INTER-OFFICE MEMORANDUM
Savannah River Site

NMP-NCS-93-0015
January 26, 1993

Keywords: RBOF, Storage Basin, Massachusetts, Limit Criticality Safety
Retention: Lifetime

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Nuclear Criticality Safety Evaluation 93-02
MIT Spent Fuel Storage in Row G (U)

INTRODUCTION AND SUMMARY

Regulatory Programs' Criticality Safety Engineering Group (CSEG) received a request to determine safe storage requirements for Massachusetts Institute of Technology (MIT) research reactor spent nuclear fuel in RBOF storage basin Row G. Subsequent discussions with RBOF personnel indicated SFO fuel would be moved into Row H, requiring an across-row interaction instead of the 'in-line' interaction requested (ref. 1).

In summary, the results indicate that high-enriched MIT plate-type uranium-aluminum alloy fuel assemblies containing up 550 grams U (or 514.25 grams U235, at 93.5% maximum enrichment) can safely be stored in Row G within MTR-9T 3 7/8-inch hardware. The analysis determined that a spacing limit of 3 assemblies (or bundles) of MIT fuel will be necessary for safe storage in Row G. If required, there shall be at least one empty hardware space between MIT and any other approved fuel in the same row.

Both Missouri University Research Reactor (MURR) and Sterling Forest Canned Oxide (SFO) high-enriched uranium-aluminum alloy fuels may be stored adjacent to MIT in Rows F and H, respectively, on an 8.5-inch center-to-center spacing. Individual spacing limits as specified on all respective Nuclear Safety Data Sheet's (NSDS's) must be followed (ref. 10-12).

Other high-enriched (HE) U-Al fuels can also be stored within the same row and adjacent to the row according to DPSPU-81-272-132 (ref. 5). For HE U-Al fuels, this study found that, "If fuel A is spaced along the row so that it may be safely stored opposite itself at pitch P and if fuel B is spaced along the row so that it may be safely stored opposite itself in row of pitch P, then fuels A and B may be stored opposite each other in rows of pitch P or greater." This also presumes that other necessary non-high-enriched U-Al interactions are allowed.

CALCULATIONAL METHOD

The JOSHUA Nuclear Criticality Safety Modules MGBS/TGAN were used for all calculations in this nuclear criticality safety evaluation (ref. 2).

MGBS is designed to compute the neutron migration area, K-infinite, and other two-group parameters for homogenous media and cylindrical cells from a built-in 12-group cross section library. The resulting two-group constants are then input to downstream code TGAN, which computes extrapolation distances from a one-dimensional analytical solution of the two-group diffusion equation for slab, cylindrical and spherical geometries. The extrapolation distance, migration area, and K-infinite are then used to calculate the effective multiplication, Keff, of the system.

CODE VALIDATION

For high-enriched U-Al alloy fuels, MGBS-TGAN correlations are considered validated via modeling critical experiments of similar Spert-D uranium-aluminum plate-type fuels (ref. 3). The resulting MGBS/TGAN calculated critical benchmark eigenvalue was 1.02, resulting in a positive code bias of +0.02. Including the positive bias, and imposing the established delta-k safety margin of 0.05, a calculated Keff below 0.97 was considered to have an adequate margin of safety.

CALCULATIONAL MODEL

Two MIT 15-plate assembly models were constructed; one for the 124-gram UAl plate assembly, the other for the heavier 131-gram UAl plate assembly. Both 15-plate assembly model nominal dimensions were 26.25" x 2.405" x 2.405" , with a rhombic structure. The modeled 'active' fuel height was 22-3/8" (ref. 14, 15).

The 124-gram plate assembly contained a maximum of 30.5 grams U235 per plate (ref.13). The 131-gram plate assembly contained a maximum of 34.2 grams U235 per plate (ref. 13). The 15-plate MIT assembly was modeled containing a maximum of 514.25 grams U-235, representing a maximum enrichment of 93.5 percent.

Homogenization of the 'rhombic' MIT assembly was made in order to set up an equivalent cylindrical fuel cell model in MGBS. The rhombic assembly cross-sectional area resulted in an equivalent fuel cell radius of 3.6611 cm. Based on the results of the homogenization calculations, the 131-gram plate assembly was selected as being the most reactive MIT assembly (ref. 4). The most reactive MIT assembly resulted in uranium and aluminum material concentrations of 229.82 gU/l and 856.28 gAl/l, respectively (refer Attachment 1 for cell homogenization calculations and model data).

Multiple 2-region models were then constructed for the cylindricized cell model in order to simulate assembly storage in Row G. The inner homogenized fuel cell radius was surrounded by varying amounts of outer water radii (or MGBS pitches). TGAN was used to calculate the radial and axial extrapolation distances (δ_{rad} and δ_z) corresponding to the various 2-region models. Radial extrapolation distances resulted from a fully reflected critical radius search; axial extrapolation distances came from a fully reflected slab calculation in the z-direction. The results of these TGAN batches were used to compute the maximum safe number of fuel assemblies in the worst configuration. Table 1 shows the maximum safe number of 'assemblies' for MIT to be N_{safe}=4 assemblies. However, since N_{crit}=5 and N_{safe}=4, and we require that $N_{crit}-N_{safe} > 1$, we must back off the limit to N_{safe} = 3 assemblies, for the worst case configuration.

Table 1 also contains similar fuel:water:aluminum:water bundled fuel safe number calculations. This was required to ascertain the effect of placing MIT fuel assemblies within an aluminum square tube dissolver bundle, and storing the 'bundled' fuel in Row G. The square bundle had an inner equivalent radius of 4.9297 cm, and an outer equivalent radius of 5.073 cm (ref. 16). The maximum safe number of square dissolver bundles was found to be N_{safe}=3 bundles. Since the assembly worst configuration limit = 3, we impose a limit of no more than 3 assemblies per dissolver bundle.

The next set of MGBS-TGAN 2-region models was constructed to reflect actual row storage conditions in order to model across-row self-interaction and evaluate MIT reactivity. A constant center-to-center row spacing of 8.5 inches was used for Row G, while the box size was modified to conserve mass within the equivalent outer cell radius. Note, when the outer cell radius = 5.553 cm, this corresponds to the actual 3-7/8 inch MTR-9T hardware used in Row G. Table 2 summarizes the across-row self-interaction, and shows at what pitch maximum reactivity would occur for 2-region and 4-region models. Note the across-row MIT self-interaction required a limit of no more than 3 assemblies (or 3 bundles) stored 'along' the row before a MTR-9T hardware space is required.

The heavily loaded MIT fuel did not meet the shipping requirements of DPSTS-244-H-1.02 (ref. 6), which specifies that the 'active' portion of the assembly must contain a minimum of 88 wt% aluminum, and no more than a maximum of 137 gU235/l. The MIT assembly investigated contained only 78.8 wt% aluminum, and a homogenized U235 concentration of 214 gU235/l. Hence the 'safe bundle' number reported on the Data Sheet should be used instead under the alternative shipping standard DPSTS-244-H-1.03 (ref. 7). This standard states that cask slots 1,3, and 5 each may contain no more that the maximum number of fuel units specified on the applicable NSDS.

The next set of MGBS-TGAN runs investigated along-row spacing requirements for MIT fuel in Row G. The extrapolation distances are for variable numbers of assembly spacings are reported in Table 4. These results were used in portion of Table 2 which includes spacing limits. As shown in Table 2, a limit of 3 assemblies or 3 bundles along Row G was required for MIT to be stored safely across from itself within MTR-9T hardware, on an 8.5-inch center-to-center spacing.

In addition across-row interaction calculations were made between MIT:H2O:SFO and MIT:H2O:MURR fuels stored adjacent to Row G. The two-group constants derived from previous studies and those generated from this study for MIT fuel are summarized in Table 3. The extrapolation distances for MIT along-row spacing studies, and the effective multiplication factors for across-row MIT interactions with SFO and MURR are summarized in Table 4. In all cases, Keff remained below the established safe value of Keff=0.97.

Attachment 1 contains pertinent MIT model data. Attachment 2 contains MIT input data records used in the Row G analysis. Associated code input/output for this NCSE is contained on run #3203 (hardcopy and microfiche).

