ALLIANT ENERGY - IES UTILITIES INC.

Duane Arnold Energy Center

Cycle 17

CORE OPERATING LIMITS REPORT

Rev. 0

November 1999

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1.0 Core Operating Limits Report

This Core Operating Limits Report for Cycle 17 has been prepared in accordance with the requirements of Technical Specification 5.6.5. The core operating limits have been developed using NRC-approved methodology (Ref. 1) and are documented in References 2, 3, 4, 7, and 8 9. The Cycle 17 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*

2. Duane Arnold Energy Center SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis, NEDC-31310P, Supp. 1, August 1993*

3. Supplemental Reload Licensing Submittal for Duane Arnold Energy Center, Reload 16, Cycle 17, J11-03517SRLR, Rev 0, October, 1999

4. Duane Arnold Energy Center GE12 Fuel Upgrade Project , NEDC-32915P, November, 1999

5. Average Power Range Monitor, Rod Block Monitor and Technical Specification Improvement (ARTS) Program for the Duane Arnold Energy Center, NEDC-30813, December 1984

6. GE Fuel Bundle Designs, NEDE-31152P*

7. Application of the "Regional Exclusion with Flow-Biased APRM Neutron Flux Scram" Stability Solution (Option I-D) to the Duane Arnold Energy Center, GENE-A00-04021-01, September 1995

8. Impact of EOC RPT and TBV OOS on ARTS Limits for Duane Arnold Energy Center, GE-NE-A0005785-21, October 1996

9. GE12 Compliance with Amendment 22 of NEDE-24011-P-A (GESTAR II), NEDE-32417P, December 1994

* Approved revision number at time reload fuel analyses are performed.

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3.0 Core Operating Limits

1. Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) - TS 3.2.1.

   a. The MAPLHGR for each fuel type as a function of planar average exposure (PAE) shall not exceed the limiting value shown in Figures 1, 2, 3, 4, 5, and 6 multiplied by the smaller of the two MAPFAC factors determined from Figures 7 and 8.

   b. During SLO, the actual MAPLHGR for each type of fuel as a function of average planar exposure shall not exceed the limiting value shown in Figures 1, 2, 3, 4, 5, and 6 multiplied by the smaller of the two MAPFAC factors determined from Figures 8 and 9.

   c. Tables 1, 2, 3 and 4 provide the MAPLHGR values (KW/ft) for the exposure points (GWd/ST) used in the SAFER/GESTR-LOCA analysis. These tables are applicable to the re-insert GE 10 fuel for Cycle 17.

      Tables 5 and 6 provide the MAPLHGR values (KW/ft) for the exposure points (GWd/ST) conservatively bounded by the SAFER/GESTR-LOCA analysis (see reference 3). These tables are applicable to the GE 12 fresh fuel for Cycle-17.

      Tables 1, 2, 3, 4, 5, and 6 correspond to Figures 1, 2, 3, 4, 5, and 6, respectively.

2. Linear Heat Generation Rate (LHGR) - TRM: 3.2.

   a. The LHGR of any rod in any GE 10 fuel assembly shall not exceed 14.4 KW/ft.
   b. The LHGR of any rod in any GE 12 fuel assembly shall not exceed 11.8 KW/ft. (Reference 4)

3. Minimum Critical Power Ratio (MCPR) -TS 3.2.2.

   a. The MCPR shall be equal to or greater than the Operating Limit MCPR, which is a function of core thermal power, core flow, fuel type, and scram time (Tau). For core thermal power greater than or equal to 25% of rated and less than 30% of rated ($25\% \leq P < 30\%$), the Operating Limit MCPR is given by Figure 10. For core

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thermal power greater than or equal to 30% of rated ($P \geq 30\%$), the Operating Limit MCPR is the greater of either:

i) The applicable flow-dependent MCPR determined from Figure 11, or

ii) The appropriate RATED POWER MCPR from Figure 12 or 13 [Figure 14 for Recirculation Pump Trip Out of Service (RPTOOS) Figure 15 for both Turbine Bypass Valves Out-of-Service (TBVOOS); Figure 16 for TBVOOS and RPTOOS; Figure 17 for a single Turbine Bypass Valve Out of Service; Figure 18 for a single Turbine Bypass Valve Out of Service and RPTOOS.], multiplied by the applicable power-dependent MCPR multiplier determined from Figure 10.

b. During SLO with core thermal power greater than or equal to 25% of rated, the SLO Operating Limit MCPR is determined by adding 0.02 to the Operating Limit MCPR determined above.

4.0 Reload Fuel Bundles

FUEL TYPE	CYCLE LOADED	NUMBER
GE10-P8DXB327-8GZ2-100M-150-T	15	40
GE10-P8DXB327-10GZ1-100M-150-T	15	80
GE10-P8DXB342-12GZ-100T-150-T	16	40
GE10-P8DXB341-9GZ-100T-150-T	16	80
GE12-P10DSB370-14GZ-100T-150-T	17	48
GE12-P10DSB371-12GZ-100T-150-T	17	80

5.0 Thermal-Hydraulic Stability - TS 3.4.1.

a. Continued reactor operation within the "Exclusion Zone" on the power/flow map, as defined on Figure 19, is not permitted.

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b. Continued reactor operation within the "Buffer Zone" on the power/flow map, as defined on Figure 19, is not permitted when the thermal-hydraulic stability monitor (SOLOMON) is not operational.

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TABLE 1

Linear Heat Generation Rate
as a function of
Planar Average Exposure*

Fuel type: GE10-P8DXB327-8GZ2-100M-150-T

Planar Average Exposure (GWd/ST)	Linear Heat Generation Rate (KW/ft)
0.0	11.72
0.2	11.77
1.0	11.88
2.0	11.96
3.0	12.04
4.0	12.10
5.0	12.17
6.0	12.24
7.0	12.31
8.0	12.39
9.0	12.47
10.0	12.56
12.5	12.57
15.0	12.33
20.0	11.81
25.0	11.29
35.0	10.20
45.0	8.48
50.1	5.90

* These are nominal values to be used for manual calculations. The actual lattice-type dependent values are modeled in the process computer.

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TABLE 2

Linear Heat Generation Rate
as a function of
Planar Average Exposure*

Fuel type: GE10-P8DXB327-10GZ1-100M-150-T

Planar Average Exposure (GWd/ST)	Linear Heat Generation Rate (KW/ft)
0.0	11.49
0.2	11.56
1.0	11.71
2.0	11.88
3.0	12.05
4.0	12.23
5.0	12.42
6.0	12.57
7.0	12.70
8.0	12.82
9.0	12.95
10.0	13.09
12.5	13.17
15.0	12.90
20.0	12.16
25.0	11.38
35.0	9.92
45.0	8.51
50.7	5.77

* These are nominal values to be used for manual calculations. The actual lattice-type dependent values are modeled in the process computer.

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TABLE 3

Linear Heat Generation Rate
as a function of
Planar Average Exposure*

Fuel type: GE10-P8DXB342-12GZ-100T-150-T

Planar Average Exposure (GWd/ST)	Linear Heat Generation Rate (KW/ft)
0.00	11.27
0.20	11.32
1.00	11.42
2.00	11.63
3.00	11.87
4.00	12.01
5.00	12.15
6.00	12.29
7.00	12.44
8.00	12.61
9.00	12.81
10.00	13.02
12.50	13.15
15.00	13.09
20.00	12.27
25.00	11.47
35.00	9.90
45.00	8.53
50.98	5.64

* These are nominal values to be used for manual calculations. The actual lattice-type dependent values are modeled in the process computer.

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TABLE 4

Linear Heat Generation Rate
as a function of
Planar Average Exposure*

Fuel type: GE10-P8DXB341-9GZ-100T-150-T

Planar Average Exposure (GWd/ST)	Linear Heat Generation Rate (KW/ft)
0.00	11.87
0.20	11.89
1.00	11.94
2.00	12.08
3.00	12.26
4.00	12.44
5.00	12.55
6.00	12.66
7.00	12.76
8.00	12.86
9.00	12.99
10.00	13.12
12.50	13.35
15.00	12.89
20.00	12.02
25.00	11.20
35.00	9.73
45.00	8.54
51.02	5.65

* These are nominal values to be used for manual calculations. The actual lattice-type dependent values are modeled in the process computer.

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TABLE 5

Linear Heat Generation Rate
as a function of
Planar Average Exposure*

Fuel type: GE12-P10DSB371-12GZ-100T-150-T

Planar Average Exposure (GWd/ST)	Linear Heat Generation Rate (KW/ft)
0.00	8.99
0.20	9.04
1.00	9.13
2.00	9.26
3.00	9.40
4.00	9.54
5.00	9.69
6.00	9.84
7.00	9.98
8.00	10.11
9.00	10.17
10.00	10.23
11.00	10.30
12.00	10.30
13.00	10.29
14.00	10.28
15.00	10.19
17.00	9.99
20.00	9.69
25.00	9.21
30.00	8.73
35.00	8.26
40.00	7.81
45.00	7.29
50.00	6.79
55.00	6.29
57.84	6.01

* These are nominal values to be used for manual calculations. The actual lattice-type dependent values are modeled in the process computer.

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TABLE 6

Linear Heat Generation Rate
as a function of
Planar Average Exposure*

Fuel type: GE12-P10DSB370-14GZ-100T-150-T

Planar Average Exposure (GWd/ST)	Linear Heat Generation Rate (KW/ft)
0.00	8.92
0.20	8.95
1.00	9.01
2.00	9.13
3.00	9.27
4.00	9.41
5.00	9.56
6.00	9.72
7.00	9.88
8.00	10.01
9.00	10.13
10.00	10.23
11.00	10.31
12.00	10.31
13.00	10.31
14.00	10.30
15.00	10.21
17.00	10.00
20.00	9.69
25.00	9.20
30.00	8.72
35.00	8.25
40.00	7.79
45.00	7.27
50.00	6.77
55.00	6.27
57.68	6.00

* These are nominal values to be used for manual calculations. The actual lattice-type dependent values are modeled in the process computer.

