t)}$	1.0
Node F	-[(4)]	-[(4)]	-	$0.498_{(s)} + 0.204_{(r)} = 0.702_{(t)}$	$0.624_{(s)} + 0.003_{(r)} = 0.627_{(t)}$	1.0
Node G	-[(4)]	-[(4)]	-	$0.498_{(s)} + 2.013_{(r)} = 2.511_{(t)}$[(6)]	$0.624_{(s)} + 0.030_{(r)} = 0.654_{(t)}$	1.0
Node H&I	-[(4)]	-[(4)]	-	$0.498_{(s)} + 5.213_{(r)} = 5.711_{(t)}$[(6)]	$0.624_{(s)} + 0.032_{(r)} = 0.656_{(t)}$	1.0
Recirculation Outlet Nozzle (N11)						
Safe End	50.8	57.1[(2)]	47.4	0.034	0.106	1.0
Nozzle End	75.9	85.3[(2)]	80.1	0.092	0.478	1.0
Noz.-Vess. Int.	46.9	52.7	80.1	0.168	0.231	1.0
Recirculation Inlet Nozzle (N10)						
Safe End	44.1	49.3[(2)]	47.4	0.002	0.006	1.0
Nozzle End	43.6	48.8	80.1	0.007	0.011	1.0
Noz.-Vess. Int.	38.6	43.2	80.1	0.066	0.095	1.0
Liner	78.5	87.8[(2),(5)]	47.4	0.657	0.716	1.0

Notes:

(1) Only the limiting component fatigue usage value is provided.

(2) The 3*Sm limit on the range of the primary-plus-secondary stress may be waved per Paragraph (1) of ASME Code Case 1441. This meets the code allowable because "there are not more than 1000 cycles of primary-plus-secondary stress range greater than 3*Sm" to satisfy paragraphs (2) through (4) of Code Case 1441, the K_e factor is applied to S_a in the CUF calculation.

(3) Thermal Bending included/Thermal Bending removed. P+Q stresses are acceptable per CLTP elastic plastic analysis. Method is valid for TPO conditions.

(4) Bounded by the P+Q evaluation for Node E.

(5) The bounding P+Q for the liner OLTP is 83.3 ksi (as compared to 78.5 ksi for the listed location). However, both locations significantly exceed the allowable value (AV) and satisfaction of ASME Code Case 1441 requirements is bounding by satisfying the listed liner location which has a significantly larger CUF.

(6) The CUF exceeds the ASME allowable (1.0) when considering system and rapid cycling. Thermal sleeve seal refurbishment or reanalysis is required prior to the end of 40 year life. TPO values reflect the TPO effect of the system cycling contribution and reanalysis of the rapid cycling contribution to CUF.

Recent GEH evaluations of corrosion values for the FW nozzle materials in a BWR environment have yielded corrosion rates less than those considered in the CLTP basis analyses. The use of lower corrosion rates in rapid cycling analyses leads to lower leakage flow through the thermal sleeve seals and consequently lower rapid cycling CUF values.

(7) (r)-rapid cycling, (s)-system cycling, and (t)-total cycling.

Table 3-5 Governing Stress Results for RPV Internal Components

Item	Component Location[2]	Service Condition	Stress/Load Category	Design Basis Value[3]	TPO Value[1]	Allowable Value
1	Shroud	Normal/Upset	$P_m + P_b$ (ksi)	<17.57	<17.57	21.45
2	Core Plate	Normal/Upset	Buckling (psid) Sliding (kips)	19.6 250.4	18.41 <250.4	25.1 443.1
3	Top Guide	Normal/Upset	P_m $P_m + P_b$ (ksi)	1.2 14.5	1.2 14.5	16.9 25.3
4	CRD Housing	Normal/Upset	P_m $P_m + P_b$ (ksi)	0.76 11.3	0.76 11.3	10.3 24.6
5	CRGT	Normal/Upset	Buckling	0.35	<0.35	0.40
6	Orificed Fuel Support	Normal/Upset	$P_m + P_b$ (ksi)	2.31	<2.31	15.6
7	Fuel Channel	Normal/Upset	Qualified by GEH proprietary method			
8	FW Sparger	Normal/Upset	Qualified by Qualitative Assessment			
9	Jet Pump	Normal/Upset	Qualified by Qualitative Assessment			
10	CS Line and Sparger	Normal/Upset	Qualified by Qualitative Assessment			
11	Access Hole Cover	Faulted	P_m+P_b (ksi)	47.38	<47.38	49.4
12	Shroud Head & Steam Separator Assembly (SHB Bracket) [4]	Faulted	P_m+P_b (ksi)	22.3	<22.3	50.7
13	ICH&GT	Normal/Upset	Qualified by Qualitative Assessment			
14	Core Differential Pressure and Liquid Control Line	Normal/Upset	Qualified by Qualitative Assessment			
15	Jet Pump Instrument Penetration Seal	Normal/Upset	Qualified by Qualitative Assessment			

Notes:

(1) The TPO-based loads are bounded by the design basis loads at the power level of 120% OLTP. Therefore, the RPV internals stresses resulting from the TPO-based loads are bounded by the design basis values at the power level of 120% OLTP.
(2) Stresses reported are for the limiting loading condition with the least margin of safety.
(3) Design basis is at the power level of 120% OLTP.
(4) SHB = shroud head bolt

Table 3-6 Evaluation of Piping Inside Containment Summary

Component(s) / Concern	Process Parameter(s)	TPO Evaluation
Recirculation System Pipe Stresses Pipe Supports	Nominal dome pressure at TPO RTP is identical to CLTP. Recirculation flow at TPO RTP is identical to CLTP. Minor change in recirculation discharge pressure Insignificant change in recirculation fluid temperature.	No effect on pipe stress and pipe supports
MS and attached piping (Inside Containment) (e.g., SRV discharge line (SRVDL) piping up to first anchor, RCIC / HPCI piping (Steam Side), MS drain lines, RPV head vent line piping located inside containment) Pipe Stresses Pipe Supports Flow-accelerated erosion/corrosion (FAC)	Nominal dome pressure at TPO RTP is identical to CLTP. Steam flow at TPO RTP is ~2% greater than CLTP. No change in MSL pressure.	Current licensing basis has sufficient margin and therefore, piping system is acceptable for TPO. Pipe stress and pipe supports meet the allowable. Minor increase in the potential for FAC (FAC concerns are covered by existing piping monitoring program)
FW and attached piping (Inside Containment) Pipe Stresses Pipe Supports FAC	Nominal dome pressure at TPO RTP is identical to CLTP. FW flow at TPO RTP is ~2% greater than CLTP. Minor change in FW line pressure. Fluid temperature increases 2°F.	Current licensing basis has sufficient margin and therefore, piping system is acceptable for TPO. Pipe stress and pipe supports meet the allowable. Minor increase in the potential for FAC (FAC concerns are covered by existing piping monitoring program).
RPV bottom head drain line, RCIC piping, HPCI piping, low pressure coolant injection (LPCI) piping, CS piping, SLCS piping, and RWCU piping Pipe Stresses Pipe Supports FAC	Nominal dome pressure at TPO RTP is identical to CLTP. Small increase in core pressure drop of < 1 psi No change in recirculation fluid temperature.	Negligible change in pipe stress. Negligible effect on pipe supports. Minor increase in the potential for FAC (FAC concerns are covered by existing piping monitoring program)

Table 3-7 Lines Evaluated in the FAC Program

Line Name	Comment
MSR Drains (East and West)	These lines, with the exception the RWCU lines, experience minor changes in fluid temperature, fluid flow velocity, and steam quality. The Fermi 2 FAC program has been updated to include the effects of TPO conditions. No wear rate increases due to the effects of TPO conditions were identified as excessive or cause for immediate concern.
No. 5 FW Heater Drains (North and South)	
Flash Tank Drains (North, Center, and South)	
No. 4 FW Heater Drains (North and South)	
Heater Drain Pump Discharge (North and South)	
No. 6 FW Heater Extraction Steam (North and South)	
No. 3 FW Heater Extraction Steam (North and South)	
FW (North and South)	
MSR Separator Drains (East and West)	
No. 5 FW Heater Extraction Steam (North and South)	
Reheater Seal Tank to No. 6 FW Heaters (North and South)	
No. 6 FW Heater Drains (North and South)	
Condensate	
RWCU	

Table 3-8 Summary of TPO Effect on the RHR System Design Basis

Operating Mode	Key Function	TPO Evaluation
LPCI Mode	Core Cooling	See Section 4.2.4
SP Cooling (SPC) and Containment Spray Cooling (CSC) Modes	Normal SPC function is to maintain pool temperature below the design limit. For abnormal events or accidents, the SPC mode maintains the long-term pool temperature below the design limit. The CSC mode sprays water into the containment to reduce post-accident containment pressure and temperature.	Containment analyses have been performed at 102% of CLTP.
Shutdown Cooling (SDC) Mode.	Removes sensible and decay heat from the reactor primary system during a normal reactor shutdown.	The slightly higher decay heat has negligible effect on the SDC mode, which has no safety function.
Steam Condensing Mode	Decay heat removal	Fermi 2 does not have a Steam Condensing Mode of RHR
Fuel Pool Cooling Assist	Supplemental fuel pool cooling in the event that the fuel pool heat load exceeds the heat removal capability of the fuel pool cooling system.	See Section 6.3.1

4.0 ENGINEERED SAFETY FEATURES

4.1 CONTAINMENT SYSTEM PERFORMANCE

TLTR Appendix G presents the methods, approach, and scope for the TPO uprate containment evaluation for LOCA. The current containment evaluations were performed at 102% of CLTP. Although the nominal operating conditions change slightly because of the TPO uprate, the required initial conditions for containment analysis inputs remain the same as previously documented.

Table 4-1 summarizes the effect of the TPO uprate on various aspects of the containment system performance.

4.1.1 Generic Letter 89-10 Program

The motor operated valve (MOV) requirements in the UFSAR were reviewed, and no changes to the functional requirements of the GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," MOVs, are identified as a result of operating at the TPO RTP level. Because previous analyses were either based on 102% of CLTP or are consistent with the plant conditions expected to result from TPO, there are no increases in the pressure or temperature at which MOVs are required to operate. Therefore, the GL 89-10 MOVs remain capable of performing their design basis functions.

4.1.2 Generic Letter 95-07 Program

The evaluation performed in support of GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," has been reviewed and no changes are identified as a result of operating at the TPO RTP level. The criteria for susceptibility to pressure locking or thermal binding were reviewed and it was determined that the slight changes in operating or environmental conditions expected to result from the TPO uprate would have no effect on the functioning of power-operated gate valves within the scope of GL 95-07. Therefore, the valves remain capable of performing their design basis functions.

4.1.3 Generic Letter 96-06

The Fermi 2 response to GL 96-06, “Assurance of Equipment Operability and Containment Integrity during Design-Basis Accident Conditions,” was reviewed for the TPO uprate. The containment design temperatures and pressures in the current GL 96-06 evaluation are not exceeded under post-accident conditions for the TPO uprate. Therefore, the Fermi 2 response to GL 96-06 remains valid under TPO uprate conditions.

4.1.4 Containment Coatings

The nominal operating conditions change slightly and the required initial conditions for containment analysis inputs remain the same for TPO. The temperature and pressure do not increase significantly. The Service Level 1 coatings are qualified to 340°F and 70 psi. Therefore, the containment coatings continue to bound the DBA temperature and pressure at TPO conditions.

4.2 EMERGENCY CORE COOLING SYSTEMS

4.2.1 High Pressure Coolant Injection

The HPCI system is a turbine driven system designed to pump water into the reactor vessel over a wide range of operating pressures. For the TPO uprate, there is no change to the nominal reactor operating pressure or the SRV setpoints. The primary purpose of the HPCI is to maintain reactor vessel coolant inventory in the event of a small break LOCA that does not immediately depressurize the RPV. The generic evaluation of the HPCI system provided in TLTR Section 5.6.7 is applicable to Fermi 2. The ability of the HPCI system to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the HPCI system are within previous evaluations and the requirements are unchanged for the TPO uprate conditions.

4.2.2 High Pressure Core Spray

The high pressure core spray (HPCS) system is not applicable to Fermi 2.

