Calculations of Condenser Performance Using PEPSE®

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ABSTRACT

This paper presents calculation models of a condenser, common to electric power generation stations. Calculations quantify the condenser's shell pressure as it depends on characteristics of the condenser, such as tube plugging that occurs as the condenser ages. The models include a small submodel of a condenser and a fossil steam turbine Rankine cycle that includes a condenser. The method of calculation closely follows that published by the Heat Exchange Institute. This method has been programmed in PEPSE.

The purpose of the paper is to demonstrate application of the method and to show that accounting for circulating water flow as tube plugging varies can affect the interpretation of results. The dependence of flow on tube plugging is calculated by accounting for the hydraulic balance between the tube-side circuit's pressure drop and the pressure head provided by the circulating water pump.

INTRODUCTION

The condenser in a steam electric power generation station is one of the most influential items of equipment in the system. Its performance strongly affects the amount of power generation and the heat rate of the station. Standard wisdom holds that the lower the shell pressure of the condenser, the better. There are important limitations of this idea (turbine choking and others), but we need to have a quantitative grasp of how the condenser pressure changes as conditions may change.

The tools to quantify the condenser pressure functionality have been available in the industry, via the HEI - Heat Exchange Institute - publications, via methods programmed in PEPSE (including “design mode” and HEI methods), and others, for some time. See References 1, 2, and 3. This paper provides some examples and a discussion on application of the HEI method of representing the heat transfer in such calculations. The tube-side pressure drop is represented by long-standing fluid-mechanical formulations programmed in PEPSE, involving friction factor and form loss factor. These do not necessarily identically match the pressure drop method presented in the HEI document. The examples address the effect of varying amounts of tube plugging as this impacts the calculated shell pressure.

Comparisons are made between results under differing assumptions in two separate scenarios. In the first and simpler scenario, the rate of flow of circulating water is held fixed. This scenario is certainly the easier to set up. Therefore, it is a method that is often used by modelers to make a quick estimate of the condenser’s performance.

It is reasonable to ask whether this assumption that is made for ease of analysis might contribute to misleading results. To answer this question, a second scenario was run, where the rate of flow was varied, as the percentage of tubes plugged was varied. The method of calculating flow in the latter scenario was to match the circulating water pump’s pressure head (which is related to flow rate) against a simulation of the hydraulic pressure drop in the condenser and its piping (which is proportional to flow rate). We can visualize this as finding the intersection of the curves of pressure drop and of pump head versus flow rate.

In order to find the intersection, PEPSE’s special features were implemented. A schedule was used to represent the pump’s head curve. The hydraulic pressure resistance of the condenser and piping was represented by a Type 1 stream. The balance between the pump head and this resistance was obtained by use of a PEPSE control. The sensitivity study feature was used to expedite analyzing the variation of tube plugging.

Numerous assumptions were required in order to apply this method. If these specific assumptions do not apply in some other system, the method of calculation still applies. Only the specific details of application differ.

THE ANALYSIS TOOL

The latest development version (GT4) of PEPSE has been used to run these analyses. Included in this version are the latest, 97, version of the steam tables, Reference 4. Also included in this version is the "sensitivity study" feature, which is applied here to quickly and easily show the effects of tube plugging over a selected range. It is possible to run these analyses using older versions. To do so would necessitate doing manual, individual, settings of each value of the tube plugging quantity and running individual cases with these values. Release of this version is planned for July, 2000.

ASSUMPTIONS

1. HEI method is a good characterization of condenser thermal performance. This includes use of the 5 °F TTD limit, per guidance of HEI.

2. Pump head versus flow curve is a good characterization of the pump's behavior.

3. The elevation pressure head for the circulating water system is negligible in comparison to the friction losses and the losses due to bends, expansions, contractions, and other "minor" losses.

4. The pump draws its circulating water supply from a reservoir at atmospheric pressure.

5. The condenser piping system exhausts the circulating water to atmospheric pressure.

6. The pressure drop through the tubes of the condenser and its piping can be characterized by the wall friction loss in a single tube (all tubes are considered to be in "parallel" in the flow circuit), plus an equivalent form loss factor that represents the pressure drop in associated piping. The use of a Type 1 stream is used because PEPSE does not include a tube-side pressure drop calculation for the HEI mode of analysis. Friction factor (functionality with Reynolds number programmed in PEPSE) and form loss factor adequately represent the hydraulic pressure drop of the tubes in the condenser and its associated piping. The form loss factor (as related to the velocity inside of the tubes) is assumed a constant of the circulating water system.

7. In the submodel application, it is adequate to maintain a "typical" shell steam side inlet flow rate and thermodynamic condition. In the system model, this assumption is not needed, because the flow rate and condition of steam adjust as changes occur in the condenser itself and throughout the turbine cycle.

8. In the submodel application, the condenser's drain inlet flow rate and thermodynamic condition are held fixed. The system model includes automatic adjustment of this inlet to the condenser.

SUBMODEL FOR PARAMETRIC ANALYSIS OF CONDENSER

A submodel has been developed using the graphics interface program (MMI) for PEPSE. The model demonstrates the analysis of the condenser in combination with the circulating water pump. The data for this model are illustrative. While the data may be close, they do not necessarily exactly match any existing system. The schematic for this submodel is shown in Figure 1. The input data file for this model, shown in Table 1, presents a concise summary of the data inputs to the PEPSE calculation. Refer to PEPSE Manual Volume 1, Reference 5 in order to interpret the data.

As seen in Figure 1 and fully documented in Table 1of the Appendix, the source component with ID = 40 provides the circulating water to the pump. As noted above, for one scenario of studies, the flow rate of water was maintained fixed, and for a second scenario, the flow rate was adjusted from case to case to maintain the balance between pump head and circulating water pressure drop. In this second scenario, the amount of circulating water flowing is proportional to the number of tubes that are not plugged. The control shown in Table 1, line sequence counter 840100, calculates the balance point. To run the fixed flow case, a “DELETE” command is placed on this control.

The hydraulic pressure drop for the condenser is simulated by stream 61, a Type 1 stream that is shown as a parallel branch originating at splitter component 60. The flow split to this branch is calculated as the amount that would flow in a single tube inside of the condenser. To accomplish this, component 60 is a “fixed-percent” splitter. Its flow split is a fraction equal to the number of passes in the condenser divided by the total number of tubes. In this study, the number of tubes is used to account for the amount of tube plugging, and therefore the number of tubes varies from one analysis case to another. For ease of implementation, PEPSE operations have been included in the model in order to automatically adjust the flow split fraction. The total number of tubes in the as-designed condenser is 36,374.

The input data for the condenser, component 20, specify a “cleanliness factor” of 85%. This conservatism is used consistently throughout the analyses. Qualitatively, the conclusions of this study would not change if the factor were 100%. It is easy to verify this assertion by changing the input 0.85 to a 1.0 and repeating the run.

The input description of Type 1 stream 61 includes the actual inside diameter and length of a tube in the condenser. In addition, a form loss coefficient is input to quantify all of the miscellaneous pressure drops in the piping between the exit of the pump and the ultimate exhaust to atmospheric pressure. These are drops due to bends, headers, sudden expansions and contractions and other minor flow resistances. This form loss factor was calculated by a preliminary run of the model with the condenser and pump at design conditions. In this run, the form loss factor was adjusted to provide atmospheric pressure at the outlet of stream 61.

Figure 2 shows the curve of normalized pump pressure rise as a function of normalized flow rate. A schedule has been used to input this curve to the analysis. The head curve is illustrative, having been extracted and normalized from related applications. This was necessary because the source of information on the condenser provided no pump description.