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MAPLHGR VS PAE

GE10-P8DXB327-8GZ2-100M-150-T

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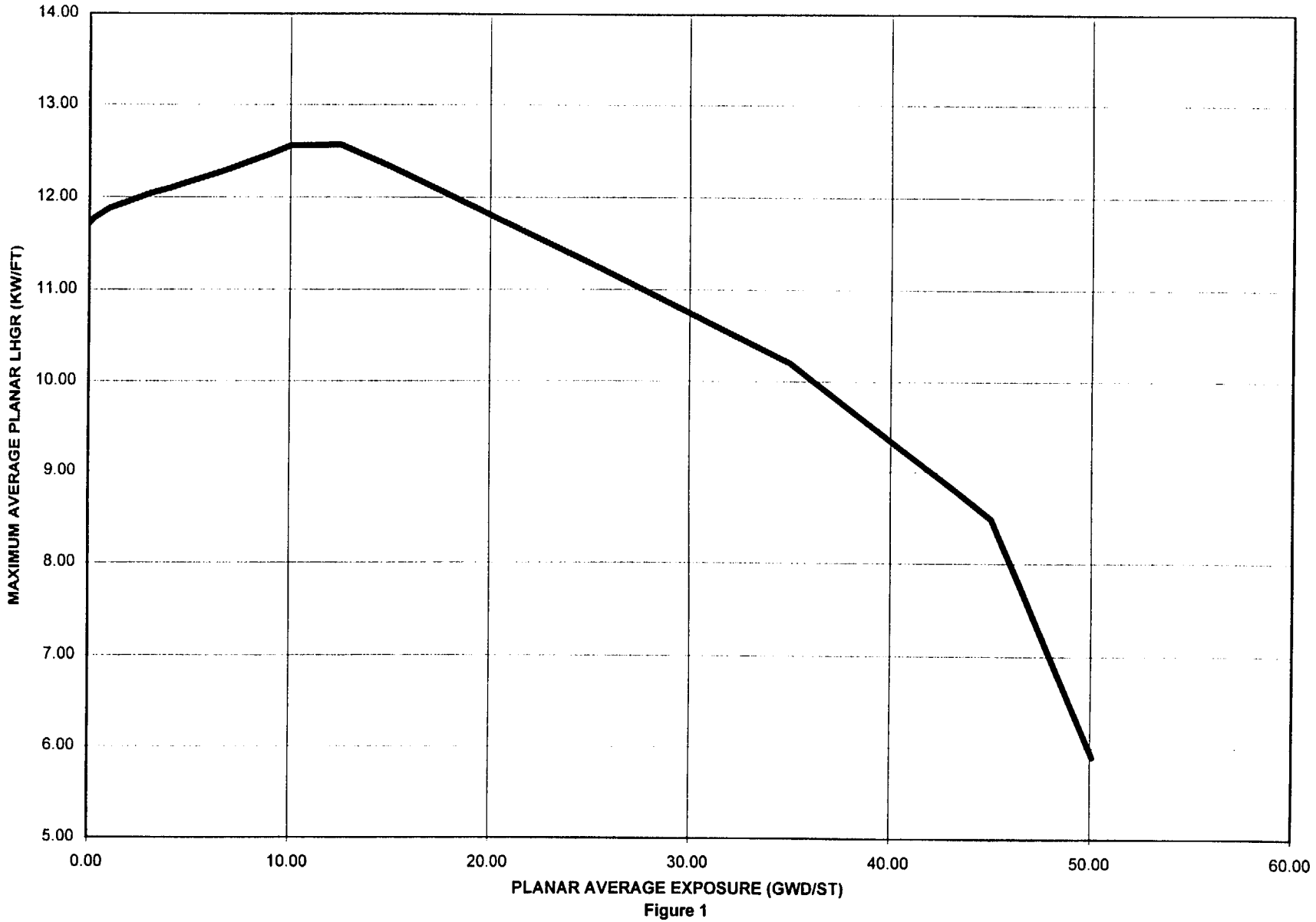