RESULTS

Table 1. MIT Safe Number Calculations

MGBS Pitch (cm)	Migration Area, M^2 (cm^2)	K_∞	Extrap. Dist. δ_{rad} (cm)	δ_z (cm)	Bz^{**2} (cm^{-2})	---K=0.97---- R_{safe}	N_{safe}	---K=1.02--- R_{crit}	N_{crit}
2-region model:									
3.8000	40.4861	1.8309	7.8754	7.8740	0.001825	9.0897	5.7217	10.1452	7.1278
4.0000	38.8587	1.8264	7.6386	7.5653	0.001856	9.0114	5.0754	10.0486	6.3109
4.2000	37.6002	1.8140	7.4279	7.2928	0.001884	9.0677	4.6612	10.1038	5.7872
4.4000	36.6217	1.7932	7.2403	7.0543	0.001909	9.2524	4.4218	10.3048	5.4849
4.6000	35.8756	1.7646	7.0738	6.8482	0.001932	9.5611	4.3201	10.6481	5.3584
4.8000	35.3145	1.7284	6.9287	6.6749	0.001950	9.9973	4.3379	11.1402	5.3865
5.0000	34.9031	1.6855	6.8045	6.5336	0.001966	10.5668	4.4663	11.7908	5.5609
5.2000	34.6137	1.6371	6.7006	6.4225	0.001978	11.2801	4.7056	12.6167	5.8869
5.5530	34.3359	1.5419	6.5623	6.2930	0.001993	12.9589	5.4460	14.6053	6.9178
5.8000	34.2816	1.4709	6.4962	6.2464	0.001998	14.5446	6.2885	16.5431	8.1354
6.0000	34.3083	1.4123	6.4588	6.2315	0.002000	16.1749	7.2674	18.6010	9.6110
4-region model:									
5.1000	37.9343	1.6802	7.0414	0.0000	0.000000	10.2698	4.0549	11.3703	4.9705
5.5530	36.8307	1.5633	6.7753	0.0000	0.000000	11.8872	4.5825	13.2233	5.6706
5.8000	36.4806	1.4928	6.6751	0.0000	0.000000	13.1112	5.1101	14.6606	6.3892
6.0000	36.2990	1.4342	6.6139	0.0000	0.000000	14.3318	5.7056	16.1244	7.2221

Table 2. Across-Row Self-Interaction (MIT:H2O:MIT)

MGBS Pitch (cm)	Migration Area, M^2 (cm^2)	K_∞	½-Row Width (cm)	Ext. δ_∞ (cm)	Bg^{**2} (cm^{-2}) [no limits]	Keff	Bg^{**2} (cm^{-2}) [limit = 3*]	Keff
2-region model:								
3.8000	40.4861	1.8309	3.3677	8.8502	0.016529	1.09688	0.020890	0.99196
4.0000	38.8587	1.8264	3.5449	8.6388	0.016622	1.10966	0.020983	1.00608
4.2000	37.6002	1.8140	3.7222	8.4580	0.016631	1.11607	0.020992	1.01380
4.4000	36.6217	1.7932	3.8994	8.3098	0.016553	1.11644	0.020913	1.01547
4.6000	35.8756	1.7646	4.0766	8.1953	0.016384	1.11136	0.020744	1.01168
4.8000	35.3145	1.7284	4.2539	8.1181	0.016120	1.10141	0.020480	1.00298
5.0000	34.9031	1.6855	4.4311	8.0801	0.015763	1.08729	0.020124	0.99008
5.2000	34.6137	1.6371	4.6084	8.1200	0.015230	1.07199	0.019590	0.97557
5.5530	34.3359	1.5419	4.9213	8.1822	0.014370	1.03246	0.018731	0.93838
5.8000	34.2816	1.4709	5.1401	8.3236	0.013612	1.00291	0.017972	0.91014
6.0000	34.3083	1.4123	5.3174	8.4799	0.012961	0.97758	0.017322	0.88585
4-region model:								
5.1000	37.9343	1.6802	4.5198	8.4563	0.014654	1.07990	0.018864	0.97938
5.5530	36.8307	1.5633	4.9213	8.4520	0.013796	1.03658	0.018006	0.93995
5.8000	36.4806	1.4928	5.1401	8.5436	0.013177	1.00816	0.017387	0.91342
6.0000	36.2990	1.4342	5.3174	8.6642	0.012622	0.98357	0.016832	0.89027

* Bucklings include along row leakage for limit of 3 assemblies (2-region) or limit of 3 bundles (4-region) from Table 4.

Table 3. Two-Group Constants for TGAN

Fuel Type	TGAN No.	Σ_1	Σ_2	c_{11}	c_{21}	c_{12}	c_{22}	M^2 (cm^2)	K_∞
previous studies:									
SFO	301	0.21132	1.8592	0.853550	0.158726	0.076316	0.956847	36.7780	1.6119
MURR	302	0.21304	2.1674	0.831890	0.172695	0.031214	0.977126	38.7730	1.3251
generated from this study:									
MIT	9	0.21451	2.2070	0.831562	0.175599	0.053998	0.967546	34.3359	1.5419
MIT	13*	0.21232	2.0254	0.840150	0.167107	0.060648	0.964110	36.8307	1.5633

TGAN #301 = derived from previous SFO calculations (ref. 8).
TGAN #302 = derived from previous MURR calculations (ref. 9).
TGAN #9 = MIT 2-region model, MGBS prob. 9, microfiche #3203.
TGAN #13 = MIT 4-region model, MGBS problem 13, microfiche #3203.
* Recommended set of two-group constants for future MIT interactions.

Table 4. Along/Across-Row Interactions with Fuels Listed

Fuel-Fuel	MGBS Pitch (cm)	M^2 (cm^2)	K_∞	½-Row L or W (cm)	Ext. Dist. δ_d or δ_∞ (cm)	Bg**2 (cm^{-2}) [no limits]	Keff	Bg**2 (cm^{-2}) [w/ limits]	Keff
along-row:									
9-9	5.5530	34.3359	1.5419	9.8425	8.9857	(2 MIT assemblies, space, etc.)			
9-9	5.5530	34.3359	1.5419	14.7640	9.0233	(3 MIT assemblies, space, etc.)			
9-9	5.5530	34.3359	1.5419	19.6850	9.0439	(4 MIT assemblies, space, etc.)			
9-9	5.5530	34.3359	1.5419	24.6060	9.0564	(5 MIT assemblies, space, etc.)			
13-13	5.5530	36.8307	1.5633	14.7640	9.4460	(3 MIT bundles, space, etc.)			
13-13	5.5530	36.8307	1.5633	19.6850	9.4875	(4 MIT bundles, space, etc.)			
13-13	5.5530	36.8307	1.5633	24.6060	9.5130	(5 MIT bundles, space, etc.)			
301-301	-----	36.7780	1.6119	14.7640	9.6686	(3 SFO bundles, space, etc.)			
302-302	-----	38.7730	1.3251	26.6700	7.9678	(4 MURR bundles, space, etc.)			
across-row:									
9-301	5.5530	34.3359	1.5419	4.9213	8.6128	0.013470	1.0543	0.017831[a]	0.9564
9-302	5.5530	34.3359	1.5419	4.9213	7.9244	0.014953	1.0188	0.019313[a]	0.9271
301-9	----	36.7780	1.6119	4.9213	8.2020	0.014327	1.0557	0.018460[c]	0.9601
302-9	----	38.7730	1.3251	6.6675	11.4044	0.007555	1.0249	0.009612[d]	0.9653
13-301	5.5530	36.8307	1.5633	4.9213	8.8842	0.012946	1.0586	0.017156[b]	0.9580
13-302	5.5530	36.8307	1.5633	4.9213	8.1626	0.014413	1.0212	0.018623[b]	0.9273
301-13	----	36.7780	1.6119	4.9213	8.2183	0.014291	1.0566	0.018425[c]	0.9608
302-13	----	38.7730	1.3251	6.6675	11.4652	0.007504	1.0264	0.009561[d]	0.9667

[a] Buckling includes limit of 3 MIT assemblies along row.
[b] Buckling includes limit of 3 MIT square bundles along row.
[c] Buckling includes limit of 3 SFO bundles along row.
[d] Buckling includes limit of 4 MURR bundles along row.

