



March 15, 2017

NG-17-0064
TS 5.6.5.d

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Duane Arnold Energy Center (DAEC)
Docket 50-331
Renewed Op. License No. DPR-49

Subject: Core Operating Limits Report for DAEC Cycle 26 Operation Revision 1

In accordance with the requirements of Duane Arnold Energy Center (DAEC) Technical Specifications Section 5.6.5.d, a copy of Revision 1 of the Core Operating Limits Report (COLR) for Cycle 26 operation of the DAEC is enclosed (Enclosure).

No new commitments or changes to any previous commitments are being made in this letter.

If you have any questions regarding this matter, please contact J. Michael Davis at (319) 851-7032.

A handwritten signature in black ink that reads "Dean Curtland".

Dean Curtland
Site Director
NextEra Energy Duane Arnold, LLC

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Duane Arnold Energy Center, USNRC
Resident Inspector, Duane Arnold Energy Center, USNRC

DUANE ARNOLD ENERGY CENTER
CYCLE 26 Revision 1
CORE OPERATING LIMITS REPORT

Duane Arnold Energy Center Cycle 26 Core Operating Limits Report





DUANE ARNOLD ENERGY CENTER
CYCLE 26
CORE OPERATING LIMITS REPORT

Revision 1
January 2017

Prepared by: Alexandre Alexseev Date: 1/31/17
JB Nuclear Fuels

Verified by: Anna Shrobin Date: 1/31/17
JB Nuclear Fuels

Approved by: CAA Date: 1/31/17
BWR Fuel Engineering Manager

1.0 Core Operating Limits Report

This Core Operating Limits Report for Cycle 26 has been prepared in accordance with the requirements of Technical Specification 5.6.5 and is applicable to operation for which rated thermal power is 1912 MWt. The core operating limits have been developed using NRC-approved methodology (Reference 1) and are established such that all applicable limits of the plant safety analysis are met. The Cycle 26 values for the core operating limits are provided in Section 3.0 of this report.

2.0 References

1. General Electric Standard Application for Reactor Fuel (GESTAR II), NEDE-24011-P-A-22, November 2015.
2. Supplemental Reload Licensing Report for Duane Arnold Energy Center, Reload 25 Cycle 26, 002N6817, Revision 0, July 2016.
3. Fuel Bundle Information Report for Duane Arnold Energy Center, Reload 25 Cycle 26, 002N6818, Revision 0, July 2016.
4. Duane Arnold Energy Center Cycle 25 Core Operating Limits Report, Revision 0, August 2014.
5. Duane Arnold Energy Center Asset Enhancement Program, Task T0201: Power/Flow Map, GE-NE-A22-00100-04-01, Revision 0, February 2000.
6. GNF Letter MFN 16-016, from B. R. Moore to US NRC Document Control Desk, GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II), NEDC-33270P, Revision 6, March 2016. (ADAMS Accession No. ML 16084A033)

3.0 Core Operating Limits

1. Average Planar Linear Heat Generation Rate (APLHGR) – TS 3.2.1
 - a. The Maximum APLHGR (MAPLHGR) applicable to all fuel types as a function of Planar Average Exposure (PAE) shall not exceed the limiting curves defined by Table 1, multiplied by the smaller of the two MAPFAC/LHGRFAC factors determined from Figures 2a and 3 [also use Figures 2a and 3 for Recirculation Pump Trip Out-of-Service (RPTOOS); Figures 2b and 3 for Turbine Bypass Valves Out-of-Service (TBVOOS); Figures 2c and 3 for RPTOOS and TBVOOS]. Figure 1 plots the MAPLHGR curve corresponding to Table 1.
 - b. The Maximum Linear Heat Generation Rate (MLHGR) applicable to all fuel rods for all fuel types as a function of Peak Pellet Exposure (PPE) shall not exceed the curves defined by Table 2, multiplied by the smaller of the two MAPFAC/LHGRFAC factors determined from Figures 2a and 3 [also use Figures 2a and 3 for Recirculation Pump Trip Out-of-Service (RPTOOS); Figures 2b and 3 for Turbine Bypass Valves Out-of-Service (TBVOOS); Figures 2c and 3 for RPTOOS and TBVOOS].
 - c. During Single Loop Operation (SLO), the actual MAPLHGR applicable to all fuel types as a function of planar average exposure shall not exceed the limiting curves defined by Table 1, multiplied by the smaller of the two MAPFAC/LHGRFAC factors determined from Figures 2a and 4 [also use Figures 2a and 4 for Recirculation Pump Trip Out-of-Service (RPTOOS); Figures 2b and 4 for Turbine Bypass Valves Out-of-Service (TBVOOS); Figures 2c and 4 for RPTOOS and TBVOOS].
 - d. During Single Loop Operation (SLO), the actual MLHGR applicable to all fuel rods for all fuel types as a function of peak pellet exposure shall not exceed the limiting curves defined by Table 2, multiplied by the smaller of the two MAPFAC/LHGRFAC factors determined from Figures 2a and 4 [also use Figures 2a and 4 for Recirculation Pump Trip Out-of-Service (RPTOOS); Figures 2b and 4 for Turbine Bypass Valves Out-of-Service (TBVOOS); Figures 2c and 4 for RPTOOS and TBVOOS].

The above MAPLHGR limits are from the Emergency Core Cooling requirements of the Loss-of-Coolant Accident (LOCA) analyses. The above MLHGR limits are from the fuel thermal-mechanical performance limits. The individual MAPLHGR and MLHGR limits, as discussed in the BASES for TS 3.2.1, are modeled in the process computer. The above can be used to determine the TS MAPLHGR or MLHGR limits in the event the process computer is not available.

2. Minimum Critical Power Ratio (MCPR) – TS 3.2.2

- a. The MCPR shall be equal to or greater than the Operating Limit MCPR (OLMCPR), which is a function of Core Thermal Power, Core Flow, and Scram Time (τ). For Core Thermal Power greater than or equal to 21.7% of rated and less than 40% of rated ($21.7\% \leq P < 40\%$), the OLMCPR is given by Figure 5a [also use Figure 5a for Recirculation Pump Trip Out-of-Service (RPTOOS); Figure 5b for Turbine Bypass Valves Out-of-Service (TBVOOS); Figure 5c for RPTOOS and TBVOOS]. For Core Thermal Power greater than or equal to 40% of rated ($P \geq 40\%$), the OLMCPR is the greater of either:
 - i) The applicable flow-dependent OLMCPR determined from Figure 6, or
 - ii) The appropriate Rated Power OLMCPR from Figure 7 or 8 [Figure 9 for Recirculation Pump Trip Out-of-Service (RPTOOS); Figure 10 for Turbine Bypass Valves Out-of-Service (TBVOOS); Figure 11 for RPTOOS and TBVOOS], multiplied by the applicable power-dependent OLMCPR multiplier determined from Figure 5a [also use Figure 5a for Recirculation Pump Trip Out-of-Service (RPTOOS); Figure 5b for Turbine Bypass Valves Out-of-Service (TBVOOS); Figure 5c for RPTOOS and TBVOOS].
- b. During SLO with Core Thermal Power greater than or equal to 21.7% of rated, the SLO OLMCPR is the greater of either:
 - i) adding 0.03 to the OLMCPR determined above, or
 - ii) a rated OLMCPR of 1.43, multiplied by the applicable power-dependent OLMCPR multiplier determined from Figure 5a [also use Figure 5a for Recirculation Pump Trip Out-of-Service (RPTOOS); Figure 5b for Turbine Bypass Valves Out-of-Service (TBVOOS); Figure 5c for RPTOOS and TBVOOS].

The above can be used to determine the TS OLMCPR limits in the event the process computer is not available.

4.0 Reload Fuel Bundles

FUEL TYPE	CYCLE LOADED	NUMBER
GNF2-P10DG2B401-13GZ-100T2-150-T6-4117	24	8
GNF2-P10DG2B408-12GZ-100T2-150-T6-4118	24	8
GNF2-P10DG2B412-16GZ-100T2-150-T6-4119	24	25
GNF2-P10DG2B424-15GZ-100T2-150-T6-4120	24	8
GNF2-P10DG2B439-13GZ-100T2-150-T6-4121	24	15
GNF2-P10DG2B394-13GZ-100T2-150-T6-4294	25	24
GNF2-P10DG2B399-12GZ-100T2-150-T6-4295	25	48
GNF2-P10DG2B413-14GZ-100T2-150-T6-4296	25	32
GNF2-P10DG2B423-15GZ-100T2-150-T6-4297	25	16
GNF2-P10DG2B436-12GZ-100T2-150-T6-4298	25	16
GNF2-P10DG2B436-14GZ-100T2-150-T6-4299	25	16
GNF2-P10DG2B394-12GZ-100T2-150-T6-4432	26	16
GNF2-P10DG2B399-12GZ-100T2-150-T6-4295	26	64
GNF2-P10DG2B413-13GZ-100T2-150-T6-4433	26	32
GNF2-P10DG2B423-15GZ-100T2-150-T6-4297	26	24
GNF2-P10DG2B436-12GZ-100T2-150-T6-4434	26	16

All Cycle 26 fuel types are of the GNF2 fuel design type. Note that bundles GNF2-P10DG2B399-12GZ-100T2-150-T6-4295 and GNF2-P10DG2B423-15GZ-100T2-150-T6-4297 loaded in Cycle 26 are identical to the bundles of the same name that were loaded in Cycle 25.

