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JONES,R.C. Office of Nuclear Reactor Regulation, Director (Post 870411

SUBJECT: Forwards supplement to 920916 response to NRC request for addl info on VIPRE-01 MOD-02 Documentation EPRI NP-2511-CCM, VIPRE-01, "Thermal-Hydraulic Analysis Code for Reactor Cores."

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G02-92-256
November 23, 1992

Mr. Robert C. Jones, Chief
Reactor Systems Branch
Division of Systems Technology
US Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Jones:

Subject: **SUPPLEMENT TO RESPONSE TO VIPRE-01 MOD-02 REVIEW QUESTIONS**

Reference: Letter dated September 16, 1992, from YY Yung, VMG to RC Jones, USNRC, "Responses to Request for Additional Information on VIPRE-01 MOD-02 Documentation EPRI NP-2511-CCM, VIPRE-01: A Thermal-Hydraulic Analysis Code for Reactor Cores (TAC No. M79498)"

This letter provides the supplement to Reference 1 as was discussed during the telephone conference on November 9, 1992, with Harry Balukjian of your staff and Heidi Komoriya of International Technical Services, Inc.

Please contact me at (509) 377-4366 if there are any questions.

Sincerely,

Y Y Yung

Y. Y. Yung, Chairman (PE16)
VIPRE-01 Maintenance Group

/bw

cc: H. Balukjian, NRC
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YG01 1/1

Supplement to Response to VIPRE-01 MOD-02 Review Questions

Previous responses to questions on the effects of VIPRE-01 results of the changes between MOD-01 and Mod-02 have been submitted (Refer to letter of 9/16/92 from YY Yung of WPPSS to RC Jones of the USNRC, reference no. G02-92-219). The response included a table showing the magnitude and direction of the differences in code results for the test case of a specific change.

The reviewers have asked for additional information on the effect of these changes on PWR transient applications, particularly in regard to the effect of changes 125 and 128, which correct errors in the thermal properties of the zircaloy fuel cladding. To address this concern, a calculation has been performed for a typical PWR transient application of the VIPRE-01 code. A number of utility applications of the code are documented in Section 10 of Volume 4 of the VIPRE-01 documentation. (Refer to EPRI-NP-2511-CCM; Volume 4 - Applications.) The FSAR loss-of-flow transient for the Comanche Peak Unit 1 nuclear station, described in Sec. 10.5, was selected for this calculation. The information available in the document describing the VIPRE model for this calculation is fairly complete, but it does not include the radial power distribution used. As a result, it was necessary to assume a reasonable distribution, based on the 'typical' values published in the Comanche Peak FSAR.

Values were selected that gave an initial MDNBR that was close to the initial value shown in Sec. 10.5. (For this calculation, the initial value of MDNBR was 1.576 for the MOD-01 results, and 1.577 for the MOD-02 results. This is consistent with the value plotted in Figure 10.5-6 on p. 10-90 of Volume 4.) However, because the radial power distribution for the calculation in Sec. 10.5 is not known, it is not reasonable to directly compare the documented results to the current calculation. It is sufficient to note that the results are of approximately the same magnitude, and show the same trends. The significant comparison is in reviewing the results obtained with MOD-02 and MOD-01 in the calculation presented here.

An input file was constructed for the transient described in Section 10.5, and was run on the current released version of VIPRE-01/MOD-02. The same input file was then run on the master version of VIPRE-01/MOD-01. (A listing of the input file is attached.) The results are shown in the attached tables; Table 1 for the MOD-01 results, and Table 2 for the MOD-02 results. As can be readily seen, the two versions of the code show the same trend in the transient, and the magnitudes of the differences are essentially the same as those displayed in the BWR transient calculation presented in the previous response.

