NEW YORK POWER AUTHORITY
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
REPORT

**CORE OPERATING LIMITS REPORT**
**REVISION 2**

REVIEWED BY: PLANT OPERATIONS REVIEW COMMITTEE

MEETING NO. 94-159 DATE 12/22/94

APPROVED BY: _____ DATE 12-29-94
REACTOR ANALYST SUPERVISOR

APPROVED BY: _____ DATE 1/6/94
RESIDENT MANAGER

1.0 PURPOSE

This report provides the cycle-specific operating limits for Cycle 12 of the James A. FitzPatrick Nuclear Power Plant. The following limits are addressed:

Operating Limit Minimum Critical Power Ratio (MCPR)

Flow Dependent MCPR Limits

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)

Linear Heat Generation Rate (LHGR)

Flow-Biased Average Power Range Monitor (APRM) and Rod Block Monitor (RBM) Settings

2.0 APPLICABILITY

The plant shall be operated within the limits specified in this report. If any of these limits are violated, the corrective actions specified in the Technical Specifications shall be taken.

3.0 REFERENCES

3.1 JAFNPP Administrative Procedure 12.05, Control of Core Operating Limits Report.

3.2 JAFNPP License Appendix A, Operating Technical Specifications.

3.3 FitzPatrick Cycle 12 Core Reload Safety Evaluation, JAF-SE-94-127.

3.4 JAFNPP SAFER/GESTR-LOCA Loss of Coolant Analysis, NEDE-31317P, including Errata and Addenda Sheets 1, 2 and 3.

3.5 Supplemental Reload Licensing Submittal for JAFNPP Reload 11 Cycle 12, GE Report 24A5167 Revision 0 December,1994. Includes a Supplement 1 containing MAPLHGR DATA.

3.6 Supplement 1 to GE Report 23A7114 June,1992. Contains MAPLHGR Data for Reload 10 Fuel.

3.7 Cycle 12 Core Reload, M1-94-164.

3.8 RAP-7.3.17 Rev.5, Core Monitoring Software and Database Changes.

4.0 DEFINITIONS

4.1 Minimum critical power ratio (MCPR) Minimum value of the ratio of that power in a fuel assembly which is calculated to cause some point in that fuel assembly to experience boiling transition to the actual assembly operating power as calculated by application of the GEXL correlation (Reference NEDE-10958).

4.2 Fraction of Limiting Power Density - The ratio of the linear heat generation rate (LHGR) existing at a given location to the design LHGR. The design LHGR is given in Table 8.2.

4.3 Maximum Fraction of Limiting Power Density - The Maximum Fraction of Limiting Power Density (MFLPD) is the highest value existing in the core of the Fraction of Limiting Power Density (FLPD).

4.4 Rated Recirculation Flow - that drive flow which produces a core flow of $77.0 \times 10^6$ lb/hr.

5.0 RESPONSIBILITIES

5.1 See AP-12.05 (Reference 3.1).

5.2 It is the responsibility of the Shift Supervisor to assure that the reactor is operated within the limits described herein.

5.3 It is the responsibility of the Reactor Analyst Supervisor to assure that the limits described herein are properly installed in the 3D-Monicore databank used for thermal limit surveillance (Reference 3.8)

6.0 SPECIAL INSTRUCTIONS/REQUIREMENTS

Not applicable.

## 7.0 PROCEDURE

### 7.1 Operating Limit MCPR

During power operation, The Operating Limit MCPR shall be equal to or greater than the limits given below.

7.1.1 Technical Specification Reference: 3.1.B

7.1.2 The Operating Limit MCPR shall be determined based on the following requirement:

7.1.2.1 The average scram time to notch position 38 shall be:

$$\tau_{AVE} \leq \tau_B$$

7.1.2.2 The average scram time to notch position 38 is determined as follows:

$$\tau_{AVE} = \frac{\sum_{i=1}^{n} N_i \tau_i}{\sum_{i=1}^{n} N_i}$$

where:

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

$N_i$ = number of active rods measured in the $_i$th surveillance, and

$\tau_i$ = average scram time to notch position 38 of all rods measured in the $_i$th surveillance test.

7.1.2.3 The adjusted analysis mean scram time is calculated as follows:

$$\tau_B \text{ (sec)} = \mu + 1.65\ \sigma \left[ \frac{N_1}{\sum_{i=1}^{n} N_i} \right]^{1/2}$$

where:

$\mu$ = mean of the distribution for the average scram insertion time to the pickup of notch position 38 = 0.706 sec.

$\sigma$ = standard deviation of the distribution for average scram insertion time to the pickup of notch position 38 = 0.016 sec.

$N_1$ = the total number of active rods measured in Technical Specification 4.3.C.1.

The number of rods to be scram tested and the test intervals are given in Technical Specification 4.3.C.

7.1.3 When requirement of 7.1.2 is met, the Operating Limit MCPR shall not be less than that specified in Table 8.1.

7.1.4 When the requirement 7.1.2 is not met (i.e. $\tau_B < \tau_{AVE}$) then the Operating Limit MCPR values (as a function of $\tau$) are given in Figure 8.1,

where $\tau = (\tau_{AVE} - \tau_B) / (\tau_A - \tau_B)$

and

$\tau_{AVE}$ = the average scram time to notch position 38 as defined in 7.1.2.2.

$\tau_B$ = the adjusted analysis mean scram time as defined in 7.1.2.3

$\tau_A$ = the scram time to notch position 38 as defined in Technical Specification 3.3.C.1.

7.1.5 During single-loop operation, the Operating Limit MCPR shall be increased by 0.01.

7.1.6 During reactor power operation with core flow less than 100 percent of rated, the Operating Limit MCPR shall be multiplied by the appropriate $K_f$ specified in Figure 8.2.

7.2 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)

7.2.1 Technical Specification Reference: 3.5.H

7.2.2 During power operation, the APLHGR for each fuel type as a function of axial location and average planar exposure shall be within limits based on applicable APLHGR limit values which have been approved for the respective fuel and lattice types.

7.2.3 When hand calculations are required, the APLHGR for each type of fuel as a function of average planar exposure shall not exceed the limiting value for the most limiting lattice (excluding natural uranium) shown in Figures 8.3.a through h.

7.2.4 During single loop operation, the APLHGR for each fuel type shall not exceed the values given in 7.2.2 or 7.2.3 above multiplied by 0.84.

7.3 Linear Heat Generation Rate (LHGR)

7.3.1 Technical Specification Reference: 3.5.I.

7.3.2 The LHGR of any rod in any fuel assembly at any axial location shall not exceed the maximum allowable LHGR specified in Table 8.2.