Figure 1

MAPLHGR VS PAE

GE10-P8DXB327-10GZ1-100M-150-T

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Verifier Initials

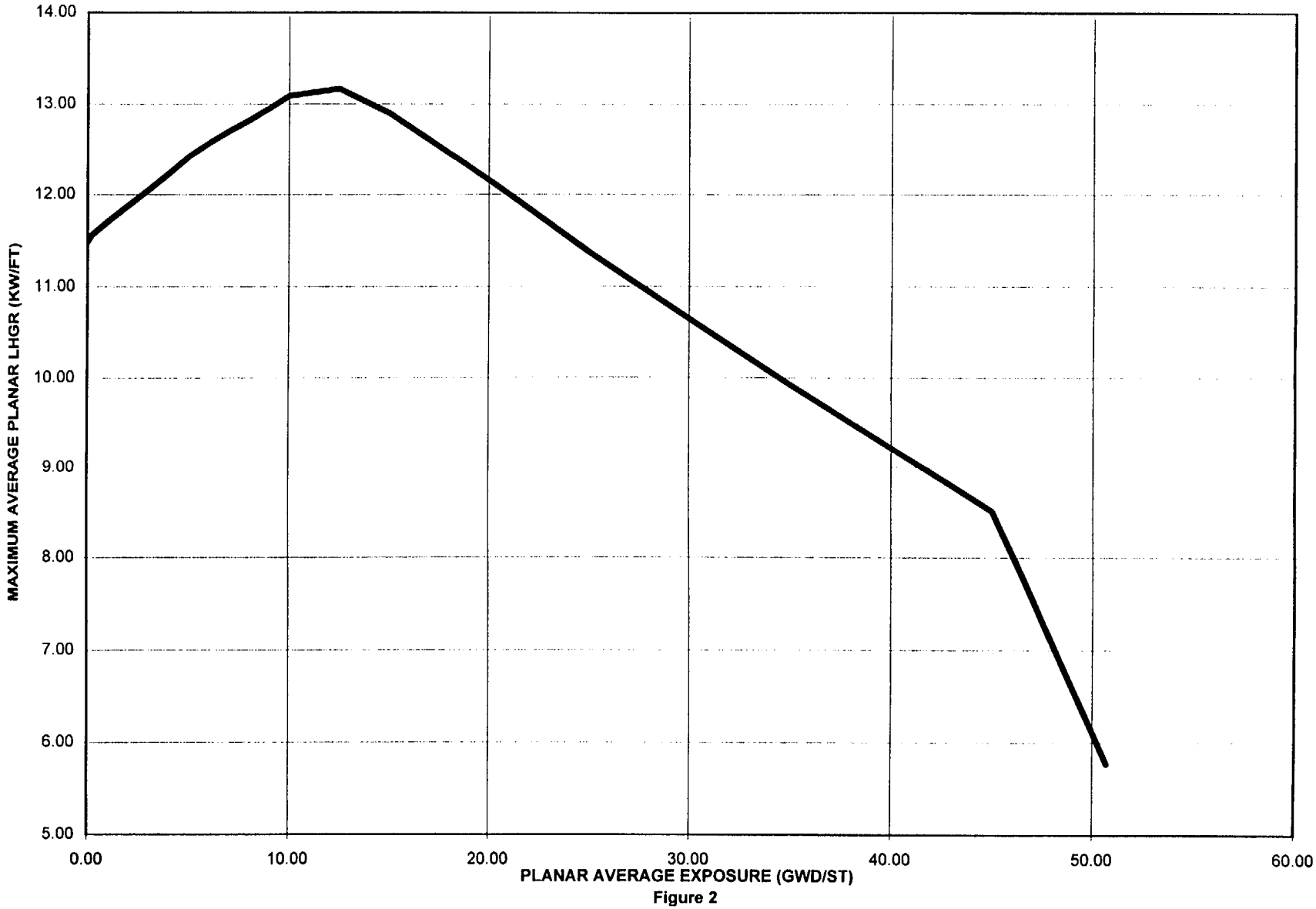

Figure 2

MAPLHGR VS PAE

GE10-P8DXB342-12GZ-100T-150-T

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Verifier Initials

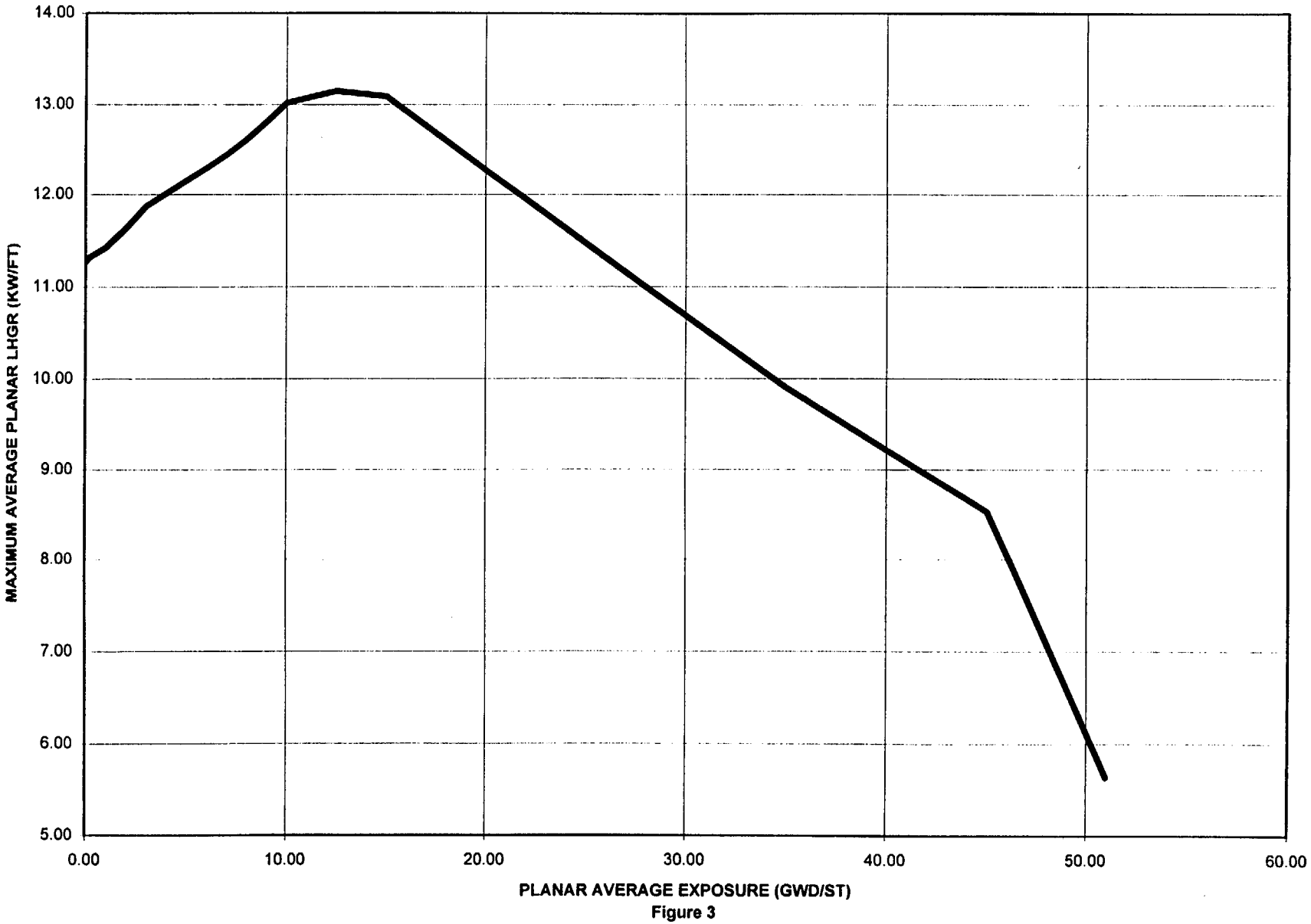

Figure 3

MAPLHGR VS PAE

GE10-P8DXB341-9GZ-100T-150_T

Preparer Initials
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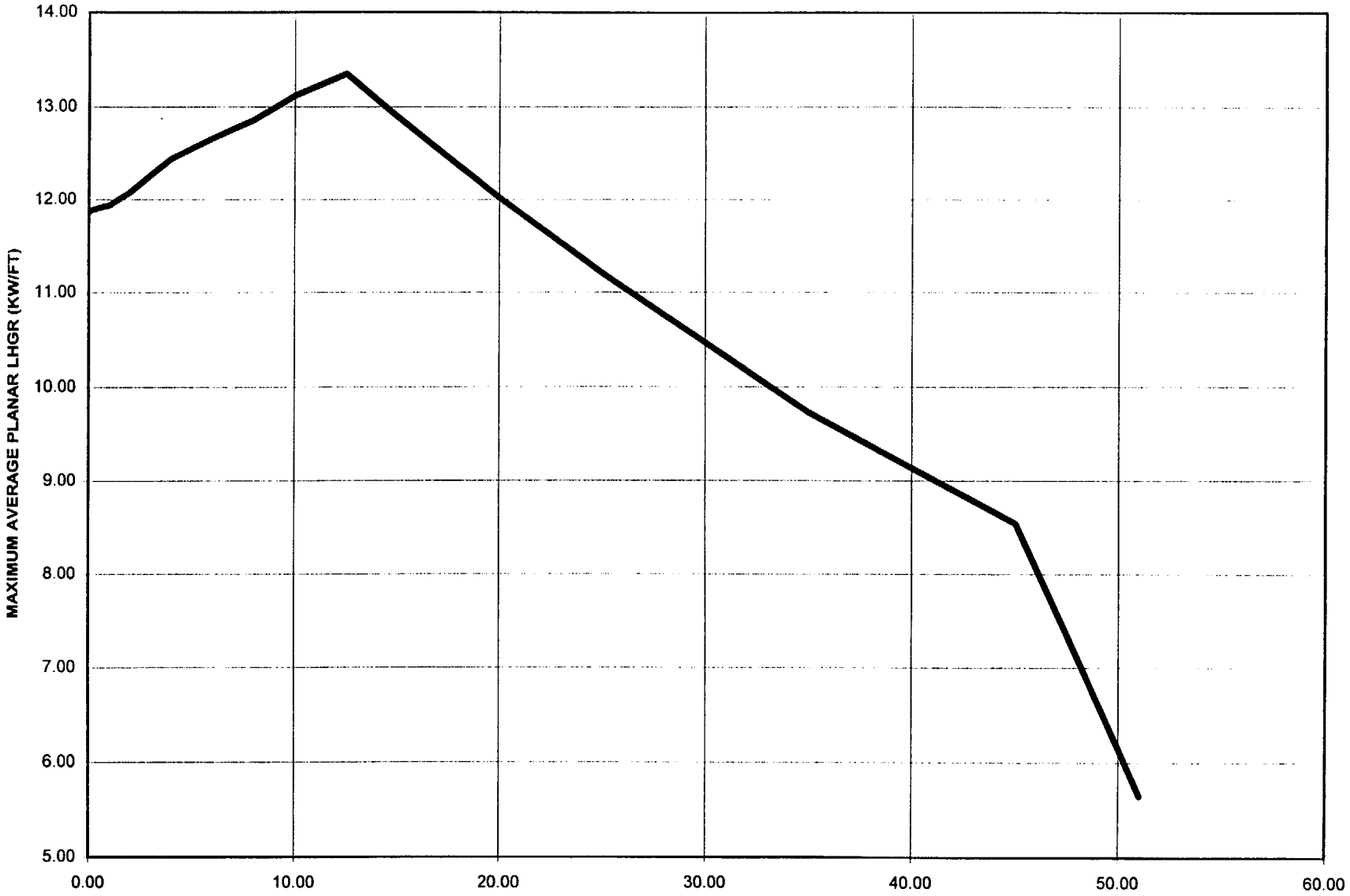

Figure 4

MAPLHGR VS PAE

GE12-P10DSB371-12GZ-100T-150-T (GE12B)

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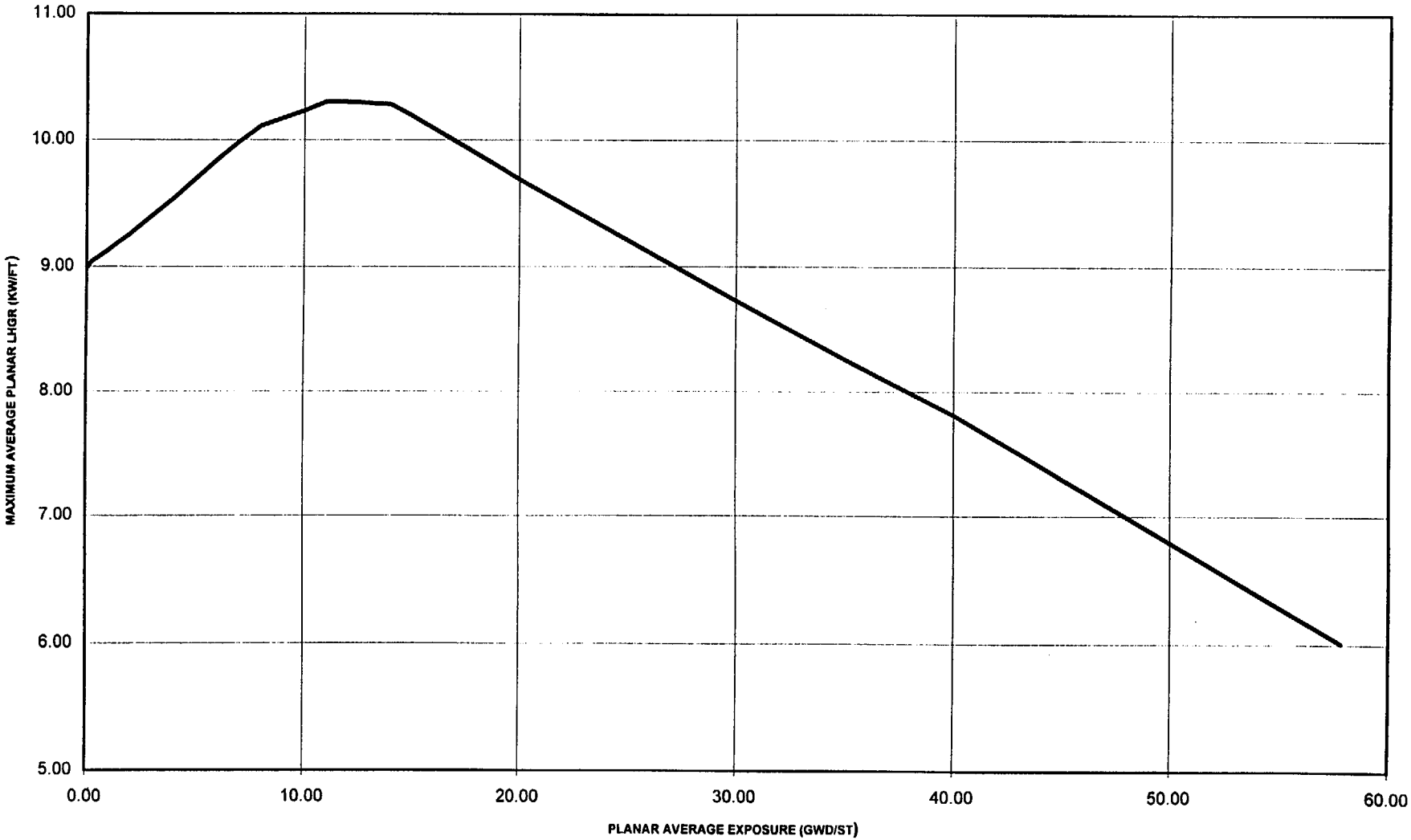

Figure 5

MAPLHGR VS PAE

GE12-P10DSB370-14GZ-100T-150-T (GE12B)