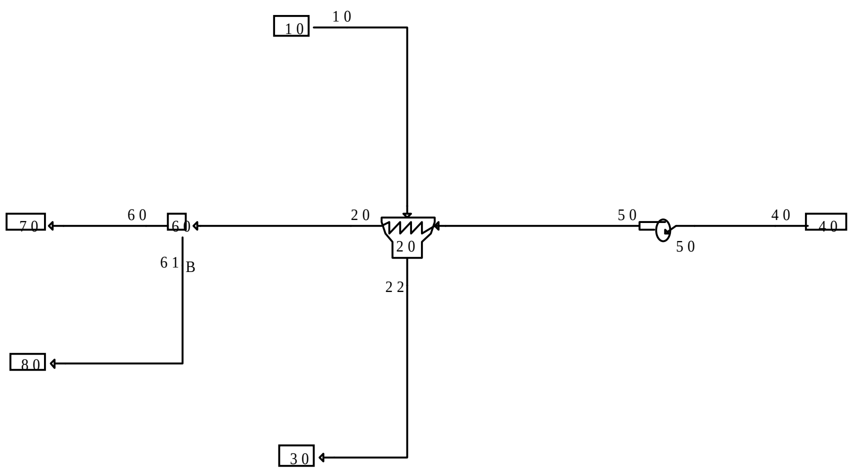
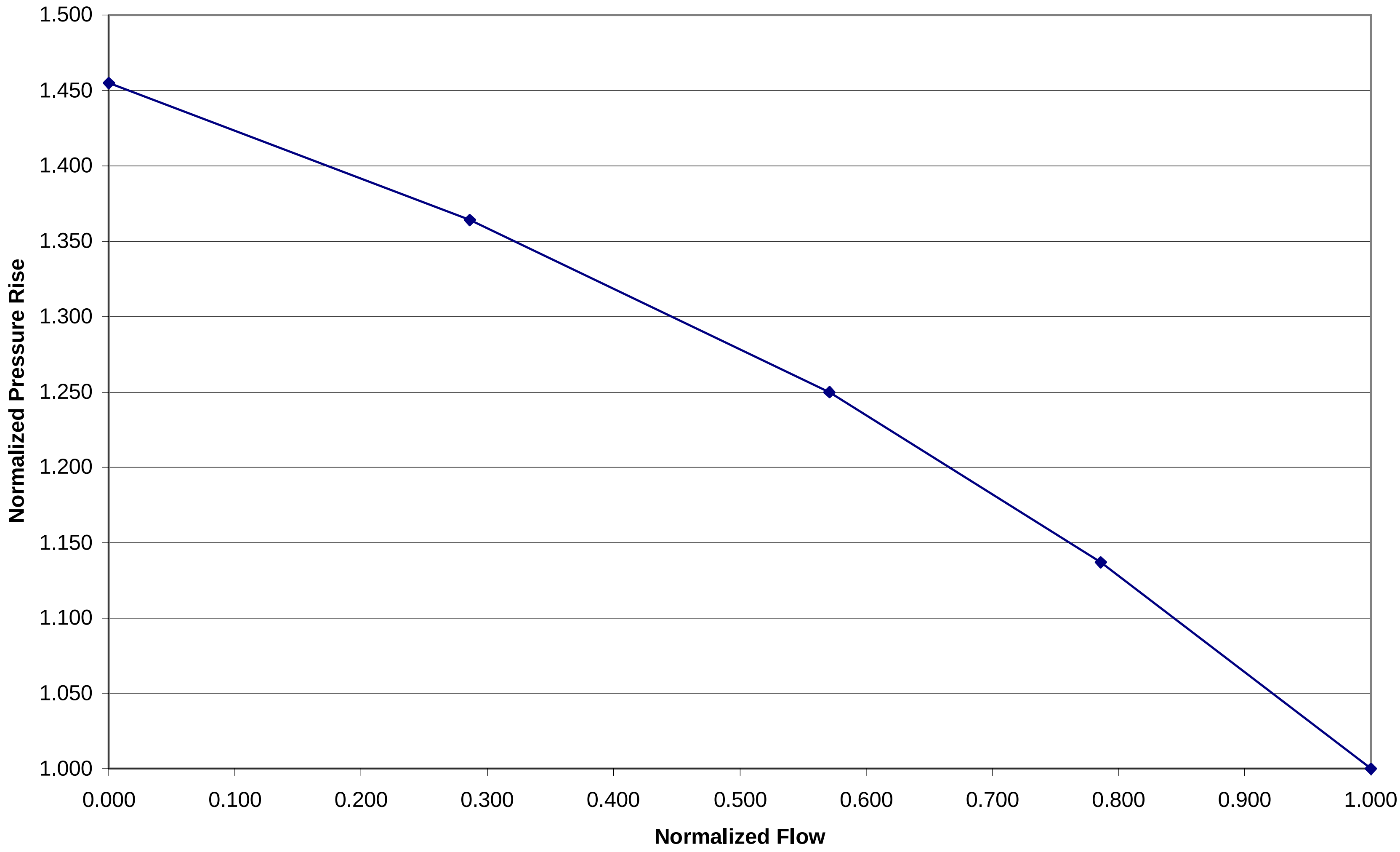


Figure 1 - Condenser Submodel for Tube-Plugging Analysis Using HEI Method

Figure 2. Normalized Circulating Water Pump Curve



In order to quantify the behavior of the condenser over the range of tube plugging, a series of stacked cases was run at discrete values of tube plugging from zero to 50 percent. While it may not be practical to operate up to this amount of plugging, the results highlight the significant difference between constant flow and variable flow rate analysis approaches.

The new “sensitivity study feature” of PEPSE was used to create the stacked cases automatically. To use this feature, in the first case the modeler specifies a starting value of an independent variable (tube plugging fraction in this case), the number of cases to be run, and the ending value of the independent variable. From this, PEPSE develops all of the other cases in the stack. In addition, the user provides a list of the dependent variables of interest. In the present case, the dependent variables selected are condenser pressure, circulating water flow, and others. This listing is found at the end of the Table 1 input data file, on the line ID’s that start with 93.

The fractional tube plugging is specified to PEPSE by the operational variable, OPVB 102. This is translated into the number of tubes effective for heat transfer by PEPSE operations.

For the scenario where circulating water flow is adjusted to obtain a hydraulic balance between the pressure head of the pump and the subsequent condenser and piping pressure drop, a PEPSE control was used. The control adjusts the flow rate at source component 40 to attain a pressure of 14.7 psia at the end of stream 61.

Once set up as described, the model is very easy to use and to modify for custom or exploratory calculations.

THE RESULTS OF THE ANALYSES USING THE SUBMODEL

Selected results of the sensitivity study for the hydraulically balanced scenario are plotted in Figure 3a, b, and c. The complete detailed results as extracted from a full PEPSE output, are shown in Table 2 of the Appendix. A similar set of output occurred for the fixed flow scenario, but those results are not tabulated here. In the figure we see the condenser’s equilibrium shell pressure plotted versus the fraction of tubes plugged. Also shown are the circulating water flow rate and the pressure drop quantity through the condenser and piping. Note that the quantity of flow for the fixed flow scenario is the same as the flow rate for the hydraulically balanced scenario at zero tube plugging.

The most striking features of the results in Figure 3 are the significant differences between the curves for the fixed flow and the hydraulically balanced scenarios. For example, over the full range of plugging, the shell pressure, in the fixed flow scenario, ranges from about 2.9 in. Hga to about 3.25 in. Hga. In contrast, in the hydraulically balanced scenario, the shell pressure varies from 2.9 in. Hga to 5.7 in. Hga. It is interesting to note that the tube-side pressure drop and the circulating water flow rate are nearly linear with fractional tube plugging over the range considered. Notice that the tube-side pressure drop is a very steep function of tube-plugging for the fixed flow scenario. Indeed the detailed run results reveal that the calculated tube-side pressure drop is so large, at 0.45 and 0.50 fractional plugging, that the exit pressure (simulated at the exit of stream 61) would be driven to negative absolute pressure, which is not physically possible. PEPSE resets the pressure drop to zero for these two cases and goes on.

