

Calculation of Byron D4 SG Tube Support Plate Differential Pressures during MSLB with RELAP5M2

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Kevin B. Ramsden

ComEd
Nuclear Fuel Services Department
Downers Grove, Illinois

Prepared by: K. B. Ramsden Date: 9/4/95

Reviewed by: Roll Jace Date: 9/4/95

Approved by: Kenneth M. Koss Date: 9/4/95
(Date Issued)

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Abstract

The purpose of this calculation is to perform and document an independent assessment of the Westinghouse calculations generated to provide structural loadings on the steam generator tube support plates during limiting transient conditions. The Main steam line break (MSLB) event from hot zero power was determined by the vendor to yield the highest differential pressures across the support plates. The vendor utilized the TRANFLO code for the initial work, and validated their results using the MULTIFLEX computer code. This assessment utilizes the RELAP5M2 computer code to analyze the limiting transient and determine the peak differential pressures seen at the most highly loaded TSP for comparison to the vendor predictions.

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1. Introduction

During a main steam line break event, the rapid blowdown of the faulted steam generator can lead to significant loads on the tube support plates. Westinghouse has performed transient thermal hydraulic calculations on the Byron 1/Braidwood 1 Model D4 steam generators in support of structural calculations regarding the extent of tube support plate deformation. As a result of questions that arose during licensing review of the vendor methodology, it was determined that an independent assessment of the limiting TSP differential pressures be performed in-house using the RELAP5 computer code. This report documents the models created for this purpose and details the results obtained.

2. Methodology/Model Description and Assumptions

2.1 Computer Code

The RELAP5M2 cycle 36.05 computer code as implemented on the ComEd IBM mainframe was employed for this calculation. This code has been installed and verified for use in controlled analysis. This computer code has the ability to model full non-equilibrium conditions, and employs a six equation/ two fluid model. This code has been extensively tested in LOCA type calculations, and has been used for licensing applications by vendors and utilities.

2.2 RELAP5M2 Model of D4 Steam Generator

The model developed for use in this calculation is depicted in Figure 1. This model is based heavily on the TRANFLO input description provided by Westinghouse. The primary side of the model used a nodalization essentially identical to that used by Westinghouse. Key secondary side flowpaths have been checked to ensure that appropriate values of inertia and pressure drop information are being consistently applied. Calculations of fluid path inertia and loss coefficients of the principal flow paths for the TRANFLO model and the corresponding RELAP input are provided in Appendix B. As can be seen, the RELAP model uses consistent, and slightly conservative values.

2.3 Initial Conditions

The vendor calculations indicate that the limiting case occurs at hot zero power conditions with water levels at normal values. The water level is at 487" , just below the swirl vanes in the separators. The temperature of the water and steam are uniform at 557 F, and saturation conditions are assumed. The primary system is at equilibrium conditions with the steam generator. The primary system is modeled with time dependent boundary conditions that specify the hot leg temperature to be constant at 557 F. It should be noted that setting initial conditions for the partially voided volumes required some effort, since RELAP requires specification of fluid quality, but the value needed is void fraction. Inspections of resultant void fractions, and total SG mass were helpful in adjusting the model to start at the correct liquid levels.

2.4 Break Model

The break is modeled using a motor valve component with an opening rate of 1 millisecond. The generator nozzle is specifically modeled to provide appropriate treatment of fluid inertia and flow limitation. The break is assumed to occur directly outside the nozzle.

2.5 Tube Support Plate Differential Pressure Calculation

The calculation of tube support plate differential pressure was accomplished by subdividing the pipe component representing the upper section of the steam generator to include thin (.2 ft) volumes on either side of the support plate. The pressure difference between these volumes was then calculated via a control variable to provide the time dependent differential pressure. This method was applied on the uppermost support plate (P) since the vendor calculations indicated that this plate experienced the highest loads. This will lead to slight conservative overprediction of the differential pressures (about 0.12 psi) across the TSP since the elevation head is not being compensated out.

2.6 Calculation of Crossflow Resistance

A review of the Westinghouse input/output for TRANFLO indicated that a crossflow resistance across the tube bundle was accounted for. An independent approach for calculating the crossflow resistance was developed based on the Zukauskus correlation as presented in Reference 2. The results of this correlation were compared to Westinghouse at the .57 second output edit, and showed comparable pressure drops. The pressure drop information calculated in this way was then converted into K-values to be added as crossflow corrections at selected junctions. This approach was used for the upper tube region(135-5) , downcomer entrance (100), and preheater (133) areas.

3. Calculations

3.1 Base Case

The base case performed is the full MSLB from Hot Zero Power Conditions. The water level is assumed to be at normal levels (487"). Comparisons to be performed include tube support plate (TSP) P differential pressure vs time and break flow rate. The full non-equilibrium two fluid model capability is utilized for this case. The default separator performance curves are applied.

3.2 Equilibrium Conditions Calculation

This case is essentially identical to the base case with two exceptions. The equilibrium switch in the volume descriptions is set to 1 to force equilibrium temperatures between phases. The other change is to set the h flag (VCAHS) in the junction description to 2 to force the code to adopt a single momentum equation at junctions. All other input remains identical. This case tests the sensitivity of the results to the two phase fluid model used.

3.3 Sensitivity Calculations

Several additional cases were run to assess the sensitivity of the base case model to variance in input parameters.

3.3.1 Separator Performance

The first set of sensitivity runs looked at the RELAP5 separator modeling of carryover/carryunder fractions. The base case used the default separator performance values ($V_{over}=0.5$, $V_{under}=0.15$). Values of V_{over} ranging from 0.25 to 1.0 were input with default V_{under} . Then V_{under} was varied from the default value of 0.15 to 0.45, while holding V_{over} at its 0.5 default value.

3.3.2 TSP Loss Coefficient

In order to assess the appropriateness of the differential pressure modeling of the upper support plate, the loss coefficient for the P TSP were varied plus and minus 10%. This allows the determination of whether the pressure drop is due to two-phase effects, or just the plate frictional losses by comparing the relative change in the differential pressures from the base case.

3.3.3 Flow Area/Inertia of Preheater Section

The junction flow areas of the base case preheater section ignored the bypass flow areas through the TSP for conservatism. An additional run was performed to determine the effect of adding this area to the existing model.

4. Results

4.1 Base Case

The base case was evaluated out to 10 seconds into the blowdown to ensure that the key load causing aspects of the MSLB were included. The base case resulted in a peak pressure of 1.97 psi across the P-TSP (Note that this includes an overprediction of approximately .12 psi, as do all the results presented). The results of the base case are depicted in Figures 2 through 7. The dome pressure is shown in Figure 2. As can be seen, the pressure drops rapidly initially and then moderates to rates of approximately 100 psi/sec or less within .2 seconds. Break mass flow rate is shown in Figure 3. Break flow is initially all steam, with entrained liquid reaching the break at approximately .7 seconds, causing an increase in the mass flow rate. The differential pressure across the P-TSP is shown in Figure 4. This shows a peak occurs about 0.5 to 0.8 seconds followed by a rapid decay to near steady-state conditions. The liquid velocity at the P-TSP is provided in Figure 5, and the corresponding liquid void fraction is shown in Figure 6. The liquid void fraction remains relatively high throughout the peak dynamic load period, and review of the flow regimes predicted indicates bubbly flow persists until after the peak load occurs. Figure 7 demonstrates the vapor void fractions at the P-TSP and at the J-TSP lower down in the boiling section. As can be seen, the void fractions remain relatively close to each other throughout the blowdown. This tends to support that the principal flow pattern is cocurrent, at least for these locations. A review of the liquid and vapor temperatures indicates that some non-equilibrium behavior is seen in the upper nodes of the model, with steam temperatures being approximately 10 degrees lower than the liquid in the early portions of the blowdown.

4.2 HEM Comparison Calculation

The model used for the base case, modified as described in section 3.2 to force equilibrium, single equation momentum calculation resulted in a reduction in peak pressure drop at the P-TSP location. The peak pressure reached on this case was 1.35 psi across the P-TSP. The principal value of this case is to indicate the range of sensitivity of the differential pressure with respect to two-phase fluid flow models. This supports that the two phase calculational uncertainty is bounded in the range of .5 psi or approximately 30%.

4.3 Results of Sensitivity Cases

4.3.1 Separator Model Sensitivity

The values of separator carryover and carryunder fractions were varied over a range of values to determine what impact the separator model has on the results. The values utilized and the corresponding results are displayed in Table 1. As can be seen, there is very little sensitivity to separator model inputs. This is most likely a result of early flooding of the separator, causing the separator model to shift to "same in/same out" behavior. The carryunder fraction is most likely insensitive due to flow reversal effects.

Case	Vover	Vunder	Max DP at P-TSP
3	.75	.15	2.087
4	1.0	.15	2.161
5	.25	.15	1.99
6	.5	.3	1.97
7	.5	.45	1.97

Table 1 Results of Separator Parametric Sensitivity

4.3.2 Effects of TSP Loss Coefficient

The loss coefficients for the P-TSP were varied by plus and minus 10%. The results are shown in Table 2. The results are as one would expect, with almost linear behavior of pressure drop with respect to loss coefficient.

