Calculation Notebook STA-042

NUCLEAR POWER GENERATION
CF3.ID4
ATTACHMENT 7.1

TITLE: CALCULATION COVER SHEET

PACIFIC GAS AND ELECTRIC COMPANY
CALCULATION COVER SHEET

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Calculation No.: STA-042

☐ Preliminary ☑ Final

Project: DIABLO CANYON POWER PLANT UNITS 1 AND 2 Date: 10/1/96
Department/ Group:

Structure, System or Component:
STEAM GENERATOR

Type or Purpose of Calculation: LOADS ON THE STEAM GENERATOR TUBE SUPPORT PLATES DURING SLB ACCIDENT

No. of Sheets:
174 + COVER SHEET + 2 FLAPPY DISKS (ATTACHMENT 1)

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9/30/98

RECORDS OF REVISIONS

Revision Number	Date	Reasons for Revision	Prepared By	Checked By	Approval Regis. Engr.	Approval Supvr.
0	10/1/96	NEW ISSUE	HML	[initials]	[signature]	[signature]

PACIFIC GAS AND ELECTRIC COMPANY
GENERAL COMPUTATION SHEET

SHEET NO. 1 OF 174 SHEETS
CALC NO. STA-042 R.0

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY

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1. Introduction

The inspection of steam generator tubes has identified tube cracks in the portions of tubes surrounded by the tube support plates. Since the tube support plats hold up the tubes, the tubes will not be burst even if cracks have been developed on the tube wall in these regions. Therefore, plugging these tubes may not be required. However, a concern was raised during steam line break accident. The fast pressure transient in the steam generator during steam line break accident may result in high pressure load on the tube support plates which may push the tube support plates up from their original locations. The concern is that, if the tube support plates are pushed up during the steam line break. the tube cracks in these regions will not be protected by the tube support plates and will be exposed to the high pressure difference from the primary side to the secondary side and fail.

The purpose of this calculation is to calculate the pressure loads on the tube support plates during the steam line break accident. The RELAP5 code mod 3.2 is used to perform the calculation. The results of this calculation then be transferred to Westinghouse to perform structure analysis to determine the displacement of the tube support plates. Since the larger the break size results in the higher pressure load on the tube support plats, the break at the steam generator steam outlet nozzle is used. In addition, the break at the downstream of the main steam flow restrictor is also analyzed.

The initial plant condition is assumed to be hot 0% power. The study of the conservatism for the initial plant condition assumption is not part of the scope of this calculation. Westinghouse already modeled the steam generator (Westinghouse Model 51) at hot 0% power using the TRANFLO code for Farley Plant (ref. 1). The Farley Model 51 steam generators are identical to the DCPP Model 51 steam generators, except for the wrapper opening at the tube sheet (Ref. 2). Therefore, in this calculation, the TRANFLO model for the steam generator is used as the bases for setting up the RELAP5 steam generator model.

2. Assumptions

The following assumptions are used in this calculation.

1. The plant is at hot 0% power.
2. The steam line break is located at the steam generator steam outlet nozzle which is upstream of the steam flow restrictor and has the largest steam flow area. The break at the downstream of the flow restrictor is also analyzed.
3. Since the high pressure loads on the tube support plats only last for less than 2 seconds, the heat transfer from the RCS to the steam generator secondary side does not have significant effect on the

pressure load on TSPs. The primary coolant flow is assumed at constant flow rate of 9148.5 lb/sec and the primary coolant pressure and temperature specified in Ref. 1 are used.

4. The steam line break induces tremendous high steam and water flow in the steam generator and the high pressure loads on the tube support plates only last for less than 2 seconds. The initial flow in the steam generator secondary side and the auxiliary feedwater injected into the steam generator have insignificant effects on the fast transient occurred in the steam generator. It is assumed that no steam is removed from the steam generator before the break and the auxiliary feedwater flow is not included in the steam generator model. The RELAP5 model does not assign any flow to the junctions of the steam generator secondary side. However, a five seconds steady state run is performed before the break is initiated which generates a natural recirculate flow in the secondary side of the steam generator due to the heat transferred from the primary side.

5. The RELAP5 code manual (Ref. 3) recommends to use the non-equilibrium model for all volumes. However, the use of non-equilibrium model for the shell side of the tube region generates more abrupt changes in the pressure loads which do not show with the use of equilibrium model for the shell side of the tube region. Since it is difficult to determine which model will generate more conservative loads on the TSPs, the non-equilibrium and equilibrium

models are used to model the shell side of the tube region in separated cases to calculate the loads on TSPs.

6. The roughness for commercial steel pipe is 0.00015 ft (or 0.0018") (Ref.) which is used for all volumes.

3. RELAP5/MOD3.2 Code

The RELAP5 code is an advanced-thermal hydraulic code which has been used as a tool to analyze transient in light water reactor systems. The RELAP5/MOD3 code is the third major variant of the RELAP5 code and the RELAP5/MOD3.2 code is the latest revision of the RELAP5/MOD3 code. The RELAP5/MOD3.2 code has been used by analysts to evaluate the thermal-hydraulic behavior of many light water reactor systems.

The RELAP5/MOD3.2 code equation set gives a two-fluid system simulation using a non-equilibrium, non-homogeneous, six-equation representation. The six basic field equations are used to solve six dependent variables-pressure, specific internal energies for gas and liquid, void fraction and velocities for gas and liquid. Constitutive models represent the interphase drag, the various flow regimes in vertical and horizontal flow, wall friction, and interphase mass transfer. The code also has the capability to simulate the presence of slabs of material adjacent to the fluid. Thus, energy transfer to and from stationary slabs of material can be simulated. Control systems and component models permit simulations of equipment controllers, balance-of-plant equipment, and lumped-node representations of various processes.

4. Analysis

There are five cases analyzed in this calculation. These cases are described as follows.

LB Case 1: The plant is at hot 0% power. A steam line break is occurred at the steam generator outlet nozzle. The initial water level in the steam generator is at 490.4 inches from the top of the tube plat which is equivalent to narrow range of 33%. The non-equilibrium model is used to model the secondary side of the tube region.

LB Case 2: This case is same as the LB Case 1, except the equilibrium model is used to model the secondary side of the tube region.

LB Case 3: This case is designed to study the effects of the initial water level and the resistances of the tube support plates on the calculated loads on the TSPs. The lower the initial water level and the higher the TSP resistance result in higher loads on the TSPs. Therefore, for this case, the initial water level is the steam generator is reduced to 466.0" (fc 10/2/) which is corresponding to narrow range water level of 16%, (HMC 10/1/96) and the TSP resistance coefficient is increased to 0.99. The remaining conditions for this case are same as those used for LB Case 1.

SB Case 1: This case is same as the LB Case 1, except the break is assumed located at the downstream of the main steam flow restrictor.

SB Case 2: This case is same as the LB Case 2, except the break is assumed located at the downstream of the main steam flow restrictor.

5. RELAP5 Input

The fluid region in the steam generator is separated in two loops. The first loop is the primary loop which models the primary side of the tubes. The second loop is the secondary loop which models the secondary side of the steam generator. Heat slabs are used to model the heat transfer from the primary side to the secondary side.

RELAP5 Model for Steam Generator Secondary Side (Secondary Loop)

The schematic diagram for the RELAP5 model for the steam generator secondary side is given in Figure 5-1. The RELAP5 model consists of the following elements.

- 2 pipe components - Component 2 consists of 30 volumes and 29 junctions. The schematic diagram for the Component 2 is shown in figure 5-2. Component 35 consists of 3 volumes and 2 junctions.
- 2 separator components - Component 19 consists of 1 volumes and 3 junctions. Component 22 consists of 1 volumes and 3 junctions.
- 5 branch components - Component 21 consists of 1 volume and 2 junctions. Component 30 consists of 1 volume and 2 junctions. Component 33 consists of 1 volume and 2 junctions. Component 34 consists of 1 volume and 1 junctions. Component 53 consists of 1 volume and 2 junctions.
- 7 single volume components - Components 17, 18, 20, 23, 32, 36 and 38.
- 2 single junction components - Components 519 and 533.
- 1 valve component - Component 518.

RELAP5 Model for Steam Generator Primary Side (Primary Loop)

The schematic diagram for the RELAP5 model for the steam generator primary side is given in Figure 5-3. The RELAP5 model consists of the following elements.

- 1 pipe component - Component 1 consists of 60 volumes and 59 junctions.

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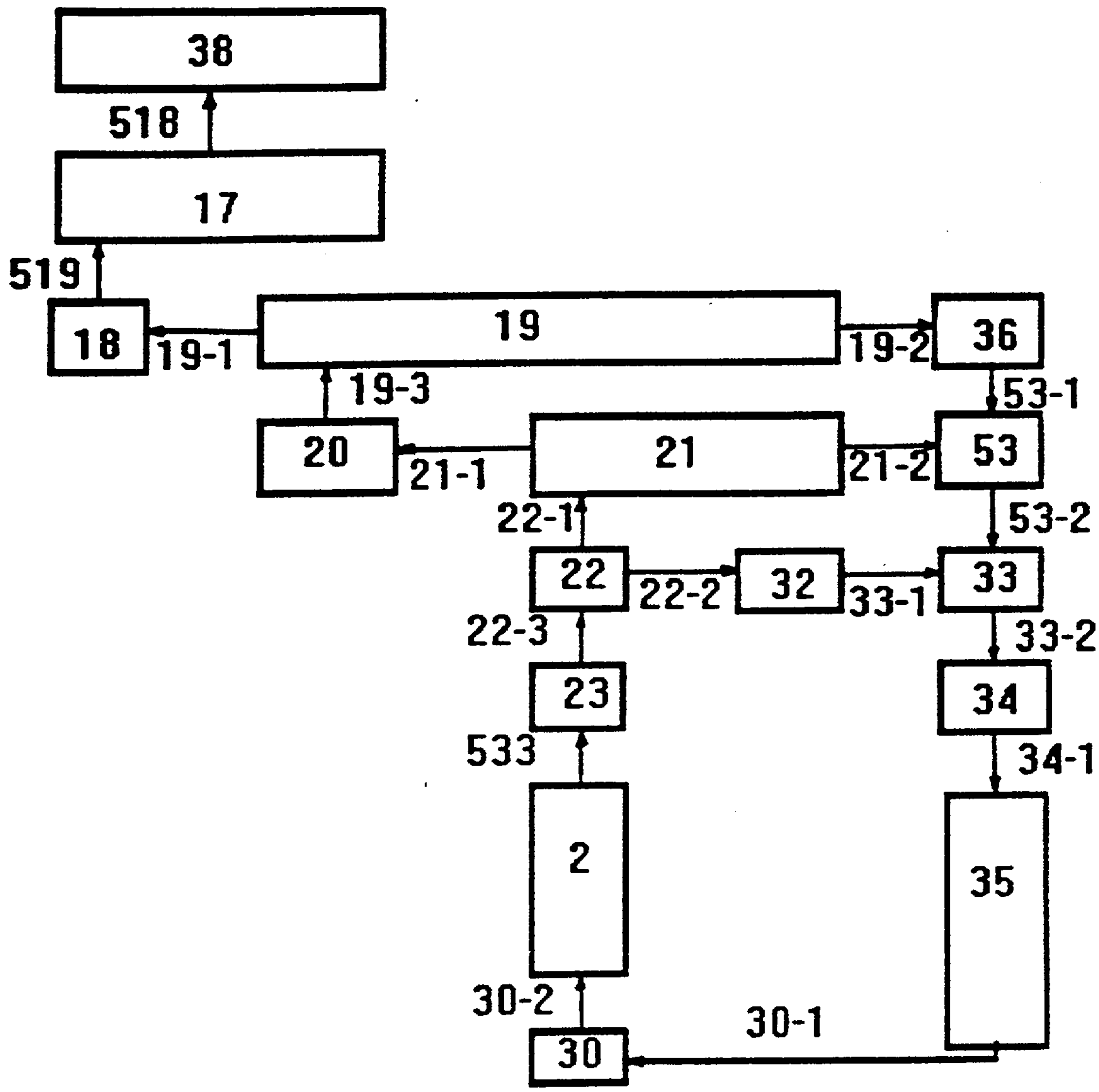

RELAP5 Steam Generator Secondary Side Model

FIGURE 5 - 1

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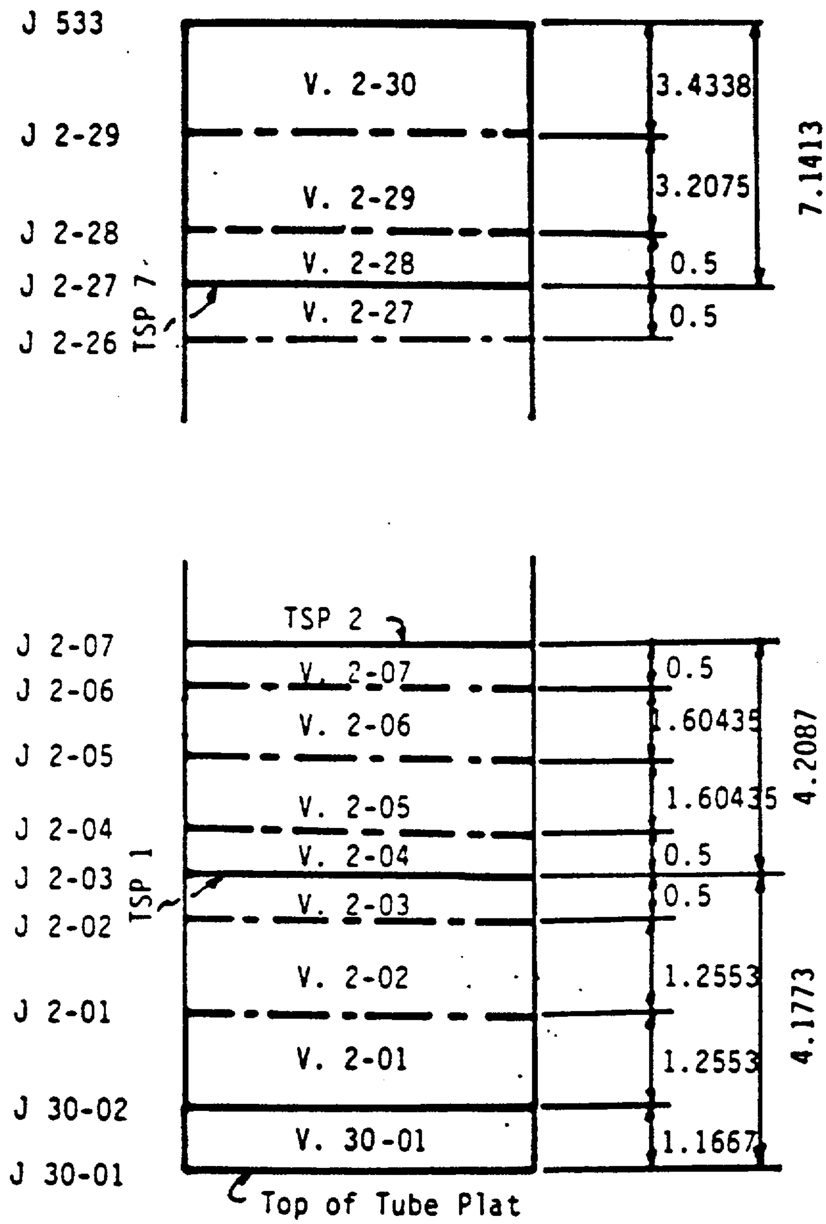

V. = Volume

J = Junction

Component 2 and Component 30

FIGURE 5 - 2

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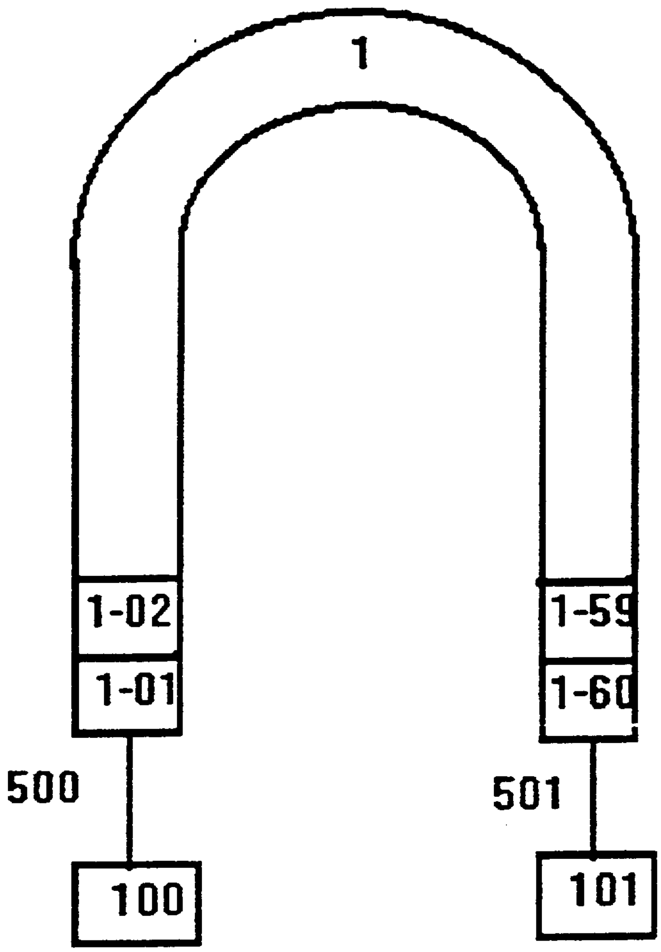

RELAP5 Steam Generator Primary Side Model

FIGURE 5 - 3

- 2 time dependent volume components - Components 100 and 101.
- 2 time dependent junction components - Components 500 and 501.

Heat Slab

There are 60 heat slabs used to model the tubes and the heat transfer from the primary side fluid to the secondary fluid. Each heat slab connects a primary side volume to a secondary side volume.

Common Input

The common RELAP5 input used for the volumes and junctions are listed in this section. The RELAP5/MOD 3.2 code has certain options available for modeling the volumes and junctions which can be switched on or off by the volume control flags and junction control flags. Since the steam line break transient is a very short and fast transient with huge flows in the secondary side of the steam generator, the defaulted options are selected to model the volumes and junctions, except specially discussed and specified for particular volumes or junctions. The switching from non-equilibrium volume model to equilibrium volume model to model the shell side of the tube region has significant effects on the TSPs' loads. As described in Section 4, a sensitivity study is performed to study the effects of switching from the non-equilibrium to the equilibrium volume model for the volumes modeling the shell side of the tube region.

The RELAP5/MOD3.2 options for modeling the volumes and junctions associated with the defaulted volume control flags and junction control flags are listed as follows.

Volume Control Flags

- t=0, the thermal front tracking model is not used.
- l=0, the mixture level tracking model is not used.
- p=0, the water packing scheme is used.
- v=0, the vertical stratification model is used.
- b=0, the pipe interphase friction model is used.
- f=0, the wall friction is used.
- e=0, the non-equilibrium model is used.

Junction Control Flags

- e=0, the modified PV term is not used.
- f=0, the CCFL model is not used.
- v=0, the horizontal stratification entrainment model is not used.
- c=0, the chocking model is used.
- a=0, a smooth area change or no area change.
- h=0, the non-homogeneous model is used.
- s=0, the momentum fluxes to the volume and from the volume are used.

As described in Section 2, the roughness of 0.00015 ft is used for all the Volumes and the initial liquid and vapor mass flow rates are zero for all the junctions which will not be discussed again for each Component. The description of the input variables is given in the Reference 4.

The default input value is used for all the input data which are not described in this section.

RELAP5 Input for LB Case 1

The Initial conditions for LB Case 1 are same as those specified in Reference 1 for the case with the steam generator water level 490.5" from the top of the tube plat and hot 0% power.

Secondary Loop

The secondary loop includes 16 components - 2, 17, 18, 19, 20, 21, 22, 23 , 30, 32, 33, 34, 35, 36, 38, 53, 518, 519 and 533. A schematic of the secondary loop is shown in the Figure 5-1.

Component 30

Component 30 is a Branch with assigned component name "tubesh" which includes a single volume (30-01) and two junctions (30-01 and 30-02). The Volume 30-01 models the shell side of the tube region from the top of the tube plat to the height of the wrapper opening which is 14" (Ref. 1). The Junction 30-01 is from the downcomer (Component 35) to the Component 30 and the Junction 30-02 is from the Component 30 to the remaining shell side of the tube region (Component 2).

As given in Ref. 1, the flow area of the shell side of tube region is 54.22 ft^2. The length for the Volume 30-01 is 14" or 1.1667'. Since the Volume 30-01 is orientated as 90 degree upward, the elevation change for the Volume 30-01 is 1.1667'. The hydraulic diameter of 0.136' is used in the TRANFLO model for the shell side of tube region (Ref. 1). The same hydraulic diameter is used for the Volume 30-01. Since the Volume 30-01 contains rod bundle, the volume control flag b is set to be 1 which initiates the use of the rod bundle interphase friction model.

As used in the TRANFLO model (Ref. 1), the water temperature of the steam generator secondary side is 547 °F. The specific volume for water at 547 °F is 0.02166 ft^3/lb. The water density at 547 °F is 46.17 lb/ft^3. The pressure at the center of node 31 of TRANFLO model is 1033.66 psia which is located 4.21/2 =2.105 ft from the top of the tube plat. The pressure at the center of the volume 30-01 can calculated as:

$$1033.66 + (2.105 - 1.1667/2) * 46.17 / 144 = 1034.15 \text{ psia}$$

The flow area of Junction 30-01 is same as the flow area of Component 35 which is 7.096 ft^2. The forward and reverse flow resistant coefficients for Junction 30-01 should be same as those given for the segment 1 of the

Connector 30 or 31 which are 0.5 and 0.5.

The flow area of Junction 30-02 equals to the cross section flow area of the wrapper opening in the horizontal direction which was calculated as 2.215 ft^2 for the Farley Model 51 steam generator (combining the flow area given in the TRANFLO model for the Connector 30 segment 2 and the Connector 31 segment 2). The wrapper opening height for Farley steam generator is 7" (Ref. 2), while the DCPP's wrapper opening height is 14". Therefore, the flow area of Junction 30-02 is 2.215 * 2 = 4.43 ft^2. As given in Westinghouse letter NSD-JLH-6070, the flow resistant coefficient for the cross flow through the wrapper opening is 5.32 based on flow area of 4.43 ft^2. The Westinghouse letter is attached to this calculation as Appendix A. Therefore, the forward and reverse flow resistant coefficients of 5.32 are used for the Junction 30-02. The following input are specified for the Component 30.

```
0300000  tubesh     branch
0300001  2          1
0300101  54.22   1.1667  0.  0.  90.  1.1667  0.00015  0.136  00100
0300200  3    1034.15   547.0
0301101  035010000   030000000   7.096   0.5    0.5    000000
0302101  030010000   002000000   4.43    5.32   5.32   000000
0301201  0.0        0.0      0.0
0302201  0.0        0.0      0.0
```

Component 2

The Component 2 is a Pipe with assigned name shell which is used to model the secondary side from the top of wrapper opening to the bottom of the primary separator. There are 30 volumes and 29 junctions included in the Component 2. The modeling scheme of the Component 2 is shown in the Figure 5-2. Volumes 2-01 to 02-03 are used to model the region from the top of the wrapper opening to the middle of the TSP 1. Volumes 2-04 to 02-07 are used to model the region from the middle of the TSP 1 to the middle of TSP 2. Volumes 2-08 to 2-11 are used to model the region from the middle of TSP 2 to the middle of the TSP 3. Volumes 2-12 to 2-15 are used to model the region from the middle of TSP 3 to the middle of the TSP 4. Volumes 2-16 to 2-19 are used to model the region from the middle of TSP 4 to the middle of the TSP 5. Volumes 2-20 to 2-23 are used to model the region from the middle of TSP 5 to the middle of the TSP 6. Volumes 2-24 to 2-27 are used to model the region from the middle of TSP 6 to the middle of the TSP 7. Volumes 2-28 to 2-30 are used to model the region from the middle of TSP 7 to the bottom of the primary separator.

To calculate the pressure difference across the TSP, a volume length of 0.5 ft is used for all the volumes adjacent to the TSP (volumes 2-03, 2-04, 2-07, 2-08, 2-11, 2-12, 2-15, 2-16, 2-19, 2-20, 2-23, 2-24, 2-27, 2-

28). The length between the TSPs not including the thickness of the TSP is given in the TRANFLO model as 2.073 * 2 = 4.146 ft (the sum of the length of segments 1 and 3 of the Connectors 40). The thickness of the TSP is given in the TRANFLO model as 0.0625 ft (the length of the segment 2). The length between the middle of TSPs is 4.146 + 0.0625 = 4.2085 ft (4.2087 ft is used in this calculation, the effect is insignificant). The length from the top of tube plat to the middle of TSP 1 is 4.146 + 0.0625/2 = 4.1773 ft. To makeup the 4.1773 ft, the volume length for volume 2-01 and 2-02 is (4.1773 - 1.1667 (length of Volume 30-01) - 0.5)/2. = 1.2553 ft. The volume length for the volumes between the TSPs but not adjacent to the TSPs (Volumes 2-05, 2-06, 2-09, 2-10, 2-13, 2-14, 2-17, 2-18, 2-21, 2-22, 2-25 and 2-26) can be calculated as (4.2087 - 0.5 - 0.5)/2 = 1.60435 ft. As given in the TRANFLO model (Ref. 1), the length from the top of the TSP 7 to the bottom of the primary separator is 7.11 ft (length of Node 24). Including the half of the TSP thickness, the sum of the volume length for Volume of 2-28, 2-29 and 2-30 should be 7.11 + 0.0625/2 = 7.1413 ft (see Figure 5-2). As given in the TRANFLO model (Ref. 1), the average length for the tube above the TSP 7 is 44.49" or 3.7075' (length for the Nodes 9 and 8). The Volume 2-28 and 2-29 are used to model the region with tubes and the Volume 2-30 does not have tube inside. Therefore, the volume length for Volume can be determined as 3.7075 - 0.5 =3.2075 ft. The volume length for Volume equals to 7.1413 - 0.5 - 3.2075 = 3.4338 ft.

The flow areas for the Volumes 2-01 to 2-27 are the same as the flow areas used for the TRANFLO Nodes 31 to 25 which are 54.22 ft^2. The flow areas for the Volumes 2-28 to 2-30 are the same as the flow areas for the TRANFLO Nodes 24 which is 70.0 ft^2. The flow areas for the Junctions of Component 2 are the same as the flow areas for the adjacent Volumes, except the flow areas for the Junctions modeling the TSPs. The flow areas for the TSPs are given in the TRANFLO model (Ref. 1) as 23.716 ft^2. Therefore, the flow area of 54.22 ft^2 is used for the Junctions 2-01, 2-02, 2-04, 2-05, 2-06, 2-08, 2-09, 2-10, 2-12, 2-13, 2-14, 2-16, 2-17, 2-18, 2-20, 2-21, 2-22, 2-24, 2-25 and 2-26. The flow area for 23.716 ft^2 is used for the Junctions 2-3, 2-7, 2-11, 2-15, 2-19, 2-23 and 2-27. The flow area of 70 ft^2 is used for the Junctions 2-28 and 2-29.

The volume sizes for all the Volumes are not specified by the input (0.0 is input for volume side). The RELAP5 code will calculate the volume size based on the volume flow area and length. All the Volumes of Component 2 are vertical upward volumes. A 90° inclination angle is used for all the volumes. For all the Volumes, the elevation changes are the same as the volumes lengths. As the Volume 30-01, the hydraulic diameter of ~~0316~~ 0.136 ft is used for all the Volumes, except the volume 2-30 (no tubes in the Volume 2-30). For the Volume 2-30, the hydraulic diameter is calculated by the RELAP5 code.

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Same as the Volume 30-01, since rod bundle is contained in the Volumes 2-01 to 2-29, the volume control flag b is set to be 1 for Volumes 2-01 to 2-29 which initiates the use of the rod bundle interphase friction model.

The initial water temperature for all the volume of Component 2 is 547 °F. As calculated for Volume 30-01, the water density is 46.17 lb/ft^3. The water static pressure reduces 46.17/144 = 0.3206 psi for every foot elevation increase. The initial pressure for Volume 30-01 is 1034.15 psia. The initial pressure used in TRANFLO model for Node 24 is 1023.75 psia (Ref. 1). The elevation at the center of the Node 24 is 7.11/2 =3.555 ft below the bottom of the primary separator. The elevation at the center of the Volume 2-30 is 3.4338 /2 =1.7169 ft below the bottom of the primary separator. The initial pressure at the center of the Volume 2-30 should be 1023.75 - (3.555 - 1.7169) * 0.3206 = 1023.17 psia. The pressure for the remaining Volumes of Component 2 can calculated by elevation difference from the Volume 2-30. Since a 5 seconds steady state run is performed to straighten out slight inconsistence of the initial conditions, high accuracy for the initial pressure input for the Volumes of Components 2 is not required. The initial pressures for the Volumes of Component 2 are calculated as follows.

Volume 2-29 1023.17 + (3.2075 +3.4338)/2*0.3206 = 1024.23 psia.

Volume 2-28 1024.23 + (3.2075 +0.5)/2*0.3206 = 1024.82 psia.

Volume 2-27 1024.82 + (0.5 + 0.5)/2*0.3206 = 1024.98 psia.

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Volume 2-26	1024.98 + (0.5 + 1.60435)/2*0.3206 = 1025.32 psia.
Volume 2-25	1025.32 + (1.60435+1.60435)/2*0.3206 = 1025.83 psia.
Volume 2-24	1025.83 + (1.60435+0.5)/2*0.3206 = 1026.17 psia.
Volume 2-23	1026.17 + (0.5 +0.5)/2*0.3206 = 1026.32 psia.
Volume 2-22	1026.32 + (0.5 +1.60435)/2*0.3206 = 1026.66 psia.
Volume 2-21	1026.66 + (1.60435+1.60435)/2*0.3206 = 1027.18 psia.
Volume 2-20	1027.18 + (1.60435+0.5)/2*0.3206 = 1027.52 psia.
Volume 2-19	1027.52 + (0.5 +0.5)/2*0.3206 = 1027.68 psia.
Volume 2-18	1027.68 + (0.5+1.60435)/2*0.3206 = 1028.01 psia.
Volume 2-17	1028.01 + (1.60435+1.60435)/2*0.3206 = 1028.53 psia.
Volume 2-16	1028.53 + (1.60435+0.5)/2*0.3206 = 1028.86 psia.
Volume 2-15	1028.86 + (0.5+0.5)/2*0.3206 = 1029.02 psia.
Volume 2-14	1029.02 + (0.5+1.60435)/2*0.3206 = 1029.36 psia.
Volume 2-13	1029.36 + (1.60435+1.60435)/2*0.3206 = 1029.87 psia.
Volume 2-12	1029.87 + (1.60435+0.5)/2*0.3206 = 1030.21 psia.
Volume 2-11	1030.21 + (0.5+0.5)/2*0.3206 = 1030.37 psia.
Volume 2-10	1030.37 + (0.5+1.60435)/2*0.3206 = 1030.71 psia.
Volume 2-09	1030.71 + (1.60435+1.60435)/2*0.3206 = 1031.22 psia.
Volume 2-08	1031.22 + (1.60435+0.5)/2*0.3206 = 1031.56 psia.
Volume 2-07	1031.56 + (0.5+0.5)/2*0.3206 = 1031.72 psia.
Volume 2-06	1031.72 + (0.5+1.60435)/2*0.3206 = 1032.06 psia.
Volume 2-05	1032.06 + (1.60435+1.60435)/2*0.3206 = 1032.57 psia.
Volume 2-04	1032.57 + (1.60435+0.5)/2*0.3206 = 1032.91 psia.

Volume 2-03 1032.91 + (0.5+0.5)/2*0.3206 = 1033.07 psia

Volume 2-02 1033.07 + (0.5+1.2553)/2*0.3206 = 1033.35 psia

Volume 2-01 1033.35 + (1.2553+1.2553)/2*0.3206 = 1033.73 psia

The hydraulic diameter is used in the CCFL correction and the interphase drag. As shown on the input for the segment 2 of connectors 34 to 40 of the TRANFLO model, the hydraulic diameter of 0.0625 ft is used for the TSPs and the resistance coefficient of 0.78 is used for both forward and reverse flow through the TSPs which includes the resistance due to area change at the TSPs. The CCFL correlation is not used in this calculation. All the junctions of the Component 2 except those associated with TSPs have no resistance. The default values for all the CCFL data are used for all junction of the Component 2.

The following input are used for the Component 2.

0020000	shell	pipe
0020001	30	
0020101	54.22	27
0020102	70.0	30
0020201	54.22	2
0020202	23.716	3
0020203	54.22	6
0020204	23.716	7
0020205	54.22	10
0020206	23.716	11

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0020207	54.22	14
0020208	23.716	15
0020209	54.22	18
0020210	23.716	19
0020211	54.22	22
0020212	23.716	23
0020213	54.22	26
0020214	23.716	27
0020215	70.0	29
0020301	1.2553	1
0020302	1.2553	2
0020303	0.5	4
0020304	1.60435	6
0020305	0.5	8
0020306	1.60435	10
0020307	0.5	12
0020308	1.60435	14
0020309	0.5	16
0020310	1.60435	18
0020311	0.5	20
0020312	1.60435	22
0020313	0.5	24
0020314	1.60435	26

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0020315	0.5	28	
0020316	3.2075	29	
0020317	3.4338	30	
0020601	90.0	30	
0020801	0.00015	0.136	29
0020802	0.00015	0.0	30
0020901	0.0	0.0	2
0020902	0.78	0.78	3
0020903	0.0	0.0	6
0020904	0.78	0.78	7
0020905	0.0	0.0	10
0020906	0.78	0.78	11
0020907	0.0	0.0	14
0020908	0.78	0.78	15
0020909	0.0	0.0	18
0020910	0.78	0.78	19
0020911	0.0	0.0	22
0020912	0.78	0.78	23
0020913	0.0	0.0	26
0020914	0.78	0.78	27
0020915	0.0	0.0	29
0021001	00100	29	
0021002	00000	30	

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GENERAL COMPUTATION SHEET

SHEET NO. 25 OF 174 SHEETS
CALC NO. STA-042 R0

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY HM LBG DATE 10/1/96 CHECK BY ____ APPROVED BY ____

0021101	000000	29					
0021201	3	1033.73	547.0	0.0	0.0	0.0	1
0021202	3	1033.34	547.0	0.0	0.0	0.0	2
0021203	3	1033.07	547.0	0.0	0.0	0.0	3
0021204	3	1032.91	547.0	0.0	0.0	0.0	4
0021205	3	1032.57	547.0	0.0	0.0	0.0	5
0021206	3	1032.06	547.0	0.0	0.0	0.0	6
0021207	3	1031.72	547.0	0.0	0.0	0.0	7
0021208	3	1031.56	547.0	0.0	0.0	0.0	8
0021209	3	1031.22	547.0	0.0	0.0	0.0	9
0021210	3	1030.71	547.0	0.0	0.0	0.0	10
0021211	3	1030.37	547.0	0.0	0.0	0.0	11
0021212	3	1030.21	547.0	0.0	0.0	0.0	12
0021213	3	1029.87	547.0	0.0	0.0	0.0	13
0021214	3	1029.36	547.0	0.0	0.0	0.0	14
0021215	3	1029.02	547.0	0.0	0.0	0.0	15
0021216	3	1028.86	547.0	0.0	0.0	0.0	16
0021217	3	1028.53	547.0	0.0	0.0	0.0	17
0021218	3	1028.01	547.0	0.0	0.0	0.0	18
0021219	3	1027.68	547.0	0.0	0.0	0.0	19
0021220	3	1027.52	547.0	0.0	0.0	0.0	20
0021221	3	1027.18	547.0	0.0	0.0	0.0	21
0021222	3	1026.66	547.0	0.0	0.0	0.0	22

0021223	3	1026.33	547.0	0.0	0.0	0.0	23
0021224	3	1026.17	547.0	0.0	0.0	0.0	24
0021225	3	1025.83	547.0	0.0	0.0	0.0	25
0021226	3	1025.32	547.0	0.0	0.0	0.0	26
0021227	3	1024.98	547.0	0.0	0.0	0.0	27
0021228	3	1024.82	547.0	0.0	0.0	0.0	28
0021229	3	1024.23	547.0	0.0	0.0	0.0	29
0021230	3	1023.17	547.0	0.0	0.0	0.0	30
0021300	1						
0021301	0.0	0.0	0.0	29			
0021401	0.0625	0.0	1.0	1.0	29		

Component 533

The Component 533 is a single junction with assigned name abovetb which is used to provide a flow junction from the Volume 02-30 (Component 2) to the Volume 23-01 (Component 23). This component consists of 1 junction (Junction 533). The Junction 533 is corresponding the Connector 33 of the TRANFLO model given in Reference 1.

The smaller of the two flow areas of Volumes 2-30 and 23-01 is 49.43 ft^2 which is used as the flow area for this junction. As given the Reference 1, no flow resistance coefficient is specified for the Connector 33 while the abrupt flow area change is specified for the Connector 33. The forward and reverse flow resistant coefficient of 0.0 is used for this junction. The junction control flag a is set to 1 to specify an abrupt area change. The following input are used for the Component 533.

```
5330000   abovertb   sngljun
5330101   002010000   023000000   49.43   0.0   0.0   000100
5330110   0.0   0.0   1.0   1.0
5330201   1   0.0   0.0   0.0
```

Component 23

The Component 23 is a single volume with assigned name abovetb which is used to model the region inside the primary separator and below the swirl vane. This component consists of 1 volume (Volume 23-01). The Volume 23-01 is corresponding the Node 23 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow area and volume size for the Node 23 are 49.43 ft^2 and 244.3 ft^3. The volume length of Node 23 is 244.3/49.43 = 4.9423 ft. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 23 is a vertical upward volume. The inclination angle is 90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 23 are given in Reference 1 as - water pressure at 1022.72 psia, water temperature at 547°F and void fraction of 0.3. The RELAP5/MOD3.2 code recognizes the water quality instead of void fraction. The void fraction and water quality are identical when the water is in pure liquid phase (void fraction and quality are zero) and the water is pure vapor phase (void fraction and quality are one). There are 5 components (23, 32, 33, 53 and 36) having water in two phases initially. The void fractions specified in the TRANFLO model for the corresponding nodes are used for these 5 components. This results in higher void fractions in these components which is equivalent to reduce the initial water level. In Reference 1, a sensitivity study using TRANFLO code was performed which concluded that the lower the initial water level generates higher loads on the TSPs. A sensitivity study is also performed using RELAP5 code to verify this conclusion. The sensitivity study is attached in the Appendix B. For all the five cases discussed in Section 4, the void fractions given in the TRANFLO model are used as water qualities in RELAP5 analysis.

For two phases fluid, the RELAP5 code does not allow to specify both the water pressure and temperature. The water pressure of TRANFLO Node 23 is used for this component. The initial water properties are specified as pressure at 1022.72 psia and the quality of 0.03. The following input are used for Component 23.

```
0230000   abovetb   snglvol
0230101   49.43   4.9423   0.0   0.0   90.0   4.9423   0.00015   0.0   00000
0230200   2   1022.72   0.03
```

Component 22

The Component 22 is a separator with assigned name speratr which is used to model the region inside the primary separator and above the swirl fan. This component consists of 1 volume (Volume 22-01) and 3 junctions (Junctions 22-01, 22-02 and 22-03). The Volume 22-01 is corresponding the Node 22 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow are and volume size for the Node 22 are 41.73 ft^2 and 163.4 ft^3. The volume length of Node 22 is 163.4/41.73 = 3.9156 ft. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 22-01 is a vertical upward volume. The inclination angle is 90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 22 are given in Reference 1 as - pressure at 1021.14 psia, temperature at 547°F and void fraction of 1.0 (pure steam). Since there is no superheated steam in the steam generator, the steam in volume 22-01 must be saturated steam. For saturated steam, the RELAP5 code does not allow to specify both the water pressure and temperature. The steam pressure of TRANFLO Node 22 is used for this component. The initial water properties are specified as pressure at 1021.14 psia and the quality of 1.0.

The Junction 22-01 connects the outlet of Volume 22-01 to the inlet of Volume 21-01 which is corresponding to the Connector 26 of the TRANFLO model. As given in the Reference 1, the smallest flow area of the three segments of the Connector 26 is 12.828 ft^2 and a forward and reverse flow resistant coefficients of 0.84 and 0.47 are associated with this flow area.

The Junction 22-02 connects the inlet of Volume 22-01 to the inlet of Volume 32-01 which is corresponding to the Connector 27 of the TRANFLO model. The smaller of the two flow areas of Volumes 22-01 and 32-01 is 17.35 ft^2 which is used as the flow area for this junction. As given the Reference 1, flow resistance is specified for the segments 2 and 3 of the Connector 27, a forward and reverse flow resistant coefficient of 0.5 associated with a flow area of 30.579 ft^2 for segment 2 and a forward and reverse flow resistant coefficient of 0.5 associated with a flow area of 18.579 ft^2 for segment 3. Therefore, for Junction 22-02, the flow resistant coefficient associated with the flow area of 17.35 ft^2 can be calculated as:

$0.5/(30.579/17.35)^2 + 0.5/(18.579/17.35)^2 = 0.161 + 0.436 = 0.597$

The Junction 22-03 connects the outlet of Volume 23-01 to the inlet of Volume 22-01 which is corresponding to the Connector 32 of the TRANFLO model. The smaller of the two flow areas of Volumes 23-01 and 22-01 is 41.73 ft^2 which is used as the flow area for this junction. As given the Reference 1, a forward and reverse flow resistant coefficient of 10.0 associated with a flow area of 44.768 ft^2 is specified for the segment 2 of the Connector 32. Therefore, for Junction 22-03, the flow resistant coefficient associated with the flow area of 41.73 ft^2 can be calculated as:

$10.0/(44.768/41.73)^2 = 8.689$

The following input are used for the Component 22.

```
0220000   speratr   separatr
0220001   3    1
0220101   41.73   3.9156   0.0   0.   90.   3.9156   0.00015   0.0   00000
0220200   2   1021.14   1.0
0221101   022010000   021000000   12.828   0.84   0.47   000000
```

0222101	022000000	032000000	17.35	0.597	0.597	000000
0223101	023010000	022000000	41.73	8.689	8.689	000000
0221201	0.0	0.0	0.0			
0222201	0.0	0.0	0.0			
0223201	0.0	0.0	0.0			

Component 21

The Component 21 is a branch with assigned name abovspr which is used to model the region below the secondary separator and above the mid-deck plate and outside the drain pipes. This component consists of 1 volume (Volume 21-01) and 2 junctions (Junctions 21-01 and 21-02). The Volume 21-01 is corresponding the Node 21 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow area and volume size for the Node 21 are 152.19 ft^2 and 347.0 ft^3. The volume length of Node 21 is 347.0/152.19 = 2.281 ft. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

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HML 10/1/96 fc 10/2/96
HML 10/1/96 fc 10/2/96

The Volume 21-01 is a vertical upward volume. The inclination angle is 90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 21 are given in Reference 1 as - pressure at 1021.12 psia, temperature at 547°F and void fraction of 1.0 (pure steam). Since there is no superheated steam in the steam generator, the steam in volume 21-01 must be saturated steam. For saturated steam, the RELAP5 code does not allow to specify both the water pressure and temperature. The steam pressure of TRANFLO Node 21 is used for this component. The initial water properties are specified as pressure at 1021.12 psia and the quality of 1.0.

The Junction 21-01 connects the outlet of Volume 21-01 to the inlet of Volume 20-01 which is corresponding to the Connector 25 of the TRANFLO model. The smaller of the two flow areas of Volumes 21-01 and 20-01 is 70.75 ft^2 which is used as the flow area for this junction. As given in the Reference 1, no flow resistance is specified for the Connector 25. However, a abrupt flow area change is specified for the Connector 25. Therefore, a forward and reverse flow resistant coefficient of 0.0 is used for this junction and the junction control flag a is set to 1 to specify a abrupt area change at this junction.

The Junction 21-02 connects the inlet of Volume 21-01 to the inlet of Volume 53-01 which is corresponding to the Connector 41 of the TRANFLO model. As given in the Reference 1, the smallest flow area of the three segments of the Connector ~~26~~ 41 is 7.96 ft^2 and a forward and reverse flow

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resistant coefficients of 1.78 and 1.67 are associated with this flow area.

The following input are used for the Component 21.

0210000	abovspr	branch							
0210001	2	1							
0210101	152.19	2.281	0.0	0.	90.	2.281	0.00015	0.0	00000
0210200	2	1021.12	1.0						
0211101	021010000	020000000	70.75	0.0	0.0	000100			
0212101	021000000	053000000	7.96	1.78	1.67	000000			
0211201	0.0	0.0	0.0						
0212201	0.0	0.0	0.0						

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Component 20

The Component 20 is a single volume with assigned name spsteam which is used to model the region outside the upper and lower secondary separator. This component consists of 1 volume (Volume 20-01). The Volume 20-01 is corresponding the Node 20 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow are and volume size for the Node 20 are 70.75 ft^2 and 527.1 ft^3. The volume length of Node 20 is 527.1/70.75 = 7.4502 ft. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 20-01 is a vertical upward volume. The inclination angle is 90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 20 are given in Reference 1 as - pressure at 1020.96 psia, temperature at 547°F and void fraction of 1.0 (pure steam). Since there is no superheated steam in the steam generator, the steam in volume 20-01 must be saturated steam. For saturated steam, the RELAP5 code does not allow to specify both the water pressure and temperature. The steam pressure of TRANFLO Node 20 is used for this component. The initial water properties are specified as pressure at 1020.96 psia and the quality of 1.0.

The following input are used for the Component 20.

```
0200000   spsteam   snglvol
0200101   70.75   7.4502   0.0  0.   90.   7.4502  0.00015   0.0   00000
0200200   2   1020.96   1.0
```

<u>Component 19</u>

The Component 19 is a separator with assigned name dryer which is used to model the region inside the secondary separator peerless vane banks. This component consists of 1 volume (Volume 19-01) and 3 junctions

400.0	55.2607
600.0	54.9895
800.0	54.7069
1000.0	54.3982
1200.0	54.0907
1400.0	53.7516

Each of the primary side volume (Component 1) connects to one heat slab as the left boundary volume. The left boundary volumes for the heat slabs 1 to 60 are Volumes 1-01 to 1-60. Due to the U-shape tubes, each secondary side volume (Components 30 and 2) connects to two heat slabs as the right boundary volume, once to the hot-leg side tubes and once to the cold-leg side tubes. The right boundary volumes for the heat slabs 1 to 60 are Volumes 30-01, 2-01 to 2-29, 2-29 to 2-01 and 30-01. The heat transfer area for each heat slab is linearly dependent on the length of heat slab which is equal to the length of the left and right boundary volumes. The heat transfer area given for the Heat Connector 1 of the TRANFLO model, which is the heat transfer area for the left side of the heat Node 1, is 2874.2 ft^2 with the volume length of 50.5" (or 4.2083 ft) for Node 1. Therefore, the heat transfer area per foot of the primary side volume length can be calculated as 2874.2/4.2083 = 682.9 ft^2. The heat transfer area to the left boundary volumes cab calculated as follows.

For Heat Slabs 1 and 60, the length of the left boundary Volumes 1-01 and transfer analysis. Then, the interval between all the 11 meshes equals to 0.00438/10 = 0.000438 ft. Since the initial water temperature at both the primary and secondary sides of the tubes is 547°F, the initial temperatures of all 11 mesh points are 547°F.

As given in the Reference 1, the tube material is inconel 600. The thermal property of the inconel 600 is given in Reference 5 which is input to the RELAP5 model as an user specified table (for composite 1). The thermal conductivity and volumetric heat capacity of inconel 600 are listed as follows.

Temperature (°F)	Thermal Conductivity (btu/s*ft*°F)
70.0	2.3843e-03
200.0	2.5232e-03
400.0	2.8009e-03
600.0	3.0787e-03
800.0	3.3565e-03
1000.0	3.6574e-03
1200.0	3.9815e-03
1400.0	4.3056e-03

Temperature (°F)	Volumetric Heat Capacity (btu/ft^3*°F)
70.0	55.6831
200.0	55.5227

```
5010000   prmout    tmdpjun
5010101   1010000   101000000   10.956
5010200   1
5010201   0.0   9148.5   0.0   0.0
5010202   1.0e6   9148.5   0.0   0.0
```

Heat Slabs

The heat slabs are used to model the steam generator tubes and provide heat transfer from the primary side of the tubes to the secondary side of the tubes. There are total 60 heat slabs modeled. Each heat slab connects one primary side volume (Component 1) and one secondary side volume (Component 2). The hydraulic diameter for Volumes 1-01 to 1-60 is 0.0642 ft which is the inside diameter of the tubes. The inside radius of the tubes is 0.0321 ft. Therefore, the left boundary coordinate for each of the heat slabs is 0.0321 ft. The tube is cylindrical shape.

The mesh location is provided by the input. As given in the heat structure input for the TRANFLO model, the distance of heat transfer for each heat connector is 0.00219 ft which equals to the half of the tube thickness. The tube thickness is 2*0.00219 = 0.00438 ft. In the RELAP5 model, 11 radial mesh points are used to model the tube wall for the heat

This component consists of 1 time dependent junction (Junction 500). The Junction 500 connects the Volume 100-01 to the Volume 1-01. The flow area of the junction equals to the flow area of the Volume 1-01 which is 10.956 ft^2. As discussed in the Section 2, a constant mass flow rate of 9148.5 lb/sec is assumed through the junction.

The following input are used for the Component 500.

```
5000000   prminl      tmdpjun
5000101   100000000   1000000   10.956
5000200   1
5000201   0.0   9148.5   0.0   0.0
5000202   1.0e6   9148.5   0.0   0.0
```

Component 501

The Component 501 is a time-dependent junction with assigned name prmout which is used to provide constant flow out the primary side of the tubes. This component consists of 1 time dependent junction (Junction 501). The Junction 501 connects the Volume 1-60 to the Volume 101-01. The flow area of the junction equals to the flow area of the Volume 1-60 which is 10.956 ft^2. As discussed in the Section 2, a constant mass flow rate of 9148.5 lb/sec is assumed flow out the primary side of the tubes.

The following input are used for the Component 501.

dependent volume (Volume 101-01). Since the volume size and length of the Volume 100-01 does not affect the calculation, an arbitrary volume size of 5000 ft^3 and an arbitrary volume length of 10 ft are used for the Volume 101-01.