Table 1 -- Summary of Results with VIPRE-01/MOD-01: Loss-of-flow Transient in Comanche Peak Unit 1

	operating conditions					critical location			hot channel conditions			rod temperatures		
case	system pressure (psia)	inlet enthalpy (btu/lbm)	inlet mass flux (mlbm/hr-ft2)	average heat rate (btu/sec-ft)	mdnbr	hot channel	hot rod	axial level (in.)	mass flux (mlbm/hr-ft2)	equil. quality	heat flux (mbtu/hr-ft2)	peak clad (F)	peak centerline (F)	time (sec)
1	2220.0	566.48	2.620	5.393	1.576	4	6	94.5	2.349	-0.063	0.442	657.6	3906.0	0.000
1	2220.0	566.48	2.541	5.393	1.537	4	6	94.5	2.262	-0.057	0.442	657.7	3906.0	0.500
1	2220.0	566.48	2.463	5.393	1.490	4	6	94.5	2.161	-0.049	0.442	657.9	3906.0	1.000
1	2231.1	566.48	2.384	5.393	1.452	4	6	94.5	2.067	-0.044	0.441	658.7	3906.0	1.500
1	2242.2	566.48	2.306	5.393	1.413	4	6	99.0	1.925	-0.020	0.419	659.4	3906.0	2.000
1	2279.2	566.48	2.247	5.393	1.402	4	6	99.0	1.875	-0.023	0.418	661.6	3906.0	2.500
1	2316.2	566.48	2.188	5.393	1.390	4	6	99.0	1.829	-0.026	0.417	663.7	3906.1	3.000
1	2353.2	566.48	2.129	5.393	1.376	4	6	99.0	1.781	-0.028	0.417	665.8	3906.2	3.500
1	2382.8	566.48	2.070	5.393	1.355	4	6	99.0	1.726	-0.028	0.417	667.5	3906.5	4.000
1	2392.7	566.48	2.011	5.393	1.478	4	6	94.5	1.714	-0.070	0.411	667.6	3831.5	4.500
1	2368.0	566.48	1.952	5.393	1.642	4	6	94.5	1.719	-0.086	0.381	665.7	3720.3	5.000
1	2334.9	566.48	1.893	5.393	1.851	4	6	90.0	1.734	-0.117	0.360	663.2	3564.7	5.500
1	2289.2	566.48	1.834	5.393	2.015	4	6	85.5	1.716	-0.133	0.343	660.0	3399.5	6.000

Table 2 -- Summary of Results with VIPRE01/MOD-02: Loss-of-flow Transient in Comanche Peak Unit 1

	operating conditions					critical location		hot channel conditions				rod temperatures		
case	system pressure (psia)	inlet enthalpy (btu/lbm)	inlet mass flux (mlbm/hr-ft2)	average heat rate (btu/sec-ft)	mdnbr	hot channel	hot rod	axial level (in.)	mass flux (mlbm/hr-ft2)	equil. quality	heat flux (mbtu/hr-ft2)	peak clad (F)	peak centerline (F)	time (sec)
1	2220.0	566.48	2.620	5.393	1.577	4	6	94.5	2.355	-0.063	0.442	657.6	3959.8	0.000
1	2220.0	566.48	2.541	5.393	1.539	4	6	94.5	2.270	-0.057	0.442	657.7	3959.8	0.500
1	2220.0	566.48	2.463	5.393	1.493	4	6	94.5	2.171	-0.049	0.442	657.9	3959.8	1.000
1	2231.1	566.48	2.384	5.393	1.455	4	6	94.5	2.080	-0.044	0.441	658.7	3959.8	1.500
1	2242.2	566.48	2.306	5.393	1.416	4	6	94.5	1.987	-0.038	0.441	659.5	3959.8	2.000
1	2279.2	566.48	2.247	5.393	1.406	4	6	99.0	1.893	-0.023	0.418	661.6	3959.8	2.500
1	2316.2	566.48	2.188	5.393	1.394	4	6	99.0	1.847	-0.026	0.417	663.7	3959.9	3.000
1	2353.2	566.48	2.129	5.393	1.380	4	6	99.0	1.798	-0.029	0.417	665.9	3959.6	3.500
1	2382.8	566.48	2.070	5.393	1.359	4	6	99.0	1.744	-0.028	0.417	667.6	3959.8	4.000
1	2392.7	566.48	2.011	5.393	1.324	4	6	99.0	1.677	-0.020	0.418	668.2	3960.6	4.500
1	2368.0	566.48	1.952	5.393	1.474	4	6	94.5	1.633	-0.060	0.403	666.3	3855.5	5.000
1	2334.9	566.48	1.893	5.393	1.698	4	6	90.0	1.696	-0.100	0.380	663.7	3711.3	5.500
1	2289.2	566.48	1.834	5.393	1.874	4	6	90.0	1.687	-0.106	0.350	660.4	3553.7	6.000