REFERENCES

(1) M. J. Beckum, "Request for RBOF Safe Storage Requirements (U), MIT", NMP-SRB-92-0447, December 7, 1992; and subsequent telecons with author.
(2) H.K. Clark, "JOSHUA Nuclear Criticality Safety Modules", DPSTM-86-700-3, NRTSC, March, 1987.
(3) H.K. Clark, "Computer Codes for Nuclear Criticality Safety Calculations", DP-1121, SRL, November 1967, pp. 72-75.
(4) H.K. Clark, "General Criteria for RBOF Storage", DPST-77-471, p. 15, October 11, 1977.
(5) T.A. Reilly, "Interaction for Storage of High-Enriched U-Al Fuels at RBOF", DPSPU-81-272-132, September 1, 1981.
(6) "Shipping Plate-Type Uranium-Aluminum Fuels", DPSTS-244-H-1.02, Approved 6/11/80.
(7) "Shipping Fissile Material in the SRP 70-Ton NFE Cask", DPSTS-244-H-1.03, Approved 7/18/77.
(8) Sterling Forest Canned Oxide (SFO) calculations, Criticality Safety Group Log Book, CB-4, p. 159.
(9) Missouri University Research Reactor (MURR) calculation file, T.A. Reilly, Microfiche #1077.
(10) Nuclear Safety Data Sheet #59, "Massachusetts Institute of Technology Reactor (MIT)", rev. 12, March 30, 1976.
(11) Nuclear Safety Data Sheet #119, "Missouri University Research Reactor (MURR)", rev. 11, October, 13, 1981.
(12) Nuclear Safety Data Sheet #198, "Sterling Forest Canned Oxide (SFO)", rev. 3, October 7, 1988.
(13) "Massachusetts Institute of Technology, Appendix A Agreements for; i) nominal 124-gram plate and ii) nominal 131-gram plate assemblies. As received after April 3, 1992 comments.

DRAWINGS

(14) MIT Drawing #R3F-1, "MIT Reactor Fuel Element Assembly", Revision G, March 19, 1975.
(15) MIT Drawing #R3F-4, "MIT Reactor Fuel Element Fuel Plate", Revision D, March 16, 1973.
(16) "RBOF MTR-Type Fuels, Square Tube Dissolver Bundle", Drawing #S5-2-6835, Revision 16, E.I. DuPont, April 7, 1975.

APPROVAL(S)

NMP-NCS-93-0015 Reviewed By: _____
(SRTC Technical Review)

Date: _____

NMP-NCS-93-0015 Approved By: _____
(Mgr., H-Canyon/RBOF Sep. Tech.)

Date: _____

NMP-NCS-93-0015 Approved By: _____
(CSEG Manager)

Date: _____

ATTACHMENT 1

MGBS-TGAN: MIT ANALYSIS

a) Homogenization Data

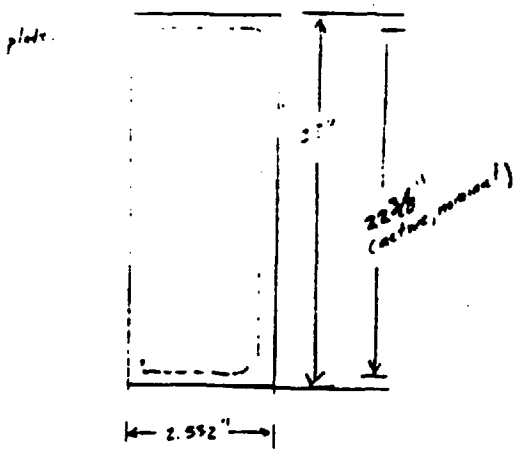
b) Model Data

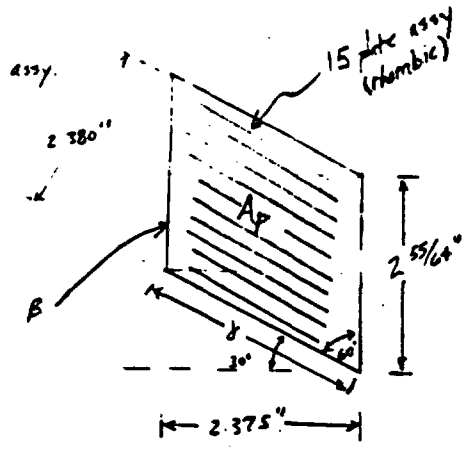
RSCF

"L" Model Data

Date 1-19-92 2/

Model Data:





$\beta = 2.380/\sin 30°$

$= 2.7482"$

$\sin 60 = 2.375/\gamma$

$\gamma = \frac{2.375'}{\sin 60} = 2.7424"$

$A_p = \gamma\beta \sin 60$

$A_p = (2.7424)(2.7482)\sin 60$

$A_p = 6.5269\ in^2$

U wt % in alloy (124 g plate) = 32.6/(32.6 + 14.3) = .695

U wt % in alloy (131 g plate) = 36.8/(36.8 + 16.4) = .692

Homogenization Equivalent Cylindrical Cell

$\square \Leftrightarrow \bigcirc$ $\quad A_p = \pi r_{eq}^2 \Rightarrow r_{eq} = \left(\frac{A_p}{\pi}\right)^{\frac{1}{2}} = \left[\frac{6.5269\ in^2/(2.54)^2}{\pi}\right]^{\frac{1}{2}} = 3.6611\ cm$

$H_f = 22.375" = 56.833\ cm$

$V_{cyl.} = \pi r_{eq}^2 H_f = \pi(3.6611)^2(56.833) = 2,393.17\ cm^3 \cong 2.3932\ l$

mass U (124 g plate assy) = $\frac{36.5(15)}{.935}$ = 489.31 g U → model as 490 g U total per assy (458.15 g_{max} U235,

* mass U (131 g plate) = $\frac{37.2(15)}{.935}$ = 548.66 g U → model as 550 g U total per assy (514.25 g_{max} U235

mass Al (124 g): 14.3 g Al × 15 = 214.5 g Al, fuel

22.375/23.5 × 700 g Al = 666.49 g Al, side plates

15[22.375/23.0 × 77.9 g Al] = 1136.75 g Al, clad

2,017.74 g Al tot.

mass Al (131 g): 16.4 × 15 = 246.0 g Al, fuel

" = 666.49 g, side plates

= 1136.75 g. clad

= 2,049.24 g Al

124 g-plate assy.