Since the flow rate is controlled by the time dependent junctions, Components 500 and 501, the pressure of the Volume 101-01 does not affect on the primary side flow calculation. There is no reverse flow in the primary side of the tubes. The temperature does not have any impact on the calculation. Therefore, the pressure in the volume 101-01 is set at slightly lower the pressure at the Volume 100-01 and the temperature of the Volume 101-01 is set at the same temperature of the Volume 100-01. The following input are used for the Component 101.

```
1010000   outplen   tmdpvol
1010101   0.0    10.0    5000.0   0.0    0.0    0.0    0.0    0.0    0
1010200   3
1010201   0.0    2200.0   547.0
1010202   5.0    2200.0   547.0
1010203  15.0     700.0   491.0
```

<u>Component 500</u>

The Component 500 is a time-dependent junction with assigned name prminl which is used to provide constant flow to the primary side of the tubes.

the primary water pressure during the transient run. In addition, since the primary water flow rate is fixed by the time dependent junctions, the primary side pressure has negligible effect on the heat transfer calculation. Therefore, this discrepancy has no impact on this analysis.

As given in the Reference 1, the primary water temperature is 547°F at the initiation of the steam line break and the temperature then is reduced by 112°F in 20 seconds or 56°F in 10 seconds. The temperature for Volume 100-01 is specified as 547°F from time 0.0 second to 5.0 seconds (steady state run) and then reduced to 491°F at time 15 seconds.

The following input are used for the Component 100.

```
1000000   inplen   tmdpvol
1000101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1000200   3
1000201   0.0   2235.7   547.0
1000202   5.0   2250.0   547.0
1000203  15.0    800.0   491.0
```

Component 101

The Component 101 is a time-dependent volume with assigned name outplen which is used as a mass sink. This component consists of 1 time

0011301 9148.5 0.0 0.0 59

Component 100

The Component 100 is a time-dependent volume with assigned name inplen which is used as a mass source at preset condition for the primary side tubes (Component 1). This component consists of 1 time dependent volume (Volume 100-01). Since the volume size and length of the Volume 100-01 does not affect the calculation, an arbitrary volume size of 5000 ft^3 and an arbitrary volume length of 10 ft are used for the Volume 100-01.

Since the flow rate is controlled by the time dependent junctions, Components 500 and 501, the pressure of the Volume 100-01 does not affect on the primary side flow calculation. As given in the Reference 1, the primary side pressure is 2250 psia at the initiation of the steam line break and the primary side pressure is reduced by 1450 psi in 10 seconds. Since the steam line break is initiated at 5 seconds in the RELAP5 analysis, the time history for the pressure is set at 2250 psia for the first 5 seconds of the run and then reduced to 800 psia in the next 10 seconds. A pressure of 2235.7 psia instead of 2250 psia is input for the Volume 100-01 at 0.0 second. The pressure is increased to 2250 psia at 5 seconds and then reduced to 800 psia from 5 seconds to 15 seconds as the pressure specified in the TRANFLO model. This slightly lower primary side water pressure during the 5 seconds steady state run does not affect

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MADE BY HM LEE DATE 10/1/96 CHECK BY ____ APPROVED BY ____

0010316	3.0	31					
0010317	0.5	33					
0010318	1.60435	35					
0010319	0.5	37					
0010320	1.60435	39					
0010321	0.5	41					
0010322	1.60435	43					
0010323	0.5	45					
0010324	1.60435	47					
0010325	0.5	49					
0010326	1.60435	51					
0010327	0.5	53					
0010328	1.60435	55					
0010329	0.5	57					
0010329	1.2553	59					
0010330	1.1667	60					
0010601	90.0	30					
0010602	-90.0	60					
0010801	0.0	0.0642	60				
0011001	00000	60					
0011101	000000	59					
0011201	3	~~1~~ 2250.0	547.0	0.0	0.0	0.0	60
0011300	1						

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junctions. As discussed in Section 4, a constant primary side mass flow rate of 9148.5 lb/sec is assumed. The initial mass flow rate of 9148.5 lb/sec is used for all the 59 junctions.

The following input are used for the Component ~~3~~ 1. HML 10/1/96 fc 10/2/96

0010000	tubes	pipe
0010001	60	
0010101	10.956	60
0010301	1.1667	1
0010302	1.2553	3
0010303	0.5	5
0010304	1.60435	7
0010305	0.5	9
0010306	1.60435	11
0010307	0.5	13
0010308	1.60435	15
0010309	0.5	17
0010310	1.60435	19
0010311	0.5	21
0010312	1.60435	23
0010313	0.5	25
0010314	1.60435	27
0010315	0.5	29

Volume 2-29. This small discrepancy does not have significant effect on the total heat transfer from the primary side to the secondary side and the effect on the loads on the TSPs is negligible.

The Volumes 1-01 to 1-30 are vertical upward volumes. The inclination angles are 90° and the elevation changes are same as the volume lengths. The Volumes 1-30 to 1-60 are vertical downward volumes. The inclination angles are -90° and the elevation changes are same as the volume lengths. The TRANFLO code specifies the hydraulic diameter of a control volume in the input for a connector. The hydraulic diameter of 0.0642 ft is specified for the Connectors 1 to 17 of the TRANFLO model. The same hydraulic diameter is used for the volumes 1-01 to 1-60. Since a constant flow rate is assumed for the primary side of the tubes during the entire transient, the friction loss in the primary side of the tubes is not important. A smooth wall is assumed for the Volumes 1-01 to 1-60. The initial pressure of 2250 psia and temperature of 547 °F are used for the Node 1 to 16 of the TRANFLO model, the same initial pressure and temperature are used for the Volumes 1-01 to 1-60.

There are 59 junctions, Junctions 1-01 to 1-59, used in the Component 1 to connect the 60 volumes of the Component 1. The junction flow area for the 59 junctions is same as the flow area for the volumes which is 10.956 ft^2. Since the tubes are smooth, no flow resistance is used for the

The length of Volumes 1-10 and 1-51 equals to the length of Volume 2-09.

The length of Volumes 1-11 and 1-50 equals to the length of Volume 2-10.

The length of Volumes 1-12 and 1-49 equals to the length of Volume 2-11.

The length of Volumes 1-13 and 1-48 equals to the length of Volume 2-12.

The length of Volumes 1-14 and 1-47 equals to the length of Volume 2-13.

The length of Volumes 1-15 and 1-46 equals to the length of Volume 2-14.

The length of Volumes 1-16 and 1-45 equals to the length of Volume 2-15.

The length of Volumes 1-17 and 1-44 equals to the length of Volume 2-16.

The length of Volumes 1-18 and 1-43 equals to the length of Volume 2-17.

The length of Volumes 1-19 and 1-42 equals to the length of Volume 2-18.

The length of Volumes 1-20 and 1-41 equals to the length of Volume 2-19.

The length of Volumes 1-21 and 1-40 equals to the length of Volume 2-20.

The length of Volumes 1-22 and 1-39 equals to the length of Volume 2-21.

The length of Volumes 1-23 and 1-38 equals to the length of Volume 2-22.

The length of Volumes 1-24 and 1-37 equals to the length of Volume 2-23.

The length of Volumes 1-25 and 1-36 equals to the length of Volume 2-24.

The length of Volumes 1-26 and 1-35 equals to the length of Volume 2-25.

The length of Volumes 1-27 and 1-34 equals to the length of Volume 2-26.

The length of Volumes 1-28 and 1-33 equals to the length of Volume 2-27.

The length of Volumes 1-29 and 1-32 equals to the length of Volume 2-28.

The length of Volumes 1-30 and 1-31 equals to the length of Volume 2-29.
However, a volume length of 3.0 ft is input for the Volumes 1-30 and 1-31 which is slightly shorter than the volume length of 3.2075 ft for the

30 volumes (Volumes 30-01, 2-01 to 2-29). There is no heat transfer from primary side to secondary side is modeled for the Volume 2-30. Since the U-tubes are used in the Model 51 steam generator, 60 volumes (Volumes 1-01 to 1-60) are needed to model the primary side of the tubes which are included in the Component 1. To connect the 60 volumes, 59 junctions (Junction 1-01 to 1-59) are also included in the Component 1.

The flow area for the primary side of the tubes used in the TRANFLO model can be calculated as the volume size of Node 1 (46.11 ft^3) divided by the flow length of Node 1 (50.5" or 4.2083 ft): 46.11/4.2083 = 10.956 ft^2. This flow area is used for all the volumes of the Component 1. To achieve correct heat transfer from the primary side to the secondary side, the volume lengths of Volumes 1-01 to 1-60 have to be same as the following volumes:

The length of Volumes 1-01 and 1-60 equals to the length of Volume 30-01.
The length of Volumes 1-02 and 1-59 equals to the length of Volume 2-01.
The length of Volumes 1-03 and 1-58 equals to the length of Volume 2-02.
The length of Volumes 1-04 and 1-57 equals to the length of Volume 2-03.
The length of Volumes 1-05 and 1-56 equals to the length of Volume 2-04.
The length of Volumes 1-06 and 1-55 equals to the length of Volume 2-05.
The length of Volumes 1-07 and 1-54 equals to the length of Volume 2-06.
The length of Volumes 1-08 and 1-53 equals to the length of Volume 2-07.
The length of Volumes 1-09 and 1-52 equals to the length of Volume 2-08.

the high loads on the TSPs only last less than 1 second after the steam line break is initiated, the heat added to the secondary side is very small during that period which does not have significant effect on the analysis results. Therefore, accurate modeling of the primary loop is not required.

As discussed in Section 2, a constant mass flow through the primary side of the tubes during the entire transient is assumed. To achieve the constant mass flow in the primary loop, two time dependent junction, Components 500 and 501, are used to provide constant mass flow rate through the entire transient. The Component 100 is used as a mass source while the Component 101 is used a mass sink. The Component 1 is used to model the primary side of the tubes.

Component 1

The Component 1 is a Pipe with assigned name tubes which is used to model the region inside (primary side) the steam generator tubes. In the TRANFLO model, the primary side of the steam generator tubes is modeled by the Nodes 1 to 16 and the Connectors 2 to 16. In the RELAP5 model, To provide correct heat transfer from primary side to the secondary side, the lengths of the volumes modeling the primary side have to be same as the lengths of the volumes modeling the secondary side of the tube region. The secondary side of the steam generator tubes are modeled by

The following input are used for the Component 35. HML 10/1/96 SC 10/2/96

0350000	downc	pipe					
0350001	3						
0350101	0.0	3					
0350201	7.096	2					
0350301	11.827	3					
0350401	122.4	3					
0350601	-90.0	3					
0350801	0.00015	0.4275	3				
0351001	00000	3					
0351101	000000	2					
0351201	3	1024.84	547.0	0.0	0.0	0.0	1
0351202	3	1028.64	547.0	0.0	0.0	0.0	2
0351203	3	1032.44	547.0	0.0	0.0	0.0	3
0351300	1						
0351301	0.0	0.0	0.0	2			

HML 10/1/96 SC 10/2/96

Primary Loop

The primary loop includes the components 1, 100, 101, 500 and 501. A schematic of the secondary loop is shown in the Figure 5-3. The primary loop is only used to provide heat source to the secondary side. Since used for the Volumes 35-01, 35-02 and 35-03. The initial pressure in the Volumes 35-01, 35-02 and 35-03 can be calculated as:

The initial pressure at the center of the Volume 30-01 = 1034.15 psia

The elevation increase from the center of the Volume 30-01 to the center of the Volume 35-03 = 11.827/2 - 1.1667/2 = 5.3302 ft.

As calculated for the Component 2, the water static pressure reduces 46.17/144 = 0.3206 psi for every foot elevation increase. Then, the initial pressure at the center of the Volume 35-03 is 1034.15 - 0.3206 * 5.3302 = 1032.44 psia.

HML 10/1/96

The elevation increase from the center of the Volume 35-03 to 35-02 or from the center of The Volume 35-02 to 35-01 is 11.827 ft. Then, the initial pressure at the center of the Volume 35-02 is 1032.44 - 0.3206 * 11.827 = 1028.64 psia and the initial pressure at the center of the Volume 35-01 is 1028.64 - 0.3206 * 11.827 = 1024.84 psia.

HML 10/1/96 IC 10/2/96

The Junction 35-01 connects the Volume 35-01 to the Volume 35-02 and the Junction 35-02 connects the Volume 35-02 to the Volume 35-03. Since the majority portion of the downcomer has flow area of 7.096 ft^2, the flow area of the Junctions 35-01 and 35-02 is set to be 7.096 ft^2. There is no abrupt area change and flow element in the downcomer. Therefore, no flow resistance is specified for the Junctions 35-01 and 35-02. The smooth area change is also used for these junctions.

The reason is the flow area in the downcomer region is not constant and the flow area of 7.096 ft^2 only represents the majority portion of the downcomer. Since the propagation of the depressurization wave due to steam line break has significant effects on this analysis, the volume length has to be preserved. The initial water inventory in the steam generator also affects the analysis. Therefore, the downcomer length and volume are preserved in this analysis. The volume length for each of the three volumes can be calculated as 35.48/3 = 11.827 ft. The volume size for each of the three volumes can be calculated as 367.2/3 = 122.4 ft^3. HML 10/1/96

The volume length and size are specified as input data while the flow area is not specified which will be calculated by the code using the volume length and size.

The Volumes 35-01, 35-02 and 35-03 are vertical downward volumes. The inclination angles are -90° and the elevation changes are same as the volume lengths. The TRANFLO code specifies the hydraulic diameter of a control volume in the input for a connector. The hydraulic diameter of 0.4275 ft is used for the segment 1 of the Connectors 30 and 31 and segment 2 of the Connectors 29 and 43 of the TRANFLO model. The same hydraulic diameter is used for the volumes 35-01, 35-02 and 35-03.

As given in Reference 1, the Nodes 35 and 37 of the TRANFLO model contain single phase water initially. The water temperature is 547 °F which is

The Junction 34-01 connects the outlet of Volume 34-01 to the inlet of Volume 35-01. Since the Nodes 35 and 37 of TRANFLO model are combined in the RELAP5 model, the Junction 34-01 is corresponding to the combination of the Connectors 29 and 43. The smaller of the two flow areas of Volumes 34-01 and 35-01 is 7.096 ft^2 which is used as the flow area for this junction. As given the Reference 1, no flow resistance is specified for the Connectors 29 and 43. However, an abrupt area change is specified for the Connectors 29 and 43. Therefore, the forward and reverse flow resistant coefficient of 0.0 is used for this junction and the control flag a is set to 1 to specify an abrupt area change at this junction.

The following input are used for the Component 34. HML 10/1/96 lc 10/2/96

```
0340000   feedrg   branch
0340001   1   1
0340101   92.1   3.1097   0.0   0.   -90.   -3.1097   0.00015   0.0   00000
0340200   3   1022.48   547.0
0341101   034010000   035000000   7.096   0.0   0.0   000100
0341201   0.0   0.0   0.0
```

HML 10/1/96 lc 10/2/96
HML 10/1/96 lc 10/2/96

Component 35

The Component 35 is a Pipe with assigned name downc which is used to model the downcomer region. In the TRANFLO model, the downcomer region is modeled by two Nodes, Node 35 for hot-leg downcomer and Node 37 for cold-leg downcomer. Since the feedwater is not included in the RELAP5 model and the heat transfer from primary side to the secondary side is insignificant for this analysis due to the short duration, the Nodes 35 and 37 of the TRANFLO model are combined in the RELAP5 model. However, due to the long length of the downcomer, the downcomer region is separated into three volumes with equal the volume lengths. There are 3 volumes (Volumes 35-01, 35-02 and 35-03) and 2 junctions (Junctions 35-01 and 35-02) included in the Component 35.

As given in the Reference 1, the combined flow area of the Nodes 35 and 37 of the TRANFLO model is 3.548 * 2 = 7.096 ft^2. The combined volume size of the Nodes 35 and 37 of the TRANFLO model is 183.6 * 2 = 367.2 ft^3. The segment 1 of the Connectors 30 and 31 and segment 2 of the Connectors 29 and 43 have the same segment length of 17.74 ft. This indicates that the half of the downcomer length (or the volume lengths for Nodes 35 and 37) is 17.74 ft and the downcomer length is 2*17.74 = 35.48 ft. However, a discrepancy is noticed. The volume size based on the combined flow area of 7.096 ft^2 for the Nodes 35 and 37 and volume length of 35.48 ft is 7.096 * 35.48 = 251.77 ft^3 which is smaller than the combined size of the Nodes 35 and 37 as given in the Reference 1.

0332201 0.0 0.0 0.0

Component 34

The Component 34 is a branch with assigned name feedrg which is used to model the region from feedring to top of the tube sheet downcomer, the region outside feedring and primary separator risers. This component consists of 1 volume (Volume 34-01) and 1 junction (Junctions 34-01). The Volume 34-01 is corresponding the Node 34 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow are and volume size for the Node 34 are 92.1 ft^2 and 286.4 ft^3. The volume length of Node 36 is 286.4/92.1 = 3.1097 ft. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 34-01 is a vertical downward volume. The inclination angle is -90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for the Node 34 of the TRANFLO model are single phase liquid at pressure of 1022.48 psia and temperature of 547 °F which are also used for the Volume 34-01.

Volume 33-01 which is corresponding to the Connector 28 of the TRANFLO model. The smaller of the two flow areas of Volumes 32-01 and 33-01 is 17.35 ft^2 which is used as the flow area for this junction. As given the Reference 1, no flow resistance is specified for the Connector 28. Therefore, the forward and reverse flow resistant coefficient of 0.0 is used for this junction.

The Junction 33-02 connects the outlet of Volume 33-01 to the inlet of Volume 34-01 which is corresponding to the Connector 23 of the TRANFLO model. As given in the Reference 1, the smallest flow area of the two segments of the Connector 23 is 79.288 ft^2 which is used as the flow area for this junction. As given the Reference 1, no flow resistance is specified for the Connector 23. Therefore, a forward and reverse flow resistant coefficient of 0.0 is used for this junction.

The following input are used for the Component 33.

```
0330000   abovfl   branch
0330001   2    1
0330101   100.79  2.9225  0.0  0.  -90.  -2.9225  0.00015   0.0   00000
0330200   2   1021.72   0.73
0331101   032010000  033000000  17.35   0.0  0.0    000000
0332101   033010000  034000000  79.288  0.0  0.0    000000
0331201   0.0    0.0    0.0
```

The Component 33 is a branch with assigned name abovfl which is used to model the lower portion of the region below the mid-deck plate and above the feedring including the region outside the drain pipes, separator downcomer and separator riser. This component consists of 1 volume (Volume 33-01) and 2 junctions (Junctions 33-01 and 33-02). The Volume 33-01 is corresponding the lower part of Node 33 of the TRANFLO model given in Reference 1. The flow area of Volume 33-01 is 100.7 ft^2 which is same as the flow area for Volume 53 or the Node 33 of TRANFLO model. As discussed for the Component 53, the volume length of Volume 33-01 should be 2.9225 ft. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 33-01 is a vertical downward volume. The inclination angle is -90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Volume 33-01 are same as those for the Volume 53-01 which are two-phase water at pressure of 1021.72 psia and quality of 0.73.

The Junction 33-01 connects the outlet of Volume 32-01 to the inlet of model. The smaller of the two flow areas of Volumes 36-01 and 53-01 is 2.34 ft² which is used as the flow area for this junction. As given the Reference 1, a forward and reverse flow resistant coefficient of 0.5 associated with a flow area of 2.34 ft² for segment 1 of the Connector 22 which is also used for the Junction 53-01.

The Junction 53-02 connects the outlet of Volume 53-01 to the inlet of Volume 33-01. This junction is created due to splitting the Node 33 of TRANFLO model into two volumes in RELAP5 model. There is no connector in the TRANFLO model corresponding to this junction. The flow area of this junction is same as the flow area of the Volumes 53-01 and 33-01 (100.7 ft²) and no flow resistance is specified for this junction.

The following input are used for the Component 53.

```
0530000   abovfr2   branch
0530001   2   1     HML 10/1/96  JC 10/2/96
0530101   100.7   3.9156  0.0  0.  -90.  -3.9156  0.00015  0.0  00000
0530200   2   1021.72   0.73
0531101   036010000  053000000  2.34   0.5   0.5   000000
0532101   053010000  033000000  100.7   0.0  0.0   000000
0531201   0.0   0.0   0.0
0532201   0.0   0.0   0.0
```

Component 33

688.6/100.7 = 6.8381 ft. The top 3.9156 portion of the volume length for Node 33 is used for the Volume 53-01. Then, the remaining 2.9225 ft of the volume length for Node 33 is used for the volume length of Volume 33-01. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 53-01 is a vertical downward volume. The inclination angle is -90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 33 are given in Reference 1 as - pressure at 1021.72 psia, temperature at 547°F and void fraction of 0.73. For a two-phase water, the RELAP5 code does not allow to specify both the water pressure and temperature. The pressure of TRANFLO Node 33 is used for this component. As discussed for the Component 23, the void fraction of 0.73 is used in the RELAP5 analysis as quality for this volume. The initial water properties are specified as pressure at 1021.72 psia and the quality of 0.73.

The Junction 53-01 connects the outlet of Volume 36-01 to the inlet of Volume 53-01 which is corresponding to the Connector 22 of the TRANFLO

Component 53

The Component 53 is a branch with assigned name abovfr2 which is used to model the upper portion of the region below the mid-deck plate and above the feedring including the region outside the drain pipes, separator downcomer and separator riser. This component consists of 1 volume (Volume 53-01) and 2 junctions (Junctions 53-01 and 53-02). The Volume 53-01 is corresponding the upper part of Node 33 of the TRANFLO model given in Reference 1. Since the RELAP5 code only allows the junctions located either at the inlet of the volume or the outlet of the volume, the Node 33 of TRANFLO model has to be separated to two volumes in the RELAP5 model, Volumes 53-01 and 33-01. Otherwise, the drain water from the primary separator (Component 22) can not be connected to the drain return at the correct elevation. As given in the Table 4.2.2 of Reference 1, the flow are and volume size for the Node 33 are 100.7 ft^2 and 688.6 ft^3. The elevation of the drain water outlet junction from the primary separator (Junction 22-02) [2 HML 10/1/96 10/2/96] is at 39.7188 ft above the center of Volume 2-01 (as given in the output of the RELAP5 analysis) which is same as the elevation of the outlet of the Volume 32-01 (or Junction 33-01). The elevation at the outlet of the Volume 36 (Junction 53-01) is 43.6344 ft above the center of the Volume 2-01. Therefore, to make the elevation at the outlet of the Volume 53-01 (or Junction 53-02) at 39.7188 ft above the center of the Volume 2-01, the volume length for the Volume 53 has to be 43.6344 - 39.7188 = 3.9156 ft. The volume length of Node 36 is significant effects on the analysis. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area input.

The Volume 36-01 is a vertical downward volume. The inclination angle is -90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 36 are given in Reference 1 as - pressure at 1021.57 psia, temperature at 547°F and void fraction of 0.82. For a two-phase water, the RELAP5 code does not allow to specify both the water pressure and temperature. The pressure of TRANFLO Node 36 is used for this component. As discussed for the Component 23, the void fraction of 0.82 is used in the RELAP5 analysis as quality for this volume. The initial water properties are specified as pressure at 1021.57 psia and the quality of 0.82.

The following input are used for the Component 36.

```
0360000   spsteam   snglvol
0360101   2.34   9.7312   0.0   0.   -90.   -9.7312   0.00015   0.0   00000
0200200   2   1021.57   0.82
```

Since the steam flow through is break is chocked through the entire transient, the initial condition for the Volume 38-01 does not affect the analysis. Saturated steam at atmospherical pressure (14.7 psia) is assumed for the Volume 38-01.

The following input are used for the Component 38.

```
0380000    contnm    snglvol
0380101    10000.0   200.0    0.0    0.0   90.0   200.0   0.00015    0.0    00000
0380200    2    14.7    1.0
```

Component 36

The Component 36 is a single volume with assigned name dsdryer which is used to model the secondary separator drain pipes. This component consists of 1 volume (Volume 36-01). The Volume 36-01 is corresponding the Node 36 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow area and volume size for the Node 36 are 2.34 ft^2 and 22.83 ft^3. The volume length of Node 36 is 22.83/2.34 = 9.7564 ft. However, since the TRANFLO code does not require perfect elevation match for its Nodes, the use of the volume length of 9.7564 ft causes a small elevation discrepancy at the junction connects the Volume 36-01. Therefore, the volume length of 9.7312 ft is used for the Volume 36-01 (equivalent 0.059 ft^3 volume reduction). The small volume length discrepancy on the water drain return from the dryer does not cause any

The following input are used for the Component 518.

5180000	break	valve				
5180101	017010000	038000000	4.6	0.0	0.0	000100
5180110	0.0	0.0	1.0	1.0		
5180201	1	0.0	0.0	0.0		
5180300	mtrvlv					
5180301	502	503	1000.0	0.0		

Component 38

The Component 38 is a single volume with assigned name contnm which is used to provide a mass sink for steam blowdown after the break is initiated. This component consists of 1 volume (Volume 38-01). Since the steam flow through the break is choked through the entire transient, a arbitrary large flow area of 10000.0 ft^2 and volume length of 200.0 ft are used. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 38-01 is a vertical upward volume. The inclination angle is 90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The Component 518 is a valve junction with assigned name break which is used to simulate the steam line break. This component consists of 1 valve junction (Junction 518) which provides a flow control from the Volume 17-01 (Component 17) to the Volume 38-01 (Component 38). The Junction 518 is corresponding the Connector 18 of the TRANFLO model given in Reference 1.

For this case, the location of the steam line break is assumed at the steam nozzle which has an inside diameter of 29" (Ref. 7). The flow area of the Junction 518 can be calculated as $(29/24)^2 * 3.1416 = 4.6\ ft^2$. Since the flow through this junction is always chocked during the entire transient, no flow resistance is assigned to this junction. However, an abrupt area change at this junction is used by setting the junction control flag a to 1. The RELAP5 motor valve is ~~sued~~ USED to simulate the initiation of the steam line break. The Trip 502 is set to open the motor valve (Initiate steam line break). The valve is initially closed and no steam is ~~blew~~ blown out from the steam generator until the Trip 502 is tripped. Since it is assumed the steam line breaks open at very high speed, a 0.001 second valve opening time (or a valve change rate of 1000 $second^{-1}$) is assumed. The Trip 503 is set to close the motor valve. Since the steam line break can not be terminated, an arbitrary long time is used for the Trip 503.

as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 17-01 is a vertical upward volume. The inclination angle is 90° and the elevation change is same as the volume length. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 17 are given in Reference 1 as - pressure at 1020.94 psia, temperature at 547°F and void fraction of 1.0 (pure steam). Since there is no superheated steam in the steam generator, the steam in volume 17-01 must be saturated steam. For saturated steam, the RELAP5 code does not allow to specify both the water pressure and temperature. The steam pressure of TRANFLO Node 17 is used for this component. The initial water properties are specified as pressure at 1020.94 psia and the quality of 1.0.

The following input are used for the Component 17.

```
0170000   sgdoom   snglvol
0170101   94.12   3.5497  0.0   0.0  90.0  3.5497  0.00015   0.0   00000
0170200   2   1020.94   1.0
```

<u>Component 518</u>

is used to provide a flow junction from the Volume 18-01 (Component 18) to the Volume 17-01 (Component 17). This component consists of 1 junction (Junction 519). The Junction 519 is corresponding the Connector 19 of the TRANFLO model given in Reference 1.

The smaller of the two flow areas of Volumes 18-01 and 17-01 is 63.49 ft^2 which is used as the flow area for this junction. As given the Reference 1, no flow resistance coefficient is specified for the Connector 19. The forward and reverse flow resistant coefficient of 0.0 is used for this junction. The following input are used for the Component 519.

```
5190000   aboverfr    sngljun
5190101   018010000   017000000   63.49   0.0   0.0   000000
5190110   0.0   0.0   1.0   1.0
5190201   1   0.0   0.0   0.0
```

<u>Component 17</u> HML 10/1/96 fc 10/2/96

The Component 17 is a single volume with assigned name sgdoom which is used to model the region above the upper deck and below the steam nozzle. This component consists of 1 volume (Volume 17-01). The Volume 17-01 is corresponding the Node 17 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow are and volume size for the Node 17 are 94.12 ft^2 and 334.1 ft^3. The volume length of Node 17 is 334.1/94.12 = 3.5497 ft. The flow area and volume length are specified while the volume length is not specified which will be calculated by the code using the volume size and flow area.

The Volume 18-01 is a horizontal volume. The inclination angle is 0.0° and there is no elevation change. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 18 are given in Reference 1 as - pressure at 1020.96 psia, temperature at 547°F and void fraction of 1.0 (pure steam). Since there is no superheated steam in the steam generator, the steam in volume 18-01 must be saturated steam. For saturated steam, the RELAP5 code does not allow to specify both the water pressure and temperature. The steam pressure of TRANFLO Node 18 is used for this component. The initial water properties are specified as pressure at 1020.96 psia and the quality of 1.0.

The following input are used for the Component 18.

```
0180000   spsteam   snglvol
0180101   63.49   0.0   473.0   0.   0.0   0.0   0.00015   0.0   00000
0180200   2   1020.96   1.0
```

Component 519

The Component 519 is a single junction with assigned name abovefr which for this junction. As given the Reference 1, a forward and reverse flow resistant coefficient of 0.5 associated with a flow area of 70.75 ft^2 is specified for the segment ~~2~~ 1 of the Connector 24. HML 10/1/96 Lc 10/2/96

The following input are used for the Component 19.

0190000	dryer	separatr							
0190001	3	1					HML 10/1/96	Lc 10/2/96	
0190101	171.4	0.7083	0.0	0.	~~10.~~ 0.0	0.0	0.00015	0.0	00000
0190200	2	1020.96	1.0						
0191101	019010000	018000000	63.49	5.502	5.502	000000			
0192101	019000000	036000000	2.34	0.5	0.5	000000			
0193101	020010000	019000000	70.75	0.5	0.5	000000			
0191201	0.0	0.0	0.0						
0192201	0.0	0.0	0.0						
0193201	0.0	0.0	0.0						

Component 18

The Component 18 is a single volume with assigned name updryer which is used to model the region inside the secondary separator. This component consists of 1 volume (Volume 18-01). The Volume 18-01 is corresponding the Node 18 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow are and volume size for the Node 18 are 63.49 ft^2 and 473.0 ft^3. The volume length of Node 18 is 473.0/63.49 = 7.45 ft. The volume size and flow area are specified as input data model. As given in the Reference 1, the smallest flow area of the two segments of the Connector 20 is 63.49 ft^2 which is used as the flow area for this junction. As given the Reference 1, flow resistance is specified for the segments 1 and 2 of the Connector 20, a forward and reverse flow resistant coefficient of 40.0 associated with a flow area of 179.54 ft^2 for segment 1 and a forward and reverse flow resistant coefficient of 0.5 associated with a flow area of 63.49 ft^2 for segment 2. Therefore, for Junction 19-01, the flow resistant coefficient associated with the flow area of 63.49 ft^2 can be calculated as:

$40.0/(179.54/63.49)^2 + 0.5 = 5.002 + 0.5 = 5.502$

The Junction 19-02 connects the inlet of Volume 19-01 to the inlet of Volume 36-01 which is corresponding to the Connector 21 of the TRANFLO model. As given in the Reference 1, the smallest flow area of the two segments of the Connector 21 is 2.34 ft^2 which is used as the flow area for this junction. As given the Reference 1, a forward and reverse flow resistant coefficient of 0.5 associated with a flow area of 2.34 ft^2 is specified for the segment 2 of the Connector 21.

The Junction 19-03 connects the outlet of Volume 20-01 to the inlet of Volume 19-01 which is corresponding to the Connector 24 of the TRANFLO model. As given in the Reference 1, the smallest flow area of the two segments of the Connector 24 is 70.75 ft^2 which is used as the flow area

(Junctions 19-01, 19-02 and 19-03). The Volume 19-01 is corresponding the Node 19 of the TRANFLO model given in Reference 1. As given in the Table 4.2.2 of Reference 1, the flow area and volume size for the Node 19 are 171.4 ft^2 and 121.4 ft^3. The volume length of Node 22 is 121.4/171.4 = 0.7083 ft. The flow area and volume length are specified as input data while the volume size is not specified which will be calculated by the code using the volume length and flow area.

The Volume 19-01 is a horizontal volume. The inclination angle is 0° and there is no elevation change. The hydraulic diameter of the volume is not specified also and the code will calculate it.

The initial water properties for Node 19 are given in Reference 1 as - pressure at 1020.96 psia, temperature at 547°F and void fraction of 1.0 (pure steam). Since there is no superheated steam in the steam generator, the steam in volume 19-01 must be saturated steam. For saturated steam, the RELAP5 code does not allow to specify both the water pressure and temperature. The steam pressure of TRANFLO Node 19 is used for this component. The initial water properties are specified as pressure at 1020.96 psia and the quality of 1.0.

The Junction 19-01 connects the outlet of Volume 19-01 to the inlet of Volume 18-01 which is corresponding to the Connector 20 of the TRANFLO

1-60 is 1.1667 ft and the heat transfer area to the left boundary volumes is 682.9*1.1667=796.74 ft^2.

For Heat Slabs 2, 3, 58 and 59, the length of the left boundary Volumes 1-02, 1-03, 1-58 and 1-59 is 1.2553 ft and the heat transfer area to the left boundary volumes is 682.9*1.2553=857.24 ft^2.

For Heat Slabs 4, 5, 8, 9, 12, 13, 16, 17, 20, 21, 24, 25, 28, 29, 32, 33, 36, 37, 40, 41, 44, 45, 48, 49, 52, 53, 56, and 57, the length of the left boundary Volumes 1-04, 1-05, 1-08, 1-09, 1-12, 1-13, 1-16, 1-17, 1-20, 1-21, 1-24, 1-25, 1-28, 1-29, 1-32, 1-33, 1-36, 1-37, 1-40, 1-41, 1-1-44, 1-45, 1-48, 1-49, 1-52, 1-53, 1-56, and 1-57 is 0.5 ft and the heat transfer area to the left boundary volumes is 682.9*0.5=341.45 ft^2.

For Heat Slabs 6, 7, 10, 11, 14, 15, 18, 19, 22, 23, 26, 27, 34, 35, 38, 39, 42, 43, 46, 47, 50, 51, 54, and 55, the length of the left boundary Volumes 1-06, 1-07, 1-10, 1-11, 1-14, 1-15, 1-18, 1-19, 1-22, 1-23, 1-26, 1-27, 1-34, 1-35, 1-38, 1-39, 1-42, 1-43, 1-46, 1-47, 1-50, 1-51, 1-54, and 1-55 is 1.60435 ft and the heat transfer area to the left boundary volumes is 682.9*1.60435=1095.61 ft^2. The length of 3.0 ft is used for Volumes 1-30 and 1-31. As described in the section for Component 1, the actual tube length modeled in the Volumes 1-30 and 1-31 is 3.2075 ft. Therefore, for the heat slabs 30 and 31, the heat transfer area to the left boundary Volumes 1-30 and 1-31 is 682.9 * 3.2075 = 2190.4 ft^2.

For each heat slab, the right boundary volume has the same length as the left boundary volume. Since the tubes have cylindrical shape, the ratio of the heat transfer areas for the right and left boundary volumes for all heat slabs equals to the ratio of the outside diameter and inside diameter of the tubes. The outside diameter of the tubes is the sum of the inside diameter of the tubes and twice of the tube wall thickness which can be calculated as 0.0642 + 2*0.00438 = 0.07296 ft. The ratio of the heat transfer areas for the right and left boundary volumes for all heat slabs equals to 0.07296/0.0642 = 1.136449. Then, the heat transfer area of the right boundary volume for each heat slab can be calculated as the heat transfer area of the left boundary volume for heat slab multiplied by 1.136449.

For Heat Slabs 1 and 60, the heat transfer area to the right boundary volumes is 1.136449*796.74 =905.4541 ft^2.

For Heat Slabs 2, 3, 58 and 59, the heat transfer area to the right boundary volumes is 1.136449*857.24=974.2092 ft^2.

For Heat Slabs 4, 5, 8, 9, 12, 13, 16, 17, 20, 21, 24, 25, 28, 29, 32, 33, 36, 37, 40, 41, 44, 45, 48, 49, 52, 53, 56, and 57, the heat transfer area to the right boundary volumes is 1.136449*341.45=388.0404 ft^2.

For Heat Slabs 6, 7, 10, 11, 14, 15, 18, 19, 22, 23, 26, 27, 34, 35, 38, 39, 42, 43, 46, 47, 50, 51, 54, and 55, the heat transfer area to the right boundary volumes is 1.136449*1095.61=1245.1044 ft^2. For Heat Slabs 30 and 31, the heat transfer area to the right boundary volumes is

1.136449*2190.4=2489.277 ft^2.

There is no heat source in all heat slabs. The initial source multiplier and the direct moderator heating multipliers for both left and right boundary volumes are set to be 0.0. The hydraulic diameters for all the left and right boundary volumes are used for the heat transfer hydraulic diameter. Since the heat transfer rate through the tubes is much lower than the CHF, arbitrary large values or default values are used for all the input related to CHF calculation for both the left and right boundary volumes.

The input data for the heat slabs are listed as follows.

```
11201000   60   11   2   1   0.0321
11201100   0     2
11201101   0.000438   10
11201201   1     10
11201301   0.0    10
11201401   547.0   11
11201501   001010000    0000   1   0    796.74   1
11201502   001020000   10000   1   0    857.24   3
11201503   001040000   10000   1   0    341.45   5
11201504   001060000   10000   1   0   1095.61   7
11201505   001080000   10000   1   0    341.45   9
```

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY

11201506	001100000	10000	1	0	1095.61	11
11201507	001120000	10000	1	0	341.45	13
11201508	001140000	10000	1	0	1095.61	15
11201509	001160000	10000	1	0	341.45	17
11201510	001180000	10000	1	0	1095.61	19
11201511	001200000	10000	1	0	341.45	21
11201512	001220000	10000	1	0	1095.61	23
11201513	001240000	10000	1	0	341.45	25
11201514	001260000	10000	1	0	1095.61	27
11201515	001280000	10000	1	0	341.45	29
11201516	001300000	10000	1	0	2190.4	31
11201517	001320000	10000	1	0	341.45	33
11201518	001340000	10000	1	0	1095.61	35
11201519	001360000	10000	1	0	341.45	37
11201520	001380000	10000	1	0	1095.61	39
11201521	001400000	10000	1	0	341.45	41
11201522	001420000	10000	1	0	1095.61	43
11201523	001440000	10000	1	0	341.45	45
11201524	001460000	10000	1	0	1095.61	47
11201525	001480000	10000	1	0	341.45	49
11201526	001500000	10000	1	0	1095.61	51
11201527	001520000	10000	1	0	341.45	53
11201528	001540000	10000	1	0	1095.61	55

PACIFIC GAS AND ELECTRIC COMPANY
GENERAL COMPUTATION SHEET

CALC NO. STA-042 R0

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY

11201529	001560000	10000	1	0	341.45	57
11201530	001580000	10000	1	0	857.24	59
11201531	001600000	0000	1	0	796.74	60
11201601	030010000	0000	1	0	905.4541	1
11201602	002010000	10000	1	0	974.2092	3
11201603	002030000	10000	1	0	388.0404	5
11201604	002050000	10000	1	0	1245.1044	7
11201605	002070000	10000	1	0	388.0404	9
11201606	002090000	10000	1	0	1245.1044	11
11201607	002110000	10000	1	0	388.0404	13
11201608	002130000	10000	1	0	1245.1044	15
11201609	002150000	10000	1	0	388.0404	17
11201610	002170000	10000	1	0	1245.1044	19
11201611	002190000	10000	1	0	388.0404	21
11201612	002210000	10000	1	0	1245.1044	23
11201613	002230000	10000	1	0	388.0404	25
11201614	002250000	10000	1	0	1245.1044	27
11201615	002270000	10000	1	0	388.0404	29
11201616	002290000	0000	1	0	2489.277	31
11201617	002280000	-10000	1	0	388.0404	33
11201618	002260000	-10000	1	0	1245.1044	35
11201619	002240000	-10000	1	0	388.0404	37
11201620	002220000	-10000	1	0	1245.1044	39

```
11201621   002200000  -10000   1   0   388.0404   41
11201622   002180000  -10000   1   0  1245.1044   43
11201623   002160000  -10000   1   0   388.0404   45
11201624   002140000  -10000   1   0  1245.1044   47
11201625   002120000  -10000   1   0   388.0404   49
11201626   002100000  -10000   1   0  1245.1044   51
11201627   002080000  -10000   1   0   388.0404   53
11201628   002060000  -10000   1   0  1245.1044   55
11201629   002040000  -10000   1   0   388.0404   57
11201630   002020000  -10000   1   0   974.2092   59
11201631   003010000    0000   1   0   905.4541   60
11201701   0   0.0   0.0   0.0   60
11201801   0.0   15.0   15.0   1.5   1.5   0.0   0.0   1.0   60
11201901   0.0   15.0   15.0   1.5   1.5   0.0   0.0   1.0   60

20100100   tbl/fctn   1   1
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
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

Control Variables

The purpose of this analysis is to determine the pressure difference across the TSPs. In this calculation, the pressure difference across the TSP is defined as the pressure at the center of the volume immediately above the TSP subtracting the pressure at the center of the volume immediately below the TSP. Since the length of the volume immediately above or below the TSP is 0.5 ft, this definition conservatively adds a 0.5 ft hydraulic head to the actual pressure difference across TSP. Control Variables 1 to 7 are used to calculate the differential pressures across TSPs 1 to 7.

Control Variable 1

Control Variable 1 is named as delptpl which is used to calculate the differential pressure across TSP 1. The delptpl is the sum of the negative pressure of the Volume 2-04 and the pressure of the Volume 2-03. The RELAP5 code used pa for the pressure. As given in Reference 3, a pa equals to 1.45038e-4 psi. A conversion factor of 1.45038e-4 is used in the Control Variable 1. The following input is used for the Control Variable 1.

```
20500100    delptpl    sum 1.45038e-4    0.0 1
20500101    0.0    -1.0,    p,    002040000    1.0,    p,    002030000
```

Control Variable 2

Control Variable 2 is named as delptp2 which is used to calculate the differential pressure across TSP 2. The delptp2 is the sum of the negative pressure of the Volume 2-08 and the pressure of the Volume 2-07. A conversion factor of 1.45038e-4 is used in the Control Variable 2 to convert pa to psi. The following input is used for the Control Variable 2.

```
20500200    delptp2    sum 1.45038e-4    0.0    1
20500201    0.0    -1.0,    p,    002080000    1.0,    p,    002070000
```

Control Variable 3

Control Variable 3 is named as delptp3 which is used to calculate the differential pressure across TSP 3. The delptp3 is the sum of the negative pressure of the Volume 2-12 and the pressure of the Volume 2-11. A conversion factor of 1.45038e-4 is used in the Control Variable 3 to convert pa to psi. The following input is used for the Control Variable 3.

```
20500300    delptp3    sum 1.45038e-4    0.0    1
20500301    0.0    -1.0,    p,    002120000    1.0,    p,    002110000
```

Control Variable 4

Control Variable 4 is named as delptp4 which is used to calculate the differential pressure across TSP 4. The delptp4 is the sum of the negative pressure of the Volume 2-16 and the pressure of the Volume 2-15. A conversion factor of 1.45038e-4 is used in the Control Variable 4 to convert pa to psi. The following input is used for the Control Variable 4.

```
20500400    delptp4    sum 1.45038e-4    0.0    1
20500401    0.0    -1.0,    p,    002160000    1.0,    p,    002150000
```

Control Variable 5

Control Variable 5 is named as delptp5 which is used to calculate the differential pressure across TSP 5. The delptp5 is the sum of the negative pressure of the Volume 2-20 and the pressure of the Volume 2-19. A conversion factor of 1.45038e-4 is used in the Control Variable 5 to convert pa to psi. The following input is used for the Control Variable

5.

20500500 delptp5 sum 1.45038e-4 0.0 1

20500501 0.0 -1.0, p, 002200000 1.0, p, 002190000

Control Variable 6

Control Variable 6 is named as delptp6 which is used to calculate the differential pressure across TSP 6. The delptp6 is the sum of the negative pressure of the Volume 2-24 and the pressure of the Volume 2-23. A conversion factor of 1.45038e-4 is used in the Control Variable 6 to convert pa to psi. The following input is used for the Control Variable 6.

20500600 delptp6 sum 1.45038e-4 0.0 1

20500601 0.0 -1.0, p, 002240000 1.0, p, 002230000

Control Variable 7

Control Variable 7 is named as delptp7 which is used to calculate the differential pressure across TSP 7. The delptp7 is the sum of the negative pressure of the Volume 2-28 and the pressure of the Volume 2-27. A conversion factor of 1.45038e-4 is used in the Control Variable 7 to convert pa to psi. The following input is used for the Control Variable 7.

20500700 delptp7 sum 1.45038e-4 0.0 1

20500701 0.0 -1.0, p, 002280000 1.0, p, 002270000

Time Step Control

A very small minimum time step of $1.0e^{-7}$ second is used for the entire run to insure that the time step can be reduced to the required size as determined by the RELAP5 time step control scheme. The steam line break is occurred at 5 seconds for this analysis. For the first 5 seconds, the steam generator is in steady state condition. The purpose for the first 5 seconds run is to self correct the slightly inconsistence in the input and a real steady state condition can be provided at the initiation of the break. For steady state run, larger time steps can be used. A maximum time step of 0.005 second is used for the first 5 seconds run.

After the initiation of the break, a very large steam flow is blown out from the steam generator which induces a very fast transient in the steam generator. In addition, a great portion of the water in the steam generator is in pure liquid phase at the initiation of the break. The depressurization wave travels at a very high speed in the liquid water. To correctly track the depressurization wave front and to limit the water property change in the components during each time step, a maximum time step of $1.0e^{-5}$ second is used immediately after the initiation of break. The depressurization wave travelling speed is substantially reduced when flashing occurs in the liquid region due to depressurization. Then, the maximum time step size can be increased. A maximum time step size of $2.5e^{-5}$ second is used starting at 0.3 second after the initiation of the break (5.3 seconds into the run). The maximum time step size is further increased to 5e^{-5} second starting at 1.5 seconds after the initiation of the break (6.5 seconds into the run). The analysis is terminated at 3 seconds after the initiation of the break (8 seconds into the run). A maximum time step size of 1.0e^{-4} second is specified in the input after 8 seconds which is not used in the run.

During the entire run, the standard major edits are printed. The time step control options ss and d are set to 0. The time step control option tt is set to 3 which allows to use a mass error analysis to control the hydrodynamics advancement time step size in addition to standard time step control. The heat conduction/transfer time step is set to the same as the hydrodynamics time step. Since the maximum time step sizes allowed are very small, the maximum time step sizes are used during the entire run. Therefore, the time step control option has no effect on the analysis.

The minor edits are printed out every 0.1 seconds which is the frequency of the differential pressure used in the TSP structure analysis performed by Westinghouse. Due to 109000 time steps advanced during the run, the major edit frequency is set to be very small to reduce the output to a manageable size. The restart is not used. An arbitrary small restart frequency is used.

The following input is used for the time step control.

201	5.0	1.d-7	0.005	3	2	200	10000
202	5.3	1.d-7	0.00001	3	1000	20000	100000
203	6.5	1.d-7	0.000025	3	400	8000	100000
204	8.0	1.d-7	0.00005	3	200	10000	100000
205	1000.0	1.d-7	0.0001	3	100	10000	100000

Trip Cards

Three trip cards are used in the input. The Trip Card 501 is used to terminate the analysis at 8 seconds. The Trip Card 502 is used to initiate the steam line break at 5 seconds. The Trip Card 503 is used to close the steam line break at an arbitrary large time of 200 seconds. For all the three Trip Cards, the latch indicator is set to 1 which makes all the three trips once set true remain true. The following input is used for the Trip Cards.

501	time	0	ge	null	0	8.0	1
502	time	0	ge	null	0	5.0	1
503	time	0	ge	null	0	200.0	1

Trip Stop Advancement Card

The Trip Card 501 is used to terminate the analysis. The following input is used for the trip stop advancement card.

600 501

Miscellaneous Input

The following input is used to indicate the problem type is a new transient.

100 new transnt

The following input is used to select the british units for both input and out output.

102 british british

To tern off the CPU time check and diagnostic edit, empty Card 105 is input.

105

The following variables are listed in the minor edit.

- The flow rates at TSPs (Junctions 2-03, 2-07, 2-11, 2-15, 2-19, 2-23 and 2-27) and the break (Junction 518).
- The pressure at the volume upstream the break (Volume 17-01).
- The differential pressures across the TSPs (Control Variables 1 to 7).

The following input is used to select the minor edit.

301 mflowj 518000000

302 mflowj 002030000

303	mflowj	002070000
304	mflowj	002110000
305	mflowj	002150000
306	mflowj	002190000
307	mflowj	002230000
308	mflowj	002270000
309	p	017010000
319	cntrlvar	1
320	cntrlvar	2
321	cntrlvar	3
322	cntrlvar	4
323	cntrlvar	5
324	cntrlvar	6
326	cntrlvar	7

The title of the analysis is set as follows.

=SLB pressure difference across the SG tube support plates

The input file name is reidpl and the output file name is reodpl.

The complete list of the input is attached in the Appendix D.

RELAP5 Input for LB Case 2

The only difference between the LB Case 1 and LB Case 2 is the equilibrium model is used in LB Case 2 for the volumes modeling the shell side of the steam generator tubes. Therefore, the only input changes from LB Case 1 to LB Case 2 are the volume control flag e is set to 1 for Volumes 2-01 to 2-30. The following input changes are used for LB Case 2.

```
0021001   00101   29
0021002   00001   30
```

The remaining input are the same as those for the LB Case 1.

The input file name is reidp2 and the output file name is reodp2.

RELAP5 Input for LB Case 3

The only difference between the LB Case 1 and LB Case 3 is the initial steam generator water level and flow resistance of the TSPs. The initial water level used in LB Case 1 is 490.5" above the steam generator tube plate, while the initial water level used in LB Case 3 is 466.0" above the steam generator tube plate. The initial void fractions for the Volumes 23-01, 32-01, 33-01 and 36-01 are changed to 0.39, 1.0, 0.93 and 1.0 from those used for the LB Case 1, as shown in Appendix C for case 61. As discussed for LB Case 1 input, the void fractions are conservatively used as qualities for LB Case 3. The initial pressures at each of the Volumes are slightly reduced due to lower water level. However, since five seconds steady state run is performed before the initiation of the break, the volume pressures will be self-corrected when the break is initiated. Therefore, it is not necessary to change the initial volume pressures for this case. The flow resistant coefficient of 0.78 is used for forward and reverse flow through the TSPs for LB Case 1. For LB Case 3, the flow resistant coefficient is increased to 0.99 for forward and reverse flow through the TSPs. The following input changes are used for LB Case 3.