Preparer Initials
Verifier Initials

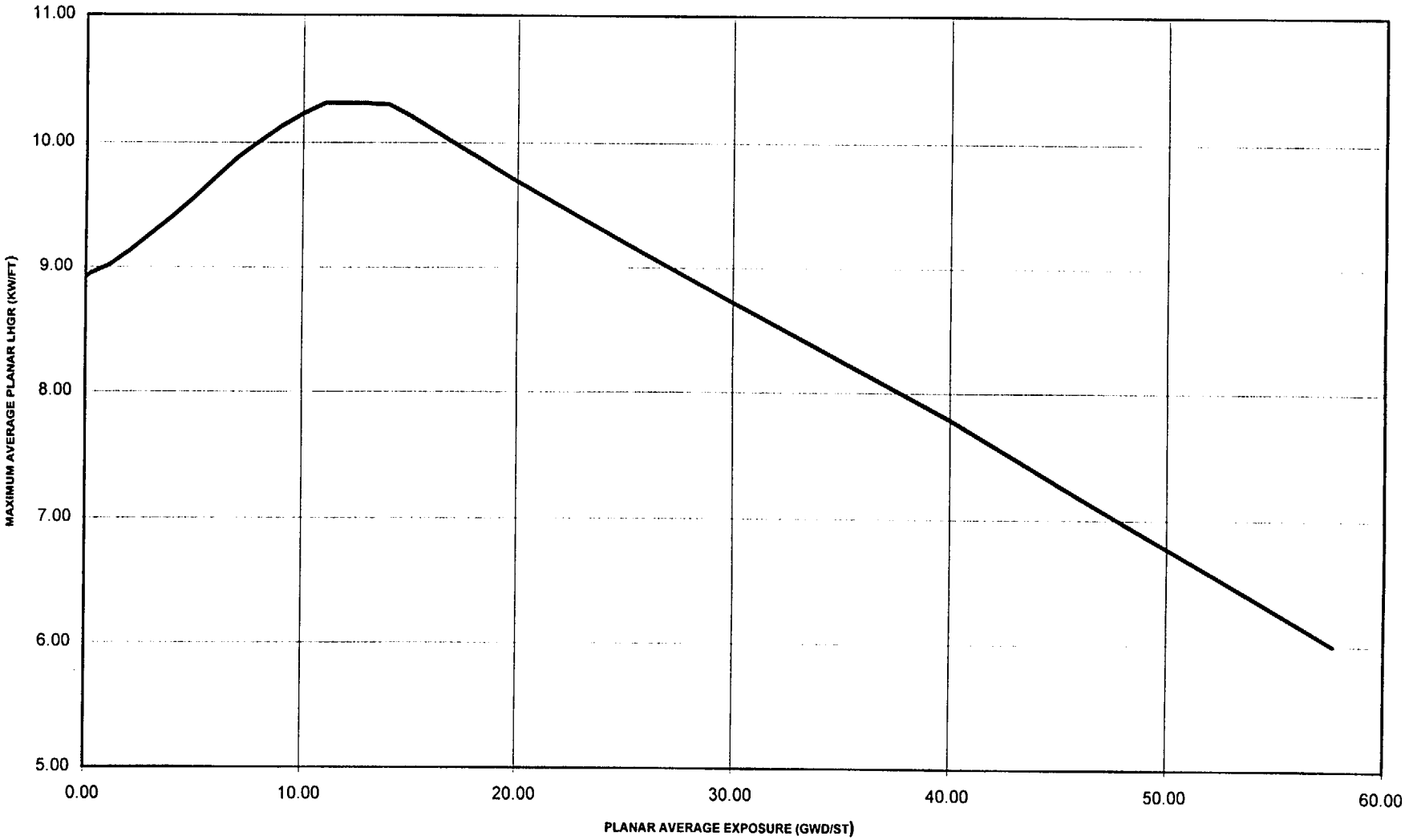

Figure 6

FLOW DEPENDENT MAPLHGR MULTIPLIER

TWO LOOP OPERATION

Preparer Initials
Verifier Initials

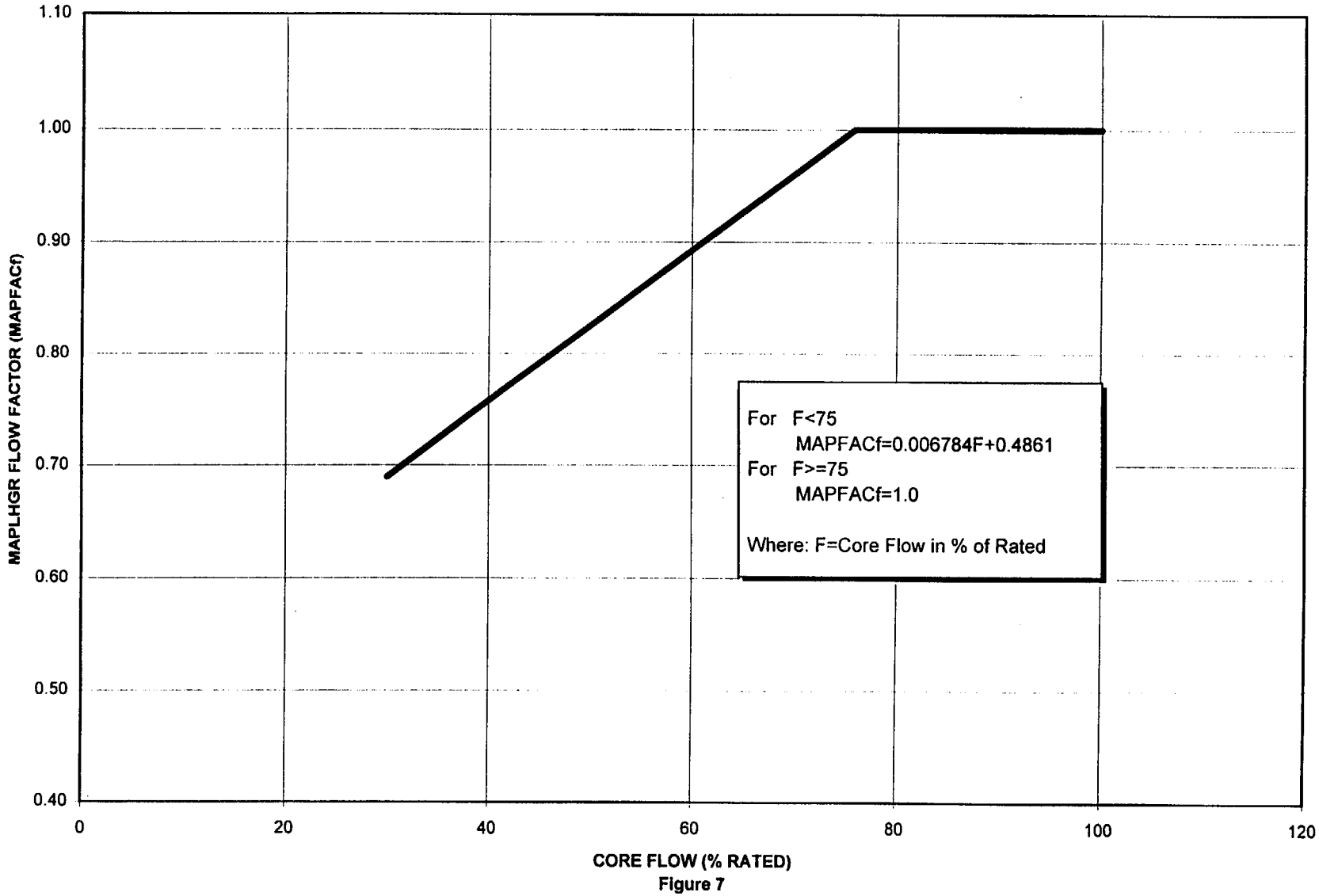

Figure 7

POWER DEPENDENT MAPLHGR MULTIPLIER

Preparer Initials
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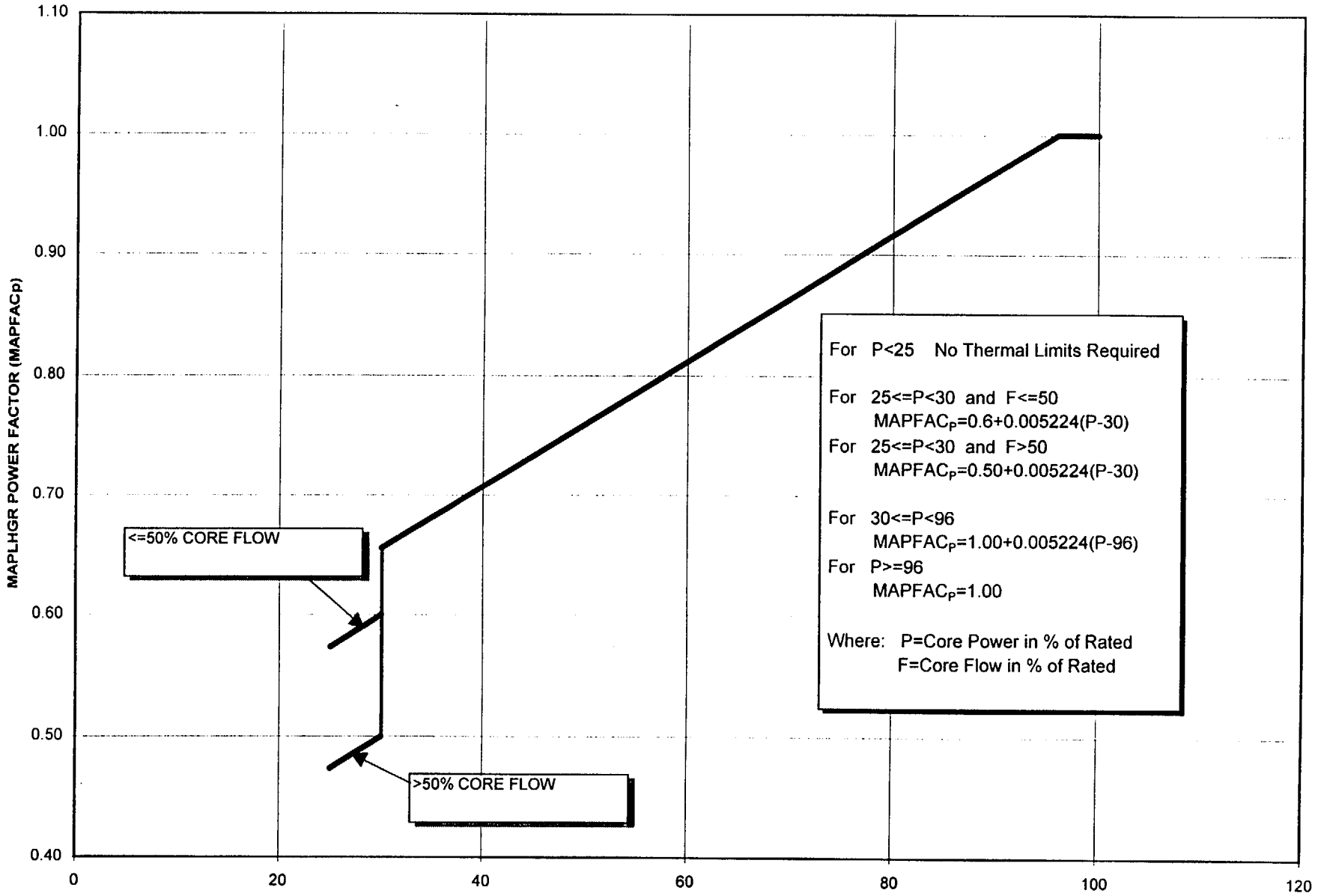