4.2.3 Core Spray

The CS system sprays water into the reactor vessel after it is depressurized. The primary purpose of the CS system is to provide reactor vessel coolant makeup for a large break LOCA and for any small break LOCA after the RPV has depressurized. It also provides spray cooling for long-term core cooling in the event of a LOCA. The generic evaluation of the CS system provided in TLTR Section 5.6.10 is applicable to Fermi 2. The ability of the CS system to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the CS system are within previous evaluations and the requirements are unchanged for the TPO uprate conditions.

4.2.4 Low Pressure Coolant Injection

The LPCI mode of the RHR system is automatically initiated in the event of a LOCA. The primary purpose of the LPCI mode is to provide reactor vessel coolant makeup during a large break LOCA or small break LOCA after the RPV has depressurized. The generic evaluation of the LPCI mode provided in TLTR Section 5.6.4 is applicable to Fermi 2. The ability of the RHR system to perform required safety functions of the LPCI mode is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the RHR system LPCI mode are within previous evaluations and the requirements are unchanged for the TPO uprate conditions.

4.2.5 Automatic Depressurization System

The ADS uses SRVs to reduce the reactor pressure following a small break LOCA when it is assumed that the high pressure systems have failed. This allows the CS and LPCI to inject coolant into the RPV. The ADS initiation logic and valve control is not affected by the TPO uprate. The generic evaluation of the ADS provided in TLTR Section 5.6.8 is applicable to Fermi 2. The ability of the ADS system to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the ADS are within previous evaluations and the requirements are unchanged for the TPO uprate conditions.

4.2.6 ECCS Net Positive Suction Head

The generic evaluation of the containment provided in TLTR Appendix G is applicable to Fermi 2. The CLTP containment analyses were based on 102% of CLTP, there is no change in the available NPSH for systems using SP water. Therefore, the TPO uprate does not affect compliance with the ECCS pump NPSH requirements.

4.3 Emergency Core Cooling System Performance

The ECCS is designed to provide protection against a postulated LOCA caused by ruptures in the primary system piping. The current 10 CFR 50.46, or LOCA, analyses for the Fermi 2 revised plant have been performed at 117% of CLTP, exceeding Appendix K requirements. The ECCS-LOCA results for Fermi 2 shown here are in conformance with the error reporting requirements of 10 CFR 50.46 through notification number 2006-001 (Subsequent notifications up to number 2011-03 have been dispositioned, concluding the plant to remain in compliance to Acceptance Criteria). Table 4-2 shows the results of the Fermi 2 ECCS-LOCA analysis. Therefore, the pre-TPO LOCA analysis for GE14 fuel bounds the 1.64% TPO uprate for Fermi 2.

Reference 20 provides justification for the elimination of the 1600°F upper bound peak clad temperature (PCT) limit and generic justification that the Licensing Basis PCT will be conservative with respect to the upper bound PCT. Reference 21 provided justification for the elimination of the upper bound PCT limit for Fermi 2.

For the TPO uprate there are no changes to the plant configuration that would invalidate the Reference 21 evaluation for conformance with Reference 20.

The pre-TPO LOCA analysis for GE14 fuel is concluded to bound the 1.64% TPO uprate for Fermi 2.

4.4 Main Control Room Atmosphere Control System

The Main Control Room atmosphere is not affected by the TPO uprate. Main Control Room habitability following a postulated accident at TPO conditions is unchanged because the Main Control Room atmosphere control system has previously been evaluated for radiation release accident conditions at 102% of CLTP. Therefore, the system remains capable of performing its safety function at the TPO conditions.

4.5 Standby Gas Treatment System

The SGTS minimizes the offsite and Main Control Room dose rates during venting and purging of the containment atmosphere under abnormal conditions. The current capacity of the SGTS was selected to maintain the secondary containment at a slightly negative pressure during such conditions. This capability is not changed by the TPO uprate conditions. The SGTS can accommodate DBA conditions at 102% of CLTP. Therefore, the system remains capable of performing its safety function for the TPO uprate condition.

4.6 Post-LOCA Combustible Gas Control System

The original licensing basis of the combustible gas control system (CGCS) was to maintain the post-LOCA concentration of oxygen or hydrogen in the containment atmosphere below the flammability limit. The generic evaluation of the CGCS provided in TLTR Sections J.2.3.10, and discussed in the NRC SER Section 5.12.3 is no longer applicable to Fermi 2 as the hydrogen combining function requirements of the system have been deleted from the TS in accordance with the 10 CFR 50.44 guidance.

Table 4-1 Summary of TPO Effect on the Containment System Performance

Topic		Key Parameters	TPO Effect
Short Term Pressure and Temperature Response			Current Analysis Based on 102% of CLTP
	Gas Temperature	Break Flow and Energy	
	Pressure	Break Flow and Energy	
Long-Term SP Temperature Response			
	Bulk Pool	Decay Heat	
	Local Temperature with SRV Discharge	Decay Heat	
Containment Dynamic Loads			
	LOCA Loads	Break Flow and Energy	
	Safety-Relief Valve Loads	Decay Heat	
	Sub-compartment Pressurization	Break Flow and Energy	
Containment Isolation Section 4.1.1 provides confirmation that MOVs are capable of performing design basis functions at TPO conditions.			The ability of containment isolation valves and operators to perform their required functions is not affected because the evaluations have been performed at 102% of CLTP.

Table 4-2 Fermi 2 ECCS-LOCA Analysis Results for GE14 Fuel

Parameter	MELLLA	Analysis Limit
Nominal PCT	1725°F	N/A
Upper Bound PCT	2077°F	≤2200°F(1)
Licensing Basis PCT	2077°F	≤2200°F(1)
Maximum Local Oxidation	8.1%	≤ 17%(1)
Core-Wide Metal-Water Reaction	≤ 0.1%	≤ 1.0%(1)

Note:
(1) 10 CFR 50.46 ECCS-LOCA Analysis Acceptance Criteria.

5.0 INSTRUMENTATION AND CONTROL

5.1 NSSS MONITORING AND CONTROL

The instruments and controls that directly interact with or control the reactor are usually considered within the NSSS. The NSSS process variables and instrument setpoints that could be affected by the TPO uprate were evaluated.

5.1.1 Neutron Monitoring System

5.1.1.1 Average Power Range Monitors, Intermediate Range Monitors, and Source Range Monitors

The APRMs are re-calibrated to indicate 100% at the TPO RTP level of 3,486 MWt. The APRM high flux scram and the upper limit of the rod block setpoints, expressed in units of percent of licensed power, are not changed. The flow biased APRM trips, expressed in units of absolute thermal power (i.e., MWt), remain the same. However, in order to accommodate limits in the stability region, new flow biased APRM ALs were established that conservatively bound the entire operating envelope. This approach for the Fermi 2 TPO uprate follows the guidelines of TLTR Section 5.6.1 and Appendix F, which is consistent with the practice approved for GE BWR uprates in ELTR1 (Reference 2).

For the TPO uprate, no adjustment is needed to ensure the intermediate range monitors (IRMs) have adequate overlap with the source range monitors (SRMs) and APRMs. However, normal plant surveillance procedures may be used to adjust the IRM overlap with the SRMs and the APRMs. The IRM channels have sufficient margin to the upscale scram trip on the highest range when the APRM channels are reading near their downscale alarm trip because the change in APRM scaling is so small for the TPO uprate.

5.1.1.2 Local Power Range Monitors and Traversing In-Core Probes

At the TPO RTP level, the flux at some LPRMs increases. However, the small change in the power level is not a significant factor to the neutronic service life of the LPRM detectors and radiation level of the traversing in-core probes (TIPs). It does not change the number of cycles in the lifetime of any of the detectors. The LPRM accuracy at the increased flux is within specified limits, and the LPRMs are designed as replaceable components. The TIPs are stored in shielded rooms. The radiation protection program for normal plant operation can accommodate a small increase in radiation levels.

5.1.1.3 Rod Block Monitor

The RBM instrumentation is referenced to an APRM channel. Because the APRM has been rescaled, there is only a small effect on the RBM performance due to the LPRM performance at the higher average local flux. The RBM instrumentation is not significantly affected by the TPO uprate conditions, and no change is needed.

5.1.2 Rod Worth Minimizer

The rod worth minimizer (RWM) does not perform a safety-related function. The function of the RWM is to support the operator by enforcing rod patterns until reactor power has reached appropriate levels. The power-dependent setpoints for the RWM are discussed in Section 5.3.8.

5.2 BOP Monitoring and Control

Operation of the plant at the TPO RTP level has minimal effect on the BOP system instrumentation and control devices. The improved FW flow measurement, which is the basis for the reduction in power uncertainty, is addressed in Section 1.4. All instrumentation with control functions has sufficient range/adjustment capability for use at the TPO uprate conditions. No safety-related BOP system setpoint changes are required as a result of the TPO uprate. The plant-specific instrumentation and control design and operating conditions are bounded by those used in the evaluations contained in the TLTR.

5.2.1 Pressure Control System

The pressure control system (PCS), working with the turbine governor and turbine protection system, properly positions the turbine control valves and bypass valves to control the reactor pressure, as well as the turbine speed and load. The reactor dome pressure is maintained at an essentially constant pressure by a pressure regulator, which controls the amount of steam admitted to the turbine. The PCS, turbine governor and turbine protection system work together through the individual valve control modules to form a system consisting of solid state governing devices, governor startup control devices, emergency devices for turbine and plant protection (e.g., overspeed trip, supervisory/manual trip, low vacuum trip, bearing low oil pressure trip). The system operates the high pressure stop valves, high pressure control valves, bypass valves, low pressure stop and low pressure intercept valves, and other protective devices.

Satisfactory reactor pressure control by the turbine pressure regulator and the turbine control valves (TCVs) requires an adequate flow margin between the TPO RTP operating condition and the steam flow capability of the TCVs at their maximum stroke (i.e., valves wide open (VWO)). Fermi 2 has demonstrated acceptable pressure control performance at current rated conditions and has in excess of the ~2% steam flow margin needed for the TPO uprate.

No modification is required to the steam bypass valves. No modifications are required to the operator indications, controls or alarm annunciators provided in the Main Control Room. The required adjustments are limited to "tuning" of the control settings that may be required to operate optimally at the TPO uprate power level.

PCS tests, consistent with the guidelines in TLTR Appendix L, will be performed during the power ascension phase.

5.2.2 Feedwater Control System

An evaluation of the ability of the FW level control system and FW turbine controls to maintain adequate water level control at the TPO uprate conditions has been performed. The ~2% increase in FW flow associated with TPO uprate is within the current control margin of these systems. No changes in the operating reactor water level or reactor water level trip set points are required for the TPO uprate. Per the guidelines of TLTR Appendix L, the performance of the FW level control system will be recorded at 95% and 100% of CLTP and confirmed at the TPO power during power ascension. These checks will demonstrate acceptable operational capability and will utilize the methods and criteria described in the original startup testing of these systems.

5.2.3 Leak Detection System

The setpoints associated with leak detection have been evaluated with respect to the ~2% higher steam flow and ~2°F increase in FW temperature for the TPO uprate. Each of the systems, where leak detection potentially could be affected, is addressed below.

Main Steam Tunnel Temperature Based Leak Detection

The 2°F increase in FW temperature for the TPO uprate decreases the leak detection trip avoidance margin. As described in TLTR Section F.4.2.8, the high steam tunnel temperature setpoint remains unchanged.

RWCU System Temperature Based Leak Detection

There is no significant effect on RWCU system temperature or pressure due to the TPO uprate. Therefore, there is no effect on the RWCU temperature based leak detection.

RCIC System Temperature Based Leak Detection

The TPO uprate does not increase the nominal vessel dome pressure or temperature. Therefore, there is no change to the RCIC system temperature or pressure, and thus, the RCIC temperature based leak detection system is not affected.

HPCI System Temperature Based Leak Detection

The TPO uprate does not increase the nominal vessel dome pressure or temperature. Therefore, there is no change to the HPCI system temperature or pressure, and thus, the HPCI temperature based leak detection system is not affected.

RHR System Temperature Based Leak Detection

The TPO uprate does not increase the nominal vessel dome pressure or temperature. Therefore, there is no change to the RHR system temperature or pressure, and thus, the RHR temperature based leak detection system is not affected.

Non-Temperature Based Leak Detection

The non-temperature based leak detection systems are not affected by the TPO uprate.

5.3 TECHNICAL SPECIFICATION INSTRUMENT SETPOINTS

The determination of instrument setpoints is based on plant operating experience, conservative licensing analyses or limiting design/operating values. Standard GEH setpoint methodologies (References 22 and 23) are used to generate the AVs and nominal trip setpoints (NTSPs) related to any AL change, as applicable. Each actual trip setting is established to preclude inadvertent initiation of the protective action, while assuring adequate allowances for instrument accuracy, calibration, drift and applicable normal and accident design basis events.