5.0 Thermal-Hydraulic Stability

- a. Continued reactor operation within the "Exclusion Region" on the power/flow map, as defined on Figure 12, is not permitted. (Surveillance Requirement 3.4.1.2)
- b. Continued reactor operation within the "Buffer Region" on the power/flow map, as defined in Figure 12, is not permitted when the thermal-hydraulic stability monitor is not operational.

TABLE 1

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Limit
as a Function of Planar Average Exposure

for

All Cycle 26 Fuel Types

Planar Average Exposure	MAPLHGR Limit
GWD/MT (GWD/ST)	kW/ft
0.00 (0.00)	13.78
18.92 (17.16)	13.78
67.00 (60.78)	6.87
70.00 (63.50)	5.50

TABLE 2

Maximum Linear Heat Generation Rate (MLHGR) Limit
as a Function of Peak Pellet Exposure

for

All Cycle 26 Fuel Types

Peak Pellet Exposure*	UO₂ MLHGR Limit
See Table B-1 of Reference 6	
Peak Pellet Exposure*	Gd₂O₃ Zone MLHGR Limit
See Table B-2 of Reference 6	

*Note that the Peak Pellet Exposure in Tables B-1 and B-2 of Reference 6 is only provided in GWD/MTU.

MAPLHGR vs Planar Average Exposure

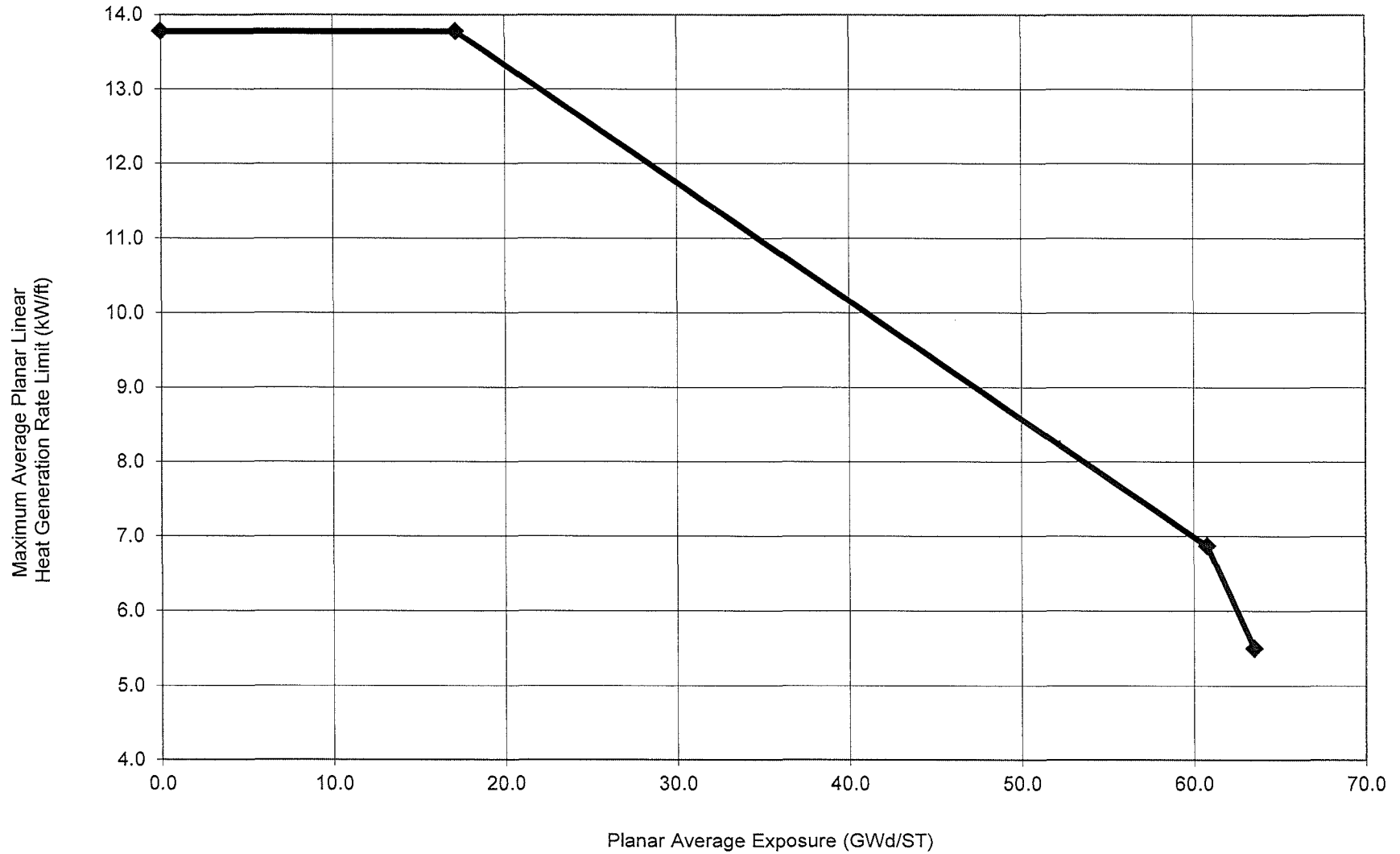


Figure 1

Power Dependent MAPLHGR and MLHGR Multipliers (Equipment in Service or RPTOOS)

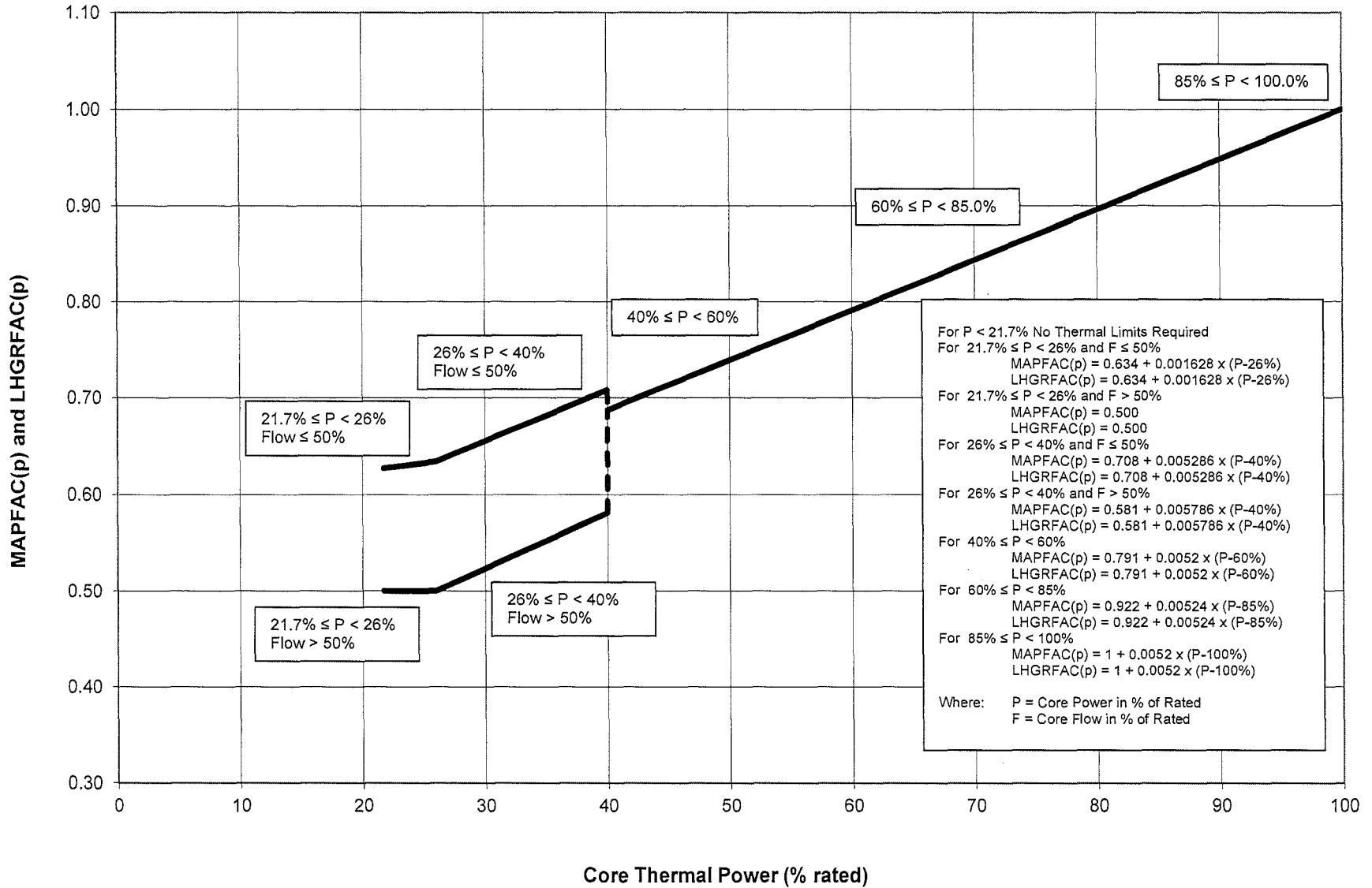


Figure 2a

Power Dependent MAPLHGR and MLHGR Multipliers (TBVOOS)

