April 16, 2020
NRC-20-0011

TS 5.6.5

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

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

Subject: Transmittal of the Core Operating Limits Report for Cycle 21

In accordance with Fermi 2 Technical Specification 5.6.5, DTE Electric Company (DTE) hereby submits a copy of the Core Operating Limits Report (COLR) for Cycle 21. This COLR will be used during the Fermi 2 twenty-first operating cycle.

No new commitments are being made in this submittal.

Should you have any questions, please contact me at (734) 586-5076.

Sincerely,

Margaret (Peg) M. Offerle
Manager – Nuclear Licensing

Enclosure: Core Operating Limits Report (COLR), Cycle 21

cc: NRC Project Manager
    NRC Resident Office
    Regional Administrator, Region III

Enclosure to
NRC-20-0011

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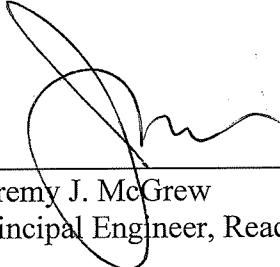**Operating License No. NPF-43**

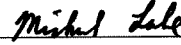**Core Operating Limits Report (COLR), Cycle 21**

FERMI 2

CORE OPERATING LIMITS REPORT

CYCLE 21

REVISION 0

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February 2020

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1.0 INTRODUCTION AND SUMMARY

This report provides the cycle specific plant operating limits, which are listed below, for Fermi 2, Cycle 21, as required by Technical Specification 5.6.5. The analytical methods used to determine these core operating limits are those previously reviewed and approved by the Nuclear Regulatory Commission in GESTAR II (Reference 7).

The cycle specific limits contained within this report are valid for the full range of the licensed operating domain.

OPERATING LIMIT	TECHNICAL SPECIFICATION
$SLMCPR_{95/95}$	2.1.1.2
APLHGR	3.2.1
MCPR	3.2.2
LHGR	3.2.3
RBM	3.3.2.1
BSP REGIONS	3.3.1.1

SLMCPR = SAFETY LIMIT MINIMUM CRITICAL POWER RATIO

APLHGR = AVERAGE PLANAR LINEAR HEAT GENERATION RATE

MCPR   = MINIMUM CRITICAL POWER RATIO

LHGR   = LINEAR HEAT GENERATION RATE

RBM   = ROD BLOCK MONITOR

BSP   = BACKUP STABILITY PROTECTION

2.0 SAFETY LIMIT MINIMUM CRITICAL POWER RATIO

2.1   Definition

TECH SPEC IDENT	OPERATING LIMIT
2.1.1.2	$SLMCPR_{95/95}$

The Technical Specification SAFETY LIMIT MINIMUM CRITICAL POWER RATIO ($SLMCPR_{95/95}$) shall be the smallest critical power ratio that exists in the core for each fuel product. The Technical Specification Safety Limit value is dependent on the fuel product line and the corresponding MCPR correlation, which is cycle independent. The value is based on the Critical Power Ratio data statistics and a 95% probability with 95% confidence that rods are not susceptible to boiling transition. (Reference 20)

The Cycle Specific $SLMCPR_{99.9}$ presented here is that power in the bundle that is statistically calculated by application of the appropriate correlations and uncertainties to cause some point in the bundle to experience boiling transition, divided by the actual bundle operating power.

2.2   Determination of Cycle Specific SLMCPR

The Cycle Specific SLMCPR, which is also known as $SLMCPR_{99.9,}$ is cycle dependent and ensures 99.9% of the fuel rods in the core are not susceptible to boiling transition. (Reference 20) The Operating Limit MCPR is set by adding the $SLMCPR_{99.9}$ and the change in MCPR for the most limiting anticipated operational occurrence such that fuel cladding will not sustain damage because of normal operation and anticipated operational occurrences.

The $SLMCPR_{99.9}$ is set such that no significant fuel damage is calculated to occur if the limit is not violated. Since the parameters that result in fuel damage are not directly observable during reactor operation, the thermal and hydraulic conditions that result in the onset of transition boiling are used to mark the beginning of the region in which fuel damage could occur. Although the onset of transition boiling would not result in damage to BWR fuel rods, the critical power at which boiling transition is calculated to occur has been adopted as a convenient limit.

For this cycle, the Two Loop and Single Loop $SLMCPR_{99.9}$ values (Reference 2) are:

Two Loop SLMCPR = 1.08

Single Loop SLMCPR = 1.11

3.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE

3.1   Definition

TECH SPEC IDENT	OPERATING LIMIT
3.2.1	APLHGR

The AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR) shall be applicable to a specific planar height and is equal to the sum of the LINEAR HEAT GENERATION RATEs (LHGRs) for all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the bundle at the height.

3.2   Determination of MAPLHGR Limit

The maximum APLHGR (MAPLHGR) limit is a function of reactor power, core flow, fuel type, and average planar exposure. The limit is developed, using NRC approved methodology described in References 7 and 8, to ensure gross cladding failure will not occur following a loss of coolant accident (LOCA). The MAPLHGR limit ensures that the peak clad temperature during a LOCA will not exceed the limits as specified in 10CFR50.46(b)(1) and that the fuel design analysis criteria defined in References 7 and 8 will be met.

The MAPLHGR limit during dual loop operation is calculated by the following equation:

$$MAPLHGR_{LIMIT} = \text{MIN} \ (MAPLHGR \ (P), MAPLHGR \ (F))$$

where:

$$MAPLHGR \ (P) = MAPFAC \ (P) \ \text{x} \ MAPLHGR_{STD}$$

$$MAPLHGR \ (F) = MAPFAC \ (F) \ \text{x} \ MAPLHGR_{STD}$$

Within four hours after entering single loop operation, the MAPLHGR limit is calculated by the following equation:

$$MAPLHGR_{LIMIT} = \text{MIN} \ (MAPLHGR \ (P), MAPLHGR \ (F))$$

where:

$$MAPLHGR \ (P) = MAPFAC \ (P) \ \text{x} \ MAPLHGR_{STD}$$

$$MAPLHGR \ (F) = MAPFAC \ (F) \ \text{x} \ MAPLHGR_{STD}$$

$$MAPFAC \ (P) \ and \ MAPFAC \ (F) \ are \ limited \ to \ 0.90$$

The Single Loop Operation multiplier on MAPLHGR is 0.90. (Reference 2)

MAPLHGR$_{STD}$, the standard MAPLHGR limit, is defined at a power of 3486 MWth and flow of 105 Mlbs/hr for each fuel type as a function of average planar exposure and is presented in Table 1. (Reference 2)   When hand calculations are required, MAPLHGR$_{STD}$ shall be determined by interpolation from Table 1. MAPFAC(P), the core power-dependent MAPLHGR limit adjustment factor, shall be calculated by using Section 3.2.1.   MAPFAC(F), the core flow-dependent MAPLHGR limit adjustment factor, shall be calculated by using Section 3.2.2.