```
0230200   2    1022.72    0.39
0320200   2    1021.26    1.0
0330200   2    1021.72    0.93
0360200   2    1021.57    0.82
0020902   0.99  0.99   3
0020904   0.99  0.99   7
0020906   0.99  0.99   11
0020908   0.99  0.99   15
0020910   0.99  0.99   19
0020912   0.99  0.99   23
0020914   0.99  0.99   27
```

The remaining input are the same as those for the LB Case 1.

The input file name is reidp5 and the output file name is reodp5.

RELAP5 Input for SB Case 1

The only difference between the LB Case 1 and SB Case 1 is the steam line break size. For LB Case 1, the cross section area of the steam generator steam outlet nozzle is used for the break size. For SB Case 1, the cross section area of the steam pipe down stream the flow restrictor is used. As given in Reference 1, the break size of 1.388 ft^2 is used for the SB Case 1. Therefore, the only input change from LB Case 1 to SB Case 1 is that the flow area of Junction 518 is changed from 4.6 ft^2 to 1.388 ft^2. The following input change is used for SB Case 1

5180101 017010000 038000000 1.388 0.0 0.0 000100

The remaining input are the same as those for the LB Case 1.

The input file name is reidp3 and the output file name is reodp3.

RELAP5 Input for SB Case 2

The only difference between the SB Case 1 and SB Case 2 is the equilibrium model is used in SB Case 2 for the volumes modeling the shell side of the steam generator tubes. Therefore, the only input changes from SB Case 1 to SB Case 2 are the volume control flag e is set to 1 for Volumes 2-01 to 2-30. The following input changes are used for SB Case 2.

0021001 00101 29

0021002 00001 30

The remaining input are the same as those for the SB Case 1.

The input file name is reidp4 and the output file name is reodp4.

6. Results

The results of all RELAP5 runs are microfiched and attached to the calculation file as Appendix G.

Large Break Case 1

The time history of the differential pressures across TSPs 1 to 7 after the initiation of the break are plotted on Figures 6-1 to 6-7. The peak differential pressures across the TSPs 1 to 7 are 1.855 psi, 5.774 psi, 9.489 psi, 9.732 psi, 9.541 psi, 9.411 and 8.784 psi, respectively. All the peak pressures are occurred at 0.5 to 0.8 second after the initiation of the break. The duration of the high differential pressure across the TSP is very short for the TSP 1 which is located nearest to the bottom of the steam generator. The duration increases when the location of the TSP is further away from the bottom of the steam generator. Therefore, even the difference is very small between the peak differential pressures across the TSPs 3 to 7, the integrated force acting on the TSP increases with the elevation of the TSP.

Large Break Case 2

The time history of the differential pressures across TSPs 1 to 7 after the initiation of the break are plotted on Figures 6-8 to 6-14. The peak differential pressures across the TSPs 1 to 7 are 1.938 psi, 2.17

DP AT TSP 1 (LB CASE 1)

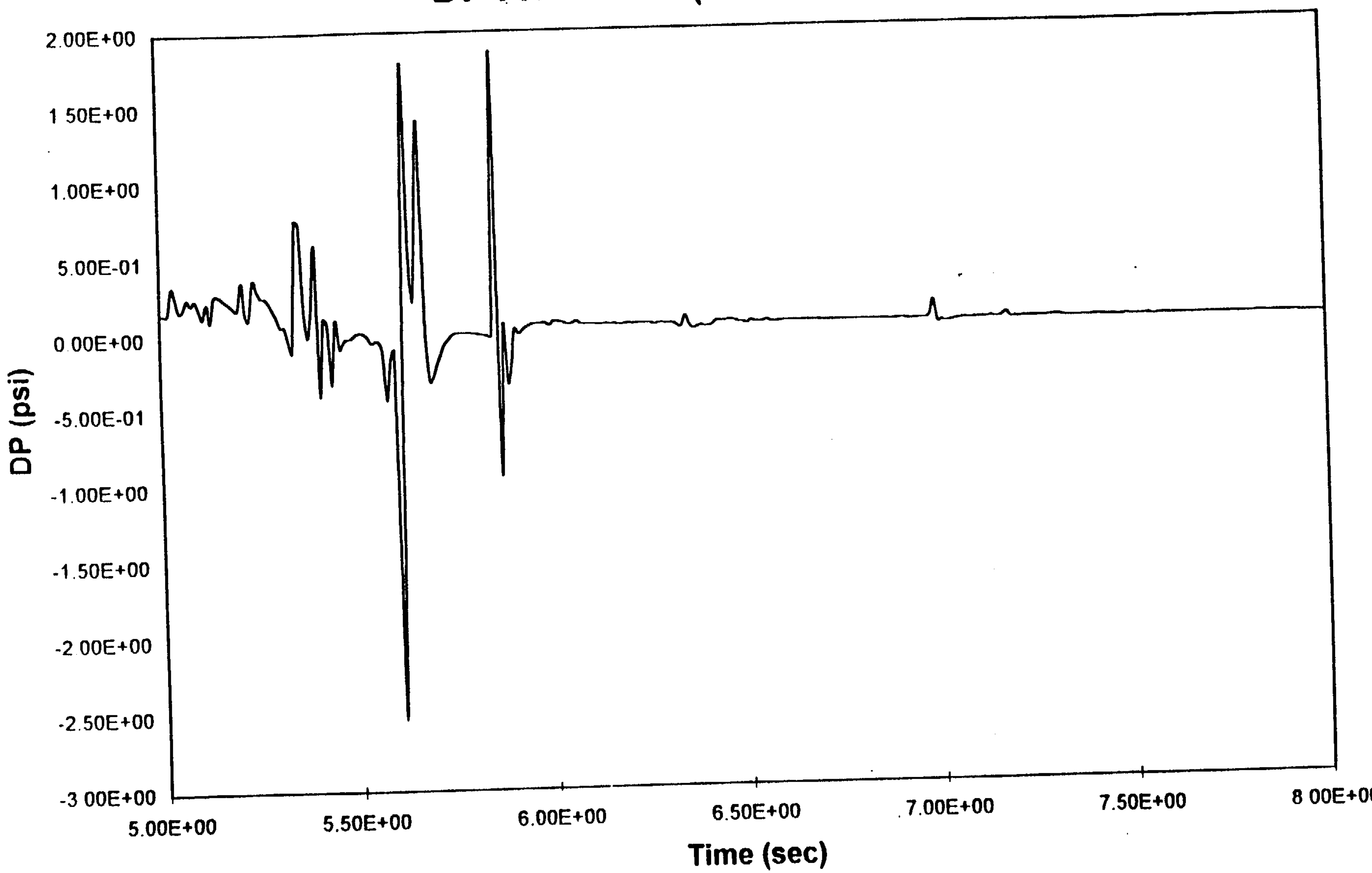

FIGURE 6-1

HAL 10/1/96
STA-002 R.0
87/174

DP AT TSP 2 (LB CASE 1)

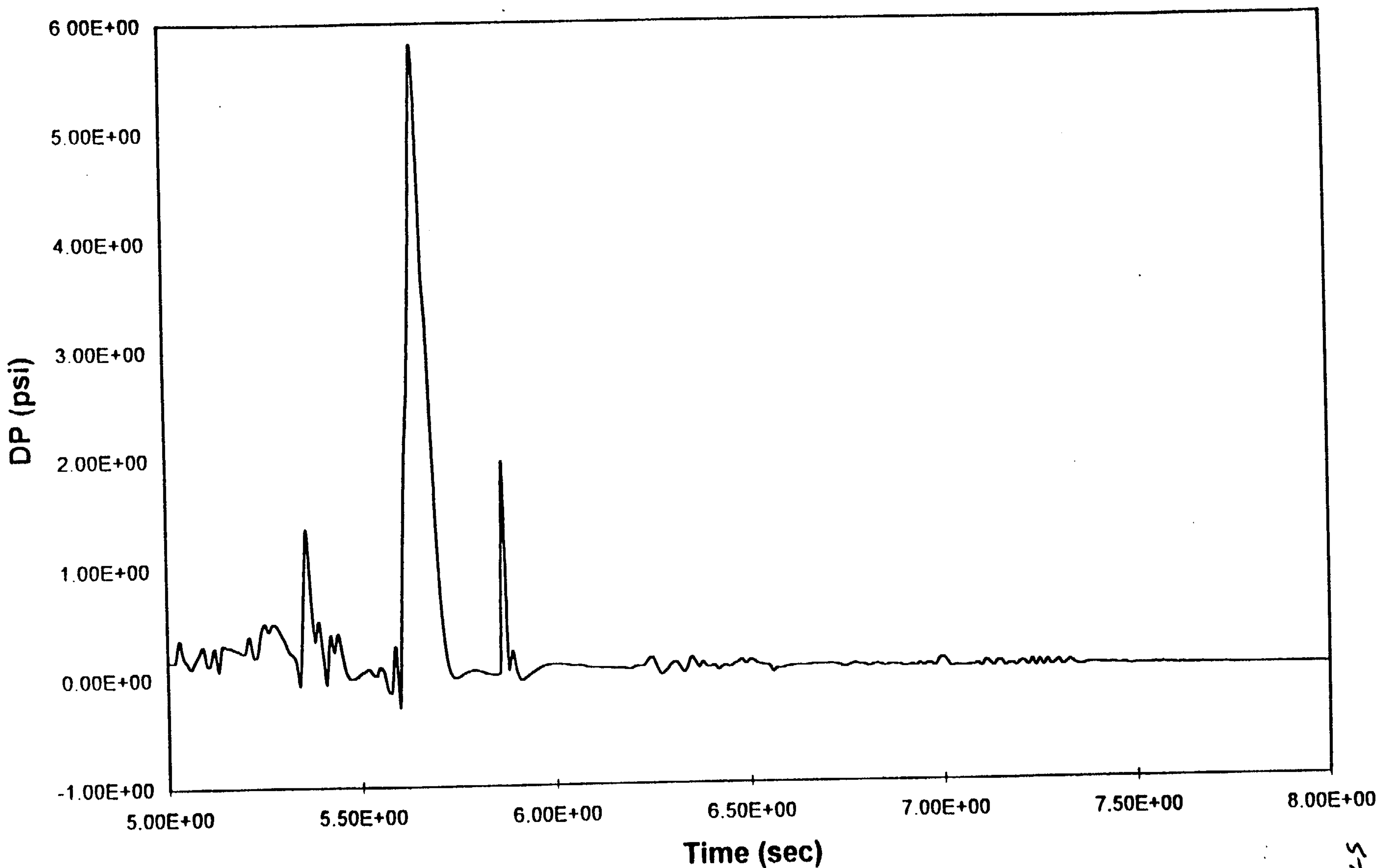

FIGURE 6-2

STA-042 R.0
JHL 10/1/96
GO/17C

DP AT TSP 3 (LB CASE 1)

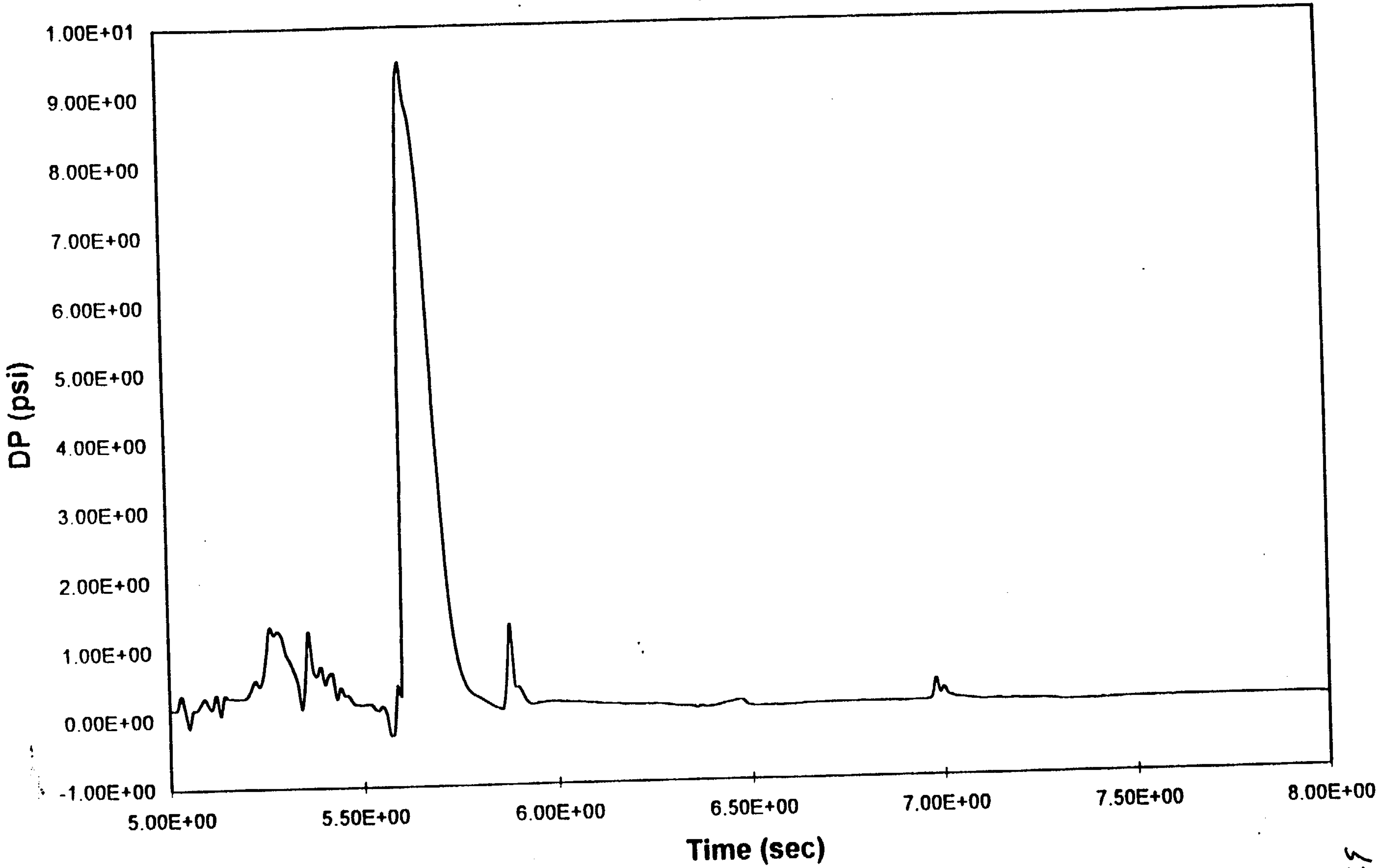

FIGURE 6-3

DP AT TSP 4 (LB CASE 1)

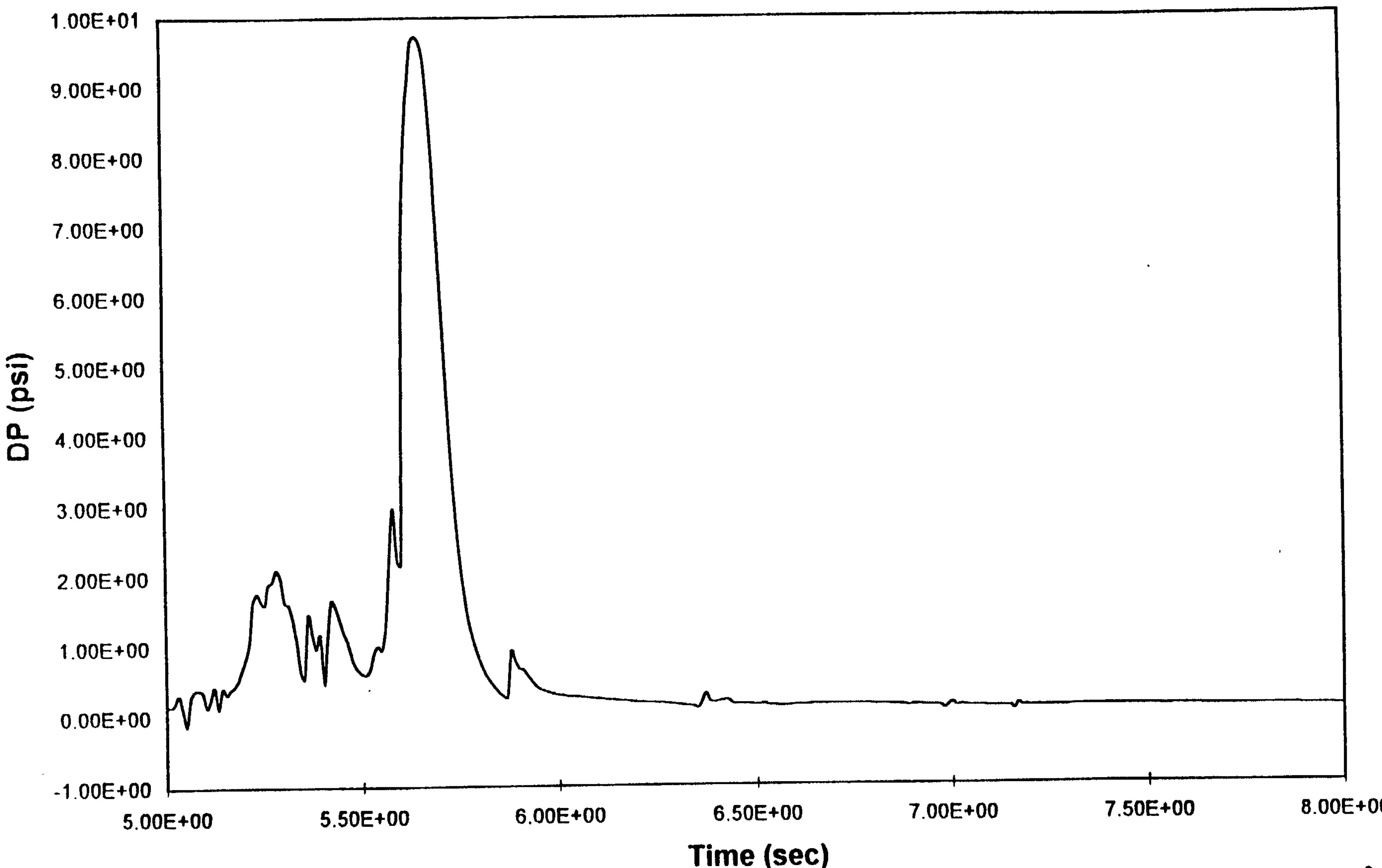

FIGURE 6-4

DP AT TSP 5 (LB CASE 1)

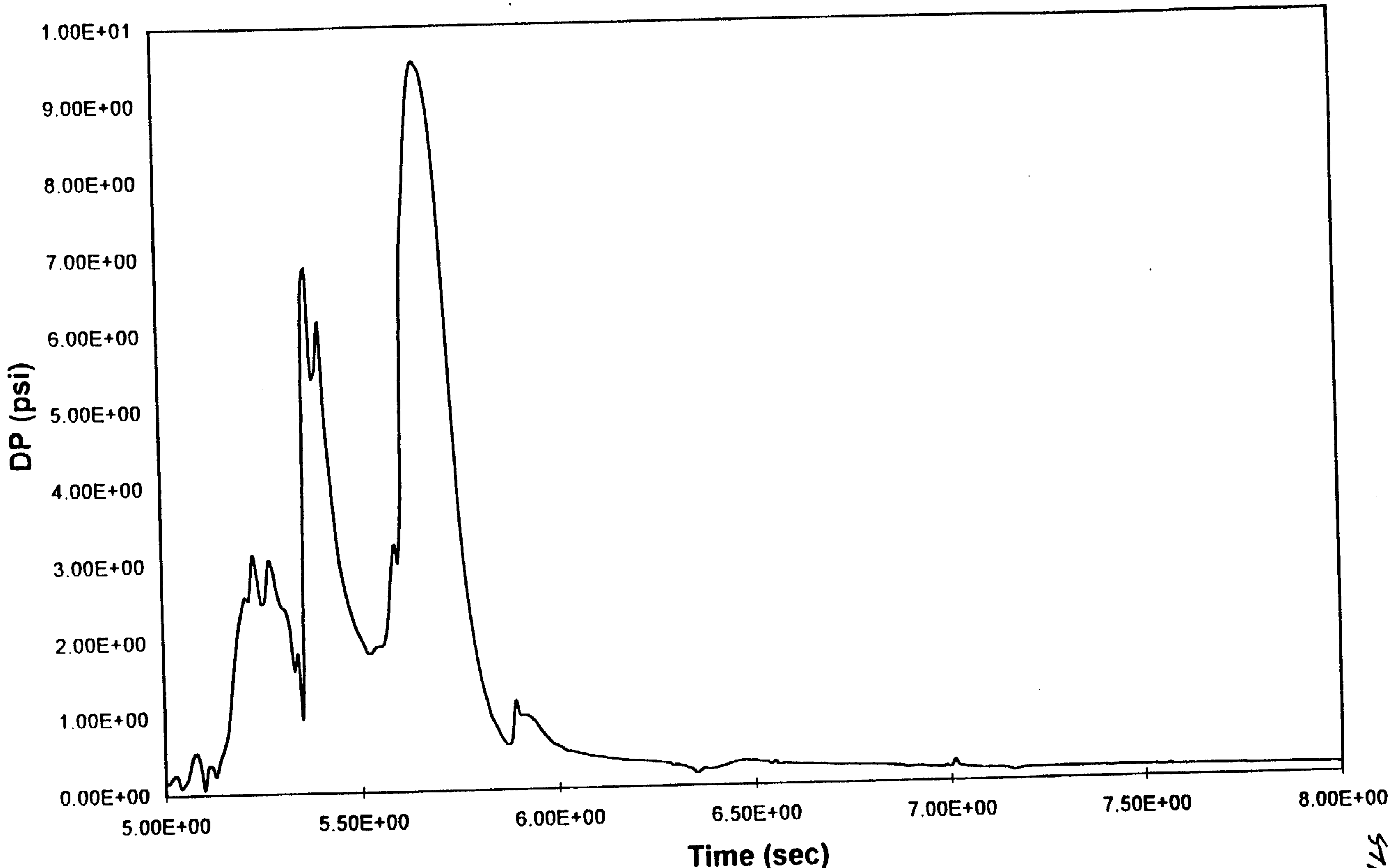

FIGURE 6-5

93/70
HAC 10/1/96
STA-042
R. 0

DP AT TSP 6 (LB CASE 1)

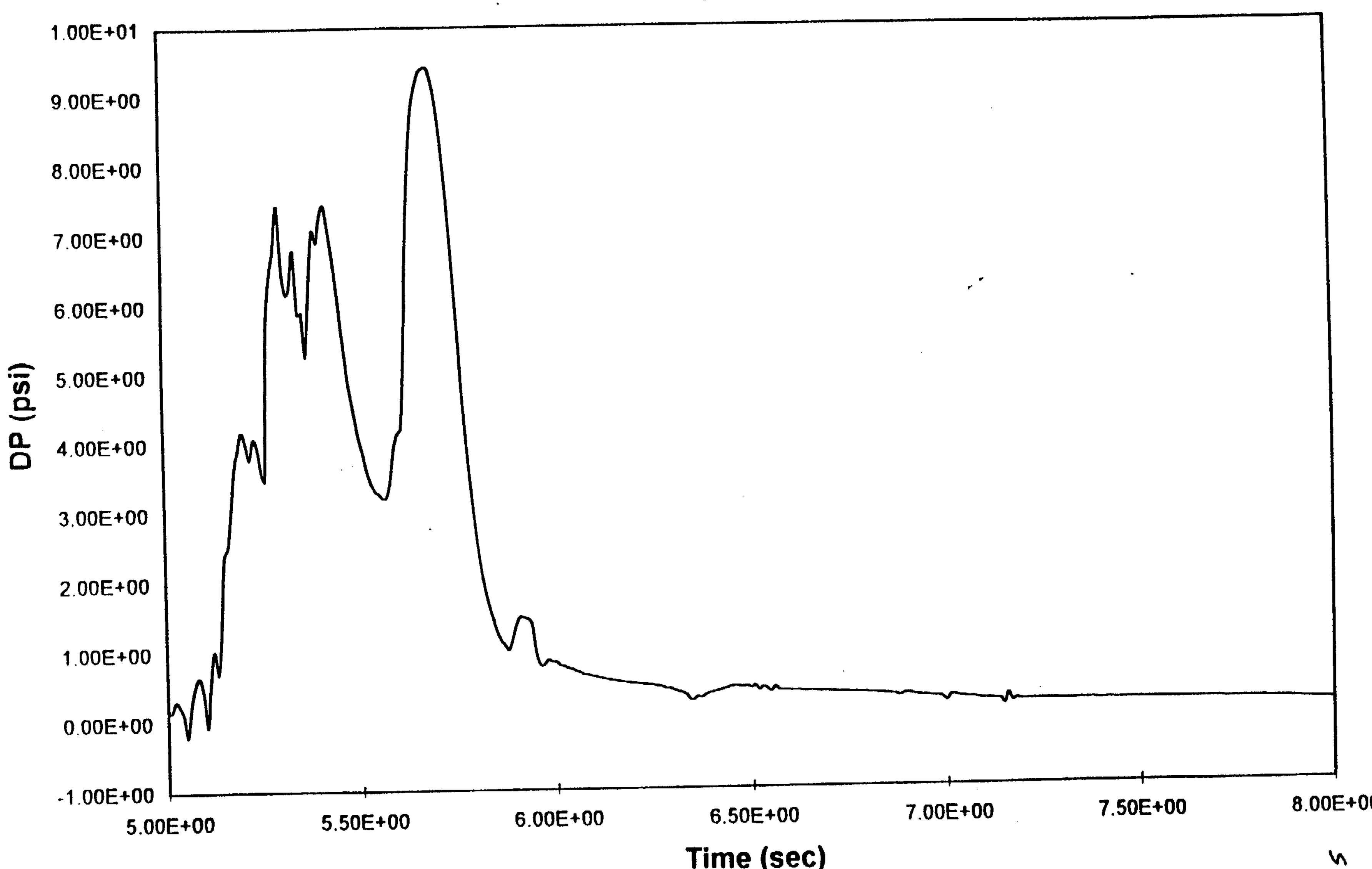

FIGURE 6-6

STA-042 R0
HHL 10/1/96
96/176

DP AT TSP 7 (LB CASE 1)

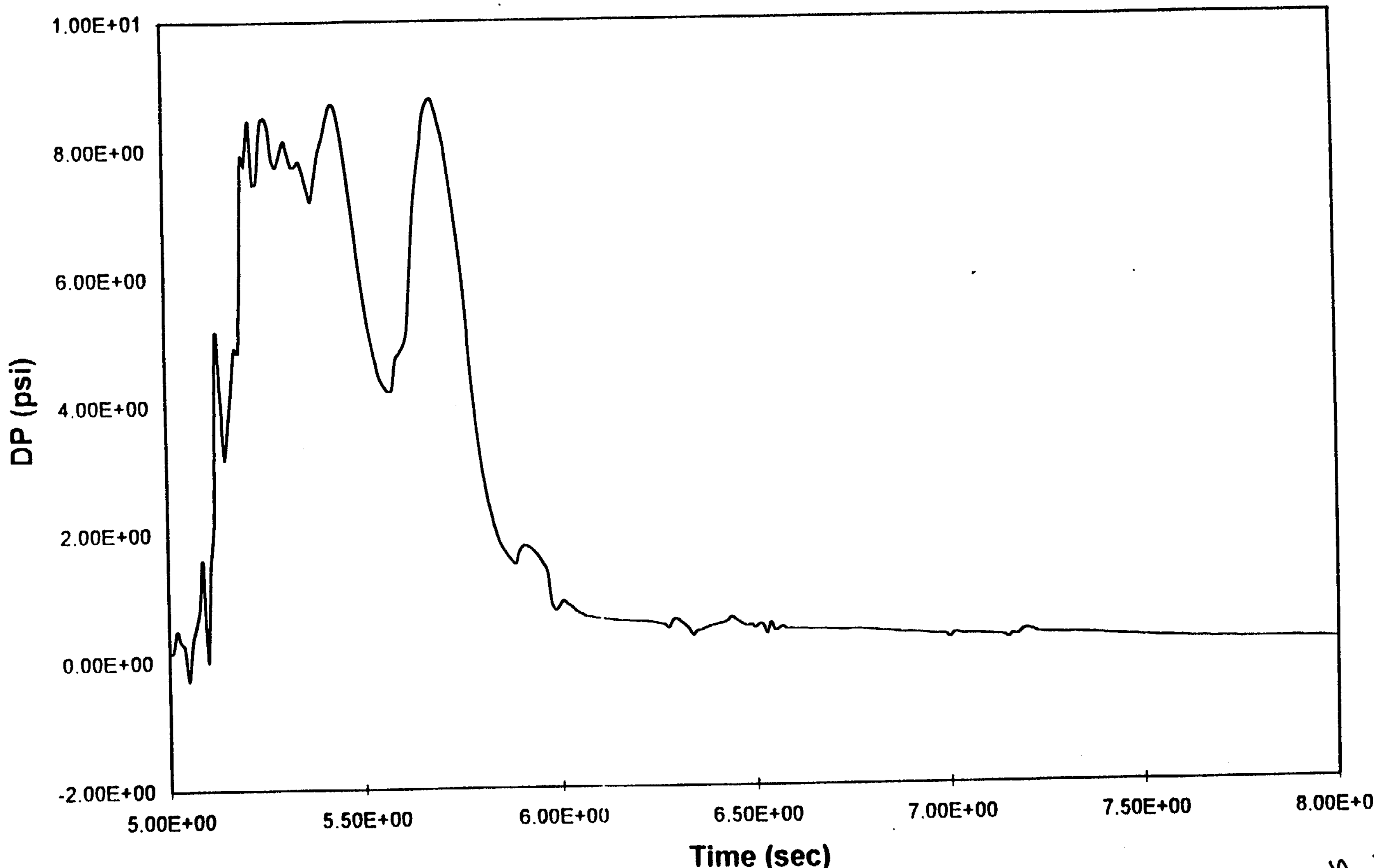

FIGURE 6-7

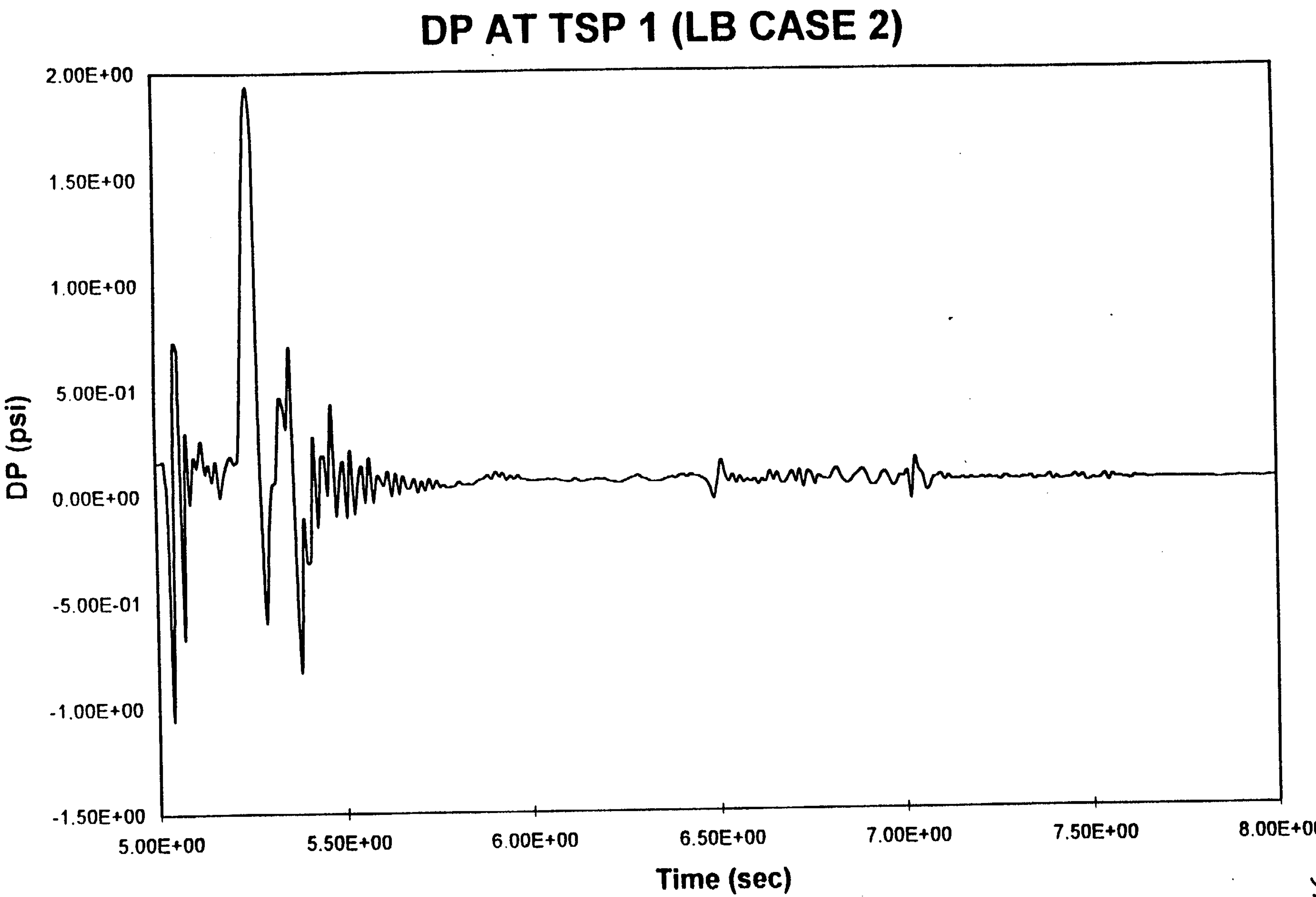
DP AT TSP 1 (LB CASE 2)
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
-5.00E-01
-1.00E+00
-1.50E+00
DP (psi)
5.00E+00
5.50E+00
6.00E+00
6.50E+00
7.00E+00
7.50E+00
8.00E+00
Time (sec)

FIGURE 6-8

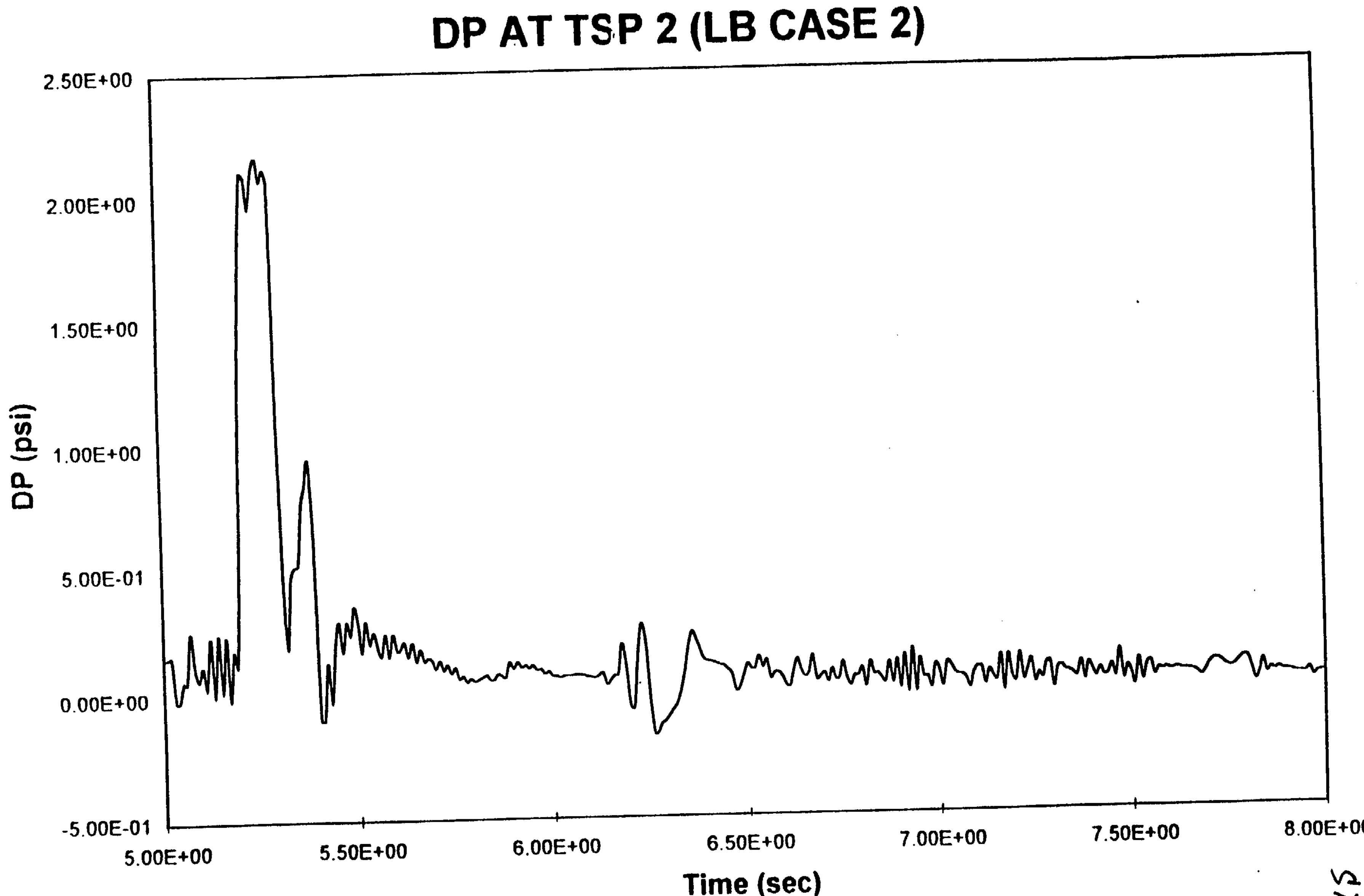

FIGURE 8-9

STA-042 R.0
HHL 10/1/96
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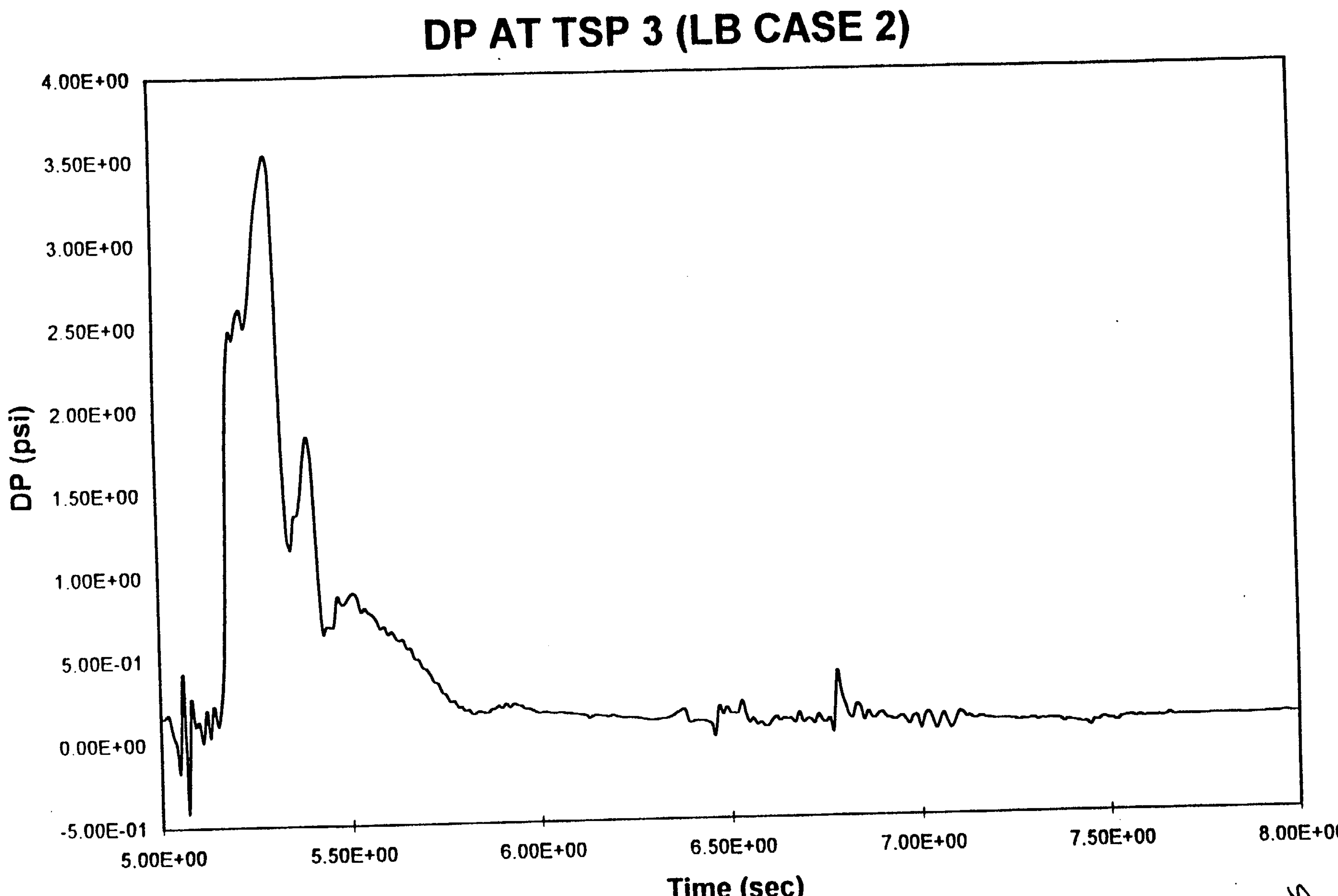

FIGURE 6-10

HML 10/1/96
STA-042
R.0
38/176

DP AT TSP 4 (LB CASE 2)

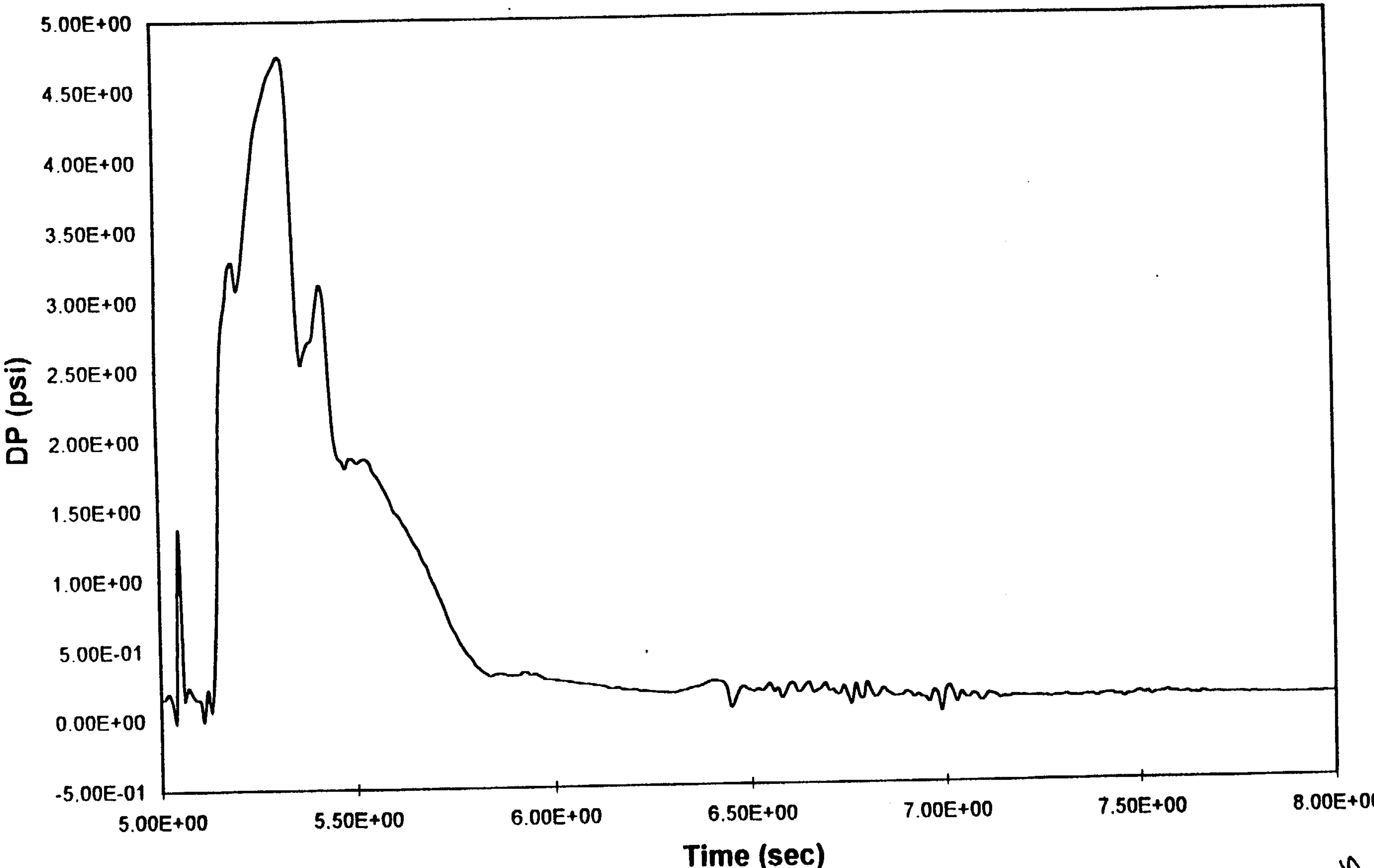

FIGURE 6-11

STA-042 R.0
HHL 10/1/96
59/174

DP AT TSP 5 (LB CASE 2)

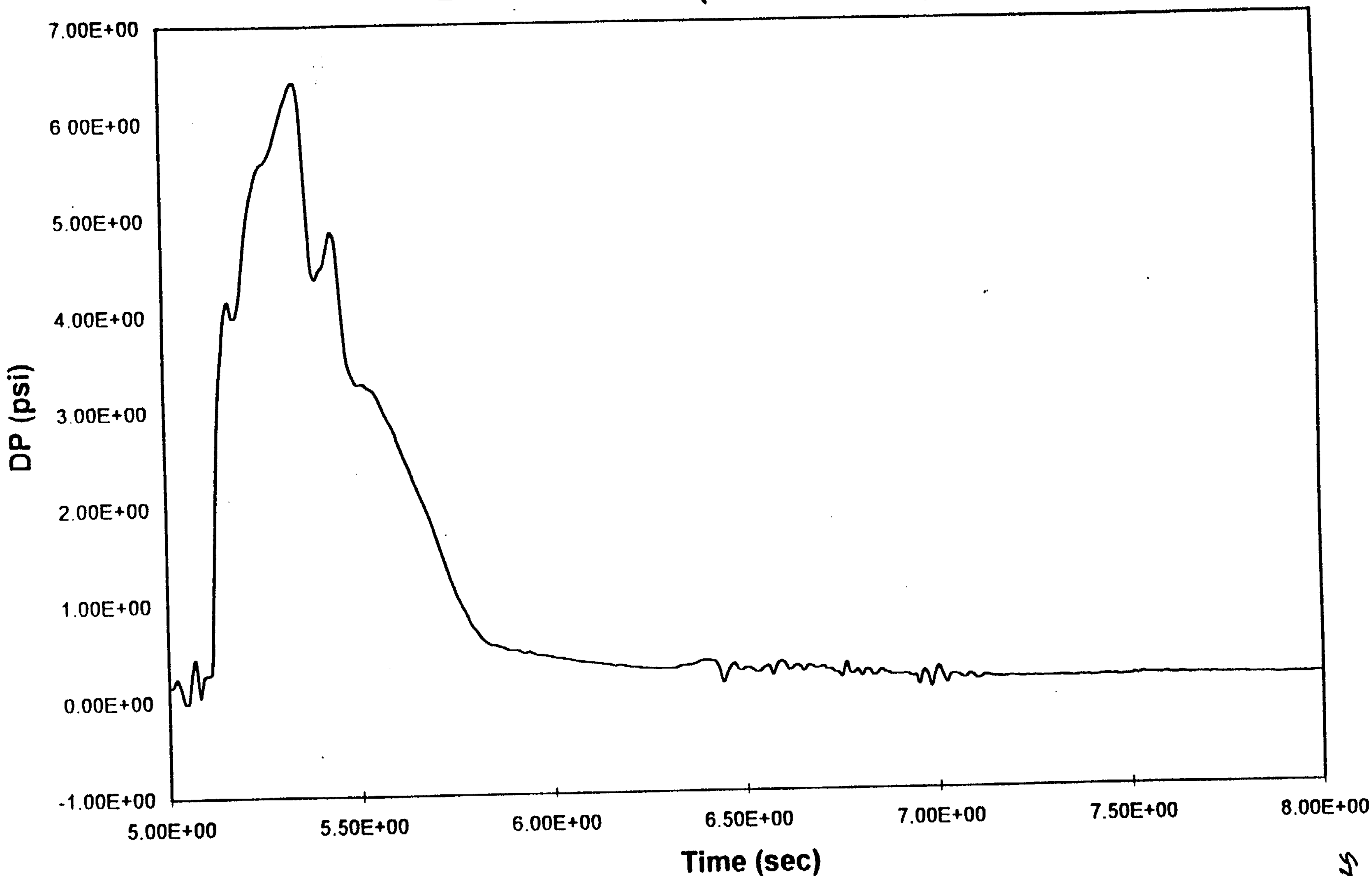

FIGURE 6-12

STA-002 R.0
HML 10/1/96
10/17/96

DP AT TSP 6 (LB CASE 2)

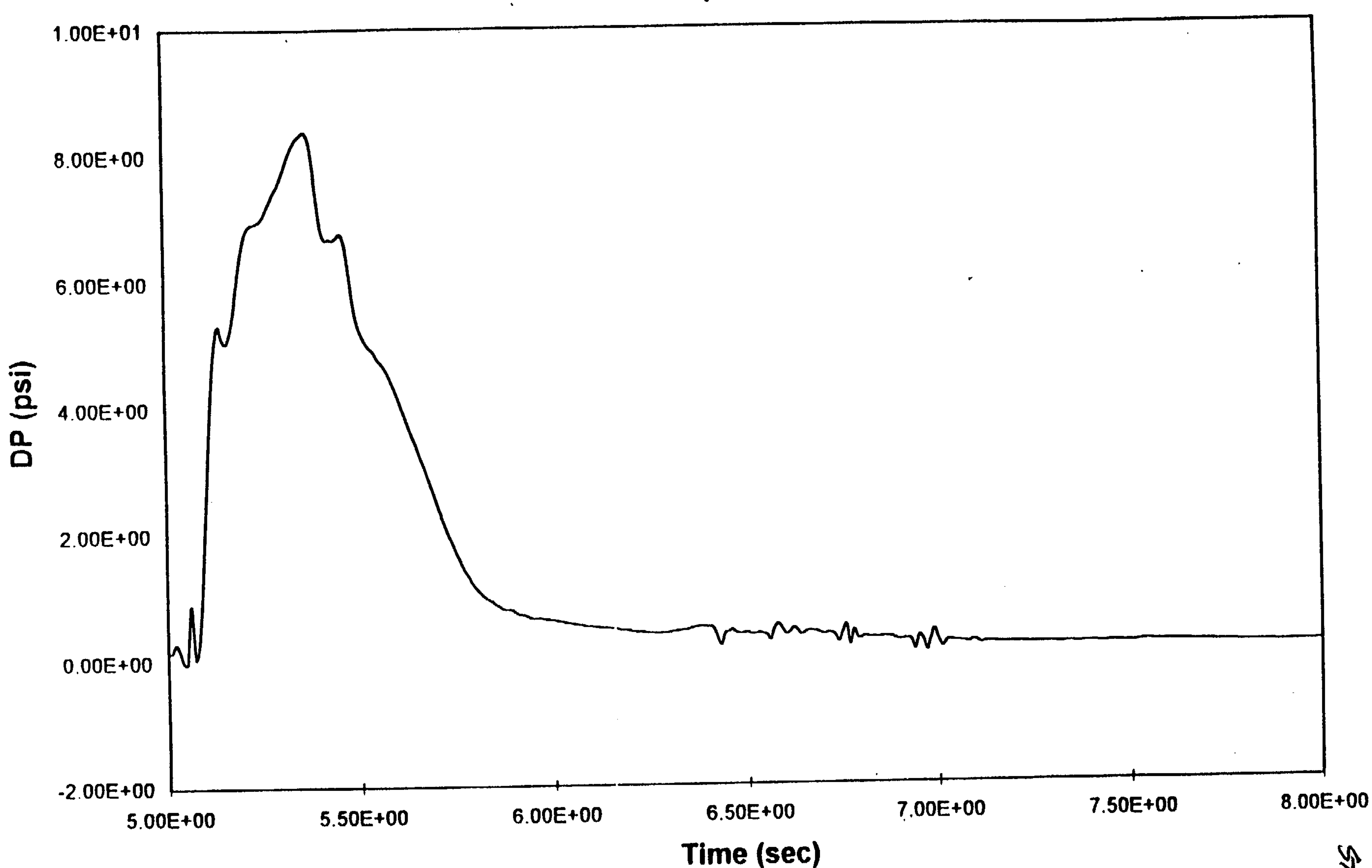

FIGURE 6-13

STA-042 R.0
HMC 10/1/96
101/174

DP AT TSP 7 (LB CASE 2)

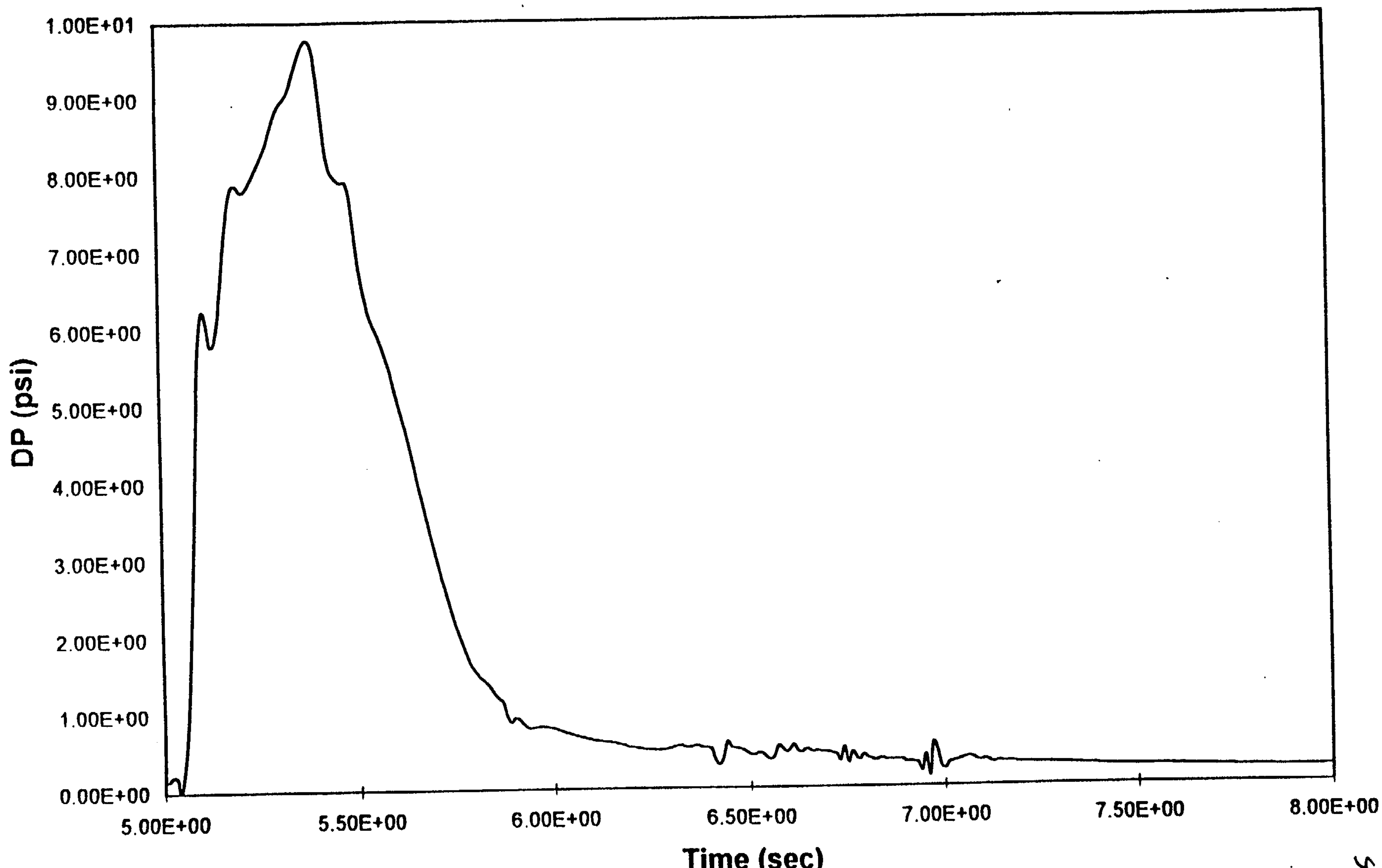

FIGURE 6-14

STA-062
R.0
HM 10/1/98
102/170

psi, 3.534 psi, 4.751 psi, 6.418 psi, 8.376 and 9.769 psi, respectively. The peak pressure across the TSP increases substantially with the increase of the TSP elevation for LB Case 2 which is quite different from the LB Case 1. All the peak pressures are occurred at 0.3 to 0.5 second after the initiation of the break which is also much earlier than those for LB Case 1. In addition, more smooth time histories are noticed for the differential pressures acting on the TSPs for LB Case 2. Similar to LB Case 1, the duration of the high differential pressure across the TSP is very short for the TSP 1 which is located nearest to the bottom of the steam generator. The duration increases when the location of the TSP is further away from the bottom of the steam generator. Except for TSPs 1 and 7, the peak differential pressures at TSPs 2 to 6 for LB Case 2 are substantially lower than those for LB Case 1. However, in general, the duration of the high differential pressure acting on each TSP is longer for LB Case 2 than that for LB Case 1. Therefore, the difference between the integrated forces acting on the TSPs for LB Case 1 and LB Case 2 are not substantial.

As discussed above, the characteristic of the differential pressures across the TSPs for LB Case 2 is substantially different from that for LB Case 1 which is a result of changing the modeling scheme from non-equilibrium to equilibrium for the shell side of the tube region. Since this is a very fast transient, it is difficult to determine which case is more accurate. Therefore, the results of both cases are transmitted to Westinghouse to perform structure analysis for the TSPs.

Large Break Case 3

The time history of the differential pressures across TSPs 1 to 7 after the initiation of the break are plotted on Figures 6-15 to 6-21. The peak differential pressures across the TSPs 1 to 7 are -4.915 psi, 12.93 psi, 12.93 psi, 11.24 psi, 10.98 psi, 11.57 and 12.84 psi, respectively. As shown in Figure 6-15 and 6-17, the peak differential pressure across TSPs 1 and 3 for LB Case 3 are spikes with very short duration which can not be explained physically. Excluding the spikes, the peak differential pressures across the TSPs 1 and 3 are 1.885 psi and 4.106 psi, respectively. All the peak pressures are occurred at 0.4 to 0.6 second after the initiation of the break which is earlier than those for LB Case 1. Similar the LB Case 1, the duration of the high differential pressure across the TSP is very short for the TSP 1 which is located nearest to the bottom of the steam generator. The duration increases when the location of the TSP is further away from the bottom of the steam generator. Therefore, even the difference is very small between the peak differential pressures across the TSPs 4 to 7, the integrated force acting on the TSP increases with the elevation of the TSP.