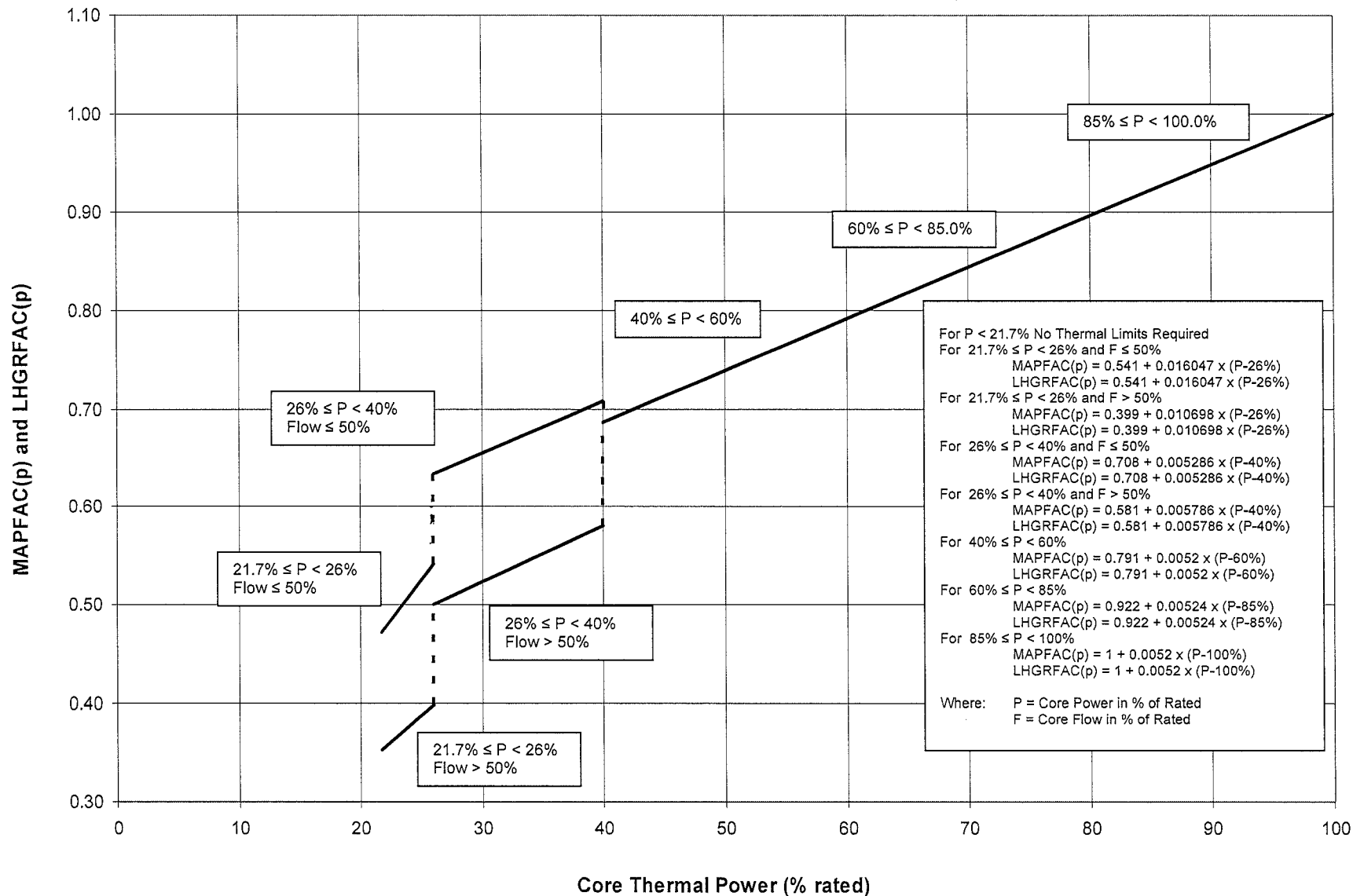


Figure 2b

Power Dependent MAPLHGR and MLHGR Multipliers (RPTOOS & TBVOOS)