## 7.4 APRM Trip Settings

### 7.4.1 APRM Flow Referenced Flux Scram Trip Setting (Run Mode)

#### 7.4.1.1 Technical Specification References:
2.1.A.1.c, Table 3.1-1, 3.1.A

#### 7.4.1.2
When the Mode Switch is in the RUN position, the APRM flow referenced flux scram trip setting shall be

$S \leq 0.66W + 54\%$ for two loop operation;

$S \leq 0.66W + 54\% - 0.66\ \Delta W$ for single loop operation;

where:

S = setting in percent of rated thermal power (2436 MWt);

W = recirculation flow in percent of rated;

$\Delta W$ = difference between two loop and single-loop effective drive flow at the same core flow.

#### 7.4.1.3
In the event of operation with a maximum fraction of limiting power density (MFLPD) greater than the fraction of rated power (FRP), the setting shall be modified as follows:

$S \leq (0.66W + 54\%)(FRP/MFLPD)$ for two loop operation;

$S \leq (0.66W + 54\% - 0.66\ \Delta W)(FRP/MFLPD)$ for single-loop operation;

where:

FRP = fraction of rated thermal power (2436 Mwt);

MFLPD = Maximum fraction of limiting power density, where the limiting power density is as specified in Table 8.2.

The ratio of FRP to MFLPD shall be set equal to 1.0 unless the actual operating value is less than the design value of 1.0, in which

case the actual operating value will be used.

7.4.2 APRM Flow Biased Rod Block Setting

7.4.2.1 Technical Specification References: 2.1.A.1.d, Table 3.2-3, 3.2.C.1

7.4.2.2 The APRM rod block trip setting shall be:

$S \leq 0.66W + 42\%$ for two loop operation;

$S \leq 0.66W + 42\% - 0.66\,\Delta W$ for single loop operation;

where:

S = rod block setting in percent of rated thermal power (2436 Mwt);

W = recirculation flow in percent of rated;

$\Delta W$ = difference between two loop and single loop effective drive flow at the same core flow.

7.4.2.3 In the event of operation with a maximum fraction of limiting power density (MFLPD) greater than the fraction of rated power (FRP), the setting shall be modified as follows:

$S \leq (0.66W + 42\%)(FRP/MFLPD)$ for two loop operation;

$S \leq (0.66W + 42\% - 0.66\Delta W)(FRP/MFLPD)$ for single loop operation;

where:

FRP = fraction of rated thermal power (2436 Mwt);

MFLPD = maximum fraction of limiting power density as specified in Table 8.2.

7.5 RBM Flow Biased Rod Block Setting

7.5.1 Technical Specification Reference: 3.2.C.1

7.5.2 The RBM flow biased rod block trip setting shall be:

$S \leq 0.66W + K$ for two loop operation;

$S \leq 0.66W + K - 0.66\Delta W$ for single loop operation;

where:

S = rod block setting in percent of initial;

W = loop flow in percent of rated

K = intercept values of 39%, 40%, 41%, 42%. 43%, and 44% can be used with the appropriate MCPR Operating Limit from Table 8.1(note that for Cycle 12 the RBM intercept value does not effect the MCPR Operating Limit for K values ≤ 44%);

$\Delta W$ = difference between two loop and single loop effective drive flow.

## 8.0 FIGURES AND TABLES



## 9.0 EXHIBITS

Not Applicable.

TABLE 8.1
MCPR Operating Limit for Incremental Cycle
Core Average Exposure

| Cycle 12 Exposure Range | GE11-P9HUB380-12GZ5-100M-146-T | All Other Fuel Bundle Types |
|---|---|---|
| BOC to 4 GWD/ST | 1.35 | 1.30 |
| >4 GWD/ST to 9 GWD/ST | 1.30 | 1.30 |
| >9 GWD/ST to 10.5 GWD/ST | 1.31 | 1.31 |
| >10.5 GWD/ST to EOC | 1.34 | 1.34 |

Technical Specification Reference: 3.1.B

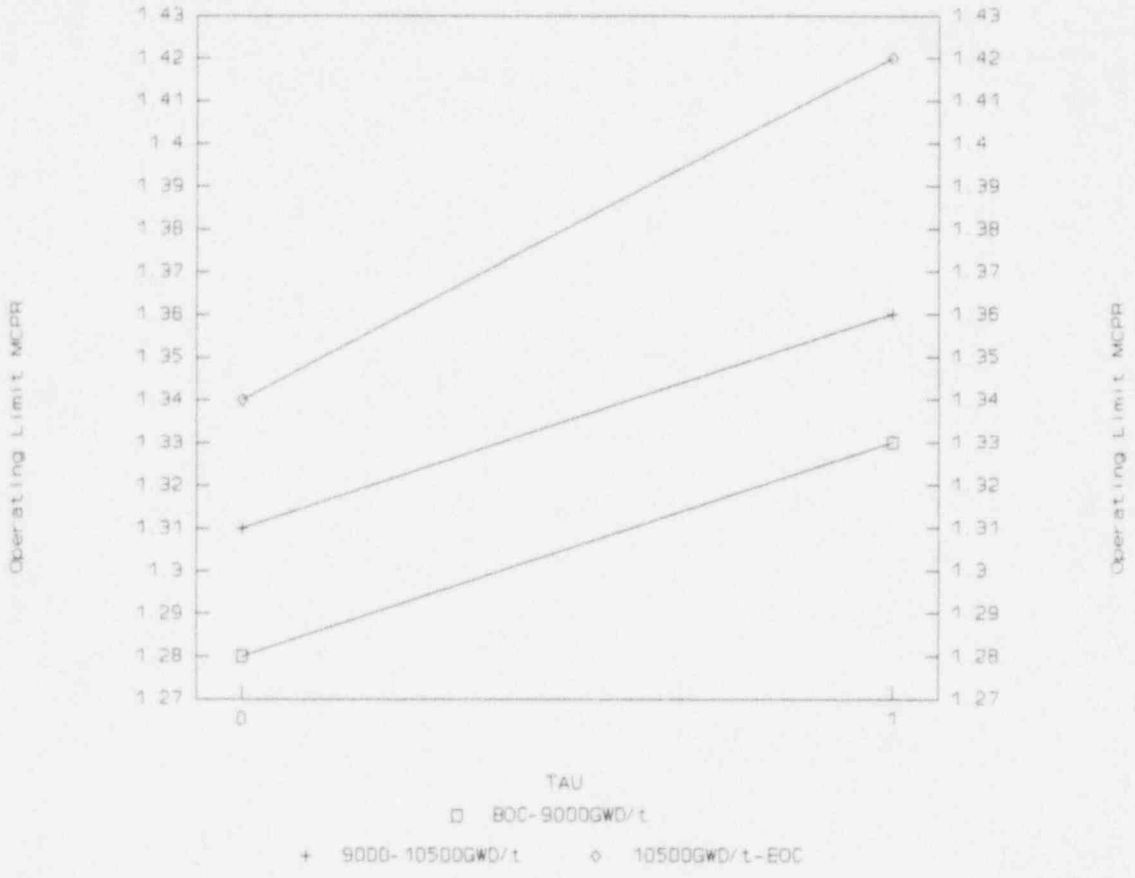
For single loop operation, these limits shall be increased by 0.01.