Table 5-1 lists the ALs that change based on results from the TPO evaluations and safety analyses. In general, if the AL does not change in the units shown in the TS, then no change in its associated plant AV and NTSP is required, as shown in the TS. Changes in the setpoint margins due to changes in instrument accuracy and calibration errors caused by the change in environmental conditions around the instrument due to the TPO uprate are negligible. Maintaining constant nominal dome pressure for the TPO uprate minimizes the potential effect on these instruments by maintaining the same fluid properties at the instruments. The setpoint evaluations are based on the guidelines in TLTR Sections 5.8 and F.4 and on Section 5.3 of Reference 22.

5.3.1 High-Pressure Scram

The high-pressure scram terminates a pressure increase transient not terminated by direct or high flux scram. Because there is no increase in nominal reactor operating pressure with the TPO uprate, the scram AL on reactor high pressure is unchanged.

5.3.2 Hydraulic Pressure Scram

The AL for the turbine valve position that initiates the T/G trip scram at high power remains the same as for the CLTP. As noted in Section 5.3.16, no modifications to the turbine are being made for the TPO uprate, so there will be no change in the first-stage pressure/steam flow relationship from previous plant operation; actuation of these safety functions remains unchanged from the current operation.

5.3.3 High-Pressure Recirculation Pump Trip

The ATWS-RPT trips the pumps during plant transients with increases in reactor vessel dome pressure. The ATWS-RPT provides negative reactivity by reducing core flow during the initial part of an ATWS. The evaluation in Section 9.3.1 demonstrates that the TS limit for the high pressure ATWS-RPT is acceptable for the TPO uprate.

5.3.4 Safety Relief Valve

Because there is no increase in reactor operating dome pressure, the SRV ALs are not changed.

5.3.5 Main Steam Line High Flow Isolation

The TS AV of this function is expressed in terms of psid. The corresponding percent rated steam flow has been scaled to reflect changes due to TPO. The setpoint will be left as-is, and the existing setpoint in terms of psid has sufficient trip avoidance margin to support the small increase in the TPO rated steam flow. Therefore, the AV at TPO remains unchanged from CLTP in terms of psid.

Because of the large spurious trip margin, sufficient margin to the trip setpoint exists to allow for normal plant testing of the MSIVs. This is consistent with TLTR Section F.4.2.5.

5.3.6 Fixed APRM Scram

The fixed APRM ALs, for both two (recirculation) loop (TLO) and SLO, expressed in percent of RTP do not change for the TPO uprate. The generic evaluation and guidelines presented in TLTR Section F.4.2.2 are applicable to Fermi 2. The limiting transient that relies on the fixed APRM trip is the vessel overpressure transient (MSIV closure (MSIVC)) with indirect scram. This event has been analyzed assuming 102% of CLTP and is reanalyzed on a cycle specific basis.

5.3.7 APRM Flow Biased Scram

The flow-referenced APRM ALs, for both TLO and SLO, are unchanged in units of absolute core thermal power versus recirculation drive flow. Because the setpoints are expressed in percent of RTP, they decrease in proportion to the power uprate or CLTP RTP/TPO RTP. This is the same approach taken for generic BWR uprates described in ELTR1 (Reference 2). There is no significant effect on the instrument errors or uncertainties from the TPO uprate. Therefore, the AV and NTSP are established by directly incorporating the change in the AL.

5.3.8 Rod Worth Minimizer Low Power Setpoint

The RWM low power setpoint (LPSP) is used to enforce the rod patterns established for the control rod drop accident (CRDA) at low power levels. The generic guidelines in TLTR Section F.4.2.9 are applicable to Fermi 2. The RWM LPSP AL is kept the same in terms of percent power, and is therefore higher in terms of absolute power. This new higher absolute power is conservative for the RWM LPSP.

5.3.9 Rod Block Monitor

The severity of the rod withdrawal error (RWE) during power operation events is dependent upon the RBM rod block setpoint. The power-dependent ALs are maintained at the same percent power. The cycle specific reload analysis is used to determine any changes in the rod block setpoints.

5.3.10 Flow Biased Rod Block Monitor (%RTP)

Fermi 2 does not have a flow biased RBM system.

5.3.11 Main Steam Line High Radiation Isolation

The MSL normal radiation level increases approximately proportional to power. The setpoint is based on normal operating background radiation level, and may be adjusted to provide the same level of protection at the TPO uprate conditions with no appreciable increase in spurious trip frequency. No change in the TS is required. This approach is consistent with TLTR Section F.4.2.8.

5.3.12 Low Steam Line Pressure MSIV Closure (RUN Mode)

The purpose of this function is to initiate MSIVC on low steam line pressure when the reactor is in the RUN mode. This AL is not changed for the TPO as discussed in TLTR Section F.4.2.7.

5.3.13 Reactor Water Level Instruments

As described in TLTR Section F.4.2.10, the TPO uprate does not result in a significant increase in the possibility of a reactor scram, equipment trip, or ECCS actuation. Use of the current ALs maintains acceptable safety system performance. The low reactor water level TS setpoints for scram, high-pressure injection, and ADS/ECCS are not changed for the TPO uprate. The high water level ALs for trip of the main turbine and FW pumps, are not changed for the TPO uprate.

Water level change during operational transients (e.g., trip of a recirculation pump, FW controller failure, loss of one FW pump) is slightly affected by the TPO uprate. The plant response following the trip of one FW pump does not change significantly, because the maximum operating rod line is not being increased. Therefore, the final power level following a single FW pump trip at TPO uprate conditions would not change relative to the remaining FW flow as exists at CLTP.

5.3.14 Main Steam Line Tunnel High Temperature Isolations

As noted in Section 5.2.3 above, the high steam tunnel temperature AL remains unchanged for the TPO uprate.

5.3.15 Low Condenser Vacuum

In order to produce more electric power, the amount of heat discharged to the main condenser increases slightly. This added heat load may slightly increase the condenser backpressure but the increase would be insignificant (less than 0.1 in. HgA). The slight change in condenser vacuum after implementation of TPO will not adversely affect any trip signals associated with low condenser vacuum (turbine trip/MSIVC).

5.3.16 TSV Closure Scram, TCV Fast Closure Scram Bypass

The turbine first-stage pressure (TFSP) bypass allows the TSV closure scram and TCV fast closure scram to be bypassed, when reactor power is sufficiently low, such that the scram functions are not needed to mitigate a T/G trip. This power level is the AL for determining the actual trip setpoint, which comes from the TFSP. The TFSP setpoint is chosen to allow operational margin so that scrams can be avoided, by transferring steam to the turbine bypass system during T/G trips at low power.

Based on the guidelines in TLTR Section F.4.2.3, the TSV closure scram and TCV fast closure scram bypass AL in percent of RTP is reduced by the ratio of the power increase. The new AL does not change with respect to absolute thermal power. [[
]] The maneuvering range for plant startup is maximized.

No modifications to the Fermi 2 turbine are made for the TPO uprate, so there is no change in the first-stage pressure/steam flow relationship from previous operation.

Table 5-1 Analytical Limits that Change Due to TPO

Parameter	Current	TPO	Justification
APRM High Neutron Flux Scram (%RTP)	124.4	No change	
APRM Flow Biased STP Scram (1)			
Fixed (%RTP)	119.54	No change	
TLO Flow Biased (%RTP) (2)	0.63W + 68.51	0.62W + 67.40	(3)
SLO Flow Biased (%RTP) (2)	0.63(W - ΔW) + 68.51	0.62(W - ΔW) + 67.40 0.62W + 62.44	(3)
APRM Flow Biased STP Rod Block (1)			
Fixed (%RTP)	113.5	No change	
TLO Flow Biased (%RTP) (2)	0.63W + 62.47	0.62W + 61.46	(3)
SLO Flow Biased (%RTP) (2)	0.63(W - ΔW) + 62.47	0.62(W - ΔW) + 61.46 0.62W + 56.50	(3)
TSV & TCV Fast Closure Scram Bypass (%RTP)	30	29.5	(4)
MSL High Flow Isolation (% rated steam flow) (psid)	 140 121.4	 137.37 121.4	(4)
RWM LPSP (%RTP)	10	No change	(5)

Notes:

(1) No credit is taken in any safety analysis for flow biased setpoints.

(2) W is % recirculation drive flow where 100% drive flow is that required to achieve 100% core flow at 100% power, and ΔW is the difference between the TLO and SLO drive flow at the same core flow. The current value of ΔW is 8% and is not changed.

(3) These changes to the ALs are based upon the methodology approved by the NRC in Reference 1.

(4) All limits scaled for an uprate of 1.64% thermal.

(5) The RWM LPSP AL is conservatively kept the same in terms of percent power.

6.0 ELECTRICAL POWER AND AUXILIARY SYSTEMS

6.1 AC POWER

Plant electrical characteristics are given in Table 6-1.

A detailed comparison of existing ratings with uprated ratings and the effect of the power uprate on the generator, generator step-up transformers, and station service transformers are shown in Tables 6-2, 6-3a, 6-3b, 6-4a, and 6-4b.

6.1.1 Off-Site Power

The generator, main unit transformer and isolated phase bus nameplate ratings are listed below:

- Generator: The generator is a direct-driven 3-phase 60 Hz, 22,000 Volt, 1800 rpm, hydrogen inner-cooled, synchronous generator rated for 1,215 MWe at a 0.90 power factor, with a 0.58 short circuit ratio at a nominal hydrogen pressure of 75 psig.
- Main Unit Transformer: The main unit transformer consists of two transformers, Main Unit Transformer #2A and Main Unit Transformer #2B, connected in parallel.
- Main Unit Transformer #2A is a 710MVA, three-phase, 345-21.1kV, forced oil and air (FOA) cooling, 65°C rise, 60 Hz, outdoor ABB transformer.
- Main Unit Transformer #2B is a 874MVA, three-phase, 345-21.1 kV, oil directed forced air (ODFA) cooling, 65°C rise, 60Hz, outdoor Hyundai transformer.
- Isolated Phase Bus Duct: The isolated phase bus duct continuous current rating is based on a 90°C rise above a 50°C rise above a 40°C ambient with forced air cooling. The Main bus is rated at 37,000A and the transformer bus subsections are rated at 18,500A (700MWe). The momentary fault current rating for the bus section and the transformer bus sections is 400,000A. The voltage rating of the system is 22,0000V. The forced cooling is handled by an air handling unit with a design heat transfer capacity of 1,440,688 Btu/hr.

The review of the existing off-site electrical equipment concluded the following:

- The Main Generator will be operating within the existing generating capability curve for TPO uprate. For summer and winter operations, the gross generator MWe output is on the existing generator capability curve at a rated power factor of 0.90.
- The isolated phase bus duct is adequate for both rated voltage and low voltage current output.
- The main transformers and the associated switchyard components (rated for maximum generator output) are adequate for the TPO uprate-related transformer output.

A grid stability analysis has been performed, considering the increase in electrical output, to demonstrate conformance to General Design Criteria (GDC)-17 (10 CFR 50, Appendix A). GDC-17 addresses on-site and off-site electrical supply and distribution systems for safety-related components. There is no significant effect on grid stability or reliability. There are no modifications associated with the TPO uprate, which would increase electrical loads beyond those levels previously included or revise the logic of the distribution systems.

6.1.2 On-Site Power

The on-site power distribution system consists of transformers, numerous buses, and switchgears. Alternating current (AC) power to the distribution system is provided from the transmission system or from the onsite DGs. The on-site distribution system loads were reviewed under normal and emergency operating scenarios. In both cases, loads are computed based on equipment nameplate ratings. These loads are used as inputs for the computation of anticipated maximum running current, voltage drop, and short circuit currents. Operation at the TPO level is achieved in both normal and emergency conditions by operating equipment at or below the nameplate ratings. Therefore, there are no changes to the calculated equipment loading, system voltage drop or short circuit current values.