Comparison between the differential pressures across the TSPs for LB Case

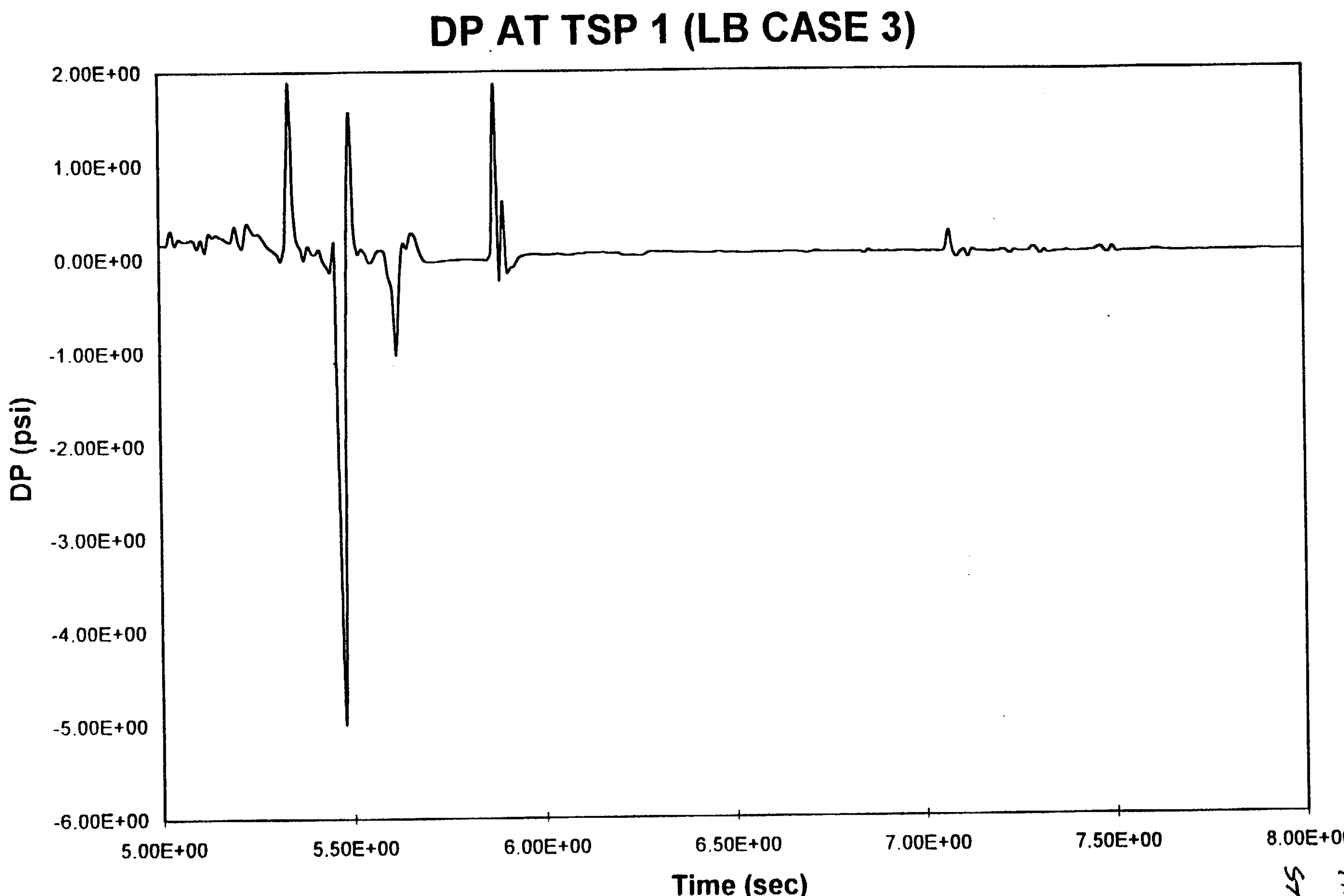

FIGURE 6-15

STA-042 R
HHL 10/1/96
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DP AT TSP 2 (LB CASE 3)

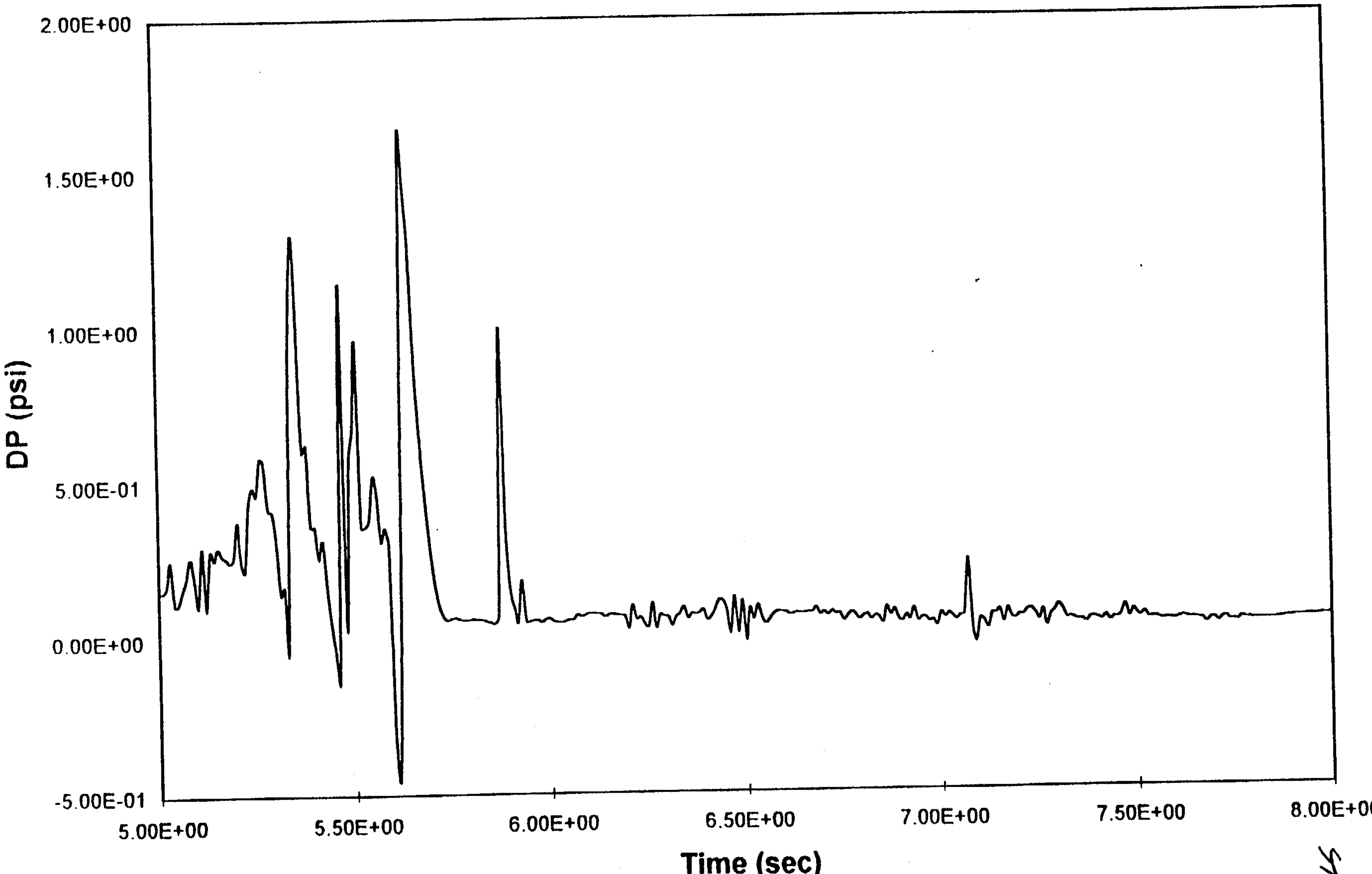

FIGURE 6-16

SAA-042 R.0
HHL 10/1/96
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DP AT TSP 3 (LB CASE 3)

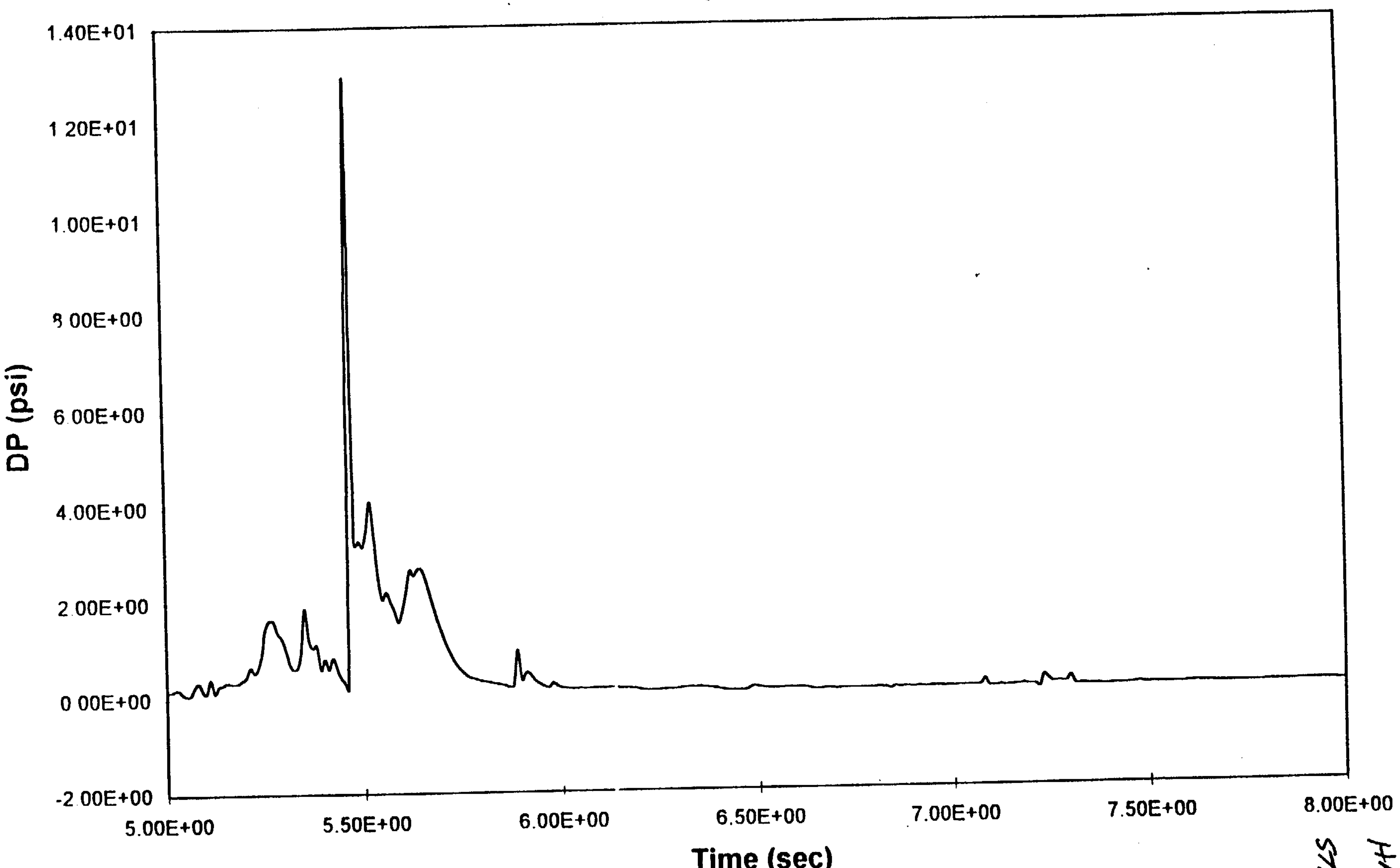

FIGURE 6-17

DP AT TSP 4 (LB CASE 3)

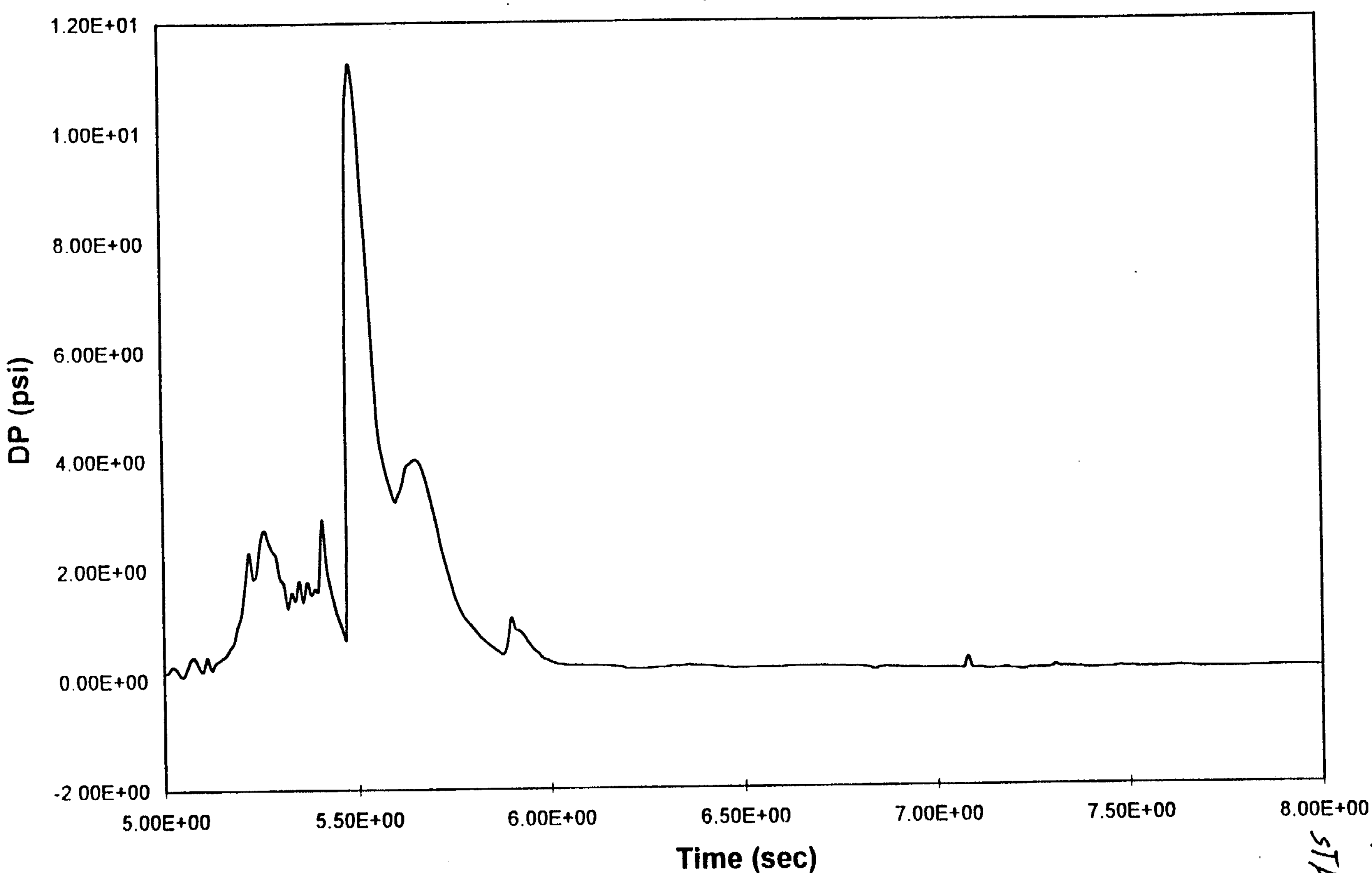

FIGURE 6-18

STA-062 R.0

HML 10/1/96

10/7/96

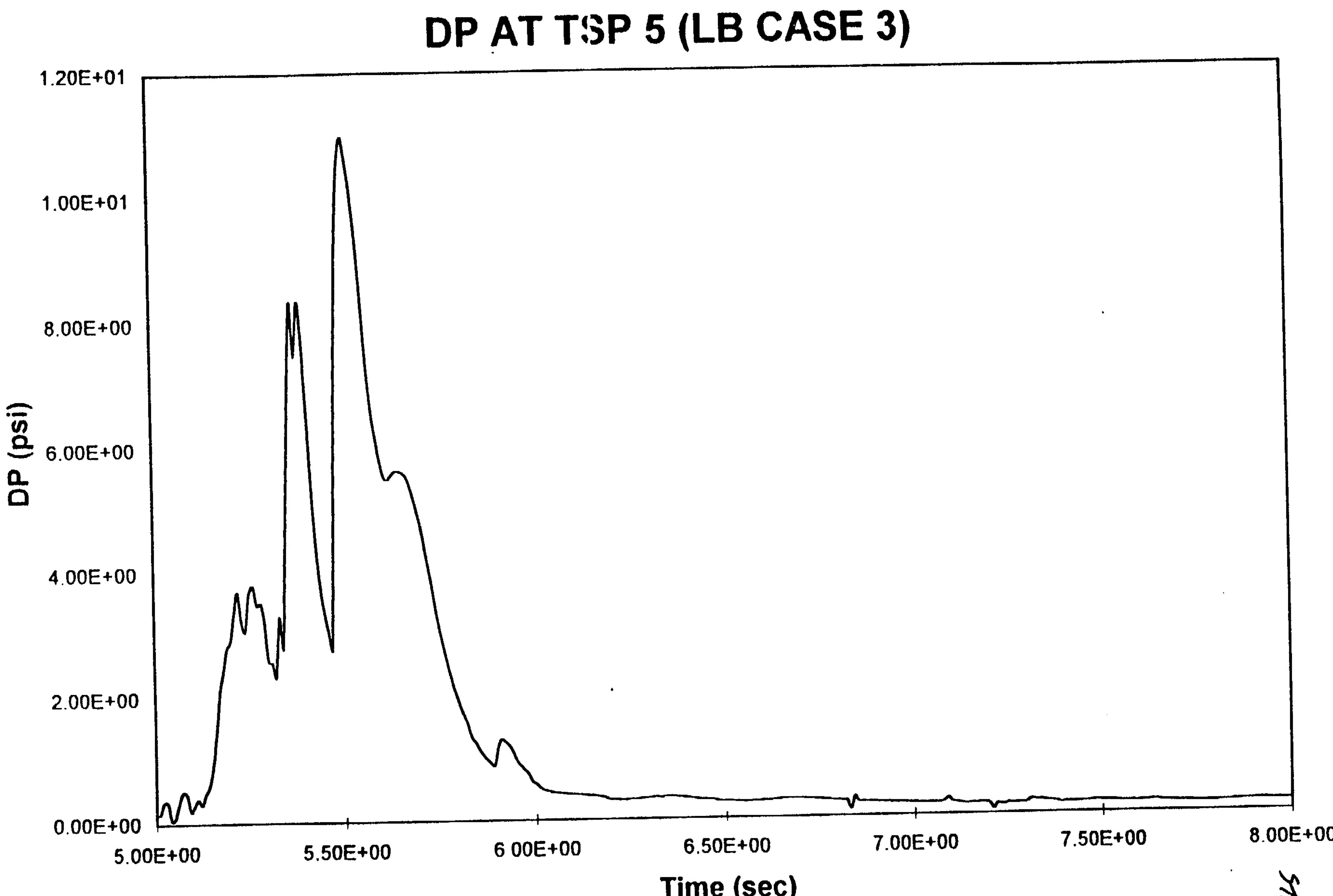

FIGURE 6-19

HHC 10/1/96
STA-042
R0

DP TA TSP 6 (LB CASE 3)

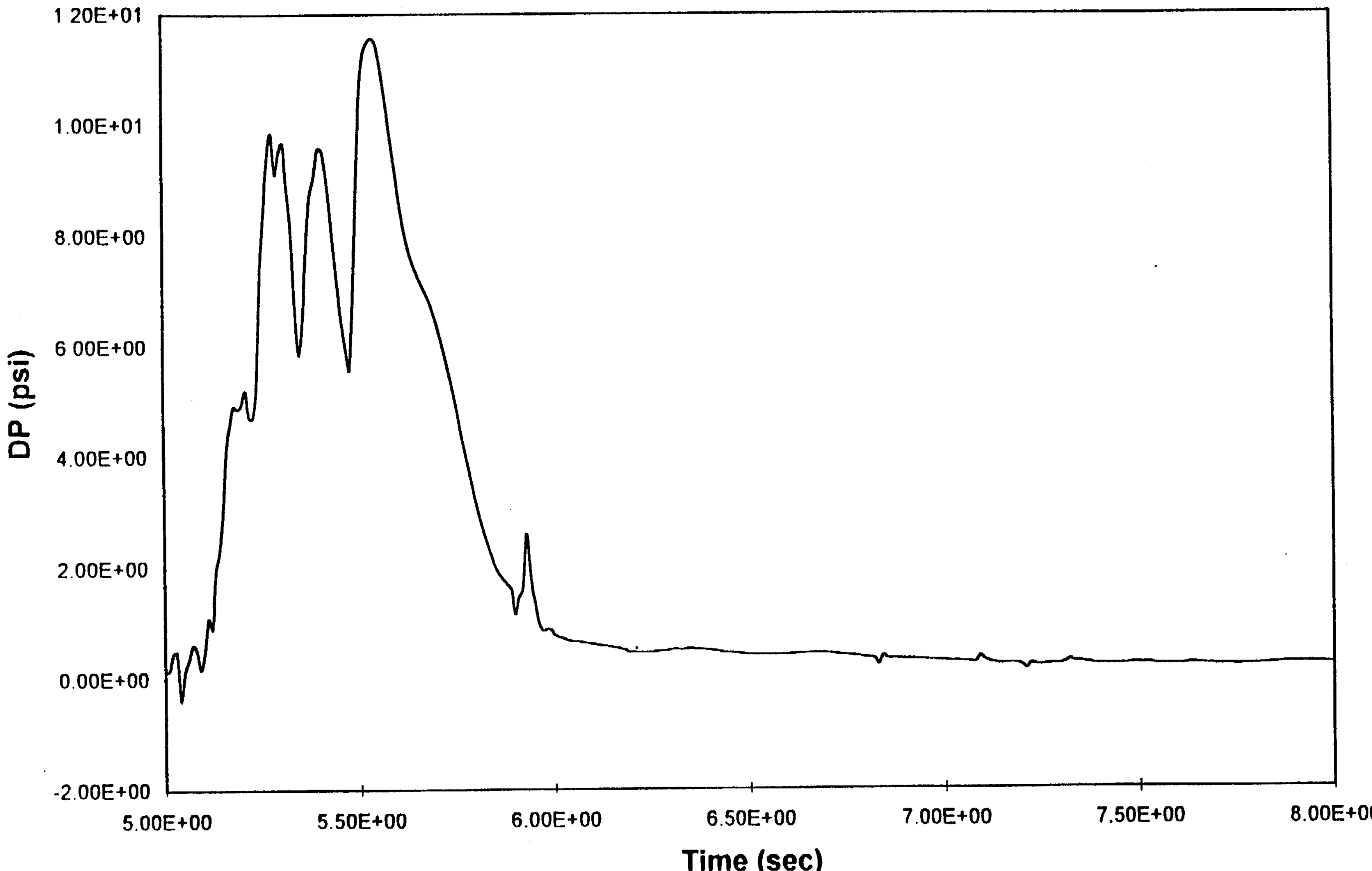

FIGURE 6-20

HMC 10/1/96 STA-042 R.0 11/0/74

DP AT TSP 7 (LB CASE 3)

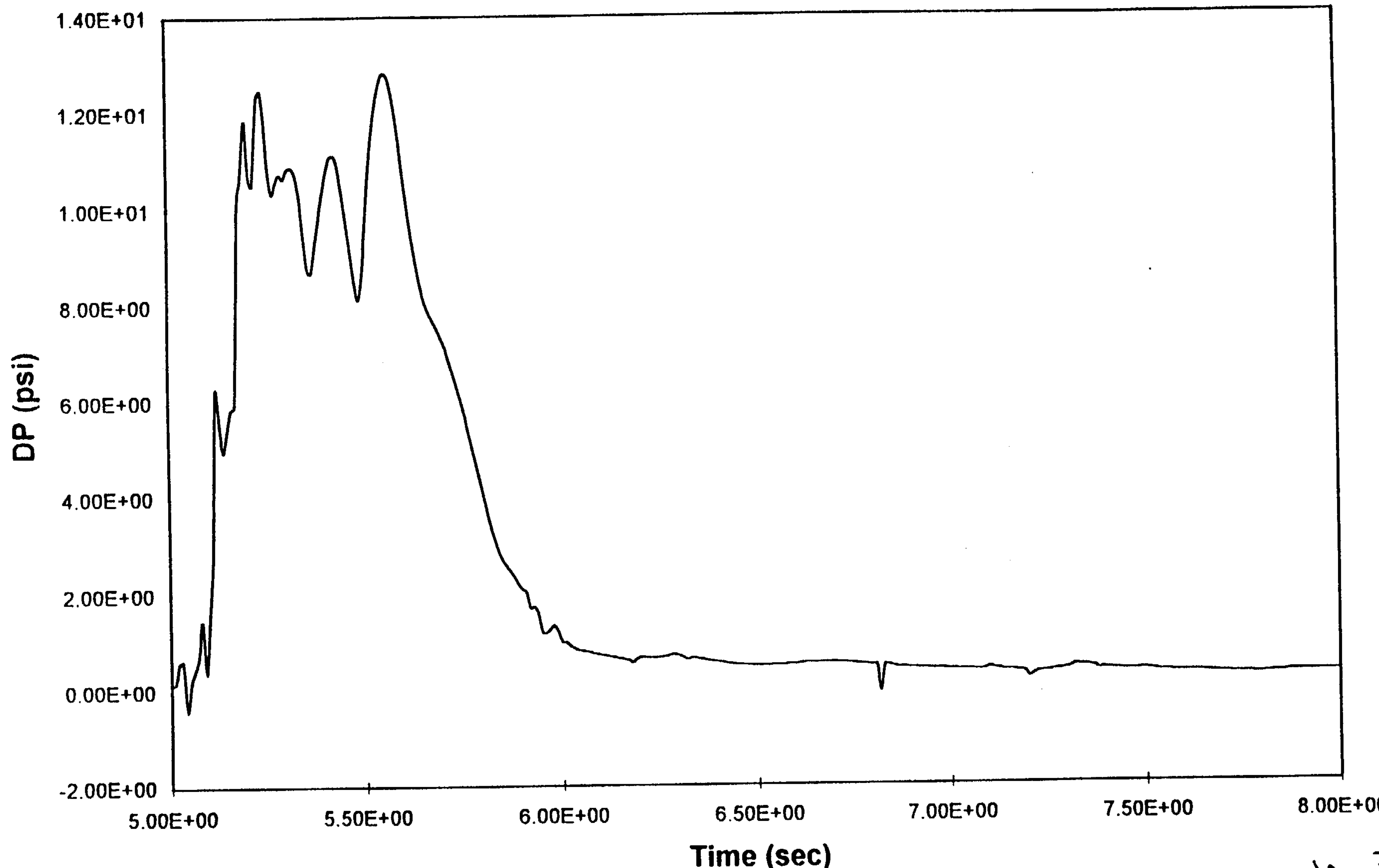

FIGURE 6-21

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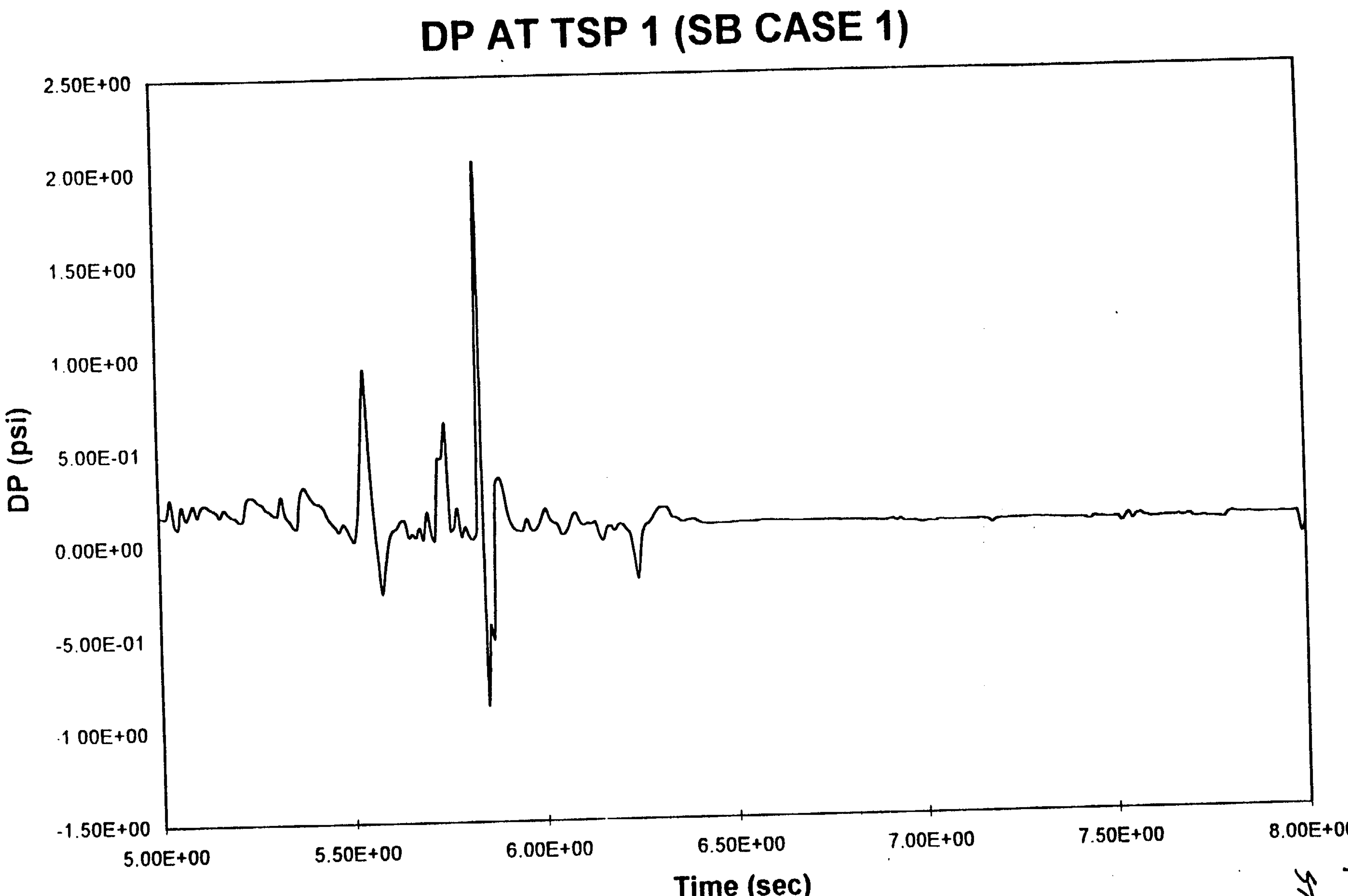
HHL 10/1/96
STA-04
R.0

1 and LB Case 3 indicates that the lower initial water level and higher TSP flow resistance used in LB Case 3 result in similar or lower differential pressures at the TSPs 1 to 3 (excluding the spikes for LB Case 3). However, for the TSPs at higher elevations (TSPs 4 to 7), the lower initial water level and higher TSP flow resistance used in LB Case 3 result in higher differential pressure and a higher differential pressure increase is calculated for a TSP at higher elevation.

Small Break Case 1

The time history of the differential pressures across TSPs 1 to 7 after the initiation of the break are plotted on Figures 6-22 to 6-28. The peak differential pressures across the TSPs 1 to 7 are 2.032 psi, 0.866 psi, 0.982 psi, 8.390 psi, 3.336 psi, 4.059 and 3.031 psi, respectively. As shown in Figure 6-22, 6-25 and 6-27, the peak differential pressure across TSPs 1, 4 and 6 for LB Case 3 are spikes with very short duration which can not be explained physically. Excluding the spikes, the peak differential pressures across the TSPs 1, 4 and 6 are 0.939 psi, 1.29 and 3.4 psi (approximate), respectively. All the peak pressures are occurred at 0.5 to 1.3 seconds after the initiation of the break. Similar to the large break cases, the duration of the high differential pressure across the TSP is very short for the TSP 1 which is located nearest to the bottom of the steam generator. The duration increases when the location of the TSP is further away from the bottom of the steam



DP AT TSP 1 (SB CASE 1)
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
-5.00E-01
-1.00E+00
-1.50E+00
DP (psi)
5.00E+00
5.50E+00
6.00E+00
6.50E+00
7.00E+00
7.50E+00
8.00E+00
Time (sec)

FIGURE 6-22

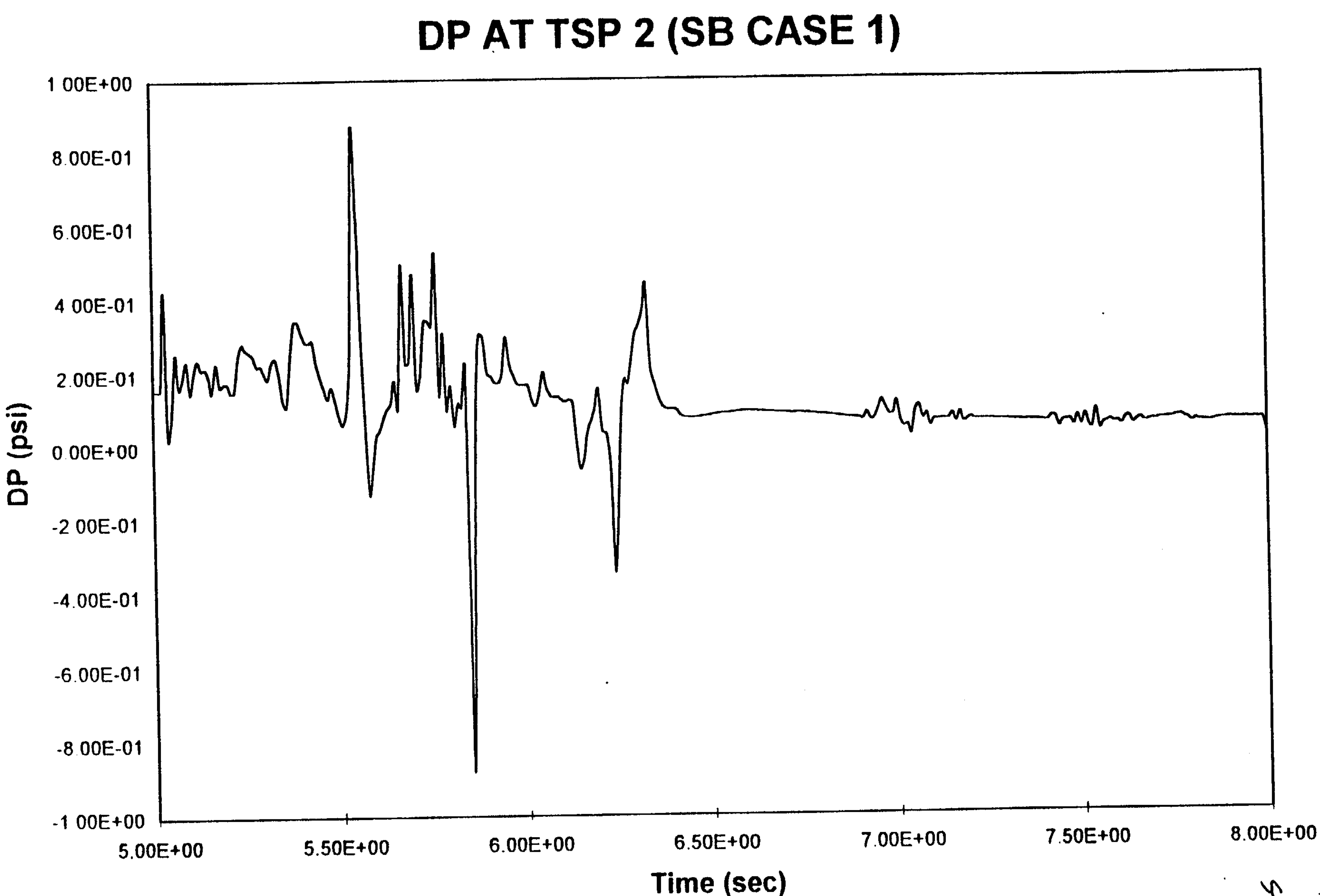


FIGURE 6-23

STA-042 R.0
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DP AT TSP 3 (SB CASE 1)

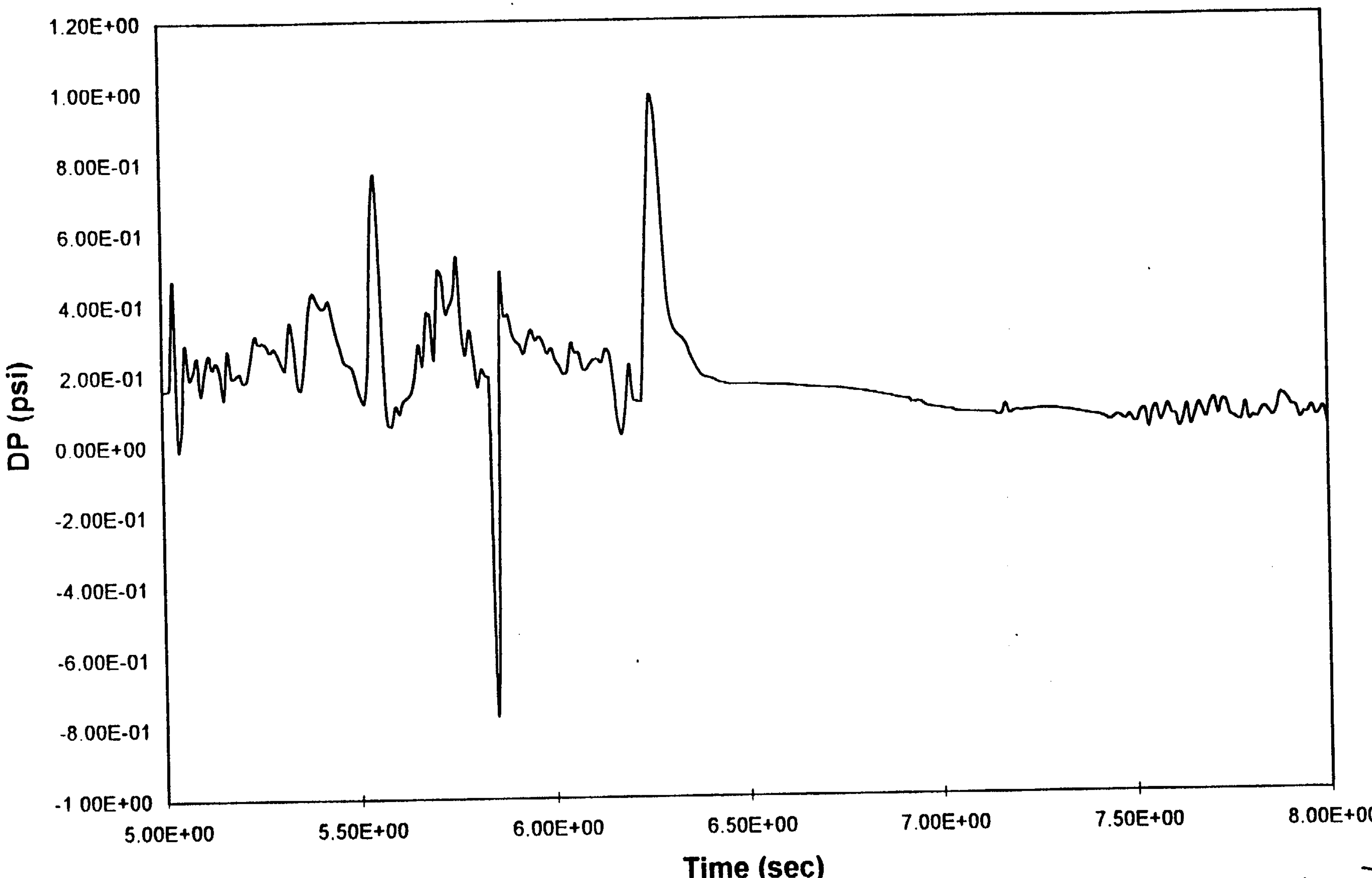

FIGURE 6-24

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STA-04 R.0

DP AT TSP 4 (SB CASE 1)

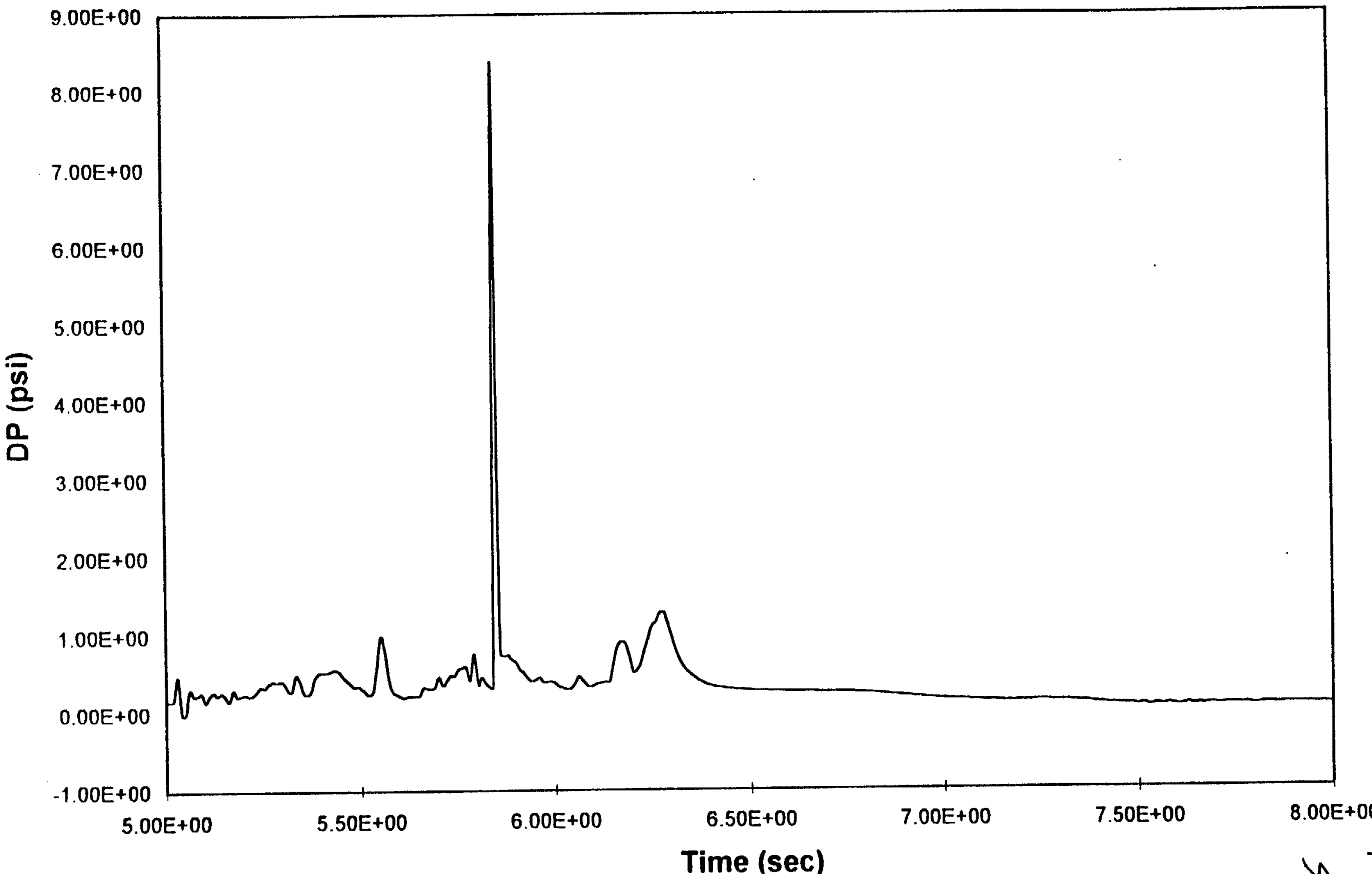

FIGURE 6-25

DP AT TSP 5 (SB CASE 1)

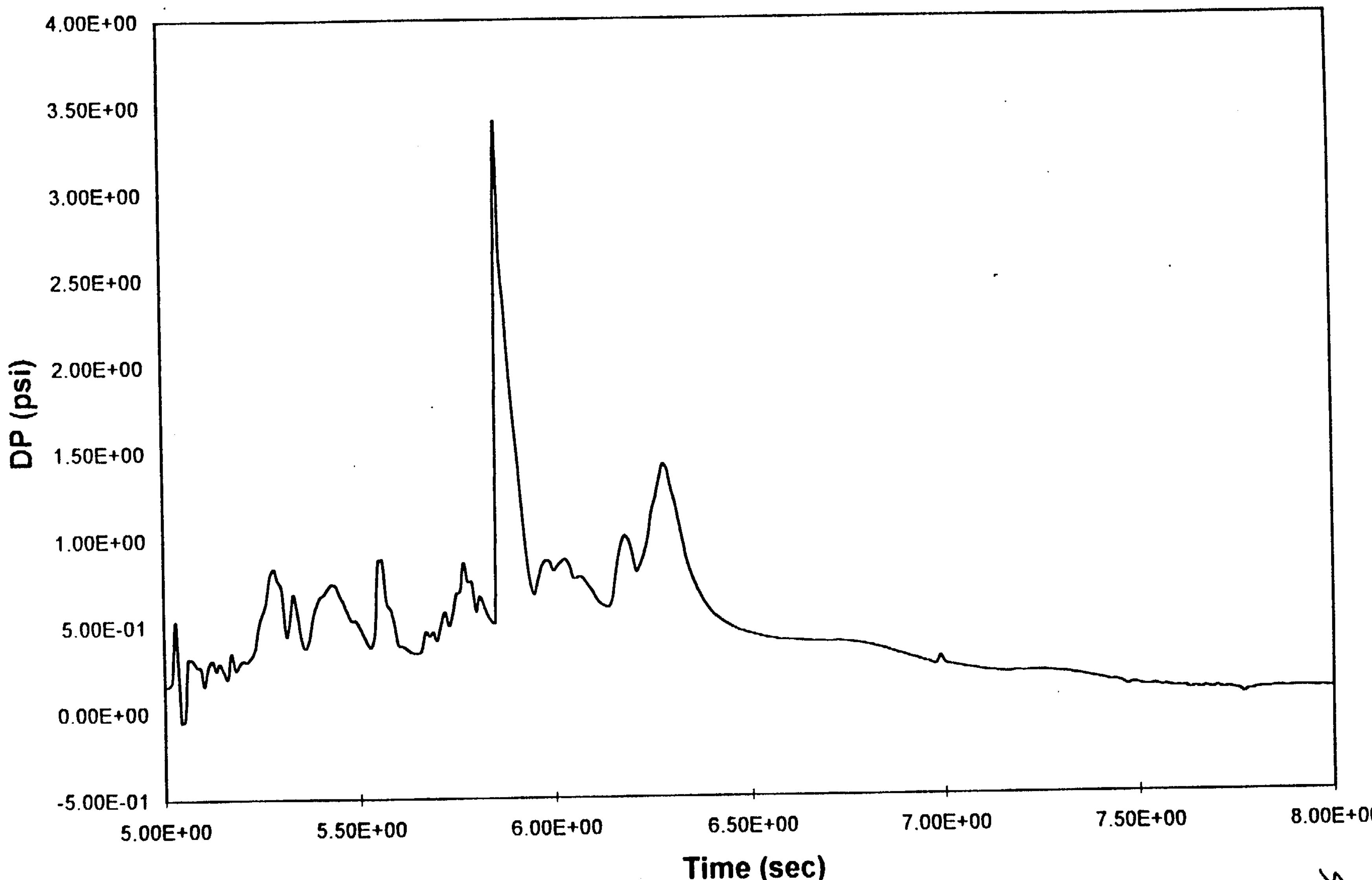

FIGURE 6-26

STA-0 R0
HML 10/1/96
11/7/96

DP AT TSP 6 (SB CASE 1)

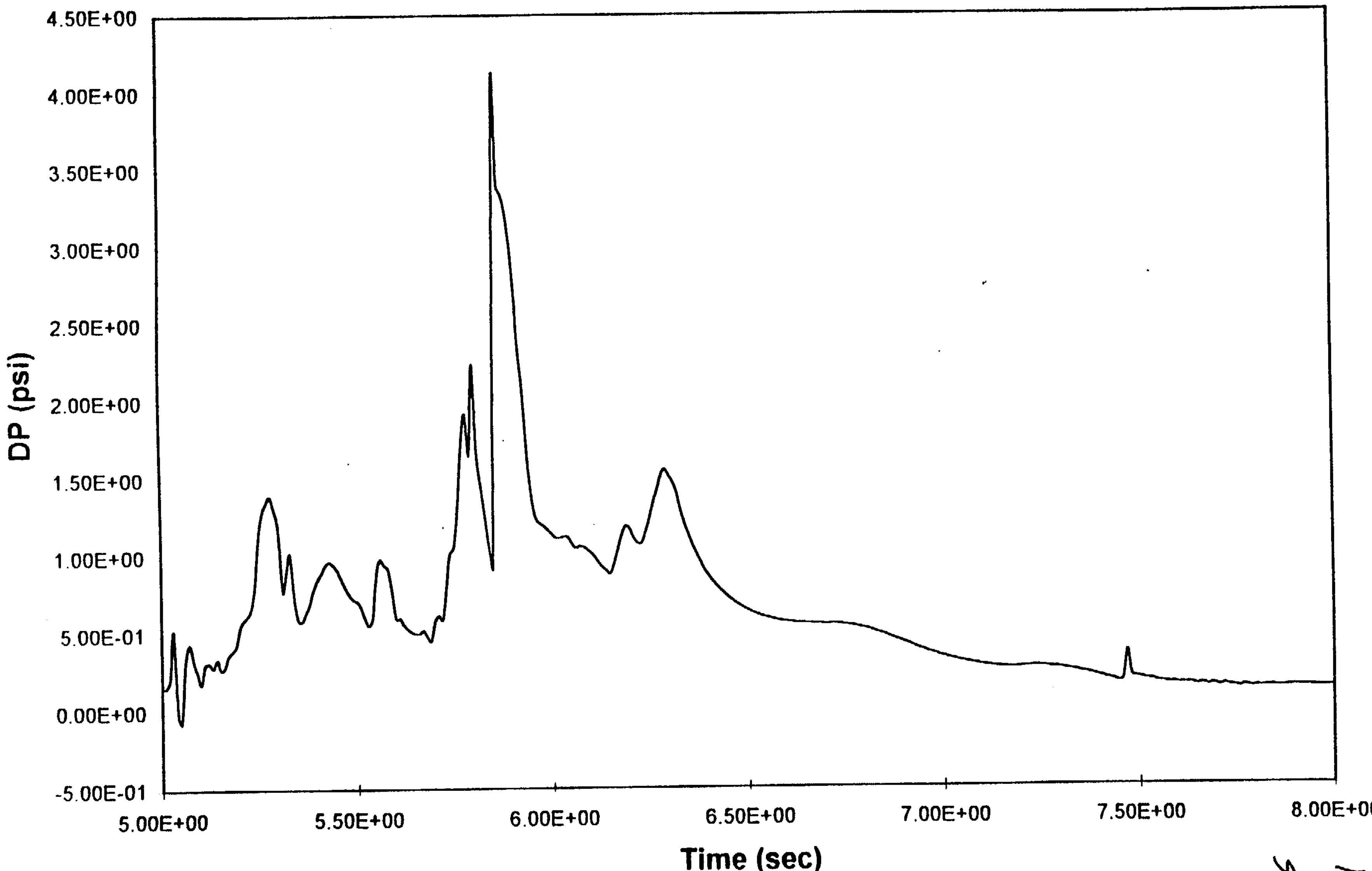

FIGURE 6-27

HAL 10/1/96
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R.0
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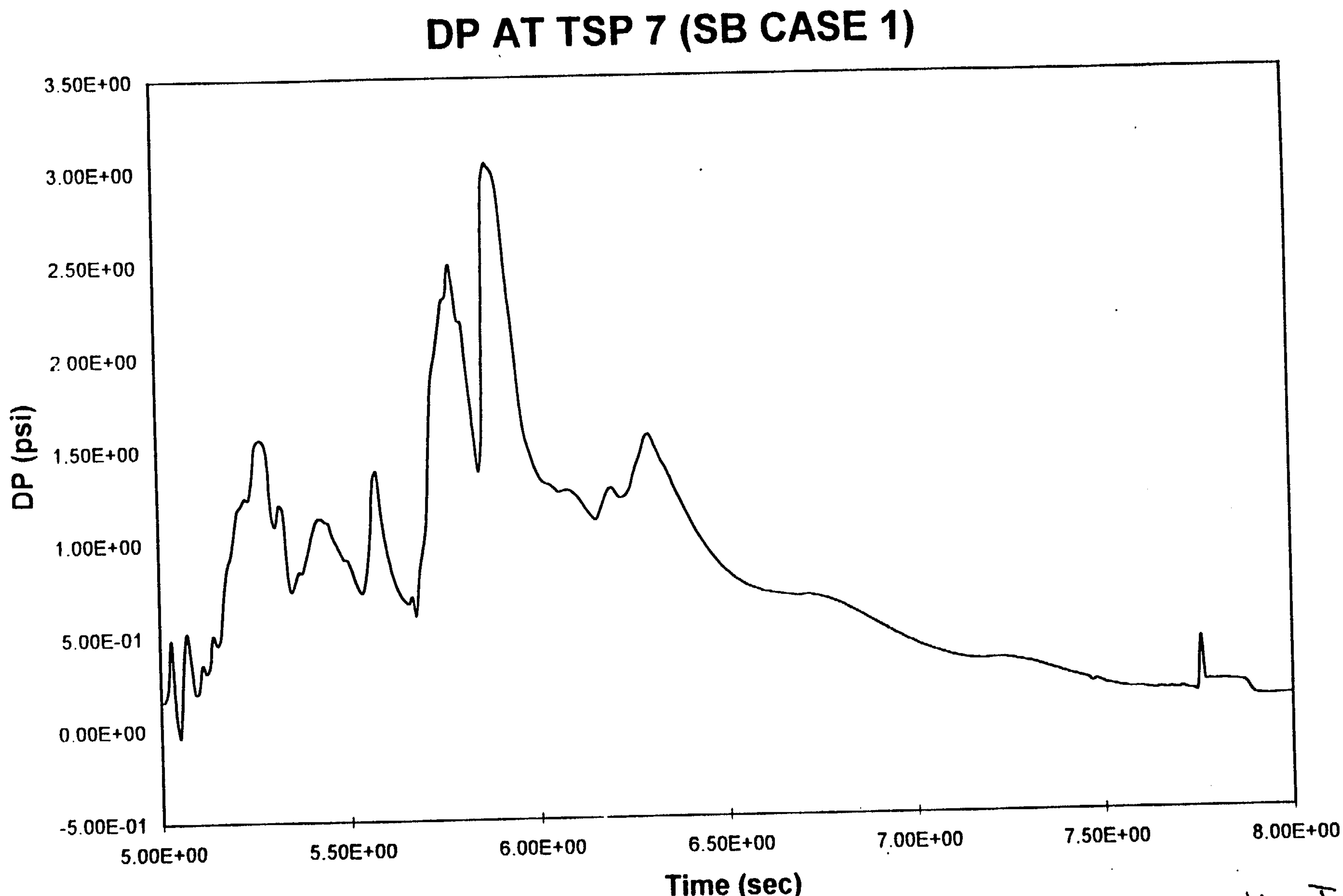

FIGURE 6-28

HML 10/1/92
STA-002
R.0
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generator. Therefore, even the difference is very small between the peak differential pressures across the TSPs 3 to 7, the integrated force acting on the TSP increases with the elevation of the TSP.

Small Break Case 2

The time history of the differential pressures across TSPs 1 to 7 after the initiation of the break are plotted on Figures 6-29 to 6-354. The peak differential pressures across the TSPs 1 to 7 are 1.264 psi, 1.414 psi, 1.386 psi, 1.500 psi, 1.697 psi, 2.278 and 2.405 psi, respectively. Similar to the LB Case 2, the peak pressure across the TSP increases with the increase of the TSP elevation for LB Case 2 which is different from the SB Case 1. All the peak pressures are occurred within 0.5 second after the initiation of the break which is also much earlier than those for SB Case 1. In addition, more smooth time histories are noticed for the differential pressures acting on the TSPs for SB Case 2. Similar to SB Case 1, the duration of the high differential pressure across the TSP is very short for the TSP 1 which is located nearest to the bottom of the steam generator. The duration increases when the location of the TSP is further away from the bottom of the steam generator.

As discussed above, the characteristic of the differential pressures across the TSPs for SB Case 2 is substantially different from that for SB Case 1 which is a result of changing the modeling scheme from non-

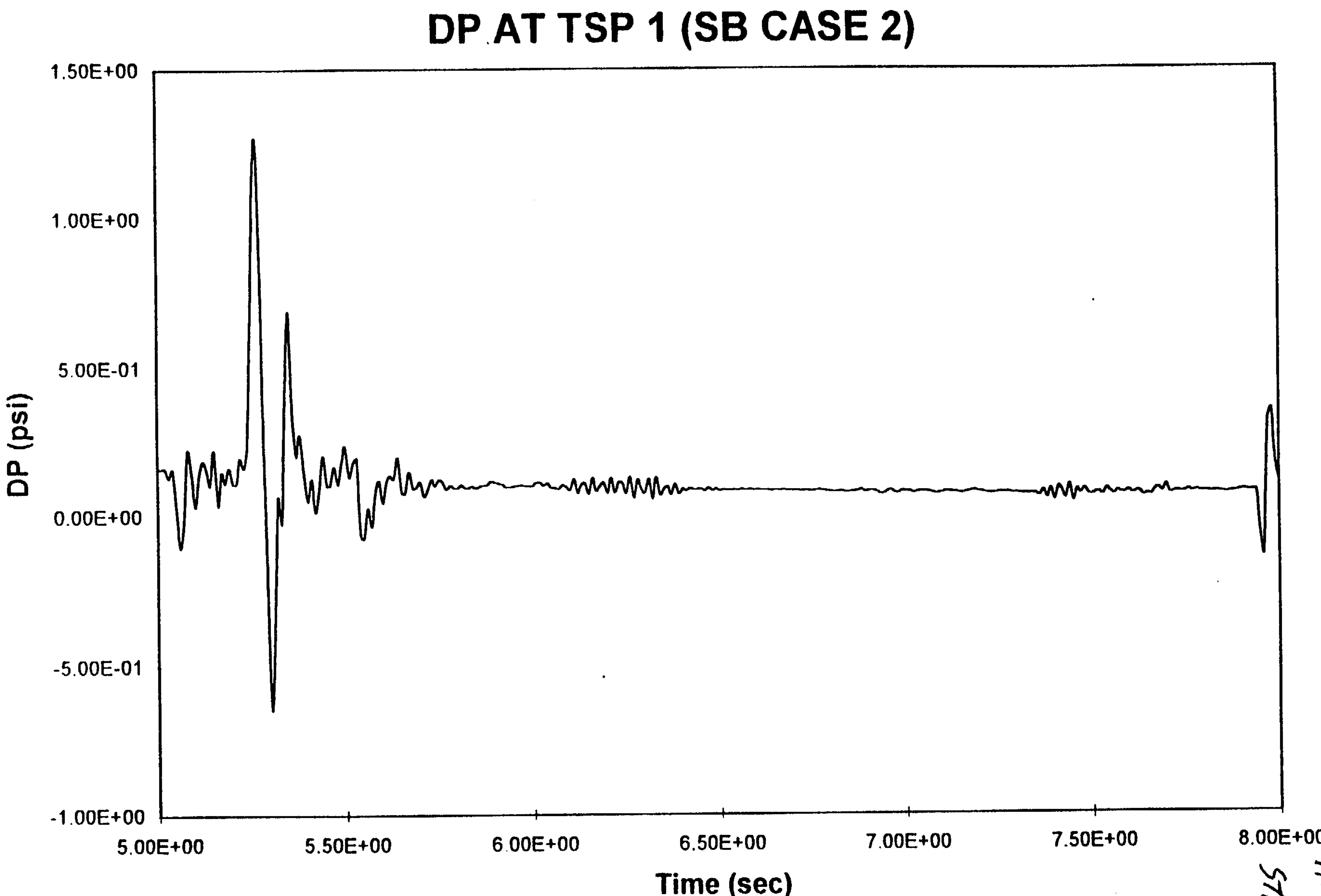
DP AT TSP 1 (SB CASE 2)
1.50E+00
1.00E+00
5.00E-01
0.00E+00
-5.00E-01
-1.00E+00
DP (psi)
5.00E+00
5.50E+00
6.00E+00
6.50E+00
7.00E+00
7.50E+00
8.00E+00
Time (sec)

FIGURE 6-29

DP AT TSP 2 (SB CASE2)

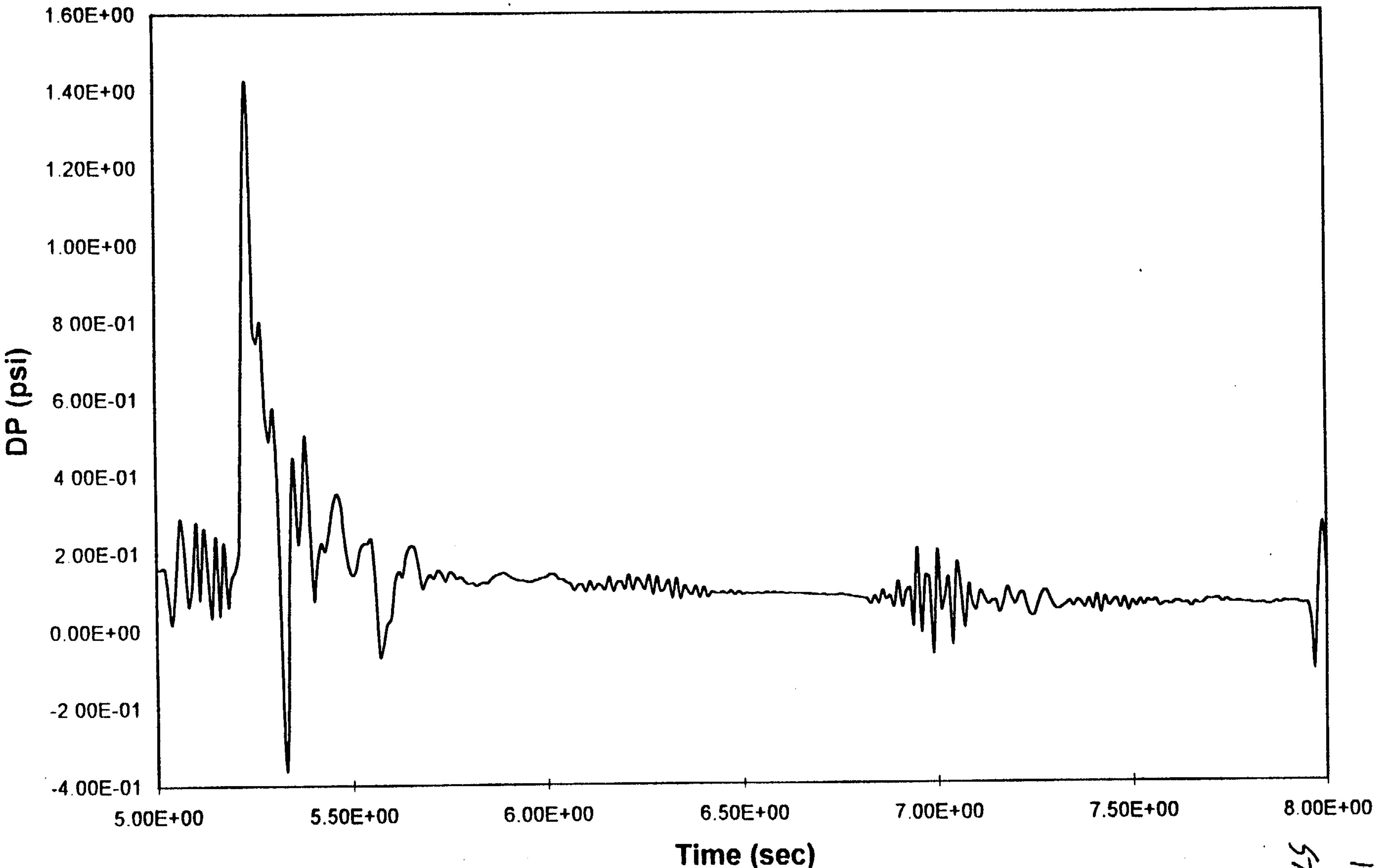

FIGURE 6-30

DP AT TSP 3 (SB CASE 2)

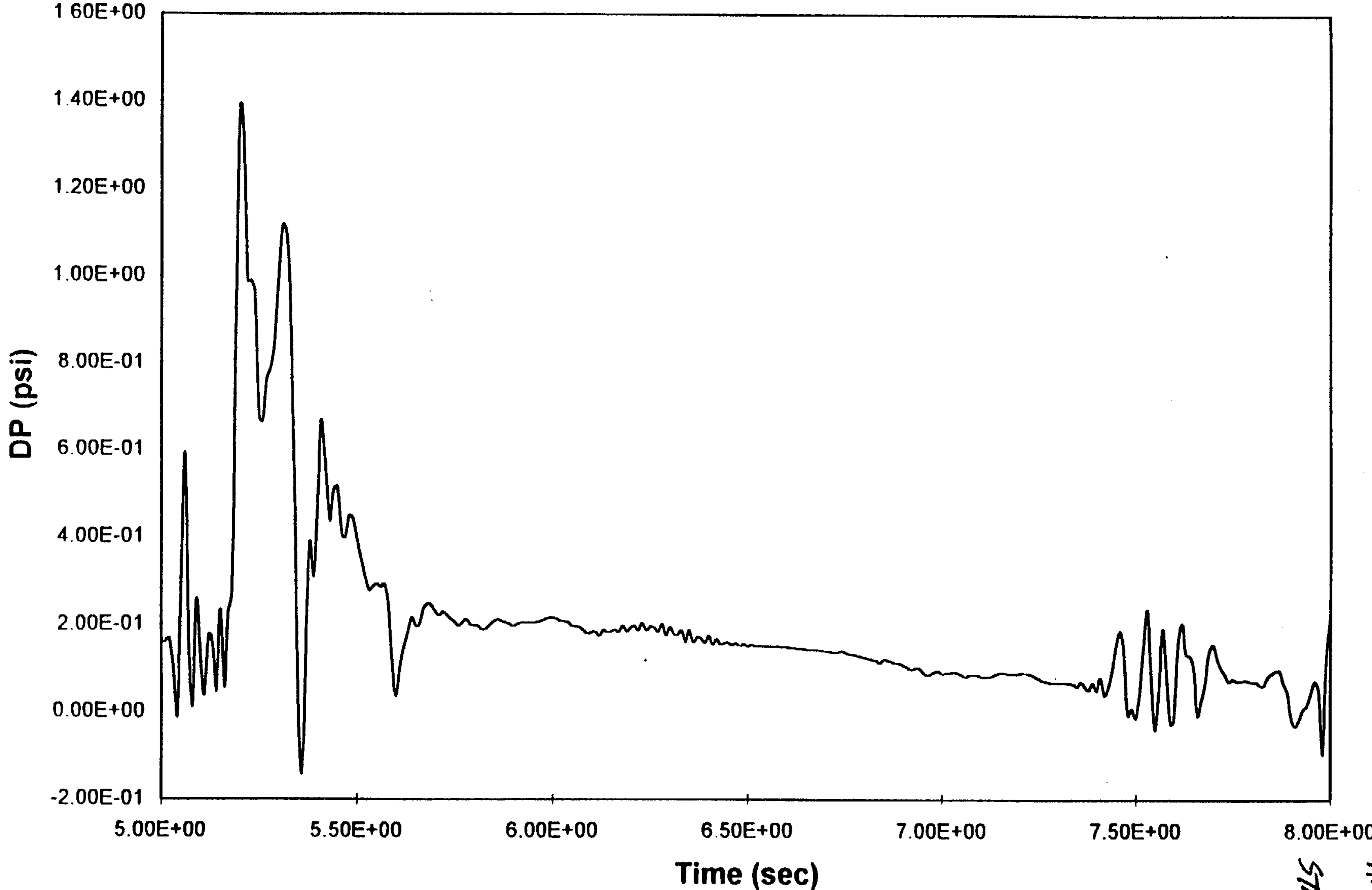

FIGURE 6-31

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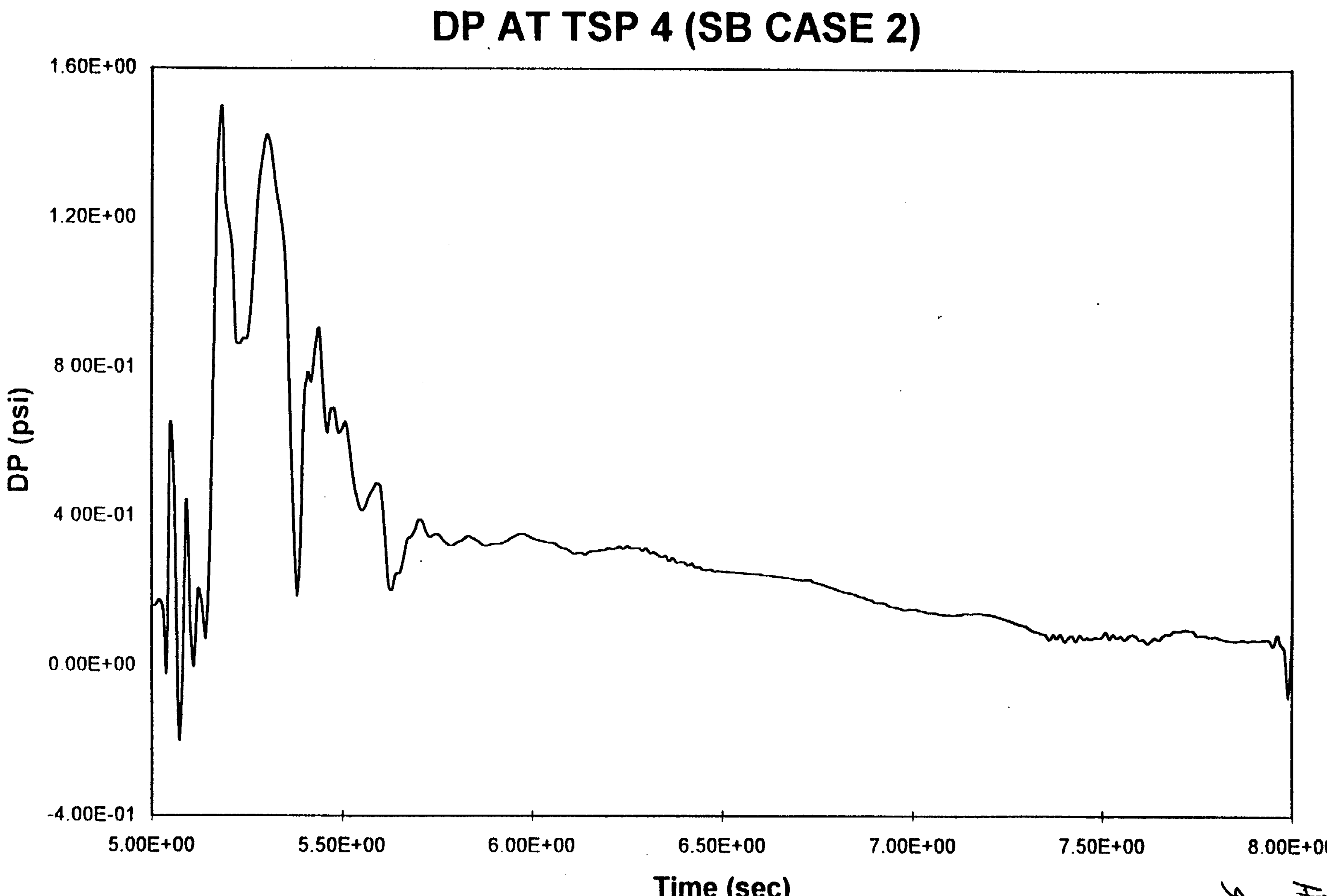
DP AT TSP 4 (SB CASE 2)
1.60E+00
1.20E+00
8 00E-01
4 00E-01
0.00E+00
-4.00E-01
DP (psi)
5.00E+00
5.50E+00
6.00E+00
6.50E+00
7.00E+00
7.50E+00
8.00E+00
Time (sec)

FIGURE 6-32

DP AT TSP 5 (SB CASE 2)

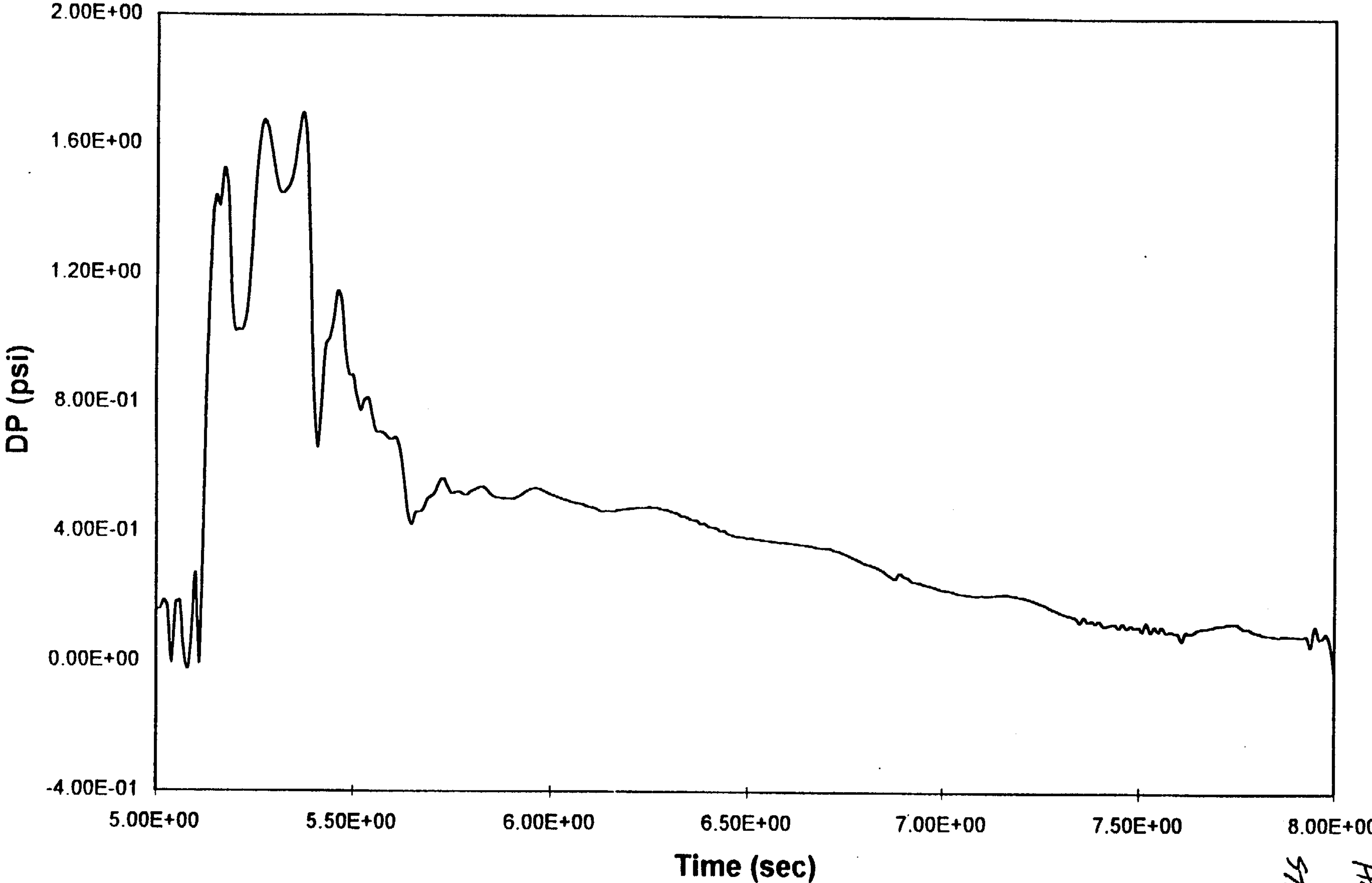

FIGURE 6-33

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DP AT TSP 6 (SB CASE 2)

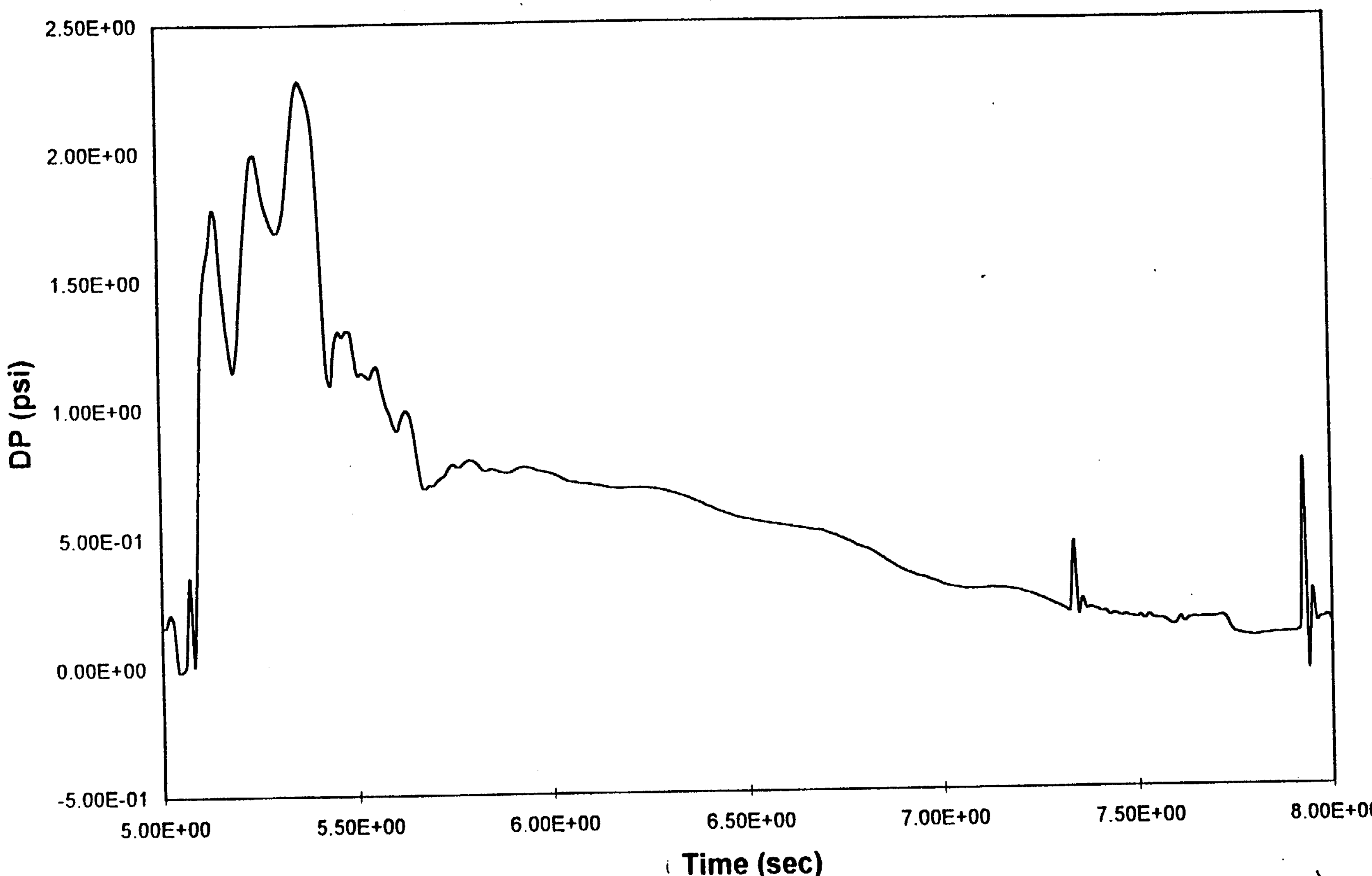

FIGURE 6-34

DP AT TSP 7 (SB CASE2)

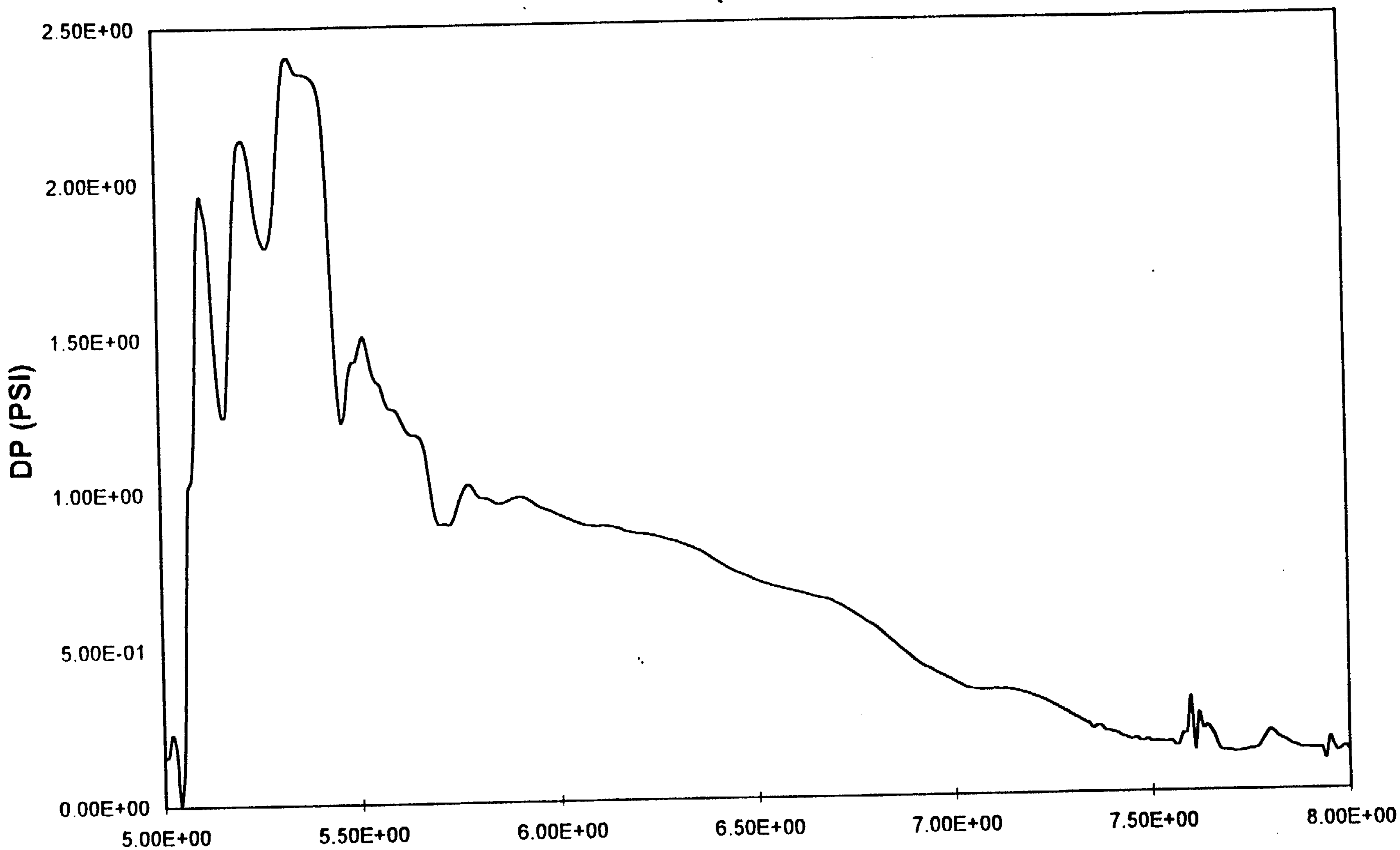

FIGURE 6-35

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equilibrium to equilibrium for the shell side of the tube region. It is difficult to determine which case is more accurate. Therefore, the results of both cases are transmitted to Westinghouse to perform structure analysis for the TSPs. However, since the extremely high differential pressures spikes calculated for some of the TSPs in SB Case 1 can not be explained physically, it may not be needed to consider these high spikes in the structure analysis.

DATA EXTRACTION FOR STP STRUCTURE ANALYSIS

The results of the RELAP5 analysis are transmitted to Westinghouse to perform structure analysis for the TSPs. In addition to the differential pressures across the TSPs, Westinghouse needs the pressure and density at the each TSP for their structure analysis . Therefore, the pressure and density at Volumes immediately above the TSPs are extracted from the RELAP5 output file with the differential pressures across the TSPs. The following input is used to extracting the data out from the RELAP5 output for each TSP.

TSP 1

The following STRIP run input is used to extract the time histories of the pressure, density and differential pressure which will be used in the structure analysis for the TSP 1.