Figure 3a. Condenser Submodel Shell Pressure Comparison

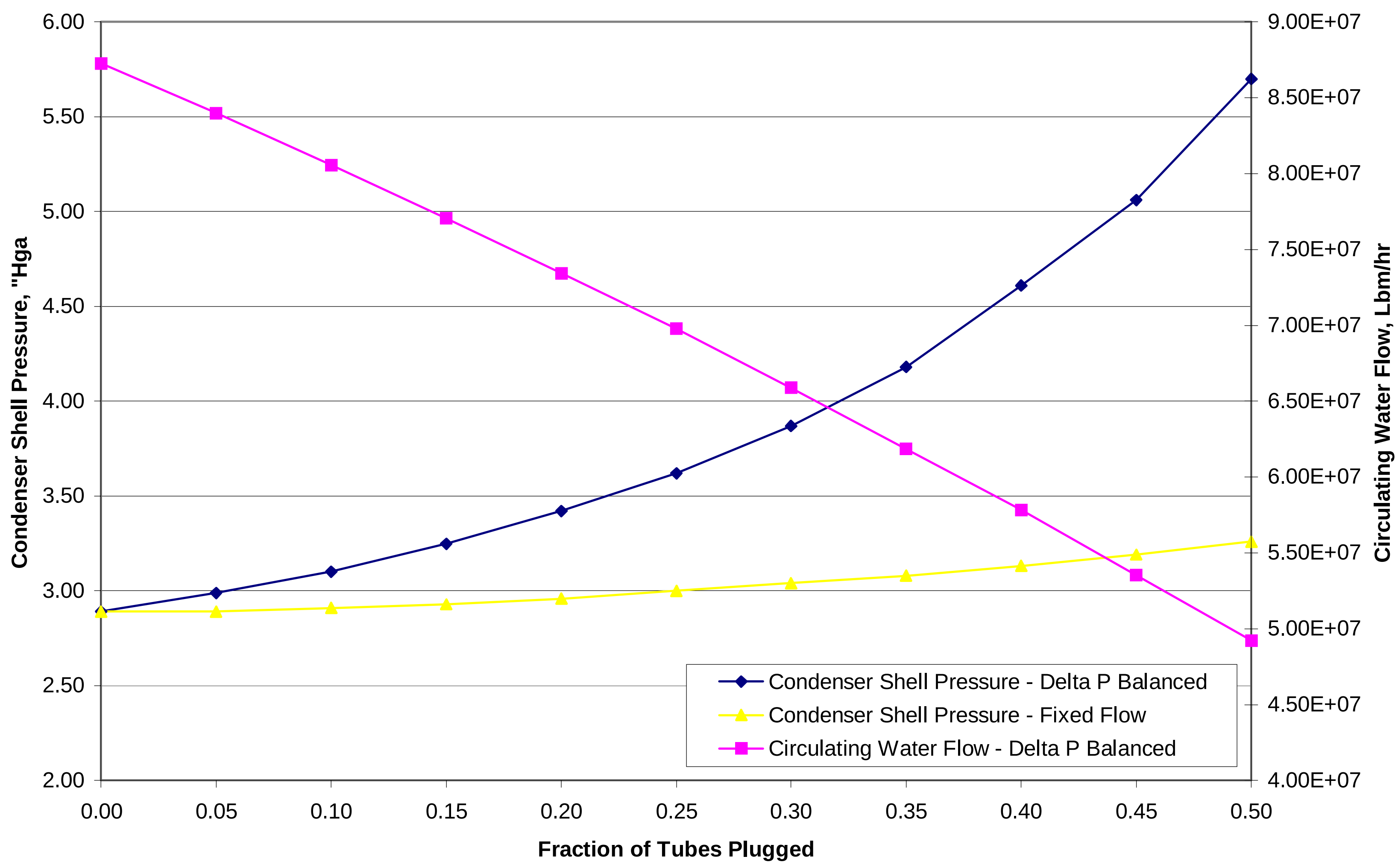


Figure 3b. Condenser Submodel Delta P Comparison

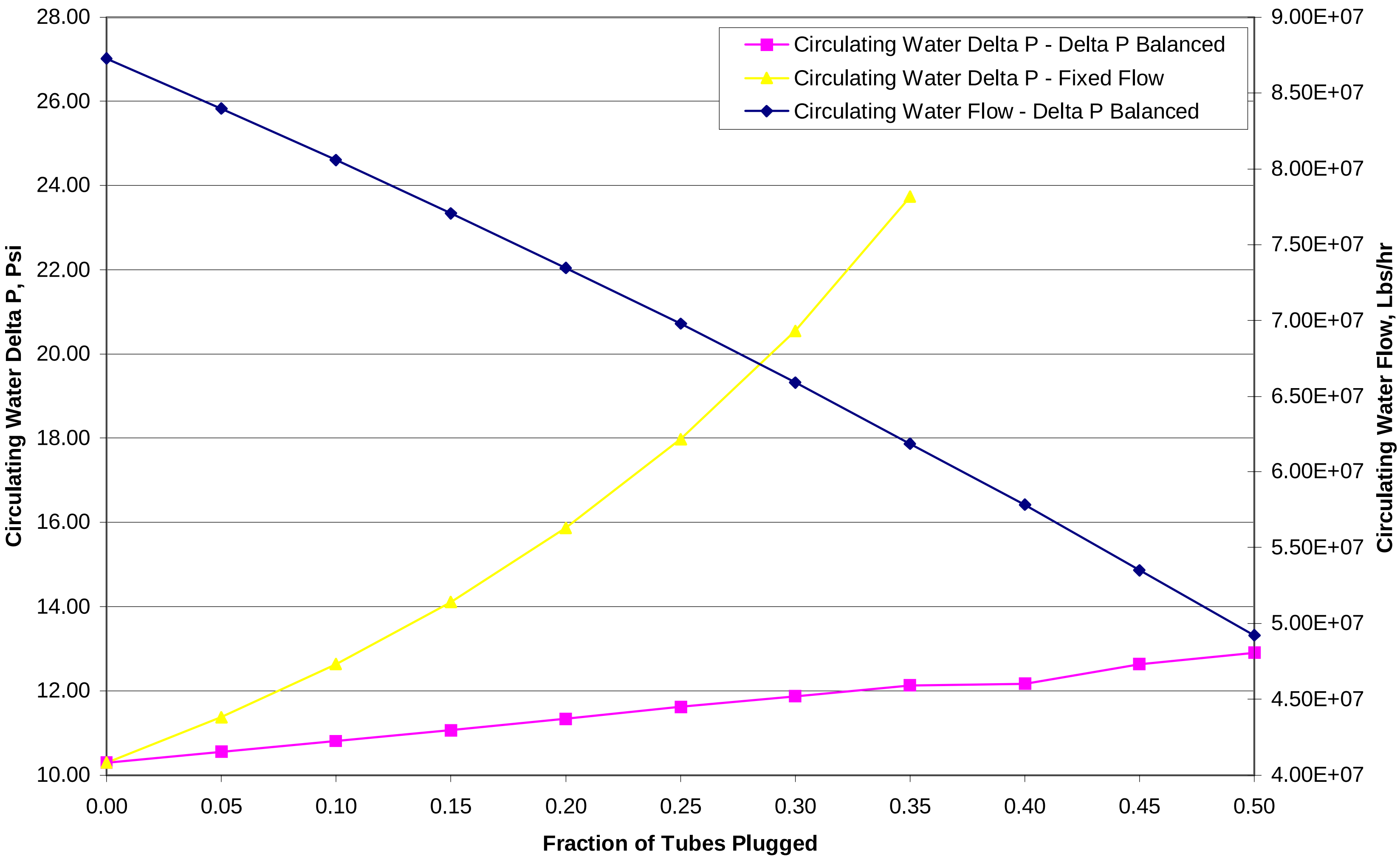
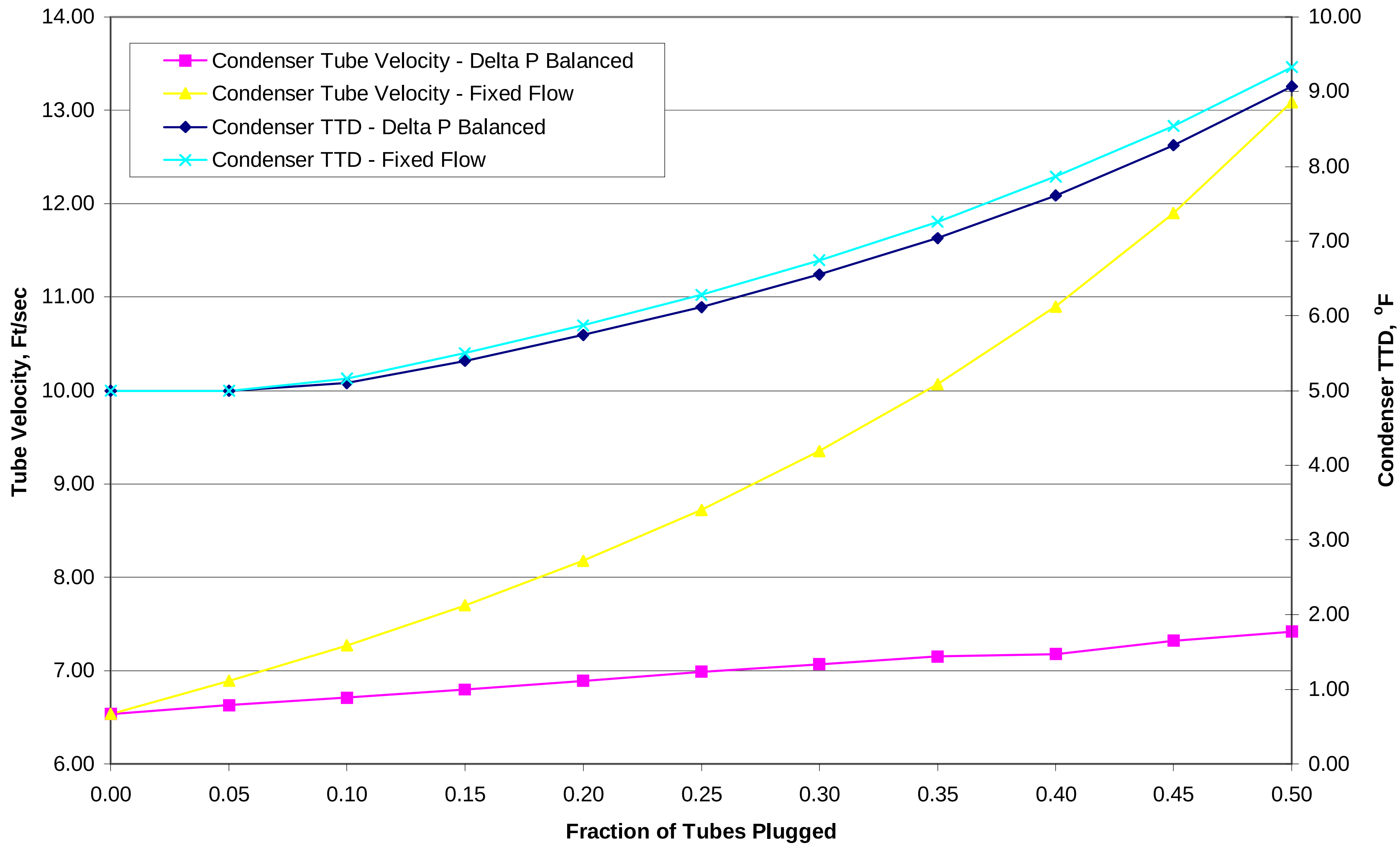


Figure 3c. Condenser Submodel TTD and Tube Velocity Comparison



We can conclude that careful representation of the circulating water flow rate appears to be important, at least for condenser pressure, as the amount of tube plugging changes. The hydraulically balanced scenario, with the flow being proportional to the number of open tubes, is more realistic than the fixed flow scenario.

STEAM TURBINE RANKINE CYCLE MODEL INCLUDING THE HEI MODE CONDENSER

A PEPSE model of a representative "fossil" steam turbine Rankine cycle has been developed using the MMI to demonstrate the application of the HEI model in the context of a real system's simulation. Thereby the impact on power generation can be assessed. The system is single-reheat, and it generates approximately 600 MW of gross electrical power. The schematic is shown in Figure 4. The input data are shown concisely via the input data file in Table 3 of the Appendix.

The condenser, component 11, is described in HEI mode, with the input specified for the actual condenser in this unit. It is not the same condenser as the one used in the earlier submodel. Nevertheless, the schematic representation and the logic of the modeling setup are the same as those in the submodel. Thus, the discussion of these details is abbreviated here. See the discussion above on the submodel.

The circulating water source is component 31 and the circulating water pump is component 603. The Type 1 stream branch used to simulate the pressure drop for the condenser piping and tubes is stream 50, originating at splitter 150. The curve of normalized pump head versus normalized circulating water flow rate is the same as the one used for the submodel and presented in Figure 2. This curve is specific to this unit, and the absolute levels match actual the pump head curve for the pump used in this cycle.

The logic and the setup of the special features - schedules, operations, control, and the sensitivity study feature - is similar to the setup in the submodel discussed above.

THE RESULTS OF THE ANALYSES USING THE SYSTEM MODEL

As for the submodel, the tube plugging study covered a range from zero to 50 percent plugged. The fixed flow and the hydraulically balanced scenarios were analyzed. In addition, the system performance was analyzed at full electrical load and at half electrical load. So, four separate sensitivity analysis runs were made with this model.

Selected results of the sensitivity study for the hydraulically balanced scenario at full load are shown in Figure 5a through d and summarized completely in Table 4 of the Appendix, as extracted from a full PEPSE output. A similar set of output occurred for the fixed flow scenario, and for the half load case, but those results are not tabulated in the Appendix.