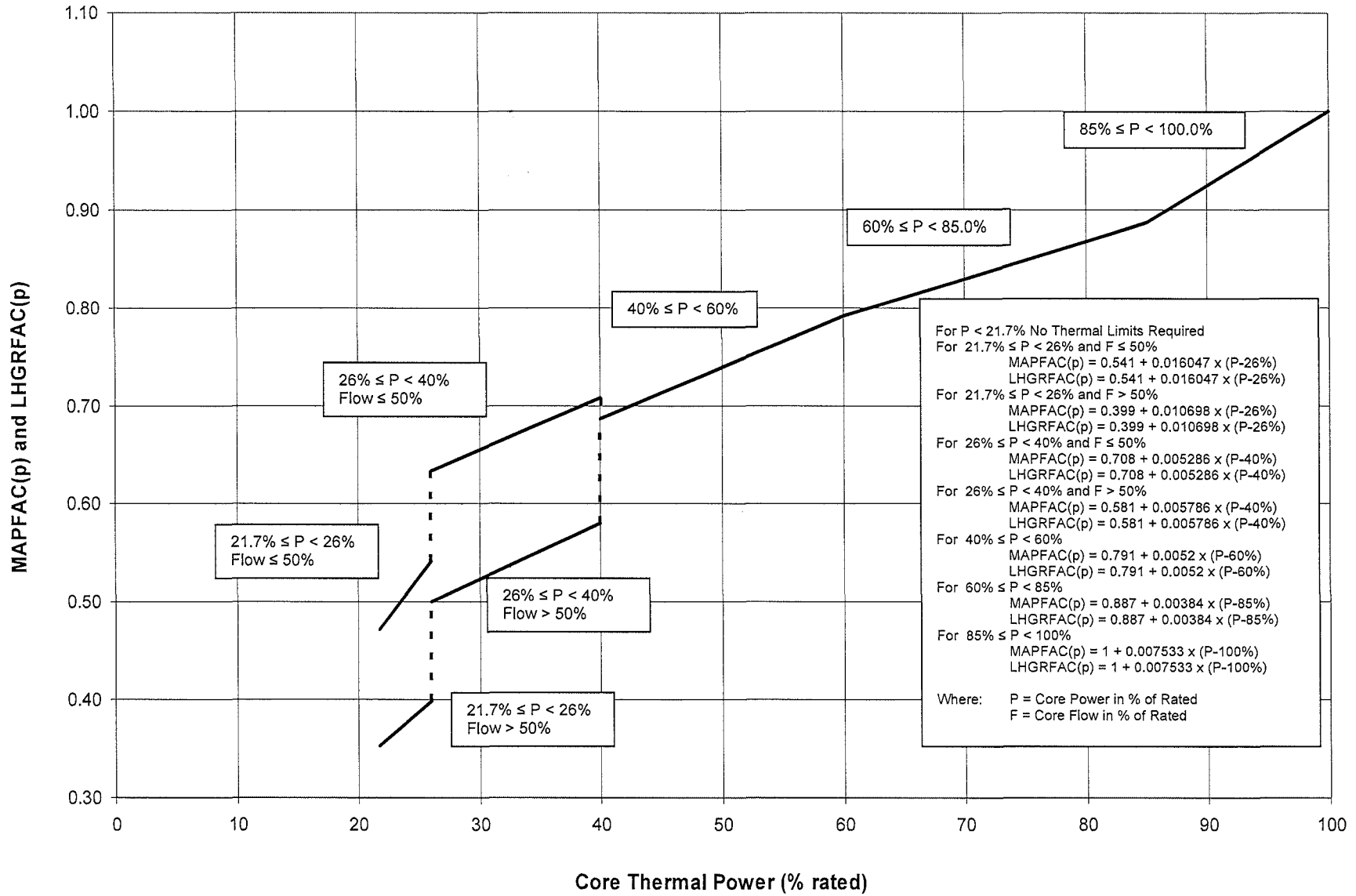


Figure 2c

Flow Dependent MAPLHGR and MLHGR Multipliers

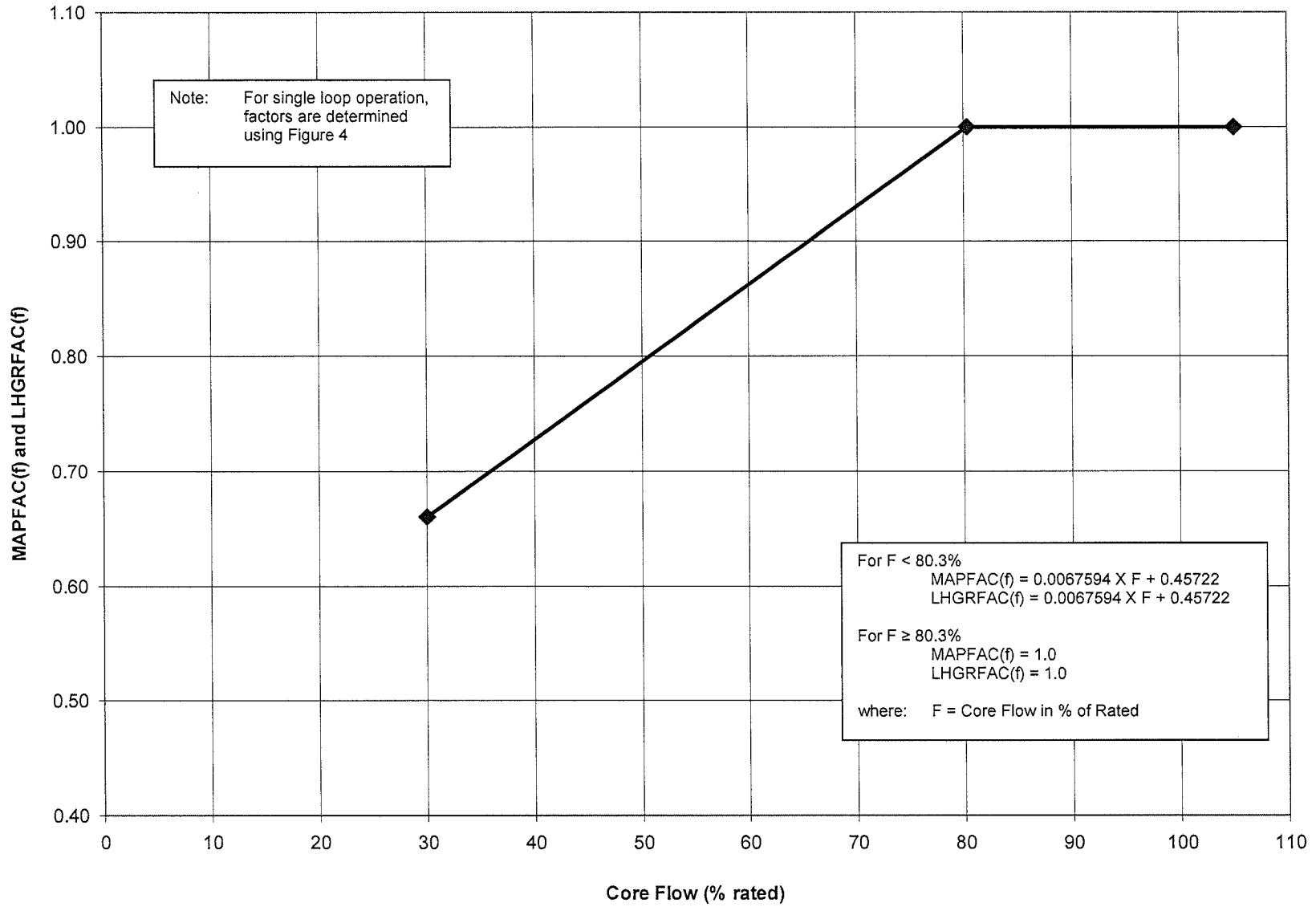


Figure 3

Flow Dependent MAPLHGR and MLHGR Multipliers Single Loop Operation

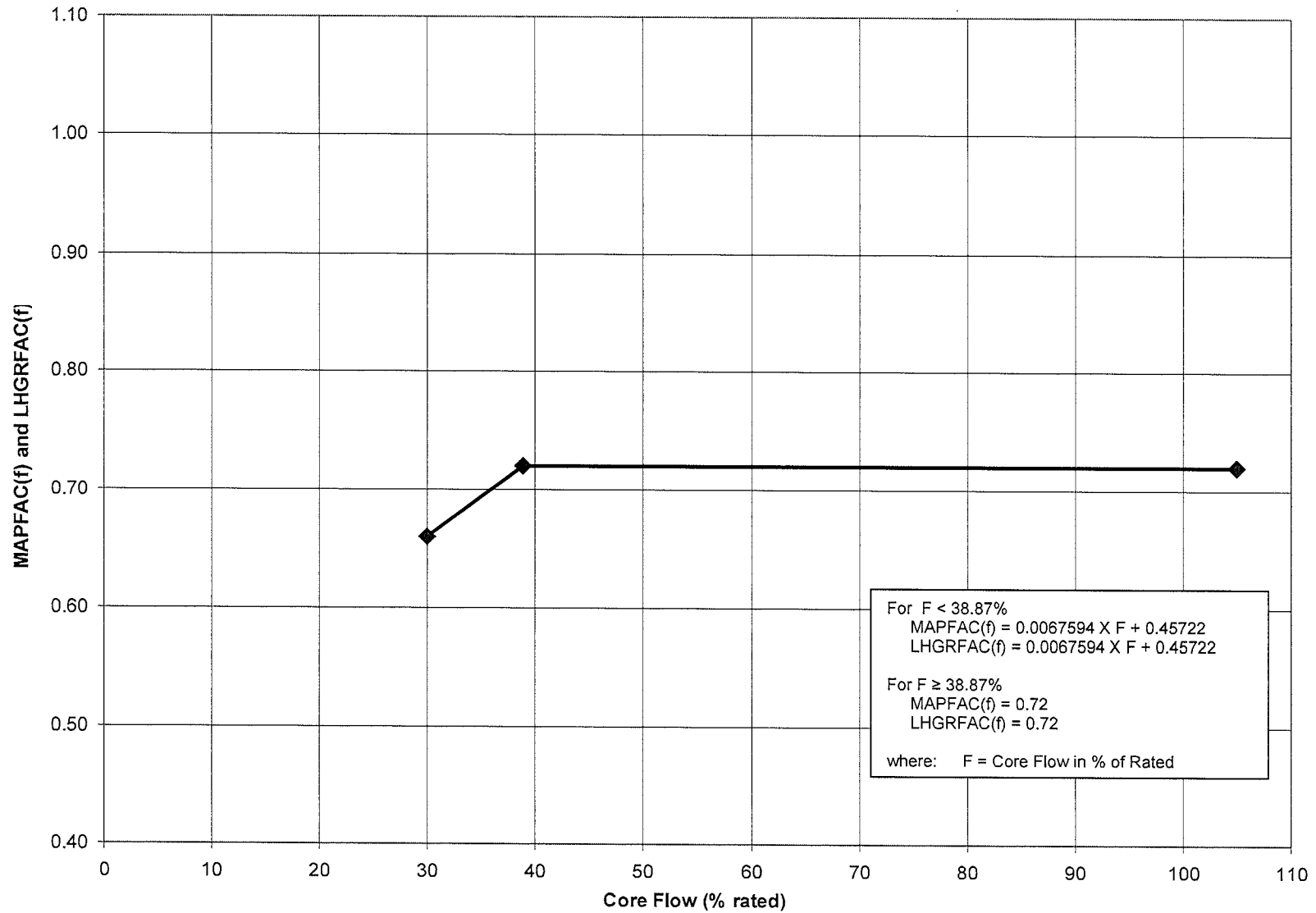


Figure 4

Power Dependent OLMCPR Limits and Multipliers (Equipment in Service or RPTOOS)