Case	K	Max DP at P-TSP
8	1.19	2.15
9	.972	1.76
Base	1.08	1.97

Table 2 Sensitivity to TSP Loss Coefficient

4.3.3 Addition of Preheat Bypass Area

This case directly added the bypass area modeled by Westinghouse to the main flow paths in the preheater section. This bypass is not modeled in the base case, since it was felt that it represented a minor impact. The effect on peak pressure across P-TSP was a very small increase to 1.974 psi, from 1.97 psi. This confirms the initial model assumption with respect to this flow path.

Dome Pressure Base Case

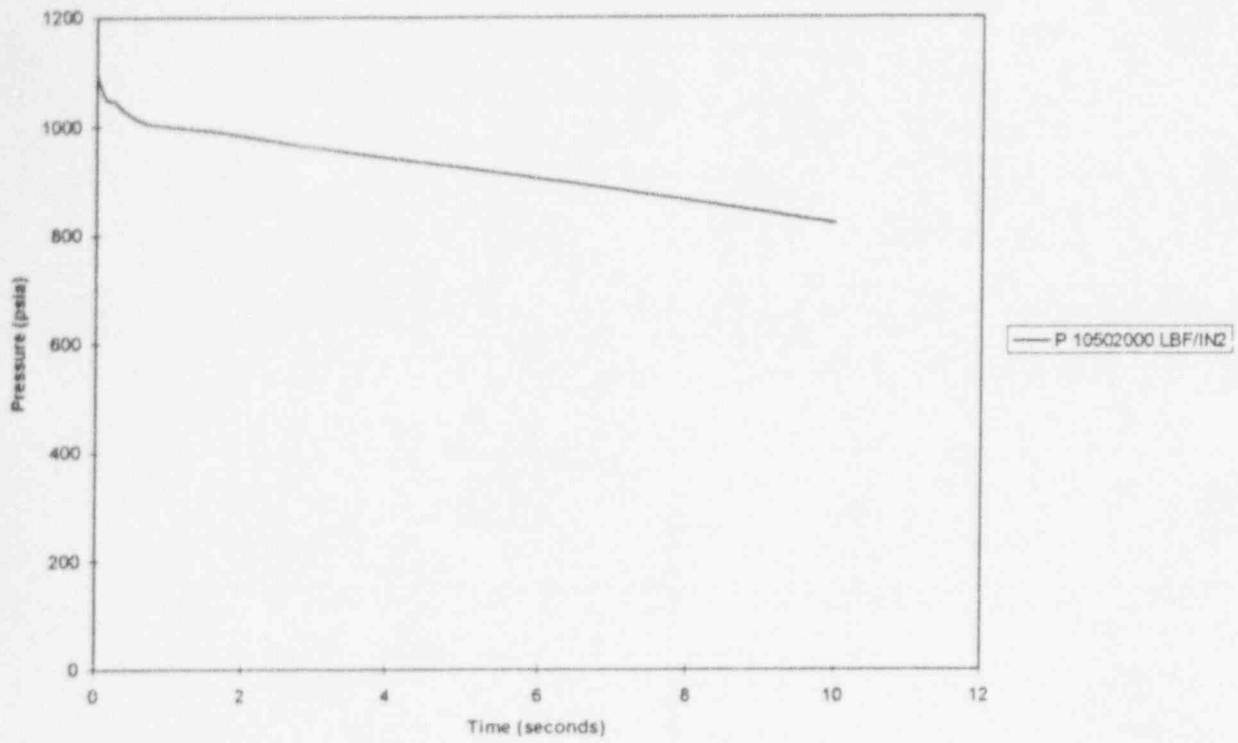


Figure 2 Dome Pressure Response Base Case

P-TSP Delta P Base Case

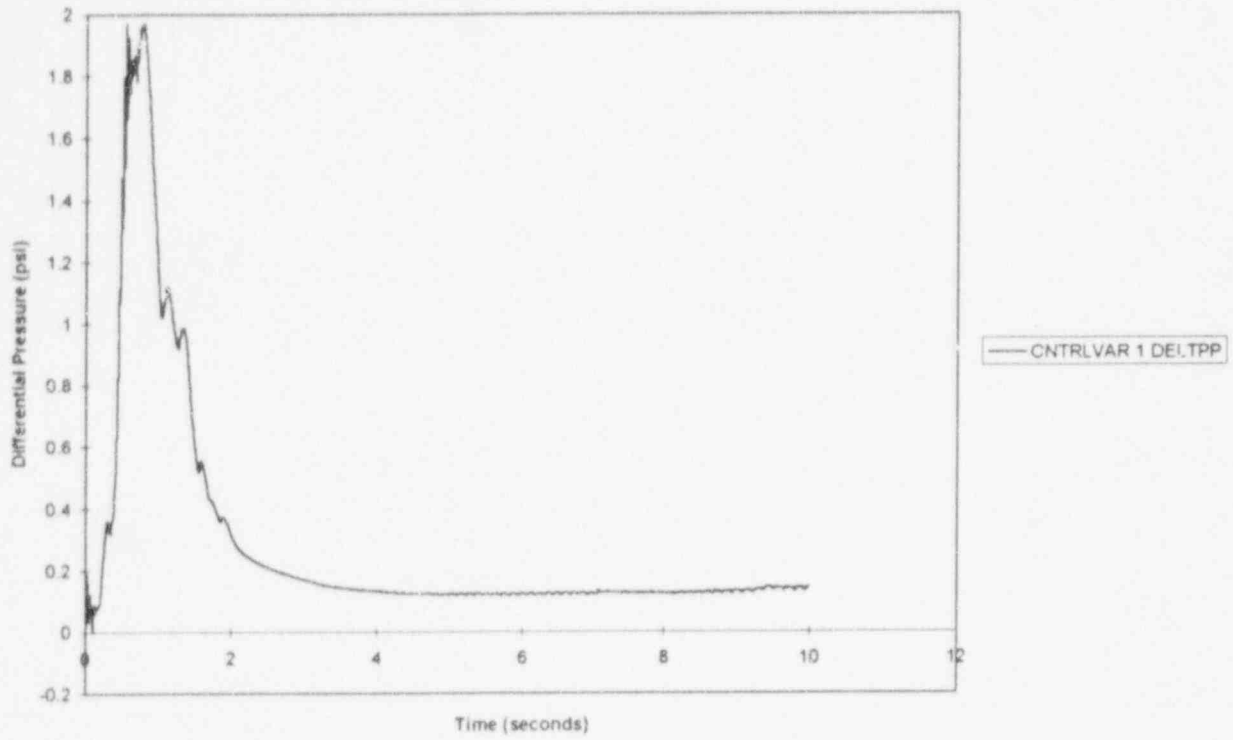


Figure 4 P-TSP Differential Pressure Base Case

Liquid Velocity at P-TSP

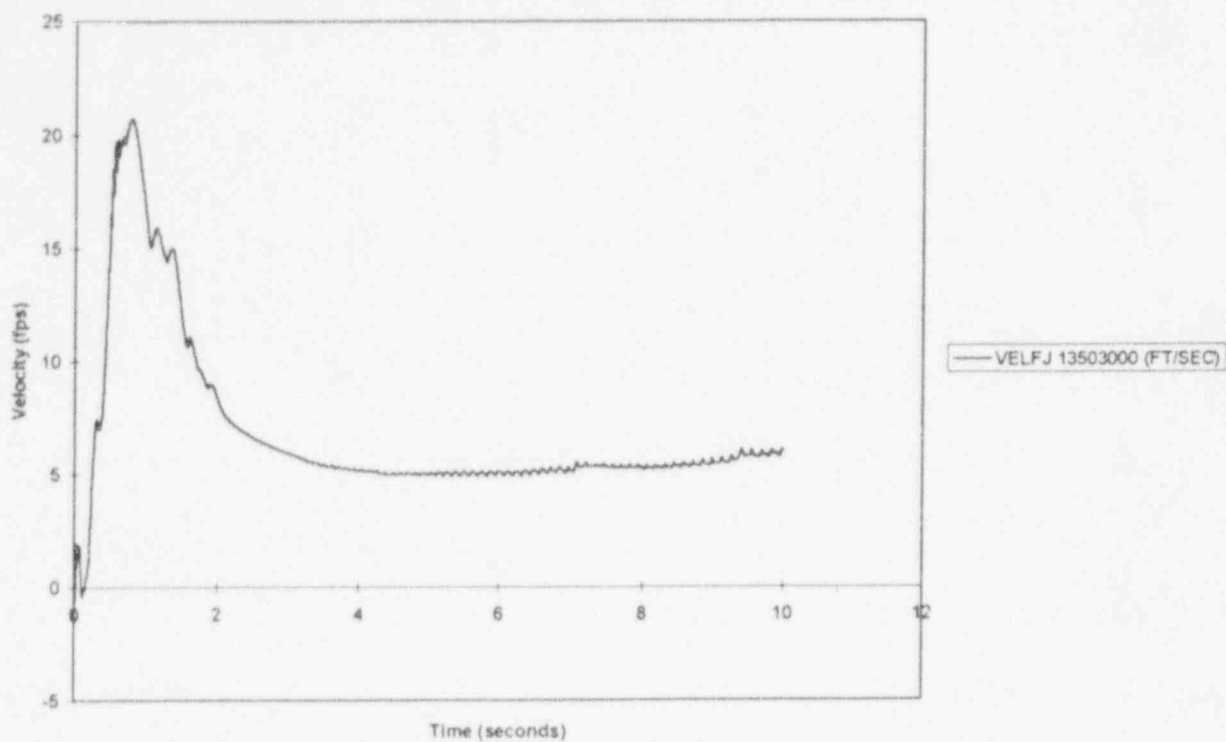


Figure 5 Liquid Velocity at P-TSP Base Case