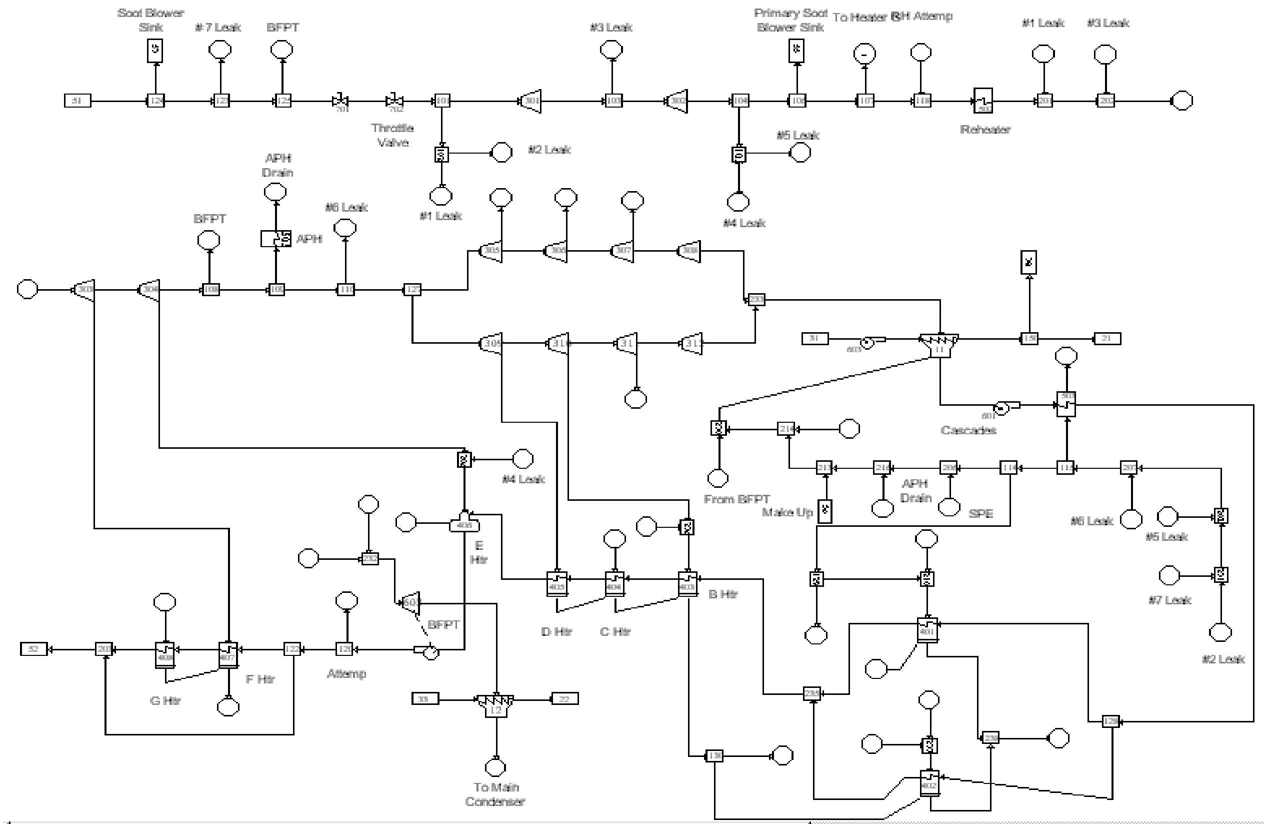


Figure 4. Single Reheat Fossil Steam Turbine Cycle For Analysis Of Tube Plugging Effect On System Performance

In the figure we see the condenser's equilibrium shell pressure plotted versus the fraction of tubes plugged. Also shown are the water velocity inside of the tubes and the system power generation.

As was true for the submodel results, the most striking features of the results in Figure 5 are the significant differences between the curves for the fixed flow and the hydraulically balanced scenarios. Indeed, the condenser shell pressure curve for the system model looks very similar to the curve for the submodel in Figure 3.

The calculated power generation changed scarcely at all for the entire range of tube plugging in the fixed flow scenario. The power changed a small amount for the hydraulically balanced scenario up to about mid-range in the tube plugging study. It appears that, while the condenser pressure my change significantly, there are compensations in the system that keep the generation at a high and desirable level. From a system operation perspective, this behavior is desirable.

The results for the half load condition, are shown in Figure 6 a through d and Table 5 of the Appendix. Here there is quite a notable difference from the full load results. The calculated condenser pressure has a much smaller variation than in the earlier cases. Consequently the calculated generation also has smaller variations. Examination of the detailed results for each of the cases in the analysis reveals that the condenser pressure that has been used in the system analyses has been set by the 5°F limitation of the HEI, as it overrules the "pure thermal" value calculated by the HEI method. See Reference 1 for further discussion of this point.

SUMMARY

The HEI method of calculating condenser pressure, as programmed in PEPSE, has been used to analyze the effect of tube plugging on condenser pressure. Two different scenarios have been used to quantify the circulating water flow rate. First, the flow rate has been held fixed over the range of tube plugging. Second, the circulating water flow rate has been calculated by balancing the pump's head against the hydraulic pressure drop through the tubes, the headers, and the piping of the condenser. In the second scenario, the flow rate reduces as the tube plugging increases and the tube-side pressure drop increases. Significant differences occur between the calculated results for the two different scenarios.

CONCLUSIONS

It is easy to run PEPSE using the HEI method of calculating condenser performance, especially using the new sensitivity study feature. The results of this study show that accounting for the variation of the circulating water flow rate as tubes of the condenser are plugged has a significant impact on the calculated condenser pressure and tube flow velocity. The specific dependence of condenser pressure on the tube plugging is affected by different assumptions that are made about this flow rate. However in the analysis, it is necessary to approach considerable and impractical levels of tube plugging before there is a large effect on the calculated turbine cycle power. At 50 percent plugging, the system power generation has reduced by only 1 percent in the example model.

Figure 5a. System Model Condenser Shell Pressure and Gross Generation Comparison - Full Load