```
=SLB pressure difference across the SG tube support plates
0000100   strip fmtout
```

```
103       0
1001      p        002040000
1002      rho      002040000
1003      cntrlvar    1
.
```

TSP 2

The following STRIP run input is used to extract the time histories of the pressure, density and differential pressure which will be used in the structure analysis for the TSP 2.

```
=SLB pressure difference across the SG tube support plates
0000100   strip fmtout
103       0
1001      p        002080000
1002      rho      002080000
1003      cntrlvar    2
.
```

TSP 3

The following STRIP run input is used to extract the time histories of the pressure, density and differential pressure which will be used in the structure analysis for the TSP 3.

```
=SLB pressure difference across the SG tube support plates
0000100   strip fmtout
```

```
103         0
1001        p       002120000
1002        rho     002120000
1003        cntrlvar    3
.
```

TSP 4

The following STRIP run input is used to extract the time histories of the pressure, density and differential pressure which will be used in the structure analysis for the TSP 4.

```
=SLB pressure difference across the SG tube support plates
0000100     strip fmtout
103         0
1001        p       002160000
1002        rho     002160000
1003        cntrlvar    4
.
```

TSP 5

The following STRIP run input is used to extract the time histories of the pressure, density and differential pressure which will be used in the structure analysis for the TSP 5.

```
=SLB pressure difference across the SG tube support plates
0000100     strip fmtout
```

```
103       0
1001      p        002200000
1002      rho      002200000
1003      cntrlvar    5
.
```

TSP 6

The following STRIP run input is used to extract the time histories of the pressure, density and differential pressure which will be used in the structure analysis for the TSP 6.

```
=SLB pressure difference across the SG tube support plates
0000100   strip fmtout
103       0
1001      p        002240000
1002      rho      002240000
1003      cntrlvar    6
.
```

TSP 7

The following STRIP run input is used to extract the time histories of the pressure, density and differential pressure which will be used in the structure analysis for the TSP 7.