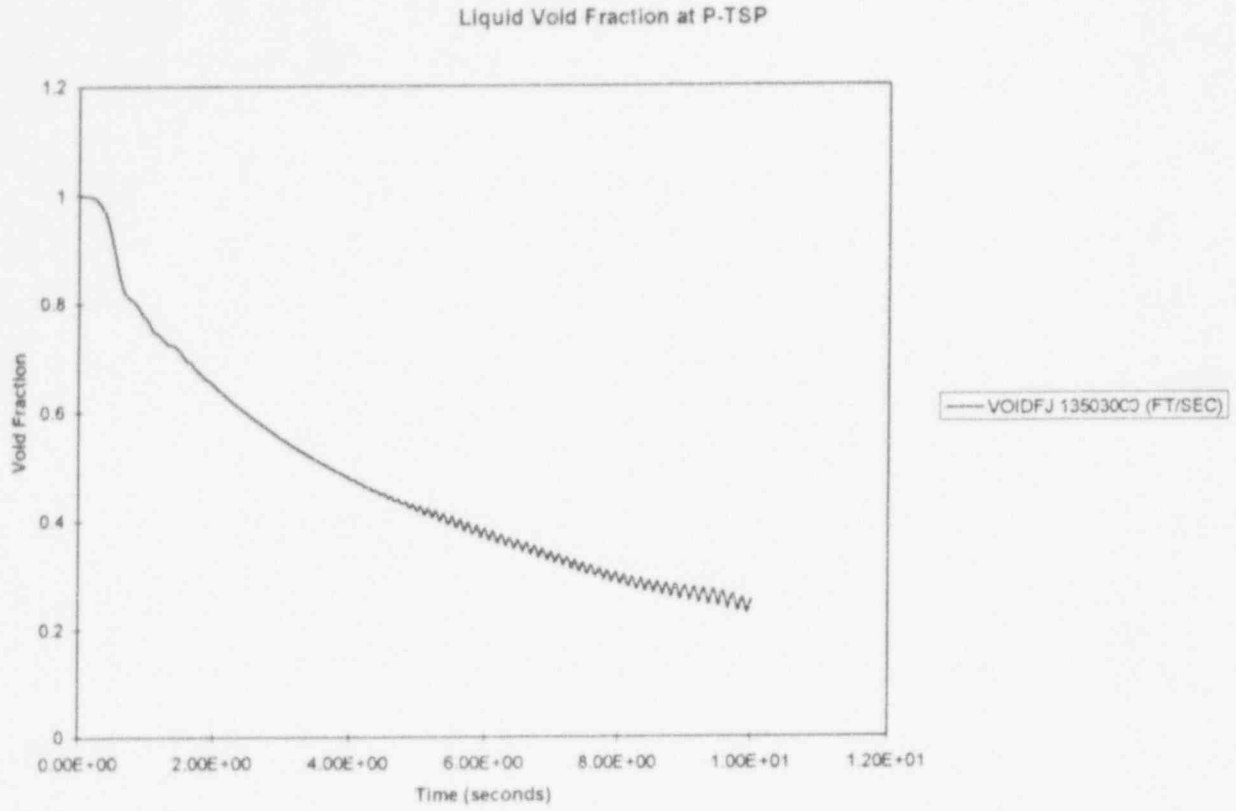


Figure 6 Liquid Void Fraction at P-TSP Base Case

Vapor Void Fraction Response

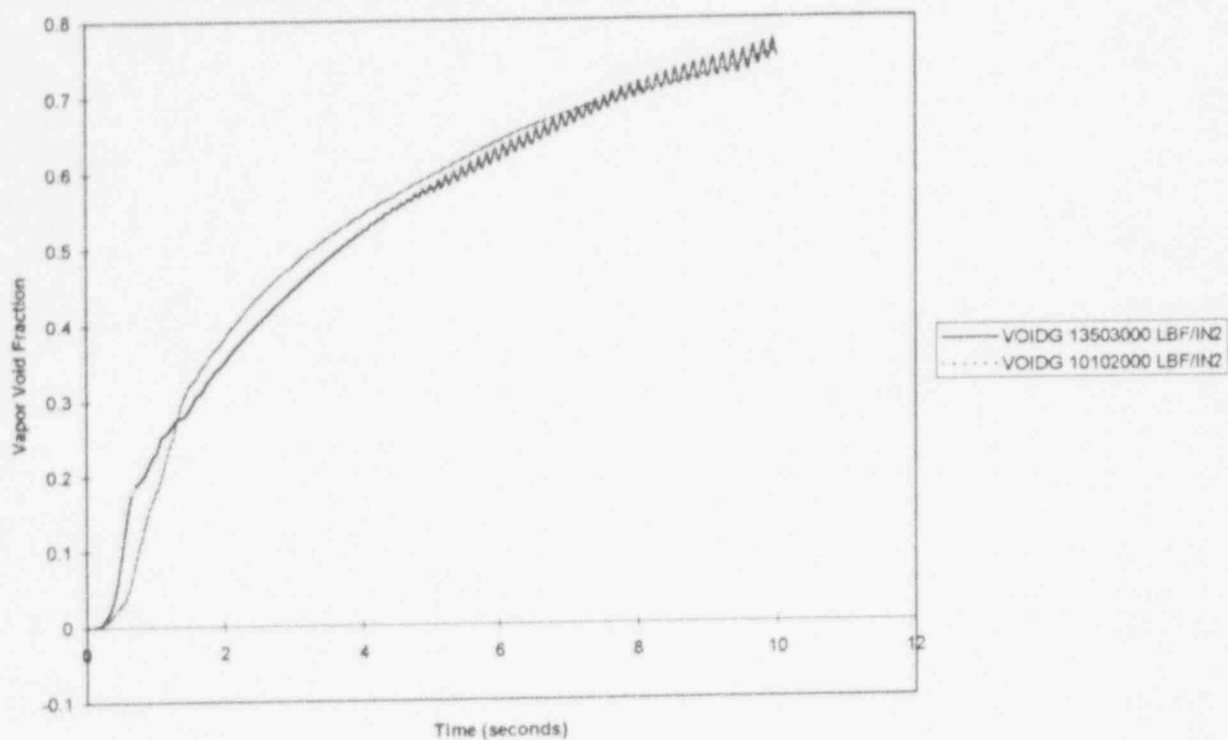


Figure 7 Vapor Void Fractions at P-TSP and J-TSP

5. Conclusions/Discussion

The peak pressure at the P-TSP has been calculated using RELAP5M2 with a model geometry comparable to that used by Westinghouse. The pressure calculated agrees fairly well with that calculated by Westinghouse (1.9 vs 1.6 psi at P-TSP). The variation between the codes can be attributed to the different constitutive models used, two-fluid by RELAP vs a drift flux formulation in TRANFLO. When a factor of two is applied to the TRANFLO results, it conservatively bounds the maximum values calculated by RELAP5M2.

6. References

- 1) TRANFLO Input Description for D4 Steam Generator
- 2) "Nuclear Systems I", N. Todreas and M. Kazimi, 1990.