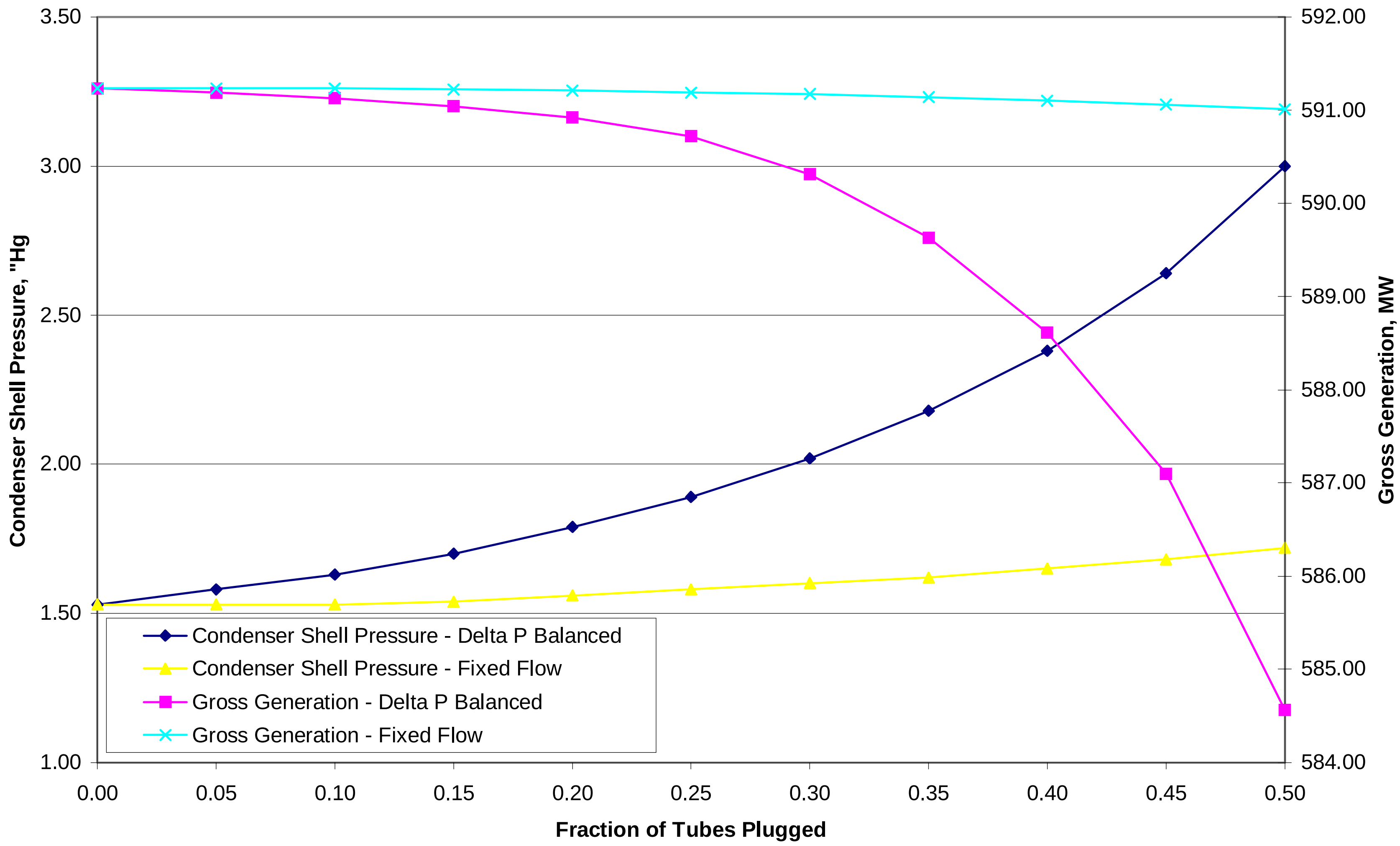


Figure 5b. System Model Condenser Shell Pressure Comparison - Full Load

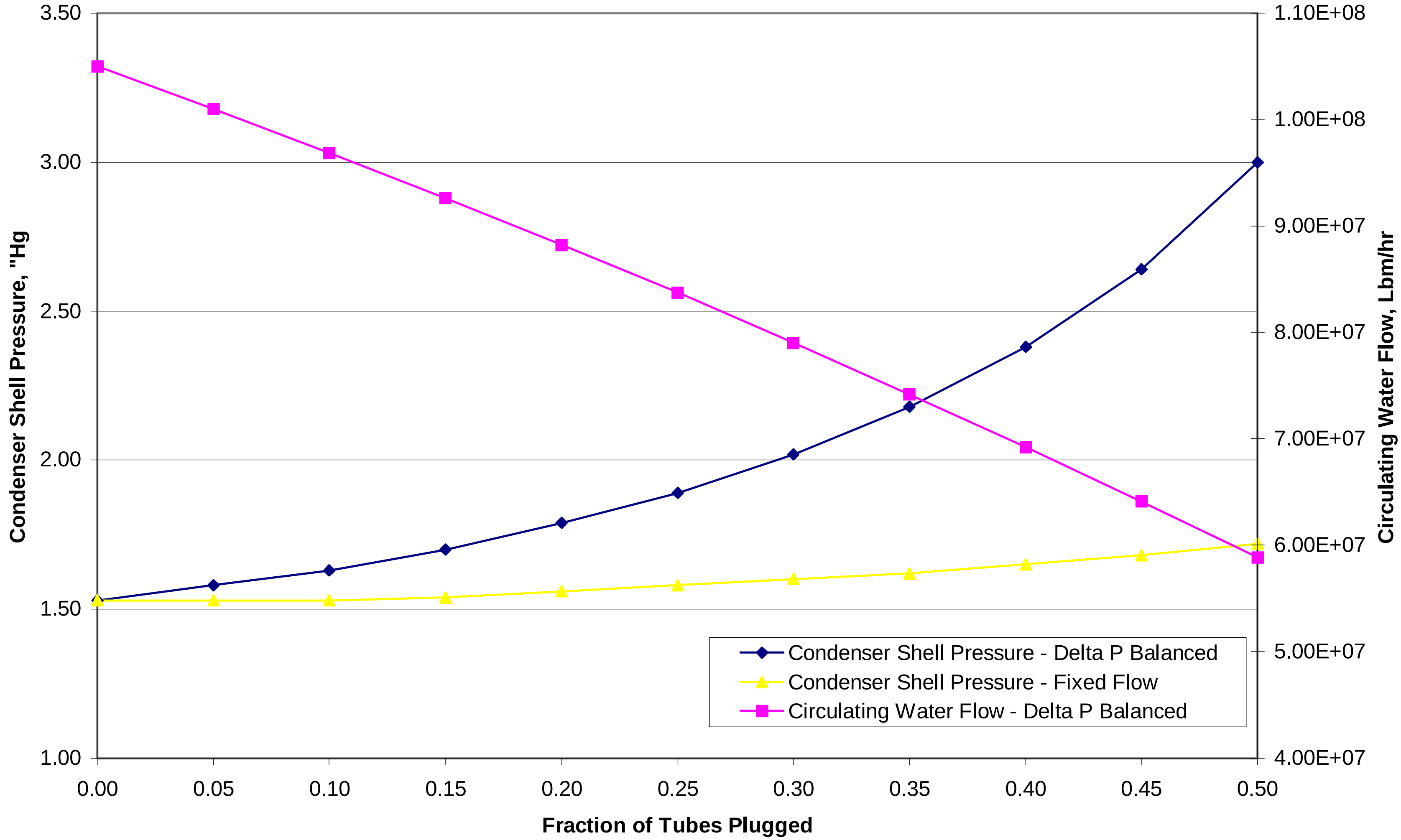


Figure 5c. System Model Condenser TTD and Tube Velocity Comparison - Full Load

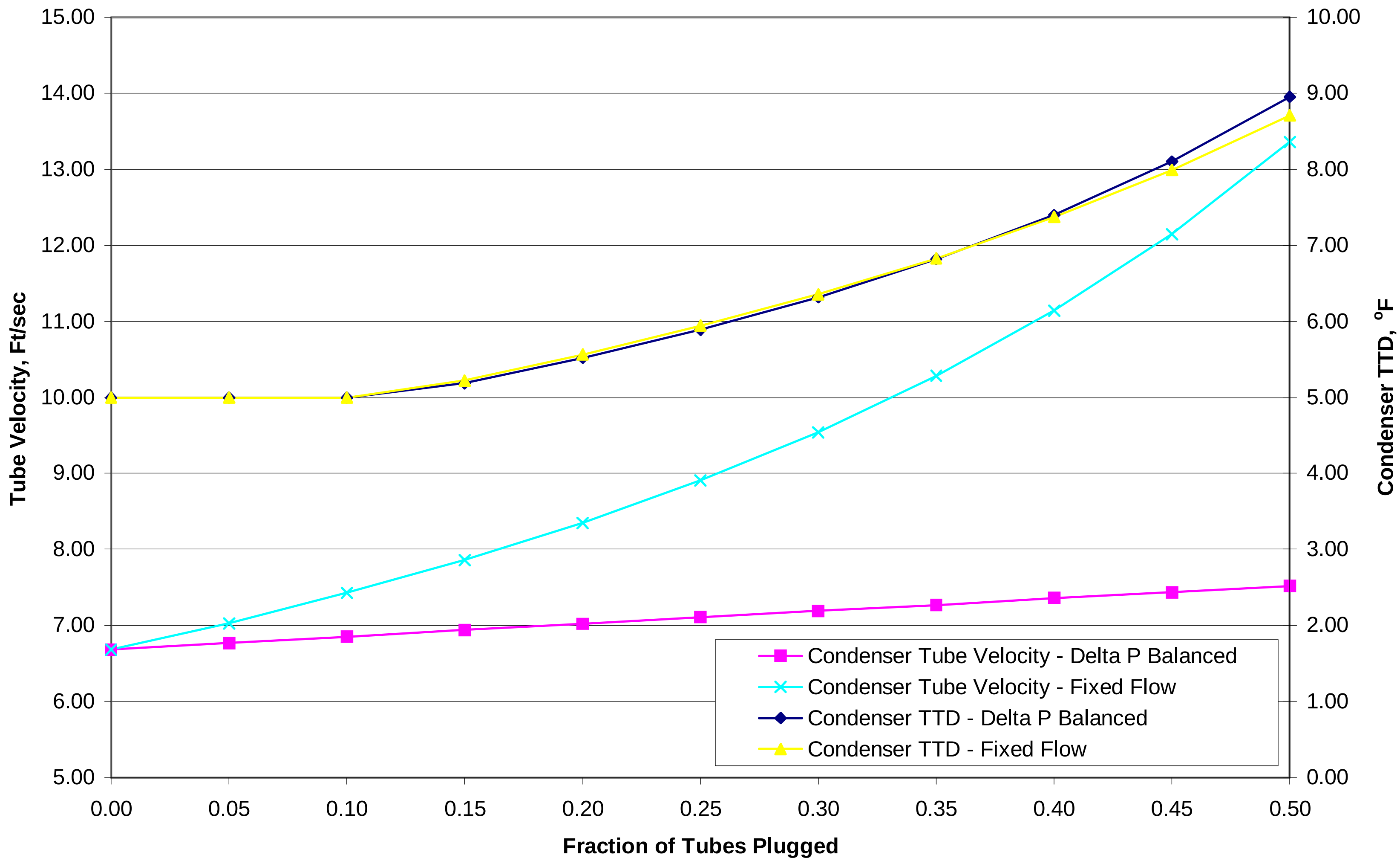
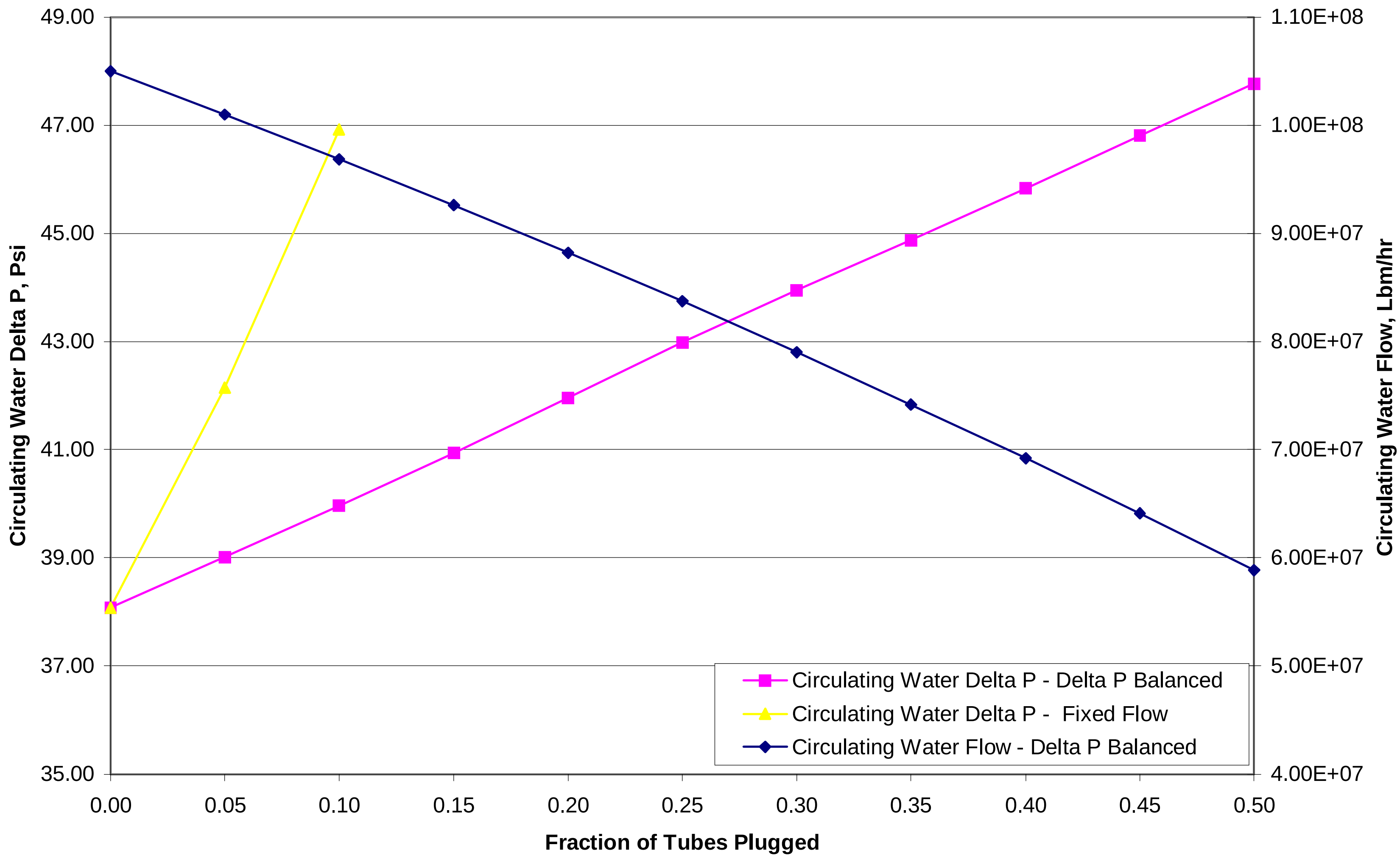