The only identifiable changes in electrical load demand are associated with the condenser pumps, heater feed pumps, and heater drain pumps. Each condenser pump brake horsepower (BHP) experiences an increase of 0.47% of its nameplate rating; each heater feed pump has an increase of 1.03% while each heater drain pump has a decrease of 0.17%. The resulting BHP demands for those pumps, due to the TPO conditions, are still well within the equipment nameplate ratings. The added equipment associated with the LEFM, including the processors and the cooling unit for the cabinet, will have no effect on the on-site AC power system. Based upon above, there will be no changes in the on-site AC power system design basis loads, voltage regulation or reduction in design margins due to the TPO conditions. The system environmental design bases are unchanged. Operation at the TPO level is achieved by utilizing existing equipment operating at or below the nameplate rating; therefore, under normal conditions, the electrical supply and distribution components (e.g., switchgears, motor control centers (MCCs), and cables) are adequate.

Station loads under emergency operation and distribution conditions (emergency DGs) are based on operational requirements. The ECCS pump loading is based on station UFSAR design basis requirements. Emergency operation at the TPO power uprate levels is achieved by utilizing existing equipment operating at or below the nameplate rating and within the calculated BHP for the stated pumps. Therefore, under emergency conditions, the electrical supply and distribution components are adequate.

No increase in flow or pressure is required of any AC-powered ECCS equipment for the TPO uprate. Therefore, the amount of power required to perform safety-related functions (pumps and valve loads) does not increase, and the current emergency power system remains adequate. The systems have sufficient capacity to support all required loads for safe shutdown, to maintain a safe shutdown condition, and to operate the engineered safety feature equipment following postulated accidents.

Because the duty cycle and duration for design basis emergency diesel generator (EDG) loads is based on analytical power levels of at least 102% of the CLTP, these will remain unchanged by TPO. Hence, the required reserve volume of emergency fuel oil is not changed. Therefore, usable emergency fuel oil reserves will be adequate to support TPO.

6.2 DC POWER

The direct current (DC) loading requirements documented in the UFSAR and station load calculations were reviewed, and no reactor power-dependent loads were identified. The DC power distribution system provides control and motive power for various systems and components. These loads are used as inputs for the computation of load, voltage drop, and short circuit current values. Operation at the TPO RTP-level does not increase any loads or revise control logic. Therefore, there are no changes to the load, voltage drop, or short circuit current values.

6.3 FUEL POOL

The following subsections address fuel pool cooling, crud and corrosion products in the fuel pool, radiation levels and structural adequacy of the fuel racks. The changes due to TPO are within the design limits of the system and its components. The fuel pool cooling system meets the UFSAR requirements at the TPO conditions.

6.3.1 Fuel Pool Cooling

The spent fuel pool (SFP) heat load remains within the capability of the fuel pool cooling and cleanup (FPCC) system as assured by cycle specific calculations to verify heat load is less than or equal to that previously analyzed. The TPO uprate does not affect the heat removal capability of the FPCC system supplemented with RHR assist mode, as shown in Table 6-5. The TPO heat load is within the design basis heat load for the FPCC system supplemented with RHR assist mode.

The SFP cooling and makeup adequacy is maintained by controlling the timing of the discharge (fuel offload) to the SFP to ensure the capability of the FPCC to maintain adequate fuel pool cooling for the TPO uprate.

The FPCC system heat exchangers, supplemented with RHR assist mode, are sufficient to remove the decay heat during normal refueling. The equipment required is not affected by TPO. For a full core off-load, the RHR system in fuel pool cooling assist mode is available to maintain the SFP water temperature below the design limit.

6.3.2 Crud Activity and Corrosion Products

The crud activity and corrosion products associated with spent fuel can increase very slightly due to the TPO. The increase is insignificant and SFP water quality is maintained by the FPCC.

6.3.3 Radiation Levels

The normal radiation levels around the SFP may increase slightly during fuel handling operation. This increase is acceptable and does not significantly increase the operational doses to personnel or equipment.

6.3.4 Fuel Racks

There is no effect on the design of the fuel racks because the maximum allowable spent fuel temperature is not being increased.

6.4 WATER SYSTEMS

The safety-related and non-safety related cooling water loads potentially affected by TPO are addressed in the following sections. The environmental effects of TPO are controlled such that none of the present limits (e.g., maximum allowed cooling water discharge temperature) are increased.

6.4.1 Service Water Systems

6.4.1.1 Safety-Related Loads

Emergency Service Water

The safety-related emergency service water (ESW) consists of EESW system, RHRSW system (see below) and emergency DG service water (EDGSW) system. These systems provide cooling water to essential equipment during and following a DBA, such as a Loss of Offsite Power (LOOP) or LOCA. The performance of the EESW system during these events does not change for TPO because the original LOCA analysis and containment response analysis were based on 102% of CLTP, the bounding power level for the TPO analysis. The required performance of the EDGSW system does not change for TPO because the existing design requirements are based on the design basis EDG rating. The TPO heat loads remain within this design rating. The increases in the heat loads to equipment cooled by ESW are within the existing capacity of the ESW system.

Residual Heat Removal Service Water

The required design performance of the RHRSW does not change for TPO because the original LOCA analysis and containment response analysis were based on at least 102% of CLTP, the bounding analytical power level for TPO. The increases in the normal operating heat loads to equipment cooled by RHRSW are within the existing capacity of the RHRSW system.

6.4.1.2 Non-Safety Related Loads

The major operational heat load increases to the service water system from TPO reflect an operational increase in main generator losses rejected to the main turbine lube oil coolers and main generator hydrogen coolers. The resulting design heat loads to the service water system are ~1.0 % above CLTP. The increases in heat loads to equipment cooled by the service water system are within the design capacities of the systems and components, which are therefore adequate to accommodate the TPO power increase.

The operational heat loads cooled by the SCCW system are unaffected by TPO power increase.

6.4.2 Main Condenser/Circulating Water/Normal Heat Sink Performance

The main condenser, circulating water, and normal heat sink systems are designed to remove the heat rejected to the condenser and thereby maintain adequately low condenser pressure as recommended by the turbine vendor.

TPO operation increases the heat rejected to the condenser and may reduce the difference between the operating pressure and the minimum condenser vacuum.

The performance of the main condenser was evaluated for operation at the TPO RTP. The evaluation confirms that the condenser, circulating water system, and heat sink are adequate for TPO operation.

6.4.2.1 Discharge Limits

The Michigan Department of Environmental Quality National Pollutant Discharge Elimination System (NPDES) permit provides the effluent limitations and monitoring requirements for effluent discharges to Lake Erie (Outfall 001A) at the site. Discharges to Lake Erie are limited to 45.1 million gallons per day (MGD) and effluent pH must be between 6.5 and 9.0. The discharge limit for total residual chlorine (TRC) is 38 μg/l and the discharge limit for Spectrus CT1300 is 15 μg/l. The use of Spectrus CT1300 is limited to two applications a year, but it is typically not used. Frequent monitoring of these parameters, when they are in use, ensures that permit limits are not exceeded. The TPO uprate has minimal effect on the above-described parameters, and no changes to NPDES permit requirements are needed.

The state discharge limits, the current discharges, and bounding analysis discharges for the TPO uprate are shown in Table 6-6. This comparison demonstrates that the plant remains within the state discharge limits during operation at TPO conditions.

6.4.3 Reactor Enclosure Cooling Water System

The Fermi 2 systems that provide for reactor/safety & auxiliaries cooling are the non-safety related RBCCW system and the safety-related EECW systems. The heat loads for these systems do not increase significantly due to TPO. The power-dependent heat loads on the RBCCW system that are increased by the TPO are those related to DW coolers and Reactor Building steam tunnel coolers during normal operation, and the fuel pool cooling heat exchangers. The design of the RBCCW heat exchangers is adequate to accommodate the heat load increase associated with TPO (less than 1%) for normal operation, while emergency heat loads cooled by the EECW system are not affected.

Changes to the RBCCW system heat loads are minimal and will result in a negligible temperature increase for the RBCCW system during normal operation. Although the RBCCW system experiences a slight heat load increase (less than 1%), the system has adequate design margin to remove the additional heat. Therefore, the RBCCW and EECW systems are acceptable for the TPO uprate.

6.4.4 Turbine Enclosure Cooling Water System

The power-dependent heat loads on the TBCCW system that are increased by the TPO, are those related to the operation of the main generator stator winding coolers and main generator isolated phase bus duct cooler, caused by increased T/G electrical output. The remaining TBCCW system heat loads are not strongly dependent upon reactor power and do not significantly increase. The TBCCW system has sufficient capacity to assure that adequate heat removal capability is available for TPO operation.

6.4.5 Ultimate Heat Sink

The ultimate heat sink (UHS) for Fermi 2 is the RHR complex, which consists of redundant enclosed reservoirs and mechanical draft cooling towers. The ESW systems, consisting of RHRSW, EDGSW, and EESW systems provide water from the UHS for equipment cooling throughout the plant. As a result of operation at the TPO RTP level, the actual post-LOCA heat load increases slightly, primarily due to higher reactor decay heat. However the ability of the UHS to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the UHS are within previous evaluations and the requirements are unchanged for TPO power uprate conditions. The current TS for UHS limits are adequate due to conservatism in the current design.

6.5 STANDBY LIQUID CONTROL SYSTEM

The SLCS is designed to shut down the reactor from rated power conditions to cold shutdown in the postulated situation that all or some of the control rods cannot be inserted. This system pumps a highly enriched sodium pentaborate solution into the vessel to achieve a sub-critical condition. The generic evaluation presented in TLTR Appendix L.3 (ATWS Evaluation) was not applicable to Fermi 2. Therefore a plant-specific ATWS evaluation for Fermi 2 TPO was performed and the results are presented in Section 9.3.1. The TPO uprate does not affect shutdown or injection capability of the SLCS system. Because the shutdown margin is reload dependent, the shutdown margin and the required reactor boron concentration are confirmed for each reload core.

The generic evaluation presented in TLTR Section 5.6.5 (SLCS) is applicable to Fermi 2. The SLCS performance was analyzed to compare the maximum discharge pressure of the SLCS pump to the SLCS relief valve nominal set pressure. The SLCS relief valve margin is adequate for the TPO uprate because the SLCS system prior to the TPO uprate has a confirmed minimum relief valve margin of greater than [[ ]] psi (measured between the inlet to the SLCS relief valve and the minimum SLCS relief valve opening setpoint accounting for setpoint tolerance).

The SLCS ATWS performance is evaluated in Section 9.3.1. The evaluation shows that the TPO has no adverse effect on the ability of the SLCS to mitigate an ATWS.

6.6 POWER-DEPENDENT HEATING, VENTILATION AND AIR CONDITIONING

The heating, ventilation and air conditioning (HVAC) systems that are potentially affected by the TPO uprate consist mainly of heating, cooling supply, exhaust, and recirculation units in the Turbine Building, Reactor Building (including steam tunnel), and primary containment.

TPO results in a minor increase in the heat load caused by the slightly higher FW operating temperature (2°F). The increased heat load is within the margin of the steam tunnel area coolers. In the DW, the increase in heat load due to the FW process temperature is within the system capacity. In the Turbine Building, the temperature increases are expected to be very low due to the minimal increase in the FW operating temperature. In the Reactor Building, the increase in heat load caused by the slightly higher FW process temperature is within the margin of the area coolers. Other areas are unaffected by the TPO because the process temperatures and electrical heat loads remain constant.

Therefore, the power-dependent HVAC systems are adequate to support the TPO uprate.

6.7 FIRE PROTECTION

Operation of the plant at the TPO RTP level does not affect the fire suppression or detection systems. There is no change in the physical plant configuration and the potential for minor changes to combustible loading as a result of the TPO uprate are addressed by controlled design change procedures (e.g., the new FW LEFM equipment).

The operator manual actions that are being used for compliance with 10 CFR 50, Appendix R were reviewed. No operator manual actions have been identified in areas where environmental conditions, such as heat, would challenge the operator. Because this uprate is being performed at a constant pressure and temperature, the normal temperature environments are not affected by TPO. Therefore, the operator manual actions required to mitigate the consequences of a fire are not affected.

A review was conducted of the fire protection program as related to administrative controls, fire barriers, fire protection responsibilities of plant personnel and resources necessary for systems required to achieve and maintain safe-shutdown. The review looked at the effect of TPO uprate and how it would affect these areas. The TPO uprate will have no effect on fire protection administrative controls, fire barriers, fire protection responsibilities of plant personnel and resources necessary for systems required to achieve and maintain safe-shutdown.

A review was conducted of all repair activities that are credited to obtain and maintain cold shutdown. The Fermi 2 Appendix R analysis demonstrates that the station can reach cold shutdown with significant margin to the 72-hour requirements in 10 CFR 50 Appendix R, Sections III.G.1.b and III.L. No "time-critical" repairs would be required to reach or maintain cold shutdown. The TPO and the additional decay heat removal would not affect the ability to reach and maintain cold shutdown within 72 hours.