TABLE 1
FUEL TYPE-DEPENDENT
STANDARD MAPLHGR LIMITS

GE14 Exposure GWD/ST	GE14 MAPLHGR kW/ft
0.0	12.82
14.51	12.82
19.13	12.82
57.61	8.00
63.50	5.00

Fuel Types
2 = GE14-P10CNAB381-4G6.0/11G5.0-100T-150-T6-4372
3 = GE14-P10CNAB381-4G6.0/9G5.0-100T-150-T6-4371
4 = GE14-P10CNAB381-15G5.0-100T-150-T6-4373
5 = GE14-P10CNAB381-6G6.0/9G5.0-100T-150-T6-4374
6 = GE14-P10CNAB385-13GZ-100T-150-T6-4571
7 = GE14-P10CNAB384-15GZ-100T-150-T6-4572
8 = GE14-P10CNAB383-13GZ-100T-150-T6-4573
9 = GE14-P10CNAB377-15GZ-100T-150-T6-4574
19 = GE14-P10CNAB381-4G6.0/12G5.0-100T-150-T6-4261
20 = GE14-P10CNAB379-15GZ-100T-150-T6-4262
21 = GE14-P10CNAB383-8G6.0/5G5.0-100T-150-T6-4478
22 = GE14-P10CNAB383-8G6.0/7G5.0-100T-150-T6-4479
23 = GE14-P10CNAB383-2G6.0/11G5.0-100T-150-T6-4480
24 = GE14-P10CNAB383-10G6.0/5G5.0-100T-150-T6-4481

TABLE 1 (CONT.)
FUEL TYPE-DEPENDENT
STANDARD MAPLHGR LIMITS

GNF3 Exposure GWD/ST	GNF3 MAPLHGR kW/ft
0.0	14.36
9.07	13.78
21.22	13.01
40.82	10.75
57.60	8.00
63.50	6.00

Fuel Types
25 = GNF3-P10CG3B388-14GZ-83AV-150-T6-4661
26 = GNF3-P10CG3B399-14GZ-83AV-150-T6-4662
27 = GNF3-P10CG3B402-16GZ-83AV-150-T6-4663
28 = GNF3-P10CG3B419-16GZ-83AV-150-T6-4664

3.2.1   Calculation of MAPFAC(P)

The core power-dependent MAPLHGR limit adjustment factor, MAPFAC(P) (Reference 2, 3 & 15), shall be calculated by one of the following equations. Note that

For $0 \le P < 25$:

> No thermal limits monitoring is required.

For $25 \le P \le 29.5$:

> #### With All Equipment OPERABLE, or MSR INOPERABLE
>
> **For core flow < 50 Mlbs/hr,**
> $$MAPFAC\ (P) = 0.568 + 0.00156\ (P – 29.5)$$
>
> **For core flow ≥ 50 Mlbs/hr**,
> $$MAPFAC\ (P) = 0.568 + 0.00156\ (P – 29.5)$$
>
> #### With Turbine Bypass INOPERABLE, or Turbine Bypass and MSR INOPERABLE
>
> **For core flow < 50 Mlbs/hr,**
> $$MAPFAC\ (P) = 0.488 + 0.01067\ (P – 29.5)$$
>
> **For core flow ≥ 50 Mlbs/hr**,
> $$MAPFAC\ (P) = 0.436 + 0.00511\ (P – 29.5)$$

For $29.5 < P \le 45$:
$$MAPFAC\ (P) = 0.713 + 0.00529\ (P - 45)$$

For $45 < P \le 60$:
$$MAPFAC\ (P) = 0.791 + 0.00520\ (P - 60)$$

For $60 < P \le 85$:
$$MAPFAC\ (P) = 0.922 + 0.00524\ (P - 85)$$

For $85 < P \le 100$:
$$MAPFAC\ (P) = 1.000 + 0.00520\ (P - 100)$$

where: P = Core power (fraction of rated power times 100).

MAPFAC(P) for Pressure Regulator Out of Service (PROOS) Limits

With one Turbine Pressure Regulator Out of Service and Reactor Power Greater Than or Equal to 25% and both Turbine Bypass and Moisture Separator Reheater (MSR) Operable:

For 25 ≤ P ≤ 29.5 :

  For core flow < 50 Mlbs/hr,
$$MAPFAC\ (P) = 0.568 + 0.00156\ (P - 29.5)$$

  For core flow ≥ 50 Mlbs/hr,
$$MAPFAC\ (P) = 0.568 + 0.00156\ (P - 29.5)$$

For 29.5 < P ≤ 45 :
$$MAPFAC\ (P) = 0.680 + 0.00626\ (P - 45)$$

For 45 < P ≤ 60 :
$$MAPFAC\ (P) = 0.758 + 0.00520\ (P - 60)$$

For 60 < P ≤ 85 :
$$MAPFAC\ (P) = 0.831 + 0.00292\ (P - 85)$$

For 85 < P ≤ 100 :
$$MAPFAC\ (P) = 1.000 + 0.00520\ (P - 100)$$

where: P = Core power (fraction of rated power times 100).

3.2.2   Calculation of MAPFAC(F)

The core flow-dependent MAPLHGR limit adjustment factor, MAPFAC(F) (Reference 2, 3, & 15), shall be calculated by the following equation:

$$MAPFAC(F) = MIN\left(C, A_F \times \frac{WT}{100} + B_F\right)$$

where:

WT = Core flow (Mlbs/hr).
A_F = Given in Table 2.
B_F = Given in Table 2.
C = 1.0 in Dual Loop and 0.90 in Single Loop.

TABLE 2   FLOW-DEPENDENT MAPLHGR LIMIT COEFFICIENTS

Maximum Core Flow[*] (Mlbs/hr)	A_F	B_F
110	0.8889	0.2613

[*]As limited by the Recirculation System MG Set mechanical scoop tube stop setting.

4.0 MINIMUM CRITICAL POWER RATIO

TECH SPEC IDENT	OPERATING LIMIT
3.2.2	MCPR

4.1   Definition

The MINIMUM CRITICAL POWER RATIO (MCPR) shall be the smallest Critical Power Ratio (CPR) that exists in the core for each type of fuel. The CPR is that power in the bundle that is calculated by application of the appropriate correlation(s) to cause some point in the bundle to experience boiling transition, divided by the actual bundle operating power.