[U] = 490 / 2.3932 l = 204.75 g U/l

[Al] = 2017.74 / 2.3932 = 843.13 g Al/l

131 g.-plate assy.*

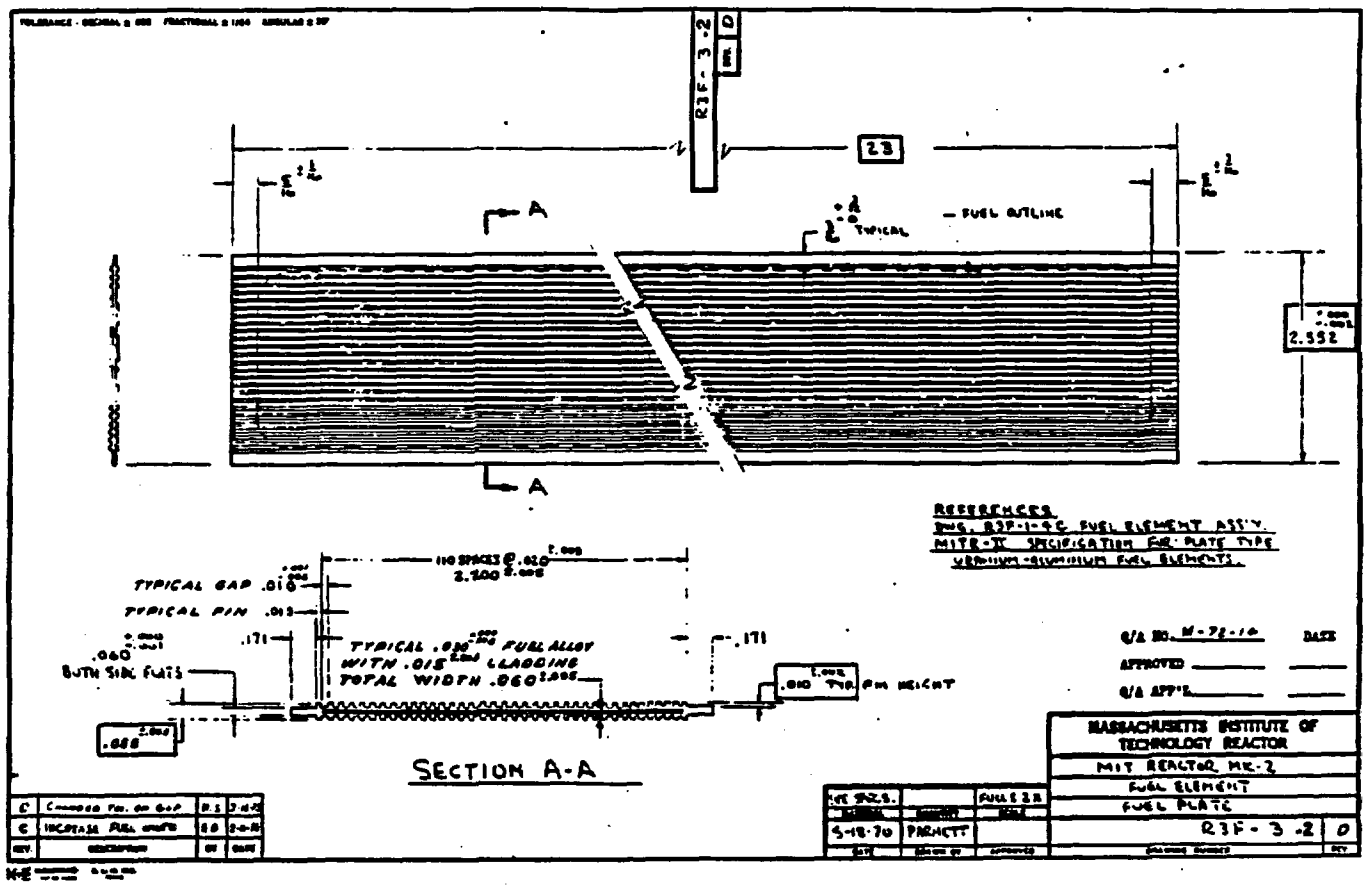
[U] = 550/2.3932 = 229.82 g U/l

[Al] = 2049.24/2.3932 = 856.28 g Al/l

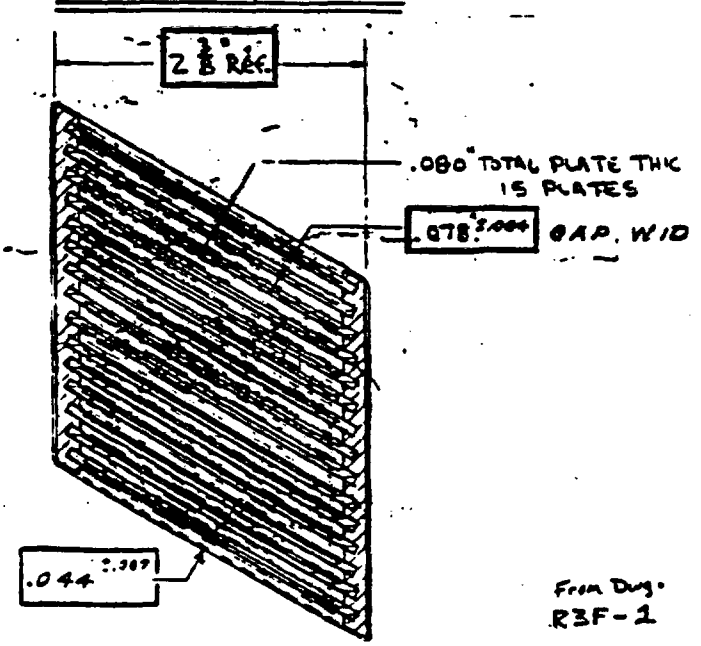
* chosen as most reactive MIT assembly type [refer Table VIII, DPST-77-47].

Massachusetts Institute of Technology Analysis (R3F-1, R3F-3, Appx. A)

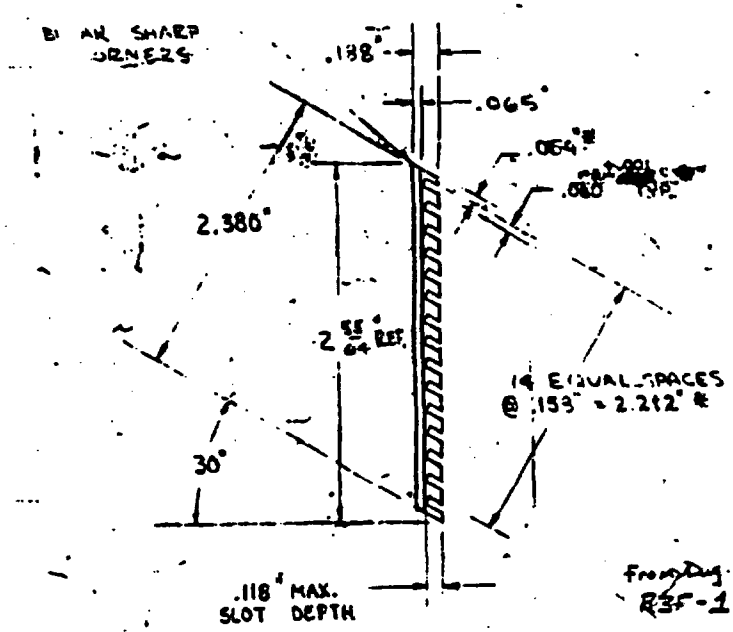
Fuel Plate Data:



Assembly Data:



From Dwg. R3F-1



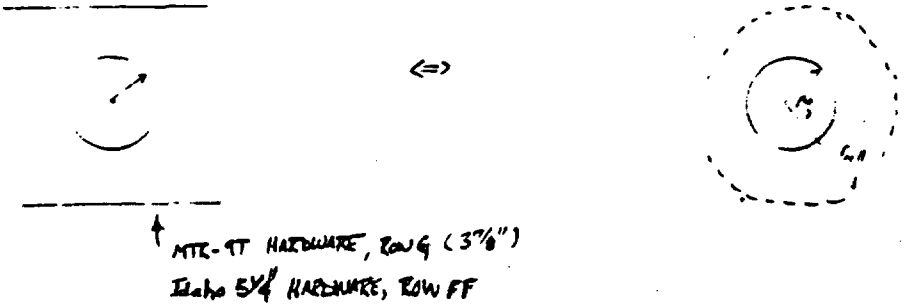
From Dwg. R3F-1

RBOC

MIT Model Data

Date 1-19-93

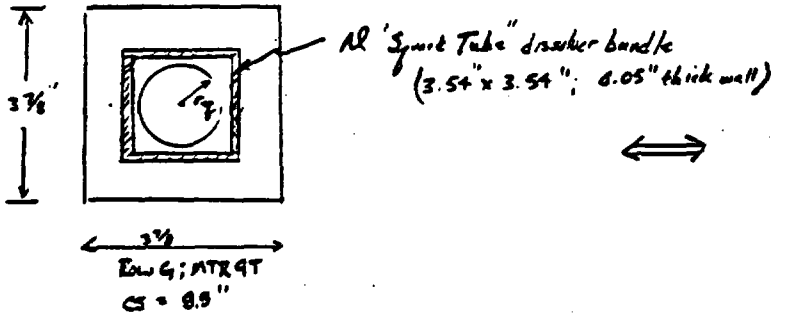
MIT - 2-Region Model



r_{eq} = equiv. fuel radius
= 3.6611 cm

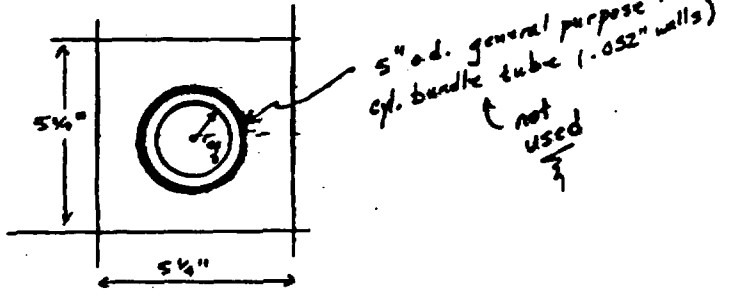
r_{cell} = outer radii of equiv. (variable pitch)