TABLE 8.2
Maximum LHGR

| Fuel Type | Fuel Bundle Design | Maximum LHGR (kw/ft) |
|---|---|---|
| BD336A | GE8x8EB | 14.4 |
| BD339A | GE8x8EB | 14.4 |
| GE10-P8HXB322 11GZ-70M-150-T | GE8x8NB-3 | 14.4 |
| GE10-P8HXB324 12GZ-70M-150-T | GE8x8NB-3 | 14.4 |
| 89LTA | GE11LTA | 14.4 |
| GE11-P9HUB356 15GZ-100M-146-T | GE11 | 14.4 |
| GE11-P9HUB359 16GZ1-100M-146-T | GE11 | 14.4 |
| GE11-P9HUB380 12GZ5-100M-146-T | GE11 | 14.4 |

Technical Specification Reference: 3.5.1

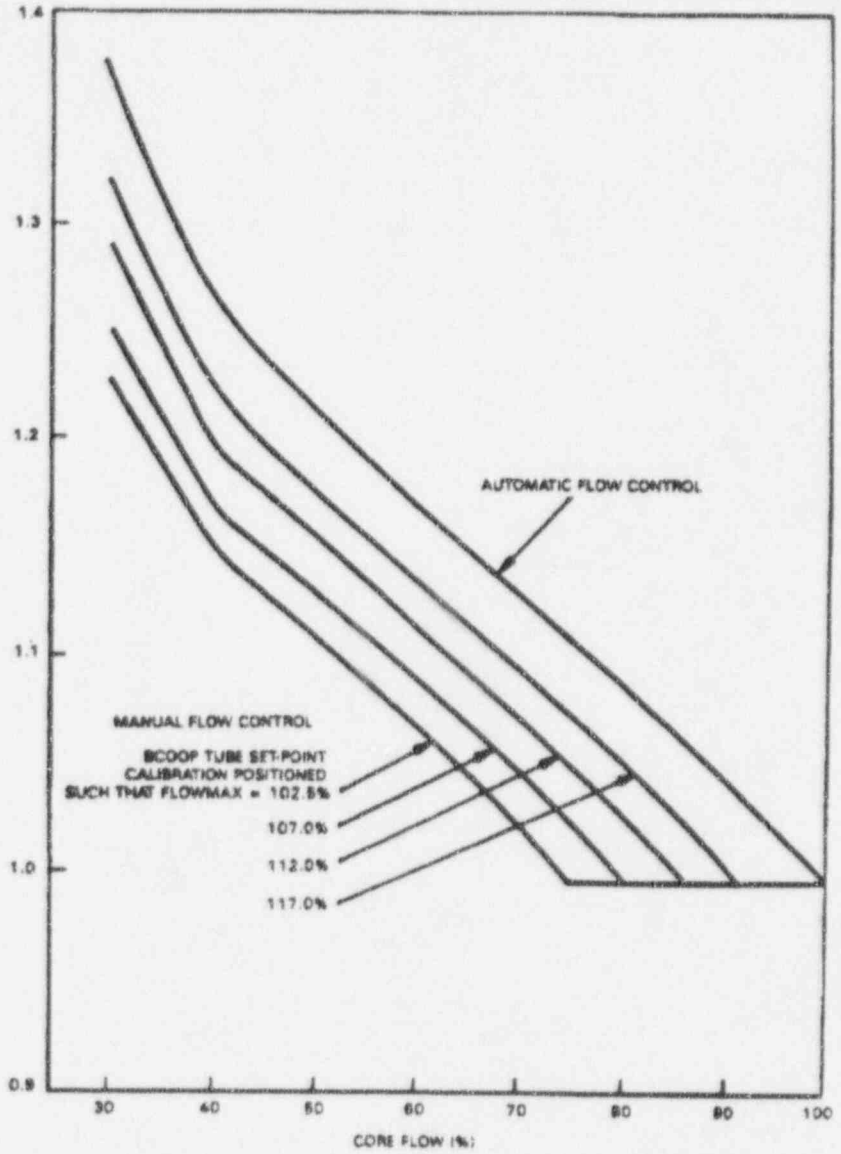
FIGURE 8.1
MCPR Operating Limit Versus $\tau$ (TAU)




Technical Specification Reference: 3.1.B

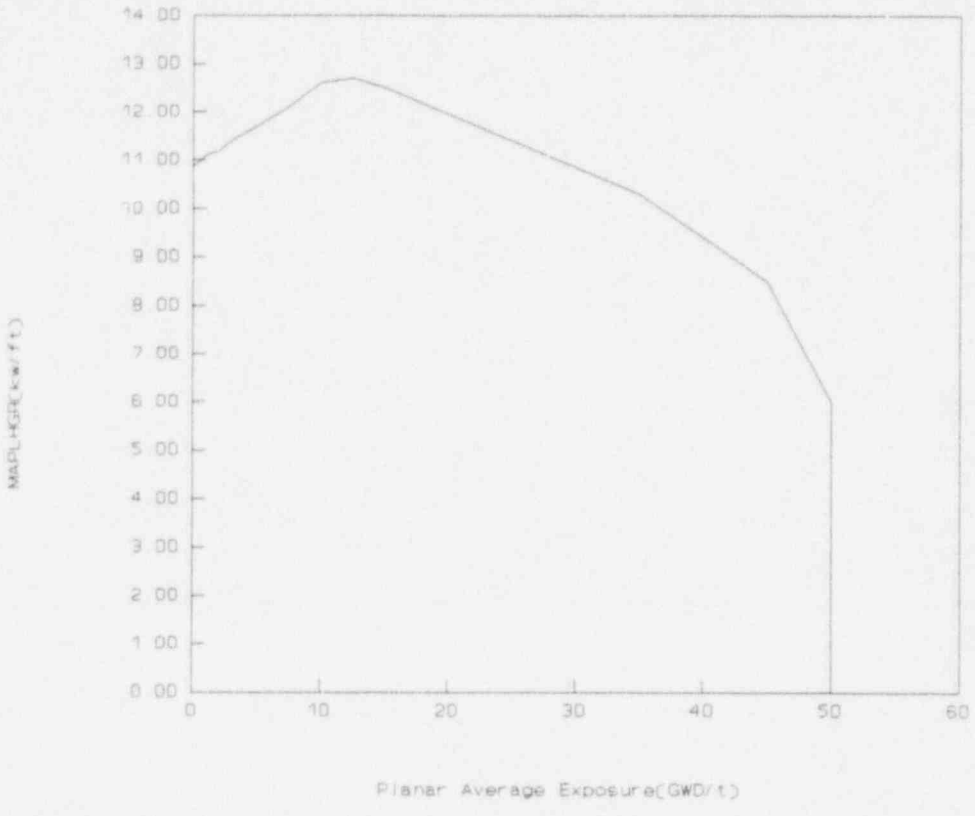
For single loop operation, these limits shall be increased by 0.01.