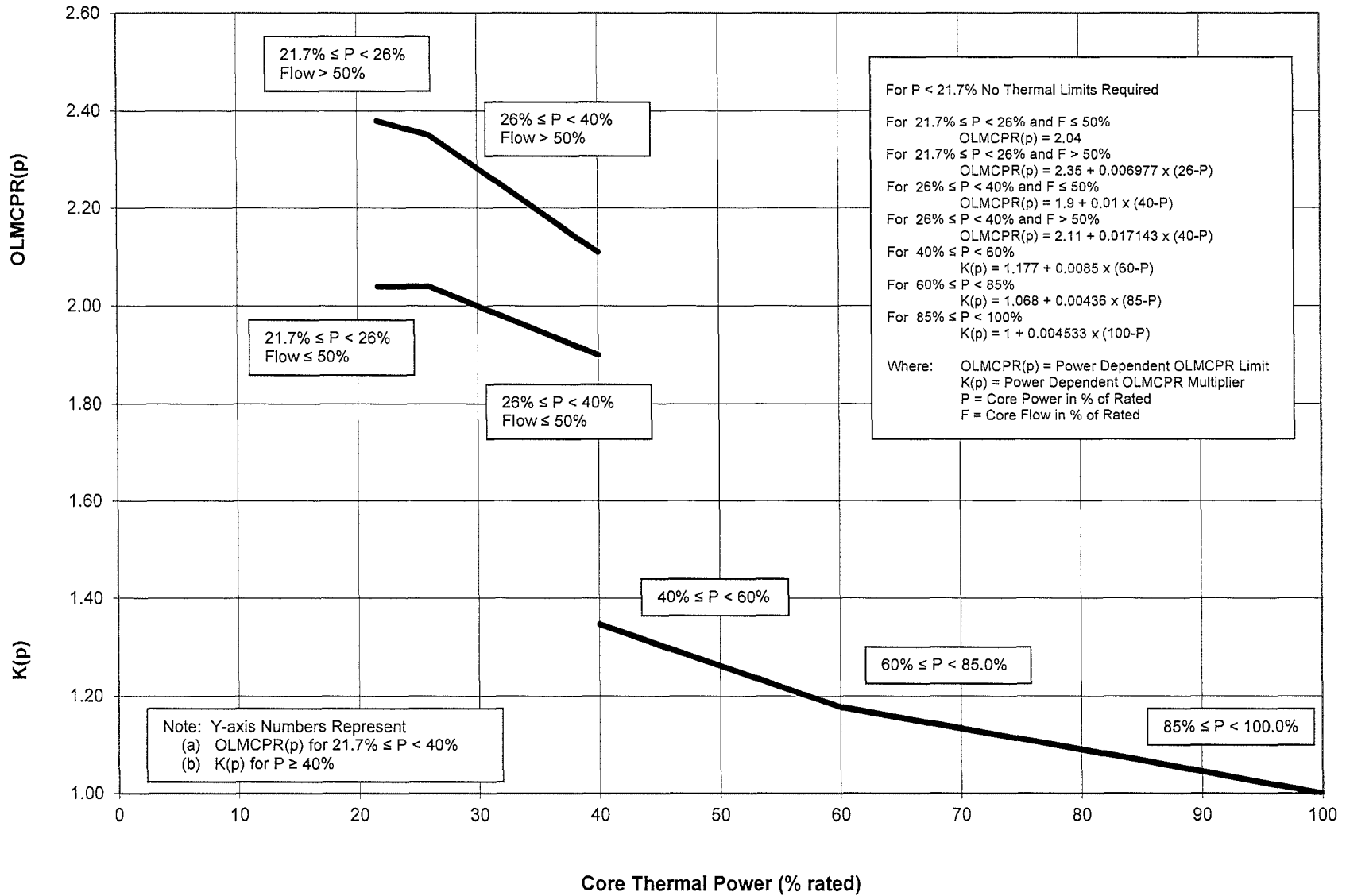
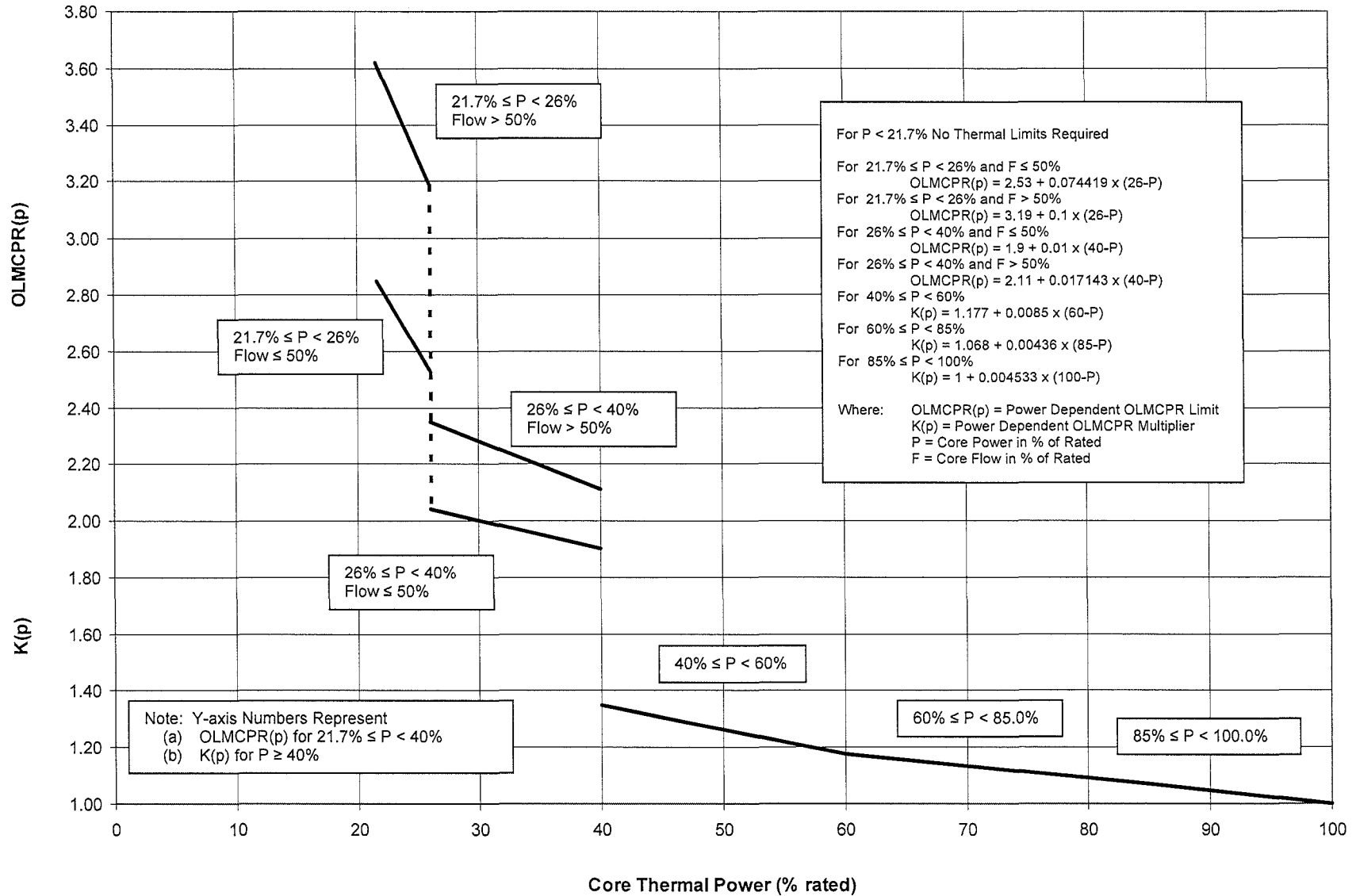


Figure 5a

Power Dependent OLMCPR Limits and Multipliers (TBVOOS)



Power Dependent OLMCPR Limits and Multipliers (RPTOOS & TBVOOS)