Therefore, the fire protection systems and analyses are not affected by the TPO uprate.

6.7.1 10 CFR 50 Appendix R Fire Event

TLTR Section L.4 presents a generic evaluation of Appendix R events for an increase of 1.5% of CLTP. [[

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Analyses show that there is an available margin of 904°F to the clad temperature limit and 45.7 psig to the containment pressure limit.

Therefore, the generic results are applicable and no further plant-specific Appendix R analysis is necessary for the TPO uprate.

6.8 SYSTEMS NOT AFFECTED BY TPO UPRATE

Based on experience and previous NRC reviews, all systems that are significantly affected by TPO are addressed in this report. Other systems not addressed by this report are not significantly affected by TPO. The systems unaffected by TPO at Fermi 2 are confirmed to be consistent with the generic description provided in the TLTR.

Table 6-1 TPO Plant Electrical Characteristics

Parameter	Value
Generator Output (MWe)	1215
Rated Voltage (kV)	22
Power Factor	0.90
Generator Output (MVA)	1350
Current Output (Amps)	35,428
Isolated Phase Bus Duct Rating: (Amps)	
Main Section	37,000
Branch Section	18,500
Main Transformers Rating (MVA)	
Transformer 2A	710
Transformer 2B	874

Table 6-2 Main Generator Ratings Comparison

Power Level	Design	Maximum Normal	
	MVA at 75 psig H_2	MWe at 75 psig H_2	MVAR at 75 psig H_2
Existing	1350	1215	588
Uprated(1)(2)	1350	1215	588

Notes:

(1) Operation at the uprated condition is not expected to have any effect on the operation of the main generator. Operation in this range is still within the operating boundaries specified in the station design analysis and operating procedures.

(2) TPO power is 1342 MVA that is bounded by the generator design rating of 1350 MVA.

Table 6-3a Main Generator Step-Up Transformer 2A Ratings Comparison

Power Level	Design MVA @ 65°C	MVA Loading
Existing	710	658
Uprated(1)	710	658

Note:

(1) Operation at the uprated condition is not expected to have any effect on the operation of the Generator Step-up Transformer. Operation in this range is still within the operating boundaries specified in station design analysis and operating procedures. The ratings are based on forced air and oil. TPO power is 654 MVA that is bounded by the transformer current design loading of 658 MVA and transformer design rating of 710 MVA.

Table 6-3b Main Generator Step-Up Transformer 2B Ratings Comparison

Power Level	Design MVA @ 65°C	MVA Loading
Existing	874	692
TPO Uprate	874	692

Table 6-4a Station Service Transformer #65 Division 2 Ratings Comparison

Rated MVA @ 65°C	Existing MVA Loading	TPO MVA Loading
37.3	35.53	35.60(1)

Note:

(1) Operation at the uprated condition is not expected to have any effect on the operation of the Station Service Transformer. Existing MVA loading uses motor nameplate ratings. TPO MVA loading includes a slight increase in motor loading due to the TPO condition. Operation in this range is still within the operating boundaries specified in station design analysis and operating procedures.

Table 6-4b Station Service Transformer #64 Division 1 Ratings Comparison

Rated MVA @ 65°C	Existing MVA Loading	TPO MVA Loading
20	15.10	15.13(1)

Note:

(1) Operation at the uprated condition is not expected to have any effect on the operation of the station service transformer. Existing MVA loading uses motor nameplate ratings. TPO MVA loading includes a slight increase in motor loading due to the TPO condition. Operation in this range is still within the operating boundaries specified in station design analysis and operating procedures.

Table 6-5 FPCC System Parameters

Parameter	CLTP	TPO
Number of RHR/fuel pool cooling trains	1 / 2	1 / 2
RHR heat exchanger flow rate, SFP/RHRSW	3500 / 9000 gpm	3500 / 9000 gpm
Fuel pool heat exchanger flow rate, SFP/RBCCW	550/800 gpm	550/800 gpm
Design heat removal capacity (one RHR heat exchanger)	30.72E+6 BTU/hr (125°F, 89°F)	30.72E+6 BTU/hr
Design heat load, (2) fuel pool heat exchangers	16.66E+6 BTU/hr (150°F, 95°F)	16.66 E+6 BTU/hr
Fuel cycle (months)	18	18
Bulk pool temperature (Normal Operation)	< 125°F	< 125°F
Bulk pool temperature (During Refueling)	< 150°F	< 150°F

Table 6-6 Effluent Discharge Comparison

Parameter	State Limit	Current (2011)	TPO
Discharges to Lake Erie - Outfall 001A (MGD)	45.1	43.2[1]	No change
Total Residual Chlorine (TRC) µg/l	38	<15[2]	No change
pH	6.5-9.0	8.7[3]	No change
Betz Dearborn Spectrus CT1300 µg/l	15	Not applicable[4]	No change

Notes:

(1) Maximum daily discharge volume in 2011. Take from monthly NPDES discharge monitoring reports for Outfall 001A.

(2) No measurable TRC discharged in 2011. 15 µg/l is the limit of detection.

(3) Maximum recorded pH value recorded in 2011.

(4) CT1300 not used in 2011.

7.0 POWER CONVERSION SYSTEMS

7.1 TURBINE-GENERATOR

The Fermi 2 main T/G is designed with a maximum flow-passing capability in excess of TPO uprate conditions to ensure that the TPO rated output is achieved. The excess capacity ensures that the T/G can meet rated conditions for continuous operating capability with allowances for variations in flow coefficients from expected values, manufacturing tolerances, and other variables that may affect the flow-passing capability of the unit. The difference in the steam-passing capability between the current analyzed and rated conditions is called the flow margin. The Fermi 2 T/G has a flow margin of 6.3% at the rated throttle steam flow of 13,362,987 lb/hr at a throttle pressure of 1,000.8 psia and rated electrical power output of 1,184.6 MW at a generator capability of 1,316 MVA at rated power factor of 0.90.

For the TPO uprate RTP of 3,488 MWt (~101.7% of CLTP), the rated throttle steam flow is increased to 13,635,359 lb/hr. The evaluated increased throttle flow is approximately 102.0% of current rated throttle flow. The evaluated increased throttle flow (~2%) is due to the steam flow increase associated with operation at 102% CLTP conditions. The maximum uprated electrical output is 1,208.3 MW at 101.7% CLTP. Maximum expected reactive power at TPO RTP conditions is expected to be 585 MVAR. These conditions result in a maximum generator load (capability) of 1,342 MVA at a rated power factor of 0.90.

Steam specification calculations were performed to determine the TPO uprate turbine steam path conditions. These TPO uprate operating conditions are bounded by the previous analysis of the turbine and generator stationary and rotating components. Thus, the increased loadings, pressure drops, thrusts, stresses, overspeed capability and other design considerations resulting from operation at TPO RTP conditions are within existing design and operating limits and therefore are acceptable at the TPO uprate condition. In addition, valves, control systems and other support systems were evaluated at a throttle steam flow of 13,722,820 lb/hr or higher and TPO operating conditions are bounded by these analyses. The results of these evaluations show that no modifications are needed to support operation at the TPO uprate condition.

The existing rotor missile analysis was performed at 120% design overspeed conditions. The TPO uprate does not change turbine rated speed. Therefore, there is no change in the missile generation probability and thus, the missile generation probability remains unchanged and is therefore acceptable.

The overspeed evaluation addressed the sensitivity of the rotor train for the capability of overspeeding. Due to the steam flow increase, the entrained energy increases slightly for the TPO uprate conditions. The steam turbine rotor train can accommodate the increased overspeed potential. The high pressure stop valve and low pressure stop valve closure times will not change, the steam piping and casing volumes will not change and the turbine control system will not change for the TPO uprate conditions. It is not necessary to change the steam turbine overspeed trip settings for TPO because the existing analysis bounds the TPO uprate conditions.

7.2 CONDENSER AND STEAM JET AIR EJECTORS

The main condenser capability was evaluated for performance at the TPO uprate conditions in Section 6.4.2. Air leakage into the condenser does not increase as a result of the TPO uprate. The small increase in hydrogen and oxygen flows from the reactor does not affect the steam jet air ejector (SJAE) capability because the design was based on operation at greater than required flows at uprate conditions. Therefore, the condenser air removal system is not affected by the TPO uprate and the SJAEs are adequate for operation at the TPO uprate conditions.

7.3 TURBINE STEAM BYPASS

The steam bypass pressure control system (SBPCS) is currently operating at a steam flow capacity of approximately 24.7% of the 100% rated flow at CLTP. The steam bypass capacity at the TPO RTP is approximately 23.5% of the 100% TPO RTP steam flow rate. The steam bypass system is non-safety related. While the bypass capacity as a percent of rated steam flow is reduced, the actual steam bypass capacity is unchanged. The transient analyses that credit the turbine bypass system use a bypass capacity that is less than the actual capacity. Therefore, the turbine bypass capacity remains adequate for TPO operation because the actual capacity (unchanged) continues to bound the value used in the analyses.

7.4 FEEDWATER AND CONDENSATE SYSTEMS

The FW and condensate systems are designed to provide FW at the temperature, pressure, quality, and flow rate required by the reactor. These systems are not safety-related; however, their performance may have an effect on plant availability and the capability to operate reliably at the TPO uprate condition.

A review of the Fermi 2 FW heaters, heater drain system, condensate demineralizers, and the pumps (FW and condenser) demonstrated that the components are capable of performing in the proper design range to provide the slightly higher TPO uprate FW flow rate at the desired temperature and pressure.

A review of the Fermi 2 heater drain system demonstrated that the components will be capable of supporting the slightly higher TPO uprate extraction flow rates. The relief valves for the No. 3 FW heaters will be replaced prior to implementation of TPO.

Performance evaluations were based on an assessment of the capability of the condensate and FW systems and equipment to remain within the design limitations of the following parameters:

- Pump NPSH
- Ability to avoid suction pressure trip
- Flow capacity
- Bearing cooling capability
- Rated driver horsepower
- Vibration

The FW system run-out and loss of FW heating events are expected to see changes small enough to remain bounded by existing analysis from the TPO uprate as shown by the experience with substantially larger power uprates.

7.4.1 Normal Operation

System operating flows for the TPO uprate increase approximately 1.97%. Operation at the TPO RTP level does not significantly affect operating conditions of these systems. Discharge pressure of the condenser pumps decreases due to the pump head characteristics at increased flows. Discharge pressure of the FW pumps will increase to compensate for the increase in FW friction losses due to higher flow. To accomplish this increase in pump discharge pressure, opening the flow control valves (FCVs) to the feed pump turbine increases the feed pump speed. During steady-state conditions, the condensate and FW systems have available NPSH for all of the pumps to operate without cavitation at the TPO uprate conditions. Adequate margin during steady-state conditions exists between the calculated minimum pump suction pressure and the minimum pump suction pressure trip set points.

The existing FW design pressure and temperature requirements will bound the operating conditions with adequate margin with the exception of the No. 3 FW heaters. The FW heaters are ASME Section VIII pressure vessels. The FW heaters were analyzed and will be acceptable for the slightly higher FW heater temperatures and pressures for the TPO uprate. The relief valves for the shell sides of the No. 3 FW heaters will be changed to accommodate TPO uprate conditions. All other heaters are verified acceptable for TPO uprate.

7.4.2 Transient Operation

To account for FW demand transients, the condensate and FW systems were evaluated to ensure that sufficient margin above the TPO uprated flow is available. For system operation with all system pumps available, the predicted operating parameters were acceptable and within the component capabilities.

Following a single FW pump trip with low reactor water level, the RRS would runback recirculation flow, such that the steam production rate is within the flow capacity of the remaining FW pumps. The runback setting prevents a reactor low water level scram, and is sufficient to maintain adequate margin to the potential P/F instability regions. Operation at the TPO condition does not degrade this capability.

7.4.3 Condensate Filter Demineralizers

The effect of the TPO uprate on the condensate filter demineralizers (CFDs) was reviewed. The CFD system can accommodate (without bypass) TPO uprate operations with one vessel removed from service (when backwash/resin change out is required).

8.0 RADWASTE AND RADIATION SOURCES

8.1 Liquid and Solid Waste Management

The liquid radwaste system collects, monitors, processes, stores, and returns processed radioactive waste to the plant for reuse, discharge, or shipment.