FIGURE 8.2
$K_f$ Factor




Technical Specification Reference: 3.1.B

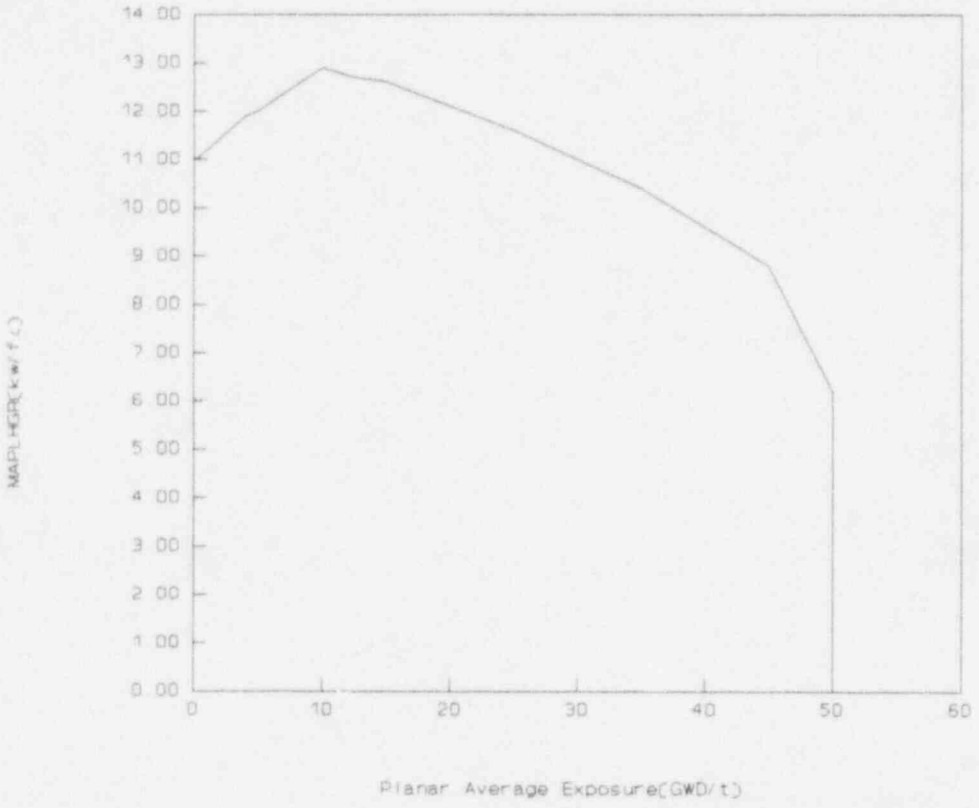
FIGURE 8.3.a
MAPLHGR Versus Planar Average Exposure: BD336A




This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: NEDC-31317P
For single loop operating these MAPLHGR values shall be multiplied by 0.84.

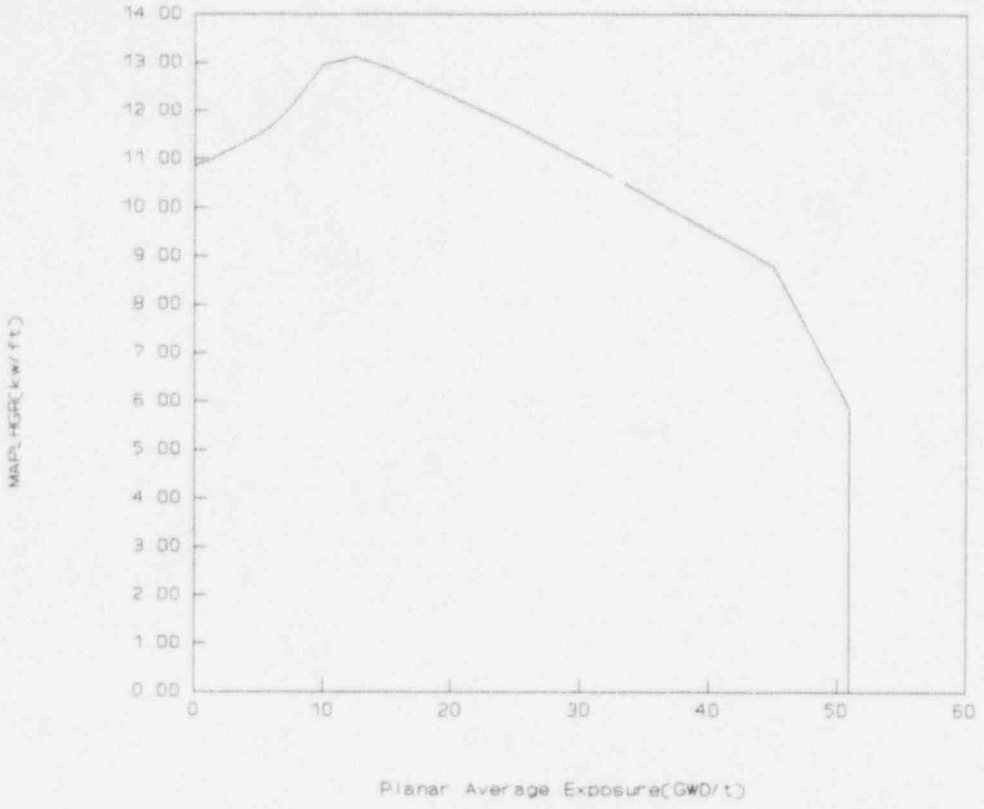
FIGURE 8.3.b
MAPLHGR Versus Planar Average Exposure:
BD339A




This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: NEDC-31317P
For single loop operating these MAPLHGR values shall be multiplied by 0.84.