Figure 8

FLOW DEPENDENT MAPLHGR MULTIPLIER

SINGLE LOOP OPERATION

Preparer Initials
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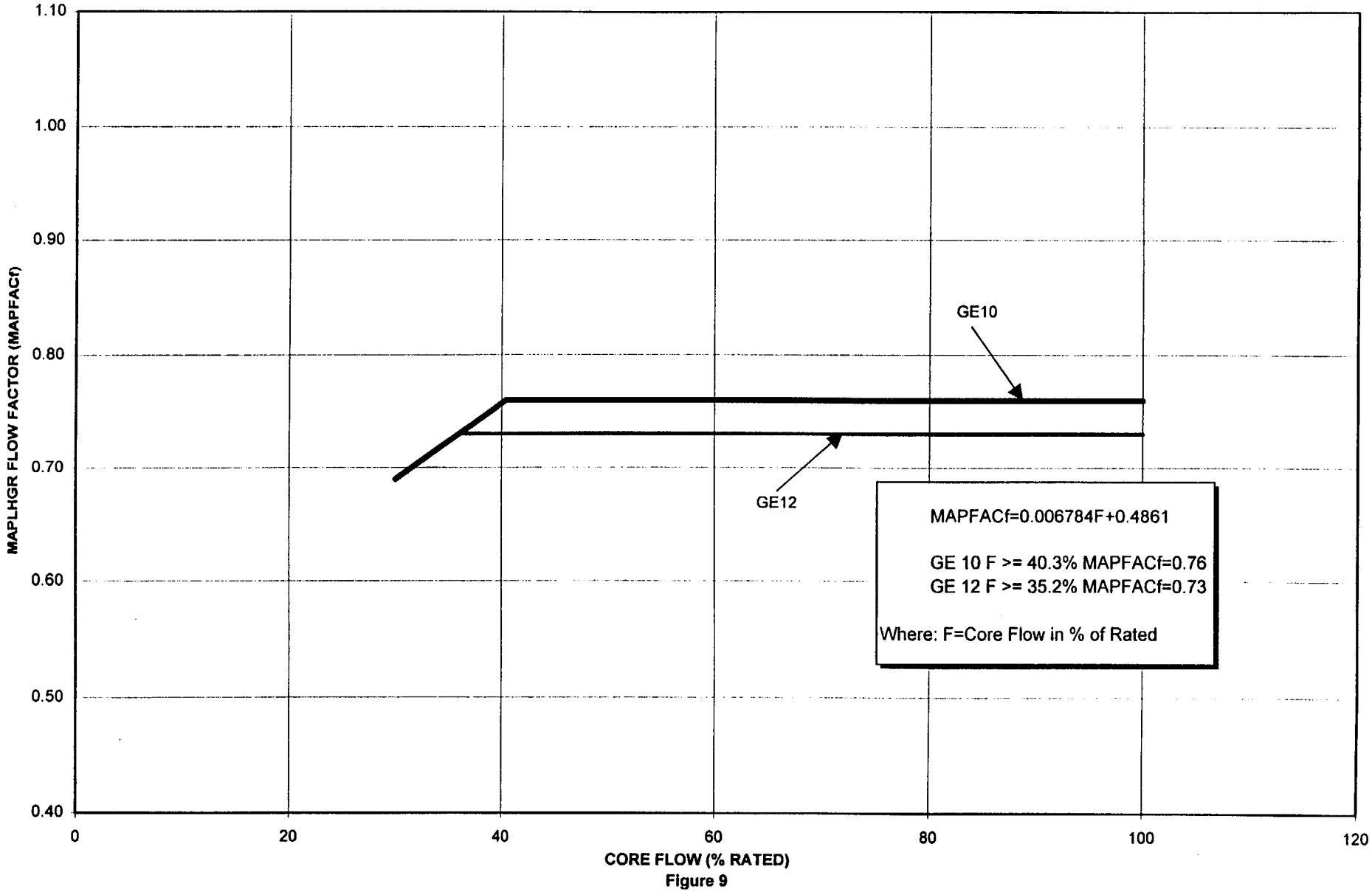

Figure 9

Power Dependent MCPR LIMITS

Preparer Initials
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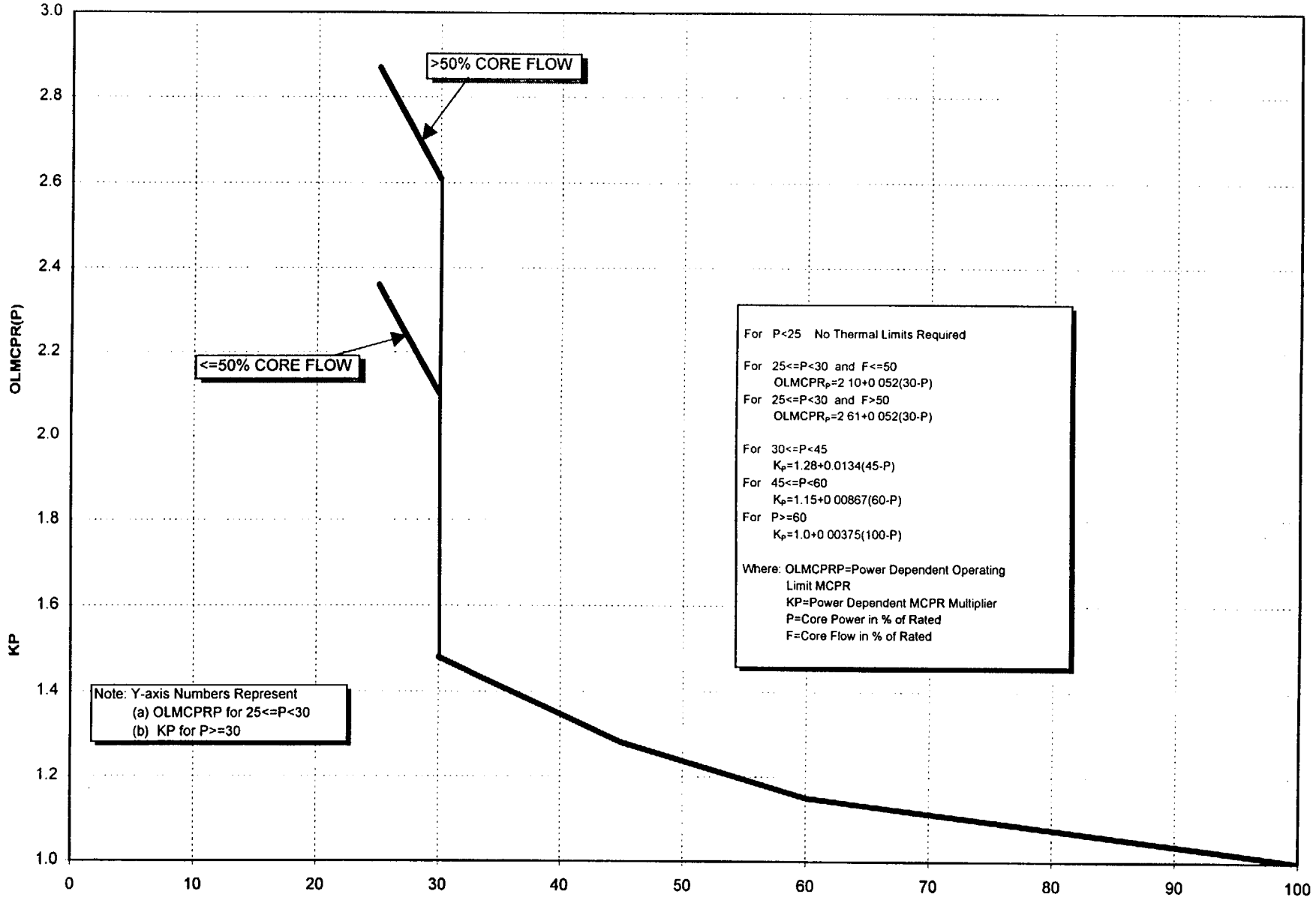

Figure 10

FLOW DEPENDENT MCPR LIMITS

Preparer Initials
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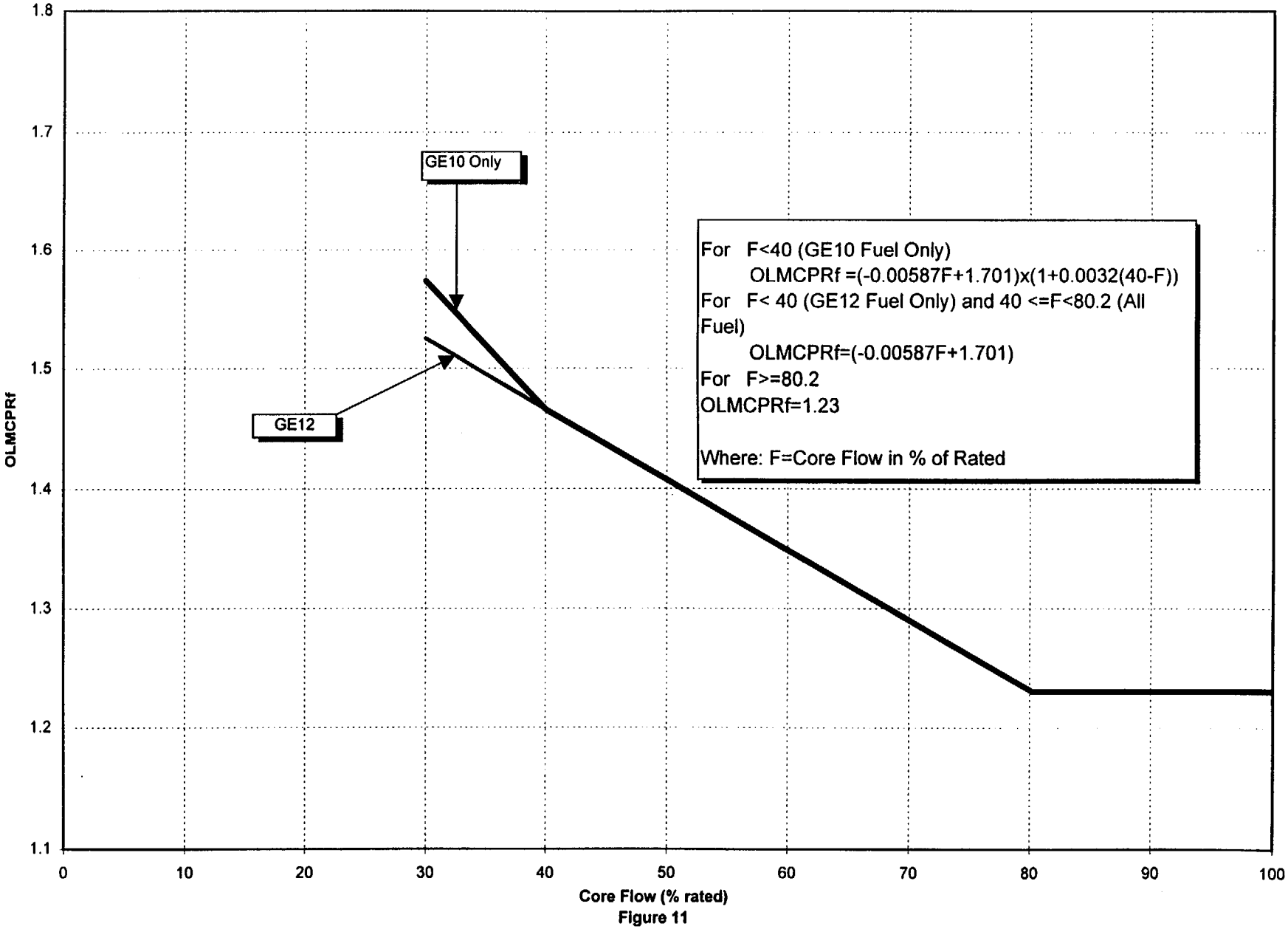