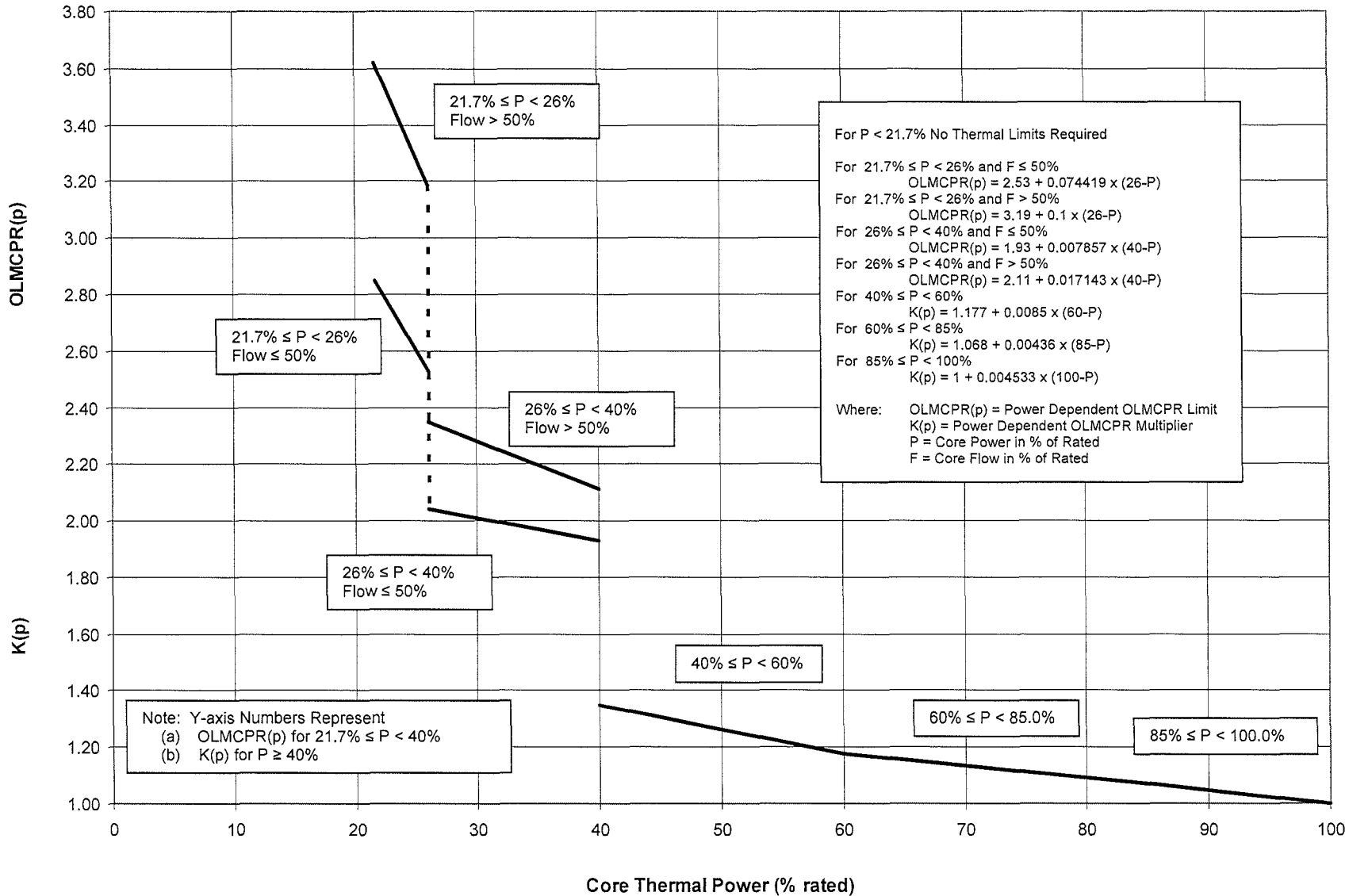


Figure 5c

Flow Dependent OLMCPR Limits

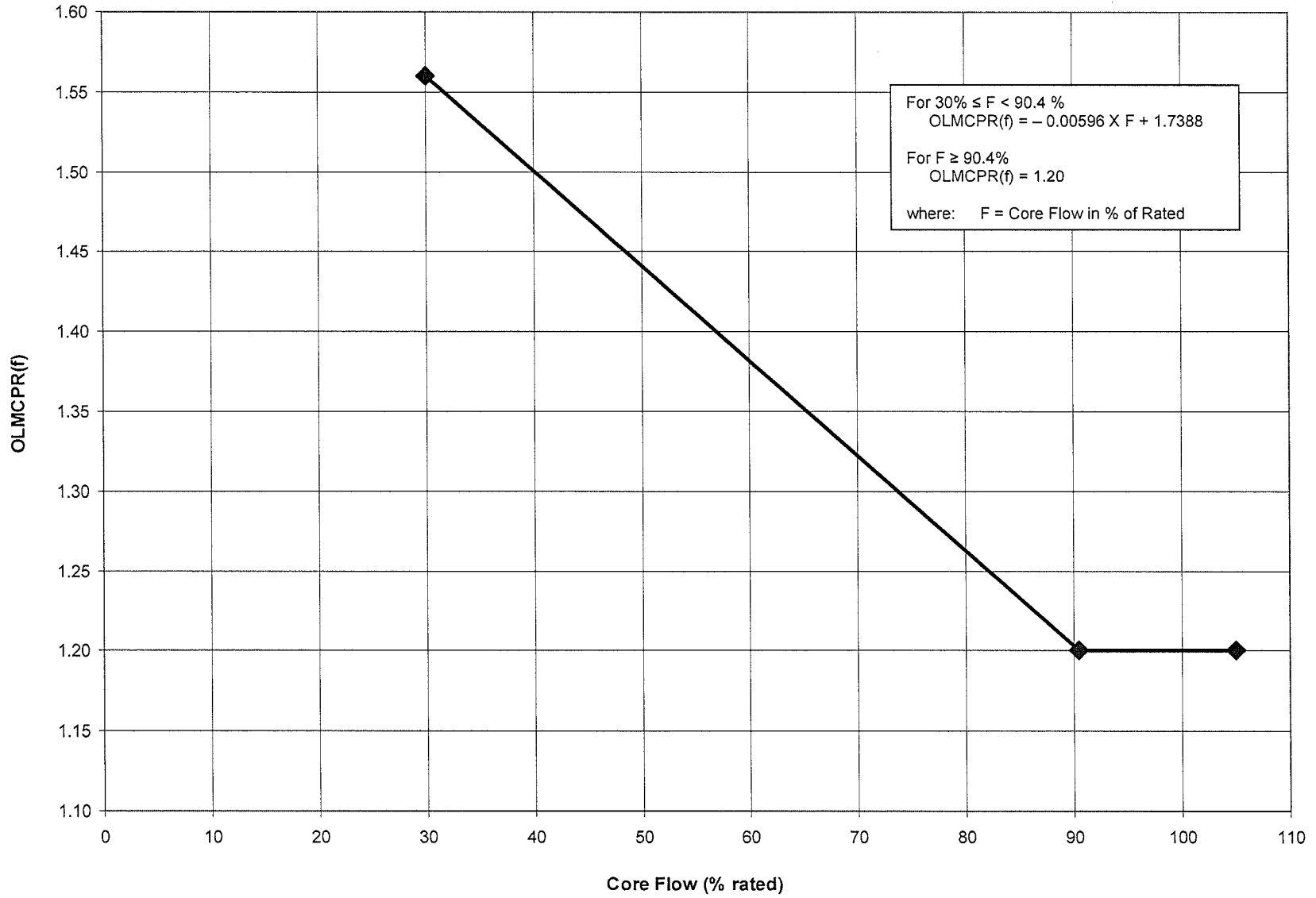


Figure 6

OLMCPR vs Scram Time (Tau)
BOC to EOR – 2037 MWd/ST Cycle Exposure

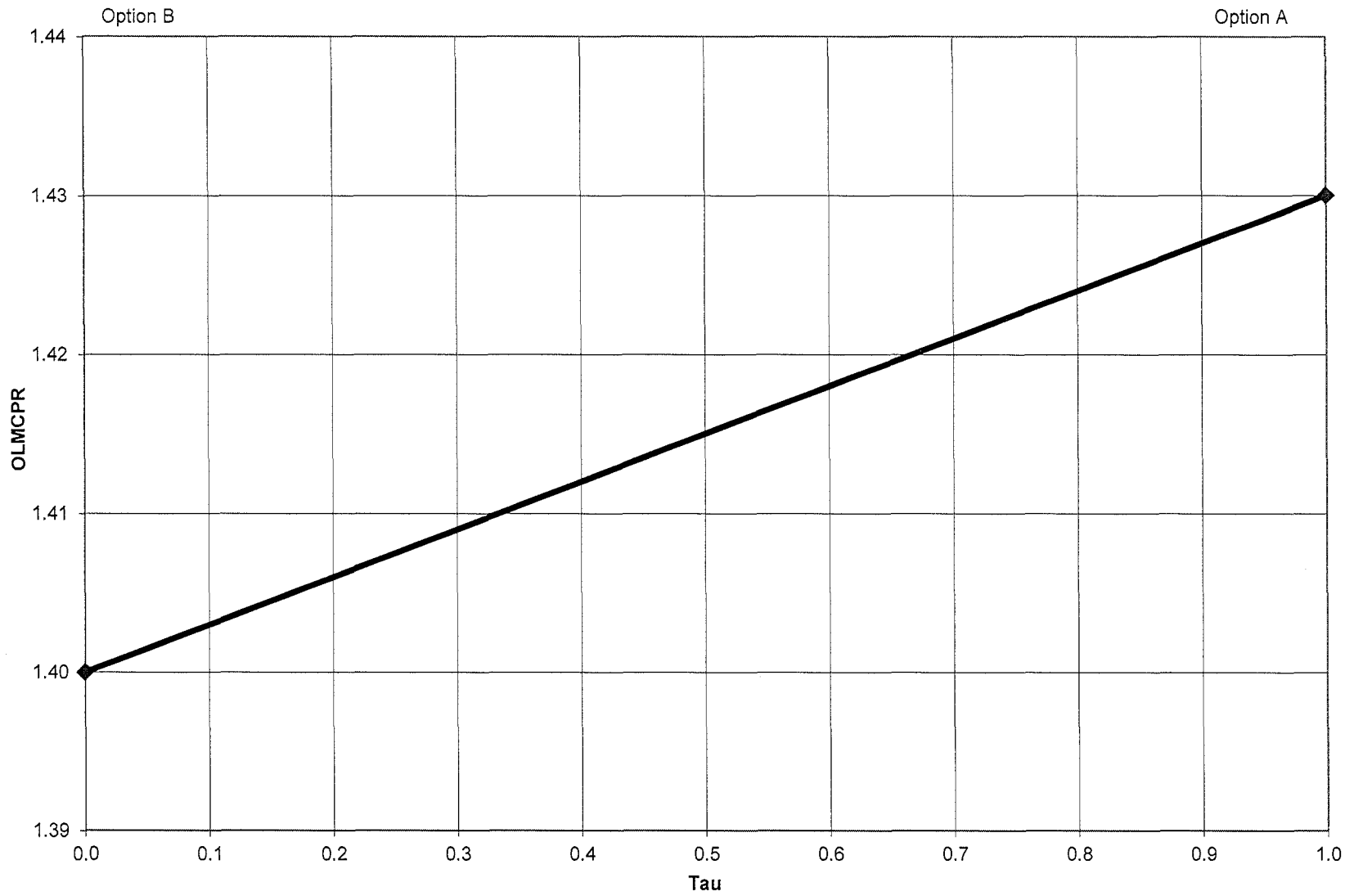