Figure 5d. System Model Circulating Water Delta P Comparison - Full Load



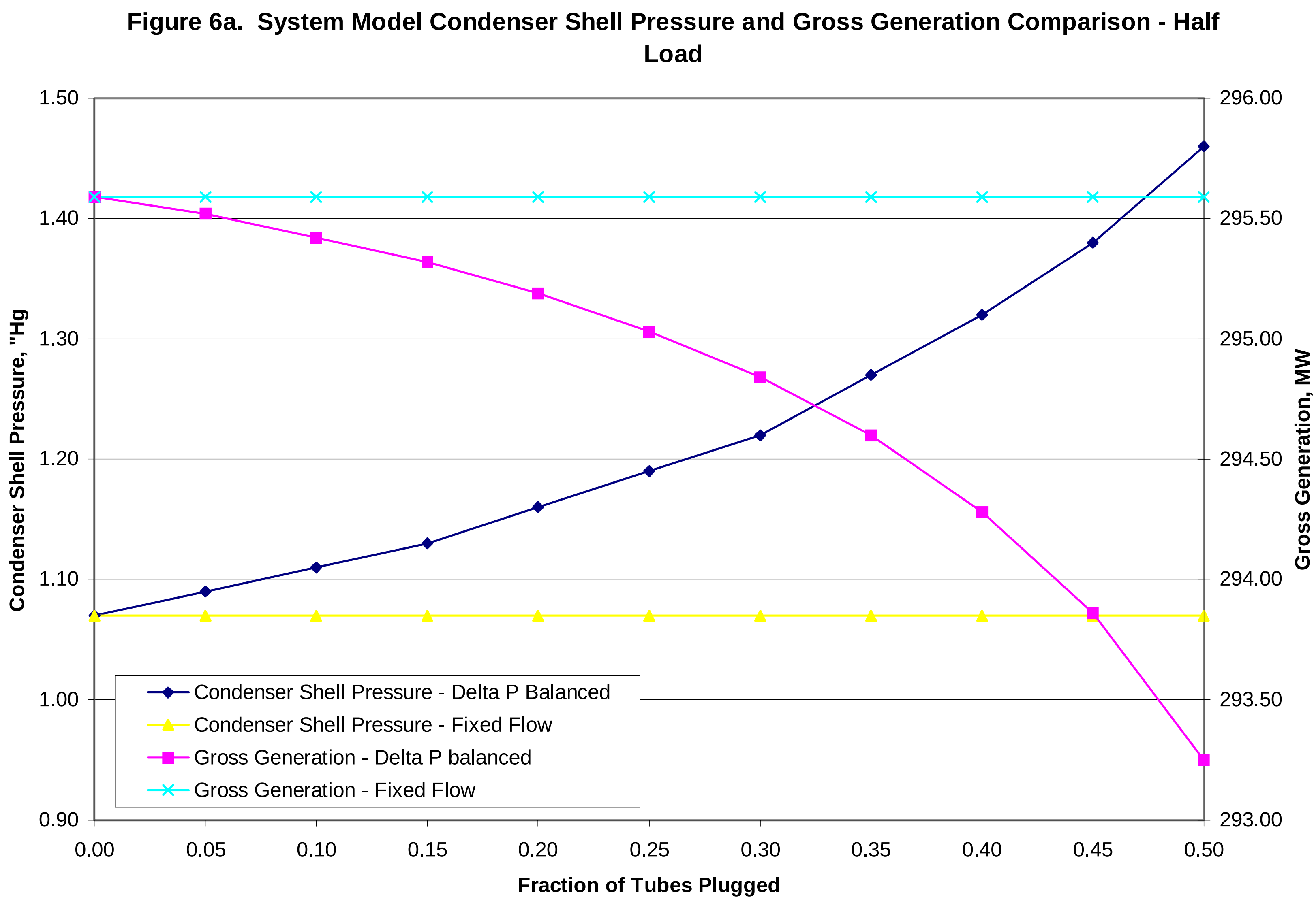


Figure 6a. System Model Condenser Shell Pressure and Gross Generation Comparison - Half Load
Condenser Shell Pressure, "Hg
Gross Generation, MW
Fraction of Tubes Plugged
1.50
1.40
1.30
1.20
1.10
1.00
0.90
296.00
295.50
295.00
294.50
294.00
293.50
293.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Condenser Shell Pressure - Delta P Balanced
Condenser Shell Pressure - Fixed Flow
Gross Generation - Delta P balanced
Gross Generation - Fixed Flow

Figure 6b. System Model Condenser Shell Pressure Comparison - Half Load

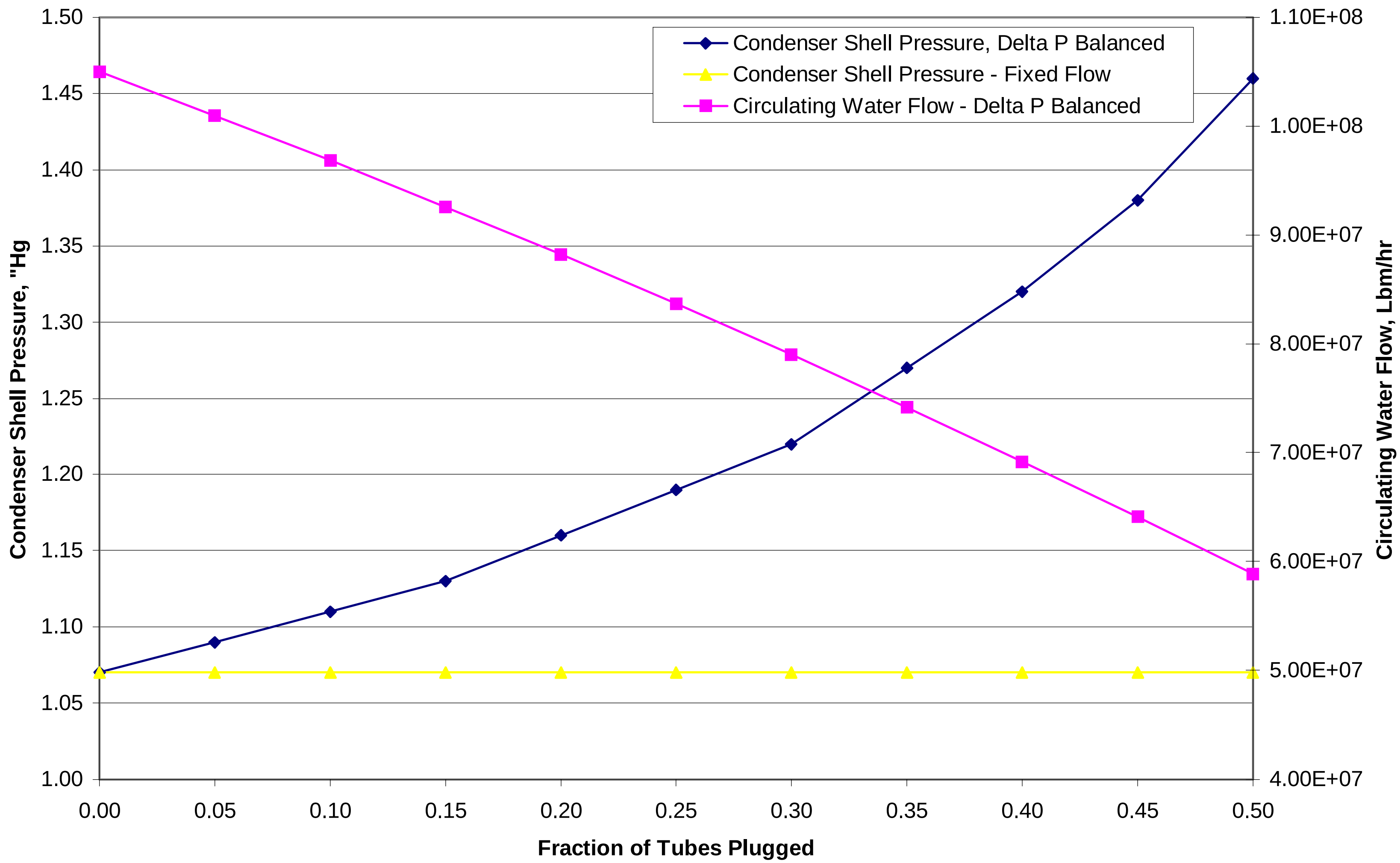
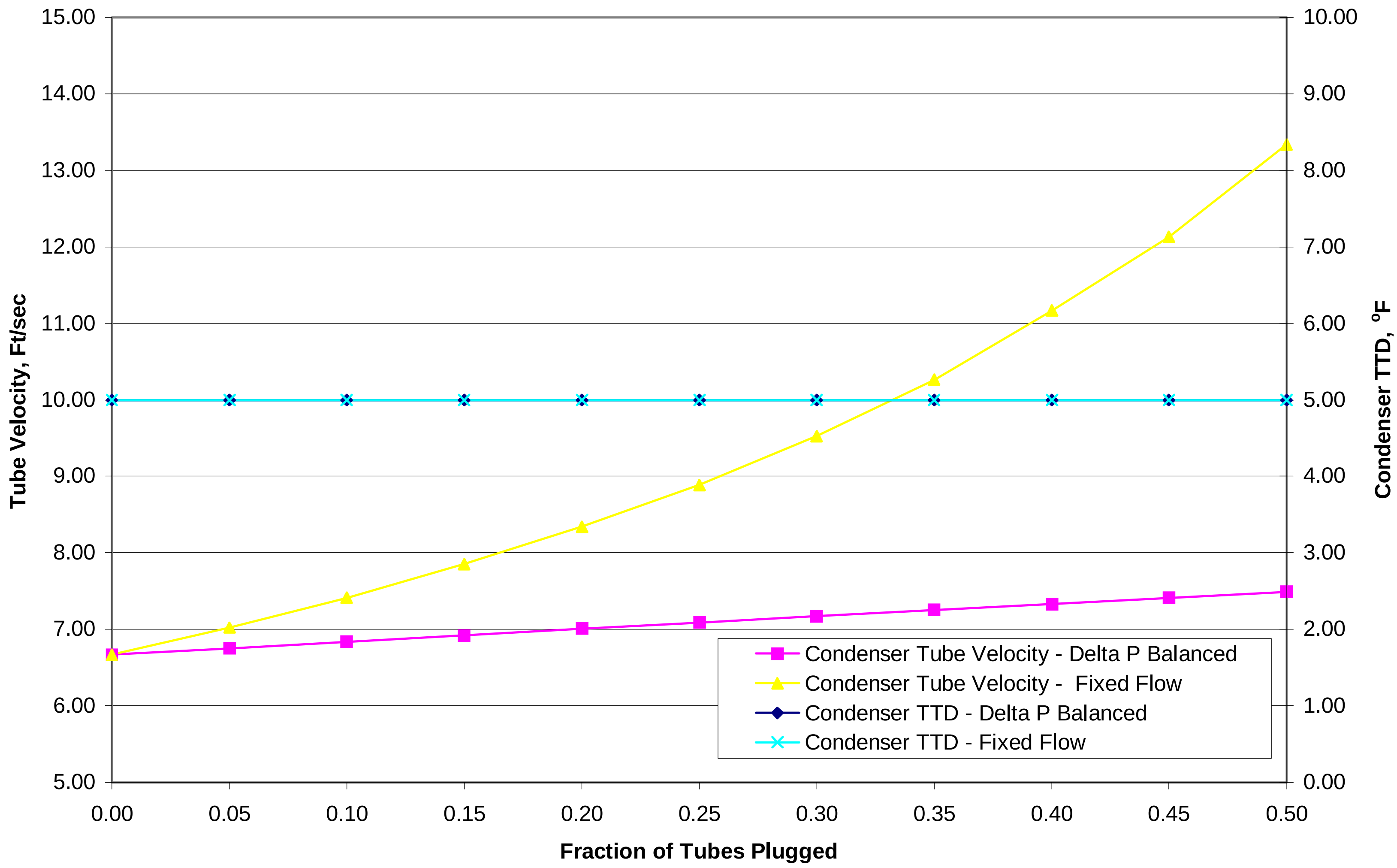