4.2   Determination of Operating Limit MCPR

The required Operating Limit MCPR (OLMCPR) (Reference 2) at steady-state rated power and flow operating conditions is derived from the established fuel cladding integrity Safety Limit MCPR and an analysis of abnormal operational transients. To ensure that the Safety Limit MCPR is not exceeded during any anticipated abnormal operational transient, the most limiting transients have been analyzed to determine which event will cause the largest reduction in CPR. Three different core average exposure conditions are evaluated. The result is an Operating Limit MCPR which is a function of exposure and τ. τ is a measure of scram speed and is defined in Section 4.3.2.

The limiting OLMCPR shall be represented by the following equation:

$$OLMCPR \ = \ MAX(MCPR(P), \ MCPR(F))$$

The process to calculate MCPR(P), the core power-dependent MCPR operating limit, is illustrated in Section 4.3.

The process to calculate MCPR(F), the core flow-dependent MCPR operating limit, is illustrated in Section 4.4.

In case of **Single Loop Operation**, the Safety Limit MCPR is increased to account for increased uncertainties in core flow measurement and TIP measurement. For Single Loop Operation, the OLMCPR is increased by 0.03 (Reference 2) from the Two Loop OLMCPR.

In case of operation with one Turbine Pressure Regulator out of service, OLMCPR limits are bounding when reactor power is less than 29.5% or greater than 85%. When reactor power is greater than or equal to 29.5% and less than or equal to 85%, then operation with one Turbine Pressure Regulator out of service is permitted if both Turbine Bypass Valves and the Moisture Separator Reheater are operable. (Reference 2 and 3)

TABLE 3   OLMCPR $_{100/105}$ AS A FUNCTION OF EXPOSURE AND τ

CONDITION	EXPOSURE (MWD/ST)		OLMCPR$_{100/105}$	
BOTH Turbine Bypass Valves **AND** Moisture Separator Reheater **OPERABLE**			Two Loop	Single Loop
	BOC to EOR-6420	$\tau = 0$	1.32	1.35
		$\tau = 1$	1.35	1.38
	EOR-6420 to EOR-3420	$\tau = 0$	1.32	1.35
		$\tau = 1$	1.41	1.44
	EOR-3420 to EOC	$\tau = 0$	1.32	1.35
		$\tau = 1$	1.42	1.45
ONE Turbine Pressure Regulator Out of Service **AND** Reactor Power between 29.5% and 85% **AND** BOTH Turbine Bypass Valves and Moisture Separator Reheater Operable				
	BOC to EOC	$\tau = 0$	1.32	1.35
		$\tau = 1$	1.42	1.45
Moisture Separator Reheater **INOPERABLE**	BOC to EOC	$\tau = 0$	1.34	1.37
		$\tau = 1$	1.45	1.48
Turbine Bypass Valve **INOPERABLE**	BOC to EOC	$\tau = 0$	1.34	1.37
		$\tau = 1$	1.46	1.49
BOTH Turbine Bypass Valve **AND** Moisture Separator Reheater **INOPERABLE**	BOC to EOC	$\tau = 0$	1.38	1.41
		$\tau = 1$	1.50	1.53

BOC = Beginning of Cycle   EOC = End of Cycle   EOR = End of Rated Conditions.
EOR is defined as 100% power, 100% core flow, and all control rods fully withdrawn.
EOR-6420 means 6420 MWD/ST before End of Rated Conditions.

4.3   Calculation of MCPR(P)

MCPR(P), the core power-dependent MCPR operating limit, shall be calculated by the following equation:

$$MCPR(P) = K_P \times OLMCPR_{100/105}$$

K_P, the core power-dependent MCPR Operating Limit adjustment factor, shall be calculated by using Section 4.3.1. $OLMCPR_{100/105}$ shall be determined by interpolation on τ from Table 3, and τ shall be calculated by using Section 4.3.2.

4.3.1   Calculation of K_P

The core power-dependent MCPR operating limit adjustment factor, K_P (Reference 2, 3, & 15), shall be calculated by using one of the following equations:

Note: P = Core power (fraction of rated power times 100) for all calculation of K_P.

For $0 \leq P < 25$:

> No thermal limits monitoring is required.

For $25 \leq P < 29.5$:

> **When All Equipment is OPERABLE,**

$$K_P = \frac{\left(K_{BYP} + \left(0.0067 \times (29.5 - P)\right)\right)}{OLMCPR_{100/105}}$$

For core flow < 50 Mlbs/hr, where: K_{BYP} = 1.94 for two loop operation
= 1.97 for single loop operation

$$K_P = \frac{\left(K_{BYP} + \left(0.0156 \times (29.5 - P)\right)\right)}{OLMCPR_{100/105}}$$

For core flow ≥ 50 Mlbs/hr, where: K_{BYP} = 2.13 for two loop operation
= 2.16 for single loop operation

When Moisture Separator Reheater is INOPERABLE,

$$K_P = \frac{\left(K_{BYP} + \left(0.0067 \times (29.5 - P)\right)\right)}{OLMCPR_{100/105}}$$

For core flow < 50 Mlbs/hr, where: K_{BYP} = 1.95 for two loop operation
                                                              = 1.98 for single loop operation

$$K_P = \frac{\left(K_{BYP} + \left(0.0156 \times (29.5 - P)\right)\right)}{OLMCPR_{100/105}}$$

For core flow ≥ 50 Mlbs/hr, where: K_{BYP} = 2.13 for two loop operation
                                                              = 2.16 for single loop operation

When Turbine Bypass is INOPERABLE,

$$K_P = \frac{\left(K_{BYP} + \left(0.0244 \times (29.5 - P)\right)\right)}{OLMCPR_{100/105}}$$

For core flow < 50 Mlbs/hr, where: K_{BYP} = 2.35 for two loop operation
                                                              = 2.38 for single loop operation

For core flow ≥ 50 Mlbs/hr, where: K_{BYP} = 2.35 for two loop operation
                                                              = 2.38 for single loop operation

When Turbine Bypass and Moisture Separator Heater are INOPERABLE,

$$K_P = \frac{\left(K_{BYP} + \left(0.0244 \times (29.5 - P)\right)\right)}{OLMCPR_{100/105}}$$

For core flow < 50 Mlbs/hr, where: K_{BYP} = 2.35 for two loop operation
                                                              = 2.38 for single loop operation

$$K_P = \frac{\left(K_{BYP} + \left(0.0178 \times (29.5 - P)\right)\right)}{OLMCPR_{100/105}}$$