Figure 7

OLMCPR vs Scram Time (Tau)
EOR – 2037 MWd/ST to EOC Cycle Exposure

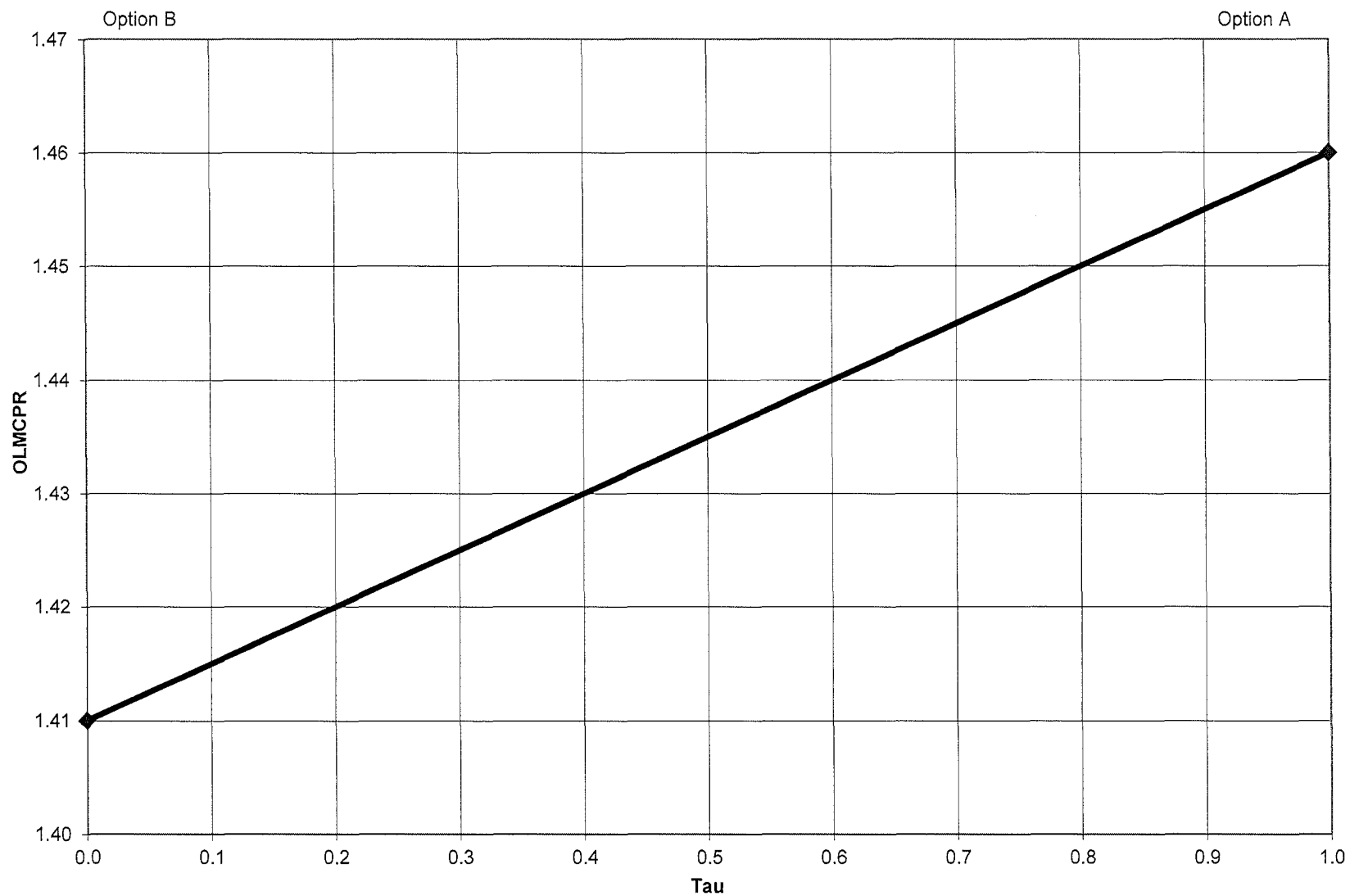


Figure 8

OLMCPR vs Scram Time (Tau) RPTOOS

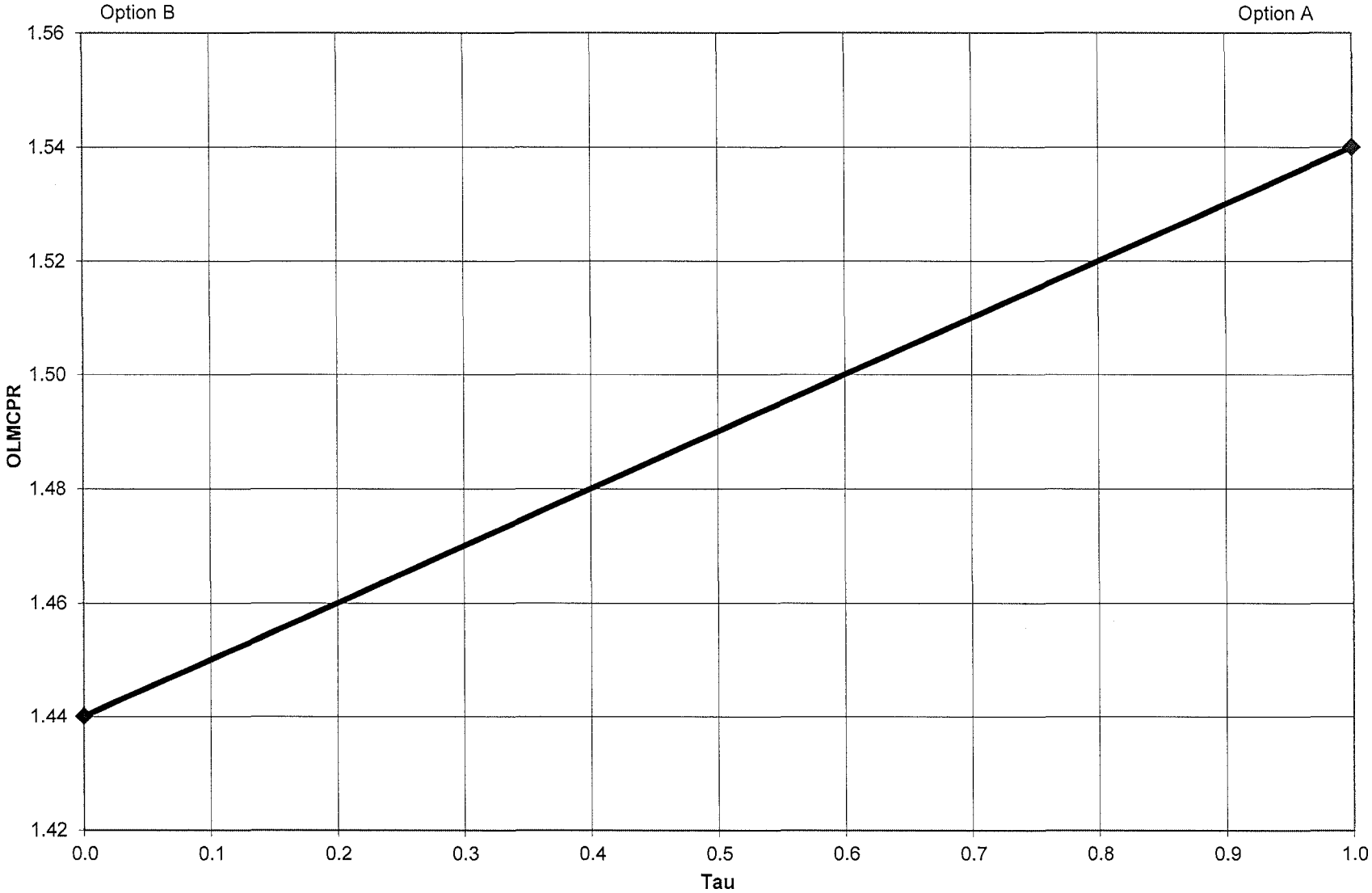


Figure 9

OLMCPR vs Scram Time (Tau)
TBVOOS