Appendix A - Microfiche Index

Microfiche ID	# of fiche	Description
NFSKR1	1	Base Case
NFSKR2		HEM case
NFSKR3		Separator Sensitivity
NFSKR4		Separator Sensitivity
NFSKR5		Separator Sensitivity
NFSKR6		Separator Sensitivity
NFSKR7		Separator Sensitivity
NFSKR8		K Sensitivity
NFSKR9		K Sensitivity
NFSKR0		Preheat Bypass area

Appendix B RELAP5 Input Deck and Verification Sheets

Summary of Principal Path Nozzle to TSP Parameters for TRANFLO D4 Model								
Junction	Segment	Area	Length	K	L/A	K/A2	Hyd dia	calc hyd d
23	1	129.35	1.77625	0	0.013732122	0	12.83	12.83369
	2	1.388	1.5	0	1.080691643	0	0.5025	1.329423
	3		0.5	0	0.1	0	2.45	2.52321
24	1	74.94	3.7242	0	0.049695757	0	11.02	9.76844
	2	129.35	1.77625	0	0.013732122	0	12.83	12.83369
25	1	179.54	0.37	40	0.002060822	0.001240902	0.0417	15.1199
	2	63.49	3.725	0.5	0.058670657	0.000124039	11.02	8.99127
28	1	70.75	3.725	0.5	0.052650177	9.98889E-05	3.92	9.491429
	2	179.54	0.37	0	0.002060822	0	0.0417	15.1199
29	1	152.67	1.1146	0	0.007300714	0	14.04	13.94265
	2	77.74	3.78	0	0.048623617	0	4.07	9.949257
30	1	24.89	0.6354		0.025528325	0	1.625	5.629643
	2	11.49	0.25	0.86	0.02175805	0.00651416	1.1042	3.824973
	3	152.67	1.1146	0	0.007300714	0	14.04	13.94265
37	1	24.89	6.2148	0	0.249690639	0	1.625	5.629643
	2	22.01	0.25	13.9	0.011358473	0.028692918	1.0729	5.293932
	3	24.89	0.6979	0	0.028039373	0	1.625	5.629643
38	1	92.13	3.59375	0	0.039007381	0	10.82	10.83101
	2	24.89	6.2148	0	0.249690639	0	1.625	5.629643
39	2	16.9996	0.0625	1.08	0.003678557	0.0037372	0.0417	4.652514
	3	36.39	4.25	0	0.116790327	0	0.1234	6.807057
Totals					2.182058931	0.040409108		

Summary of Principal Path Nozzle to TSP Parameter for RELAP5M2 Model

Volume	Area	Length	K	L/A	K/A2	hyd
107	1.388 ✓	1.5 ✓	0	1.080692	0	0.5025 ✓
1051	63.49 ✓	7.45 ✓	0	0.117341	0	11.02 ✓
1052	98.79 ✓	3.55 ✓	0	0.035935	0	12.83 ✓
124	171.4 ✓	0.708 ✓	0	0.004131	0	0.0417 ✓
124-104	70.75 ✓		0.5 ✓		9.99E-05	
124-105	63.49 ✓		5.502 ✓		0.001365	
104	70.75 ✓	7.45 ✓	0	0.1053	0	4.07 ✓
103	151.32 ✓	2.35 ✓	0	0.01553	0	14.04 ✓
j102-103	11.49 ✓	0	0.86 ✓	0	0.006514	
103-104	77.74 ✓		0		0	
102	25.8121 ✓	14.1567 ✓	0	0.548452	0	1.625
j135-102	22.01 ✓	0	13.9 ✓	0	0.028693	
135	55.25 ✓	8.1566 ✓	0	0.147631	0	12.34 ✓
j135tsp	16.9996 ✓	0	1.08 ✓	0	0.003737	
Totals				2.055012	0.040409	

Summary of Separator drain Path Parameters for TRANFLO D4 Model									
Junction	Segment	Area	Length	K	L/A	K/A2	Hyd dia	calc hyd	
23	1	129.35	1.77625	0	0.013732	0	12.83	12.83369	
	2	1.388	1.5	0	1.080692	0	0.5025	1.329423	
	3	5	0.5	0	0.1	0	2.45	2.52321	
24	1	74.94	3.7242	0	0.049696	0	11.02	9.76844	
	2	129.35	1.77625	0	0.013732	0	12.83	12.83369	
25	1	179.54	0.37	40	0.002061	0.001241	0.0417	15.1199	
	2	63.49	3.725	0.5	0.058671	0.000124	11.02	8.99127	
28	1	70.75	3.725	0.5	0.05265	9.99E-05	3.92	9.491429	
	2	179.54	0.37	0	0.002061	0	0.0417	15.1199	
29	1	152.67	1.1146	0	0.007301	0	14.04	13.94265	
	2	77.74	3.78	0	0.048624	0	4.07	9.949257	
30	1	24.89	0.6354		0.025528	0	1.625	5.629643	
	2	11.49	0.25	0.86	0.021758	0.006514	1.1042	3.824973	
	3	152.67	1.1146	0	0.007301	0	14.04	13.94265	
31	1	24.89	0.6979		0.028039	0	1.625	5.629643	
	2	19.78	2.9167	0.5	0.147457	0.001278	0.5417	5.018588	
32	1	19.78	2.9167	0.5	0.147457	0.001278	0.5417	5.018588	
	2	104.07	2.9167	0	0.028026	0	3.1026	11.51148	
33	1	104.07	2.9167	0	0.028026	0	3.1026	11.51148	
	2	27.91	0.0625	1.28	0.002239	0.001643	0.8333	5.9614	
	3	126.49	3.9635	0	0.031334	0	4.51	12.69102	
64/34	1	126.5	3.935	0	0.031107	0	4.51	12.69152	
	2	5.7356	15.8125	0	2.756904	0	0.3442	2.702451	
36/35	1	5.7356	15.8125	0.5	2.756904	0.015199	0.3442	2.702451	
	2	3.1184	1.1068	0	0.354926	0	0.1234	1.992665	
Totals					7.796226	0.027377			

Summary of Separator Drain path Parameter for RELAP5M2 Model

Volume	Area	Length	K	L/A	K/A2	hyd
107	1.388	1.5	0	1.080692	0	0.5025
1051	63.49	7.45	0	0.117341	0	11.02
1052	98.79	3.55	0	0.035935	0	12.83
124	171.4	0.708	0	0.004131	0	0.0417
124-104	70.75		0.5		9.99E-05	
124-105	63.49		5.502		0.001365	
104	70.75	7.45	0	0.1053	0	
103	151.32	2.35	0	0.01553	0	14.04
j102-103	11.49	0	0.86	0	0.006514	
103-104	77.74		0		0	
102	25.8121	14.1567	0	0.548452	0	1.625
j111-102	22.01	0	1	0	0.002064	
111	111.07	0.2202	0	0.001983	0	0
j110-111	111.07	0	0	0	0	
111-112	5.7356		0		0	
1121	5.74	2.814292	0	0.490295	0	0.3442
1122	5.74	1.001	0	0.17439	0	0.3442
1123	5.74	6.570134	0	1.144623	0	0.3442
1124	5.74	10.38443	0	1.809134	0	0.3442
1125	5.74	10.38443	0	1.809134	0	0.3442
100	56.45	0.5	0	0.008857	0	
112-100	5.7356	0	0.5	0	0.015199	
Totals				7.345797	0.025242	

Summary of Dryer Drain Path Parameters for TRANFLO D4 Model								
Junction	Segment	Area	Length	K	L/A	K/A2	Hyd dia	calc hyd
23	1	129.35	1.77625	0	0.013732	0	12.83	12.83369
	2	1.388	1.5	0	1.080692	0	0.5025	1.329423
	3	5	0.5	0	0.1	0	2.45	2.52321
24	1	74.94	3.7242	0	0.049696	0	11.02	9.76844
	2	129.35	1.77625	0	0.013732	0	12.83	12.83369
25	1	179.54	0.37	40	0.002061	0.001241	0.0417	15.1199
	2	63.49	3.725	0.5	0.058671	0.000124	11.02	8.99127
26	1	20.36	3.7242	0	0.182917	0	0.6767	5.091635
	2	2.0211	8.1925	0.5	4.053486	0.122404	1.6042	1.604214
27	1	2.0211	8.1925	0.5	4.053486	0.122404	1.6042	1.604214
	2	126.49	3.9635	0	0.031334	0	4.51	12.69102
64/34	1	126.5	3.935	0	0.031107	0	4.51	12.69152
	2	5.7356	15.8125	0	2.756904	0	0.3442	2.702451
36/35	1	5.7356	15.8125	0.5	2.756904	0.015199	0.3442	2.702451
	2	3.1184	1.1068	0	0.354926	0	0.1234	1.992665
Totals					15.53965	0.261371		

Summary of Dryer Drain Path Parameters for RELAP5M2 Model

Volume	Area	Length	K	L/A	K/A2	hyd
107	1.388	1.5	0	1.080692	0	0.5025
1051	63.49	7.45	0	0.117341	0	11.02
1052	98.79	3.55	0	0.035935	0	12.83
124	171.4	0.708	0	0.004131	0	0.0417
124-250	2.0211		0.5		0.122404	
124-105	63.49		5.502		0.001365	
250	2.02	16.5408	0	8.188515	0	
111	111.07	0.2202	0	0.001983	0	0
1250-111	2.02	0	0.5	0	0.122537	
111-112	5.7356		0		0	
1121	5.74	2.814292	0	0.490295	0	0.3442
1122	5.74	1.001	0	0.17439	0	0.3442
1123	5.74	6.570134	0	1.144623	0	0.3442
1124	5.74	10.38443	0	1.809134	0	0.3442
1125	5.74	10.38443	0	1.809134	0	0.3442
100	56.45	0.5	0	0.008857	0	
112-100	5.7356	0	0.5	0	0.015199	
Totals				14.86503	0.261504	