Figure 6c. System Model Condenser TTD and Tube Velcoity Comparison - Half Load



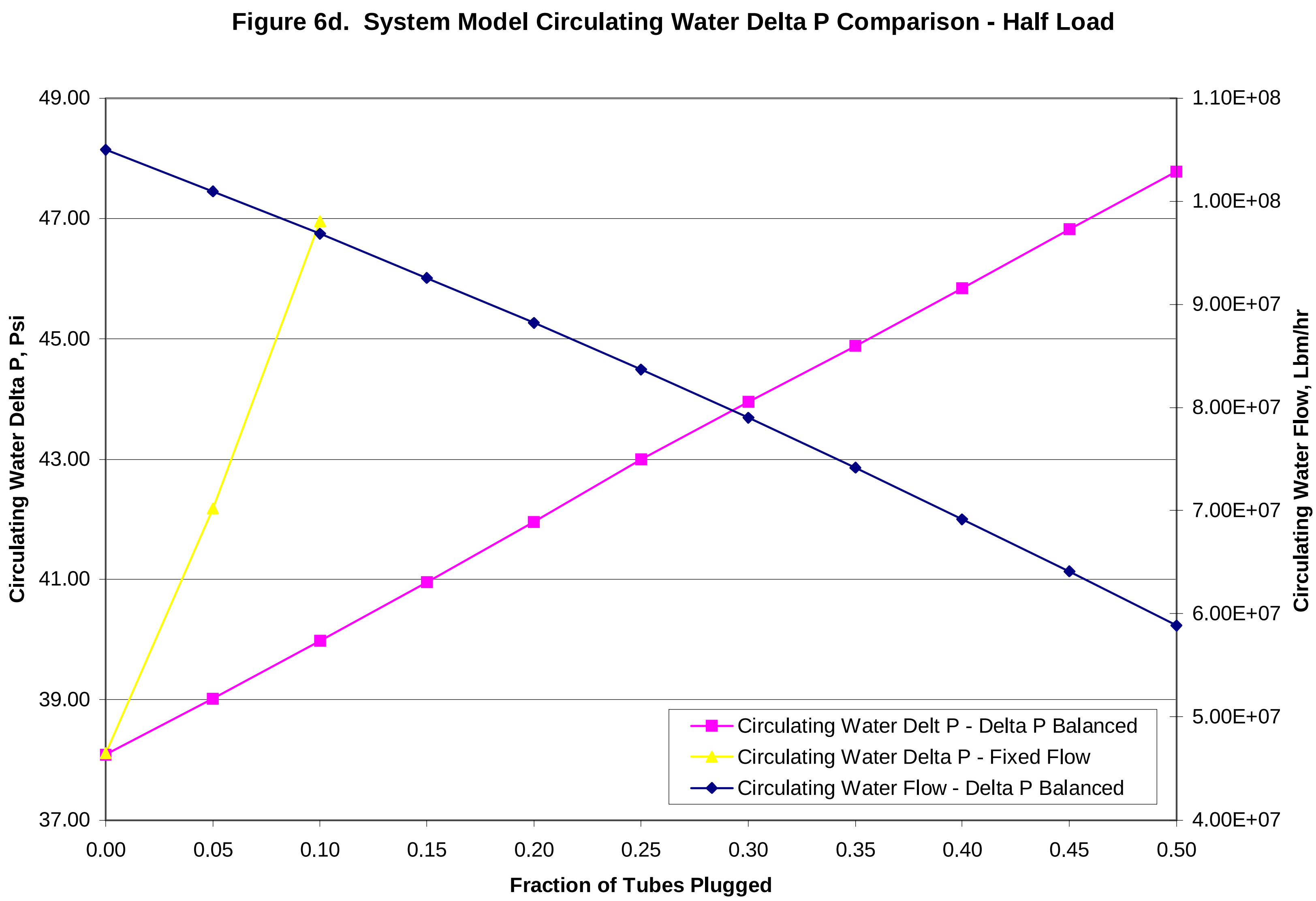


Figure 6d. System Model Circulating Water Delta P Comparison - Half Load
Circulating Water Delta P, Psi
Circulating Water Flow, Lbm/hr
Fraction of Tubes Plugged
49.00
47.00
45.00
43.00
41.00
39.00
37.00
1.10E+08
1.00E+08
9.00E+07
8.00E+07
7.00E+07
6.00E+07
5.00E+07
4.00E+07
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Circulating Water Delt P - Delta P Balanced
Circulating Water Delta P - Fixed Flow
Circulating Water Flow - Delta P Balanced

This study has shown that flow rate of circulating water plays an important role in obtaining reliable results from analysis. This is true for tube plugging. It is also reasonable to conclude that analyses of retubing should consider the hydraulic balance in order to properly represent the role of flow rate. Factors in retubing studies would be changes of inside diameter and of surface roughness.

REFERENCES

1. Standards for Steam Surface Condensers, Ninth Edition, Heat Exchange Institute Incorporated, Cleveland, Ohio, 1995.
2. Alder, et al, User's Guide, PEPSE and PEPSE-GT, Idaho Falls, Idaho, 1999.
3. Minner, et al., Engineering Model Description, PEPSE Manual Volume II, Idaho Falls, Idaho, 1998.
4. ASME Steam Properties for Industrial Use, Based on IAPWS-IF97, Professional Version, The American Society of Mechanical Engineers, ASME Press, NY, 1998.
5. Fleming, et al. User Input Description, PEPSE, PEPSE Manual Volume I 1999, Idaho Falls, Idaho.

APPENDIX

This appendix contains tables that document the detailed inputs for the models and provides selected output results.