Major sources of liquid and wet solid waste are from the CFDs. The TPO uprate results in a ~2% increased flow rate through the condensate system, potentially resulting in a reduction in the average time between backwashes of the CFD resin. This potential reduction of CFD service time does not affect plant safety.

The floor drain collector subsystem and the waste collector subsystem both receive periodic inputs from a variety of sources. Neither subsystem experiences a significant increase in volume due to operation at the TPO uprate condition.

The activated corrosion products in the waste stream are expected to increase proportionally to the TPO uprate. However, the total volume of processed waste is not expected to increase appreciably. The only significant increase in processed waste is due to the more frequent backwashes of the CFDs; small increases will also be from the RWCU and FPCC. A review of plant operating effluent reports and the slight increase expected from the TPO uprate, leads to the conclusion that the requirements of 10 CFR 20 and 10 CFR 50, Appendix I will continue to be met. Therefore, the TPO uprate does not adversely affect the processing of liquid radwaste and there are no significant environmental effects.

8.2 Gaseous Waste Management

The gaseous waste systems collect, control, process, and dispose of gaseous radioactive waste generated during normal operation and abnormal operational occurrences. The gaseous waste management systems include the offgas system and various building ventilation systems. The systems are designed to meet the requirements of 10 CFR 20 and 10 CFR 50, Appendix I.

Non-condensable radioactive gas from the main condenser normally contains activation gases and fission product radioactive noble gas parents. These are the major sources of radioactive gas, and are greater than all other sources combined. These non-condensable gases, along with non-radioactive air in-leakage, are continuously removed from the main condensers by the SJAE that discharge into the offgas system.

Building ventilation systems control airborne radioactive gases by using devices such as high efficiency particulate air (HEPA) and charcoal filters, and radiation monitors that activate isolation dampers or trip supply and exhaust fans, or by maintaining negative or positive air pressure to limit migration of gases. The changes to the gaseous radwaste releases are proportional to the change in core power, and the total releases are a small fraction of the design basis releases.

The release limit is an administratively controlled variable and is not a function of core power. The gaseous effluents are well within limits at CLTP operation and remain well within limits following implementation of the TPO uprate. There are no significant environmental effects due to the TPO uprate.

The offgas system was evaluated for the TPO uprate. Radiolysis of water in the core region, which forms H_2 and O_2, increases linearly with core power, thus increasing the heat load on the recombiner and related components. The offgas system design basis H_2 is 186 cfm (with a corresponding stoichiometric O_2 of 93 cfm). The expected H_2 flow rate for the TPO uprate is 120.9 cfm (60.4 cfm of O_2). The increase in H_2 and O_2 due to the TPO uprate remains well with the capacity of the system. Therefore, the TPO uprate does not affect the offgas system design or operation.

8.3 RADIATION SOURCES IN THE REACTOR CORE

TLTR Appendix H describes the methodology and assumptions for the evaluation of radiological effects for the TPO uprate.

During power operation, the radiation sources in the core are directly related to the fission rate. These sources include radiation from the fission process, accumulated fission products and neutron reactions as a secondary result of fission. Historically, these sources have been defined in terms of energy released per unit of reactor power. Therefore, for TPO, the percent increase in the operating source terms is no greater than the percent increase in power. The source term increases due to the TPO uprate are bounded by the safety margins of the design basis sources.

The post-operation radiation sources in the core are primarily the result of accumulated fission products. Two separate forms of post-operation source data are normally applied. The first is the core gamma-ray source, which is used in shielding calculations for the core and for individual fuel bundles. This source term is defined in terms of MeV/sec per watt of reactor thermal power (or equivalent) at various times after shutdown. Therefore, the total gamma energy source increases in proportion to reactor power.

The second set of post-operation source data consists primarily of nuclide activity inventories for fission products in the fuel. These are needed for post-accident and SFP evaluations, which are performed in compliance with regulatory guidance that applies different release and transport assumptions to different fission products. The core fission product inventories for these evaluations are based on an assumed fuel irradiation time, which develops "equilibrium" activities in the fuel (typically three years). Most radiologically significant fission products reach equilibrium within a 60-day period. The calculated inventories are approximately proportional to core thermal power. Consequently, for TPO, the inventories of those radionuclides, which reached or approached equilibrium, are expected to increase in proportion to the thermal power increase. The inventories of the very long-lived radionuclides, which did not approach equilibrium, are both power and exposure dependent. They are expected to increase proportionally with power if the fuel irradiation time remains within the current basis.

Thus, the long-lived radionuclides are expected to increase proportionally to power. The radionuclide inventories are provided in terms of Curies per megawatt of reactor thermal power at various times after shutdown.

The core source term is included in the analyses for LOCAs and fuel handling accidents (FHAs) and those analyses are done at 102% CLTP. The CRDA is analyzed under the original licensing basis and is bounded by the GE14 fuel analysis of Reference 24.

Reference 1, Appendix H.3 methodology states that the mass of coolant lost does not change for constant reactor pressure TPO uprate.

The previous analyses for Fermi 2 bound the accident source terms for a TPO uprate because they were evaluated with consideration of at least 2% overpower uncertainty. With operation at TPO conditions, the bounding set of power level assumptions remains the same as the previous analyses because of the reduced uncertainty.

8.4 RADIATION SOURCES IN REACTOR COOLANT

8.4.1 Coolant Activation Products

During reactor operation, the coolant passing through the core region becomes radioactive as a result of nuclear reactions. The coolant activation is the dominant source in the Turbine Building and in the lower regions of the DW. Because these sources are produced by interactions in the core region, their rates of production are proportional to power. However, the concentration in the steam remains nearly constant, because the increase in activation production is balanced by the increase in steam flow. As a result, the activation products, observed in the reactor water and steam, increase in approximate proportion to the increase in thermal power.

8.4.2 Activated Corrosion Products

The reactor coolant contains activated corrosion products from metallic materials entering the water and being activated in the reactor region. Under the TPO uprate conditions, the FW flow increases with power, the activation rate in the reactor region increases with power, and the filter efficiency of the condensate demineralizers may decrease as a result of the FW flow increase. The net result may be an increase in the activated corrosion product production. However, the TPO uprate corrosion product concentrations are not expected to exceed the design basis concentrations. Therefore, no change is required in the design basis activated corrosion product concentrations for the TPO uprate.

8.4.3 Fission Products

Fission products in the reactor coolant are separable into the products in the steam and the products in the reactor water. The activity in the steam consists of noble gases released from the core plus carryover activity from the reactor water. The noble gases released during plant operation result from the escape of minute fractions of the fission products from the fuel rods.

Noble gas release rates are based on a standard conservative value of 0.1 Ci/sec at t= 30 minute holdup. This activity is the noble gas offgas that is included in the Fermi 2 design. The design basis release rates remain bounding for the TPO uprate.

The fission product activity in the reactor water, like the activity in the steam, is the result of minute releases from the fuel rods. As is the case for the noble gases, there is no expectation that releases from the fuel increase due to the TPO uprate. Activity levels in the reactor water are expected to be approximately equal to current measured data, which are fractions of the design basis values. Therefore, the design basis values are unchanged.

8.5 RADIATION LEVELS

Normal operation radiation levels increase slightly for the TPO uprate. Fermi 2 was designed with substantial conservatism for higher-than-expected radiation sources. Thus, the increase in radiation levels does not affect radiation zoning or shielding in the various areas of the plant because it is offset by conservatism in the design, source terms, and analytical techniques.

Post-operation radiation levels in most areas of the plant increase by no more than the percentage increase in power level. In a few areas near the SFP cooling system piping and the reactor water piping, where accumulation of corrosion product crud is expected, as well as near some liquid radwaste equipment, the increase could be slightly higher. The radiation levels in areas with significant N-16 radiation are expected to increase by more than the percentage increase in power level.

Regardless, individual worker exposures will be maintained within acceptable limits by the site as low as is reasonably achievable (ALARA) program, which controls access to radiation areas. Procedural controls compensate for increased radiation levels.

The change in core activity inventory resulting from the TPO uprate (Section 8.3) increases post-accident radiation levels by no more than approximately the percentage increase in power level. The slight increase in the post-accident radiation levels has no significant effect on the plant or the habitability of the on-site Emergency Response facilities. A review of areas requiring post-accident occupancy concluded that access needed for accident mitigation is not significantly affected by the TPO uprate.

Section 9.2 addresses the Main Control Room doses for the worst-case accident.

8.6 NORMAL OPERATION OFF-SITE DOSES

The TS limits implement the guidelines of 10 CFR 50, Appendix I. A review of the normal radiological effluent doses shows that at CLTP, the annual doses are a small fraction of the doses allowed by TS limits. The TPO uprate does not involve significant increases in the offsite dose from noble gases, airborne particulates, iodine, tritium, or liquid effluents. In addition, radiation from shine is not a significant exposure pathway. Present offsite radiation levels are a negligible portion of background radiation. Therefore, the normal offsite doses are not significantly affected by operation at the TPO RTP level and remain below the limits of 10 CFR 20 and 10 CFR 50 Appendix I.

8.7 BOP RADIATION SOURCES

Normal operation and post-accident conditions BOP radiation sources increase slightly for the TPO uprate, but the existing design basis accommodates power levels above the TPO level. Fermi 2 was designed with substantial conservatism for higher-than-expected radiation sources. Thus, the increase in BOP radiation sources does not affect radiation zoning or shielding in the various areas of the plant because it is offset by conservatism in the design, source terms, and analytical techniques.

Regardless, individual worker exposures will be maintained within acceptable limits by the site ALARA program, which controls access to radiation areas. Procedural controls compensate for increased radiation levels.

9.0 REACTOR SAFETY PERFORMANCE EVALUATIONS

9.1 ANTICIPATED OPERATIONAL OCCURRENCES

TLTR Appendix E provides a generic evaluation of the AOOs for TPO uprate plants. [[

]] Also included are the analytical methods to be used and operating conditions to be assumed. The AOO events are organized into two major groups: Fuel Thermal Margin Events, and Transient Overpressure Events.

TLTR Table E-2 illustrates the effect of a 1.5% power uprate on the OLMCPR. [[

]] The OLMCPR changes for the 1.64% uprate may be slightly larger than shown in Table E- 2, but the changes are expected to be within the normal cycle-to-cycle variation. The overpressure events and loss of FW transient are currently performed with the assumption of 2% overpower. Therefore, they are applicable and bounding for the TPO uprate.

The reload transient analysis includes the worst overpressure event, which is usually the closure of all MSIVs with high neutron flux scram.

The evaluations and conclusions of TLTR Appendix E are applicable to the Fermi 2 TPO uprate. Therefore, it is sufficient for the plant to perform the standard reload analyses at the first fuel cycle that implement the TPO uprate.

9.2 DESIGN BASIS ACCIDENTS

The radiological consequences of a DBA are basically proportional to the quantity of radioactivity released to the environment. This quantity is a function of the fission products released from the core as well as the transport mechanisms from the core to the release point. The radiological releases at the TPO uprate power are generally expected to increase in proportion to the core inventory increase, which is in proportion to the power increase.

Postulated DBA events have been evaluated and analyzed to show that the NRC regulations are met for 2% above the CLTP. DBA events have either been previously analyzed at 102% of CLTP or are not dependent on core thermal power. The main steam line break (MSLB) outside containment (as well as the Instrument Line Break) was evaluated using a 4 μCi/g dose equivalent I-131 limit on reactor coolant activity. The limit on reactor coolant activity is unchanged for the TPO uprate condition. The evaluation/analysis was based on the methodology, assumptions, and analytical techniques described in the RGs, the Standard Review Plan (SRP) (where applicable), and in previous SERs.

For the DBA LOCA, the slight increase in the post-accident radiation levels has no significant effect on the plant or the habitability of the on-site Emergency Response facilities. A review of areas requiring post-accident occupancy concluded that access needed for accident mitigation is not significantly affected by the TPO uprate.

9.3 SPECIAL EVENTS

9.3.1 Anticipated Transient Without Scram

TLTR Section 5.3.5 and TLTR Appendix L present a generic evaluation of the sensitivity of an ATWS to a change in power typical of the TPO uprate. The evaluation is based on previous analyses for power uprate projects. For a TPO uprate, if a plant has sufficient margin for the projected changes in peak parameters given in TLTR Section L.3.5, [[

]] The previous ATWS analysis did not demonstrate the required margins for generic evaluation to the peak vessel bottom head pressure limit and to the pool temperature limit. [[

]]

NEDC-33004P-A, Revision 4, "Constant Pressure Power Uprate," July 2003 (also referred to as the "CLTR") was approved by the NRC as an acceptable method for evaluating the effects of CPPUs. Section 9.3.1 of the CLTR addresses the effect of CPPU on ATWS. The CLTR methodology was used to analyze and evaluate the Fermi 2 ATWS event.