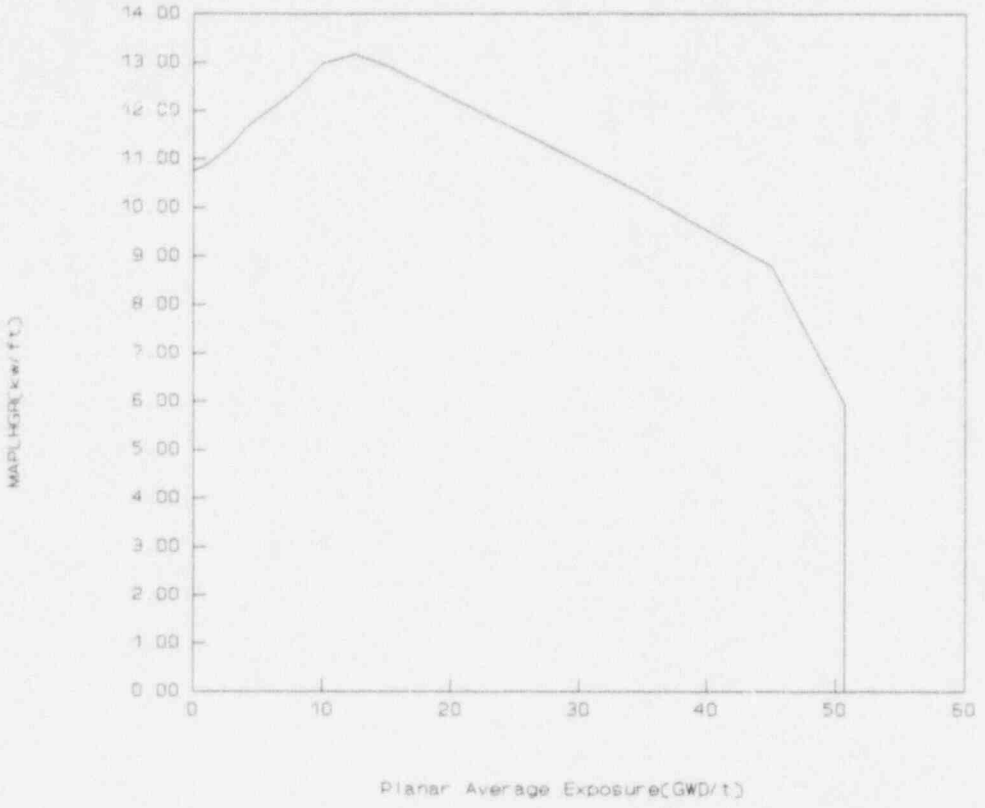
FIGURE 8.3.c
MAPLHGR Versus Planar Average Exposure:
GE10-P8HXB322-11GZ-70M-150-T




This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: NEDC-31317P
For single loop operating these MPLHGR values shall be multiplied by 0.84.

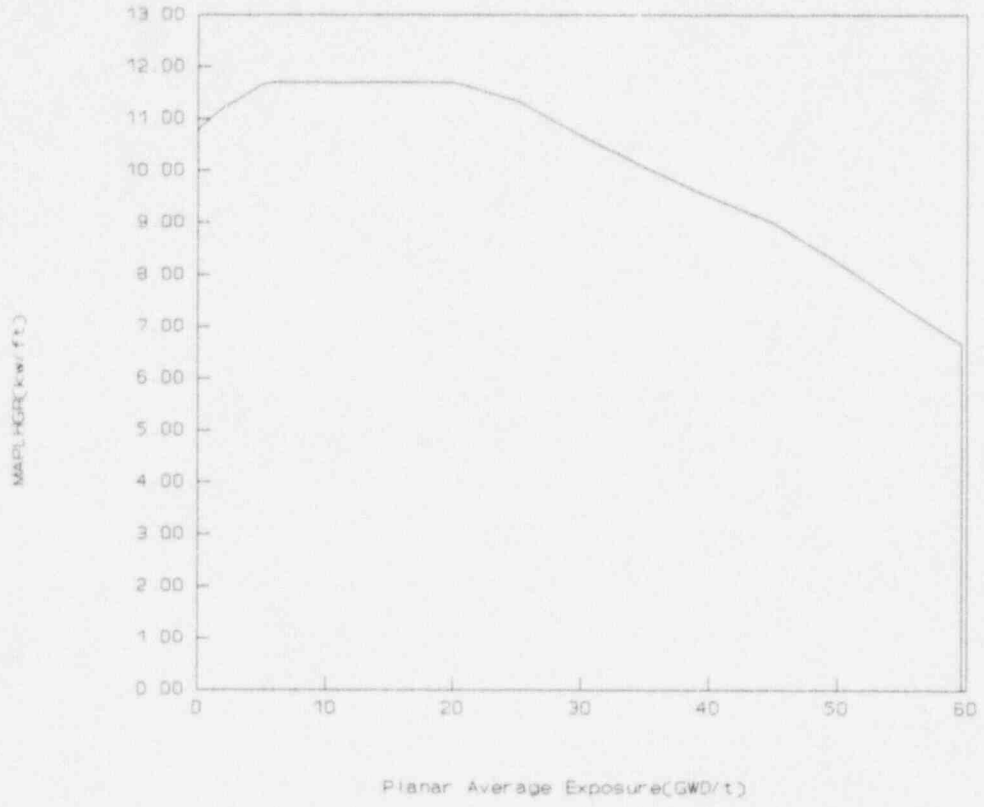
FIGURE 8.3.d
MAPLHGR Versus Planar Average Exposure:
GE10-P8HXB324-12GZ-70M-150T




This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: NEDC-31317P
For single loop operating these MAPLHGR values shall be multiplied by 0.84.