Summary of Principal Path through tube sheets for TRANFLO D4 Model								
Junction	Segment	Area	Length	K	L/A	K/A2	Hyd dia	calc hyd
46	1	28.225	0.25	0	0.008857396	0	0.1234	5.994947
	2	6.4488	0.0625	1.25	0.009691726	0.030057454	0.0093	2.865549
	3	27.9	1.21875	0	0.043682796	0	0.1234	5.960332
45	1	27.9	1.21875	0	0.043682796	0	0.1234	5.960332
	2	8.0485	0.0625	1.1	0.007765422	0.016980981	0.0417	3.201296
	3	27.9	1.46875	0	0.052643369	0	0.1234	5.960332
44	1	27.9	1.46875	0	0.052643369	0	0.1234	5.960332
	2	8.0485	0.0625	1.1	0.007765422	0.016980981	0.0417	3.201296
	3	27.9	1.46875	0	0.052643369	0	0.1234	5.960332
43	1	27.9	1.46875	0	0.052643369	0	0.1234	5.960332
	2	7.8717	0.0625	1.13	0.007939835	0.018236495	0.0417	3.16594
	3	27.9	1.7604	0	0.063096774	0	0.1234	5.960332
42	1	27.9	1.7604	0	0.063096774	0	0.1234	5.960332
	2	7.0398	0.0625	1.2	0.008878093	0.024213669	0.0417	2.993978
	3	27.9	1.7604	0	0.063096774	0	0.1234	5.960332
41	1	56.45	1.7604	0	0.03118512	0	0.1234	8.478135
	2	16.9996	0.0625	1.08	0.003676557	0.0037372	0.0417	4.652514
	3	56.45	1.0604	0	0.018784765	0	0.1234	8.478135
40	1	56.45	1.7604	0	0.03118512	0	0.1234	8.478135
	2	16.9996	0.0625	1.08	0.003676557	0.0037372	0.0417	4.652514
	3	56.45	1.0604	0	0.018784765	0	0.1234	8.478135
39	1	56.45	1.7604	0	0.03118512	0	0.1234	8.478135
	2	16.9996	0.0625	1.08	0.003676557	0.0037372	0.0417	4.652514
	3	36.39	4.25	0	0.116790327	0	0.1234	6.807057
Totals					0.797072172	0.117681182		

Summary of Tube Sheet Path Parameters for RELAP5M2 Model							
Volume	Area	Length	K	L/A	K/A2	hyd	
100	56.45	0.5	0	0.008857	0	1.625	
100-121	6.4488	0	1.25	0	0.030057	0	
121	27.9	2.437	0	0.087348	0	1.625	
121-101	8.0485		1.1		0.016981		
1011	27.9	3	0	0.107527	0	0.1234	
1012	27.9	3	0	0.107527	0	0.1234	
1013	27.9	3.5833	0	0.128434	0	0.1234	
12	8.0485	0	1.1	0	0.016981	0	
23	7.8717	0	1.13	0	0.018236	0	
134	56.45	3.5208	0	0.06237	0	0.1234	
101-134	7.0398	0	1.2	0	0.024214		
134-135	16.9149		1.08		0.003775		
1351	56.45	3.5833	0	0.063477	0	0.1234	
1352	56.45	3.3733	0	0.059757	0	0.1234	
1353	56.45	0.11	0	0.001949	0	0.1234	
1354	55.25	0.11	0	0.001991	0	0.1234	
1355	55.25	8.1566	0	0.147631	0	0.1234	
12	16.9996	0	1.08	0	0.003737	0	
34	16.9996	0	1.08	0	0.003737	0	
Totals				0.776868	0.117719		

Summary of Deck plate drain Path Parameters for TRANFLO D4 Model								
Junction	Segment	Area	Length	K	L/A	K/A2	Hyd dia	calc hyd
23	1	129.35	1.77625	0	0.013732	0	12.83	12.83369
	2	1.388	1.5	0	1.080692	0	0.5025	1.329423
	3	5	0.5	0	0.1	0	2.45	2.52321
24	1	74.94	3.7242	0	0.049696	0	11.02	9.76844
	2	129.35	1.77625	0	0.013732	0	12.83	12.83369
25	1	179.54	0.37	40	0.002061	0.001241	0.0417	15.1199
	2	63.49	3.725	0.5	0.058671	0.000124	11.02	8.99127
28	1	70.75	3.725	0.5	0.05265	9.99E-05	3.92	9.491429
	2	179.54	0.37	0	0.002061	0	0.0417	15.1199
29	1	152.67	1.1146	0	0.007301	0	14.04	13.94265
	2	77.74	3.78	0	0.048624	0	4.07	9.949257
62	1	152.67	1.177	0	0.007709	0	14.04	13.94265
	2	7.29	0.0625	1.7	0.008573	0.031988	0.1667	3.046717
	3	104.07	2.9167	0	0.028026	0	3.1026	11.51148
33	1	104.07	2.9167	0	0.028026	0	3.1026	11.51148
	2	27.91	0.0625	1.28	0.002239	0.001643	0.8333	5.9614
	3	126.49	3.9635	0	0.031334	0	4.51	12.69102
64/34	1	126.5	3.935	0	0.031107	0	4.51	12.69152
	2	5.7356	15.8125	0	2.756904	0	0.3442	2.702451
36/35	1	5.7356	15.8125	0.5	2.756904	0.015199	0.3442	2.702451
	2	3.1184	1.1068	0	0.354926	0	0.1234	1.992665
Totals					7.434969	0.050295		

Summary of Deck plate Drain Parameters for RELAP5M2 Model							
Volume	Area	Length	K	L/A	K/A2	hyd	
107	1.388	1.5	0	1.080692	0	0.5025	
1051	63.49	7.45	0	0.117341	0	11.02	
1052	98.79	3.55	0	0.035935	0	12.83	
124	171.4	0.708	0	0.004131	0	0.0417	
124-104	70.75		0.5		9.99E-05		
124-105	63.49		5.502		0.001365		
104	70.75	7.45	0	0.1053	0		
103	151.32	2.35	0	0.01553	0	14.04	
103-110	11.49	7.29	1.77	0.634465	0.013407		
103-104	77.74		0		0		
110	111.07	14.1567	0	0.127457	0	0	
111	111.07	0.2202	0	0.001983	0	0	
110-111	111.07	0	0	0	0		
111-112	5.7356		0		0		
1121	5.74	2.814292	0	0.490295	0	0.3442	
1122	5.74	1.001	0	0.17439	0	0.3442	
1123	5.74	6.570134	0	1.144623	0	0.3442	
1124	5.74	10.38443	0	1.809134	0	0.3442	
1125	5.74	10.38443	0	1.809134	0	0.3442	
100	56.45	0.5	0	0.008857	0		
112-100	5.7356	0	0.5	0	0.015199		
Totals				7.559267	0.030071		

=STAND ALONE STEAM GENERATOR MODEL FOR D4 SG

* HOT STANDBY NONEQUILIBRIUM MODELS USED

* (THIS DECK IS BASED ON WESTINGHOUSE TRANFLOW D4 *)

* MODEL USED FOR TUBE SUPPORT PLATE DP CALCULATION *

* This model contains more detail in dome area

* *
* THIS DATA IS CONTAINED IN *
* NFSkr.RELAP5M2.CNTL(basene) *
* includes two more small nodes at upper tsp *
* models upper dome with explicit W volumes *
* Includes .2 ft slabs for P-TSP dp calc *
* includes crossflow resistances *

*

*

100 NEW TRANSNT

*

*

102 BRITISH BRITISH

105

*

*----- TIME STEP CARDS

*

* END DTMIN DTMAX OPT MIN MAJ RSTRT

201 2.5 1.D-7 0.0005 3 5 4000 2500

202 4.0 1.D-7 0.001 3 10 4000 2500

203 10.5 1.D-7 0.001 3 20 4000 2500

*

*

*----- MINOR EDIT VARIABLES

*

* VARIABLE CODE PARAMETER LOCATION

301 VELFJ 135030000 *veloc

302 VOIDFJ 135030000 *void fract

303 RHOFJ 135030000 *density

304 CNTRLVAR 1 *comp dp

305 MFLOWJ 300000000 *Break flow

306 P 105020000 *dome pressure

307 VOIDG 135030000 *void frac

308 VOIDG 101020000 *SG WATER MASS

*

*----- TRIP INPUT DATA

*

*VARIABLE TRIP CARDS

* VARIABLE PARAM RELATION VARIABLE PARAM CONS LATCH

501 TIME 0 GE NULL 0 10.0 L

502 TIME 0 GE NULL 0 .001 L

503 TIME 0 GE NULL 0 100. L

*
* TRIP IDENTIFIER ;
* |
* 501 =>PROBLEM STOP ;
*-----
*

*TRIP STOP ADVANCEMENT CARD

* TRP NO.

600 501

*----- HYDRODYNAMIC COMPONENTS

*
*-----
* PRIMARY SIDE MODEL ;
* PLENUMS AND TUBES MODELLED EXPLICITLY ;
* HOT LEG AND COLD LEG REPRESENTED BY TDVS ;
*-----
*

0420000 INPLEN TMDPVOL

*
* FLOWA L VOL AZI INCL DZ ROUGH HYD FE

0420101 0.0 5.2183 147.64 0.0 0.0 0.0 0.0 0.0 00

0420101 0.0 5.2183 5000. 0.0 0.0 0.0 0.0 0.0 00

* EBT

0420200 3

* TIME PRESS TEMP

0420201 0.0 2250.00 557.000

0420202 1.0E6 2250.00 557.000

0470000 OUTPLEN TMDPVOL

*
* FLOWA L VOL AZI INCL DZ ROUGH HYD FE

0470101 0.0 5.2183 147.64 0.0 0.0 0.0 0.0 0.0 00

0470101 0.0 5.2183 5000. 0.0 0.0 0.0 0.0 0.0 00

* EBT

0470200 3

* TIME PRESS TEMP

0470201 0.0 2206.77 557.