3⅞" - MIT: 4-Region Model (Dwg 55-2-6835)



r_{eq} = equiv. fuel radius
r_i = inner bundle equiv. radius
= 4.9297
r_o = outer bundle equiv. radius
= 5.073 cm
r_{cell} = equiv. outer cell radii (variable pitch)

5¼" - MIT: 4-Region Model (Dwg 54-2-609)

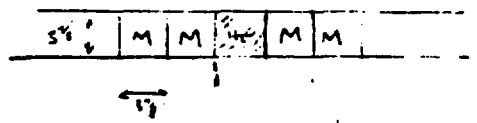


r_{eq} = equiv. fuel radius
r_i = inner cyl. tube radius
= 6.2179 cm
r_o = outer cyl. tube radius
= 6.3500 cm
r_{cell} = outer 'cell' equiv. r (variable pitch)

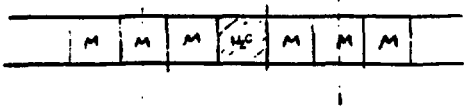
280F
MIT Model Data

1-19-93

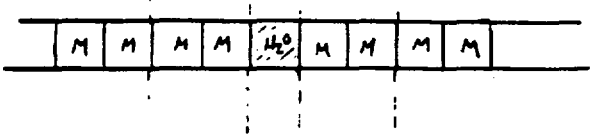
Row G Along-Row Interactions



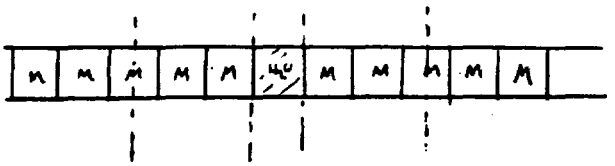
2 assy



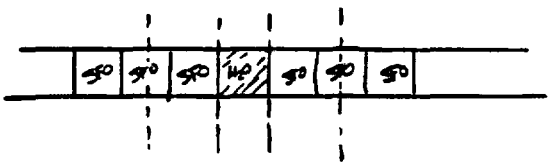
3 assy , 3 bundles



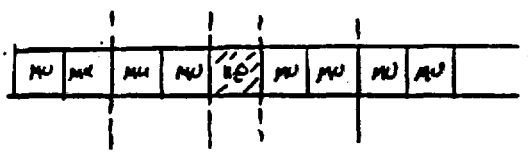
4 assy , 4 bundles



5 assy , 5 bundles

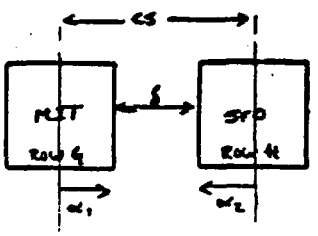


3 SFO bundles (3 7/8"-hardware)$_{\text{Row H}}$

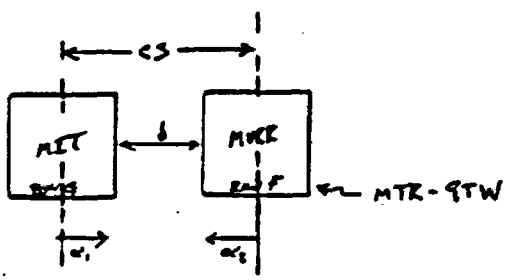


4 MURR bundles (5¼" hardware)$_{\text{Row F}}$

Across-Row Interactions



cs = 8.5" = 21.59 cm
α1 = 4.9213 cm
α2 = 4.9213 cm
δ = cs − (α1 + α2) = 11.747 cm



cs = 8.5" = 21.59 cm
α1 = 4.9213
α2 = 6.6675
δ = cs − (α1 + α2) = 10.001 cm

ATTACHMENT 2

MGBS-TGAN: MIT ANALYSIS

a) Input Data Records

MGBS:
input.koko.mass2806
input.mgbs.control.mass.1 => 2-region
input.mgbs.control.mass.12 => 4-region
input.radii.mass.1
input.mgbs.type.mass.1 => U-Al meat
input.mgbs.type.mass.2 => H2O
input.mgbs.type.mass.3 => Aluminum

TGAN:
input.tgan.mass2806
input.tgan.data.mass
input.tgan.general.mass.1
input.tgan.general.mass.2
input.tgan.general.mass.3
input.tgan.general.mass.4
input.tgan.general.mass.5
input.tgan.control.mass.1 => δ-radial
input.tgan.control.mass.2 => δ-axial
input.tgan.control.mass.3 => δ-across (self)
input.tgan.control.mass.4 => δ-along (along-row)
input.tgan.control.mass.5 => δ-across (other fuels)

```
MASS      DESIGNATION (NAME) FOR STUDY
          JOBNAME FOR DATA SET WITH PREVIOUS OUTPUT RECORDS
        2 NUMBER OF PROGRAMS (MODULES)
        5 NUMBER OF LINES OF COMMENTS. MAY BE 0.
        2 NUMBER OF BATCHES (APPLIES ONLY TO GLASS, MGBS(SLEN
          OR EXPT)-TGAN(ABBR OR EXPT), TGAN(    ), ANSN OR KENO
          WHEN PRECEDED BY HRXN). MAY BE 0.
        1 1 TO PRINT INPUT RECORDS; 2 TO PRINT COMPUTED INPUT
          RECORDS AS WELL; 3 TO READ & PRINT AMPX LIBRARY ALSO:

            OPTIONAL INPUT RECORDS ARE--  INPUT.KOKO
 .ADBN.?NAME.?N,       .ANSN.?NAME.?N,       .GLSS.?NAME.?N,
 .MGEX.?NAME.?N,       .SLEN.?NAME.?N,       .TWTR.?NAME.?N, OR
 .DISL.?NAME.,         .PADJ.?NAME.?N,       .TSLA.?NAME.
                     PROGRAM    OPTION
                       MGBS
                       TGAN
```



```
  1  **************************************************************
  2  MGBS-TGAN:    MASSACHUSETTS INSTITUTE OF TECHNOLOGY
  3
  4            ROW G ANALYSIS = MTR-9T  3-7/8" HARDWARE
  5  **************************************************************
```



```
LIST ORDER IN WHICH BATCHES WILL BE READ. DOES NOT APPLY TO TGAN
BATCHES. DEFAULTS TO SEQUENTIAL ORDER. MAY NOT EXCEED 50.
  1  0        2  0
```

2806.INPUT.MGBS.CONTROL.MASS.1

```
NO. OF RPTS.          NO. OF REGNS.      NO. OF TYPES  GEOMETRY
      10                    2   (<24)         2            1
 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0    REGION TYPES
 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0    REQUIRED RADII
   1   1   0   0   0   0   0   0   0    REQUIRED MATERIAL TYPES
 BEST      NSG      NOSG      SRCE      SOLN      RES      WT     MP
   1         0         0         0         1        0        0        0
```


2806.INPUT.MGBS.CONTROL.MASS.1

```
4  NO. OF COMMENT LINES. (MAY BE 0; MAY NOT EXCEED 9)
**********************************************************************
MGBS MODEL: MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT)
            U(93.5%)AL PLATE FUEL --- TWO REGION MODEL
**********************************************************************
```

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2806.INPUT.MGBS.CONTROL.MASS.12

NO. OF RPTS.	NO. OF REGNS.	NO. OF TYPES	GEOMETRY
3	4 (<24)	3	1

1 2 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 REGION TYPES
0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 REQUIRED RADII
0 0 1 0 0 0 0 0 0 REQUIRED MATERIAL TYPES