[[ ]] ATWS analysis is required for TPO RTP to ensure that the following ATWS acceptance criteria are met:

- Maintain reactor vessel integrity (i.e., peak vessel bottom head pressure less than the ASME Service Level C limit of 1500 psig).
- Maintain containment integrity (i.e., maximum containment pressure and temperature less than the limiting pressure (56 psig) and temperature (198°F) of the containment structure).
- Maintain coolable core geometry.

The TPO RTP ATWS analysis is performed using the NRC-approved code ODYN (Table 1-1). The key inputs to the ATWS analysis are provided in Table 9-1. The results of the analysis are provided in Table 9-2.

The results of the ATWS analysis meet the above ATWS acceptance criteria. Therefore, the Fermi 2 response to an ATWS event at TPO is acceptable. The potential for thermal-hydraulic instability in conjunction with ATWS events is evaluated in Section 9.3.1.4.

Fermi 2 also meets the ATWS mitigation requirements defined in 10 CFR 50.62:

- Installation of an alternate rod insertion (ARI) system;
- Boron injection equivalent to 86 gpm; and
- Installation of automatic RPT logic (i.e., ATWS-RPT).

There are no changes to the assumed operator actions for the TPO RTP ATWS analysis.

When required by changes in plant configuration (as identified by the design change process), changes to Emergency Operating Procedures (EOPs), including changes to EOP calculations and plant data, are developed and implemented in accordance with plant administrative procedures for EOP program maintenance.

Fermi 2 performs EOP calculations in accordance with the BWR Owners Group Emergency Procedure Guidelines (EPGs) / Severe Accident Guidelines (SAGs). The EOP calculation input and output data is reviewed and verified by Engineering. Changes to the EOP calculation outputs are forwarded to Operations for use in revising the EOP procedures/flow charts and supporting documents. Finally, the EOP flow charts are verified and validated by operations, including trial use in the simulator.

The ATWS mitigation strategy is based on the BWROG EPGs, which are incorporated in the existing Fermi 2 EOPs. TPO implementation does not significantly change the transient sequence of events. Therefore, there is no change in operator strategy on ATWS level reduction or early boron injection. TPO may affect some of the calculated curves, but does not affect stability mitigation actions.

Fermi 2 meets all CLTR dispositions and the results in this evaluation are described below. The topics addressed in this evaluation are:

Topic	CLTR Disposition	Fermi 2 Result
ATWS (Overpressure) - Event Selection	[[	Meets CLTR Disposition
ATWS (Overpressure) - Limiting Events		Meets CLTR Disposition
ATWS (SP Temperature) - Event Selection		Meets CLTR Disposition
ATWS (SP Temperature) - Limiting Events		Meets CLTR Disposition
ATWS (PCT)	]]	Meets CLTR Disposition

9.3.1.1 ATWS (Overpressure)

As stated in Section 9.3.1 of the CLTR, the higher operating steam flow may result in higher peak vessel pressures. The higher power and decay heat will result in higher SP temperatures.

The increased core power and reactor steam flow rates, in conjunction with the SRV capacity and response times, affect the capability of the SLCS to mitigate the consequences of an ATWS event. The SLCS ATWS performance capability is evaluated in Section 6.5. The evaluation shows that the TPO has no adverse effect on the ability of the SLCS to mitigate an ATWS.

The overpressure evaluation includes consideration of the most limiting RPV overpressure case. TLTR Appendix L considers four ATWS events: [[

]] The ATWS (Overpressure) – Event Selection meets all CLTR dispositions.

As shown in Section 3.7 of ELTR2, [[

]] The MSIVC and PRFO cases were performed for Fermi 2. The analysis results are given in Table 9-2. The MSIVC and PRFO sequence of events are given in Tables 9-3 and 9-4. Therefore, ATWS (Overpressure) – Limiting Events meets all CLTR dispositions.

9.3.1.2 ATWS (Suppression Pool Temperature)

As stated in Section 9.3.1 of the CLTR, the higher operating steam flow will result in higher peak vessel pressures. The higher power and decay heat may result in higher SP temperatures. The increased core power and reactor steam flow rates, in conjunction with the SRV capacity and response times, could affect the capability of the SLCS to mitigate the consequences of an ATWS event.

The SP temperature evaluation includes consideration of the most limiting RHR pool cooling capability case. TLTR Appendix L considered four ATWS events: [[

]] The ATWS (SP Temperature) – Event Selection meets all CLTR dispositions.

The MSIVC and PRFO cases were performed for Fermi 2. The key inputs to the ATWS analysis are provided in Table 9-1. The ATWS analysis results are given in Table 9-2. The MSIVC and PRFO sequence of events are given in Tables 9-3 and 9-4. The ATWS (SP Temperature) – Limiting Events meets all CLTR dispositions.

9.3.1.3 ATWS (Peak Cladding Temperature)

TLTR Appendix L.3 states that power uprate has a negligible effect on the PCT. Cladding temperature and oxidation are closely related. With no significant effect on cladding temperature there will also be no significant effect on oxidation. [[

]]

For ATWS events, the acceptance criteria for PCT and local cladding oxidation for ECCS, defined in 10 CFR 50.46, are adopted to ensure an ATWS event does not impede core cooling.

For TPO, PCT and local cladding oxidation are not required to be explicitly analyzed per Appendix L.3 of the TLTR. Therefore, ATWS (PCT) is in compliance with the acceptance criteria of 10 CFR 50.46; subsequently, coolable core geometry is assured by meeting the 2200°F PCT and the 17% local cladding oxidation acceptance criteria stated in 10 CFR 50.46.

9.3.1.4 ATWS with Core Instability

Section 9.3.3 of the CLTR states that the ATWS with core instability event occurs at natural circulation following an RPT. Therefore, it is initiated at approximately the same power level as a result of TPO operation because the MELLLA upper boundary is not increased. The core design necessary to achieve TPO operations may affect the susceptibility to coupled thermal-hydraulic/neutronic core oscillations at the natural circulation condition, but would not significantly affect the event progression.

Several factors affect the response of an ATWS instability event, including operating power, flow conditions, and core design. The limiting ATWS core instability evaluation presented in References 25 and 26 was performed for an assumed plant initially operating at OLTP and the MELLLA minimum flow point. [[

]]

TPO allows plants to increase their operating thermal power but does not allow an increase in control rod line. [[

]]

[[

]]

Initial operating conditions of FWHOOS and FFWTR do not significantly affect the ATWS instability response reported in References 25 and 26. The limiting ATWS evaluation assumes that all FW heating is lost during the event and the injected FW temperature approaches the lowest achievable main condenser hot well temperature. [[

]]

[[

]] Therefore, the TPO effect on ATWS with core instability at Fermi 2 meets all CLTR dispositions.

9.3.1.5 SLCS System Performance and Hardware

Based on the results of the [[ ]] ATWS analysis, the maximum reactor lower plenum pressure following the limiting ATWS event reaches 1185 psig (1200 psia) during the time the SLCS is analyzed to be in operation. The discharge pressure of the SLCS pump at this RPV pressure was compared to the SLCS relief valve setpoint of 1370 psig with additional consideration given to system head losses and elevation changes. The resulting relief valve setpoint margin for ATWS is 110 psi for Fermi 2. The pump discharge relief valves are periodically tested to maintain this tolerance. Therefore, the current SLCS process parameters associated with the minimum boron injection rate are not changed.

The SLCS ATWS performance is evaluated for a representative core design for TPO. The evaluation shows that TPO has no adverse effect on the ability of the SLCS to mitigate an ATWS. Therefore, the system performance and hardware meets all TLTR dispositions.

9.3.1.6 Suppression Pool Temperature Following an ATWS Event

As stated in Section 6.5 of the CLTR, changes in the fuel design for TPO may require modifications to the SLCS as a result of the increase in the SP temperature for the limiting ATWS event.

The boron injection rate requirement for maintaining the peak SP water temperature limits, following the limiting ATWS event with SLCS injection, is not increased for TPO. Therefore, the SP temperature following an ATWS event meets all CLTR dispositions.

9.3.1.7 Equipment Out-of-Service and Flexibility Options

MELLLA, ICF and SLO: The TPO ATWS analyses were performed along the MELLLA boundary. The TPO ATWS analysis at MELLLA conditions bounds operation at ICF and in SLO. Therefore, TPO continues to support these performance improvement features.

SRV OOS: The TPO ATWS analysis was performed with four SRVs OOS. Therefore, TPO continues to support this EOOS option.

FWHOOS and FFWTR: FWHOOS and FFWTR are operational flexibility options that allow continued operation with reduced FW temperature. Initial power is unchanged for both the FWHOOS and FFWTR conditions. The additional reactivity associated with the reduced FW temperature is typically offset with control rods, as needed. This makes the core less reactive due to the lower void fraction. Thus, the use of normal FW temperature is conservative for ATWS analyses.

ARTS, TBV OOS, MSR OOS, and ADS OOS: The TPO ATWS analysis is not affected by these performance improvement features.

9.3.2 Station Blackout

TLTR Appendix L provides a generic evaluation of a potential loss of all AC power supplies based on previous plant response and coping capability analyses for typical power uprate projects. The previous power uprate evaluations have been performed according to the applicable bases for the plant (e.g., the bases, methods, and assumptions of RG 1.155 and/or Nuclear Utilities Management and Resources Council (NUMARC) 87-00). This evaluation is for confirmation of continued compliance to 10 CFR 50.63. It is recognized that this evaluation is dependent upon many plant-specific design and equipment parameters.

Specifically, the following main considerations were evaluated:

- The adequacy of the condensate/reactor coolant inventory.
- The capacity of the Class 1E batteries.
- The station blackout (SBO) compressed Nitrogen requirements.
- The ability to maintain containment integrity.
- The effect of loss of ventilation on rooms that contain equipment essential for plant response to a SBO event.

Applicable operator actions have previously been assumed consistent with the plant EPGs. These are the currently accepted procedures for each plant and SBO analysis. For the TPO uprate, there is no significant change in the time available for the operator to perform these assumed actions.

[[ ]] Fermi 2 currently has margins of 37,438 gallons to the available condensate storage inventory volume and 29°F to the containment peak temperature limit. [[ ]] Therefore, no Fermi 2-specific SBO analysis is performed for the TPO uprate.

Table 9-1 Key Inputs for ATWS Analysis

Input Variable	TPO RTP
Reactor power (MWt)	[[
Reactor dome pressure (psia)	
Each SRV capacity at 1090 psig (Mlbm/hr)	
High pressure ATWS-RPT (psig)	
Number of SRVs OOS	
Number of Manual Start SLCS Pumps	]]

Table 9-2 Results for ATWS Analysis

Parameter Acceptance Criteria	TPO RTP(1)
Peak Vessel Bottom Pressure (psig)	1489
Peak SP Temperature (°F)	184.4
Peak Containment Pressure (psig)	10.5
PCT (°F)	Generic Assessment
Local Cladding Oxidation (%)	Generic Assessment

Note:

(1) Cladding temperature and oxidation calculations are not required per Appendix L.3 of TLTR.