FIGURE 8.3.e
MAPLHGR Versus Planar Average Exposure:
89LTA

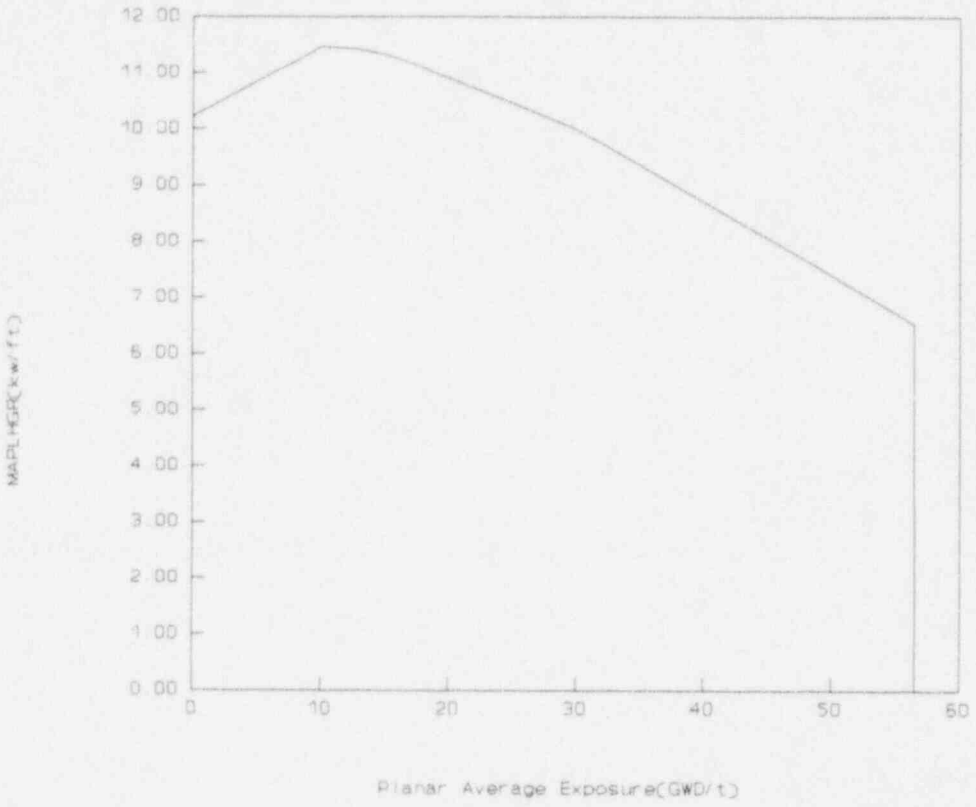



This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: NEDC-31317P
For single loop operating these MAPLHGR values shall be multiplied by 0.84.

FIGURE 8.3.f

MAPLHGR Versus Planar Average Exposure:
GE11-P9HUB356-15GZ-100M-146-T and ATRIUM-10A*

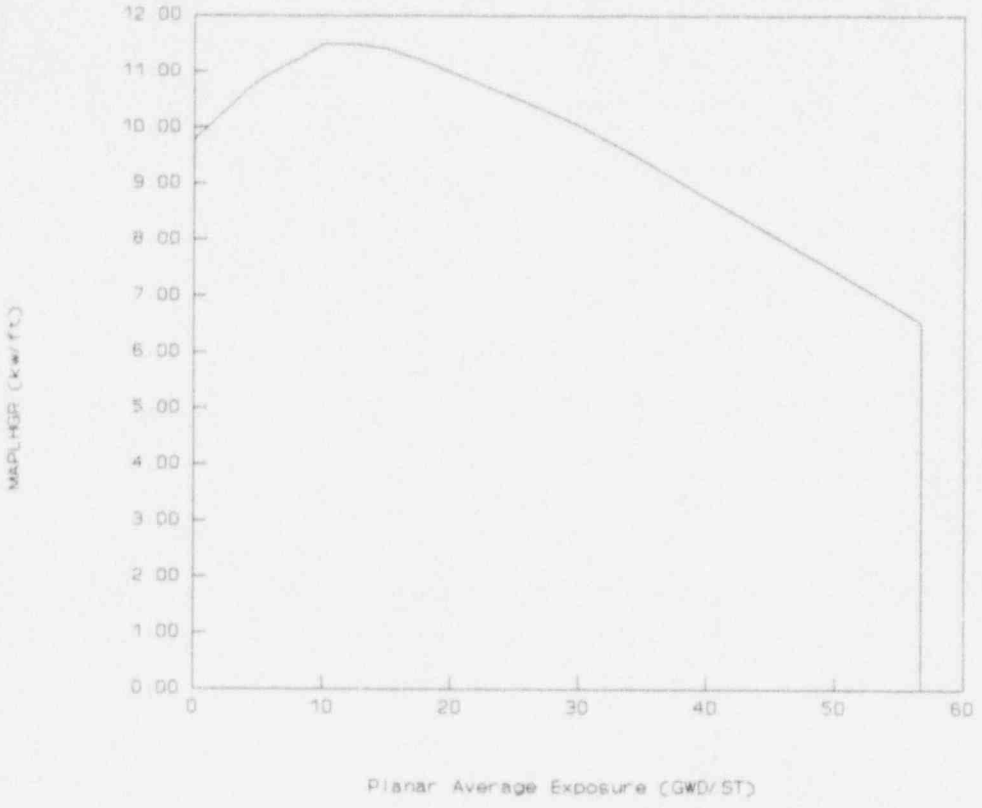



*The A10-339 bundle will be monitored as a GE11-P9HUB356-15GZ-100M-146-T bundle. Operation to the limiting MAPLHGR for the GE11 bundle assures this bundle will remain within LHGR limits, see Reference 3.8.

This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: A23A7114 Rev 1
For single loop operating these MAPLHGR values shall be multiplied by 0.84.

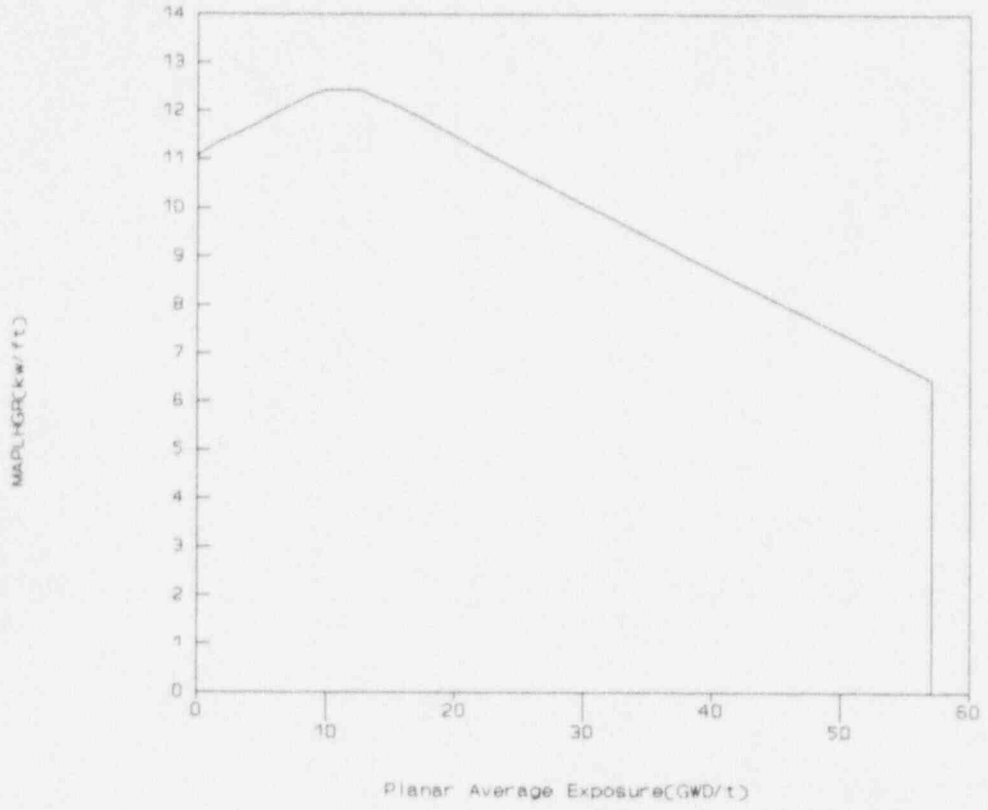
FIGURE 8.3.g
MAPLHGR Versus Planar Average Exposure:
GE11-P9HUB359-16GZ1-100M-146-T




This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: 23A7114 Rev 1
For single loop operating these MAPLHGR values shall be multiplied by 0.84.