For core flow ≥ 50 Mlbs/hr, where: K_{BYP} = 2.42 for two loop operation
                                                              = 2.45 for single loop operation

For 29.5 $\leq$ P < 45 :

$$K_P = 1.150 + \big(0.0021 \times (45 - P)\big)$$

For 45 $\leq$ P < 60 :

$$K_P = 1.150$$

For 60 $\leq$ P < 85 :

$$K_P = 1.056 + \big(0.0038 \times (85 - P)\big)$$

For 85 $\leq$ P $\leq$ 100 :

$$K_P = 1.000 + \big(0.0037 \times (100 - P)\big)$$

K$_P$ for Pressure Regulator Out of Service Limits

With one Turbine Pressure Regulator Out of Service, Reactor Power greater than 29.5%, and both Turbine Bypass and Moisture Separator Reheater Operable:

For 29.5 $\leq$ P < 45 :

$$K_P = 1.303 + \big(0.0081 \times (45 - P)\big)$$

For 45 $\leq$ P < 60 :

$$K_P = 1.241 + \big(0.0041 \times (60 - P)\big)$$

For 60 $\leq$ P $\leq$ 85 :

$$K_P = 1.28 + \big(0.0033 \times (85 - P)\big)$$

For Reactor Power < 29.5% and Reactor Power > 85%, the Pressure Regulator Out of Service condition is not limiting (Reference 2).

4.3.2   Calculation of τ

The value of τ, which is a measure of the conformance of the actual control rod scram times to the assumed average control rod scram time in the reload licensing analysis (References 4 & 24), shall be calculated by using the following equation:

$$\tau = \frac{(\tau_{ave} - \tau_B)}{\tau_A - \tau_B}$$

where: $\tau_A = 1.096$ seconds

$$\tau_B = 0.830 + 0.019 \text{ x } 1.65 \sqrt{\frac{N_1}{\sum\limits_{i=1}^{n} N_i}} \quad \text{seconds}$$

$$\tau_{ave} = \frac{\sum\limits_{i=1}^{n} N_i \tau_i}{\sum\limits_{i=1}^{n} N_i}$$

n = number of surveillance tests performed to date in cycle,

N_i = number of active control rods measured in the ith surveillance test,

τ_i = average scram time to notch 36 of all rods measured in the ith surveillance test, and

N_1 = total number of active rods measured in the initial control rod scram time test for the cycle (Technical Specification Surveillance Requirement 3.1.4.4).

The value of τ shall be calculated and used to determine the applicable $OLMCPR_{100/105}$ value from Table 3 within 72 hours of the conclusion of each control rod scram time surveillance test required by Technical Specification Surveillance Requirements 3.1.4.1, 3.1.4.2, and 3.1.4.4.

4.4   Calculation of MCPR(F)

MCPR(F), the core flow-dependent MCPR operating limit (Reference 2 & 3), shall be calculated by using the following equation:

For Two Loop Operation $\quad$ $MCPR(F) = MAX(1.21, (A_F \times \frac{WT}{100} + B_F))$

For Single Loop Operation $\quad$ $MCPR(F) = MAX(1.24, (A_F \times \frac{WT}{100} + B_F))$

where:

$\quad$ WT $\;=\;$ Core flow (Mlbs/hr).
$\quad$ A_F $\;=\;$ Given in Table 4.
$\quad$ B_F $\;=\;$ Given in Table 4.

TABLE 4   FLOW-DEPENDENT MCPR LIMIT COEFFICIENTS

	Maximum Core Flow[*] (Mlbs/hr)	A_F	B_F
Two Loop Operation	110	-0.596	1.739
Single Loop Operation	110	-0.596	1.769

[*]As limited by the Recirculation System MG Set mechanical scoop tube stop setting.

5.0 LINEAR HEAT GENERATION RATE

TECH SPEC IDENT	OPERATING LIMIT
3.2.3	LHGR

5.1   Definition

The LINEAR HEAT GENERATION RATE (LHGR) shall be the heat generation rate per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length. By maintaining the operating LHGR below the applicable LHGR limit, it is assured that all thermal-mechanical design bases and licensing limits for the fuel will be satisfied.

5.2   Determination of LHGR Limit

The maximum LHGR limit is a function of reactor power, core flow, fuel and rod type, and fuel rod nodal exposure. The limit is developed, using NRC approved methodology described in Reference 7, to ensure the cladding will not exceed its yield stress and that fuel thermal-mechanical design criteria will not be violated during any postulated transient events. The LHGR limit ensures the fuel mechanical design requirements as defined in References 1, 21, & 25 will be met.

The LHGR limit during dual loop operation is calculated by the following equation:

$$LHGR_{LIMIT} = MIN \ (LHGR \ (P), LHGR \ (F))$$

where:

$$LHGR \ (P) = LHGRFAC \ (P) \ \text{x} \ LHGR_{STD}$$

$$LHGR \ (F) = LHGRFAC \ (F) \ \text{x} \ LHGR_{STD}$$

Within four hours after entering single loop operation, the LHGR limit is calculated by the following equation:

$$LHGR_{LIMIT} = MIN \ (LHGR \ (P), LHGR \ (F))$$

where:

$$LHGR \ (P) = LHGRFAC \ (P) \ \text{x} \ LHGR_{STD}$$

$$LHGR \ (F) = LHGRFAC \ (F) \ \text{x} \ LHGR_{STD}$$

LHGRFAC (P) and LHGRFAC (F) are limited to 0.90

The Single Loop Operation multiplier on LHGR is 0.90. (Reference 2)

$LHGR_{STD}$, the standard LHGR limit, is defined at a power of 3486 MWth and flow of 105 Mlbs/hr for each fuel and rod type as a function of fuel rod nodal exposure. $LHGR_{STD}$ is found in the reference cited in Table 5. When hand calculations are required, $LHGR_{STD}$ shall be determined by interpolation of the limits provided in the Table 5 reference. LHGRFAC(P), the core power-dependent LHGR limit adjustment factor, shall be calculated by using Section 5.2.1. LHGRFAC(F), the core flow-dependent LHGR limit adjustment factor, shall be calculated by using Section 5.2.2.

TABLE 5
STANDARD LHGR LIMITS FOR VARIOUS FUEL TYPES

For GE14 fuel listed below, the most limiting LHGR for Uranium Only fuel rod is found in NEDC-32868P Revision 6 Table D-2 (References 1 & 21).

For GE14 fuel listed below, the most limiting LHGR for Gadolinia Bearing fuel rods is found in NEDC-32868P Revision 6 Table D-4 (References 1 & 21). Utilize the row for 6% Rod/Section wt-% Gd_2O_3.