BEST	NSG	NOSG	SRCE	SOLN	RES	WT	MP
1	0	0	0	1	0	0	-10

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2806.INPUT.MGBS.CONTROL.MASS.12

4 NO. OF COMMENT LINES. (MAY BE 0; MAY NOT EXCEED 9)

****

MGBS MODEL: MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT)
U(93.5%)AL PLATE FUEL -- FOUR REGION (SQ. TUBE) BUNDLE MODELS

****

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2806.INPUT.MGBS.RADII.MASS.1

```
    18  NUMBER OF REQUESTED RADII ( < 51 )
.020000  BUCKLING, IF REQUESTED
                   REQUESTED RADII
 3.661099     3.799994     4.000000     4.200000     4.400000
 4.599998     4.799994     5.000000     5.200000     5.552999
 5.799994     6.000000     4.929700     5.073000     5.099998
 5.552999     5.799996     6.000000
```

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2806.INPUT.MGBS.TYPE.MASS.1

```
POSITION 1 DENOTES U COMPOSITION (5 ITEMS-233,234,235,236,238)
POSITION 2 DENOTES PU COMPOSITION (4 ITEMS-239,240,241,242)
POSITION 3 DENOTES MIXTURE TYPE (2 FOR AQUEOUS SOLUTION, 3 FOR
           METAL OR OXIDE)
POSITION 4 DENOTES FOR SOLUTION G NO3/L, FOR METAL THE DENSITY
POSITION 5,6,... DENOTES FOR SOLUTION G U/L, X IN UOX, DENSITY
           OF UOX, G PU/L, X IN PUOX,...., DENSITY OF BEOX FOR
           POSITION 46, VOID FRACTION IN POSITION 50; FOR METAL
           OR OXIDE WEIGHT FRACTION O, U, PU,....., BE FOR POS-
           ITION 19.

         O, U,PU,TH,AL,ZR,FE,CR,NI, B,CD,GD,PB, C,BE,   VOID
SOLUTION    5, 8,11,14,17,20,23,26,29,32,35,38,41,44,    50
METAL    5, 6, 7, 8, 9,10,11,12,13,14,15,16,17,18,19
    1 0 2 0 1   0 1 0 0 0   0 0 0 1 0   1 0 0 0 0   0 0 0 0 0
    0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0
```


2806.INPUT.MGBS.TYPE.MASS.1

```
  9 NO. OF ITEMS OF DATA. IF U COMPOSITION IS REQUIRED, 5 ITEMS
    MUST BE SUPPLIED. IF PU, 4. SOME ZEROS MAY BE NECESSARY TO
    BLANK PREVIOUS ITEMS. (<377 WITH ONLY 1 TYPE ; MAY BE 0)  :
0.00000E 00  0.00000E 00  9.35000E-01  0.00000E 00  6.50000E-02
2.29820E 02  1.89000E 01  8.56280E 02  2.70000E 00
```

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2806.INPUT.MGBS.TYPE.MASS.2

```
POSITION 1 DENOTES U COMPOSITION (5 ITEMS-233,234,235,236,238)
POSITION 2 DENOTES PU COMPOSITION (4 ITEMS-239,240,241,242)
POSITION 3 DENOTES MIXTURE TYPE (2 FOR AQUEOUS SOLUTION, 3 FOR
           METAL OR OXIDE)
POSITION 4 DENOTES FOR SOLUTION G NO3/L, FOR METAL THE DENSITY
POSITION 5,6,... DENOTES FOR SOLUTION G U/L, X IN UOX, DENSITY
           OF UOX, G PU/L, X IN PUOX,....., DENSITY OF BEOX FOR
           POSITION 46, VOID FRACTION IN POSITION 50; FOR METAL
           OR OXIDE WEIGHT FRACTION O, U, PU,....., BE FOR POS-
           ITION 19.

         O, U,PU,TH,AL,ZR,FE,CR,NI, B,CD,GD,PB, C,BE,   VOID
SOLUTION    5, 8,11,14,17,20,23,26,29,32,35,38,41,44,    50
METAL    5, 6, 7, 8, 9,10,11,12,13,14,15,16,17,18,19
    0 0 2 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0
    0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0
```

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2806.INPUT.MGBS.TYPE.MASS.2

```
  0 NO. OF ITEMS OF DATA. IF U COMPOSITION IS REQUIRED, 5 ITEMS
    MUST BE SUPPLIED. IF PU, 4. SOME ZEROS MAY BE NECESSARY TO
    BLANK PREVIOUS ITEMS. (<377 WITH ONLY 1 TYPE ; MAY BE 0)  :
```

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2806.INPUT.MGBS.TYPE.MASS.3

```
POSITION 1 DENOTES U COMPOSITION (5 ITEMS-233,234,235,236,238)
POSITION 2 DENOTES PU COMPOSITION (4 ITEMS-239,240,241,242)
POSITION 3 DENOTES MIXTURE TYPE (2 FOR AQUEOUS SOLUTION, 3 FOR
           METAL OR OXIDE)
POSITION 4 DENOTES FOR SOLUTION G NO3/L, FOR METAL THE DENSITY
POSITION 5,6,... DENOTES FOR SOLUTION G U/L, X IN UOX, DENSITY
           OF UOX, G PU/L, X IN PUOX,...., DENSITY OF BEOX FOR
           POSITION 46, VOID FRACTION IN POSITION 50; FOR METAL
           OR OXIDE WEIGHT FRACTION O, U, PU,....., BE FOR POS-
           ITION 19.

         O, U,PU,TH,AL,ZR,FE,CR,NI, B,CD,GD,PB, C,BE,   VOID
SOLUTION    5, 8,11,14,17,20,23,26,29,32,35,38,41,44,    50
METAL    5, 6, 7, 8, 9,10,11,12,13,14,15,16,17,18,19
    0 0 3 1 0   0 0 0 1 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0
    0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0   0 0 0 0 0
```

PAGE 1

2806.INPUT.MGBS.TYPE.MASS.3

```
  2 NO. OF ITEMS OF DATA. IF U COMPOSITION IS REQUIRED, 5 ITEMS
    MUST BE SUPPLIED. IF PU, 4. SOME ZEROS MAY BE NECESSARY TO
    BLANK PREVIOUS ITEMS. (<377 WITH ONLY 1 TYPE ; MAY BE 0)  :
2.70000E 00  1.00000E 00
```

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2806.INPUT.TGAN.MASS2806

```
 MASS     DESIGNATION OF STUDY    1 PNCH=0, WRITE=1, BOTH=2
  5 NO. OF BATCHES, IF >0         1  >0 TO PRINT INPUT RECORDS
ND(I)=0,1, OR 2 DENOTES NONE, MGBS, OR ADJUSTED HAMMER OR RAHAB
 1 ND(1) OUTPUT WITH ABOVE NAME FROM JOB DATA SET
 1 ND(2) LIBRARY DATA      1  ND(3) INPUT.TGAN.DATA.?NAME
REMAINING RECORDS--      INPUT.TGAN.GENERAL.?NAME.?N
       TYPES 1 & 3-      INPUT.TGAN.CONTROL.?NAME.?N
           N RUNS FROM 1 THRU NO. OF RECORDS REQUIRED
       TYPE 2------      INPUT.TGAN.RBC.?NAME  (NON-STD)
                 OR-     INPUT.TGAN.PREP.?NAME (NSE-24,134)
```

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2806.INPUT.TGAN.DATA.MASS

21 NO. OF DATA ITEMS (NO. OF SETS X 7)

SIGMA-1	SIGMA-2	C11	C21	C12	C22	XMS	
.21132	1.8592	.853550	.158726	.076316	.956847	36.7780	← SFO
.21304	2.1674	.831890	.172695	.031214	.977126	38.7730	← MURR
.26170	1.7116	.873959	.094393	.057015	.944945	35.4062	← NOT used (RBWR)