FIGURE 3.3.h
MAPLHGR Versus Planar Average Exposure:
GE11-P9HUB380-12GZ5-100M-146-T




This curve represents the limiting exposure dependent MAPLHGR values.

Technical Specification Reference: 3.5.H
Reference: 24A5167 Rev 0
For single loop operating these MAPLHGR values shall be multiplied by 0.84.

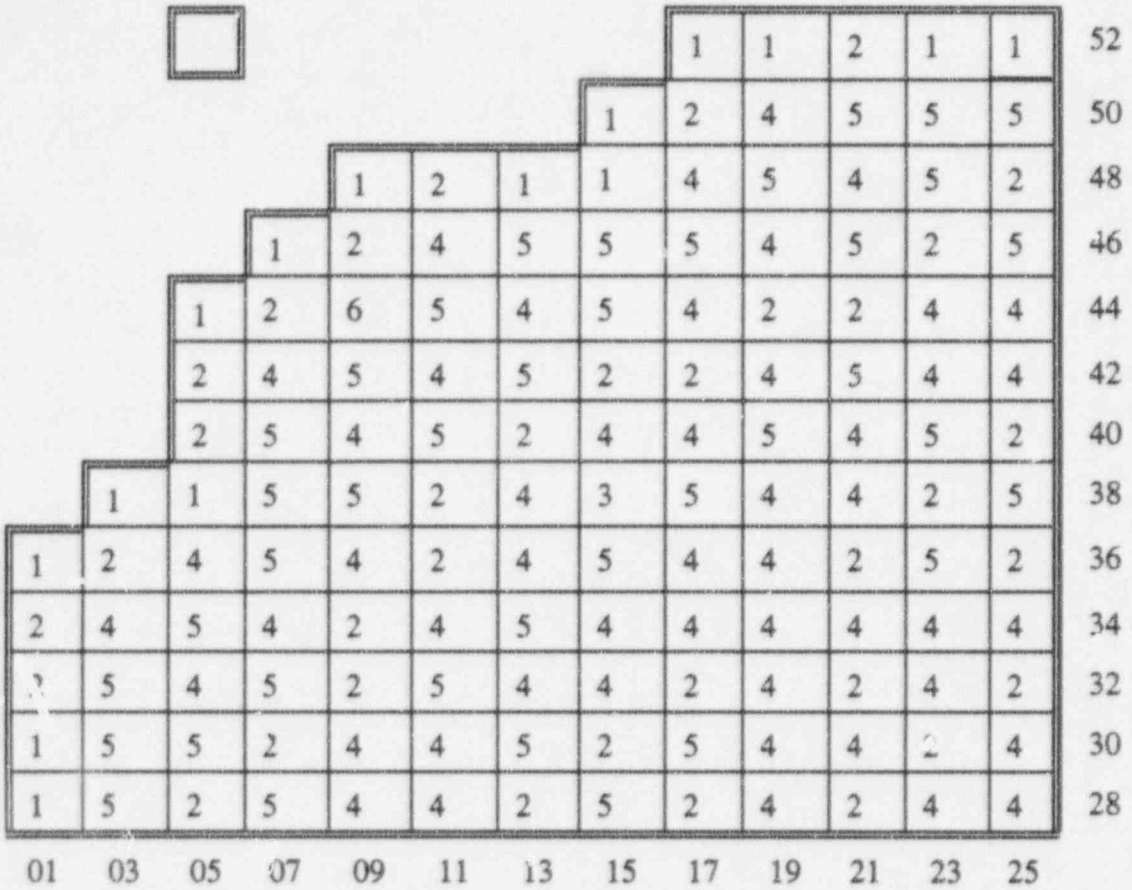



FIGURE 8.4.a
CYCLE 12 LOADING PATTERN, UPPER LEFT QUADRANT, BUNDLE DESIGN

1 = GE8x8EB, Bundle Types BD319A, BD336A, BD339A
2 = GE8x8NB-3, Bundle Types P81XB322, P81XB324
3 = GE11LTA, Bundle Type 89LTA
4 = GE11, Bundle Type P91UB356, P91UB359
5 = GE11, Bundle Type P91UB380
6 = ATRIUM-10A, Bundle Type A10-339