Figure 11

MCPR vs TAU
BOC to (EOC - 2000 MWD/STU)

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Option B

Option A

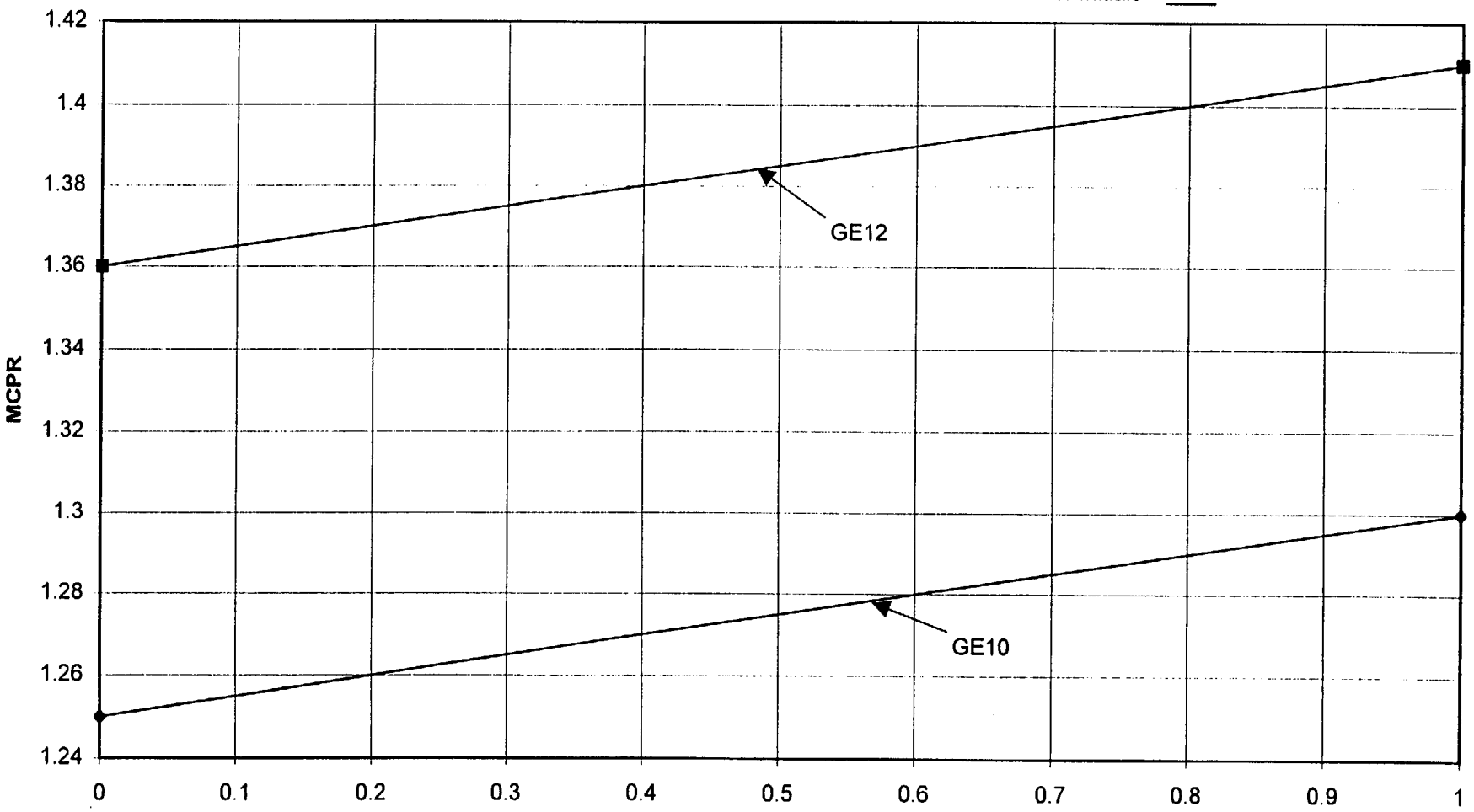

Figure 12

Limiting Event:
GE10 -> LRNBP Standard
GE12 -> LRNBP ELLL

MCPR vs TAU
(EOC - 2000 MWD/STU) to EOC

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Verifier Initials

Option B

Option A

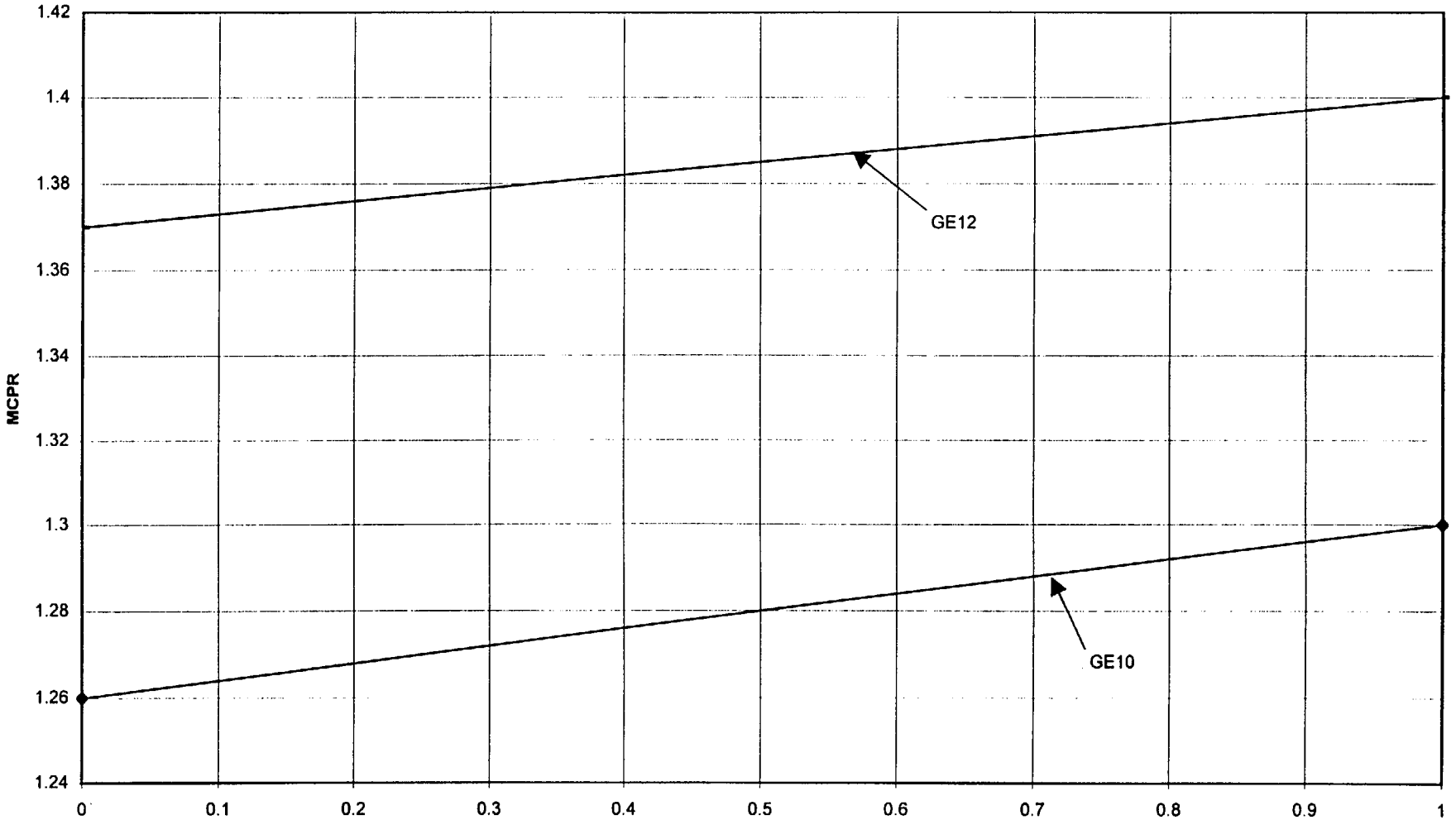

Figure 13

Limiting Event
GE10 -> LRNBP Standard
GE12 -> LRNBP ELLL

MCPR vs TAU
RPTOOS