Fuel Types
2 = GE14-P10CNAB381-4G6.0/11G5.0-100T-150-T6-4372
3 = GE14-P10CNAB381-4G6.0/9G5.0-100T-150-T6-4371
4 = GE14-P10CNAB381-15G5.0-100T-150-T6-4373
5 = GE14-P10CNAB381-6G6.0/9G5.0-100T-150-T6-4374
6 = GE14-P10CNAB385-13GZ-100T-150-T6-4571
7 = GE14-P10CNAB384-15GZ-100T-150-T6-4572
8 = GE14-P10CNAB383-13GZ-100T-150-T6-4573
9 = GE14-P10CNAB377-15GZ-100T-150-T6-4574
19 = GE14-P10CNAB381-4G6.0/12G5.0-100T-150-T6-4261
20 = GE14-P10CNAB379-15GZ-100T-150-T6-4262
21 = GE14-P10CNAB383-8G6.0/5G5.0-100T-150-T6-4478
22 = GE14-P10CNAB383-8G6.0/7G5.0-100T-150-T6-4479
23 = GE14-P10CNAB383-2G6.0/11G5.0-100T-150-T6-4480
24 = GE14-P10CNAB383-10G6.0/5G5.0-100T-150-T6-4481

TABLE 5 (CONT.)
STANDARD LHGR LIMITS FOR VARIOUS FUEL TYPES

For GNF3 fuel listed below, the most limiting LHGR for Uranium Only fuel rod is found in NEDC-33879P Revision 2 Table A-1 (References 1 & 25).

For GNF3 fuel listed below, the most limiting LHGR for Gadolinia Bearing fuel rods is found in NEDC-33879P Revision 2 Table A-2 (References 1 & 25). Utilize the row for 6% Rod/Section wt-% Gd_2O_3.

Fuel Types
25 = GNF3-P10CG3B388-14GZ-83AV-150-T6-4661
26 = GNF3-P10CG3B399-14GZ-83AV-150-T6-4662
27 = GNF3-P10CG3B402-16GZ-83AV-150-T6-4663
28 = GNF3-P10CG3B419-16GZ-83AV-150-T6-4664

5.2.1   Calculation of LHGRFAC(P)

The core power-dependent LHGR limit adjustment factor, LHGRFAC(P) (Reference 2, 3, & 15), shall be calculated by one of the following equations:

For 0 ≤ P < 25 :

   No thermal limits monitoring is required.

For 25 ≤ P ≤ 29.5 :

   With All Equipment OPERABLE, or MSR INOPERABLE

   For core flow < 50 Mlbs/hr,
   $$LHGRFAC\ (P) = 0.568 + 0.00156\ (P - 29.5)$$

   For core flow ≥ 50 Mlbs/hr,
   $$LHGRFAC\ (P) = 0.568 + 0.00156\ (P - 29.5)$$

   With Turbine Bypass INOPERABLE, or Turbine Bypass and MSR INOPERABLE

   For core flow < 50 Mlbs/hr,
   $$LHGRFAC\ (P) = 0.488 + 0.01067\ (P - 29.5)$$

   For core flow ≥ 50 Mlbs/hr,
   $$LHGRFAC\ (P) = 0.436 + 0.00511\ (P - 29.5)$$

For 29.5 < P ≤ 45 :
   $$LHGRFAC\ (P) = 0.713 + 0.00529\ (P - 45)$$

For 45 < P ≤ 60 :
   $$LHGRFAC\ (P) = 0.791 + 0.00520\ (P - 60)$$

For 60 < P ≤ 85 :
   $$LHGRFAC\ (P) = 0.922 + 0.00524\ (P - 85)$$

For 85 < P ≤ 100 :
   $$LHGRFAC\ (P) = 1.000 + 0.00520\ (P - 100)$$

where: P = Core power (fraction of rated power times 100).

LHGRFAC(P) for Pressure Regulator Out of Service Limits

With one Turbine Pressure Regulator Out of Service and Reactor Power Greater Than or Equal to 25% and both Turbine Bypass and Moisture Separator Reheater Operable:

For 25 ≤ P ≤ 29.5 :

        For core flow < 50 Mlbs/hr,
$$LHGRFAC\ (P) = 0.568 + 0.00156\ (P - 29.5)$$

        For core flow ≥ 50 Mlbs/hr,
$$LHGRFAC\ (P) = 0.568 + 0.00156\ (P - 29.5)$$

For 29.5 < P ≤ 45 :
$$LHGRFAC\ (P) = 0.680 + 0.00626\ (P - 45)$$

For 45 < P ≤ 60 :
$$LHGRFAC\ (P) = 0.758 + 0.00520\ (P - 60)$$

For 60 < P ≤ 85 :
$$LHGRFAC\ (P) = 0.831 + 0.00292\ (P - 85)$$

For 85 < P ≤ 100 :
$$LHGRFAC\ (P) = 1.000 + 0.00520\ (P - 100)$$

where: P = Core power (fraction of rated power times 100).

5.2.2   Calculation of LHGRFAC(F)

The core flow-dependent LHGR limit adjustment factor, LHGRFAC(F) (Reference 2, 3, & 15), shall be calculated by the following equation:

$$LHGRFAC(F) = MIN(C, A_F \times \frac{WT}{100} + B_F)$$

where:

WT = Core flow (Mlbs/hr).
A_F = Given in Table 6.
B_F = Given in Table 6.
C = 1.0 in Dual Loop and 0.90 in Single Loop.

TABLE 6   FLOW-DEPENDENT LHGR LIMIT COEFFICIENTS

Maximum Core Flow[*] (Mlbs/hr)	A_F	B_F
110	0.8889	0.2613

[*]As limited by the Recirculation System MG Set mechanical scoop tube stop setting.