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2806.INPUT.TGAN.GENERAL.MASS.1

```
    INNER ALBEDOS                        OUTER ALBEDOS
FAST   1.000  SLOW   1.000          FAST   0.000  SLOW   0.000
FACTOR FOR BUCKLING OR EXTRAPOLATION DISTANCE     .7000
SPEED-UP FACTOR   0.000 (DEFAULTS TO 1)
EXTRAPOLATION DISTANCE OR RADIUS INCREMENT  10.000
```


2806.INPUT.TGAN.GENERAL.MASS.1

```
NO. OF T REGIONS  0          NO. OF F REGIONS  2
ARRANGEMENT (0 FOR T, 1 FOR F)  1 1 0 0 0   0 0 0 0 0   0 0
GEOM (SLAB=0, CYL=1, SPH=2)  1   CONVERGENCE EXPONENT  8
SEARCH (0 FOR BUCKLING, N FOR THICKNESS OF REGION N)  1
NKG (0-4 FOR TYPE 3; % CONC. CHANGE FOR TYPE 2; SEE DP-1121)   0
FLUX POINTS PER F REGION (0 BEYOND FIRST)   0  0  0  0  0  0
SOLN. TYPE (3 FOR ABBREVIATED, 2 FOR CONC. SEARCH)  3
INDEX >0 TO REQUEST TRANSVERSE BUCKLING (NOT FOR TYPE 2)  0
TYPE 2 ONLY --> CONC. DATA  0   NO. REFL.  0   REFL. SPEC.    0
   INDEX (0=NON STD.; >0=CONC. PROFILES FROM NSE-24,134)  0
```


2806.INPUT.TGAN.GENERAL.MASS.1

```
4  NO. OF COMMENT LINES. (< 10; MAY BE 0)
**********************************************************
MIT TGAN MODEL: CRITICAL RADIUS SEARCH
FOR CRITICAL RADIAL EXTRAPOLATION DISTANCE
**********************************************************
```

2806.INPUT.TGAN.GENERAL.MASS.2

```
    INNER ALBEDOS                        OUTER ALBEDOS
FAST   1.000  SLOW   1.000          FAST   0.000  SLOW   0.000
FACTOR FOR BUCKLING OR EXTRAPOLATION DISTANCE     .7000
SPEED-UP FACTOR   0.000 (DEFAULTS TO 1)
EXTRAPOLATION DISTANCE OR RADIUS INCREMENT  25.000
```



```
NO. OF T REGIONS  0          NO. OF F REGIONS  2
ARRANGEMENT (0 FOR T, 1 FOR F)  1 1 0 0 0   0 0 0 0 0   0 0
GEOM (SLAB=0, CYL=1, SPH=2)  0   CONVERGENCE EXPONENT  8
SEARCH (0 FOR BUCKLING, N FOR THICKNESS OF REGION N)  0
NKG (0-4 FOR TYPE 3; % CONC. CHANGE FOR TYPE 2; SEE DP-1121)  0
FLUX POINTS PER F REGION (0 BEYOND FIRST)   0  0  0  0  0  0
SOLN. TYPE (3 FOR ABBREVIATED, 2 FOR CONC. SEARCH)  0
INDEX >0 TO REQUEST TRANSVERSE BUCKLING (NOT FOR TYPE 2)  0
TYPE 2 ONLY --> CONC. DATA  0   NO. REFL.  0   REFL. SPEC.    0
   INDEX (0=NON STD.; >0=CONC. PROFILES FROM NSE-24,134)  0
```



```
4  NO. OF COMMENT LINES. (< 10; MAY BE 0)
*****************************************************
MIT TGAN MODEL:  1D SLAB CALCULATION FOR
AXIAL EXTRAPOLATION DISTANCES (USED TO FIND BZ**2)
*****************************************************
```

2806.INPUT.TGAN.GENERAL.MASS.3

```
    INNER ALBEDOS                        OUTER ALBEDOS
FAST    1.000  SLOW    1.000         FAST    1.000  SLOW    1.000
FACTOR FOR BUCKLING OR EXTRAPOLATION DISTANCE     .7000
SPEED-UP FACTOR    0.000 (DEFAULTS TO 1)
EXTRAPOLATION DISTANCE OR RADIUS INCREMENT  25.000
```



```
NO. OF T REGIONS  0          NO. OF F REGIONS  2
ARRANGEMENT (0 FOR T, 1 FOR F)  1 1 0 0 0   0 0 0 0 0   0 0
GEOM (SLAB=0, CYL=1, SPH=2)  0   CONVERGENCE EXPONENT  8
SEARCH (0 FOR BUCKLING, N FOR THICKNESS OF REGION N)  0
NKG (0-4 FOR TYPE 3; % CONC. CHANGE FOR TYPE 2; SEE DP-1121)    0
FLUX POINTS PER F REGION (0 BEYOND FIRST)   0  0  0  0  0  0
SOLN. TYPE (3 FOR ABBREVIATED, 2 FOR CONC. SEARCH)  0
INDEX >0 TO REQUEST TRANSVERSE BUCKLING (NOT FOR TYPE 2)  0
TYPE 2 ONLY --> CONC. DATA  0   NO. REFL.  0   REFL. SPEC.    0
   INDEX (0=NON STD.; >0=CONC. PROFILES FROM NSE-24,134)  0
```



```
5  NO. OF COMMENT LINES. (< 10; MAY BE 0)
************************************************************
MIT TGAN MODEL:  1D SLAB CALCULATION
 1-11, ACROSS 8.5-INCH ROW SELF-INTERACTIONS; 2-REGION MODEL
12-15, ACROSS 8.5-INCH ROW SELF-INTERACTIONS; 4-REGION SQ. TUBE
```

2806.INPUT.TGAN.GENERAL.MASS.4

```
    INNER ALBEDOS                        OUTER ALBEDOS
FAST    1.000  SLOW    1.000         FAST    1.000  SLOW    1.000
FACTOR FOR BUCKLING OR EXTRAPOLATION DISTANCE     .7000
SPEED-UP FACTOR    0.000 (DEFAULTS TO 1)
EXTRAPOLATION DISTANCE OR RADIUS INCREMENT  25.000
```


2806.INPUT.TGAN.GENERAL.MASS.4

```
NO. OF T REGIONS  0          NO. OF F REGIONS  3
ARRANGEMENT (0 FOR T, 1 FOR F)  1 1 1 0 0   0 0 0 0 0   0 0
GEOM (SLAB=0, CYL=1, SPH=2)  0   CONVERGENCE EXPONENT  8
SEARCH (0 FOR BUCKLING, N FOR THICKNESS OF REGION N)  0
NKG (0-4 FOR TYPE 3; % CONC. CHANGE FOR TYPE 2; SEE DP-1121)    0
FLUX POINTS PER F REGION (0 BEYOND FIRST)   0  0  0  0  0  0
SOLN. TYPE (3 FOR ABBREVIATED, 2 FOR CONC. SEARCH)  0
INDEX >0 TO REQUEST TRANSVERSE BUCKLING (NOT FOR TYPE 2)  0
TYPE 2 ONLY --> CONC. DATA  0   NO. REFL.  0   REFL. SPEC.    0
   INDEX (0=NON STD.; >0=CONC. PROFILES FROM NSE-24,134)  0
```

2806.INPUT.TGAN.GENERAL.MASS.4

```
9  NO. OF COMMENT LINES. (< 10; MAY BE 0)
*******************************************************
MIT TGAN MODEL:  ALONG-ROW INTERACTIONS
9-9 (2 ASSY.-SPACE); 9-9 (3 ASSY.-SPACE);
9-9 (4 ASSY.-SPACE); 9-9 (5 ASSY.-SPACE);
13-13 (3 SQ.BNDLES-SPACE); 13-13 (4 SQ.BNDLES-SPACE);
13-13 (5 SQ.BNDLES-SPACE);
301-301 (3 SFO BUNDLES, SPACE, ETC....)
302-302 (4 MURR BUNDLES, SPACE, ETC...)
*******************************************************
```

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2806.INPUT.TGAN.GENERAL.MASS.5

```
    INNER ALBEDOS                        OUTER ALBEDOS
FAST    1.000  SLOW    1.000        FAST    1.000  SLOW    1.000
FACTOR FOR BUCKLING OR EXTRAPOLATION DISTANCE     .7000
SPEED-UP FACTOR  .0.000 (DEFAULTS TO 1)
EXTRAPOLATION DISTANCE OR RADIUS INCREMENT  25.000
```