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Option B

Option A

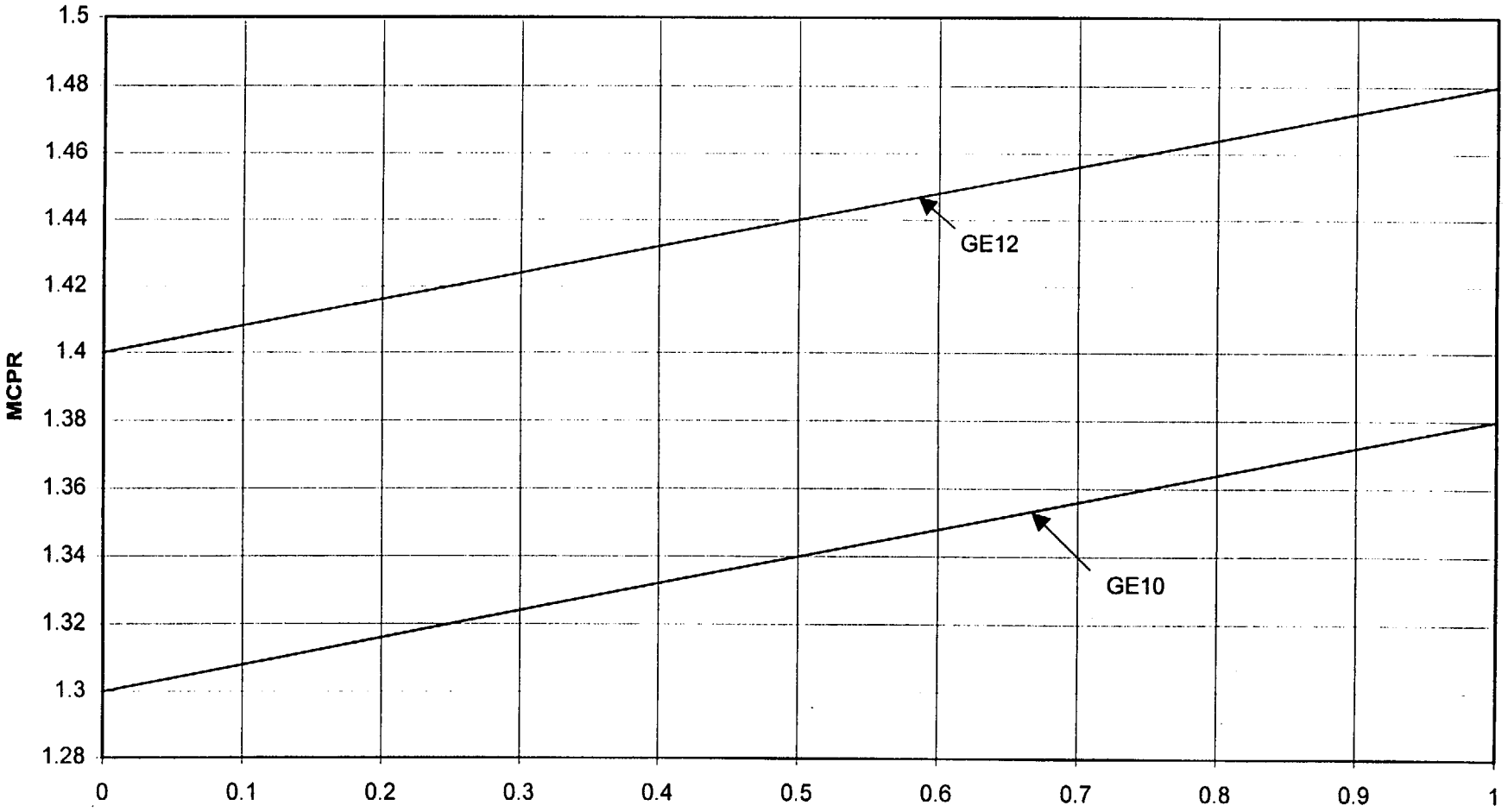

Figure 14

Limiting Event
LRNBP Standard for all fuel

MCPR vs TAU
TBVOOS

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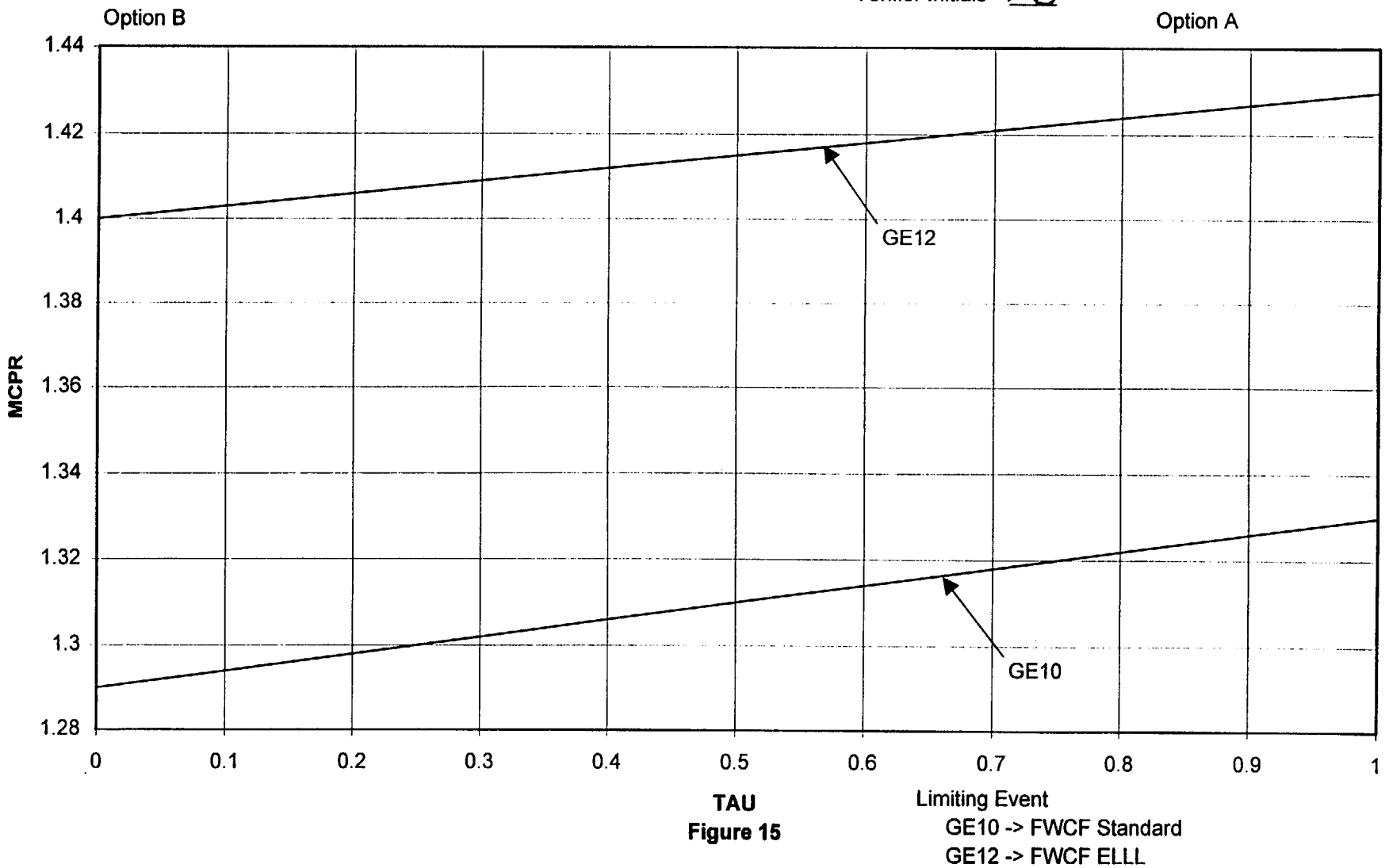

Figure 15

Limiting Event
GE10 -> FWCF Standard
GE12 -> FWCF ELLL

MCPR vs TAU
TBVOOS - RPTOOS

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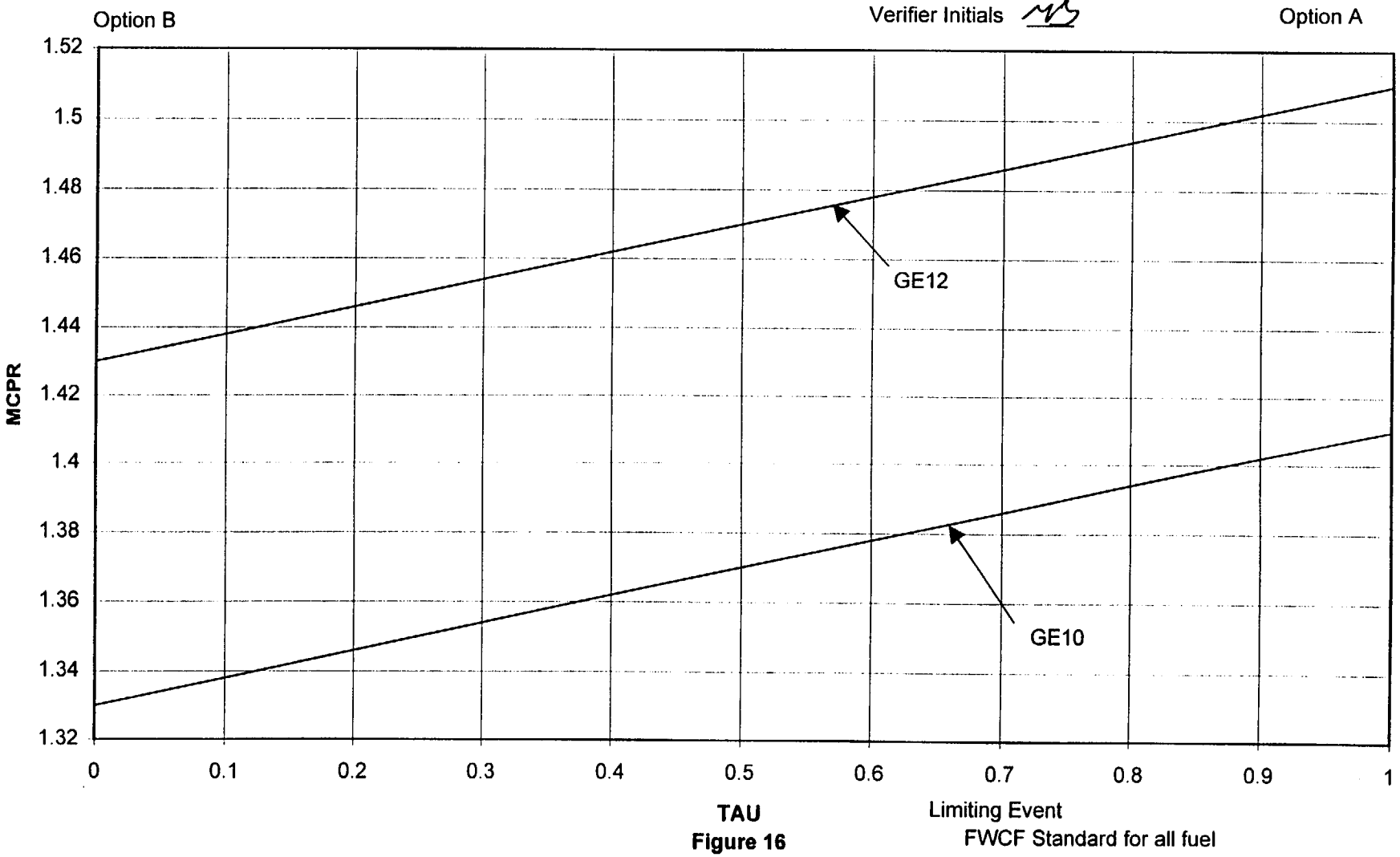
Verifier Initials