Table 9-3 MSIVC Sequence of Events

Item	Event	TPO RTP BOC(1) Event Time (sec)	TPO RTP EOC Event Time (sec)
1	MSIV Isolation Initiated	[[	
2	MSIVs Fully Closed		
3	Peak Neutron Flux		
4	High Pressure ATWS Setpoint		
5	Opening of the First Relief Valve		
6	Recirculation Pumps Trip		
7	Peak Heat Flux		
8	Peak Vessel Pressure		
9	FW Reduction Initiated		
10	Boron Injection Initiation Temperature (BIIT) Reached		
11	SLCS Pumps Start		
12	RHR Cooling Initiated		
13	Hot Shutdown Achieved (Neutron Flux Remains < 0.1%)		
14	Peak SP Temperature		]]

Note:

BOC = Beginning-of-Cycle

Table 9-4 PRFO Sequence of Events

Item	Event	TPO RTP BOC Event Time (sec)	TPO RTP EOC Event Time (sec)
1	TCV and Bypass Valves Start Open	[[	
2	MSIV Closure Low Steamline Pressure Reached		
3	MSIV Closure Initiated		
4	MSIVs Fully Closed		
5	Peak Neutron Flux		
6	High Pressure ATWS Setpoint		
7	Opening of the First Relief Valve		
8	Recirculation Pumps Trip		
9	Peak Heat Flux		
10	Peak Vessel Pressure		
11	FW Reduction Initiated		
12	BIIT Reached		
13	SLCS Pump Starts		
14	RHR Cooling Initiated		
15	Hot Shutdown Achieved (Neutron Flux Remains <0.1%)		
16	Peak SP Temperature		]]

10.0 OTHER EVALUATIONS

10.1 HIGH ENERGY LINE BREAK

Because the TPO uprate system operating temperatures and pressures change only slightly, there is no significant change in HELB mass and energy releases. The FW lines, near the pump discharge, increase < 2°F and < 2 psi. The recirculation line temperature decreases approximately by 0.1°F with a 0.1 BTU/lbm enthalpy decrease. These changes are insignificant in relation to the effect on the line break calculations. Vessel dome pressure and the other portion of the RCPB remain at current operating pressure or lower. Therefore, the consequences of any postulated HELB would not significantly change. The postulated break locations remain the same because the piping configuration does not change due to the TPO uprate.

The HELB evaluation was performed for all systems evaluated in the UFSAR. At the TPO RTP level, HELBs outside the DW would result in an insignificant change in the sub-compartment pressure and temperature profiles. The affected building and cubicles that support safety-related functions are designed to withstand the resulting pressure and thermal loading following an HELB at the TPO RTP. A brief discussion of each break is noted below.

10.1.1 Steam Line Breaks

The critical pressure affecting the high-energy steam line break analysis is the reactor vessel dome pressure. Because there is no pressure increase for the TPO, the MSL pressure decreases and there is a slight decrease in the MSLB blowdown rate. The MSLB is used to establish the peak pressure and the temperature environment in the MS tunnel. Design margins within the HELB analysis for a MSLB provide adequate margin to the limits in the steam tunnel.

10.1.2 Liquid Line Breaks

10.1.2.1 Feedwater Line Break

The TPO uprate increases the FW temperature by 2°F and pressure by < 2 psi which results in an insignificant increase in the FW mass and energy release. As a result of the small increase in FW temperature and pressure, the blowdown rate changes marginally and energy increases slightly. The original (CLTP) analysis was performed with conservative system pressures. These conservatisms more than offset the effects of the temperature change. Therefore, the original HELB analysis is bounding.

10.1.2.2 ECCS Line Breaks

Because there is no increase in the reactor dome pressure relative to the original analysis, the mass flow rate does not increase. Therefore, the previous HELB analysis is bounding for the TPO uprate condition.

Because these lines are normally isolated, the TPO uprate does not affect the line break analyses for breaks outside DW.

10.1.2.3 RCIC System Line Breaks

Because there is no increase in the reactor dome pressure relative to the original analysis, the mass flow rate does not increase. Therefore, the previous HELB analysis is bounding for the TPO uprate conditions.

10.1.2.4 RWCU System Line Break

As a result of the small decrease in recirculation temperature with negligible increase in pressure, the blowdown rate increases slightly and energy decreases slightly. The original (CLTP) analysis was performed with a conservative system pressure. These conservatisms more than offset the effects of the temperature change, so the original HELB analysis is bounding.

10.1.2.5 CRD System Line Break

The CRD pipe break analysis is not affected by the TPO uprate.

10.1.2.6 Building Heating Line Break

Reactor Building heating lines are not connected to the reactor-turbine primary loop. Therefore building heating lines are not affected.

10.1.2.7 Pipe Whip and Jet Impingement

Because there is no change in the nominal vessel dome pressure, pipe whip and jet impingement loads do not significantly change. Existing calculations supporting the dispositions of potential targets of pipe whip and jet impingement from postulated HELBs have been reviewed and determined to be adequate for the safe shutdown effects in the TPO RTP conditions. Existing pipe whip restraints, jet impingement shields, and their supporting structures are also adequate for the TPO uprate conditions.

10.1.2.8 Internal Flooding from HELB

None of the plant flooding zones contains a potential HELB location affected by the reactor operating conditions changed for the TPO uprate. The high energy line systems' operational modes evaluated for HELB are not affected by the TPO uprate, nor are the plant internal flooding analysis or safe shutdown analysis.

10.2 Moderate Energy Line Break

None of the plant flooding zones contains moderate energy line break (MELB) locations affected by the reactor operating conditions changed for the TPO uprate. The following systems contain potential MELB locations in plant flooding zones: service water, EECW, RHR, Reactor Building heating steam, fire protection, RWCU, CRD, RCIC, CS, FPCC, HPCI, chilled water, RBCCW, and torus water management system.

No new moderate energy lines are identified. No new equipment is affected by spraying. Protection requirements for safe-shutdown equipment for a postulated MELB are not dependent on power level. All sources and protection measures against flooding are independent of power level. Internal flooding will not alter the ability of the plant to reach safe shutdown under TPO. Therefore, the plant internal flooding analysis is not affected.

10.3 ENVIRONMENTAL QUALIFICATION

Safety-related components must be qualified for the environment in which they operate. The TPO increase in power level increases the radiation levels experienced by equipment during normal operation and accident conditions. Because the TPO uprate does not increase the nominal vessel dome pressure, there is a very small effect on pressure and temperature conditions experienced by equipment during normal operation and accident conditions. The resulting environmental conditions are bounded by the existing environmental parameters specified for use in the EQ program.

10.3.1 Electrical Equipment

The environmental conditions for safety-related electrical equipment were reviewed to ensure that the existing qualification for the normal and accident conditions expected in the area where the devices are located remain adequate. Conservatisms in the equipment qualifications were originally applied to the environmental parameters, and no change is needed for the TPO uprate.

10.3.1.1 Inside Containment

EQ for safety-related electrical equipment located inside the containment is based on DBA-LOCA or HELB conditions and their resultant temperature, pressure, humidity and radiation consequences, and includes the environments expected to exist during normal plant operation. The current accident conditions for temperature and pressure are based on analyses initiated from ≥ 102% of CLTP. Normal temperatures may increase slightly near the FW and reactor recirculation lines and will be evaluated through the EQ temperature monitoring program, which tracks such information for equipment aging considerations. The current radiation levels under normal plant conditions also increase slightly. The current plant environmental envelope for radiation is not exceeded by the changes resulting from the TPO uprate.

10.3.1.2 Outside Containment

Accident temperature, pressure, and humidity environments used for qualification of equipment outside containment result from an MSLB in the pipe tunnel, or other HELBs, whichever is limiting for each area. The HELB pressure and temperature profiles bound the TPO uprate conditions. There is adequate margin in the qualification envelopes to accommodate the small changes due to TPO conditions. Maximum accident radiation levels used for qualification of equipment outside containment are from a DBA-LOCA.

10.3.2 Mechanical Equipment With Non-Metallic Components

Operation at the TPO RTP level increases the normal process temperature very slightly in the FW and reactor recirculation piping. The slight increase in normal and accident radiation was evaluated in Section 10.3. Evaluation of the safety-related mechanical equipment with non-metallic components for temperature and radiation is not part of the Fermi 2 EQ program licensing basis.

10.4 TESTING

The TPO uprate power ascension is based on the guidelines in TLTR Section L.2. Pre-operational tests are not needed because there are no significant changes to any plant systems or components that require such testing.

In preparation for operation at TPO uprate conditions, routine measurements of reactor and system pressures, flows, and selected major rotating equipment vibration are taken near 95% and 100% of CLTP, and at 100% of TPO RTP. The measurements will be taken along the same rod pattern line used for the increase to TPO RTP. Core power from the APRMs is re-scaled to the TPO RTP before exceeding the CLTP and any necessary adjustments will be made to the APRM alarm and trip settings.

The turbine pressure controller setpoint will be readjusted at ≤ 95% of CLTP and held constant. The setpoint is reduced so the reactor dome pressure is the same at TPO RTP as for the CLTP. Adjustment of the pressure setpoint before taking the baseline power ascension data establishes a consistent basis for measuring the performance of the reactor and the TCVs.

Demonstration of acceptable fuel thermal margin will be performed prior to and during power ascension to the TPO RTP at each steady-state heat balance point defined above. Fuel thermal margin will be projected to the TPO RTP point after the measurements taken at 95% and 100% of CLTP to show the estimated margin. The thermal margin will be confirmed by the measurements taken at full TPO RTP conditions. The demonstration of core and fuel conditions will be performed with the methods currently used at Fermi 2.

Performance of the pressure and FW/level control systems will be recorded at each steady-state point defined above. The checks will utilize the methods and criteria described in the original startup testing of these systems to demonstrate acceptable operational capability. Water level changes of ±3 inches and pressure setpoint step changes of ±3 psi will be used. If necessary, adjustments will be made to the controllers and actuator elements.

Because level and pressure changes can produce power excursions above the initial condition for these tests, the final tests will be performed at a power level with a margin to TPO RTP equal to the largest anticipated excursion. The magnitude of the anticipated excursions is based on those experienced in the same tests performed at 95% and 100% of CLTP projected to TPO RTP (and other available operating experience). The intention of this margin is to avoid exceeding the licensed power limit (NRC RIS 2007-21), while creating the largest practical power difference from CLTP to obtain responses that are representative of TPO power.

The increase in power for the TPO uprate is sufficiently small that large transient tests are not necessary. High power testing performed during initial startup demonstrated the adequacy of the safety and protection systems for such large transients. Operational occurrences have shown the unit response is clearly bounded by the safety analyses for these events. [[

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10.5 OPERATOR TRAINING AND HUMAN FACTORS

No additional training (apart from normal training for plant changes) is required to operate the plant in the TPO uprate condition. For TPO uprate conditions, operator response to transient, accident, and special events is not affected. Operator actions for maintaining safe shutdown, core cooling, and containment cooling, do not change for the TPO uprate. Minor changes to the P/F map, flow-referenced setpoint, and other associated changes, will be communicated through normal operator training. Simulator changes and validation for the TPO uprate will be performed in accordance with established Fermi 2 plant certification testing procedures.

10.6 PLANT LIFE

Two degradation mechanisms may be influenced by the TPO uprate: (1) irradiation assisted stress corrosion cracking (IASCC) and (2) FAC. The increase in irradiation of the core internal components influences IASCC. The increases in steam and FW flow rate influence FAC. However, the sensitivity to the TPO uprate is small and various programs are currently implemented to monitor the aging of plant components, including EQ, FAC, and in-service inspection. EQ is addressed in Section 10.3, and FAC is addressed in Section 3.5. These programs address the degradation mechanisms and do not change for the TPO uprate. The core internals see a slight increase in fluence, but the inspection strategy used at Fermi 2, based on the BWRVIP, is sufficient to address the increase. The Maintenance Rule also provides oversight for the other mechanical and electrical components, important to plant safety, to guard against age-related degradation.

The longevity of most equipment is not affected by the TPO uprate because there is no significant change in the operating conditions. No additional maintenance, inspection, testing, or surveillance procedures are required.

10.7 NRC and Industry Communications

NRC and industry communications are generically addressed in the TLTR, Section 10.8. Per the TLTR, it is not necessary to review prior dispositions of NRC and industry communications and no additional information is required in this area.

10.8 Plant Procedures and Programs

Plant procedures and programs are in place to:

1. Monitor and maintain instrument calibration during normal plant operation to assure that instrument uncertainty is not greater than the uncertainty used to justify the TPO uprate;
2. Control the software and hardware configuration of the associated instrumentation;
3. Perform corrective actions, where required, to maintain instrument uncertainty within limits;
4. Report deficiencies of the associated instruments to the manufacturer; and
5. Receive and resolve the manufacturer's deficiency reports.

10.9 Emergency Operating Procedures

The EOP action thresholds are plant unique and will be addressed using standard procedure updating processes. It is expected that the TPO uprate will have a negligible or no effect on the operator action thresholds and to the EOPs in general.

10.10 Individual Plant Examination

Fermi 2 maintains and regularly updates a station PRA model. Use of the model is integrated with station operations and decision-making.

The Fermi 2 PRA model and analysis will not be specifically updated for TPO, because the change in plant risk from the subject power uprate is insignificant. This conclusion is supported by NRC RIS 2002-03. In response to feedback received during the public workshop held on August 23, 2001, the NRC wrote, "The NRC has generically determined that measurement uncertainty recapture power uprates have an insignificant effect on plant risk. Therefore, no risk information is requested to support such applications."

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