```
=SLB pressure difference across the SG tube support plates
0000100   strip fmtout
```

```
103      0
1001     p        002280000
1002     rho      002280000
1003     cntrlvar   7
.
```

Since the pressure and density data extracted from the RELAP5 output file are in the unit of pa and kg/m^3. Microsoft Excel program is used to convert pa to psi by multiplying a factor of $1.45038e^{-4}$ to the pressure data and convert kg/m^3 to lb/ft^3 by dividing a factor of 16.0185 to the density data. The names for the Excel files transmitted to Westinghouse are SLBLBC1.XLS, SLBLBC2.XLS and SLBLBC3.XLS for LB Cases 1, 2 and 3 and SLBSBC1.XLS and SLBSBC2.XLS for SB Cases 1 and 2. All these files are stored in two flappy disks which is attached as Attachment 1.

7. References

1. Westinghouse Calculation TH-95-001,'Model 51 Steam Generator TRANFLO Model Development', Dated 9/30/96.

2. Westinghouse Letter NCE-85-529, from NCD engineering to M. Oshinsky, " GENF Input for Models 44, 44F, 51, 51F and F Steam Generators", September 5, 1985. This letter is also attached to this calculation file as Appendix E.

3. ASME Steam Table.

4. RELAP5/Mod3 Code User's Manual.

5. WCAP-11206, Loss of Feed Flow, Steam Generator Tube Rupture and Steam Line Break Thermohydraulic Experiments.

6. Nuclear Heat Transport, Published by ANS.

7. Westinghouse Drawing 350794-B, "Steam Generator Nozzle to Elliptical Head". This Drawing is also attached to this calculation file as Appendix F.

Appendix A

Loss Coefficient of Tube Bundle Crossflow

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STA-062 R.

NSD-JLH-6070

From: Steam Generator Design & Analysis
WIN: 224-5992
Date: March 7, 1996
Subject: Loss Coefficient of Tube Bundle Crossflow for RELAP Modeling

To: M. J. Miller

cc: T. A. Pitterle
G. P. Lilly
W. J. Scherder

This is to respond to an action item generated during the March 6, 1996, reviewing meeting between Hsiung Lee and Westinghouse concerning the computer modeling of TRANFLO and RELAP for Model 51 steam generators. Please forward this to Hsiung Lee for his information and use.

The TRANFLO model for steam line break event considers a crossflow resistance across the tubesheet. The RELAP code may not have a built-in correlation for this crossflow resistance. It was agreed that Westinghouse should provide an equivalent corssflow loss coefficient for the use in the RELAP simulation.

The built-in correlation for the crossflow resistance in the TRANFLO code is as follows:

$$K = 1.92\,\mathrm{Re}_v^{-0.145}\left(\frac{P}{De}\right)^{0.6} N_L$$

where

Re_v = Reynolds number
P = tube pitch
De = hydraulic diameter
N_L = number of tube rows in crossflow

The Reynolds number is defined as below:

$$\mathrm{Re}_v = \frac{\rho V_{max} De}{\mu}$$

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where

ρ = fluid density
V_{max} = velocity through the tube gap
μ = dynamic viscosity

The hydraulic diameter is defined as below:

$$De = 4(\pi/4)\left[D_{iw}^2 - 2N_{UT}D_o^2\right]/\left[\pi\left(D_{iw} + 2N_{UT}D_o\right)\right]$$

where

D_{iw} = inside diameter of wrapper
N_{UT} = number of U-tubes
D_o = outside diameter of U-tube

Now, for Model 51 steam generators, Diw = 123.50", NUT = 3388, Do = 0.875", P = 1.2812". The TRANFLO model considers NL = 24 for effective crossflow at the tubesheet. Therefore, it follows that De = 1.6628". Finally, we obtain the following

$$K = 39.4\,Re_v^{-0.145}$$

At a Reynolds number of 1.0 x 10^6, K = 5.32, and at a Reynolds number of 2.0 x 10^6, K = 4.81. Note that V_{max} for Reynolds number is based on a flow area of 4.43 ft^2 for the crossflow. Consider that V_{max} = 10 ft/sec of saturated water at 1000 psia, it follows that Re = 46.32 x 10 x 1.6628/(12 x 0.00006293) = 1.02 x 10^6.

Considering the above discussion, we recommend, as an approximation, to use K =5.32 in the RELAP calculation.

Approved:

M. H. Hu
SG Design and Analysis

J. L. Houtman, Manager
SG Design and Analysis

Appendix B

Sensitivity Study for Initial Steam Generator Water Level

As discussed in Section 5, void fraction used in the TRANFLO model is input into RELAP5 model as quality. A sensitivity study is performed in this Appendix to show that the RELAP5 model is conservative. The LB Case 2 is reanalyzed in LB Case 4 with changing the void fractions used for Volumes 23-01, 32-01, 33-01, 53-01 and 36-01 to water qualities. The equation 12-3a of Reference 6 gives the relation between void fraction and water quality as follows.

F = (X * Vg)/(Vf +X * Vfg)

where F = void fraction

X = water quality

Vf = specific volume for water

Vg = specific volume for steam

Vfg = Vg - Vf

The above equation can be rewritten as:

F * Vf + X * F * (Vg - Vf) = X * Vg

X * (Vg - F * Vg + F * Vf) = F * Vf

X = (F * Vf)/((1-F) * Vg + F * Vf)

For Volume 23-01, the pressure is 1022.72 psia. The specific volumes for saturated water and steam at 1022.72 psia are 0.02167 ft^3/lbm and 0.43491 ft^3/lbm. Then, the water quality for void fraction 0.03 is 0.00154.

For Volume 32-01, the pressure is 1021.26 psia. The specific volumes for saturated water and steam at 1021.26 psia are 0.02167 ft^3/lbm and 0.43560

ft^3/lbm. Then, the water quality for void fraction 0.92 is 0.364.

For Volumes 33-01 and 53-01, the pressure is 1021.72 psia. The specific volumes for saturated water and steam at 1021.72 psia are 0.02167 ft^3/lbm and 0.43539 ft^3/lbm. Then, the water quality for void fraction 0.73 is 0.119.

For Volume 36-01, the pressure is 1021.57 psia. The specific volumes for saturated water and steam at 1021.57 psia are 0.02167 ft^3/lbm and 0.43546 ft^3/lbm. Then, the water quality for void fraction 0.83 is 0.195.

The following input change are used in the reanalysis.

0230200	2	1022.72	0.00154
0320200	2	1021.26	0.364
0330200	2	1021.72	0.119
0530200	2	1021.72	0.119
0360200	2	1021.57	0.195

The remain input is the same as those used for LB Case 2. The input file name is reidp6 and the output file name is reodp6.

The results of the LB Case 4 are microfiched and attached in the Appendix G. The time history of the differential pressures across TSPs 1 to 7 after the initiation of the break are plotted on Figures B-1 to B-7. The peak differential pressures across the TSPs 1 to 7 are 1.814 psi, 2.116 psi, 2.559

psi, 3.987 psi, 5.733 psi, 7.814 and 9.130 psi, respectively. The time history curves for the differential pressure across the TSPs for LB Case 4 are very similar to those for LB Case 2. The magnitude of the differential pressure across the TSPs for LB Case 4 are smaller then those for LB Case 2. Therefore, it can be conclude that the RELAP5 model used in this calculation is conservative.

DP AT TSP 1 (LB CASE 4)

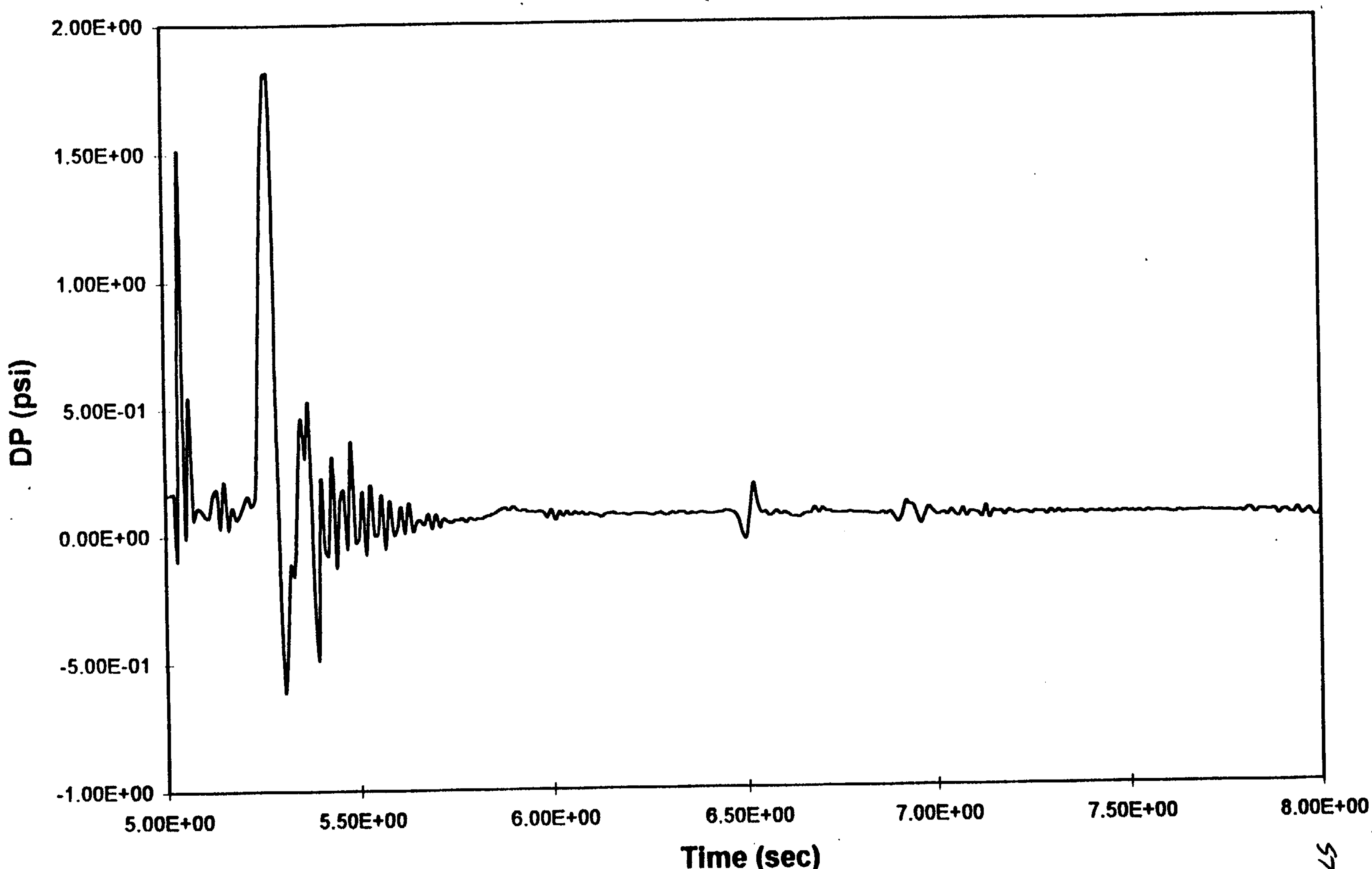

FIGURE B-1

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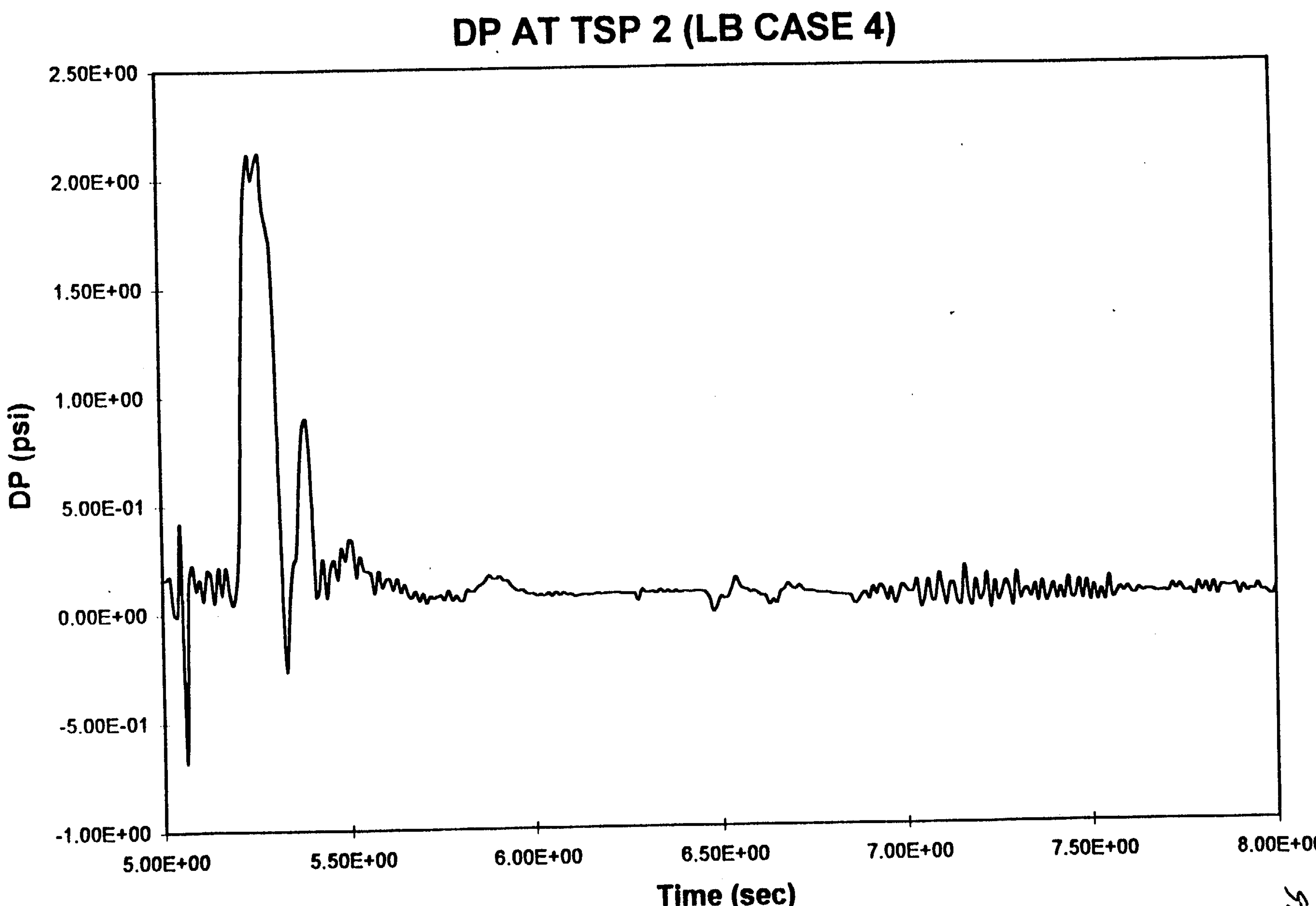

FIGURE B-2

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DP AT TSP 3 (LB CASE 4)

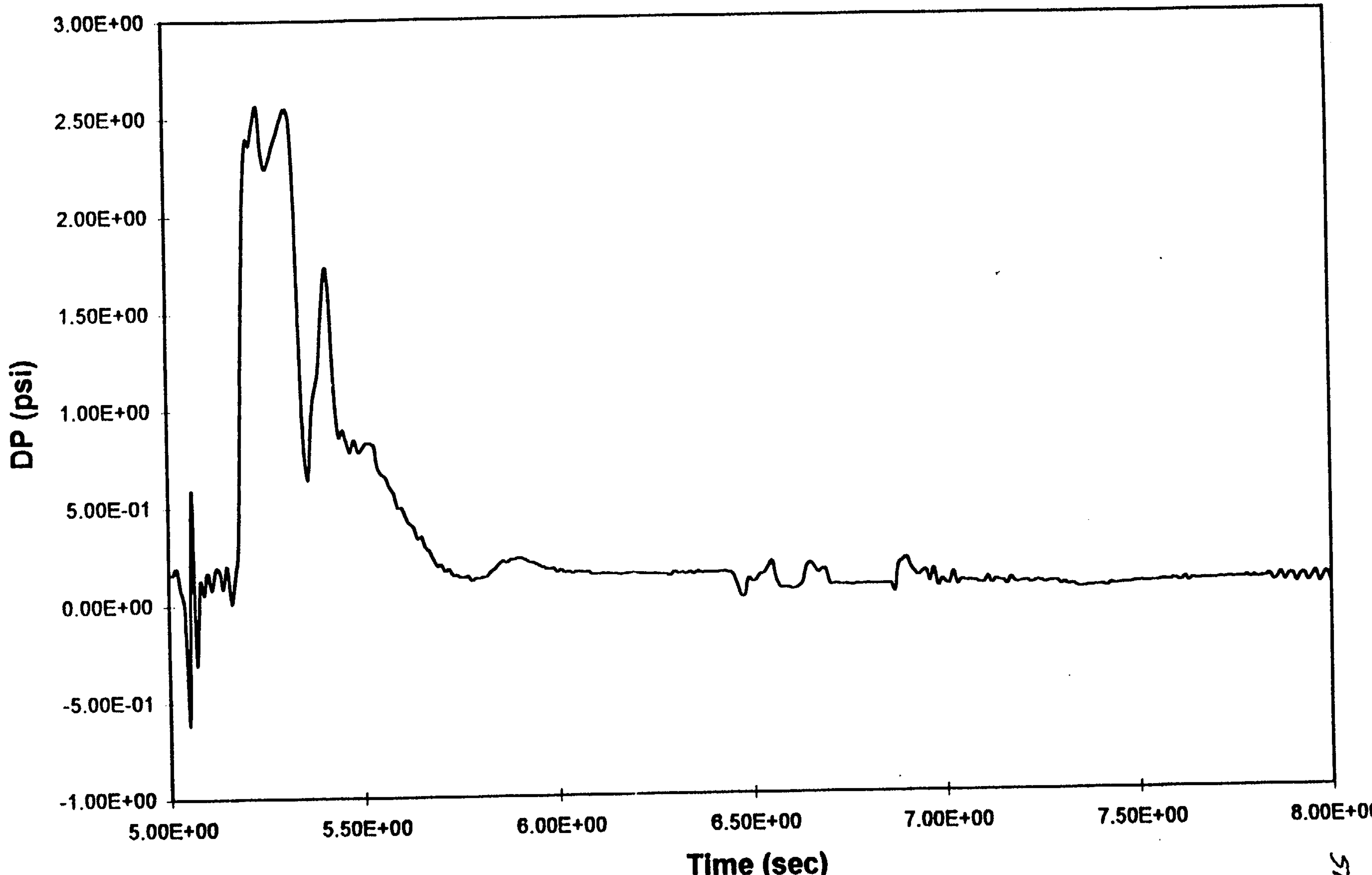

FIGURE B-3

STA-042 e
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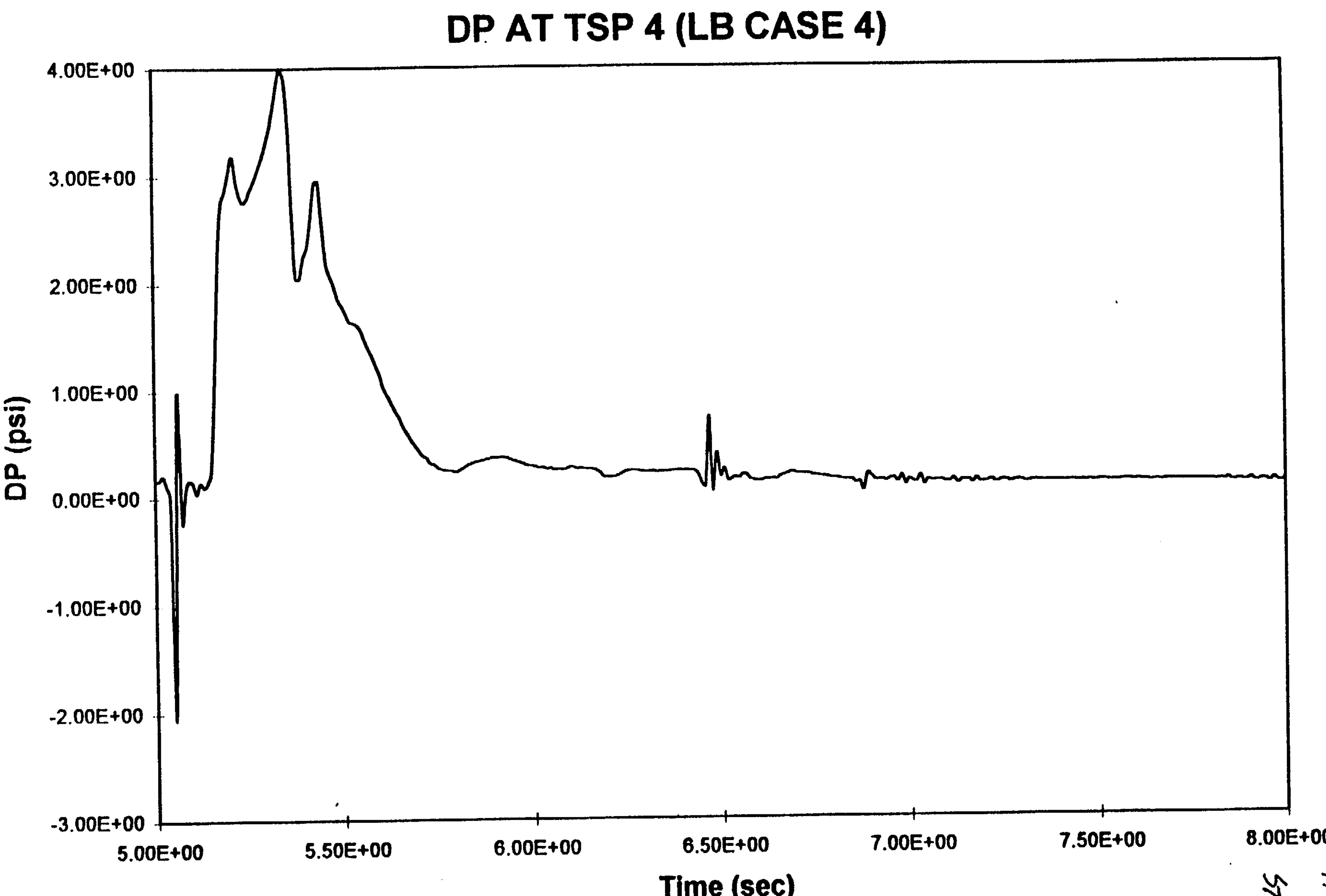

FIGURE B-4

STA-042
Rev 0
HAL 10/1/96

DP AT TSP 5 (LB CASE 4)

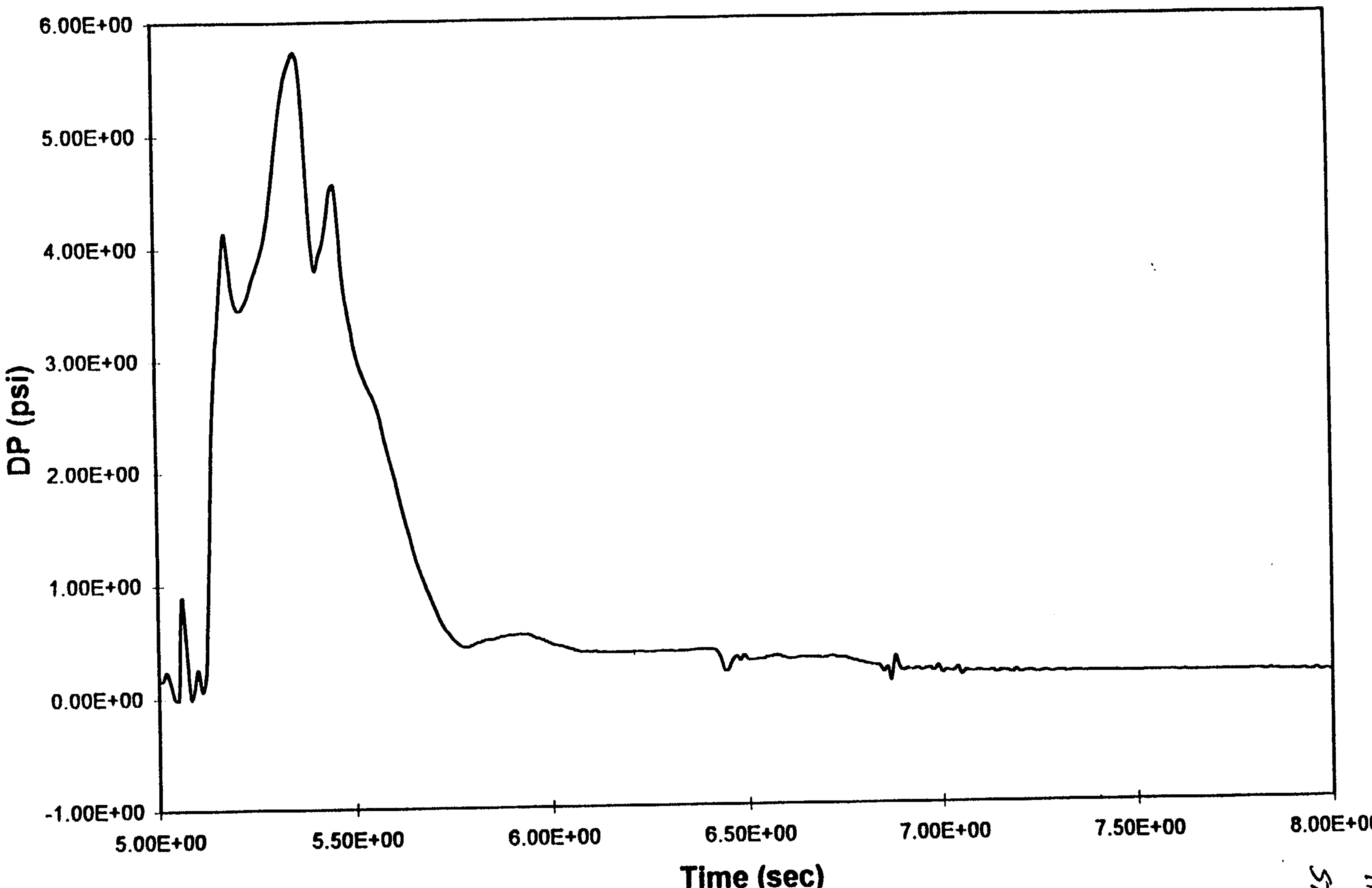

FIGURE B-5

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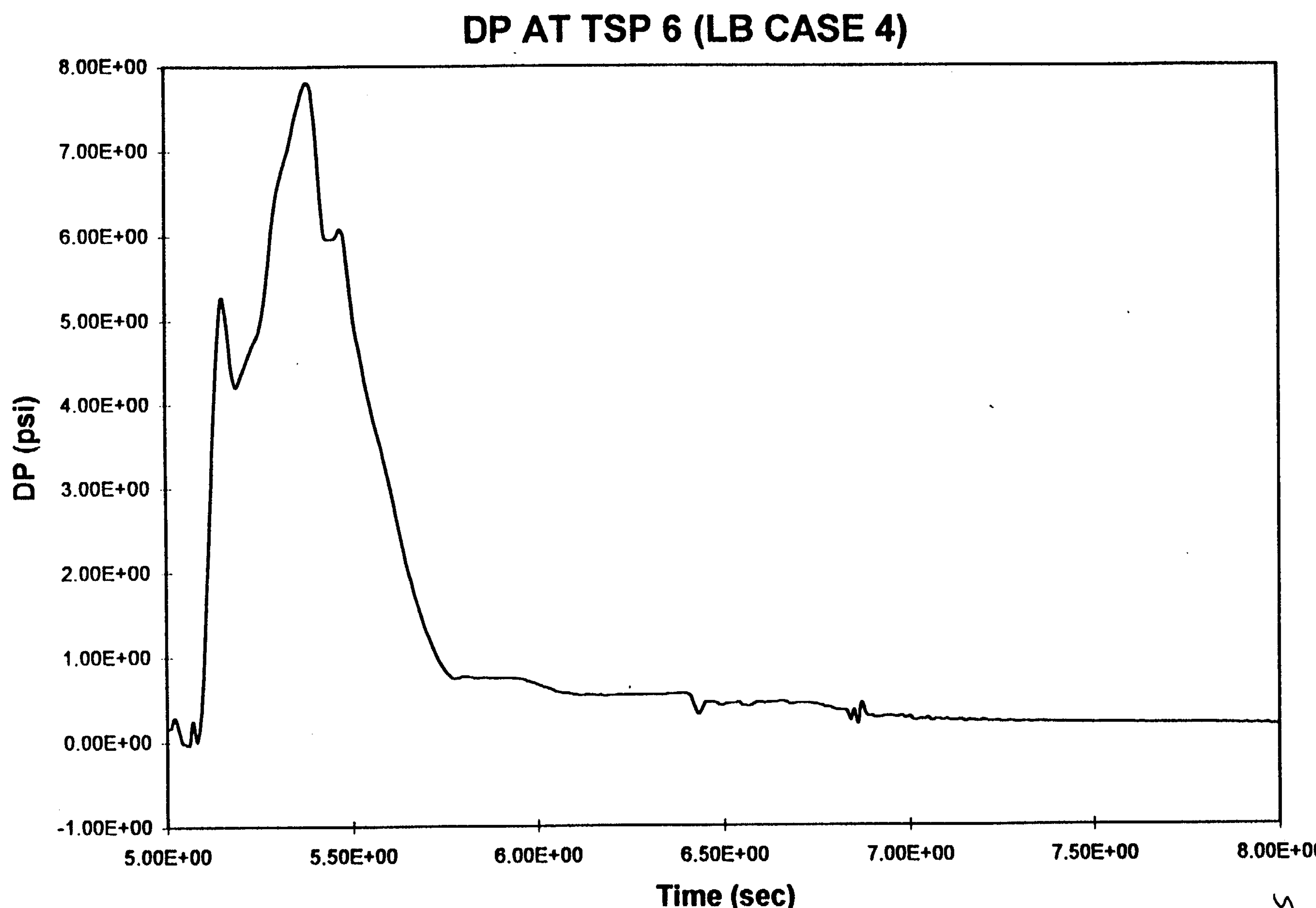

FIGURE B-6

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STA-042
R. 0

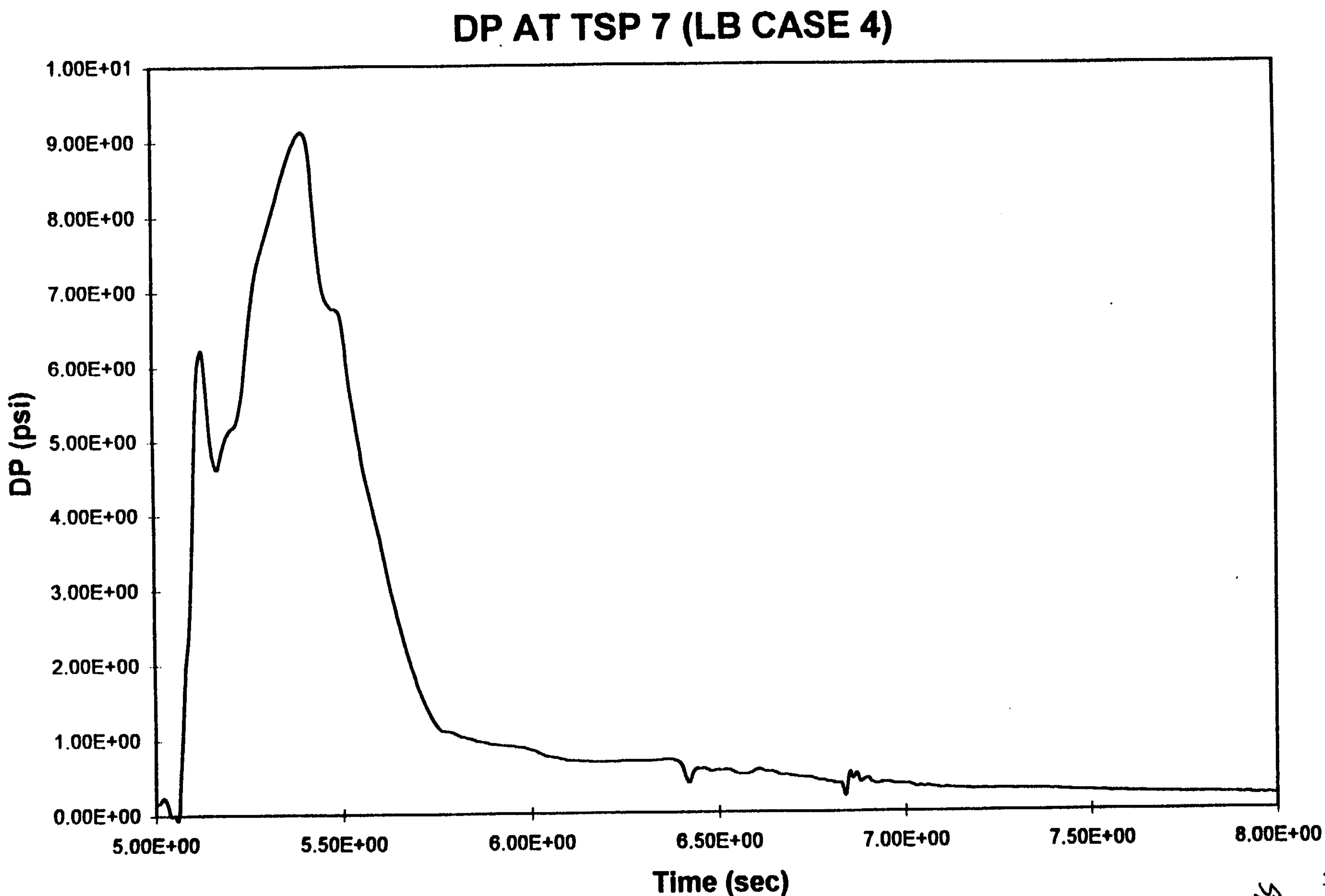

FIGURE B-7

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R. 0

Appendix C

Tranflo Input Changes for Case 61

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STA-042
R.0

arley-1 SLB HOT STD -Nominal Level (490") - DER

31	0	244.3	38.57	1022.72	547	0.03	0
	0	86.73	42.97	1021.26	547	0.92	0
33	0	688.6	42.04	1021.72	547	0.73	0
36	0	22.83	43.52	1021.57	547	0.82	0
1.548	17.74	.4275	0.5	0.5	3		
1.548	17.74	.4275	0.5	0.5	3		
23.716	0.0625	0.0625	0.78	0.78	3		
23.716	0.0625	0.0625	0.78	0.78	3		
23.716	0.0625	0.0625	0.78	0.78	3		
23.716	0.0625	0.0625	0.78	0.78	3		
23.716	0.0625	0.0625	0.78	0.78	3		
23.716	0.0625	0.0625	0.78	0.78	3		
23.716	0.0625	0.0625	0.78	0.78	3		

} Nodes for Water level

} Connectors 30 & 31, O.C. Resist.

} Connectors 34-40 TSP loss coeff

Case 1 Cards to be changed for Case 61

JAN 25 '96 16:48 FROM OPL LICENSING

arley-1 SLB HOT STD -Worst case (case 61)

33	0	244.3	38.57	1022.17	547	0.39	0
32	0	86.73	42.97	1021.28	547	1	0
33	0	688.6	42.04	1021.28	547	0.93	0
36	0	22.83	43.52	1021.07	547	1	0
1.548	17.74	.4275	0.0	0.0	3		
1.548	17.74	.4275	0.0	0.0	3		
23.716	0.0625	0.0625	0.99	0.99	3		
23.716	0.0625	0.0625	0.99	0.99	3		
23.716	0.0625	0.0625	0.99	0.99	3		
23.716	0.0625	0.0625	0.99	0.99	3		
23.716	0.0625	0.0625	0.99	0.99	3		
23.716	0.0625	0.0625	0.99	0.99	3		
23.716	0.0625	0.0625	0.99	0.99	3		

Case 61 cards changed from Case 1

Appendix D

Input Listing for LB Case 1

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STA-042
R.0

```
=SLB pressure difference across the SG tube support plats
* hot standby nonequilibrium models
*
*
*
100 new transnt
*
*
102  british  british
105
*
********
*     time step cards
*
*
201      5.    1.d-7    0.005     3    2      200      10000
202    5.3   1.d-7    0.00001   3    1000   20000    100000
203    6.5   1.d-7   0.000025   3    400    8000     100000
204    8.0   1.d-7   0.00005    3    200    10000    100000
205 1000.0   1.d-7   0.00010    3    100    10000    100000
********************************
*     minor edit variables
*
*
301    mflowj    518000000
302    mflowj    002030000
303    mflowj    002070000
304    mflowj    002110000
305    mflowj    002150000
[illegible]    mflowj    002190000
3[illegible]    mflowj    002230000
308    mflowj    002270000
309    p         017010000
*310    p         018010000
*311    p         019010000
*312    p         020010000
*313    p         021010000
*314    p         022010000
*315    p         023010000
*316    p         033010000
*317    p         034010000
*318    p         036010000
319    cntrlvar    1
320    cntrlvar    2
321    cntrlvar    3
322    cntrlvar    4
323    cntrlvar    5
324    cntrlvar    6
325    cntrlvar    7
*
*
*
*
*

   ***********************
*    trip input data
*
*
501    time    0    ge    null    0    8.0    1
```

```
502     time    0    ge    null    0      5.0    1
503     time    0    ge    null    0    200.0    1
*
*
*
*
*
*
600   501
*
*************************************************************
*   hydrodynamic components
*
*************************************************************
*   primary side model
*   hot leg and cold leg represented by tdvs
*************************************************************
*
1000000   inplen    tmdpvol
1000101   0.0   10.0    5000.0   0.0   0.0   0.0   0.0   0.0   0
1000200    3
1000201    0.0   2235.7   547.0
1000202    5.0   2250.0   547.0
1000203   15.0    800.0   491.0
*1000204   1.0e6   800.0   491.0
*
*
1010000   outplen   tmdpvol
1010101   0.0   10.0    5000.0   0.0   0.0   0.0   0.0   0.0   0
1010200    3
1010201   0.0    2200.0   547.0
1010202   5.0    2200.0   547.0
1010203   15.0   700.0    491.0
*
*
0010000 tubes  pipe
0010001  60
0010101  10.956    60
0010301  1.1667    1
0010302  1.2553    3
0010303  0.5       5
0010304  1.60435   7
0010305  0.5       9
0010306  1.60435   11
0010307  0.5       13
0010308  1.60435   15
0010309  0.5       17
0010310  1.60435   19
0010311  0.5       21
0010312  1.60435   23
0010313  0.5       25
0010314  1.60435   27
0010315  0.5       29
0010316  3.0       31
0010317  0.5       33
0010318  1.60435   35
0010319  0.5       37
0010320  1.60435   39
0010321  0.5       41
0010322  1.60435   43
```

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```
0010323   0.5         45
0010324   1.60435     47
0010325   0.5         49
0010326   1.60435     51
0010327   0.5         53
0010328   1.60435     55
0010329   0.5         57
0010330   1.2553      59
0010331   1.1667      60
0010601    90.0       30
0010602   -90.0       60
0010801    0.0        0.0642    60
0011001    00000   60
0011101    000000   59
0011201    3 2250.0    547.0    0.0    0.0    0.0    60
0011300    1
0011301    9148.5     0.0    0.0    59
*
*
5000000    prminl    tmdpjun
5000101    100000000    1000000    10.956
5000200     1
5000201    0.0    9148.5     0.0    0.0
5000202    1.0e6    9148.5    0.0    0.0
*
*
5010000    prmout    tmdpjun
5010101    1010000    101000000    10.956
5010200     1
5010201    0.0    9148.5     0.0    0.0
5010202    1.0e6    9148.5    0.0    0.0
*
*
0020000 shell   pipe
0020001   30
0020101   54.22      27
0020102   70.0       30
0020201   54.22      2
0020202   23.716     3
0020203   54.22      6
0020204   23.716     7
0020205   54.22      10
0020206   23.716     11
0020207   54.22      14
0020208   23.716     15
0020209   54.22      18
0020210   23.716     19
0020211   54.22      22
0020212   23.716     23
0020213   54.22      26
0020214   23.716     27
0020215   70.0       29
0020301   1.2553     1
0020302   1.2553     2
0020303   0.5        4
0020304   1.60435    6
0020305   0.5        8
0020306   1.60435    10
0020307   0.5        12
0020308   1.60435    14
```

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0020309	0.5	16					
0020310	1.60435	18					
0020311	0.5	20					
00[illegible]312	1.60435	22					
00[illegible]13	0.5	24					
0020314	1.60435	26					
0020315	0.5	28					
0020316	3.2075	29					
0020317	3.4338	30					
0020601	90.0	30					
0020801	0.00015	0.136	29				
0020802	0.00015	0.0	30				
0020901	0.0	0.0	2				
0020902	0.78	0.78	3				
0020903	0.0	0.0	6				
0020904	0.78	0.78	7				
0020905	0.0	0.0	10				
0020906	0.78	0.78	11				
0020907	0.0	0.0	14				
0020908	0.78	0.78	15				
0020909	0.0	0.0	18				
0020910	0.78	0.78	19				
0020911	0.0	0.0	22				
0020912	0.78	0.78	23				
0020913	0.0	0.0	26				
0020914	0.78	0.78	27				
0020915	0.0	0.0	29				
0021001	00100	29					
0021002	00000	30					
0[illegible]101	000000	29					
0[illegible]201	3	1033.73	547.0	0.0	0.0	0.0	1
0021202	3	1033.34	547.0	0.0	0.0	0.0	2
0021203	3	1033.07	547.0	0.0	0.0	0.0	3
0021204	3	1032.91	547.0	0.0	0.0	0.0	4
0021205	3	1032.57	547.0	0.0	0.0	0.0	5
0021206	3	1032.06	547.0	0.0	0.0	0.0	6
0021207	3	1031.72	547.0	0.0	0.0	0.0	7
0021208	3	1031.56	547.0	0.0	0.0	0.0	8
0021209	3	1031.22	547.0	0.0	0.0	0.0	9
0021210	3	1030.71	547.0	0.0	0.0	0.0	10
0021211	3	1030.37	547.0	0.0	0.0	0.0	11
0021212	3	1030.21	547.0	0.0	0.0	0.0	12
0021213	3	1029.87	547.0	0.0	0.0	0.0	13
0021214	3	1029.36	547.0	0.0	0.0	0.0	14
0021215	3	1029.02	547.0	0.0	0.0	0.0	15
0021216	3	1028.86	547.0	0.0	0.0	0.0	16
0021217	3	1028.53	547.0	0.0	0.0	0.0	17
0021218	3	1028.01	547.0	0.0	0.0	0.0	18
0021219	3	1027.68	547.0	0.0	0.0	0.0	19
0021220	3	1027.52	547.0	0.0	0.0	0.0	20
0021221	3	1027.18	547.0	0.0	0.0	0.0	21
0021222	3	1026.66	547.0	0.0	0.0	0.0	22
0021223	3	1026.33	547.0	0.0	0.0	0.0	23
0021224	3	1026.17	547.0	0.0	0.0	0.0	24
[illegible]1225	3	1025.83	547.0	0.0	0.0	0.0	25
[illegible]1226	3	1025.32	547.0	0.0	0.0	0.0	26
0021227	3	1024.98	547.0	0.0	0.0	0.0	27
0021228	3	1024.82	547.0	0.0	0.0	0.0	28
0021229	3	1024.23	547.0	0.0	0.0	0.0	29
0021230	3	1023.17	547.0	0.0	0.0	0.0	30

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```
0021300    1
0021301    0.0          0.0    0.0    29
0021401    0.0625       0.0    1.0    1.0    29
*
*
0350000 downc   pipe
0350001  3
0350101  0.0         3
0350201  7.096       2
0350301  11.827      3
0350401  122.4       3
0350601  -90.0       3
0350801   0.00015    0.4275   3
0351001   00000   3
0351101   000000   2
0351201   3 1024.84   547.0    0.0    0.0    0.0    1
0351202   3 1028.64   547.0    0.0    0.0    0.0    2
0351203   3 1032.44   547.0    0.0    0.0    0.0    3
0351300   1
0351301   0.0          0.0    0.0    2
*
*
0300000   tubesh    branch
0300001   2        1
0300101  54.22  1.1667  0.   0.   90.  1.1667  0.00015  0.136  00100
0300200  3   1034.15   547.0
0301101  035010000   030000000  7.096    0.5   0.5   000000
0302101  030010000   002000000  4.43     5.32  5.32  000000
0301201   0.0    0.0    0.0
0302201   0.0    0.0    0.0
*
0340000   feedrg    branch
0340001   1        1
0340101  92.1  3.1097  0.0    0. -90.   -3.1097   0.00015  0.0   00000
0340200  3   1022.48   547.0
0341101  034010000   035000000  7.096    0.0   0.0    000100
0341201   0.0    0.0    0.0
*
*
0230000   abovetb    snglvol
0230101   49.43   4.9423   0.0    0.0    90.   4.9423   0.00015  0.0   00000
0230200    2  1022.72   0.03
*
*
5330000   abovetb    sngljun
5330101   002010000  023000000   49.43   0.0   0.0   000100
5330110   0.0   0.0    1.0    1.0
5330201   1    0.0    0.0    0.0
*
*
0220000   speratr    separatr
0220001   3        1
0220101   41.73   3.9156    0.0   0.   90.   3.9156   0.00015   0.0   00000
0220200   2  1021.14     1.0
0221101   022010000    021000000   12.828   0.84   0.47    000000
0222101   022000000    032000000   17.35    0.597  0.597   000000
0223101   023010000    022000000   41.73    8.689  8.689   000000
0221201    0.0    0.0    0.0
0222201    0.0    0.0    0.0
```

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R.0

```
0223201    0.0    0.0    0.0
*
*
0320000    liqsept    snglvol
0320101    17.35    0.0    86.75    0.0    0.    0.0    0.00015    0.0    00000
0320200     2  1021.26    0.92
*
*
0330000    abovfl    branch
0330001    2         1
0330101    100.7    2.9225   0.0   0.0   -90.0    -2.9225    0.00015    0.0    00000
0330200     2  1021.72    0.73
0331101    032010000   033000000   17.35    0.0    0.0    000000
0332101    033010000   034000000   79.288   0.0    0.0    000000
0331201    0.0    0.0    0.0
0332201    0.0    0.0    0.0
*
*
0530000    abovfr2   branch
0530001    2         1
0530101    100.7    3.9156   0.0   0.0   -90.0    -3.9156    0.00015    0.0    00000
0530200     2  1021.72    0.73
0531101    036010000   053000000   2.34     0.5    0.5    000000
0532101    053010000   033000000   100.7    0.0    0.0    000000
0531201    0.0    0.0    0.0
0532201    0.0    0.0    0.0
*
*
0210000    abovspr   branch
0210001    2    1
0210101    152.19   2.281   0.0    0.0    90.   2.281    0.00015   0.0   00000
0210200     2  1021.12   1.0
0211101    021010000    020000000    70.75    0.0    0.0    000100
0212101    021000000   053000000   7.96    1.78    1.67    000000
0211201    0.0    0.0    0.0
0212201    0.0    0.0    0.0
*
*
0200000    spsteam   snglvol
0200101    70.75    7.4502    0.0   0.0    90.    7.4502    0.00015    0.0    00000
0200200     2  1020.96   1.0
*
*
0190000    dryer     separatr
0190001    3         1
0190101    171.4   0.7083    0.0   0.   0.    0.    0.00015   0.0   00000
0190200   2  1020.96    1.0
0191101   019010000    018000000   63.49     5.502  5.502  000000
0192101   019000000    036000000   2.34      0.5    0.5    000000
0193101   020010000    019000000   70.75     0.5    0.5    000000
0191201    0.0    0.0    0.0
0192201    0.0    0.0    0.0
0193201    0.0    0.0    0.0
*
*
0360000    dsdryer   snglvol
0360101    2.34      9.7312     0.0    0.0   -90.   -9.7312    0.00015   0.0   00000
0360200     2      1021.57    0.82
*
*
```

```
0180000    updryer   snglvol
0180101    63.49    0.0    473.0    0.0    0.    0.0  0.00015  0.0   00000
0180200     2      1020.96    1.0
*
*
*
0170000    sgdoom    snglvol
0170101    94.12    3.5497  0.0    0.0    90.    3.5497   0.00015  0.0   00000
0170200     2      1020.94    1.0
*
*
0380000    contnm    snglvol
0380101    10000.0     200.0    0.0   0.0    90.   200.0   0.0        0.0   00000
0380200     2      14.7        1.0
*
*
5190000    abovefr    sngljun
5190101    018010000  017000000   63.49   0.0    0.0      000000
5190110    0.0   0.0    1.0    1.0
5190201    1    0.0    0.0    0.0
*
*
5180000    break      valve
5180101    017010000  038000000   4.6          0.0    0.0     000100
5180110    0.0   0.0    1.0    1.0
5180201    1    0.0    0.0    0.0
5180300    mtrvlv
5180301    502    503    1000.0    0.0
*
*
* heat structure input
*
***********************************
11201000    60   11   2   1   0.0321
11201100      0      2
11201101      0.000438      10
11201201     1         10
11201301     0.0       10
11201401     547.0          11
11201501     001010000    0000    1    0    796.74      1
11201502     001020000   10000    1    0    857.24     3
11201503     001040000   10000    1    0    341.45     5
11201504     001060000   10000    1    0    1095.61    7
11201505     001080000   10000    1    0    341.45     9
11201506     001100000   10000    1    0    1095.61    11
11201507     001120000   10000    1    0    341.45     13
11201508     001140000   10000    1    0    1095.61    15
11201509     001160000   10000    1    0    341.45     17
11201510     001180000   10000    1    0    1095.61    19
11201511     001200000   10000    1    0    341.45     21
11201512     001220000   10000    1    0    1095.61    23
11201513     001240000   10000    1    0    341.45     25
11201514     001260000   10000    1    0    1095.61    27
11201515     001280000   10000    1    0    341.45     29
11201516     001300000   10000    1    0    2190.4    31
11201517     001320000   10000    1    0    341.45     33
11201518     001340000   10000    1    0    1095.61    35
11201519     001360000   10000    1    0    341.45     37
11201520     001380000   10000    1    0    1095.61    39
11201521     001400000   10000    1    0    341.45     41
```

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R.0

```
11201522     001420000   10000   1   0    1095.61   43
11201523     001440000   10000   1   0    341.45    45
11201524     001460000   10000   1   0    1095.61   47
11[illegible]525     001480000   10000   1   0    341.45    49
11[illegible]526     001500000   10000   1   0    1095.61   51
11201527     001520000   10000   1   0    341.45    53
11201528     001540000   10000   1   0    1095.61   55
11201529     001560000   10000   1   0    341.45    57
11201530     001580000   10000   1   0    857.24    59
11201531     001600000    0000   1   0    796.74     60
11201601     030010000    0000   1   0    905.4541    1
11201602     002010000   10000   1   0    974.2092   3
11201603     002030000   10000   1   0    388.0404   5
11201604     002050000   10000   1   0    1245.1044  7
11201605     002070000   10000   1   0    388.0404   9
11201606     002090000   10000   1   0    1245.1044  11
11201607     002110000   10000   1   0    388.0404   13
11201608     002130000   10000   1   0    1245.1044  15
11201609     002150000   10000   1   0    388.0404   17
11201610     002170000   10000   1   0    1245.1044  19
11201611     002190000   10000   1   0    388.0404   21
11201612     002210000   10000   1   0    1245.1044  23
11201613     002230000   10000   1   0    388.0404   25
11201614     002250000   10000   1   0    1245.1044  27
11201615     002270000   10000   1   0    388.0404   29
11201616     002290000    0000   1   0    2489.277    31
11201617     002280000  -10000   1   0    388.0404   33
11201618     002260000  -10000   1   0    1245.1044  35
11[illegible]1619     002240000  -10000   1   0    388.0404   37
1[illegible]1620     002220000  -10000   1   0    1245.1044  39
11[illegible]1621     002200000  -10000   1   0    388.0404   41
11201622     002180000  -10000   1   0    1245.1044  43
11201623     002160000  -10000   1   0    388.0404   45
11201624     002140000  -10000   1   0    1245.1044  47
11201625     002120000  -10000   1   0    388.0404   49
11201626     002100000  -10000   1   0    1245.1044  51
11201627     002080000  -10000   1   0    388.0404   53
11201628     002060000  -10000   1   0    1245.1044  55
11201629     002040000  -10000   1   0    388.0404   57
11201630     002020000  -10000   1   0    974.2092   59
11201631     030010000    0000   1   0    905.4541    60
11201701     0      0.0     0.0     0.0     60
11201801     0.0  15.0    15.0    1.5    1.5    0.0    0.0    1.0    60
11201901     0.0  15.0    15.0    1.5    1.5    0.0    0.0    1.0    60
*
*
*   composition type and data format
*
*****************************************************
20100100     tbl/fctn     1    1    * inconel
20100101      70.0        2.3843e-03
20100102     200.0        2.5232e-03
20100103     400.0        2.8009e-03
20100104     600.0        3.0787e-03
2[illegible]0105     800.0        3.3565e-03
[illegible]0106    1000.0        3.6574e-03
20100107    1200.0        3.9815e-03
20100108    1400.0        4.3056e-03
20100151      70.0        55.6831
20100152     200.0        55.5227
```

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```
20100153    400.0       55.2607
20100154    600.0       54.9895
20100155    800.0       54.7069
2    0156   1000.0      54.3982
2.. .0157   1200.0      54.0907
20100158   1400.0       53.7516
*
*   control component cards
*
*   compute pressure difference
*
*****************************************************
20500100   delptp1   sum   1.45038e-4   0.0   1
20500101   0.0   -1.0, p, 002040000   1.0, p,  002030000
20500200   delptp2   sum   1.45038e-4   0.0   1
20500201   0.0   -1.0, p, 002080000   1.0, p,  002070000
20500300   delptp3   sum   1.45038e-4   0.0   1
20500301   0.0   -1.0, p, 002120000   1.0, p,  002110000
20500400   delptp4   sum   1.45038e-4   0.0   1
20500401   0.0   -1.0, p, 002160000   1.0, p,  002150000
20500500   delptp5   sum   1.45038e-4   0.0   1
20500501   0.0   -1.0, p, 002200000   1.0, p,  002190000
20500600   delptp6   sum   1.45038e-4   0.0   1
20500601   0.0   -1.0, p, 002240000   1.0, p,  002230000
20500700   delptp7   sum   1.45038e-4   0.0   1
20500701   0.0   -1.0, p, 002280000   1.0, p,  002270000
*
*   end of the input
*
*   ************************************************
.
```

Appendix E

Steam Generator Design Alternation

(Westinghouse Letter NCE-85-529)

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HMC 10/1/96

STA-042 R.0

CN-T -90-167

NCE-85-529

From NCD ENGINEERING

WIN 474-4604

Date September 5, 1985

Subject GENF Inputs for Models 44, 44F, 51, 51F, and F Steam Generators

To M. Oshinsky - SGTD Forest Hills

cc: J. C. Buker
D. E. Ford
N. J. Georges
G. P. Lilly
G. V. Smith
M. J. Sredzienski
R. M. Wilson

As we discussed on the phone last week, I have prepared a list of GENF inputs for most Westinghouse Models 44, 44F, 51, 51F, and F Steam Generators. These inputs which are based on the latest information available for the plants, should be used in conjunction with the recently revised GENF code (Version 2.0).

It is recommended that these inputs should be incorporated in your GENF data bank. Inputs for Models 13, 14, 24, 27, and 33 steam generators are not yet available. Due to the geometrical differences among these models, re-programming may be required. I plan to work on them early next year and hope to have them ready before the CDC-7600 is phased out. In the meantime, inputs from the current data bank together with the previous version of GENF should be used to calculate the performance of these older model steam generators. The input data from the current data bank are not compatible with the latest version of GENF.

Please contact me if you have any questions or comments.