Limiting Event
FWCF Standard for all fuel

Figure 16

MCPR vs TAU
1TBVOOS

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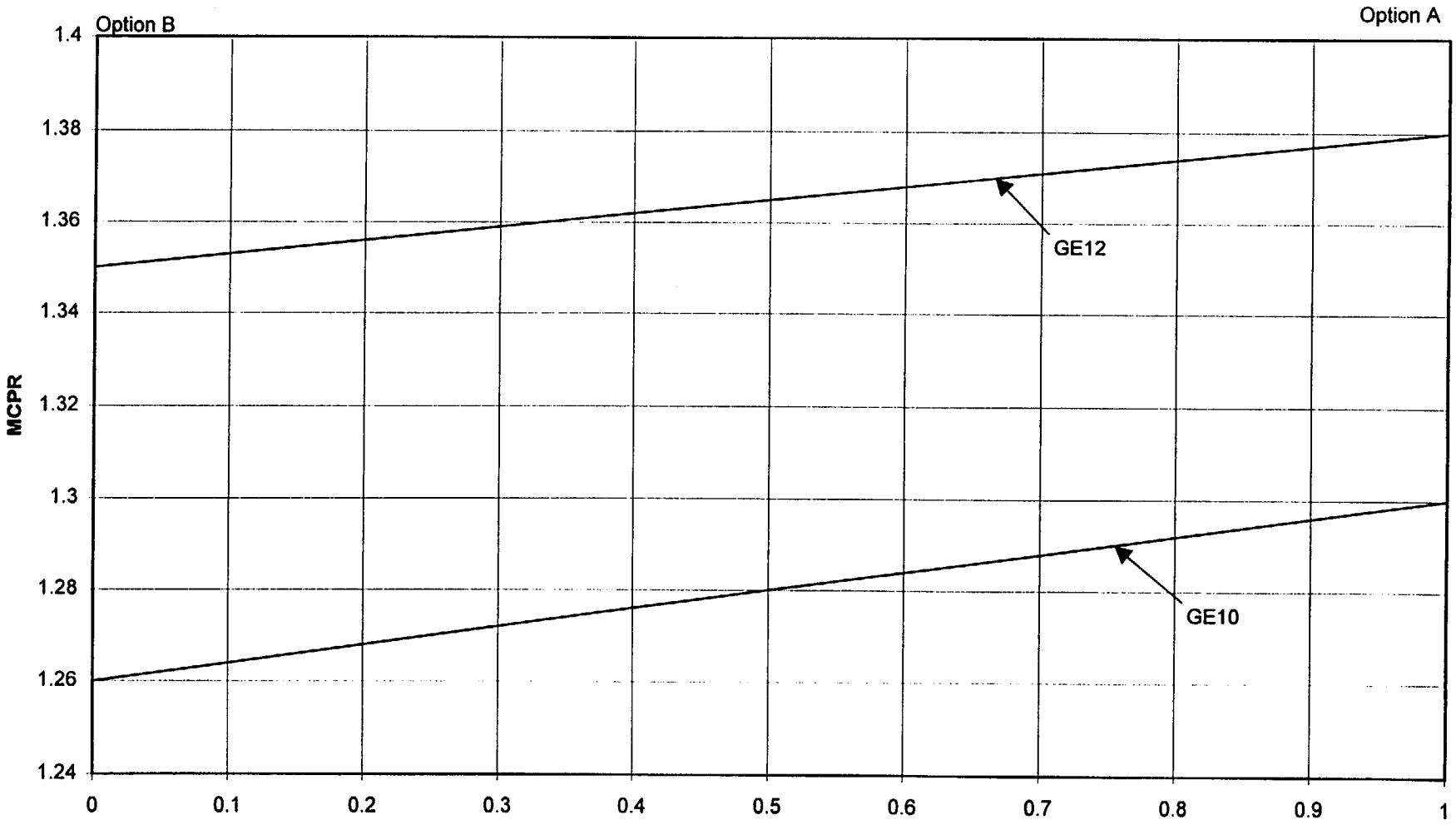

Figure 17

Limiting Event
GE10 -> FWCF Standard
GE12 -> FWCF ELLL

MCPR vs TAU
1TBVOOS - RPTOOS

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Verifier Initials

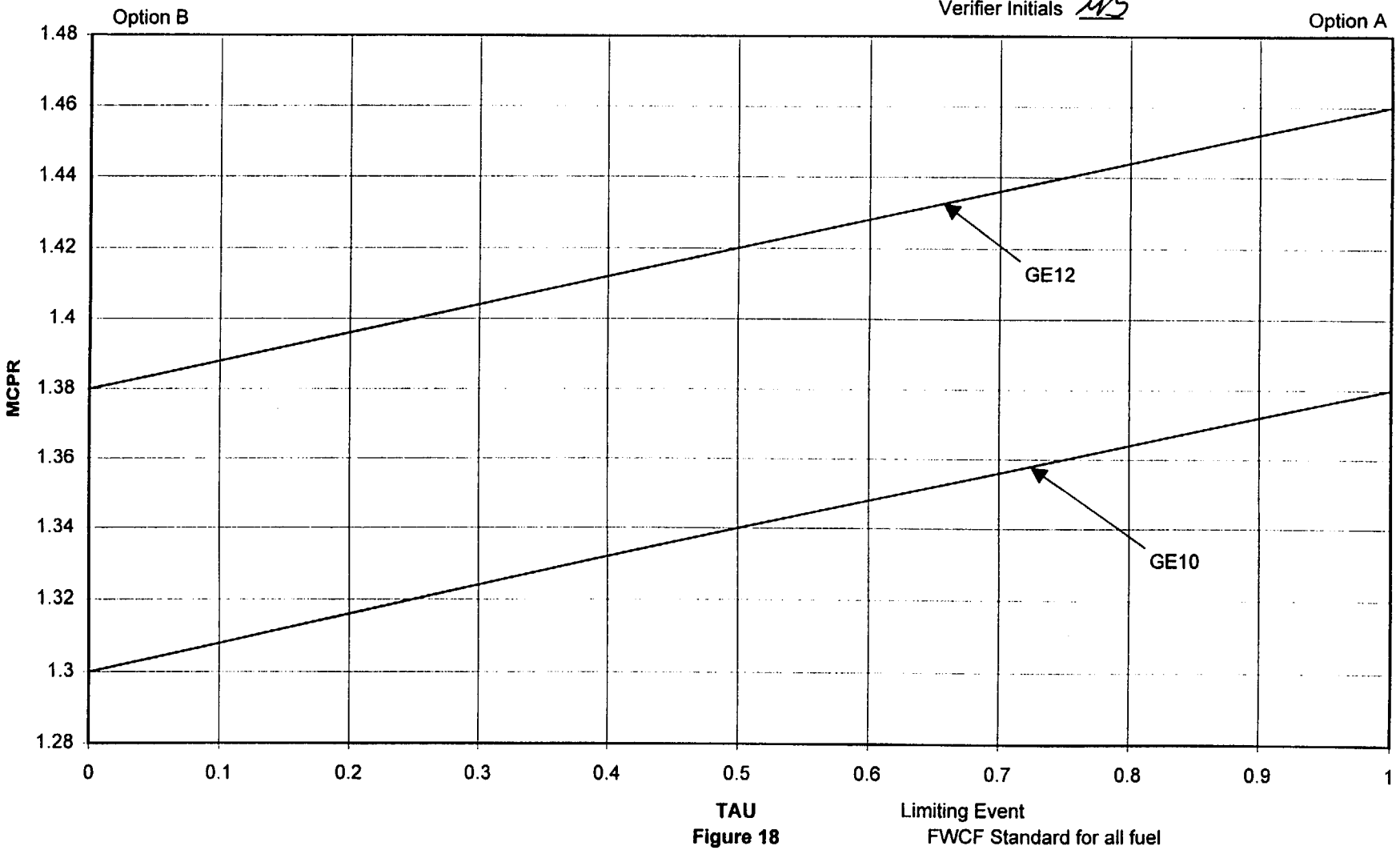

Figure 18

DAEC Stability Power/Flow Map

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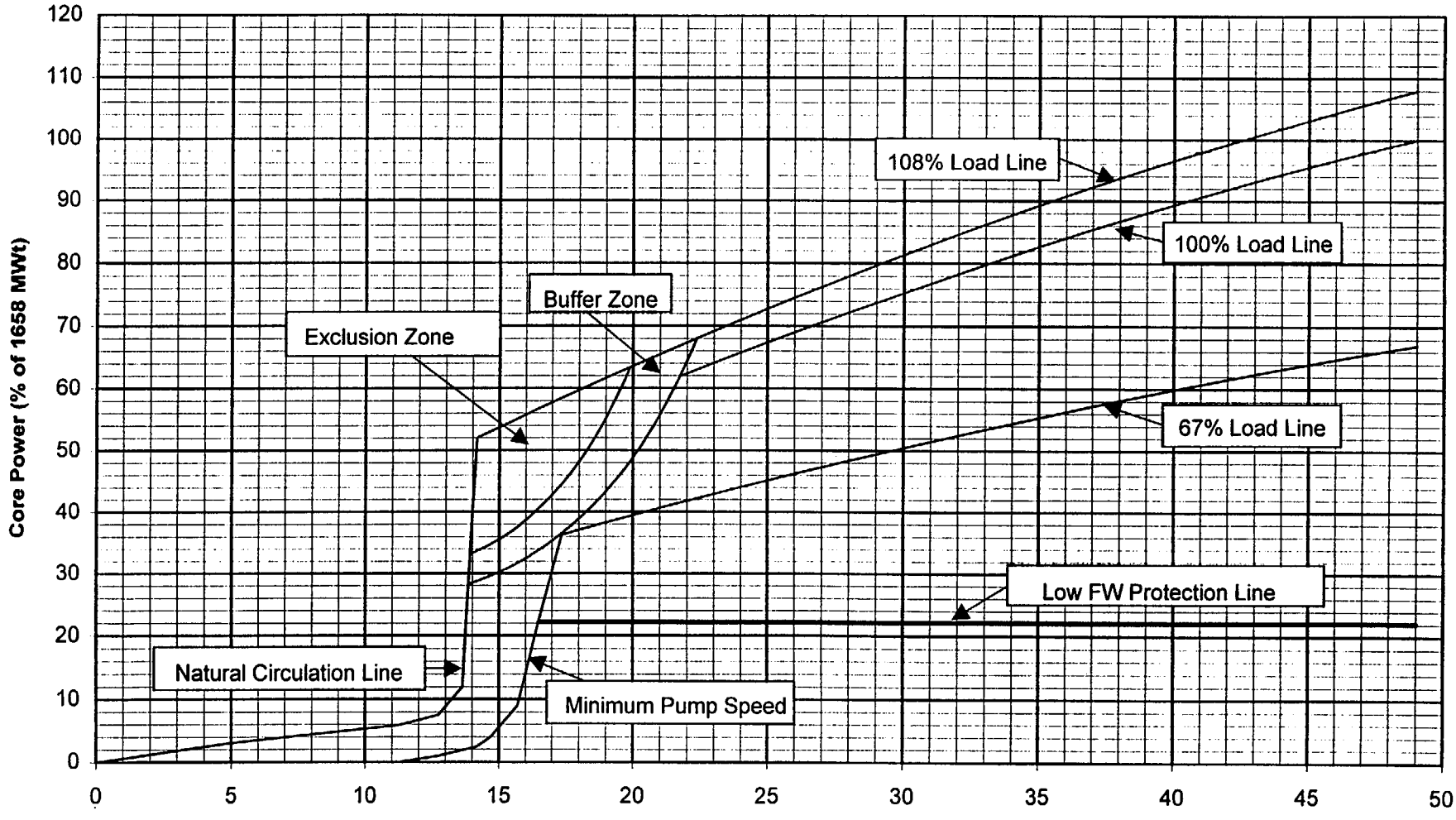

Figure 19