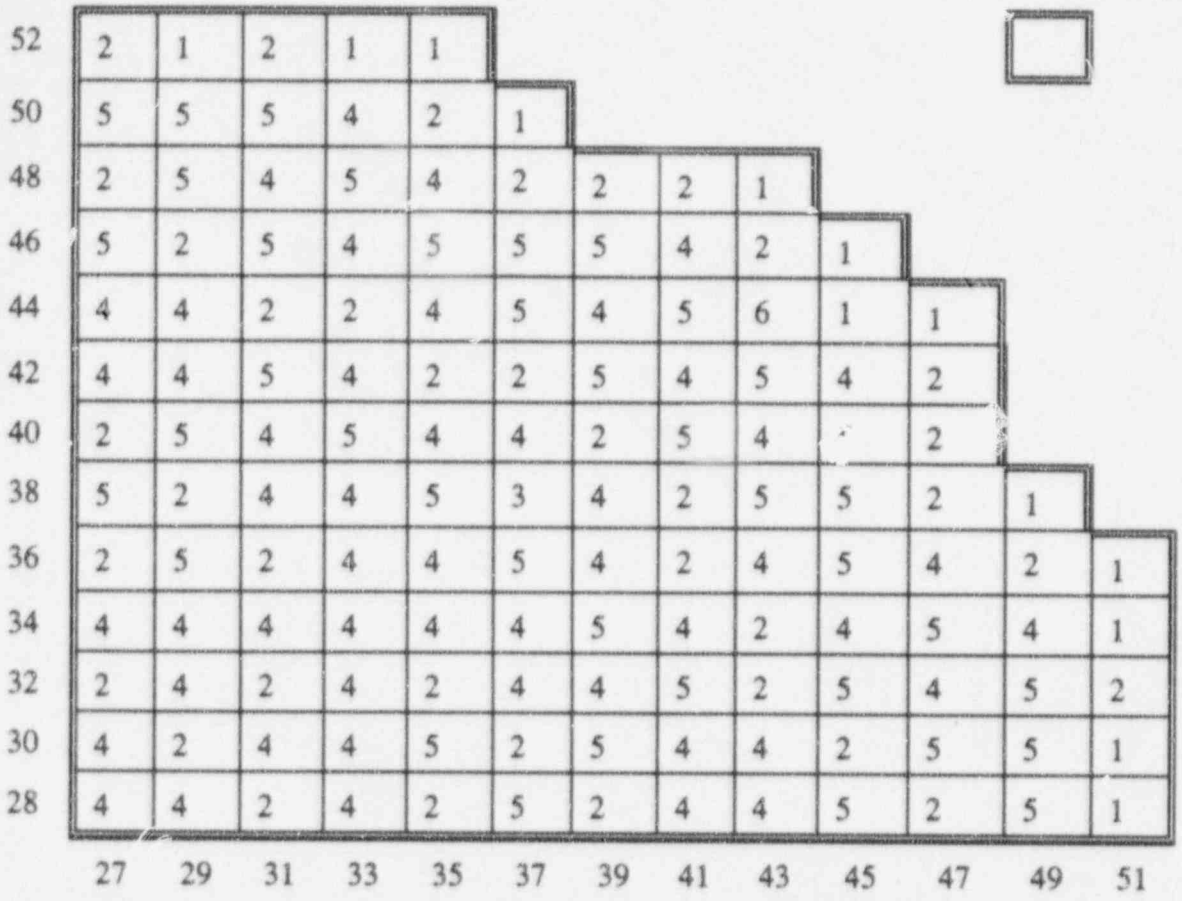



FIGURE 8.4.b
CYCLE 12 LOADING PATTERN, UPPER RIGHT QUADRANT, BUNDLE DESIGN

1 = GE8x8EB, Bundle Types BD319A, BD336A, BD339A
2 = GE8x8NB-3, Bundle Types P81XB322, P81XB324
3 = GE11LTA, Bundle Type 89LTA
4 = GE11, Bundle Type P91UB356, P91UB359
5 = GE11, Bundle Type P91UB380
6 = ATRIUM-10A, Bundle Type A10-339

| | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 4 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 4 | 5 | 2 | 5 | 2 |
| 24 | 4 | 2 | 4 | 4 | 5 | 2 | 5 | 4 | 4 | 2 | 5 | 5 | 1 |
| 22 | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 5 | 2 | 5 | 4 | 5 | 2 |
| 20 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 2 | 4 | 5 | 4 | 2 |
| 18 | 2 | 5 | 2 | 4 | 4 | 5 | 4 | 2 | 4 | 5 | 4 | 2 | 1 |
| 16 | 5 | 2 | 4 | 4 | 5 | 3 | 4 | 2 | 5 | 5 | 1 | 1 | |
| 14 | 2 | 5 | 4 | 5 | 4 | 4 | 2 | 5 | 4 | 5 | 1 | | |
| 12 | 4 | 4 | 5 | 4 | 2 | 2 | 5 | 4 | 5 | 4 | 2 | | |
| 10 | 4 | 4 | 2 | 2 | 4 | 5 | 4 | 5 | 6 | 2 | 1 | | |
| 08 | 5 | 2 | 5 | 4 | 5 | 5 | 5 | 4 | 2 | 1 | | | |
| 06 | 2 | 5 | 4 | 5 | 4 | 2 | 2 | 2 | 1 | | | | |
| 04 | 5 | 5 | 5 | 4 | 2 | 1 | | | | | | | |
| 02 | 1 | 1 | 2 | 2 | 1 | | | | | | | | |

FIGURE 8.4.c
CYCLE 12 LOADING PATTERN, LOWER RIGHT QUADRANT, BUNDLE DESIGN

1 = GE8x8EB, Bundle Types BD319A, BD336A, BD339A
2 = GE8x8NB-3, Bundle Types P81XB322, P81XB324
3 = GE11LTA, Bundle Type [illegible]LTA
4 = GE11, Bundle Type P91UB356, P91UB359
5 = GE11, Bundle Type P91UB380
6 = ATRIUM-10A, Bundle Type A10-339

| 01 | 03 | 05 | 07 | 09 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 2 | 5 | 4 | 4 | 2 | 5 | 2 | 4 | 2 | 4 | 4 | 26 |
| 1 | 5 | 5 | 2 | 4 | 4 | 5 | 2 | 5 | 4 | 4 | 2 | 4 | 24 |
| 2 | 5 | 4 | 5 | 2 | 5 | 4 | 4 | 2 | 4 | 2 | 4 | 2 | 22 |
| 1 | 4 | 5 | 4 | 2 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 20 |
| 1 | 2 | 4 | 5 | 4 | 2 | 4 | 5 | 4 | 4 | 2 | 5 | 2 | 18 |
| | 1 | 1 | 5 | 5 | 2 | 4 | 3 | 5 | 4 | 4 | 2 | 5 | 16 |
| | | 2 | 5 | 4 | 5 | 2 | 4 | 4 | 5 | 4 | 5 | 2 | 14 |
| | | 2 | 4 | 5 | 4 | 5 | 2 | 2 | 4 | 5 | 4 | 4 | 12 |
| | | 1 | 1 | 6 | 5 | 4 | 5 | 4 | 2 | 2 | 4 | 4 | 10 |
| | | | 1 | 1 | 4 | 5 | 5 | 5 | 4 | 5 | 2 | 5 | 08 |
| | | | | 1 | 2 | 1 | 2 | 4 | 5 | 4 | 5 | 2 | 06 |
| | | | | | | | 1 | 2 | 4 | 5 | 5 | 5 | 04 |
| | | | | | | | | 1 | 2 | 2 | 1 | 1 | 02 |

FIGURE 8.4.d
CYCLE 12 LOADING PATTERN, LOWER LEFT QUADRANT, BUNDLE DESIGN

1 = GE8x8EB, Bundle Types BD319A, BD336A, BD339A
2 = GE8x8NB-3, Bundle Types P81XB322, P81XB324
3 = GE11LTA, Bundle Type 89LTA
4 = GE11, Bundle Type P91UB356, P91UB359
5 = GE11, Bundle Type P91UB380
6 = ATRIUM-10A, Bundle Type A10-339