0470202 1.0E6 2206.77 557.

```

*-----*
1510000 TUBES PIPE
*
*   NV
1510001 21
*
*   FLOWA NV
1510101 11.0088 21
*
*   LENGTH NV
1510301 .5625 1
1510302 2.5 2
1510303 3.0 3
1510304 3.5833 8
1510305 3.445 10
1510306 3.5833 14
1510307 1.5 19
1510308 1.0 20
1510309 .5625 21
*
*   VOLUME NV
1510401 0.0 21
*
*   INCLINE ANGLE NV
1510601 90.0 8
1510602 90.0 9
1510603 -90.0 10
1510604 -90.0 21
*
*   ELEV CNG NV
*510701 1.7525 1
*510702 2.5 2
*510703 3.0 3
*510704 3.5833 8
*510705 3.445 9
*510706 -3.445 10
*510707 -3.5833 14
*510708 -1.5 19
*510709 -1.0 20
*510710 -.5625 21
*
*   ROUGH HYD DIA NV
1510801 0.0 .0553333 21
*
*   FE NV
1511001 00 21
*
*   VCAHS NJ
1511101 10000 9
1511102 00000 10
1511103 20000 20
*
*   FLAG P T DUMMY DUMMY DUMMY NV
1511201 3 2250.0 557.0 0.0 0. 0. 21

```

```

*
*   FLAG=1 => (LBM/SEC)
1511300 1
*
*   LFLOW   VFLOW INTERFACE FLOW   NJ
1511301 9763.12 0.0   0.0   20
*-----*
1500000 JUNCT TMDPJUN
*
*   FROM   TO   AREA
1500101 042000000 151000000 1.0
*
*   FLAG
1500200 1
*
*   TIME LFLOW   VFLOW INTFLOW
1500201 0.0 9763.12 0.0 0.0
1500202 1.0E6 9763.12 0.0 0.0
*-----*
1590000 JUNCT SNGLJUN
*
*   FROM   TO   AREA   FJUNF FJUNR VCAHS
1590101 151010000 047000000 9.823 15 0.0 0.0 20000
*
*   FLAG LFLOW   VFLOW INTFLOW
1590201 1 9763.12 0.0 0.0
*-----*
*
*
*
*-----*
* SECONDARY SIDE MODEL           |
* 90% - 10% FEED FLOW SPLIT      |
* BOUND CNDS REPRESENTED BY TIME DEPENDENT |
* JUNCTIONS AND TME DEPENDENT VOLUMES    |
*-----*
*
*-----*
9020000 MNFEED TMDPVOL
*
*   FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
9020101 0.0 31.1533 147.64 0.0 0.0 0.0 0.0 0.0 00
9020101 0.0 31.1533 5000. 0.0 0.0 0.0 0.0 0.0 00
*
*   EBT
9020200 003
*
*   TIME PRESS TEMP
9020201 0.0 1200.0 435.0
9020202 1.0E6 1200.0 435.0
*-----*
3020000 FLJUN TMDPJUN
*

```

* FROM TO AJUN
3020101 902000000 132000000 1.0

* FLAG
3020200 1

* TIME LFLOW VFLOW INT FLOW
3020201 0.0 0.0 0.0 0.0
3020202 1.0E6 0.0 0.0 0.0

=====

1000000 RISER BRANCH

* NJ FLAG
1000001 3 1

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1000101 56.45 0.0 28.22 0.0 90.4999 .00015 .1234 00

* FLAG P X
1000200 2 1119.15 0.00
1000200 1 557.0 0.00

* FROM TO AJUN FJUN FJUNR VCAHS
1001101 112010000 100000000 5.7356 .50 .50 00000

*add crossflow resistance

1001101 112010000 100000000 5.7356 41.1 41.1 00000
1002101 100010000 121000000 6.4488 1.25 1.25 10000
1003101 100010000 131000000 6.1798 1.28 1.28 10000

* LFLOW VFLOW INT FLOW

1001201 0.0 0.0 0.0
1002201 0.0 0.0 0.0
1003201 0.0 0.0 0.0

1210000 RISER1 BRANCH

* NJ FLAG
1210001 2 1

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1210101 27.9 0.0 68.01 0.0 90.2.437 .00015 .1234 00

* FLAG P X
1210200 2 1118.67 0.00
1210200 1 557.0 0.00

* FROM TO AJUN FJUN FJUNR VCAHS
1211101 131000000 121000000 2.7297 .38 0.34 00000
1212101 121010000 101000000 8.0485 1.1 1.1 10000

* LFLOW VFLOW INT FLOW

1211201 0.0 0.0 0.0
1212201 0.0 0.0 0.0

1310000 RISER2 BRANCH

* NJ FLAG

1310001 0 1

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1310101 28.225 0.0 26.46 0.0 90. 0.937 .00015 0.1234 00

* FLAG P X

1310200 2 1118.67 0.00

1310200 1 557.00 0.00

* FROM TO AJUN FJUN FJUNR VCAHS

* LFLOW VFLOW INT FLOW

=====

1320000 RISER3 BRANCH

* NJ FLAG

1320001 2 1

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1320101 27.9 0.0 40.11 0.0 90. 1.437 .00015 0.1234 00

* FLAG P X

1320200 2 1118.67 0.00

1320200 1 557.00 0.00

* FROM TO AJUN FJUN FJUNR VCAHS

1321101 132000000 131010000 0.7975 1.80 1.80 10000

1322101 132010000 133000000 4.42 6.18 6.18 10000

* LFLOW VFLOW INT FLOW

1321201 0.0 0.0 0.0

1322201 0.0 0.0 0.0

=====

1340000 UPRSR BRANCH

* NJ FLAG

1340001 3 1

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1340101 56.45 0.0 198.75 0.0 90. 3.52 .00015 0.1234 00

* FLAG P X

1340200 2 1114.68 0.00

1340200 1 557.00 0.00

* FROM TO AJUN FJUN FJUNR VCAHS

1341101 101010000 134000000 7.0398 1.20 1.20 10000

1342101 133010000 134000000 7.0398 1.2 1.2 10000

1343101 134010000 135000000 16.9149 1.08 1.08 10000

* LFLOW VFLOW INT FLOW
 1341201 0.0 0.0 0.0
 1342201 0.0 0.0 0.0
 1343201 0.0 0.0 0.0

=====

1010000 BOIL2-5 PIPE

* NV
 1010001 3

* FLOWA NV
 1010101 27.9 3

* JAREA NJ
 1010201 8.0485 1
 1010202 7.8717 2

* LENGTH NV
 1010301 3.0 2
 1010302 3.5833 3

* VOLUME NV
 1010401 0.0 3

* INCLINE ANGLE NV
 1010601 90.0 3

* ELEV CNG NV
 1010701 3.0 2
 1010702 3.5833 3

* ROUGH HYD DIA NV
 1010801 .00015 0.1234 3

* FJUNF FJUNR NJ
 1010901 1.1 1.1 1
 1010902 1.13 1.13 2

* FE NV
 1011001 00 3

* VCAHS NJ
 1011101 10000 2

* FLAG P X DUMMY DUMMY DUMMY NV
 1011201 2 1117.80 0 0 0 0 1
 1011202 2 1116.85 0 0 0 0 2
 1011203 2 1115.81 0 0 0 0 3
 1011201 1 557.00 0 0 0 0 1
 1011202 1 557.00 0 0 0 0 2
 1011203 1 557.00 0 0 0 0 3

* FLAG=0 => (LBM/SEC)
 1011300 1

*
 * LFLOW VFLOW INTERFACE FLOW NJ
 1011301 0.0 0.0 0.0 2

1330000 PRHEAT PIPE

* NV
 1330001 5

* FLOWA NV
 1330101 26.3462 3
 1330101 27.9 5

* JAREA NJ
 1330201 4.2478 1
 1330202 4.2478 2
 1330203 4.2478 3
 1330204 7.0398 4

*add bypass area to flow path

*1330201 4.9938 1
 *1330202 4.9938 2
 *1330203 4.9938 3
 *1330204 7.0398 4

* LENGTH NV
 1330301 1.5 4
 1330302 3.5833 5
 1330302 3.6463 5

* VOLUME NV
 1330401 0.0 5

* INCLINE ANGLE NV
 1330601 90.0 5

* ELEV CNG NV
 1330701 1.5 4
 1330702 3.5833 5
 1330702 3.6463 5

* ROUGH HYD DIA NV
 1330801 00015 0.1234 5

* FJUNF FJUNR NJ
 1330901 9.16 9.16 1
 1330902 5.92 5.92 2
 1330903 5.48 5.48 3
 1330904 1.2 1.2 4

*add crossflow resistance of 11 to first 3 junctions

1330901 20.16 20.16 1
 1330902 16.92 16.92 2
 1330903 16.48 16.48 3
 1330904 1.2 1.2 4