6.0   CONTROL ROD BLOCK INSTRUMENTATION

TECH SPEC IDENT	SETPOINT
3.3.2.1	RBM

6.1   Definition

The nominal trip setpoints and allowable values of the control rod withdrawal block instrumentation are shown in Table 7. These values are consistent with the bases of the A̲PRM R̲od Block T̲echnical S̲pecification Improvement Program (ARTS) and the MCPR operating limits. (References 2, 5, & 10)

TABLE 7   CONTROL ROD BLOCK INSTRUMENTATION SETPOINTS WITH FILTER

Setpoint	Trip Setpoint	Allowable Value
Low power setpoint	27.0	28.4
Intermediate power setpoint	62.0	63.4
High power setpoint	82.0	83.4
Low trip setpoint	117.0	118.9
Intermediate trip setpoint	112.2	114.1
High trip setpoint	107.2	109.1
Downscale trip setpoint	94.0	92.3

For this cycle, the analyzed high trip setpoint of 111% bounds the setpoints in Table 7. The OLMCPR associated with the RBM setpoint of 111% is 1.26 for dual loop operation. (Reference 2)

7.0 BACKUP STABILITY PROTECTION REGIONS

|	
TECH SPEC REFERENCE 3.3.1.1 Action Condition J	**OPERATING LIMIT** Alternate method to detect and suppress thermal hydraulic instability oscillations
TRM REFERENCE 3.4.1.1	**OPERATING LIMIT** Scram, Exit, and Stability Awareness Regions

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7.1   Definition

The Backup Stability Protection (BSP) Regions are an integral part of the Tech Spec required alternative method to detect and suppress thermal hydraulic instability oscillations in that they identify areas of the power/flow map where there is an increased probability that the reactor core could experience a thermal hydraulic instability. The BSP Regions are required if the Oscillation Power Range Monitors are inoperable. Regions are identified that are either excluded from planned entry (Scram Region), or where specific actions are required to be taken to immediately leave the region (Exit Region). A region is also identified where operation is allowed provided that additional monitoring is performed to verify that the reactor core is not exhibiting signs of core thermal hydraulic instability (Stability Awareness Region). (Reference 2)

The boundaries of the Scram and Exit regions are established on a cycle specific basis based upon core decay ratio calculations performed using NRC approved methodology.

BSP boundaries for this cycle defined in Figure 1 are applicable when final feedwater temperature is near the optimum range as illustrated in 20.107.02, Loss of Feedwater Heating Abnormal Operating Instruction Enclosure A. Figure 2 is applicable to operation with Feedwater Heaters Out-Of-Service (FWHOOS) or with Final Feedwater Temperature Reduction (FFWTR) or when final feedwater temperature is 15ºF to 20ºF below the optimum range. Figure 3 is applicable to operation with Feedwater Heaters Out-Of-Service (FWHOOS) or with Final Feedwater Temperature Reduction (FFWTR) or when final feedwater temperature is 20ºF to 55ºF below the optimum range.

**FIGURE 1:   BSP REGIONS (NOMINAL FEEDWATER TEMPERATURE)**
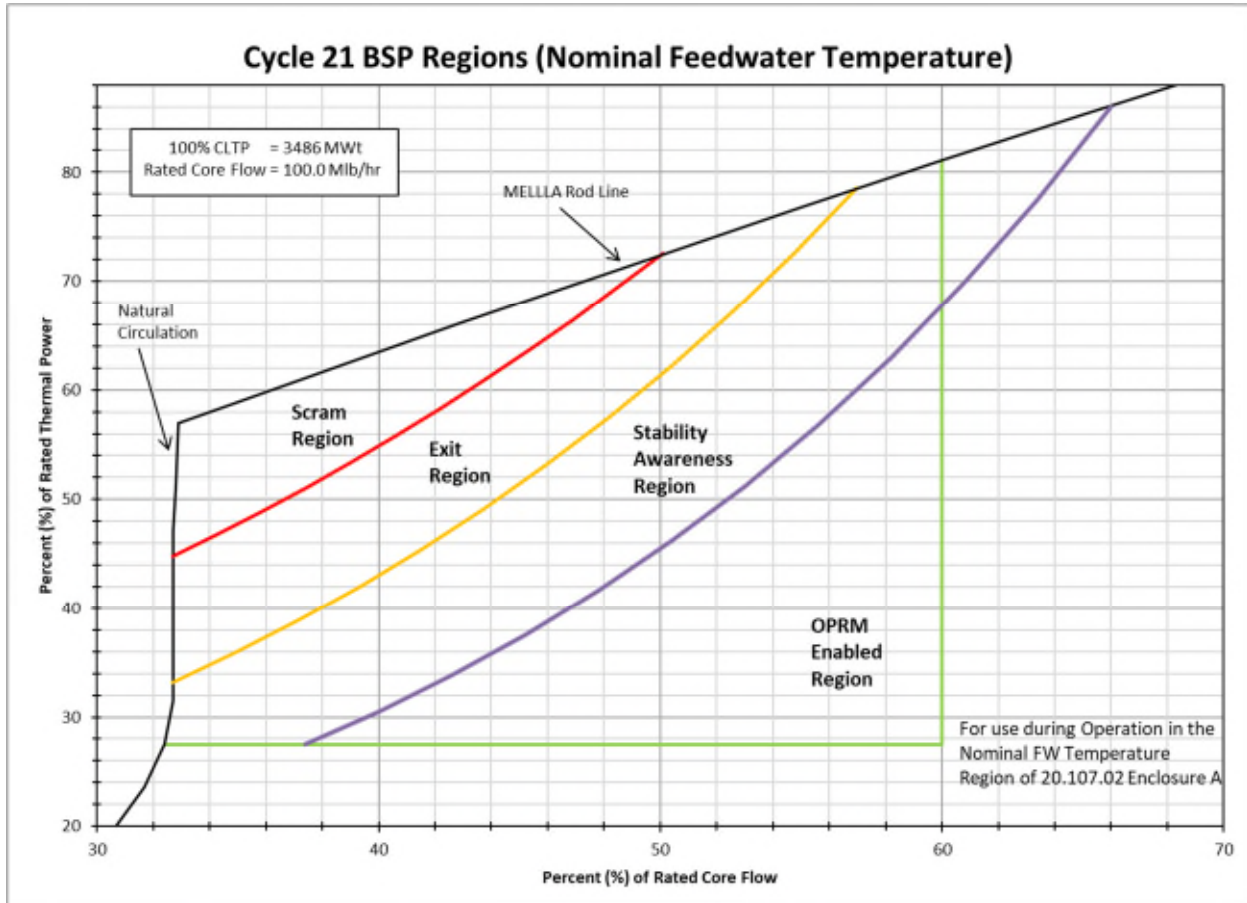
Nominal feedwater heating exists with all feedwater heaters in service, the moisture separator reheaters in service, and reactor water cleanup in or out of service. Nominal feedwater temperature is determined with the Loss of Feedwater Heating Abnormal Operating Procedure, 20.107.02. If feedwater temperature is less than 15 degrees Fahrenheit below the Optimum Line of the Feedwater Inlet Temperature vs. Reactor Power graph provided in Enclosure A of 20.107.02, then Figure 1 can be used.