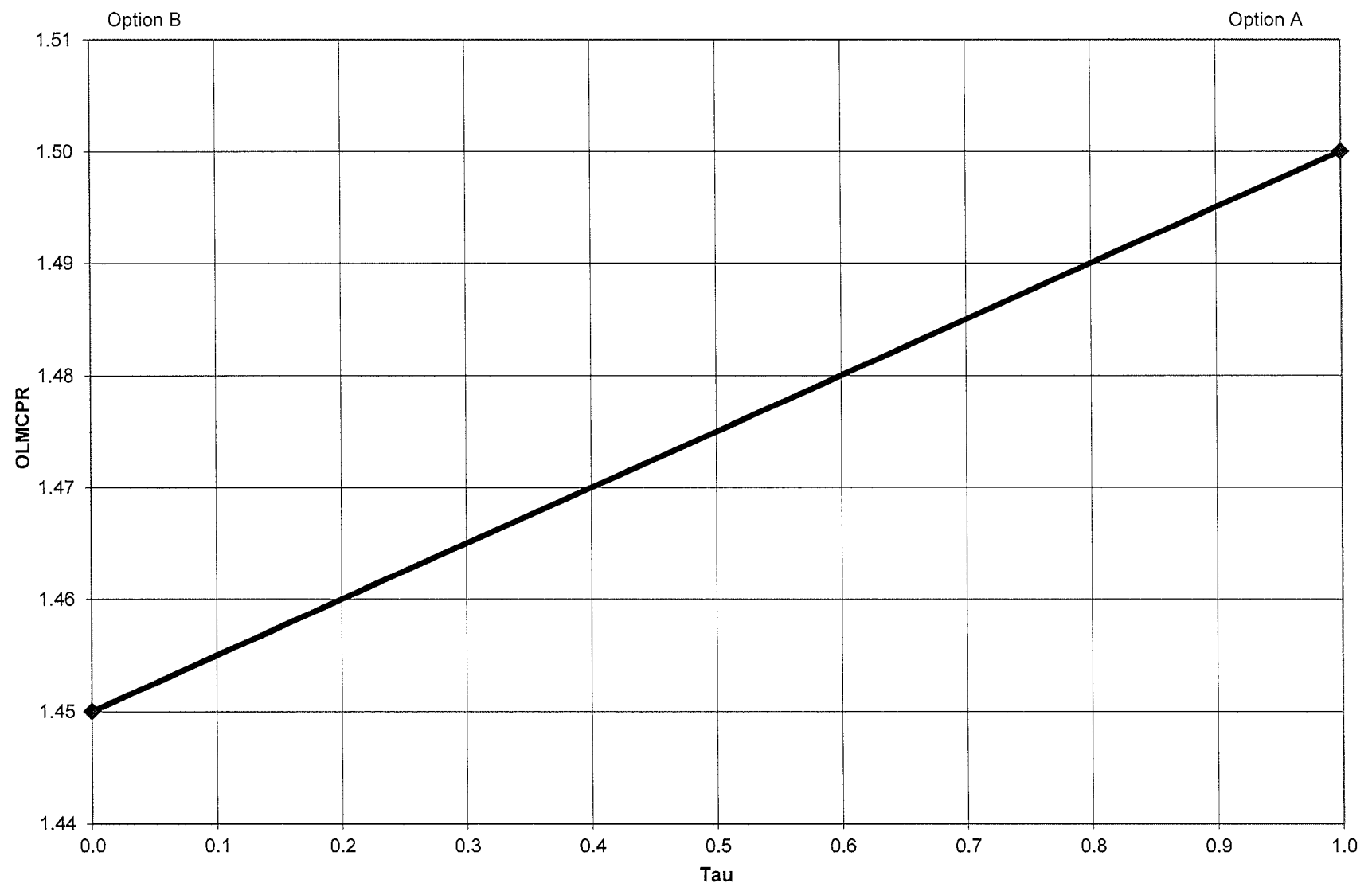


Figure 10

OLMCPR vs Scram Time (Tau) RPTOOS & TBVOOS

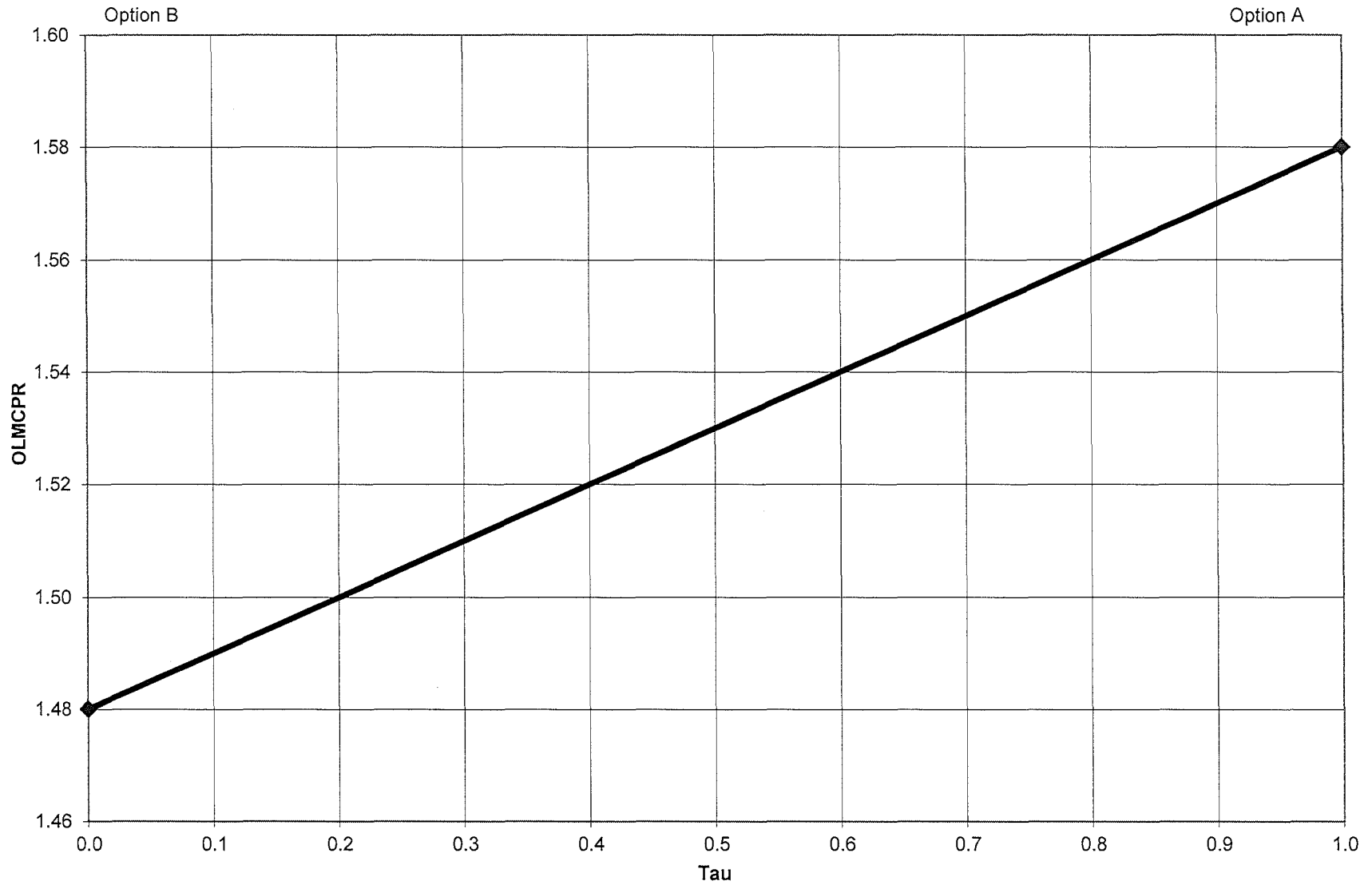


Figure 11

DAEC Power/Flow Map Cycle 26 - 1912 MWth

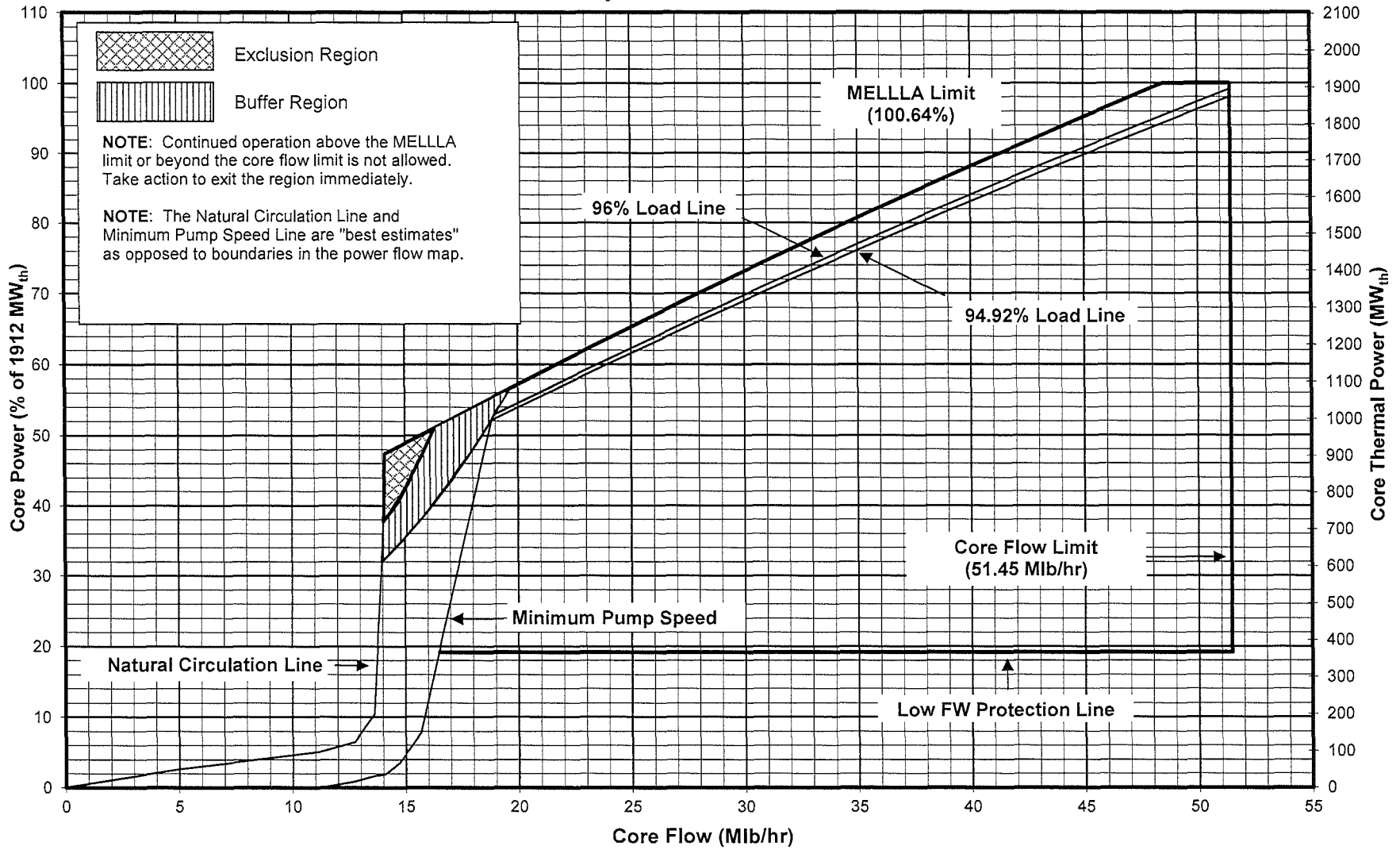


Figure 12