Input File for MOD-01 to MOD-02 Comparison:

Typical PWR Transient Application

```
*/
*/ ************************************************ /*
*/ PWR transient test, comparing MOD2 with MOD1 /*
*/ ************************************************ /*
*/
*vipre.1
1,0,0
*vipre.2
 Comanche Peak Unit 1: FSAR loss of flow test (VIPRE Vol. 4; sec. 10.5)
*geom.1
geom,16,16,32,0,0,0
*geom.2
144.0,0.0,0.5
*geom.4
 1,  0.0590,   0.6299,   0.4406, 2,  3,0.068, 0.496,  13,0.122,0.992
 2,  0.1362,   1.1750,   1.1750, 3,  3,0.122, 0.496,  5,0.122,0.496, 13,0.244,0.992
 3,  0.1180,   1.2598,   0.8812, 2,  4,0.068, 0.496,  6,0.122,0.496
 4,  0.0590,   0.6299,   0.4406, 1,  7,0.122, 0.496
 5,  0.1362,   1.1750,   1.1750, 2,  6,0.122, 0.496, 13,0.244,0.992
 6,  0.1362,   1.1750,   1.1750, 2,  7,0.122, 0.496,  9,0.122,0.496
 7,  0.1362,   1.1750,   1.1750, 2,  8,0.122, 0.496, 10,0.122,0.496
 8,  0.0590,   0.6299,   0.4406, 1, 11,0.068, 0.496
 9,  0.1180,   1.2598,   0.8812, 2, 10,0.068, 0.496, 13,0.244,0.992
10,  0.1180,   1.2598,   0.8812, 2, 11,0.122, 0.496, 12,0.068,0.496
11,  0.1180,   1.2598,   0.8812, 1, 13,0.244, 0.992
12,  0.1180,   1.2598,   0.8812, 1, 13,0.312, 0.992
13,  3.4518,  30.6169,  28.3457, 1, 14,1.054, 8.466
14, 38.1089, 348.0445, 310.1883, 1, 15,3.162,12.699
15,190.5445,1740.2225,1550.9415, 1, 16,7.378,25.398
16,685.9602,6264.8010,5583.3894
*
*rods.1
rods,1,20,1,2
*rods.2
144.0,0.0,0,0
*rods.3
-1
*rods.5
1.55
*rods.9
 1,1,1.60,1,  1,0.125, 13,0.375
 2,1,1.63,1,  2, 0.25, 13, 0.75
 3,1,1.63,1,  1, 0.25,  2, 0.25,  3, 0.25, 13, 0.25
 4,1,1.59,1,  2, 0.25,  5, 0.25, 13, 0.50
 5,1,1.59,1,  2, 0.25,  3, 0.25,  5, 0.25,  6, 0.25
 6,1,1.63,1,  3, 0.25,  4, 0.25,  6, 0.25,  7, 0.25
 7,1,1.60,1,  4,0.125,  7, 0.25,  8,0.125
 8,1,1.58,1,  5, 0.25, 13, 0.75
 9,1,1.58,1,  5, 0.25,  6, 0.25,  9, 0.25, 13, 0.25
10,1,1.61,1,  6, 0.25,  7, 0.25,  9, 0.25, 10, 0.25
11,1,1.61,1,  7, 0.25,  8, 0.25, 10, 0.25, 11, 0.25
12,1,1.58,1,  9, 0.25, 13, 0.75
13,1,1.59,1, 10, 0.25, 11, 0.25, 12, 0.25, 13, 0.25
14,1,1.57,1, 11, 0.25, 13, 0.75
15,1,1.54,1, 12, 0.25, 13, 0.75
16,1,1.53,1, 12, 0.25, 13, 0.75
17,2,1.53,1, 13, 18.0
18,2,0.99,1, 14,264.0
19,2,1.08,1, 15,1320.0
20,2,0.97,1, 16,4752.0
0
*
*rods.62
1,nucl,0.374,0.3225,9,0.0,0.0225
*rods.63
0,0,0,0,0,900.0,0.95,0.0
```

```
*rods.62
2,dumy,0.374
*
corr,1,1,0
*corr.2
levy,homo,homo,none
*corr.6
ditb,thsp,thsp,w-31,cond,g5.7
*corr.9
w-31
*corr.11
0.038,0.046,0.86
*
mixx,0,0,1
*mixx.2
0.8,0.038,0.0
*mixx.3
0.0380,0.0, ? * beta for gap  1, (connecting channels  1 and  3)
0.0253,0.0, ? * beta for gap  2, (connecting channels  1 and 13)