*
* FE NV
1331001 00 5
*

* VCAHS NJ
1331101 10000 4
*

* FLAG P X DUMMY DUMMY DUMMY NV
1331201 2 1118.04 .0 0. 0. 0. 1
1331202 2 1117.56 .0 0. 0. 0. 2
1331203 2 1117.09 .0 0. 0. 0. 3
1331204 2 1116.62 .0 0. 0. 0. 4
1331205 2 1115.81 .0 0. 0. 0. 5
1331201 1 557.00 .0 0. 0. 0. 1
1331202 1 557.00 .0 0. 0. 0. 2
1331203 1 557.00 .0 0. 0. 0. 3
1331204 1 557.00 .0 0. 0. 0. 4
1331205 1 557.00 .0 0. 0. 0. 5
*

* FLAG=0 => (LBM/SEC)
1331300 1
*

* LFLOW VFLOW INTERFACE FLOW NJ
1331301 0.0 0.0 0.0 4
*

=====

1350000 UPRISER PIPE
*

* NV
1350001 5
*

* FLOWA NV
1350101 56.45 3
1350102 55.25 5
*

* JAREA NJ
1350201 16.9996 1
1350202 55.25 2
1350203 16.9996 3
1350204 55.25 4
*

* LENGTH NV
1350301 3.5833 1
1350302 3.5733 2
1350303 .01 4
1350302 3.3733 2
1350303 .11 4
1350302 3.1733 2
1350303 .21 4
*1350302 2.9733 2
*1350303 .31 4
1350304 8.1566 5
*

* VOLUME NV

```

1350401 0.0 5
*
*   INCLINE ANGLE  NV
1350601 90.0 5
*
*   ELEV CNG  NV
*1350701 3.5833 2
*1350702 8.1666 3
*
*   ROUGH HYD DIA NV
1350801 .00015 0.1234 5
*
*   FJUNF  FJUNR  NJ
1350901 1.08 1.08 1
1350902 0 0 2
1350903 1.08 1.08 3
1350904 0 0 4
*test sensitivity of loss coeff
*1350903 .972 972 3
*
*   FE NV
1351001 00 5
*
*   VCAHS NJ
1351101 10000 1
1351102 10000 2
1351103 10000 3
1351104 10000 4
*
*   FLAG P X DUMMY DUMMY DUMMY NV
1351201 2 1113.55 0 0 0 0 1
1351202 2 1112.42 0 0 0 0 2
1351203 2 1110.59 0 0 0 0 3
1351203 2 1110.59 1.0 0 0 0 3
1351201 1 557.00 0 0 0 0 1
1351202 1 557.00 0 0 0 0 2
1351203 1 557.00 0 0 0 0 5
*1351203 1 557.00 1.0 0 0 0 3
*
*   FLAG=0 => (LBM/SEC)
1351300 1
*
*   LFLOW VFLOW INTERFACE FLOW NJ
1351301 0.0 0.0 0.0 4
*
=====
1020000 SEP SEPARATR
*
*   NJ FLAG
1020001 3 1
*
*   FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1020101 0.0 14.1567 365.4148 0.0 90. 14.1567 .00015 1.625 00
*
*   FLAG P UF UG VG

```

1020200 2 1107.31 .227
1020200 2 1107.31 1.0
1020200 1 557.00 1.0
*1020200 1 557.00 .3494
1020200 1 557.00 .03
*1020200 1 557.00 .015

* FROM TO AJUN FJUN FJUNR VCAHS VFLIM

1021101 102010000 103000000 22.01 13.9 13.90 10000
1022101 102000000 111000000 19.78 0.5 0.5 00000
1023101 135010000 102000000 24.8873 0.5 1.0 10000

* rearrange losses

1021101 102010000 103000000 11.49 0.86 0.86 10000
1022101 102000000 111000000 19.78 1.0 1.0 00000
1023101 135010000 102000000 22.01 13.9 13.9 10000

* add crossflow resistance term

1023101 135010000 102000000 22.01 18.12 18.12 10000

* sensitivity values of vover/vunder

*1021101 102010000 103000000 11.49 0.86 0.86 10000 .25
*1022101 102000000 111000000 19.78 1.0 1.0 00000 .15
*1023101 135010000 102000000 22.01 13.9 13.9 10000

* LFLOW VFLOW INT FLOW

1021201 0.0 0.0 0.0
1022201 0.0 0.0 0.0
1023201 0.0 0.0 0.0

=====

1030000 DOME BRANCH

* NJ FLAG

1030001 2 1

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE

1030101 123.051 5. 0.0 0.0 90. 5. .00015 1.625 00
1030101 123.051 5. 0.0 0.0 90. 5. .00015 0.0 00
1030101 151.32 0. 356.23 0.0 90. 2.35415 .00015 14.04 00

* FLAG P UF UG VG

1030200 2 1107.31 1.0

1030200 1 557.00 1.0

* FROM TO AJUN FJUN FJUNR VCAHS VFLIM

1031101 103000000 110010000 7.29 1.77 1.77 10000
1032101 103010000 104000000 77.74 0. 0. 10000
*1033101 103000000 110010000 19.78 0.5 0.5 10000

* LFLOW VFLOW INT FLOW

1031201 0.0 0.0 0.0
1032201 0.0 0.0 0.0
*1033201 0.0 0.0 0.0

=====

1040000 UDC SNGLVOL

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE

1040101 70.75 0.0 527.08 0.0 0.0 0.00015 4.07 00

* FLAG P X

1040200 001 557. 1.0

=====

2500000 DRYERDRN SNGLVOL

* FLOWA FLOWL VOL AZIINCL DZ ROUGH HYD FE
2500101 2.02 16.5108 0.0 0.0 -90. -16.5108 0.00015 0.0 00

* FLAG P X

2500200 001 557. .025

1240000 DRYER BRANCH

* NJ FLAG

1240001 3 1

* FLOWA FLOWL VOL AZIINCL DZ ROUGH HYD FE
1240101 171.4 0. 121.41 0.0 00. 0.0 .00015 0.417 00

* FLAG P UF UG VG

1240200 1 557.00 1.0

* FROM TO AJUN FJUN FJUNR VCAHS VFLIM

1241101 104010000 124000000 70.75 .5 .5 10000

1242101 124010000 105000000 63.49 5.502 5.502 10000

1243101 250000000 124000000 2.0211 0.5 0.5 10000

* LFLOW VFLOW INT FLOW

1241201 0.0 0.0 0.0

1242201 0.0 0.0 0.0

1243201 0.0 0.0 0.0

1050000 dome PIPE

* NV

1050001 2

* FLOWA NV

1050101 63.49 1

1050102 98.79 2

* JAREA NJ

1050201 74.94 1

* LENGTH NV

1050301 0. 2

* VOLUME NV

1050401 473.0 1

1050402 350.7 2

*

* INCLINE ANGLE NV

1050601 00.0 1

1050602 90.0 2

*

*

* ROUGH HYD DIA NV

1050801 .00015 11.02 1

1050802 .00015 12.83 2

*

* FJUNF FJUNR NJ

1050901 .0 .00 1

*

* FE NV

1051001 00 2

*

* VCAHS NJ

1051101 10000 1

*

* FLAG P X DUMMY DUMMY DUMMY NV

1051201 1 557.00 1.0 0. 0. 0. 2

*

* FLAG=0 => (LBM/SEC)

1051300 1

*

* LFLOW VFLOW INTERFACE FLOW NJ

1051301 0.0 0.0 0.0 1

*

=====

=====

1060000 nozzle SNGLJUN

*

* FROM TO AREA FJUNF FJUNR VCAHS
1060101 105010000 107000000 1.388 0.0 0.0 10100

*

* FLAG LFLOW VFLOW INT FLOW

1060201 1 0.0 0.0 0.0

1070000 nozzle SNGLVOL

*

* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1070101 1.388 1.5 0.0 0.0 90. 1.5 .00015 0.5025 00

*

* FLAG P X

1070200 002 1106. 1.0

1070200 001 557. 1.0

*

3000000 BREAK VALVE

*

* FROM TO AJUN

3000101 107010000 900000000 1.388 0.0 0.0 00100

*

*

* TIME LFLOW VFLOW INTFLOW

3000201 1 0.0 0.0 0.0

3000300 MTRVLV
3000301 502 503 1000.0.0
*3000301 502 503 2.0 0.0

9000000 break TMDPVOL

*
* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
9000101 0.0 31.1533 147.64 0.0 0.0 0.0 0.0 0.0 00
9000101 5.0 0.0 9999. 0.0 0.0 0.0 0.0 0.0 00