FIGURE 2:   BSP REGIONS (20°F TEMPERATURE REDUCTION)
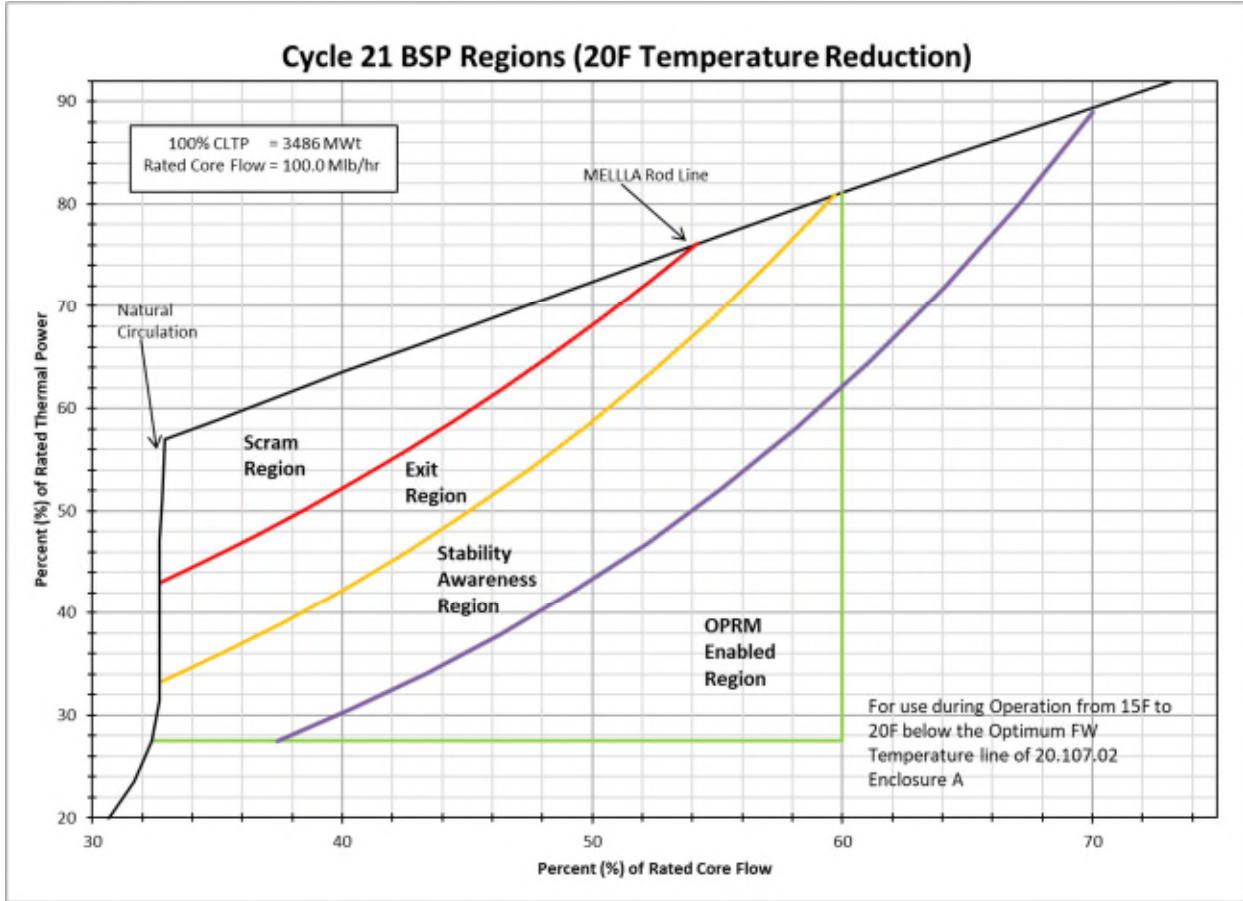
Reduced feedwater temperature is analyzed for a 20 degree Fahrenheit reduction in feedwater temperature. If feedwater temperature is between 15 degrees Fahrenheit to 20 degrees Fahrenheit below the Optimum Line of the Feedwater Inlet Temperature vs. Reactor Power graph provided in Enclosure A of 20.107.02, then Figure 2 should be used.

FIGURE 3:   BSP REGIONS (55°F TEMPERATURE REDUCTION)
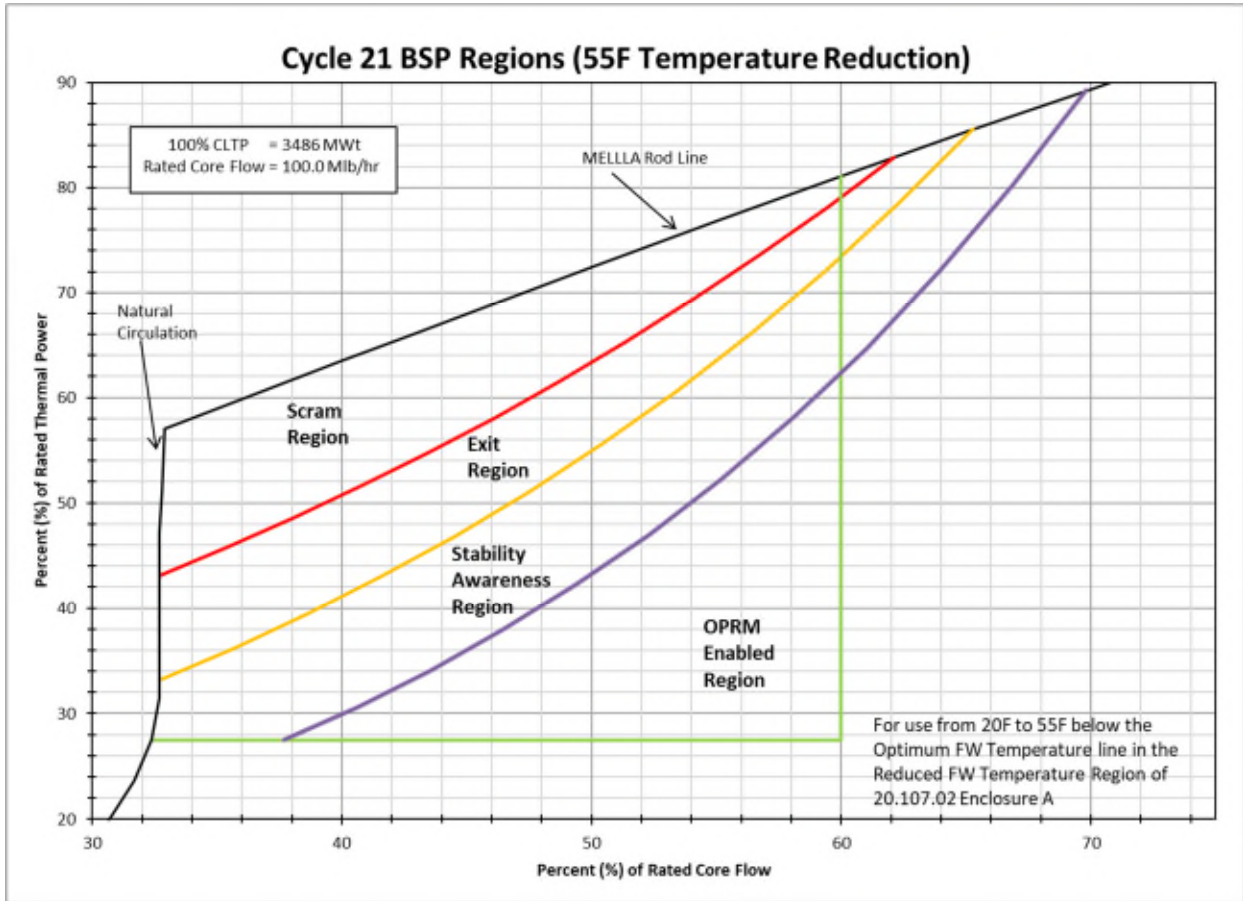
Reduced feedwater temperature is analyzed for a 55 degree Fahrenheit reduction in feedwater temperature. If feedwater temperature is more than 20 degrees Fahrenheit below the Optimum Line of the Feedwater Inlet Temperature vs. Reactor Power graph provided in Enclosure A of 20.107.02, then Figure 3 should be used.