0.0380,0.0, ? * beta for gap  3, (connecting channels  2 and  3)
0.0380,0.0    * beta for gap  4, (connecting channels  2 and  5)
0.0253,0.0, ? * beta for gap  5, (connecting channels  2 and 13)
0.0380,0.0, ? * beta for gap  6, (connecting channels  3 and  4)
0.0380,0.0, ? * beta for gap  7, (connecting channels  3 and  6)
0.0380,0.0    * beta for gap  8, (connecting channels  4 and  7)
0.0380,0.0, ? * beta for gap  9, (connecting channels  5 and  6)
0.0168,0.0, ? * beta for gap 10, (connecting channels  5 and 13)
0.0380,0.0, ? * beta for gap 11, (connecting channels  6 and  7)
0.0380,0.0    * beta for gap 12, (connecting channels  6 and  9)
0.0380,0.0, ? * beta for gap 13, (connecting channels  7 and  8)
0.0380,0.0, ? * beta for gap 14, (connecting channels  7 and 10)
0.0380,0.0, ? * beta for gap 15, (connecting channels  8 and 11)
0.0380,0.0    * beta for gap 16, (connecting channels  9 and 10)
0.0215,0.0, ? * beta for gap 17, (connecting channels  9 and 13)
0.0380,0.0, ? * beta for gap 18, (connecting channels 10 and 11)
0.0380,0.0, ? * beta for gap 19, (connecting channels 10 and 12)
0.0215,0.0    * beta for gap 20, (connecting channels 11 and 13)
0.0190,0.0, ? * beta for gap 21, (connecting channels 12 and 13)
0.0022,0.0, ? * beta for gap 22, (connecting channels 13 and 14)
0.0015,0.0, ? * beta for gap 23, (connecting channels 14 and 15)
0.0007,0.0    * beta for gap 24, (connecting channels 15 and 16)
*
drag,1,1,4
*drag.2
0.0155,0.0,0.0, 64.0,-1.0,0.0
*drag.7
0.374,0.496
*drag.8
2.66,-0.20,0.0, 0.0,0.0,0.5
*
grid,0,2
*grid.2
1.12,0.80
*grid.4
-1,7
*grid.6
 0.75,2, 21.35,1, 42.35,1, 62.45,1, 83.05,1, 103.55,1, 124.15,1
0
*
oper,1,2,0,1
*oper.2
0.0,0.0,2.6,0.0
*oper.5
 2220.0,565.1,2.62,68.28,0.0
*2220.0,565.1,2.62, 0.00,0.0
*oper.16
```

```
*0,0,0,0
 12, 0, 7, 7
*oper.13 -- system pressure forcing function
 0.0,1.00,  1.0,1.00,  2.0,1.01,  3.8,1.07
 4.4,1.08,  5.3,1.06,  7.0,0.99,  7.5,0.98
 9.5,0.97, 13.0,0.96, 16.5,0.94, 30.0,0.93
*oper.15 -- inlet flow forcing function
 0.0,1.00,  2.0,0.88,  6.0,0.70,  9.5,0.58
15.5,0.43, 25.0,0.33, 30.0,0.30
*oper.16 -- power forcing function
 0.0,1.00,  4.5,1.00,  3.8,0.81,  5.5,0.18
 5.5,0.16, 15.0,0.07, 30.0,0.03
*
cont
*cont.2
6.0,12,20,50,3,2,0,0
*0.0, 0,30,50,3,2,0,0
*cont.3
0.0 *default all convergence criteria
*cont.6
5,13,0,14,13,0,1,1,0,0,0,1,1,0
*cont.7
5000.0
*cont.8 -- channels to be printed
1,2,3,4,5,6,7,8,9,10,11,12,13
*cont.10 -- rods to be printed
1,2,3,4,5,6,7,8,9,10,11,12,13,14
*cont.11 -- CHF channels to be printed
1,2,3,4,5,6,7,8,9,10,11,12,13
*
endd
*
0
```