K. W. Chan
Nuclear Components Eng.

APPROVED; D. E. Ford, Manager
Nuclear Components Eng.

gdm

Attachment

Discard Date:

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STA-042 R.0

51 SERIES STEAM GENERATORS

Default Geometry: CN-TA-90-167

INPUT DATA BASED ON MODEL 51 STEAM GENERATOR DEFAULT GEOMETRY

1	MODEL =	51	MODE =	0	IFNAL =	1
	IT =	1	IUBEND =	0	INPU =	0
2	DPI =	31.00	DPO =	31.00	ALI =	12.22
	ALO =	12.22	ALPHAI =	11.00	ALPHAO =	11.00
	DC =	125.12	TTP =	21.28		
3	DIU =	123.00	DILS =	129.38	DIUS =	168.50
	DSN =	29.00	DFU =	14.32	DICDP =	15.81
	ANDP =	0.	DIDP =	5.05		
4	DT =	56.00	DH =	20.00	DPOD =	28.00
	H2 =	22.19	ALPHA =	37.00	XNR =	3.
	GAPR =	0.43	DIUU =	135.22		
5	HE =	34.38	SL =	86.88	HT =	33.64
	XLS =	3.21	DIRC =	62.25	HTB =	417.03
	XLUS =	232.16	HD =	6.50		
6	HUO =	14.00	XLU =	380.81	XLRTC =	21.50
	XLUU =	11.31	XLRC =	12.74	XLR =	196.49
	XLLS =	359.99	XLSTC =	71.76		
7	XLTS =	41.45	ANTS =	7.	ELFDR =	463.00
	ELSN =	721.00	CK1 =	0.780	CKR =	10.000
	CKFUR =	9.420	CKSH =	0.230		
8	CKDC =	0.000	CKSEP2 =	92.000	DIDCB =	65.61
	XLDCB =	60.00	TKDCB =	0.313	ASNV =	4.587
9	V1M =	14.57	V2M =	5.36	V3M =	0.34
	V4M =	3.54	V5M =	1.32	V6M =	45.38
	X4 =	0.50	X5 =	0.70		
10	TU =	0.375	TKLDP =	0.375	TKRDP =	0.375
	TKUDP =	0.750	TKRSR =	0.250	TKCDP =	0.250
	TKDP =	0.258	TKTS =	0.750		
14	STP =	7.00	DO =	0.8750	TT =	0.05250
	PT =	1.2810	AN =	3388.	AO =	51500.
	ARRCT =	0.50	ACJ =	0.87		
15	PCL =	100.00	RF =	0.000100	PS =	850.00
	UBD =	0.	TAUG =	0.00	US =	0.00000
11-13	ALTS 1 =	50.12	AFTS 1 =	23.77	ADCO 1 =	0.200
	ALTS 2 =	99.87	AFTS 2 =	23.77	ADCO 2 =	0.200
	ALTS 3 =	149.62	AFTS 3 =	23.77	ADCO 3 =	0.200
	ALTS 4 =	199.37	AFTS 4 =	23.77	ADCO 4 =	0.200
	ALTS 5 =	249.12	AFTS 5 =	23.77	ADCO 5 =	0.200
	ALTS 6 =	298.87	AFTS 6 =	23.77	ADCO 6 =	0.200
	ALTS 7 =	348.62	AFTS 7 =	23.77	ADCO 7 =	0.200

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STA-042 R.0

51 Series Steam Generators Standard Features:

- 0 3 56-inch primary separators
- 0 Steam nozzle with no flow limiting devices
- 0 Fillet type tube-to-tubesheet weld
- 0 Secondary separator with Westinghouse formed vanes and perforated plates
- 0 Downcomer resistance plate removed
- 0 0.5 orifice

Farley 1 (ALA)

Special features: None

List input update: RF = 0.00016, CKSEP2 = 125.0

Farley 2 (APR)

Special features: 7 inch wrapper opening

List input update: HWO = 7.00, XLN = 385.81, RF = 0.00016, CKSEP2 = 125.0

D. C. Cook 1 & 2 (AEP/AMP)

Special features: None

List input update: RF = 0.00020, CKSEP2 = 125.0

Zion 1 & 2 (CWE/COM)

Special features: 0.6 orifice
High downcomer resistance plate setting

List input update: DPOD = 33.50, CKDC = 16.9, CKSEP2 = 125.0

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R. 0

CN-T -90-167

Beaver Valley 1 (DLW)

Special features: None

List input update: RF = 0.00016, CKSEP2 = 125.0

TAKAHAMA 1 (TAK)

Special features: 0.6 orifice
Low downcomer resistance plate setting

List input update: DPOD = 33.50, CKDC = 7.26, CKSEP2 = 125.0

OHI 1 (OHI)

Special features: 0.6 orifice
Low downcomer resistance plate setting

List input update: DPOD = 33.50, CKDC = 7.26, RF = 0.00005, CKSEP2 = 125.0

KORI 1 (KOR)

Special features: 7 inch wrapper opening

List input update: HWO = 7.00, XLW = 385.81, CKSEP2 = 125.0

Prairie Island 1 & 2 (NSP/NRP)

Special features: None

List input update: RF = 0.00018, CKSEP2 = 125.0

Diablo Canyon 1 (PGE)

Special features: None XLW = 380.81

List input update: RF = 0.00018, CKSEP2 = 125.0

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Diablo Canyon 2 (PEG)

Special features: None

List input update: RF = 0.00018, CKSEP2 = 125.0

Trojan (POR)

Special features: None

List input update: RF = 0.00005, CKSEP2 = 125.0

Salem 1 (PSE)

Special features: None

List input update: RF = 0.00018, CKSEP2 = 125.0

Sequoyah 1 (TVA)

Special features: None

List input update: RF = 0.00006, CKSEP2 = 125.0

Seauoyah 2 (TEN)

Special features: None

List input update: RF = 0.00006, CKSEP2 = 125.0

North Anna 1 (VRA)

Special features: None

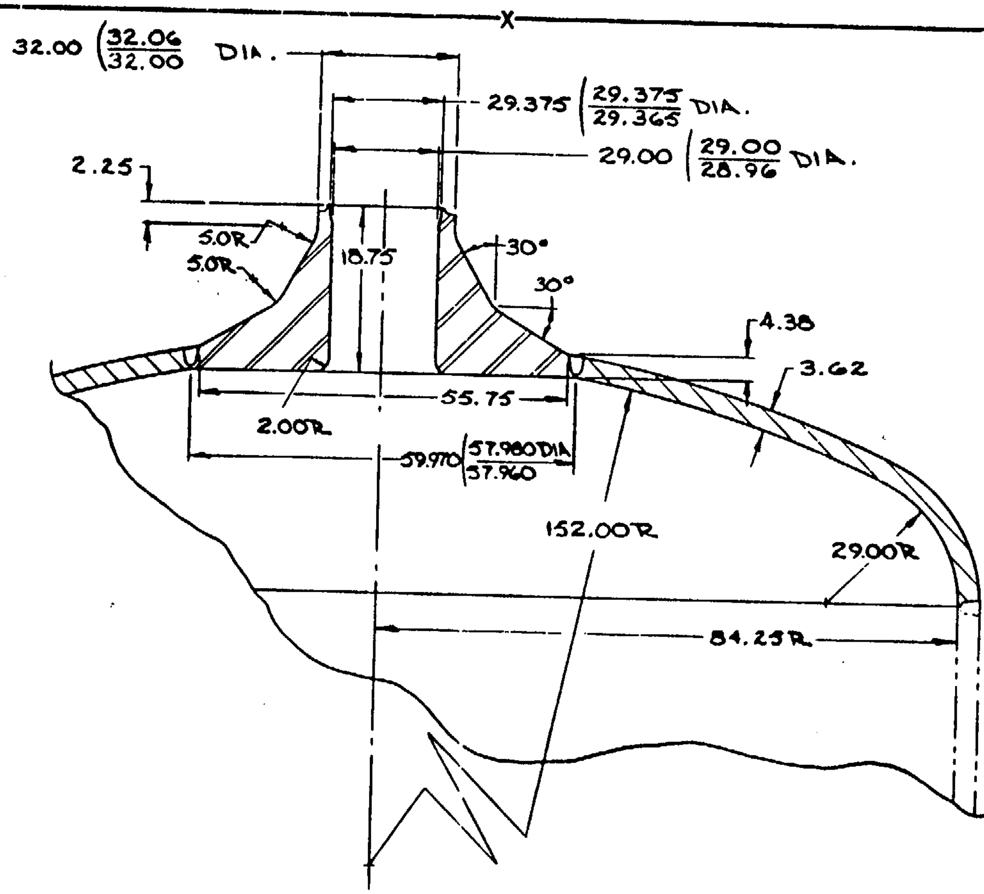
List input update: RF = 0.00005, CKSEP2 = 125.0

Appendix F

Westinghouse Drawing 350794-B

Steam Generator Nozzle to Elliptical Head

51 Series Steam Generator



S.O.
D.S.
1

ITEM	CHANGE

LAST NUMBER USED	
ITEM	PARTS LIST
NONE	NONE

ISSUE DATE
ENGRS REF DWG

Westinghouse Electric Corporation
TAMPA DIVISION TAMPA FLA.
APPARATUS 51 SERIES STM GEN.
TITLE STEAM OUTLET NOZZLE TO ELLIPTICAL HEAD

DFTM	R. OLSON		MECH ENG	W. A. Riggle	350794-B
CHKD	R.A.O		MFG APP		
DESIGN APP			QUAL CONT		
MATL & WELD APP			DRAWING NOT TO SCALE		SHEET NO 1 OF 1 SHEETS

872C799001

HHL 10/1/96 STA-002 R.0

167/17K

Appendix G

Microfiches for the RELAP5 Runs

PACIFIC GAS AND ELECTRIC COMPANY
GENERAL COMPUTATION SHEET

SHEET NO. 174 OF 174 SHEETS
CALC NO. STA-042 R.0

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY ____

[redacted]

REDDP 6

PACIFIC GAS AND ELECTRIC COMPANY
ERAL COMPUTATION SHEET

SHEET NO. 173 OF 174 SHEETS
CALC NO. STA-042 R, 0

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY

[redacted]

REDDP 5

[redacted]

RGODP 4

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY ____

[redacted]

REGODP 3

IFIC GAS AND ELECTRIC COMPANY
GENERAL COMPUTATION SHEET

SHEET NO. 170 OF 174 SHEETS
CALC NO. STA-042 R.0

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY

RGODP 2

PACIFIC GAS AND ELECTRIC COMPANY
'IERAL COMPUTATION SHEET

SHEET NO 169 OF 174 SHEETS
CALC NO. STA-042 R0

SUBJECT Loads on the Steam Generator Support Plats During SLB Accident
MADE BY H M Lee DATE 10/1/96 CHECK BY L R Chang APPROVED BY

[redacted]

RFODP 1

Hard Copy Listings of Input Decks for RELAP5

```
=SLB pressure difference across the SG tube support plats
* hot standby nonequilibrium models
*
*
*
100 new transnt
*
*
102  british  british
105
*
********
*    time step cards
*
*
201     5.   1.d-7   0.005   3   2     200     10000
202   5.3    1.d-7   0.00001  3   1000  20000   100000
203   6.5    1.d-7  0.000025  3   400   8000    100000
204   8.0    1.d-7  0.00005   3   200   10000   100000
205 1000.0  1.d-7  0.00010   3   100   10000   100000
******************************
*    minor edit variables
*
*
301   mflowj   518000000
302   mflowj   002030000
303   mflowj   002070000
304   mflowj   002110000
305   mflowj   002150000
306   mflowj   002190000
307   mflowj   002230000
308   mflowj   002270000
309   p       017010000
*310   p       018010000
*311   p       019010000
*312   p       020010000
*313   p       021010000
*314   p       022010000
*315   p       023010000
*316   p       033010000
*317   p       034010000
*318   p       036010000
319   cntrlvar   1
320   cntrlvar   2
321   cntrlvar   3
322   cntrlvar   4
323   cntrlvar   5
324   cntrlvar   6
325   cntrlvar   7
*
*
*
```

```
*
*
*
*************************
*   trip input data
*
*
501   time  0  ge  null  0   8.0  l
502   time  0  ge  null  0    5.0  l
503   time  0  ge  null  0  200.0  l
*
*
*
*
*
*
600  501
*
*******************************************************
*  hydrodynamic components
*
*******************************************************
*  primary side model
*  hot leg and cold leg represented by tdvs
*******************************************************
*
1000000   inplen   tmdpvol
1000101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1000200    3
1000201    0.0   2235.7   547.0
1000202    5.0   2250.0   547.0
1000203   15.0    800.0   491.0
*1000204   1.0e6   800.0   491.0
*
*
1010000   outplen   tmdpvol
1010101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1010200    3
1010201   0.0   2200.0  547.0
1010202   5.0   2200.0  547.0
1010203   15.0  700.0   491.0
*
*
0010000 tubes  pipe
0010001  60
0010101  10.956   60
0010301  1.1667   1
0010302  1.2553   3
0010303  0.5      5
0010304  1.60435  7
0010305  0.5      9
0010306  1.60435  11
```

```
0010307 0.5     13
0010308 1.60435 15
0010309 0.5     17
0010310 1.60435 19
0010311 0.5     21
0010312 1.60435 23
0010313 0.5     25
0010314 1.60435 27
0010315 0.5     29
0010316 3.0     31
0010317 0.5     33
0010318 1.60435 35
0010319 0.5     37
0010320 1.60435 39
0010321 0.5     41
0010322 1.60435 43
0010323 0.5     45
0010324 1.60435 47
0010325 0.5     49
0010326 1.60435 51
0010327 0.5     53
0010328 1.60435 55
0010329 0.5     57
0010330 1.2553  59
0010331 1.1667  60
0010601  90.0   30
0010602 -90.0   60
0010801  0.0    0.0642  60
0011001  00000  60
0011101  000000 59
0011201  3 2250.0  547.0  0.0  0.0  0.0  60
0011300  1
0011301  9148.5  0.0  0.0  59
*
*
5000000  prminl  tmdpjun
5000101  100000000  1000000  10.956
5000200  1
5000201  0.0  9148.5  0.0  0.0
5000202  1.0e6  9148.5  0.0  0.0
*
*
5010000  prmout  tmdpjun
5010101  1010000  101000000  10.956
5010200  1
5010201  0.0  9148.5  0.0  0.0
5010202  1.0e6  9148.5  0.0  0.0
*
*
0020000 shell  pipe
0020001  30
0020101  54.22  27
```

```
0020102 70.0    30
0020201 54.22   2
0020202 23.716  3
0020203 54.22   6
0020204 23.716  7
0020205 54.22   10
0020206 23.716  11
0020207 54.22   14
0020208 23.716  15
0020209 54.22   18
0020210 23.716  19
0020211 54.22   22
0020212 23.716  23
0020213 54.22   26
0020214 23.716  27
0020215 70.0    29
0020301 1.2553  1
0020302 1.2553  2
0020303 0.5     4
0020304 1.60435 6
0020305 0.5     8
0020306 1.60435 10
0020307 0.5     12
0020308 1.60435 14
0020309 0.5     16
0020310 1.60435 18
0020311 0.5     20
0020312 1.60435 22
0020313 0.5     24
0020314 1.60435 26
0020315 0.5     28
0020316 3.2075  29
0020317 3.4338  30
0020601  90.0   30
0020801  0.00015  0.136   29
0020802  0.00015  0.0     30
0020901  0.0   0.0   2
0020902  0.78  0.78  3
0020903  0.0   0.0   6
0020904  0.78  0.78  7
0020905  0.0   0.0   10
0020906  0.78  0.78  11
0020907  0.0   0.0   14
0020908  0.78  0.78  15
0020909  0.0   0.0   18
0020910  0.78  0.78  19
0020911  0.0   0.0   22
0020912  0.78  0.78  23
0020913  0.0   0.0   26
0020914  0.78  0.78  27
0020915  0.0   0.0   29
0021001  00100   29
```

```
0021002  00000   30
0021101  000000  29
0021201  3 1033.73  547.0  0.0  0.0  0.0  1
0021202  3 1033.34  547.0  0.0  0.0  0.0  2
0021203  3 1033.07  547.0  0.0  0.0  0.0  3
0021204  3 1032.91  547.0  0.0  0.0  0.0  4
0021205  3 1032.57  547.0  0.0  0.0  0.0  5
0021206  3 1032.06  547.0  0.0  0.0  0.0  6
0021207  3 1031.72  547.0  0.0  0.0  0.0  7
0021208  3 1031.56  547.0  0.0  0.0  0.0  8
0021209  3 1031.22  547.0  0.0  0.0  0.0  9
0021210  3 1030.71  547.0  0.0  0.0  0.0  10
0021211  3 1030.37  547.0  0.0  0.0  0.0  11
0021212  3 1030.21  547.0  0.0  0.0  0.0  12
0021213  3 1029.87  547.0  0.0  0.0  0.0  13
0021214  3 1029.36  547.0  0.0  0.0  0.0  14
0021215  3 1029.02  547.0  0.0  0.0  0.0  15
0021216  3 1028.86  547.0  0.0  0.0  0.0  16
0021217  3 1028.53  547.0  0.0  0.0  0.0  17
0021218  3 1028.01  547.0  0.0  0.0  0.0  18
0021219  3 1027.68  547.0  0.0  0.0  0.0  19
0021220  3 1027.52  547.0  0.0  0.0  0.0  20
0021221  3 1027.18  547.0  0.0  0.0  0.0  21
0021222  3 1026.66  547.0  0.0  0.0  0.0  22
0021223  3 1026.33  547.0  0.0  0.0  0.0  23
0021224  3 1026.17  547.0  0.0  0.0  0.0  24
0021225  3 1025.83  547.0  0.0  0.0  0.0  25
0021226  3 1025.32  547.0  0.0  0.0  0.0  26
0021227  3 1024.98  547.0  0.0  0.0  0.0  27
0021228  3 1024.82  547.0  0.0  0.0  0.0  28
0021229  3 1024.23  547.0  0.0  0.0  0.0  29
0021230  3 1023.17  547.0  0.0  0.0  0.0  30
0021300  1
0021301  0.0     0.0  0.0  29
0021401  0.0625   0.0  1.0  1.0  29
*
*
0350000 downc  pipe
0350001 3
0350101 0.0     3
0350201 7.096   2
0350301 11.827  3
0350401 122.4   3
0350601 -90.0   3
0350801  0.00015  0.4275 3
0351001  00000 3
0351101  000000 2
0351201  3 1024.84  547.0  0.0  0.0  0.0  1
0351202  3 1028.64  547.0  0.0  0.0  0.0  2
0351203  3 1032.44  547.0  0.0  0.0  0.0  3
0351300  1
0351301  0.0     0.0  0.0  2
```

```
*
*
0300000  tubesh  branch
0300001  2    1
0300101  54.22  1.1667  0.  0.  90.  1.1667  0.00015  0.136  00100
0300200  3  1034.15  547.0
0301101  035010000  030000000  7.096   0.5  0.5  000000
0302101  030010000  002000000  4.43    5.32  5.32  000000
0301201  0.0  0.0  0.0
0302201  0.0  0.0  0.0
*
*
0340000  feedrg  branch
0340001  1    1
0340101  92.1  3.1097  0.0   0. -90.  -3.1097  0.00015  0.0  00000
0340200  3  1022.48  547.0
0341101  034010000  035000000  7.096   0.0  0.0  000100
0341201  0.0  0.0  0.0
*
*
0230000  abovetb  snglvol
0230101  49.43  4.9423  0.0  0.0  90.  4.9423  0.00015  0.0  00000
0230200  2  1022.72  0.03
*
*
5330000  abovetb  sngljun
5330101  002010000  023000000  49.43  0.0  0.0  000100
5330110  0.0  0.0  1.0  1.0
5330201  1  0.0  0.0  0.0
*
*
0220000  speratr  separatr
0220001  3    1
0220101  41.73  3.9156  0.0  0.  90.  3.9156  0.00015  0.0  00000
0220200  2  1021.14  1.0
0221101  022010000  021000000  12.828  0.84  0.47  000000
0222101  022000000  032000000  17.35  0.597  0.597  000000
0223101  023010000  022000000  41.73  8.689  8.689  000000
0221201  0.0  0.0  0.0
0222201  0.0  0.0  0.0
0223201  0.0  0.0  0.0
*
*
0320000  liqsept  snglvol
0320101  17.35  0.0  86.75  0.0   0.  0.0  0.00015  0.0  00000
0320200  2  1021.26  0.92
*
*
0330000  abovf1  branch
0330001  2    1
0330101  100.7  2.9225  0.0  0.0  -90.0  -2.9225  0.00015  0.0  00000
0330200  2  1021.72  0.73
```

```
0331101  032010000 033000000 17.35  0.0  0.0  000000
0332101  033010000 034000000 79.288 0.0  0.0  000000
0331201  0.0  0.0  0.0
0332201  0.0  0.0  0.0
*
*
0530000  abovfr2 branch
0530001  2   1
0530101  100.7  3.9156 0.0 0.0 -90.0  -3.9156  0.00015  0.0  00000
0530200   2 1021.72 0.73
0531101  036010000 053000000 2.34   0.5  0.5  000000
0532101  053010000 033000000 100.7  0.0  0.0  000000
0531201  0.0  0.0  0.0
0532201  0.0  0.0  0.0
*
*
0210000  abovspr branch
0210001  2  1
0210101  152.19 2.281 0.0  0.0  90.  2.281  0.00015 0.0 00000
0210200   2 1021.12 1.0
0211101  021010000  020000000  70.75  0.0  0.0  000100
0212101  021000000 053000000 7.96  1.78  1.67  000000
0211201  0.0  0.0  0.0
0212201  0.0  0.0  0.0
*
*
0200000  spsteam snglvol
0200101  70.75  7.4502  0.0 0.0  90.  7.4502  0.00015  0.0  00000
0200200   2 1020.96 1.0
*
*
0190000  dryer   separatr
0190001  3    1
0190101  171.4 0.7083  0.0 0. 0.  0.  0.00015 0.0 00000
0190200 2  1020.96  1.0
0191101 019010000  018000000 63.49   5.502 5.502 000000
0192101 019000000  036000000 2.34    0.5  0.5  000000
0193101 020010000  019000000 70.75   0.5  0.5  000000
0191201  0.0  0.0  0.0
0192201  0.0  0.0  0.0
0193201  0.0  0.0  0.0
*
*
0360000  dsdryer snglvol
0360101  2.34   9.7312   0.0  0.0 -90. -9.7312  0.00015 0.0 00000
0360200   2   1021.57  0.82
*
*
0180000  updryer snglvol
0180101  63.49  0.0  473.0  0.0   0.  0.0 0.00015 0.0 00000
0180200   2   1020.96  1.0
*
```

```
*
*
0170000  sgdoom   snglvol
0170101  94.12  3.5497  0.0   0.0   90.   3.5497   0.00015  0.0  00000
0170200   2    1020.94   1.0
*
*
0380000  contnm   snglvol
0380101  10000.0   200.0   0.0  0.0   90.  200.0  0.0     0.0  00000
0380200   2    14.7     1.0
*
*
5190000  abovefr   sngljun
5190101  018010000  017000000  63.49  0.0   0.0   000000
5190110  0.0  0.0   1.0   1.0
5190201  1   0.0   0.0   0.0
*
*
5180000  break    valve
5180101  017010000  038000000  4.6      0.0   0.0   000100
5180110  0.0  0.0   1.0   1.0
5180201  1   0.0   0.0   0.0
5180300  mtrvlv
5180301  502   503   1000.0   0.0
*
*
*  heat structure input
*
**********************************
11201000   60  11  2  1  0.0321
11201100    0    2
11201101    0.000438     10
11201201    1      10
11201301    0.0    10
11201401    547.0     11
11201501    001010000   0000   1   0   796.74    1
11201502    001020000  10000   1   0   857.24   3
11201503    001040000  10000   1   0   341.45   5
11201504    001060000  10000   1   0   1095.61  7
11201505    001080000  10000   1   0   341.45   9
11201506    001100000  10000   1   0   1095.61  11
11201507    001120000  10000   1   0   341.45   13
11201508    001140000  10000   1   0   1095.61  15
11201509    001160000  10000   1   0   341.45   17
11201510    001180000  10000   1   0   1095.61  19
11201511    001200000  10000   1   0   341.45   21
11201512    001220000  10000   1   0   1095.61  23
11201513    001240000  10000   1   0   341.45   25
11201514    001260000  10000   1   0   1095.61  27
11201515    001280000  10000   1   0   341.45   29
11201516    001300000  10000   1   0   2190.4  31
11201517    001320000  10000   1   0   341.45   33
```

```
11201518   001340000  10000   1   0   1095.61  35
11201519   001360000  10000   1   0   341.45   37
11201520   001380000  10000   1   0   1095.61  39
11201521   001400000  10000   1   0   341.45   41
11201522   001420000  10000   1   0   1095.61  43
11201523   001440000  10000   1   0   341.45   45
11201524   001460000  10000   1   0   1095.61  47
11201525   001480000  10000   1   0   341.45   49
11201526   001500000  10000   1   0   1095.61  51
11201527   001520000  10000   1   0   341.45   53
11201528   001540000  10000   1   0   1095.61  55
11201529   001560000  10000   1   0   341.45   57
11201530   001580000  10000   1   0   857.24   59
11201531   001600000  0000   1   0   796.74   60
11201601   030010000  0000   1   0   905.4541   1
11201602   002010000  10000   1   0   974.2092  3
11201603   002030000  10000   1   0   388.0404  5
11201604   002050000  10000   1   0   1245.1044 7
11201605   002070000  10000   1   0   388.0404  9
11201606   002090000  10000   1   0   1245.1044 11
11201607   002110000  10000   1   0   388.0404  13
11201608   002130000  10000   1   0   1245.1044 15
11201609   002150000  10000   1   0   388.0404  17
11201610   002170000  10000   1   0   1245.1044 19
11201611   002190000  10000   1   0   388.0404  21
11201612   002210000  10000   1   0   1245.1044 23
11201613   002230000  10000   1   0   388.0404  25
11201614   002250000  10000   1   0   1245.1044 27
11201615   002270000  10000   1   0   388.0404  29
11201616   002290000  0000   1   0   2489.277   31
11201617   002280000 -10000   1   0   388.0404  33
11201618   002260000 -10000   1   0   1245.1044 35
11201619   002240000 -10000   1   0   388.0404  37
11201620   002220000 -10000   1   0   1245.1044 39
11201621   002200000 -10000   1   0   388.0404  41
11201622   002180000 -10000   1   0   1245.1044 43
11201623   002160000 -10000   1   0   388.0404  45
11201624   002140000 -10000   1   0   1245.1044 47
11201625   002120000 -10000   1   0   388.0404  49
11201626   002100000 -10000   1   0   1245.1044 51
11201627   002080000 -10000   1   0   388.0404  53
11201628   002060000 -10000   1   0   1245.1044 55
11201629   002040000 -10000   1   0   388.0404  57
11201630   002020000 -10000   1   0   974.2092  59
11201631   030010000  0000   1   0   905.4541   60
11201701   0   0.0   0.0   0.0   60
11201801   0.0  15.0   15.0   1.5   1.5   0.0   0.0   1.0   60
11201901   0.0  15.0   15.0   1.5   1.5   0.0   0.0   1.0   60
*
*
*   composition type and data format
*
```

```
****************************************************
20100100   tbl/fctn   1   1   * inconel
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
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
*
*   control component cards
*
*   compute pressure difference
*
****************************************************
20500100  delptp1  sum  1.45038e-4  0.0  1
20500101  0.0  -1.0, p, 002040000  1.0, p,  002030000
20500200  delptp2  sum  1.45038e-4  0.0  1
20500201  0.0  -1.0, p, 002080000  1.0, p,  002070000
20500300  delptp3  sum  1.45038e-4  0.0  1
20500301  0.0  -1.0, p, 002120000  1.0, p,  002110000
20500400  delptp4  sum  1.45038e-4  0.0  1
20500401  0.0  -1.0, p, 002160000  1.0, p,  002150000
20500500  delptp5  sum  1.45038e-4  0.0  1
20500501  0.0  -1.0, p, 002200000  1.0, p,  002190000
20500600  delptp6  sum  1.45038e-4  0.0  1
20500601  0.0  -1.0, p, 002240000  1.0, p,  002230000
20500700  delptp7  sum  1.45038e-4  0.0  1
20500701  0.0  -1.0, p, 002280000  1.0, p,  002270000
*
*   end of the input
*
****************************************************
```

```
=SLB pressure difference across the SG tube support plats
* hot standby nonequilibrium models
*
*
*
100 new transnt
*
*
102  british  british
105
*
********
*    time step cards
*
*
201    5.  1.d-7  0.005  3  2    200    10000
202   5.3  1.d-7  0.00001  3  1000  20000  100000
203   6.5  1.d-7  0.000025  3  400  8000   100000
204   8.0  1.d-7  0.00005  3  200  10000  100000
205 1000.0  1.d-7  0.00010  3  100  10000  100000
*******************************
*    minor edit variables
*
*
301  mflowj  518000000
302  mflowj  002030000
303  mflowj  002070000
304  mflowj  002110000
305  mflowj  002150000
306  mflowj  002190000
307  mflowj  002230000
308  mflowj  002270000
309  p     017010000
*310  p     018010000
*311  p     019010000
*312  p     020010000
*313  p     021010000
*314  p     022010000
*315  p     023010000
*316  p     033010000
*317  p     034010000
*318  p     036010000
319  cntrlvar  1
320  cntrlvar  2
321  cntrlvar  3
322  cntrlvar  4
323  cntrlvar  5
324  cntrlvar  6
325  cntrlvar  7
*
*
*
```

```
*
*
*
**************************
*   trip input data
*
*
501   time  0  ge  null  0   8.0  l
502   time  0  ge  null  0    5.0  l
503   time  0  ge  null  0  200.0  l
*
*
*
*
*
*
600  501
*
**********************************************************
*  hydrodynamic components
*
**********************************************************
*  primary side model
*  hot leg and cold leg represented by tdvs
**********************************************************
*
1000000  inplen  tmdpvol
1000101  0.0  10.0  5000.0  0.0  0.0  0.0  0.0  0.0  0
1000200   3
1000201   0.0  2235.7  547.0
1000202   5.0  2250.0  547.0
1000203  15.0   800.0  491.0
*1000204  1.0e6  800.0  491.0
*
*
1010000  outplen  tmdpvol
1010101  0.0  10.0  5000.0  0.0  0.0  0.0  0.0  0.0  0
1010200   3
1010201  0.0  2200.0  547.0
1010202  5.0  2200.0  547.0
1010203  15.0  700.0  491.0
*
*
0010000 tubes  pipe
0010001  60
0010101  10.956  60
0010301  1.1667  1
0010302  1.2553  3
0010303  0.5     5
0010304  1.60435  7
0010305  0.5     9
0010306  1.60435  11
```

```
0010307 0.5     13
0010308 1.60435 15
0010309 0.5     17
0010310 1.60435 19
0010311 0.5     21
0010312 1.60435 23
0010313 0.5     25
0010314 1.60435 27
0010315 0.5     29
0010316 3.0     31
0010317 0.5     33
0010318 1.60435 35
0010319 0.5     37
0010320 1.60435 39
0010321 0.5     41
0010322 1.60435 43
0010323 0.5     45
0010324 1.60435 47
0010325 0.5     49
0010326 1.60435 51
0010327 0.5     53
0010328 1.60435 55
0010329 0.5     57
0010330 1.2553  59
0010331 1.1667  60
0010601  90.0   30
0010602 -90.0   60
0010801  0.0    0.0642  60
0011001  00000  60
0011101  000000  59
0011201  3 2250.0  547.0  0.0  0.0  0.0  60
0011300  1
0011301  9148.5  0.0  0.0  59
*
*
5000000  prminl  tmdpjun
5000101  100000000  1000000  10.956
5000200   1
5000201  0.0  9148.5  0.0  0.0
5000202  1.0e6  9148.5  0.0  0.0
*
*
5010000  prmout  tmdpjun
5010101  1010000  101000000  10.956
5010200   1
5010201  0.0  9148.5  0.0  0.0
5010202  1.0e6  9148.5  0.0  0.0
*
*
0020000 shell  pipe
0020001  30
0020101  54.22   27
```

```
0020102 70.0    30
0020201 54.22   2
0020202 23.716  3
0020203 54.22   6
0020204 23.716  7
0020205 54.22   10
0020206 23.716  11
0020207 54.22   14
0020208 23.716  15
0020209 54.22   18
0020210 23.716  19
0020211 54.22   22
0020212 23.716  23
0020213 54.22   26
0020214 23.716  27
0020215 70.0    29
0020301 1.2553  1
0020302 1.2553  2
0020303 0.5     4
0020304 1.60435 6
0020305 0.5     8
0020306 1.60435 10
0020307 0.5     12
0020308 1.60435 14
0020309 0.5     16
0020310 1.60435 18
0020311 0.5     20
0020312 1.60435 22
0020313 0.5     24
0020314 1.60435 26
0020315 0.5     28
0020316 3.2075  29
0020317 3.4338  30
0020601  90.0   30
0020801  0.00015  0.136   29
0020802  0.00015  0.0     30
0020901  0.0   0.0   2
0020902  0.78  0.78  3
0020903  0.0   0.0   6
0020904  0.78  0.78  7
0020905  0.0   0.0   10
0020906  0.78  0.78  11
0020907  0.0   0.0   14
0020908  0.78  0.78  15
0020909  0.0   0.0   18
0020910  0.78  0.78  19
0020911  0.0   0.0   22
0020912  0.78  0.78  23
0020913  0.0   0.0   26
0020914  0.78  0.78  27
0020915  0.0   0.0   29
0021001  00101   29
```

```
0021002  00001   30
0021101  000000  29
0021201  3 1033.73  547.0  0.0  0.0  0.0  1
0021202  3 1033.34  547.0  0.0  0.0  0.0  2
0021203  3 1033.07  547.0  0.0  0.0  0.0  3
0021204  3 1032.91  547.0  0.0  0.0  0.0  4
0021205  3 1032.57  547.0  0.0  0.0  0.0  5
0021206  3 1032.06  547.0  0.0  0.0  0.0  6
0021207  3 1031.72  547.0  0.0  0.0  0.0  7
0021208  3 1031.56  547.0  0.0  0.0  0.0  8
0021209  3 1031.22  547.0  0.0  0.0  0.0  9
0021210  3 1030.71  547.0  0.0  0.0  0.0  10
0021211  3 1030.37  547.0  0.0  0.0  0.0  11
0021212  3 1030.21  547.0  0.0  0.0  0.0  12
0021213  3 1029.87  547.0  0.0  0.0  0.0  13
0021214  3 1029.36  547.0  0.0  0.0  0.0  14
0021215  3 1029.02  547.0  0.0  0.0  0.0  15
0021216  3 1028.86  547.0  0.0  0.0  0.0  16
0021217  3 1028.53  547.0  0.0  0.0  0.0  17
0021218  3 1028.01  547.0  0.0  0.0  0.0  18
0021219  3 1027.68  547.0  0.0  0.0  0.0  19
0021220  3 1027.52  547.0  0.0  0.0  0.0  20
0021221  3 1027.18  547.0  0.0  0.0  0.0  21
0021222  3 1026.66  547.0  0.0  0.0  0.0  22
0021223  3 1026.33  547.0  0.0  0.0  0.0  23
0021224  3 1026.17  547.0  0.0  0.0  0.0  24
0021225  3 1025.83  547.0  0.0  0.0  0.0  25
0021226  3 1025.32  547.0  0.0  0.0  0.0  26
0021227  3 1024.98  547.0  0.0  0.0  0.0  27
0021228  3 1024.82  547.0  0.0  0.0  0.0  28
0021229  3 1024.23  547.0  0.0  0.0  0.0  29
0021230  3 1023.17  547.0  0.0  0.0  0.0  30
0021300  1
0021301  0.0     0.0  0.0  29
0021401  0.0625   0.0  1.0  1.0  29
*
*
0350000 downc  pipe
0350001 3
0350101 0.0    3
0350201 7.096   2
0350301 11.827  3
0350401 122.4   3
0350601 -90.0   3
0350801  0.00015  0.4275 3
0351001  00000 3
0351101  000000 2
0351201  3 1024.84  547.0  0.0  0.0  0.0  1
0351202  3 1028.64  547.0  0.0  0.0  0.0  2
0351203  3 1032.44  547.0  0.0  0.0  0.0  3
0351300  1
0351301  0.0     0.0  0.0  2
```

```
*
*
0300000  tubesh  branch
0300001  2    1
0300101  54.22  1.1667  0.  0.  90.  1.1667  0.00015  0.136  00100
0300200  3   1034.15   547.0
0301101  035010000   030000000  7.096    0.5   0.5   000000
0302101  030010000   002000000  4.43     5.32  5.32  000000
0301201   0.0   0.0   0.0
0302201   0.0   0.0   0.0
*
*
0340000  feedrg  branch
0340001  1    1
0340101  92.1  3.1097  0.0    0. -90.   -3.1097   0.00015  0.0  00000
0340200  3   1022.48   547.0
0341101  034010000   035000000  7.096    0.0   0.0   000100
0341201   0.0   0.0   0.0
*
*
0230000  abovetb  snglvol
0230101  49.43  4.9423  0.0   0.0   90.   4.9423   0.00015  0.0  00000
0230200   2  1022.72  0.03
*
*
5330000  abovetb  sngljun
5330101  002010000  023000000  49.43  0.0  0.0  000100
5330110  0.0  0.0   1.0   1.0
5330201  1   0.0   0.0   0.0
*
*
0220000  speratr  separatr
0220001  3    1
0220101  41.73  3.9156   0.0  0.  90.  3.9156   0.00015  0.0  00000
0220200  2  1021.14   1.0
0221101  022010000   021000000  12.828  0.84  0.47   000000
0222101  022000000   032000000  17.35   0.597 0.597  000000
0223101  023010000   022000000  41.73   8.689 8.689  000000
0221201   0.0   0.0   0.0
0222201   0.0   0.0   0.0
0223201   0.0   0.0   0.0
*
*
0320000  liqsept  snglvol
0320101  17.35   0.0   86.75   0.0    0.   0.0  0.00015  0.0  00000
0320200   2  1021.26  0.92
*
*
0330000  abovf1  branch
0330001  2    1
0330101  100.7  2.9225  0.0  0.0  -90.0  -2.9225   0.00015   0.0   00000
0330200   2  1021.72  0.73
```

```
0331101  032010000 033000000 17.35  0.0  0.0   000000
0332101  033010000 034000000 79.288 0.0  0.0   000000
0331201  0.0  0.0  0.0
0332201  0.0  0.0  0.0
*
*
0530000  abovfr2  branch
0530001  2    1
0530101  100.7  3.9156  0.0  0.0  -90.0  -3.9156  0.00015  0.0  00000
0530200   2  1021.72  0.73
0531101  036010000 053000000 2.34   0.5  0.5   000000
0532101  053010000 033000000 100.7  0.0  0.0   000000
0531201  0.0  0.0  0.0
0532201  0.0  0.0  0.0
*
*
0210000  abovspr  branch
0210001  2  1
0210101  152.19 2.281  0.0  0.0  90.  2.281  0.00015 0.0 00000
0210200   2  1021.12  1.0
0211101  021010000  020000000  70.75  0.0  0.0  000100
0212101  021000000 053000000 7.96  1.78  1.67  000000
0211201  0.0  0.0  0.0
0212201  0.0  0.0  0.0
*
*
0200000  spsteam  snglvol
0200101  70.75  7.4502  0.0 0.0  90.  7.4502  0.00015  0.0  00000
0200200   2  1020.96  1.0
*
*
0190000  dryer   separatr
0190001  3    1
0190101  171.4 0.7083  0.0 0.  0.  0.  0.00015 0.0 00000
0190200 2  1020.96  1.0
0191101 019010000  018000000 63.49   5.502 5.502 000000
0192101 019000000  036000000 2.34    0.5  0.5  000000
0193101 020010000  019000000 70.75   0.5  0.5  000000
0191201  0.0  0.0  0.0
0192201  0.0  0.0  0.0
0193201  0.0  0.0  0.0
*
*
0360000  dsdryer  snglvol
0360101  2.34    9.7312   0.0  0.0 -90.  -9.7312  0.00015 0.0  00000
0360200   2    1021.57  0.82
*
*
0180000  updryer  snglvol
0180101  63.49  0.0  473.0  0.0   0.  0.0 0.00015 0.0 00000
0180200   2    1020.96  1.0
*
```

```
*
*
0170000  sgdoom  snglvol
0170101  94.12  3.5497  0.0  0.0  90.  3.5497  0.00015  0.0  00000
0170200   2    1020.94   1.0
*
*
0380000  contnm  snglvol
0380101  10000.0   200.0  0.0  0.0  90.  200.0  0.0     0.0  00000
0380200   2    14.7     1.0
*
*
5190000  abovefr  sngljun
5190101  018010000  017000000  63.49  0.0  0.0   000000
5190110  0.0  0.0  1.0  1.0
5190201  1  0.0  0.0  0.0
*
*
5180000  break    valve
5180101  017010000  038000000  4.6     0.0  0.0   000100
5180110  0.0  0.0  1.0  1.0
5180201  1  0.0  0.0  0.0
5180300  mtrvlv
5180301  502  503  1000.0  0.0
*
*
*  heat structure input
*
**********************************
11201000  60  11  2  1  0.0321
11201100   0   2
11201101   0.000438    10
11201201   1    10
11201301   0.0   10
11201401   547.0    11
11201501   001010000  0000  1  0  796.74   1
11201502   001020000  10000  1  0  857.24  3
11201503   001040000  10000  1  0  341.45  5
11201504   001060000  10000  1  0  1095.61  7
11201505   001080000  10000  1  0  341.45  9
11201506   001100000  10000  1  0  1095.61  11
11201507   001120000  10000  1  0  341.45  13
11201508   001140000  10000  1  0  1095.61  15
11201509   001160000  10000  1  0  341.45  17
11201510   001180000  10000  1  0  1095.61  19
11201511   001200000  10000  1  0  341.45  21
11201512   001220000  10000  1  0  1095.61  23
11201513   001240000  10000  1  0  341.45  25
11201514   001260000  10000  1  0  1095.61  27
11201515   001280000  10000  1  0  341.45  29
11201516   001300000  10000  1  0  2190.4  31
11201517   001320000  10000  1  0  341.45  33
```

```
11201518   001340000  10000   1   0   1095.61  35
11201519   001360000  10000   1   0   341.45   37
11201520   001380000  10000   1   0   1095.61  39
11201521   001400000  10000   1   0   341.45   41
11201522   001420000  10000   1   0   1095.61  43
11201523   001440000  10000   1   0   341.45   45
11201524   001460000  10000   1   0   1095.61  47
11201525   001480000  10000   1   0   341.45   49
11201526   001500000  10000   1   0   1095.61  51
11201527   001520000  10000   1   0   341.45   53
11201528   001540000  10000   1   0   1095.61  55
11201529   001560000  10000   1   0   341.45   57
11201530   001580000  10000   1   0   857.24   59
11201531   001600000   0000  1   0  796.74    60
11201601   030010000   0000  1   0  905.4541   1
11201602   002010000  10000   1   0   974.2092  3
11201603   002030000  10000   1   0   388.0404  5
11201604   002050000  10000   1   0   1245.1044 7
11201605   002070000  10000   1   0   388.0404  9
11201606   002090000  10000   1   0   1245.1044 11
11201607   002110000  10000   1   0   388.0404  13
11201608   002130000  10000   1   0   1245.1044 15
11201609   002150000  10000   1   0   388.0404  17
11201610   002170000  10000   1   0   1245.1044 19
11201611   002190000  10000   1   0   388.0404  21
11201612   002210000  10000   1   0   1245.1044 23
11201613   002230000  10000   1   0   388.0404  25
11201614   002250000  10000   1   0   1245.1044 27
11201615   002270000  10000   1   0   388.0404  29
11201616   002290000   0000  1   0  2489.277   31
11201617   002280000 -10000   1   0   388.0404  33
11201618   002260000 -10000   1   0   1245.1044 35
11201619   002240000 -10000   1   0   388.0404  37
11201620   002220000 -10000   1   0   1245.1044 39
11201621   002200000 -10000   1   0   388.0404  41
11201622   002180000 -10000   1   0   1245.1044 43
11201623   002160000 -10000   1   0   388.0404  45
11201624   002140000 -10000   1   0   1245.1044 47
11201625   002120000 -10000   1   0   388.0404  49
11201626   002100000 -10000   1   0   1245.1044 51
11201627   002080000 -10000   1   0   388.0404  53
11201628   002060000 -10000   1   0   1245.1044 55
11201629   002040000 -10000   1   0   388.0404  57
11201630   002020000 -10000   1   0   974.2092  59
11201631   030010000   0000  1   0  905.4541   60
11201701   0   0.0   0.0   0.0   60
11201801   0.0  15.0   15.0   1.5   1.5   0.0   0.0   1.0   60
11201901   0.0  15.0   15.0   1.5   1.5   0.0   0.0   1.0   60
*
*
*   composition type and data format
*
```

```
****************************************************
20100100  tbl/fctn  1  1  * inconel
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
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
*
*  control component cards
*
*  compute pressure difference
*
****************************************************
20500100  delptp1  sum  1.45038e-4  0.0  1
20500101  0.0  -1.0, p, 002040000  1.0, p,  002030000
20500200  delptp2  sum  1.45038e-4  0.0  1
20500201  0.0  -1.0, p, 002080000  1.0, p,  002070000
20500300  delptp3  sum  1.45038e-4  0.0  1
20500301  0.0  -1.0, p, 002120000  1.0, p,  002110000
20500400  delptp4  sum  1.45038e-4  0.0  1
20500401  0.0  -1.0, p, 002160000  1.0, p,  002150000
20500500  delptp5  sum  1.45038e-4  0.0  1
20500501  0.0  -1.0, p, 002200000  1.0, p,  002190000
20500600  delptp6  sum  1.45038e-4  0.0  1
20500601  0.0  -1.0, p, 002240000  1.0, p,  002230000
20500700  delptp7  sum  1.45038e-4  0.0  1
20500701  0.0  -1.0, p, 002280000  1.0, p,  002270000
*
*  end of the input
*
****************************************************
.
```

```
=SLB pressure difference across the SG tube support plats
* hot standby nonequilibrium models
*
*
*
100 new transnt
*
*
102  british  british
105
*
********
*    time step cards
*
*
201    5.  1.d-7   0.005   3   2    200    10000
202  5.3   1.d-7   0.00001  3   1000  20000   100000
203  6.5   1.d-7  0.000025  3   400   8000    100000
204  8.0   1.d-7  0.00005   3   200   10000   100000
205 1000.0  1.d-7  0.00010   3   100   10000   100000
******************************
*    minor edit variables
*
*
301   mflowj   518000000
302   mflowj   002030000
303   mflowj   002070000
304   mflowj   002110000
305   mflowj   002150000
306   mflowj   002190000
307   mflowj   002230000
308   mflowj   002270000
309   p       017010000
*310   p       018010000
*311   p       019010000
*312   p       020010000
*313   p       021010000
*314   p       022010000
*315   p       023010000
*316   p       033010000
*317   p       034010000
*318   p       036010000
319   cntrlvar   1
320   cntrlvar   2
321   cntrlvar   3
322   cntrlvar   4
323   cntrlvar   5
324   cntrlvar   6
325   cntrlvar   7
*
*
*
```

```
*
*
*
**************************
*   trip input data
*
*
501   time  0  ge  null  0   8.0  l
502   time  0  ge  null  0    5.0  l
503   time  0  ge  null  0  200.0  l
*
*
*
*
*
*
600  501
*
***********************************************************
*  hydrodynamic components
*
***********************************************************
*  primary side model
*  hot leg and cold leg represented by tdvs
***********************************************************
*
1000000   inplen   tmdpvol
1000101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1000200    3
1000201    0.0   2235.7   547.0
1000202    5.0   2250.0   547.0
1000203   15.0    800.0   491.0
*1000204   1.0e6   800.0   491.0
*
*
1010000   outplen   tmdpvol
1010101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1010200    3
1010201   0.0   2200.0  547.0
1010202   5.0   2200.0  547.0
1010203   15.0  700.0   491.0
*
*
0010000 tubes  pipe
0010001  60
0010101  10.956   60
0010301  1.1667   1
0010302  1.2553   3
0010303  0.5      5
0010304  1.60435  7
0010305  0.5      9
0010306  1.60435  11
```

```
0010307 0.5     13
0010308 1.60435 15
0010309 0.5     17
0010310 1.60435 19
0010311 0.5     21
0010312 1.60435 23
0010313 0.5     25
0010314 1.60435 27
0010315 0.5     29
0010316 3.0     31
0010317 0.5     33
0010318 1.60435 35
0010319 0.5     37
0010320 1.60435 39
0010321 0.5     41
0010322 1.60435 43
0010323 0.5     45
0010324 1.60435 47
0010325 0.5     49
0010326 1.60435 51
0010327 0.5     53
0010328 1.60435 55
0010329 0.5     57
0010330 1.2553  59
0010331 1.1667  60
0010601  90.0   30
0010602 -90.0   60
0010801  0.0    0.0642  60
0011001  00000  60
0011101  000000 59
0011201  3 2250.0  547.0  0.0  0.0  0.0  60
0011300  1
0011301  9148.5  0.0  0.0  59
*
*
5000000  prminl  tmdpjun
5000101  100000000  1000000  10.956
5000200   1
5000201  0.0  9148.5  0.0  0.0
5000202  1.0e6  9148.5  0.0  0.0
*
*
5010000  prmout  tmdpjun
5010101  1010000  101000000  10.956
5010200   1
5010201  0.0  9148.5  0.0  0.0
5010202  1.0e6  9148.5  0.0  0.0
*
*
0020000 shell  pipe
0020001 30
0020101 54.22   27
```

```
0020102 70.0    30
0020201 54.22   2
0020202 23.716  3
0020203 54.22   6
0020204 23.716  7
0020205 54.22   10
0020206 23.716  11
0020207 54.22   14
0020208 23.716  15
0020209 54.22   18
0020210 23.716  19
0020211 54.22   22
0020212 23.716  23
0020213 54.22   26
0020214 23.716  27
0020215 70.0    29
0020301 1.2553  1
0020302 1.2553  2
0020303 0.5     4
0020304 1.60435 6
0020305 0.5     8
0020306 1.60435 10
0020307 0.5     12
0020308 1.60435 14
0020309 0.5     16
0020310 1.60435 18
0020311 0.5     20
0020312 1.60435 22
0020313 0.5     24
0020314 1.60435 26
0020315 0.5     28
0020316 3.2075  29
0020317 3.4338  30
0020601  90.0   30
0020801  0.00015  0.136   29
0020802  0.00015  0.0     30
0020901  0.0   0.0   2
0020902  0.78  0.78  3
0020903  0.0   0.0   6
0020904  0.78  0.78  7
0020905  0.0   0.0   10
0020906  0.78  0.78  11
0020907  0.0   0.0   14
0020908  0.78  0.78  15
0020909  0.0   0.0   18
0020910  0.78  0.78  19
0020911  0.0   0.0   22
0020912  0.78  0.78  23
0020913  0.0   0.0   26
0020914  0.78  0.78  27
0020915  0.0   0.0   29
0021001  00100   29
```

```
0021002  00000   30
0021101  000000  29
0021201  3 1033.73 547.0  0.0  0.0  0.0  1
0021202  3 1033.34 547.0  0.0  0.0  0.0  2
0021203  3 1033.07 547.0  0.0  0.0  0.0  3
0021204  3 1032.91 547.0  0.0  0.0  0.0  4
0021205  3 1032.57 547.0  0.0  0.0  0.0  5
0021206  3 1032.06 547.0  0.0  0.0  0.0  6
0021207  3 1031.72 547.0  0.0  0.0  0.0  7
0021208  3 1031.56 547.0  0.0  0.0  0.0  8
0021209  3 1031.22 547.0  0.0  0.0  0.0  9
0021210  3 1030.71 547.0  0.0  0.0  0.0  10
0021211  3 1030.37 547.0  0.0  0.0  0.0  11
0021212  3 1030.21 547.0  0.0  0.0  0.0  12
0021213  3 1029.87 547.0  0.0  0.0  0.0  13
0021214  3 1029.36 547.0  0.0  0.0  0.0  14
0021215  3 1029.02 547.0  0.0  0.0  0.0  15
0021216  3 1028.86 547.0  0.0  0.0  0.0  16
0021217  3 1028.53 547.0  0.0  0.0  0.0  17
0021218  3 1028.01 547.0  0.0  0.0  0.0  18
0021219  3 1027.68 547.0  0.0  0.0  0.0  19
0021220  3 1027.52 547.0  0.0  0.0  0.0  20
0021221  3 1027.18 547.0  0.0  0.0  0.0  21
0021222  3 1026.66 547.0  0.0  0.0  0.0  22
0021223  3 1026.33 547.0  0.0  0.0  0.0  23
0021224  3 1026.17 547.0  0.0  0.0  0.0  24
0021225  3 1025.83 547.0  0.0  0.0  0.0  25
0021226  3 1025.32 547.0  0.0  0.0  0.0  26
0021227  3 1024.98 547.0  0.0  0.0  0.0  27
0021228  3 1024.82 547.0  0.0  0.0  0.0  28
0021229  3 1024.23 547.0  0.0  0.0  0.0  29
0021230  3 1023.17 547.0  0.0  0.0  0.0  30
0021300  1
0021301  0.0     0.0  0.0  29
0021401  0.0625   0.0  1.0  1.0  29
*
*
0350000 downc  pipe
0350001  3
0350101  0.0     3
0350201  7.096   2
0350301  11.827  3
0350401  122.4   3
0350601  -90.0   3
0350801  0.00015  0.4275  3
0351001  00000  3
0351101  000000  2
0351201  3 1024.84  547.0  0.0  0.0  0.0  1
0351202  3 1028.64  547.0  0.0  0.0  0.0  2
0351203  3 1032.44  547.0  0.0  0.0  0.0  3
0351300  1
0351301  0.0     0.0  0.0  2
```

```
*
*
0300000  tubesh  branch
0300001  2    1
0300101  54.22  1.1667  0.  0.  90.  1.1667  0.00015  0.136  00100
0300200  3   1034.15   547.0
0301101  035010000   030000000  7.096    0.5   0.5   000000
0302101  030010000   002000000  4.43     5.32  5.32  000000
0301201   0.0   0.0   0.0
0302201   0.0   0.0   0.0
*
*
0340000  feedrg  branch
0340001  1    1
0340101  92.1  3.1097  0.0    0. -90.   -3.1097   0.00015  0.0  00000
0340200  3   1022.48   547.0
0341101  034010000   035000000  7.096    0.0   0.0   000100
0341201   0.0   0.0   0.0
*
*
0230000   abovetb   snglvol
0230101   49.43   4.9423   0.0   0.0   90.   4.9423   0.00015  0.0  00000
0230200    2  1022.72  0.03
*
*
5330000   abovetb   sngljun
5330101   002010000  023000000  49.43  0.0  0.0  000100
5330110   0.0  0.0   1.0   1.0
5330201   1   0.0   0.0   0.0
*
*
0220000   speratr   separatr
0220001   3    1
0220101   41.73  3.9156   0.0  0.  90.  3.9156   0.00015  0.0  00000
0220200  2  1021.14   1.0
0221101  022010000   021000000  12.828  0.84  0.47   000000
0222101  022000000   032000000  17.35   0.597 0.597  000000
0223101  023010000   022000000  41.73   8.689 8.689  000000
0221201   0.0   0.0   0.0
0222201   0.0   0.0   0.0
0223201   0.0   0.0   0.0
*
*
0320000   liqsept   snglvol
0320101   17.35   0.0   86.75   0.0    0.   0.0  0.00015  0.0  00000
0320200    2  1021.26  0.92
*
*
0330000   abovf1   branch
0330001   2    1
0330101   100.7   2.9225  0.0  0.0  -90.0   -2.9225   0.00015   0.0   00000
0330200    2  1021.72  0.73
```

```
0331101  032010000  033000000  17.35  0.0  0.0   000000
0332101  033010000  034000000  79.288  0.0  0.0   000000
0331201  0.0  0.0  0.0
0332201  0.0  0.0  0.0
*
*
0530000  abovfr2  branch
0530001  2    1
0530101  100.7  3.9156  0.0  0.0  -90.0  -3.9156  0.00015  0.0  00000
0530200   2  1021.72  0.73
0531101  036010000  053000000  2.34   0.5  0.5   000000
0532101  053010000  033000000  100.7  0.0  0.0   000000
0531201  0.0  0.0  0.0
0532201  0.0  0.0  0.0
*
*
0210000  abovspr  branch
0210001  2  1
0210101  152.19  2.281  0.0  0.0  90.  2.281  0.00015  0.0  00000
0210200   2  1021.12  1.0
0211101  021010000  020000000  70.75  0.0  0.0  000100
0212101  021000000  053000000  7.96  1.78  1.67  000000
0211201  0.0  0.0  0.0
0212201  0.0  0.0  0.0
*
*
0200000  spsteam  snglvol
0200101  70.75  7.4502  0.0  0.0  90.  7.4502  0.00015  0.0  00000
0200200   2  1020.96  1.0
*
*
0190000  dryer   separatr
0190001  3    1
0190101  171.4  0.7083  0.0  0.  0.  0.  0.00015  0.0  00000
0190200  2  1020.96  1.0
0191101  019010000  018000000  63.49   5.502 5.502 000000
0192101  019000000  036000000  2.34    0.5  0.5  000000
0193101  020010000  019000000  70.75   0.5  0.5  000000
0191201  0.0  0.0  0.0
0192201  0.0  0.0  0.0
0193201  0.0  0.0  0.0
*
*
0360000  dsdryer  snglvol
0360101  2.34    9.7312   0.0  0.0  -90.  -9.7312  0.00015  0.0  00000
0360200   2   1021.57  0.82
*
*
0180000  updryer  snglvol
0180101  63.49  0.0  473.0  0.0   0.  0.0  0.00015  0.0  00000
0180200   2   1020.96  1.0
*
```

```
*
*
0170000  sgdoom   snglvol
0170101  94.12  3.5497  0.0   0.0   90.   3.5497   0.00015  0.0  00000
0170200   2    1020.94   1.0
*
*
0380000  contnm   snglvol
0380101  10000.0   200.0   0.0  0.0   90.  200.0  0.0     0.0  00000
0380200   2    14.7     1.0
*
*
5190000  abovefr  sngljun
5190101  018010000  017000000  63.49  0.0   0.0    000000
5190110  0.0  0.0   1.0   1.0
5190201  1   0.0   0.0   0.0
*
*
5180000  break    valve
5180101  017010000  038000000  1.388     0.0   0.0    000100
5180110  0.0  0.0   1.0   1.0
5180201  1   0.0   0.0   0.0
5180300  mtrvlv
5180301  502   503   1000.0   0.0
*
*
*  heat structure input
*
***********************************
11201000   60  11  2  1  0.0321
11201100    0    2
11201101    0.000438     10
11201201    1      10
11201301    0.0    10
11201401    547.0     11
11201501    001010000   0000   1   0   796.74    1
11201502    001020000  10000   1   0   857.24   3
11201503    001040000  10000   1   0   341.45   5
11201504    001060000  10000   1   0   1095.61  7
11201505    001080000  10000   1   0   341.45   9
11201506    001100000  10000   1   0   1095.61  11
11201507    001120000  10000   1   0   341.45   13
11201508    001140000  10000   1   0   1095.61  15
11201509    001160000  10000   1   0   341.45   17
11201510    001180000  10000   1   0   1095.61  19
11201511    001200000  10000   1   0   341.45   21
11201512    001220000  10000   1   0   1095.61  23
11201513    001240000  10000   1   0   341.45   25
11201514    001260000  10000   1   0   1095.61  27
11201515    001280000  10000   1   0   341.45   29
11201516    001300000  10000   1   0   2190.4  31
11201517    001320000  10000   1   0   341.45   33
```

```
11201518  001340000 10000  1  0  1095.61  35
11201519  001360000 10000  1  0  341.45   37
11201520  001380000 10000  1  0  1095.61  39
11201521  001400000 10000  1  0  341.45   41
11201522  001420000 10000  1  0  1095.61  43
11201523  001440000 10000  1  0  341.45   45
11201524  001460000 10000  1  0  1095.61  47
11201525  001480000 10000  1  0  341.45   49
11201526  001500000 10000  1  0  1095.61  51
11201527  001520000 10000  1  0  341.45   53
11201528  001540000 10000  1  0  1095.61  55
11201529  001560000 10000  1  0  341.45   57
11201530  001580000 10000  1  0  857.24   59
11201531  001600000  0000  1  0  796.74   60
11201601  030010000  0000  1  0  905.4541   1
11201602  002010000 10000  1  0  974.2092 3
11201603  002030000 10000  1  0  388.0404 5
11201604  002050000 10000  1  0  1245.1044 7
11201605  002070000 10000  1  0  388.0404 9
11201606  002090000 10000  1  0  1245.1044 11
11201607  002110000 10000  1  0  388.0404 13
11201608  002130000 10000  1  0  1245.1044 15
11201609  002150000 10000  1  0  388.0404 17
11201610  002170000 10000  1  0  1245.1044 19
11201611  002190000 10000  1  0  388.0404 21
11201612  002210000 10000  1  0  1245.1044 23
11201613  002230000 10000  1  0  388.0404 25
11201614  002250000 10000  1  0  1245.1044 27
11201615  002270000 10000  1  0  388.0404 29
11201616  002290000  0000  1  0  2489.277  31
11201617  002280000 -10000  1  0  388.0404 33
11201618  002260000 -10000  1  0  1245.1044 35
11201619  002240000 -10000  1  0  388.0404 37
11201620  002220000 -10000  1  0  1245.1044 39
11201621  002200000 -10000  1  0  388.0404 41
11201622  002180000 -10000  1  0  1245.1044 43
11201623  002160000 -10000  1  0  388.0404 45
11201624  002140000 -10000  1  0  1245.1044 47
11201625  002120000 -10000  1  0  388.0404 49
11201626  002100000 -10000  1  0  1245.1044 51
11201627  002080000 -10000  1  0  388.0404 53
11201628  002060000 -10000  1  0  1245.1044 55
11201629  002040000 -10000  1  0  388.0404 57
11201630  002020000 -10000  1  0  974.2092 59
11201631  030010000  0000  1  0  905.4541  60
11201701  0  0.0  0.0  0.0  60
11201801  0.0  15.0  15.0  1.5  1.5  0.0  0.0  1.0  60
11201901  0.0  15.0  15.0  1.5  1.5  0.0  0.0  1.0  60
*
*
*  composition type and data format
*
```

```
*****************************************************
20100100  tbl/fctn  1  1  * inconel
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
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
*
*  control component cards
*
*  compute pressure difference
*
*****************************************************
20500100  delptp1  sum  1.45038e-4  0.0  1
20500101  0.0  -1.0, p, 002040000  1.0, p,  002030000
20500200  delptp2  sum  1.45038e-4  0.0  1
20500201  0.0  -1.0, p, 002080000  1.0, p,  002070000
20500300  delptp3  sum  1.45038e-4  0.0  1
20500301  0.0  -1.0, p, 002120000  1.0, p,  002110000
20500400  delptp4  sum  1.45038e-4  0.0  1
20500401  0.0  -1.0, p, 002160000  1.0, p,  002150000
20500500  delptp5  sum  1.45038e-4  0.0  1
20500501  0.0  -1.0, p, 002200000  1.0, p,  002190000
20500600  delptp6  sum  1.45038e-4  0.0  1
20500601  0.0  -1.0, p, 002240000  1.0, p,  002230000
20500700  delptp7  sum  1.45038e-4  0.0  1
20500701  0.0  -1.0, p, 002280000  1.0, p,  002270000
*
*  end of the input
*
*****************************************************
.
```

```
=SLB pressure difference across the SG tube support plats
* hot standby nonequilibrium models
*
*
*
100 new transnt
*
*
102  british  british
105
*
********
*    time step cards
*
*
201    5.   1.d-7   0.005   3   2     200     10000
202   5.3   1.d-7   0.00001  3   1000  20000   100000
203   6.5   1.d-7  0.000025  3   400   8000    100000
204   8.0   1.d-7  0.00005   3   200   10000   100000
205 1000.0  1.d-7  0.00010   3   100   10000   100000
******************************
*    minor edit variables
*
*
301   mflowj   518000000
302   mflowj   002030000
303   mflowj   002070000
304   mflowj   002110000
305   mflowj   002150000
306   mflowj   002190000
307   mflowj   002230000
308   mflowj   002270000
309   p      017010000
*310   p      018010000
*311   p      019010000
*312   p      020010000
*313   p      021010000
*314   p      022010000
*315   p      023010000
*316   p      033010000
*317   p      034010000
*318   p      036010000
319   cntrlvar   1
320   cntrlvar   2
321   cntrlvar   3
322   cntrlvar   4
323   cntrlvar   5
324   cntrlvar   6
325   cntrlvar   7
*
*
*
```

```
*
*
*
**************************
*   trip input data
*
*
501   time  0  ge  null  0   8.0  l
502   time  0  ge  null  0    5.0  l
503   time  0  ge  null  0  200.0  l
*
*
*
*
*
*
600   501
*
***********************************************************
*  hydrodynamic components
*
***********************************************************
*  primary side model
*  hot leg and cold leg represented by tdvs
***********************************************************
*
1000000   inplen   tmdpvol
1000101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1000200    3
1000201    0.0   2235.7   547.0
1000202    5.0   2250.0   547.0
1000203   15.0    800.0   491.0
*1000204   1.0e6   800.0   491.0
*
*
1010000   outplen   tmdpvol
1010101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1010200    3
1010201   0.0   2200.0  547.0
1010202   5.0   2200.0  547.0
1010203   15.0  700.0   491.0
*
*
0010000 tubes  pipe
0010001  60
0010101  10.956   60
0010301  1.1667   1
0010302  1.2553   3
0010303  0.5      5
0010304  1.60435  7
0010305  0.5      9
0010306  1.60435  11
```

```
0010307 0.5     13
0010308 1.60435 15
0010309 0.5     17
0010310 1.60435 19
0010311 0.5     21
0010312 1.60435 23
0010313 0.5     25
0010314 1.60435 27
0010315 0.5     29
0010316 3.0     31
0010317 0.5     33
0010318 1.60435 35
0010319 0.5     37
0010320 1.60435 39
0010321 0.5     41
0010322 1.60435 43
0010323 0.5     45
0010324 1.60435 47
0010325 0.5     49
0010326 1.60435 51
0010327 0.5     53
0010328 1.60435 55
0010329 0.5     57
0010330 1.2553  59
0010331 1.1667  60
0010601  90.0   30
0010602 -90.0   60
0010801  0.0    0.0642  60
0011001  00000 60
0011101  000000 59
0011201  3 2250.0  547.0  0.0  0.0  0.0  60
0011300  1
0011301  9148.5  0.0  0.0  59
*
*
5000000  prminl  tmdpjun
5000101  100000000  1000000  10.956
5000200  1
5000201  0.0  9148.5  0.0  0.0
5000202  1.0e6  9148.5  0.0  0.0
*
*
5010000  prmout  tmdpjun
5010101  1010000  101000000  10.956
5010200  1
5010201  0.0  9148.5  0.0  0.0
5010202  1.0e6  9148.5  0.0  0.0
*
*
0020000 shell  pipe
0020001  30
0020101  54.22  27
```

```
0020102 70.0    30
0020201 54.22   2
0020202 23.716  3
0020203 54.22   6
0020204 23.716  7
0020205 54.22   10
0020206 23.716  11
0020207 54.22   14
0020208 23.716  15
0020209 54.22   18
0020210 23.716  19
0020211 54.22   22
0020212 23.716  23
0020213 54.22   26
0020214 23.716  27
0020215 70.0    29
0020301 1.2553  1
0020302 1.2553  2
0020303 0.5     4
0020304 1.60435 6
0020305 0.5     8
0020306 1.60435 10
0020307 0.5     12
0020308 1.60435 14
0020309 0.5     16
0020310 1.60435 18
0020311 0.5     20
0020312 1.60435 22
0020313 0.5     24
0020314 1.60435 26
0020315 0.5     28
0020316 3.2075  29
0020317 3.4338  30
0020601  90.0   30
0020801  0.00015  0.136   29
0020802  0.00015  0.0     30
0020901  0.0   0.0   2
0020902  0.78  0.78  3
0020903  0.0   0.0   6
0020904  0.78  0.78  7
0020905  0.0   0.0   10
0020906  0.78  0.78  11
0020907  0.0   0.0   14
0020908  0.78  0.78  15
0020909  0.0   0.0   18
0020910  0.78  0.78  19
0020911  0.0   0.0   22
0020912  0.78  0.78  23
0020913  0.0   0.0   26
0020914  0.78  0.78  27
0020915  0.0   0.0   29
0021001  00101   29
```

```
0021002  00001   30
0021101  000000  29
0021201  3 1033.73  547.0  0.0  0.0  0.0  1
0021202  3 1033.34  547.0  0.0  0.0  0.0  2
0021203  3 1033.07  547.0  0.0  0.0  0.0  3
0021204  3 1032.91  547.0  0.0  0.0  0.0  4
0021205  3 1032.57  547.0  0.0  0.0  0.0  5
0021206  3 1032.06  547.0  0.0  0.0  0.0  6
0021207  3 1031.72  547.0  0.0  0.0  0.0  7
0021208  3 1031.56  547.0  0.0  0.0  0.0  8
0021209  3 1031.22  547.0  0.0  0.0  0.0  9
0021210  3 1030.71  547.0  0.0  0.0  0.0  10
0021211  3 1030.37  547.0  0.0  0.0  0.0  11
0021212  3 1030.21  547.0  0.0  0.0  0.0  12
0021213  3 1029.87  547.0  0.0  0.0  0.0  13
0021214  3 1029.36  547.0  0.0  0.0  0.0  14
0021215  3 1029.02  547.0  0.0  0.0  0.0  15
0021216  3 1028.86  547.0  0.0  0.0  0.0  16
0021217  3 1028.53  547.0  0.0  0.0  0.0  17
0021218  3 1028.01  547.0  0.0  0.0  0.0  18
0021219  3 1027.68  547.0  0.0  0.0  0.0  19
0021220  3 1027.52  547.0  0.0  0.0  0.0  20
0021221  3 1027.18  547.0  0.0  0.0  0.0  21
0021222  3 1026.66  547.0  0.0  0.0  0.0  22
0021223  3 1026.33  547.0  0.0  0.0  0.0  23
0021224  3 1026.17  547.0  0.0  0.0  0.0  24
0021225  3 1025.83  547.0  0.0  0.0  0.0  25
0021226  3 1025.32  547.0  0.0  0.0  0.0  26
0021227  3 1024.98  547.0  0.0  0.0  0.0  27
0021228  3 1024.82  547.0  0.0  0.0  0.0  28
0021229  3 1024.23  547.0  0.0  0.0  0.0  29
0021230  3 1023.17  547.0  0.0  0.0  0.0  30
0021300  1
0021301  0.0     0.0  0.0  29
0021401  0.0625  0.0  1.0  1.0  29
*
*
0350000 downc  pipe
0350001  3
0350101  0.0     3
0350201  7.096   2
0350301  11.827  3
0350401  122.4   3
0350601  -90.0   3
0350801  0.00015  0.4275  3
0351001  00000  3
0351101  000000  2
0351201  3 1024.84  547.0  0.0  0.0  0.0  1
0351202  3 1028.64  547.0  0.0  0.0  0.0  2
0351203  3 1032.44  547.0  0.0  0.0  0.0  3
0351300  1
0351301  0.0     0.0  0.0  2
```

```
*
*
0300000  tubesh  branch
0300001  2    1
0300101 54.22 1.1667 0. 0. 90. 1.1667 0.00015 0.136 00100
0300200 3  1034.15  547.0
0301101 035010000  030000000 7.096   0.5  0.5  000000
0302101 030010000  002000000 4.43    5.32 5.32 000000
0301201  0.0  0.0  0.0
0302201  0.0  0.0  0.0
*
*
0340000  feedrg  branch
0340001  1    1
0340101 92.1 3.1097 0.0   0. -90.  -3.1097  0.00015 0.0 00000
0340200 3  1022.48  547.0
0341101 034010000  035000000 7.096   0.0  0.0  000100
0341201  0.0  0.0  0.0
*
*
0230000  abovetb  snglvol
0230101  49.43  4.9423  0.0  0.0  90.  4.9423  0.00015 0.0 00000
0230200   2  1022.72  0.03
*
*
5330000  abovetb  sngljun
5330101  002010000  023000000  49.43  0.0  0.0  000100
5330110  0.0  0.0  1.0  1.0
5330201  1  0.0  0.0  0.0
*
*
0220000  speratr  separatr
0220001  3    1
0220101  41.73  3.9156  0.0  0.  90.  3.9156  0.00015  0.0  00000
0220200  2  1021.14  1.0
0221101  022010000  021000000  12.828  0.84  0.47  000000
0222101  022000000  032000000  17.35  0.597 0.597  000000
0223101  023010000  022000000  41.73  8.689 8.689  000000
0221201  0.0  0.0  0.0
0222201  0.0  0.0  0.0
0223201  0.0  0.0  0.0
*
*
0320000  liqsept  snglvol
0320101  17.35  0.0  86.75  0.0   0.  0.0 0.00015  0.0  00000
0320200   2  1021.26  0.92
*
*
0330000  abovf1  branch
0330001  2    1
0330101  100.7  2.9225 0.0 0.0 -90.0  -2.9225  0.00015  0.0  00000
0330200   2  1021.72  0.73
```

```
0331101  032010000 033000000 17.35  0.0  0.0   000000
0332101  033010000 034000000 79.288 0.0  0.0   000000
0331201  0.0  0.0  0.0
0332201  0.0  0.0  0.0
*
*
0530000  abovfr2 branch
0530001  2    1
0530101  100.7  3.9156 0.0 0.0 -90.0  -3.9156  0.00015  0.0  00000
0530200   2 1021.72 0.73
0531101  036010000 053000000 2.34   0.5  0.5   000000
0532101  053010000 033000000 100.7  0.0  0.0   000000
0531201  0.0  0.0  0.0
0532201  0.0  0.0  0.0
*
*
0210000  abovspr branch
0210001  2  1
0210101  152.19 2.281  0.0  0.0  90.  2.281  0.00015 0.0 00000
0210200   2 1021.12  1.0
0211101  021010000  020000000  70.75  0.0  0.0  000100
0212101  021000000 053000000 7.96  1.78  1.67  000000
0211201  0.0  0.0  0.0
0212201  0.0  0.0  0.0
*
*
0200000  spsteam  snglvol
0200101  70.75  7.4502  0.0 0.0  90.  7.4502  0.00015  0.0  00000
0200200   2 1020.96  1.0
*
*
0190000  dryer   separatr
0190001  3    1
0190101  171.4 0.7083  0.0 0.  0.  0.   0.00015 0.0 00000
0190200 2  1020.96  1.0
0191101 019010000  018000000 63.49   5.502 5.502 000000
0192101 019000000  036000000 2.34    0.5  0.5  000000
0193101 020010000  019000000 70.75   0.5  0.5  000000
0191201  0.0  0.0  0.0
0192201  0.0  0.0  0.0
0193201  0.0  0.0  0.0
*
*
0360000  dsdryer  snglvol
0360101  2.34    9.7312   0.0  0.0 -90. -9.7312  0.00015 0.0 00000
0360200   2    1021.57  0.82
*
*
0180000  updryer  snglvol
0180101  63.49  0.0  473.0  0.0   0.   0.0 0.00015  0.0  00000
0180200   2    1020.96  1.0
*
```

```
*
*
0170000  sgdoom  snglvol
0170101  94.12  3.5497  0.0  0.0  90.  3.5497  0.00015  0.0  00000
0170200  2  1020.94  1.0
*
*
0380000  contnm  snglvol
0380101  10000.0  200.0  0.0  0.0  90.  200.0  0.0  0.0  00000
0380200  2  14.7  1.0
*
*
5190000  abovefr  sngljun
5190101  018010000  017000000  63.49  0.0  0.0  000000
5190110  0.0  0.0  1.0  1.0
5190201  1  0.0  0.0  0.0
*
*
5180000  break  valve
5180101  017010000  038000000  1.388  0.0  0.0  000100
5180110  0.0  0.0  1.0  1.0
5180201  1  0.0  0.0  0.0
5180300  mtrvlv
5180301  502  503  1000.0  0.0
*
*
*  heat structure input
*
**********************************
11201000  60  11  2  1  0.0321
11201100  0  2
11201101  0.000438  10
11201201  1  10
11201301  0.0  10
11201401  547.0  11
11201501  001010000  0000  1  0  796.74  1
11201502  001020000  10000  1  0  857.24  3
11201503  001040000  10000  1  0  341.45  5
11201504  001060000  10000  1  0  1095.61  7
11201505  001080000  10000  1  0  341.45  9
11201506  001100000  10000  1  0  1095.61  11
11201507  001120000  10000  1  0  341.45  13
11201508  001140000  10000  1  0  1095.61  15
11201509  001160000  10000  1  0  341.45  17
11201510  001180000  10000  1  0  1095.61  19
11201511  001200000  10000  1  0  341.45  21
11201512  001220000  10000  1  0  1095.61  23
11201513  001240000  10000  1  0  341.45  25
11201514  001260000  10000  1  0  1095.61  27
11201515  001280000  10000  1  0  341.45  29
11201516  001300000  10000  1  0  2190.4  31
11201517  001320000  10000  1  0  341.45  33
```

```
11201518  001340000  10000  1  0  1095.61  35
11201519  001360000  10000  1  0  341.45   37
11201520  001380000  10000  1  0  1095.61  39
11201521  001400000  10000  1  0  341.45   41
11201522  001420000  10000  1  0  1095.61  43
11201523  001440000  10000  1  0  341.45   45
11201524  001460000  10000  1  0  1095.61  47
11201525  001480000  10000  1  0  341.45   49
11201526  001500000  10000  1  0  1095.61  51
11201527  001520000  10000  1  0  341.45   53
11201528  001540000  10000  1  0  1095.61  55
11201529  001560000  10000  1  0  341.45   57
11201530  001580000  10000  1  0  857.24   59
11201531  001600000  0000  1  0  796.74   60
11201601  030010000  0000  1  0  905.4541   1
11201602  002010000  10000  1  0  974.2092  3
11201603  002030000  10000  1  0  388.0404  5
11201604  002050000  10000  1  0  1245.1044 7
11201605  002070000  10000  1  0  388.0404  9
11201606  002090000  10000  1  0  1245.1044 11
11201607  002110000  10000  1  0  388.0404  13
11201608  002130000  10000  1  0  1245.1044 15
11201609  002150000  10000  1  0  388.0404  17
11201610  002170000  10000  1  0  1245.1044 19
11201611  002190000  10000  1  0  388.0404  21
11201612  002210000  10000  1  0  1245.1044 23
11201613  002230000  10000  1  0  388.0404  25
11201614  002250000  10000  1  0  1245.1044 27
11201615  002270000  10000  1  0  388.0404  29
11201616  002290000  0000  1  0  2489.277   31
11201617  002280000 -10000  1  0  388.0404  33
11201618  002260000 -10000  1  0  1245.1044 35
11201619  002240000 -10000  1  0  388.0404  37
11201620  002220000 -10000  1  0  1245.1044 39
11201621  002200000 -10000  1  0  388.0404  41
11201622  002180000 -10000  1  0  1245.1044 43
11201623  002160000 -10000  1  0  388.0404  45
11201624  002140000 -10000  1  0  1245.1044 47
11201625  002120000 -10000  1  0  388.0404  49
11201626  002100000 -10000  1  0  1245.1044 51
11201627  002080000 -10000  1  0  388.0404  53
11201628  002060000 -10000  1  0  1245.1044 55
11201629  002040000 -10000  1  0  388.0404  57
11201630  002020000 -10000  1  0  974.2092  59
11201631  030010000  0000  1  0  905.4541   60
11201701  0   0.0   0.0   0.0   60
11201801  0.0  15.0   15.0   1.5   1.5   0.0   0.0   1.0   60
11201901  0.0  15.0   15.0   1.5   1.5   0.0   0.0   1.0   60
*
*
*   composition type and data format
*
```

```
*****************************************************
20100100   tbl/fctn   1   1   * inconel
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
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
*
*   control component cards
*
*   compute pressure difference
*
*****************************************************
20500100  delptp1   sum   1.45038e-4   0.0   1
20500101  0.0   -1.0, p, 002040000   1.0, p,  002030000
20500200  delptp2   sum   1.45038e-4   0.0   1
20500201  0.0   -1.0, p, 002080000   1.0, p,  002070000
20500300  delptp3   sum   1.45038e-4   0.0   1
20500301  0.0   -1.0, p, 002120000   1.0, p,  002110000
20500400  delptp4   sum   1.45038e-4   0.0   1
20500401  0.0   -1.0, p, 002160000   1.0, p,  002150000
20500500  delptp5   sum   1.45038e-4   0.0   1
20500501  0.0   -1.0, p, 002200000   1.0, p,  002190000
20500600  delptp6   sum   1.45038e-4   0.0   1
20500601  0.0   -1.0, p, 002240000   1.0, p,  002230000
20500700  delptp7   sum   1.45038e-4   0.0   1
20500701  0.0   -1.0, p, 002280000   1.0, p,  002270000
*
*   end of the input
*
*****************************************************
.
```

```
=SLB pressure difference across the SG tube support plats
* hot standby nonequilibrium models
*
*
*
100 new transnt
*
*
102  british  british
105
*
********
*    time step cards
*
*
201    5.  1.d-7  0.005  3  2    200    10000
202  5.3  1.d-7  0.00001  3  1000  20000  100000
203  6.5  1.d-7  0.000025  3  400  8000   100000
204  8.0  1.d-7  0.00005  3  200  10000  100000
205 1000.0  1.d-7  0.00010  3  100  10000  100000
*******************************
*    minor edit variables
*
*
301  mflowj  518000000
302  mflowj  002030000
303  mflowj  002070000
304  mflowj  002110000
305  mflowj  002150000
306  mflowj  002190000
307  mflowj  002230000
308  mflowj  002270000
309  p     017010000
*310  p     018010000
*311  p     019010000
*312  p     020010000
*313  p     021010000
*314  p     022010000
*315  p     023010000
*316  p     033010000
*317  p     034010000
*318  p     036010000
319  cntrlvar  1
320  cntrlvar  2
321  cntrlvar  3
322  cntrlvar  4
323  cntrlvar  5
324  cntrlvar  6
325  cntrlvar  7
*
*
*
```

```
*
*
*
**************************
*   trip input data
*
*
501   time  0  ge  null  0   8.0  l
502   time  0  ge  null  0    5.0  l
503   time  0  ge  null  0  200.0  l
*
*
*
*
*
*
600  501
*
************************************************************
*  hydrodynamic components
*
************************************************************
*  primary side model
*  hot leg and cold leg represented by tdvs
************************************************************
*
1000000   inplen   tmdpvol
1000101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1000200    3
1000201    0.0   2235.7   547.0
1000202    5.0   2250.0   547.0
1000203   15.0    800.0   491.0
*1000204   1.0e6   800.0   491.0
*
*
1010000   outplen   tmdpvol
1010101   0.0   10.0   5000.0   0.0   0.0   0.0   0.0   0.0   0
1010200    3
1010201   0.0   2200.0  547.0
1010202   5.0   2200.0  547.0
1010203   15.0  700.0   491.0
*
*
0010000 tubes  pipe
0010001  60
0010101  10.956   60
0010301  1.1667   1
0010302  1.2553   3
0010303  0.5      5
0010304  1.60435  7
0010305  0.5      9
0010306  1.60435  11
```

```
0010307 0.5     13
0010308 1.60435 15
0010309 0.5     17
0010310 1.60435 19
0010311 0.5     21
0010312 1.60435 23
0010313 0.5     25
0010314 1.60435 27
0010315 0.5     29
0010316 3.0     31
0010317 0.5     33
0010318 1.60435 35
0010319 0.5     37
0010320 1.60435 39
0010321 0.5     41
0010322 1.60435 43
0010323 0.5     45
0010324 1.60435 47
0010325 0.5     49
0010326 1.60435 51
0010327 0.5     53
0010328 1.60435 55
0010329 0.5     57
0010330 1.2553  59
0010331 1.1667  60
0010601  90.0   30
0010602 -90.0   60
0010801  0.0    0.0642  60
0011001  00000  60
0011101  000000 59
0011201  3 2250.0  547.0  0.0  0.0  0.0  60
0011300  1
0011301  9148.5  0.0  0.0  59
*
*
5000000  prminl  tmdpjun
5000101  100000000  1000000  10.956
5000200  1
5000201  0.0  9148.5  0.0  0.0
5000202  1.0e6  9148.5  0.0  0.0
*
*
5010000  prmout  tmdpjun
5010101  1010000  101000000  10.956
5010200  1
5010201  0.0  9148.5  0.0  0.0
5010202  1.0e6  9148.5  0.0  0.0
*
*
0020000 shell  pipe
0020001 30
0020101 54.22   27
```

```
0020102 70.0    30
0020201 54.22   2
0020202 23.716  3
0020203 54.22   6
0020204 23.716  7
0020205 54.22   10
0020206 23.716  11
0020207 54.22   14
0020208 23.716  15
0020209 54.22   18
0020210 23.716  19
0020211 54.22   22
0020212 23.716  23
0020213 54.22   26
0020214 23.716  27
0020215 70.0    29
0020301 1.2553  1
0020302 1.2553  2
0020303 0.5     4
0020304 1.60435 6
0020305 0.5     8
0020306 1.60435 10
0020307 0.5     12
0020308 1.60435 14
0020309 0.5     16
0020310 1.60435 18
0020311 0.5     20
0020312 1.60435 22
0020313 0.5     24
0020314 1.60435 26
0020315 0.5     28
0020316 3.2075  29
0020317 3.4338  30
0020601  90.0   30
0020801  0.00015  0.136   29
0020802  0.00015  0.0     30
0020901  0.0   0.0   2
0020902  0.99  0.99  3
0020903  0.0   0.0   6
0020904  0.99  0.99  7
0020905  0.0   0.0   10
0020906  0.99  0.99  11
0020907  0.0   0.0   14
0020908  0.99  0.99  15
0020909  0.0   0.0   18
0020910  0.99  0.99  19
0020911  0.0   0.0   22
0020912  0.99  0.99  23
0020913  0.0   0.0   26
0020914  0.99  0.99  27
0020915  0.0   0.0   29
0021001  00100   29
```

```
0021002  00000   30
0021101  000000  29
0021201  3 1033.73  547.0  0.0  0.0  0.0  1
0021202  3 1033.34  547.0  0.0  0.0  0.0  2
0021203  3 1033.07  547.0  0.0  0.0  0.0  3
0021204  3 1032.91  547.0  0.0  0.0  0.0  4
0021205  3 1032.57  547.0  0.0  0.0  0.0  5
0021206  3 1032.06  547.0  0.0  0.0  0.0  6
0021207  3 1031.72  547.0  0.0  0.0  0.0  7
0021208  3 1031.56  547.0  0.0  0.0  0.0  8
0021209  3 1031.22  547.0  0.0  0.0  0.0  9
0021210  3 1030.71  547.0  0.0  0.0  0.0  10
0021211  3 1030.37  547.0  0.0  0.0  0.0  11
0021212  3 1030.21  547.0  0.0  0.0  0.0  12
0021213  3 1029.87  547.0  0.0  0.0  0.0  13
0021214  3 1029.36  547.0  0.0  0.0  0.0  14
0021215  3 1029.02  547.0  0.0  0.0  0.0  15
0021216  3 1028.86  547.0  0.0  0.0  0.0  16
0021217  3 1028.53  547.0  0.0  0.0  0.0  17
0021218  3 1028.01  547.0  0.0  0.0  0.0  18
0021219  3 1027.68  547.0  0.0  0.0  0.0  19
0021220  3 1027.52  547.0  0.0  0.0  0.0  20
0021221  3 1027.18  547.0  0.0  0.0  0.0  21
0021222  3 1026.66  547.0  0.0  0.0  0.0  22
0021223  3 1026.33  547.0  0.0  0.0  0.0  23
0021224  3 1026.17  547.0  0.0  0.0  0.0  24
0021225  3 1025.83  547.0  0.0  0.0  0.0  25
0021226  3 1025.32  547.0  0.0  0.0  0.0  26
0021227  3 1024.98  547.0  0.0  0.0  0.0  27
0021228  3 1024.82  547.0  0.0  0.0  0.0  28
0021229  3 1024.23  547.0  0.0  0.0  0.0  29
0021230  3 1023.17  547.0  0.0  0.0  0.0  30
0021300  1
0021301  0.0     0.0  0.0  29
0021401  0.0625   0.0  1.0  1.0  29
*
*
0350000 downc  pipe
0350001  3
0350101  0.0     3
0350201  7.096   2
0350301  11.827  3
0350401  122.4   3
0350601  -90.0   3
0350801  0.00015  0.4275  3
0351001  00000  3
0351101  000000  2
0351201  3 1024.84  547.0  0.0  0.0  0.0  1
0351202  3 1028.64  547.0  0.0  0.0  0.0  2
0351203  3 1032.44  547.0  0.0  0.0  0.0  3
0351300  1
0351301  0.0     0.0  0.0  2
```