2806.INPUT.TGAN.GENERAL.MASS.5

```
NO. OF T REGIONS  0          NO. OF F REGIONS  3
ARRANGEMENT (0 FOR T, 1 FOR F)  1 1 1 0 0   0 0 0 0 0   0 0
GEOM (SLAB=0, CYL=1, SPH=2)  0   CONVERGENCE EXPONENT  8
SEARCH (0 FOR BUCKLING, N FOR THICKNESS OF REGION N)  0
NKG (0-4 FOR TYPE 3; % CONC. CHANGE FOR TYPE 2; SEE DP-1121)    0
FLUX POINTS PER F REGION (0 BEYOND FIRST)   0  0  0  0  0  0
SOLN. TYPE (3 FOR ABBREVIATED, 2 FOR CONC. SEARCH)  0
INDEX >0 TO REQUEST TRANSVERSE BUCKLING (NOT FOR TYPE 2)  0
TYPE 2 ONLY --> CONC. DATA  0   NO. REFL.  0   REFL. SPEC.    0
   INDEX (0=NON STD.; >0=CONC. PROFILES FROM NSE-24,134)  0
```

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```
9  NO. OF COMMENT LINES. (< 10; MAY BE 0)
*****************************************************************
MIT TGAN MODEL:  ACROSS ROW INTERACTIONS...
 MIT  (NSDS #59) : H2O : SFO  (NSDS #198), 9-301, 13-301
 MIT  (NSDS #59) : H2O : MURR (NSDS #119), 9-302, 13-302
 SFO  (NSDS #198): H2O : MIT  (NSDS #59) , 301-9, 301-13
 MURR (NSDS #119): H2O : MIT  (NSDS #59) , 302-9, 302-13

*****************************************************************
```

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2806.INPUT.TGAN.CONTROL.MASS.1

```
  30 NO. OF REGION SPECIFICATIONS (<201).  MGBS OUTPUT NUMBERED
FROM 1, LIBRARY DATA FROM 201, INPUT DATA FROM 301. ALL NT+NF
REGIONS MUST BE SPECIFIED FOR EACH PROBLEM. 0 DENOTES NO CHANGE
N SUCCESSIVE ZEROS MAY BE DENOTED BY -N                          :
   1 201    2 201    3   201    4 201    5 201      6 201    7 201    8
 201    9 201   10 201    11 201   12 201   13    201   14 201   15 201
```



```
   3    NO. OF ENTRIES (<201).  THICKNESS OF EACH OF NT+NF OR NT
+NF+1 REGIONS MUST BE GIVEN.  0.0 DENOTES NO CHANGE.
Z SUCCESSIVE ZEROS MAY BE DENOTED BY -Z.                        :
 0.0000E 00  3.0480E 01  -.2800E 02
```

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22 NO. OF REGION SPECIFICATIONS (<201). MGBS OUTPUT NUMBERED FROM 1, LIBRARY DATA FROM 201, INPUT DATA FROM 301. ALL NT+NF REGIONS MUST BE SPECIFIED FOR EACH PROBLEM. 0 DENOTES NO CHANGE
N SUCCESSIVE ZEROS MAY BE DENOTED BY -N :
1 201 2 201 3 201 4 201 5 201 6 201 7 201 8 201 9 201 10 201 11 201

3 NO. OF ENTRIES (<201). THICKNESS OF EACH OF NT+NF OR NT +NF+1 REGIONS MUST BE GIVEN. 0.0 DENOTES NO CHANGE.
Z SUCCESSIVE ZEROS MAY BE DENOTED BY -Z. :
2.8416E 01 5.0000E 01 -.2000E 02

2806.INPUT.TGAN.CONTROL.MASS.3

30 NO. OF REGION SPECIFICATIONS (<201). MGBS OUTPUT NUMBERED FROM 1, LIBRARY DATA FROM 201, INPUT DATA FROM 301. ALL NT+NF REGIONS MUST BE SPECIFIED FOR EACH PROBLEM. 0 DENOTES NO CHANGE
N SUCCESSIVE ZEROS MAY BE DENOTED BY -N :

```
   1 201    2 201    3   201    4 201    5 201     6 201    7 201   8
 201    9 201   10 201    11 201   12 201   13   201   14 201   15 201
```


30 NO. OF ENTRIES (<201). THICKNESS OF EACH OF NT+NF OR NT +NF+1 REGIONS MUST BE GIVEN. 0.0 DENOTES NO CHANGE.
Z SUCCESSIVE ZEROS MAY BE DENOTED BY -Z. :

```
 3.3677E 00  7.4273E 00  3.5449E 00  7.2501E 00  3.7222E 00
 7.0728E 00  3.8994E 00  6.8956E 00  4.0766E 00  6.7184E 00
 4.2539E 00  6.5411E 00  4.4311E 00  6.3639E 00  4.6084E 00
 6.1186E 00  4.9213E 00  5.8737E 00  5.1401E 00  5.6549E 00
 5.3174E 00  5.4776E 00  4.5198E 00  6.2752E 00  4.9213E 00
 5.8737E 00  5.1401E 00  5.6549E 00  5.3174E 00  5.4776E 00
```

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```
  27 NO. OF REGION SPECIFICATIONS (<201).  MGBS OUTPUT NUMBERED
FROM 1, LIBRARY DATA FROM 201, INPUT DATA FROM 301. ALL NT+NF
REGIONS MUST BE SPECIFIED FOR EACH PROBLEM. 0 DENOTES NO CHANGE
N SUCCESSIVE ZEROS MAY BE DENOTED BY -N                          :
   9 201   9   9 201     9   9 201   9   9   201   9  13 201  13
  13 201  13  13 201    13 301 201 301 302   201 302
```



```
  27    NO. OF ENTRIES (<201).  THICKNESS OF EACH OF NT+NF OR NT
+NF+1 REGIONS MUST BE GIVEN.  0.0 DENOTES NO CHANGE.
Z SUCCESSIVE ZEROS MAY BE DENOTED BY -Z.                        :
 9.8425E 00  9.8425E 00  9.8425E 00  1.4764E 01  9.8425E 00
 1.4764E 01  1.9685E 01  9.8425E 00  1.9685E 01  2.4606E 01
 9.8425E 00  2.4606E 01  1.4764E 01  9.8425E 00  1.4764E 01
 1.9685E 01  9.8425E 00  1.9685E 01  2.4606E 01  9.8425E 00
 2.4606E 01  1.4764E 01  9.8425E 00  1.4764E 01  2.6670E 01
 1.3335E 01  2.6670E 01
```

2806.INPUT.TGAN.CONTROL.MASS.5

```
  24 NO. OF REGION SPECIFICATIONS (<201).  MGBS OUTPUT NUMBERED
FROM 1, LIBRARY DATA FROM 201, INPUT DATA FROM 301. ALL NT+NF
REGIONS MUST BE SPECIFIED FOR EACH PROBLEM. 0 DENOTES NO CHANGE
N SUCCESSIVE ZEROS MAY BE DENOTED BY -N                          :
   9 201 301   9 201   302 301 201   9 302   201   9  13 201 301
  13 201 302 301 201    13 302 201  13
```


2806.INPUT.TGAN.CONTROL.MASS.5

```
  24    NO. OF ENTRIES (<201).  THICKNESS OF EACH OF NT+NF OR NT
+NF+1 REGIONS MUST BE GIVEN.  0.0 DENOTES NO CHANGE.
Z SUCCESSIVE ZEROS MAY BE DENOTED BY -Z.                        :
 4.9213E 00  1.1747E 01  4.9213E 00  4.9213E 00  1.0001E 01
 6.6675E 00  4.9213E 00  1.1747E 01  4.9213E 00  6.6675E 00
 1.0001E 01  4.9213E 00  4.9213E 00  1.1747E 01  4.9213E 00
 4.9213E 00  1.0001E 01  6.6675E 00  4.9213E 00  1.1747E 01
 4.9213E 00  6.6675E 00  1.0001E 01  4.9213E 00
```