*
* EBT
9000200 002

*
* TIME PRESS X
9000201 0.0 14.7 1.0
9000202 1.0E6 14.7 1.0

1110000 UDC1 BRANCH

*
* NJ FLAG
1110001 3 1

*
* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1110101 111.07 13.76 0.0 0.0 -90. -13.76 0.00015 0.0 00
1110101 111.07 .2192 0.0 0.0 -90. -2192 0.00015 0.0 00
1110101 111.07 .2202 0.0 0.0 -90. -2202 0.00015 0.0 00

*
* FLAG P X
1110200 2 1107.0 0.0
1110200 1 557.0 1.0
1110200 1 557.0 0.0

*
* FROM TO AJUN FJUN FJUNR VCAHS
1111101 111010000 112000000 5.7356 1.15 1.28 20000
1111101 111010000 112000000 5.7356 0.0 0.00 20000
1112101 111000000 110000000 5.7356 0.0 0.0 20000
1112101 111000000 110000000 111.07 0.0 0.0 20000
1113101 250010000 111000000 2.02 0.5 0.5 20000

*
* LFLOW VFLOW INT FLOW
1111201 0.0 0.0 0.0
1112201 0.0 0.0 0.0
1113201 0.0 0.0 0.0

1100000 UDC SNGLVOL

*
* FLOWA FLOWL VOL AZI INCL DZ ROUGH HYD FE
1100101 111.07 13.5408 0.0 0.0 90. 13.5408 0.0 0.0 00
1100101 111.07 14.1567 0.0 0.0 90. 14.1567 0.0 0.0 00

*
* FLAG P X
1100200 002 1106. 0.22
1100200 001 557. 1.0

*1100200 001 557. 0.3494
1100200 001 557. 0.03
*1100200 001 557. 0.015

1120000 LDC1-3 PIPE

*
* NV
1120001 5

* FLOWA NV
1120101 6.99203 5
1120101 5.74 5

* LENGTH NV
1120301 2.814292 1
1120302 1.0 2
1120302 1.001 2
1120303 6.570134 3
1120304 10.384433 5

* VOLUME NV
1120401 0.0 5

* INCLINE ANGLE NV
1120601 -90.0 5

* ELEV CNG NV
1120701 -2.814292 1
1120702 -1.0 2
1120703 -6.570134 3
1120704 -10.384433 5

* ROUGH HYD DIA NV
1120801 0.0 4067 5
1120801 0.00015 3442 5

* FE NV
1121001 00 5

* VCAHS NJ
1121101 20000 4

* FLAG P X DUMMY DUMMY DUMMY NV
1121201 1 557.00 1.0 0. 0. 0. 2
1121202 1 557.00 .629 0. 0. 0. 3
1121202 1 557.00 .07 0. 0. 0. 3
1121203 1 557.00 0.0 0. 0. 0. 5
1121201 1 557.00 0.0 0. 0. 0. 2
1121202 1 557.00 0.0 0. 0. 0. 3
1121203 1 557.00 0.0 0. 0. 0. 5

* FLAG=0 => (LBM/SEC)
1121300 1

```

*   LFLOW   VFLOW INTERFACE FLOW   NJ
1121301   0.0   0.0   0.0   4
.....

```

```

*----- HEAT STRUCTURE INPUT
*

```

```

*GENERAL DATA
*   NH NP  GEO SS  LEFT COORD.
11511000 21 11  2  1  0.02766665
=====

```

```

*MESH FLAGS
*   LOCATION FLG   FORMAT FLAG
11511100  0           2
=====

```

```

*MESH DATA
*   MESH INTERVAL INT #
11511101.000358335  10
=====

```

```

*COMPOSITION DATA
*   COMP. #  INT #
11511201  1    10
=====

```

```

*HEAT DISTRIBUTION DATA
*   SOURCE INT #
11511301 0.0  10
=====

```

```

*INITIAL TEMPERATURE DATA
*   TEMP.  INT #
11511401 557.0  11
=====

```

```

*LEFT BC CARDS
*   BVL  INC TYPE SURF  CYL HT  STRUCT #
11511501 151010000 0000 1  0  447.65  1
11511502 151020000 0000 1  0  1989.54  2
11511503 151030000 10000 1  0  2387.45  4
11511504 151050000 10000 1  0  2851.67  8
11511505 151090000 10000 1  0  2741.59  10
11511506 151110000 10000 1  0  2851.67  14
11511507 151150000 10000 1  0  1193.72  19
11511508 151200000 0000 1  0  795.82  20
11511509 151210000 0000 1  0  447.65  21
=====

```

```

*RIGHT BC CARDS
*   BVR  INC TYPE SURF  CYL HT  STRUCT #
11511601 100010000 0  1  0  505.62  1
11511602 121010000 0000 1  0  2247.22  2
11511603 101010000 10000 1  0  2696.66  4
11511604 101030000 0000 1  0  3221.02  5
11511605 134010000 0000 1  0  3221.02  6
11511606 135010000 10000 1  0  3221.02  8
11511607 135050000 0000 1  0  3096.67  10
11511608 135020000 -10000 1  0  3221.02  12
11511609 134010000 0000 1  0  3221.02  13
11511610 133050000 0000 1  0  3221.02  14
11511611 133040000 -10000 1  0  1348.33  18

```


11511612	132010000	0000	1	0	1348.33	19
11511613	131010000	0	1	0	898.89	20
11511614	100010000	0	1	0	505.62	21

*SOURCE DATA

SOURCE	MULT	LDH	RDH	STRUCT #
11511701	0	0.0	0.0	21

*LEFT BOUNDARY CARDS

CHF	HYDIAM	HED	CHN	LEN	STRUCT #
11511801	0	0.0	0.0	0.0	21

*RIGHT BOUNDARY CARDS

CHF	HYDIAM	HED	CHN	LEN	STRUCT #
11511901	0	0.0	0.0	0.0	21

*----- HEAT STRUCTURE THERMAL PROPERTY DATA

*COMPOSITION TYPE AND DATA FORMAT

MATERIAL TYPE	FLAG	FLAG
20100100	TBL/FCTN	1 1 *INCONEL

* THERMAL CONDUCTIVITY DATA (BTU/SEC-FT/DEG F) AND VOLUMETRIC HEAT |
 * CAPACITY DATA (BTU/FT**3-DEG F) VERSUS TEMPERATURE FOR ABOVE |
 * COMPOSITION |

*INCONEL 600 THERMAL CONDUCTIVITY DATA

TEMPERATURE	THERMAL CONDUCTIVITY
20100101	70.0 2.3843E-03
20100102	200.0 2.5232E-03
20100103	400.0 2.8009E-03
20100104	600.0 3.0787E-03
20100105	800.0 3.3565E-03
20100106	1000.0 3.6574E-03
20100107	1200.0 3.9815E-03
20100108	1400.0 4.3056E-03
20100109	1600.0 4.6296E-03

*INCONEL 600 VOLUMETRIC HEAT CAPACITY DATA

TEMPERATURE	HEAT CAPACITY
20100151	70.0 55.6831
20100152	200.0 55.5227
20100153	400.0 55.2607
20100154	600.0 54.9895
20100155	800.0 54.7069
20100156	1000.0 54.3982
20100157	1200.0 54.0907

20100158 1400.0 53.7516
20100159 1600.0 53.4205
20100160 1800.0 53.0796

*
*----- CONTROL SYSTEM FOR MEASURING SG LEVEL
*
*
*-----

* NOTE: THE FOLLOWING CONTROL SYSTEM IS TO WORK IN BRITISH ;
* UNITS (LBM, LBF, FT, S, P=LBF/SQIN). IN RELAP5 ;
* THE QUANTITIES STORED IN ARRAYS ARE IN SI UNITS. ;
* THEREFORE, CONVERSIONS FROM SI TO BRITISH UNITS ;
* MUST BE MADE. ;
*-----

*----- CONTROL VARIABLE CARD TYPE
20500000 999

*----- CONTROL COMPONENT CARDS

* COMPUTE PRESSURE DIFFERENCE

* NAME TYPE SCALE(Psi/PA) INIT FLAG
20500100 DELTPP SUM 1.45003E-04 0.0 1
* A0 A1 VAR VOL A2 VAR VOL
20500101 0.0 -1.0, P, 135040000 1.0, P, 135030000

* NAME TYPE SCALE(Psi/PA) INIT FLAG
20500200 DELTPN SUM 1.45003E-04 0.0 1
* A0 A1 VAR VOL A2 VAR VOL
20500201 0.0 -1.0, P, 135030000 1.0, P, 135010000

* NAME TYPE SCALE(Psi/PA) INIT FLAG
20500300 DELTPN SUM 1.45003E-04 0.0 1
* A0 A1 VAR VOL A2 VAR VOL
20500301 0.0 -1.0, P, 101020000 1.0, P, 101010000

* NAME TYPE SCALE(Psi/PA) INIT FLAG

* NAME TYPE SCALE(Psi/PA) INIT FLAG
20500400 DELTPP SUM 1.45003E-04 0.0 1
* A0 A1 VAR VOL A2 VAR VOL
20500401 0.0 -1.0, P, 135030000 1.0, P, 135020000
20500402 -12.127, RHO, 135030000 -5.3517 RHO, 135020000

* END OF INPUT DECK - PROBLEM END *