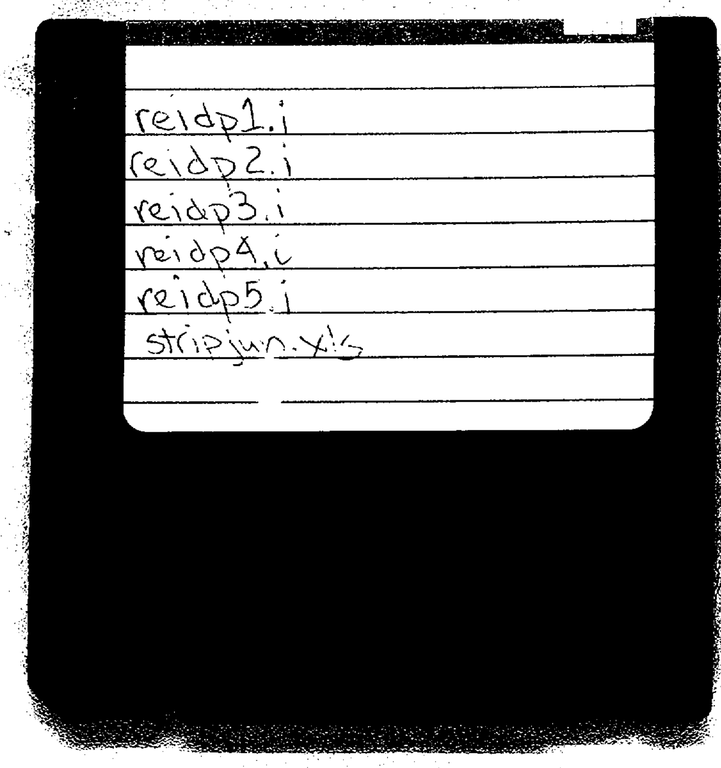
```
*
*
0300000  tubesh  branch
0300001  2    1
0300101 54.22 1.1667 0. 0. 90. 1.1667 0.00015 0.136 00100
0300200 3  1034.15  547.0
0301101 035010000  030000000 7.096   0.0  0.0  000000
0302101 030010000  002000000 4.43    5.32 5.32 000000
0301201  0.0  0.0  0.0
0302201  0.0  0.0  0.0
*
*
0340000  feedrg  branch
0340001  1    1
0340101 92.1 3.1097 0.0   0. -90.  -3.1097  0.00015 0.0 00000
0340200 3  1022.48  547.0
0341101 034010000  035000000 7.096   0.0  0.0  000100
0341201  0.0  0.0  0.0
*
*
0230000  abovetb  snglvol
0230101  49.43  4.9423  0.0  0.0  90.  4.9423  0.00015 0.0 00000
0230200   2 1022.72 0.39
*
*
5330000  abovetb  sngljun
5330101  002010000 023000000 49.43 0.0 0.0 000100
5330110  0.0 0.0  1.0  1.0
5330201  1  0.0  0.0  0.0
*
*
0220000  speratr  separatr
0220001  3    1
0220101  41.73 3.9156  0.0 0. 90. 3.9156  0.00015 0.0 00000
0220200 2  1021.14  1.0
0221101 022010000  021000000 12.828 0.84 0.47  000000
0222101 022000000  032000000 17.35  0.597 0.597 000000
0223101 023010000  022000000 41.73  8.689 8.689 000000
0221201  0.0  0.0  0.0
0222201  0.0  0.0  0.0
0223201  0.0  0.0  0.0
*
*
0320000  liqsept  snglvol
0320101  17.35  0.0  86.75  0.0   0.  0.0 0.00015 0.0 00000
0320200   2 1021.26 1.0
*
*
0330000  abovf1  branch
0330001  2    1
0330101  100.7  2.9225 0.0 0.0 -90.0  -2.9225  0.00015  0.0  00000
0330200   2 1021.72 0.93
```

```
0331101  032010000 033000000 17.35  0.0  0.0   000000
0332101  033010000 034000000 79.288 0.0  0.0   000000
0331201  0.0  0.0  0.0
0332201  0.0  0.0  0.0
*
*
0530000  abovfr2  branch
0530001  2    1
0530101  100.7  3.9156 0.0 0.0 -90.0  -3.9156  0.00015  0.0  00000
0530200   2  1021.72  0.93
0531101  036010000  053000000 2.34   0.5  0.5   000000
0532101  053010000  033000000 100.7  0.0  0.0   000000
0531201  0.0  0.0  0.0
0532201  0.0  0.0  0.0
*
*
0210000  abovspr  branch
0210001  2  1
0210101  152.19 2.281  0.0  0.0  90.  2.281  0.00015 0.0 00000
0210200   2  1021.12  1.0
0211101  021010000  020000000  70.75  0.0  0.0  000100
0212101  021000000  053000000 7.96  1.78  1.67  000000
0211201  0.0  0.0  0.0
0212201  0.0  0.0  0.0
*
*
0200000  spsteam  snglvol
0200101  70.75  7.4502  0.0 0.0  90.  7.4502  0.00015  0.0  00000
0200200   2  1020.96  1.0
*
*
0190000  dryer   separatr
0190001  3    1
0190101  171.4 0.7083  0.0 0.  0.  0.   0.00015 0.0 00000
0190200 2  1020.96  1.0
0191101 019010000  018000000 63.49   5.502 5.502 000000
0192101 019000000  036000000 2.34    0.5  0.5  000000
0193101 020010000  019000000 70.75   0.5  0.5  000000
0191201  0.0  0.0  0.0
0192201  0.0  0.0  0.0
0193201  0.0  0.0  0.0
*
*
0360000  dsdryer  snglvol
0360101  2.34    9.7312    0.0  0.0 -90.  -9.7312  0.00015  0.0  00000
0360200   2    1021.57   1.0
*
*
0180000  updryer  snglvol
0180101  63.49  0.0  473.0  0.0   0.  0.0 0.00015 0.0 00000
0180200   2    1020.96   1.0
*
```

```
*
*
0170000  sgdoom  snglvol
0170101  94.12  3.5497  0.0   0.0   90.   3.5497   0.00015  0.0  00000
0170200   2    1020.94   1.0
*
*
0380000  contnm   snglvol
0380101  10000.0    200.0   0.0  0.0   90.  200.0  0.0     0.0  00000
0380200   2    14.7     1.0
*
*
5190000  abovefr  sngljun
5190101  018010000  017000000  63.49  0.0   0.0    000000
5190110  0.0  0.0   1.0   1.0
5190201  1   0.0   0.0   0.0
*
*
5180000  break    valve
5180101  017010000  038000000  4.6       0.0   0.0    000100
5180110  0.0  0.0   1.0   1.0
5180201  1   0.0   0.0   0.0
5180300  mtrvlv
5180301  502   503   1000.0   0.0
*
*
*  heat structure input
*
**********************************
11201000   60  11  2  1  0.0321
11201100    0    2
11201101    0.000438     10
11201201    1      10
11201301   0.0    10
11201401   547.0     11
11201501   001010000   0000   1   0   796.74    1
11201502   001020000  10000   1   0   857.24   3
11201503   001040000  10000   1   0   341.45   5
11201504   001060000  10000   1   0   1095.61  7
11201505   001080000  10000   1   0   341.45   9
11201506   001100000  10000   1   0   1095.61  11
11201507   001120000  10000   1   0   341.45   13
11201508   001140000  10000   1   0   1095.61  15
11201509   001160000  10000   1   0   341.45   17
11201510   001180000  10000   1   0   1095.61  19
11201511   001200000  10000   1   0   341.45   21
11201512   001220000  10000   1   0   1095.61  23
11201513   001240000  10000   1   0   341.45   25
11201514   001260000  10000   1   0   1095.61  27
11201515   001280000  10000   1   0   341.45   29
11201516   001300000  10000   1   0   2190.4  31
11201517   001320000  10000   1   0   341.45   33
```

```
11201518  001340000  10000  1  0  1095.61  35
11201519  001360000  10000  1  0  341.45   37
11201520  001380000  10000  1  0  1095.61  39
11201521  001400000  10000  1  0  341.45   41
11201522  001420000  10000  1  0  1095.61  43
11201523  001440000  10000  1  0  341.45   45
11201524  001460000  10000  1  0  1095.61  47
11201525  001480000  10000  1  0  341.45   49
11201526  001500000  10000  1  0  1095.61  51
11201527  001520000  10000  1  0  341.45   53
11201528  001540000  10000  1  0  1095.61  55
11201529  001560000  10000  1  0  341.45   57
11201530  001580000  10000  1  0  857.24   59
11201531  001600000  0000  1  0  796.74   60
11201601  030010000  0000  1  0  905.4541  1
11201602  002010000  10000  1  0  974.2092  3
11201603  002030000  10000  1  0  388.0404  5
11201604  002050000  10000  1  0  1245.1044 7
11201605  002070000  10000  1  0  388.0404  9
11201606  002090000  10000  1  0  1245.1044 11
11201607  002110000  10000  1  0  388.0404  13
11201608  002130000  10000  1  0  1245.1044 15
11201609  002150000  10000  1  0  388.0404  17
11201610  002170000  10000  1  0  1245.1044 19
11201611  002190000  10000  1  0  388.0404  21
11201612  002210000  10000  1  0  1245.1044 23
11201613  002230000  10000  1  0  388.0404  25
11201614  002250000  10000  1  0  1245.1044 27
11201615  002270000  10000  1  0  388.0404  29
11201616  002290000  0000  1  0  2489.277  31
11201617  002280000 -10000  1  0  388.0404  33
11201618  002260000 -10000  1  0  1245.1044 35
11201619  002240000 -10000  1  0  388.0404  37
11201620  002220000 -10000  1  0  1245.1044 39
11201621  002200000 -10000  1  0  388.0404  41
11201622  002180000 -10000  1  0  1245.1044 43
11201623  002160000 -10000  1  0  388.0404  45
11201624  002140000 -10000  1  0  1245.1044 47
11201625  002120000 -10000  1  0  388.0404  49
11201626  002100000 -10000  1  0  1245.1044 51
11201627  002080000 -10000  1  0  388.0404  53
11201628  002060000 -10000  1  0  1245.1044 55
11201629  002040000 -10000  1  0  388.0404  57
11201630  002020000 -10000  1  0  974.2092  59
11201631  030010000  0000  1  0  905.4541  60
11201701  0  0.0  0.0  0.0  60
11201801  0.0  15.0  15.0  1.5  1.5  0.0  0.0  1.0  60
11201901  0.0  15.0  15.0  1.5  1.5  0.0  0.0  1.0  60
*
*
*  composition type and data format
*
```

```
****************************************************
20100100   tbl/fctn   1   1   * inconel
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
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
*
*   control component cards
*
*   compute pressure difference
*
****************************************************
20500100  delptp1  sum  1.45038e-4  0.0  1
20500101  0.0  -1.0, p, 002040000  1.0, p,  002030000
20500200  delptp2  sum  1.45038e-4  0.0  1
20500201  0.0  -1.0, p, 002080000  1.0, p,  002070000
20500300  delptp3  sum  1.45038e-4  0.0  1
20500301  0.0  -1.0, p, 002120000  1.0, p,  002110000
20500400  delptp4  sum  1.45038e-4  0.0  1
20500401  0.0  -1.0, p, 002160000  1.0, p,  002150000
20500500  delptp5  sum  1.45038e-4  0.0  1
20500501  0.0  -1.0, p, 002200000  1.0, p,  002190000
20500600  delptp6  sum  1.45038e-4  0.0  1
20500601  0.0  -1.0, p, 002240000  1.0, p,  002230000
20500700  delptp7  sum  1.45038e-4  0.0  1
20500701  0.0  -1.0, p, 002280000  1.0, p,  002270000
*
*   end of the input
*
****************************************************
.
```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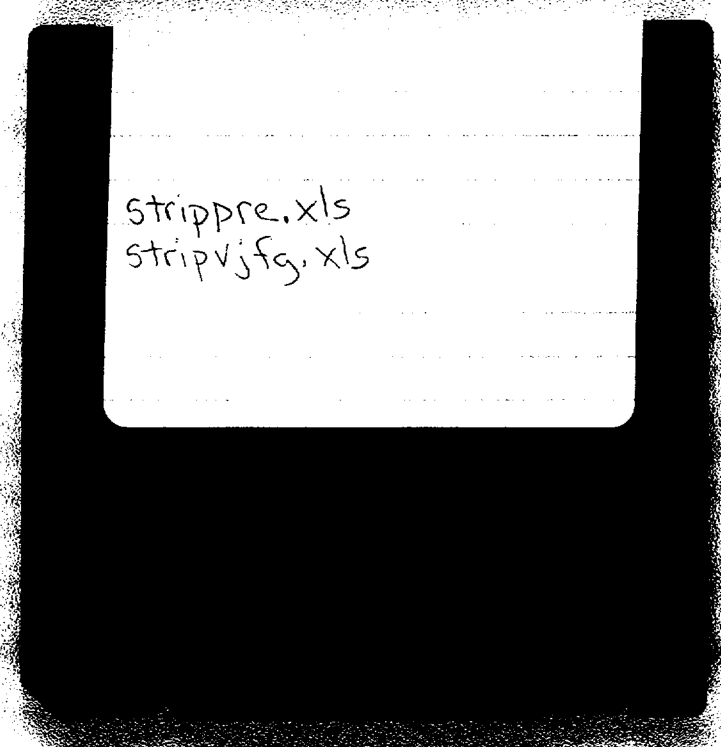
reidp2.i
reidp3.i
reidp4.i
reidp5.i
stripjun.xls


strippre.xls
stripvjfg.xls