8.0 REFERENCES

Core Operating Limits Report references are cited for two purposes. Many references are used as the basis for information, numbers, and equations found in COLR. These references tend to be fuel type or cycle specific. Other references are listed as basis information for the content and structure of COLR but are not Cycle specific.

1.   "Fuel Bundle Information Report for Fermi 2 Reload 20 Cycle 21," Global Nuclear Fuel, DRF 004N8821, Revision 0, November 2019 (LHGR Limits), DTC: TRVEND, DSN: C21 FBIR

2.   "Supplemental Reload Licensing Report for Fermi 2 Reload 20 Cycle 21," Global Nuclear Fuel, DRF: 004N8820, Revision 0, November 2019 (MAPLHGR Limits, SLO Multiplier, MCPR Limits, SLMCPR, Off-Rated Limits, Backup Stability Regions, OPRM setpoints, RBM setpoint, PROOS), DTC: TRVEND, DSN: C21 SRLR

3.   "GNF3 Fuel Design Cycle-Independent Analyses for Fermi 2 Power Plant," GE-Hitachi, 004N7423, Revision 0, November 2019. (GNF3 and GE14 ARTS Limits, RR Pump Seizure, PROOS), Edison File Number: T19-158

4.   Letter from Greg Porter to B. L. Myers, "Scram Times for Improved Tech Specs." GP-99014, October 22, 1999 containing DRF A12-00038-3, Vol. 4 information from G. A. Watford, GE, to Distribution, Subject: Scram Times versus Notch Position (TAU Calculation), Edison File Number: R1-7242

5.   NUMAC Power Range Neutron Monitoring System (PRNM) Surveillance Validation, Design Calculation DC-4608 Volume 1, Revision G (RBM A and B Setpoints), DTC: TDPINC, DSN: DC-4608 VOL I

6.   Detroit Edison Fermi-2 Thermal Power Optimization Task T0201: Operating Power/Flow Map, Edison File Number: T13-050 (P-F Map for BSP figures)

7.   "General Electric Standard Application for Reactor Fuel (GESTAR II)," NEDE-24011-P-A, Revision 29 with amendments, Edison File Number: R1-8103

8.   "TRACG Application for Emergency Core Cooling Systems / Loss-of-Coolant-Accident Analyses for BWR/2-6," GE-Hitachi, NEDE-33005P-A, Revision 2, May 2018, DTC: TRVEND, DSN: NEDE 33005 P A, Edison File Number: R1-8509

9.   Not Used

10. "Maximum Extended Operating Domain Analysis for Detroit Edison Company Enrico Fermi Energy Center Unit 2," GE Nuclear Energy, NEDC-31843P, July 1990 (RBM Setpoints) , Edison File Number: R1-7177

11. Not Used

12. "DTE Energy Enrico Fermi Unit 2 TRACG ECCS Loss-of-Coolant Accident (LOCA) Analysis," GE-Hitachi, 005N1475, Revision 1, November 2019, Edison File Number: T19-137

13. Letter from T. G. Colburn to W. S. Orser, "Fermi-2 - Amendment No. 87 to Facility Operating License No. NPF-43 (TAC NO. M82102)," September 9, 1992

14. Letter from J. F. Stang to W. S. Orser, "Amendment No. 53 to Facility Operating License No. NPF-43: (TAC No. 69074)," July 27, 1990

15. "Fermi 2 TRACG Implementation for Reload Licensing Transient Analysis", Revision 1, 0000-0128-8831-R1, June 2014, (GE14 ARTS Limits), Edison File Number: R1-8124

16. "Methodology and Uncertainties for Safety Limit MCPR Evaluations," NEDC-32601P-A, August 1999, Edison File Number: R1-7239

17. "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," NEDC-32694P-A, August 1999, Edison File Number: R1-7240

18. "R-Factor Calculation Method for GE11, GE12, and GE13 Fuel," NEDC-32505P-A, Revision 1, July 1999, Edison File Number: R1-7238

19. "Turbine Control Valve Out-Of-Service for Enrico Fermi Unit-2," GE – Nuclear Energy, GE-NE-J11-03920-07-01, October 2001, Edison File Number: R1-8160

20. "Fermi 2 - Issuance of Amendment No. 214 Re: Technical Specifications Task Force (TSTF) TSTF-564, "Safety Limit Minimum Critical Power Ratio" (EPID L-2019-LLA-0028)" Letter from Sujata Goetz, NRC, to Peter Dietrich, DTE Electric dated November 5, 2019 (SLMCPR)

21. "GE14 Compliance with Amendment 22 of NEDE-24011-P-A (GESTAR II)," NEDC-32868P, Revision 6, March 2016 (LHGR Limits), Edison File Number: R1-7307

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23. Qualification of the One-Dimensional Core Transient Model for Boiling Water Reactors – Volume 1, NEDO-24154-A, August 1986, Edison File Number: R1-7389.

24. Letter from G. G. Jones to A. D. Smart, "Fermi 2 Technical Specification Changes," February 17, 1989

25. "GNF3 Generic Compliance with NEDE-24011-P-A (GESTAR II)," NEDC-33879P, Revision 2, March 2018 (LHGR Limits), Edison File Number: R1-8483