Table 1 - Input Data File for Condenser Submodel

```
010001       80        PRINT
*
*
*      DATE: Friday, May 19, 2000
*       TIME: 4:15 PM
*    MODEL: Ugmhei.mdl
*  JOB FILE: C:\PEPSE\CHKV65\ugmhei.job
*
*
*
*
=C:\PEPSE\CHKV65\UGMHEI(SET 1) - BASE CASE, CIRC HYDRAULIC BALANCE
*
*****************************
*  GENERIC INPUT DATA
*****************************
*
*
012002       3          2          1          0
*
*****************************
*  STREAMS
*****************************
*
*
500400 40        U         50        I
500600 60        U         70        I
500610 60        B         80        I
500100 10        U         20        S
500500 50        U         20        T
500220 20        D         30        I
500200 20        T         60        I
*
* TY 1 STRM TO SIMULATE CONDENSER HYDRAULIC DEL P
600610   1  0.777  36.  0.0  25.  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
*****************************
*  COMPONENTS
*****************************
*
*
*
* HEI CONDENSER
700200   10  0     5        0.0    -2.5
700205   2    0.0  0.875  432.  36374.  2  -0.85  1  0.0  18  0
*
*
```

```
700300   30
700302     0
*
*
700700   30
700702     0
*
*
700800   30
700802     0
*
* STEAM SOURCE TO CONDENSER
700100   31  0.95  1.41  2560000.  0.0  0.0  0
700102     0       0       0
*
* ATMOSPHERIC PRESSURE CIRC WATER SOURCE
700400   31  80.  14.7  87283130.  0.0  0.0  0
700402     0    0        0
*
* CIRC WATER PUMP
700500   41    25.    0.0    0.0    0.0
700501    0.0  0.0    0.0    0.0    0.0    0.0
*
* SPLIT TO SIMULATE FLOW IN A SINGLE CONDENSER TUBE
700600   63  0.0 5.00000000E-005
*
*****************************
*  SPECIAL FEATURES
*****************************
*
*
*
*
800100 "NORMALIZED PUMP DP VALUES"
* X VALUES
810100   0.0  0.286  0.571  0.786  1.
* Z AND Y VALUES
810110   0.0  1.455  1.364  1.25  1.137  1.
* MULTIPLIERS
820100    10.3  87283130.  0.0
*
* VARIABLES FOR PUMP PRESSURE VERSUS FLOW CURVE
830100     1    PDPUM    50    WW    40
*
*
*
* CONTROL CIRC WATER FLOW FOR TUBE OUT P=PATM
840100     WWVSC    40    14.7    0.0    1.    PP    61
840105     2     0
840109     1000000.  90000000.
*
```

```
*
*
* BASELINE NUMBER OF CONDENSER TUBES
871010   36374.
*
* BASELINE FRACTION OF TUBES PLUGGED
871020   0.0
*
*
*
* FRAC OF NORMAL TUBES
880010   XNC  20   DIV   ONE  0   OPVB  1
880011   0.0  36374.  0.0
880015   999  -1
*
* ADJUST INITIAL CIRC WATER FLOW PER NUMBER TUBES
880020   OPVB  1   MUL   WWVSC  40   WWVSC  40
880025   999  -1
*
* CALCULATE FRAC FLOW SPLIT TO A SINGLE TUBE
881010   ONE      0    DIV    XNC     20      FRSPL  60
881011   2.  0.0  0.0
*
* ONE MINUS FRAC TUBES PLUGGED
881030   ONE      0   SUB    OPVB  102    OPVB  103
*
* NUMBER OF TUBES ACTIVE
881040   OPVB  103   MUL   OPVB  101    XNC      20
*
* CALC CONDENSER PRESSURE DROP
881110    PP     -61     SUB    PP        61    OPVB   111
*
* CALCULATE TUBE CROSS SECTIONAL AREA
881210   'DD'    61     SQR   OPVB   121
*
* TUBE FLOW AREA, SQ FT, X 3600
881220   PI4IN2  0    MUL   OPVB    121    OPVB   122
881221   0.0       0.0    3600.
*
* TUBE VELOCITY, FT/SEC
881230   WV  61   DIV   OPVB   122   OPVB  123
*
* CONDENSER SHELL PRESSURE, IN.HGA
881240   PP   -22   DIV   PSIHGA  0    OPVB  124
*
*
*
*
*
*
*
```

```
* OUTPUT GLOBAL SUPPRESSION CARD
020000  PRINT    PRINT    NOPRNT
020002  NOPRNT   * Geometry Configuration of Model
020004  NOPRNT   * Stream Properties
020005  NOPRNT   * Comparison of Component Port Test Data With Stream Properties
020015  NOPRNT   * Detailed Mixer Performance Output
020016  NOPRNT   * Detailed Splitter Performance Output
020021  NOPRNT   * Second Law of Thermodynamics Performance - Components
020022  NOPRNT   * Second Law of Thermodynamics Performance - Streams
020023  NOPRNT   * Second Law of Thermodynamics Performance - System
020024  NOPRNT   * Material Descriptions Used in the Model
020025  NOPRNT   * First Law of Thermodynamics Performance - Envelope
020032  NOPRNT   * Input Schedule Number N Table of Values
020033  NOPRNT   * Variable Sets Which Reference Schedules
020034  NOPRNT   * Controls Input
020037  NOPRNT   * Definitions of Special Operations Specified
020078  NOPRNT   * Nonzero Operational Variables
*
* CYCLE FLAGS
010200   0    0    0    5    0    0    0.0    0.0
010000  ENGLISH
*
*
*  FILE UGMHEISS
*
*  ACTIVATE SENSITIVITY STUDY FEATURE
*
*    NSWSNS PRNSNS
930000    1    *  PRINT
*930008  DELETE
*       XTISNS
930001  'CONDENSER FRAC TUBES PLUGGED'
*      XCSNS IDXSNS XVSNS1 XVSNS2 NPTSNS
930002   OPVB   102    0.    .5      11
*       YTISNS
930011  'CONDENSER SHELL PRESSURE, IN.HGA'
*      YCSNS IDYSNS
930012    OPVB  124
*
930021  'CONDENSER CIRC WATER FLOW'
*
930022    WW    40
*
930031  'CONDENSER PRESSURE DROP'
*
930032    OPVB  111
*
930041  'CONDENSER TTD'
*
930042    TTDOUT  20
*
```

```
930051  'PUMP PRESSURE RISE'
*
930052    PDUPMP  50
*
930061  'PUMP POWER'
*
930062    BKUPMP  50
*
930071  'CONDENSER TUBE VELOCITY, FT/SEC'
*
930072    OPVB    123
*
*
******************************
*     END OF BASE DECK
******************************
*
*
.
```

Table 2 - Sensitivity Study Results for Condenser Submodel in Hydraulically Balanced Flow Scenario

VERSION GT97 CREATED 19 MAY 00 DATE 05/19/00. PAGE 12
SENSITIVITY STUDY CASE 11, X = 5.00000E-01; X IS OPVB (102)
** SAVE CASE **

SENSITIVITY STUDY CALCULATION RESULTS
CONDENSER SUBMODEL WITH DELTA P BALANCED

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 1	
	X INDEPENDENT	VARIABLE:	
0.0000E+00	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
2.8939E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
8.7284E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.0300E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.0300E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
7.8365E+02	BKUPMP(50),	PUMP POWER	KW
6.5428E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 2	
	X INDEPENDENT	VARIABLE:	
5.0000E-02	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
2.9856E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
8.3976E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.0550E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.0550E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
7.7224E+02	BKUPMP(50),	PUMP POWER	KW
6.6278E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 3	
	X INDEPENDENT	VARIABLE:	
1.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
3.0989E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
8.0575E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.0808E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.1010E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.0807E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
7.5901E+02	BKUPMP(50),	PUMP POWER	KW
6.7145E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 4	
	X INDEPENDENT	VARIABLE:	
1.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
3.2465E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
7.7072E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.1071E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.4014E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.1071E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
7.4379E+02	BKUPMP(50),	PUMP POWER	KW
6.8026E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 5	
	X INDEPENDENT	VARIABLE:	
2.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
3.4203E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
7.3450E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.1335E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.7374E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.1345E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
7.2636E+02	BKUPMP(50),	PUMP POWER	KW
6.8906E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 6	
	X INDEPENDENT	VARIABLE:	
2.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
3.6239E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
6.9780E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.1622E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
6.1171E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.1622E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
7.0692E+02	BKUPMP(50),	PUMP POWER	KW
6.9855E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 7	
	X INDEPENDENT	VARIABLE:	
3.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
3.8746E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
6.5892E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.1879E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
6.5470E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.1879E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
6.8230E+02	BKUPMP(50),	PUMP POWER	KW
7.0709E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 8	
	X INDEPENDENT	VARIABLE:	
3.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
4.1836E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
6.1867E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.2127E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
7.0392E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.2129E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
6.5408E+02	BKUPMP(50),	PUMP POWER	KW
7.1538E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 9	
	X INDEPENDENT	VARIABLE:	
4.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
4.6110E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
5.7834E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.2166E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
7.6113E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.2416E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
6.2594E+02	BKUPMP(50),	PUMP POWER	KW
7.1750E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 10	
	X INDEPENDENT	VARIABLE:	
4.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
5.0592E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
5.3518E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.2633E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
8.2780E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.2647E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
5.8997E+02	BKUPMP(50),	PUMP POWER	KW
7.3246E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 11	
	X INDEPENDENT	VARIABLE:	
5.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
5.6982E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
4.9217E+07	WW (40),	CONDENSER CIRC WATER FLOW	LBM/HR
1.2905E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
9.0733E+00	TTDOUT(20),	CONDENSER TTD	DEL DEG F
1.2904E+01	PDUPMP(50),	PUMP PRESSURE RISE	PSIA
5.5360E+02	BKUPMP(50),	PUMP POWER	KW
7.4169E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

Table 3 - Input Data File for Single Reheat Fossil Steam Turbine Cycle Performance Study, at Full Load and Hydraulically Balanced Scenario

```
010001  80  PRINT
*
*
*      DATE: Friday, May 19, 2000
*       TIME: 3:00 PM
*    MODEL: ugmsys.mdl
*  JOB FILE: C:\PEPSE\CHKV65\UGMSYS.job
*
*
*
*
=C:\PEPSE\CHKV65\UGMSYS(SET 1)-TIM F-HEI-GLM-DP BAL
*
*  GENERIC INPUT DATA
■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*
*
*
010200   2  3  1  1  1  0  0.0  0.0
*
010000  ENGLISH  ENGLISH
*
*
* Generator Data
011010     1     2     1  0  3600  686000.  0.9  74.7  74.7  0.0
011011   0.0  0.0  0.0
*
* Convergence Data
012000    30  0.0  0.0  0.0  0.0  0.0  0  0.0
*
*  STREAMS
■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
*
*
501360   51   U     124   I
501390  124   U     123   I
500010  123   U     125   I
500020  125   U     701   I
500030  701   U     702   I
500040  702   U     101   I
500060  101   U     301   I
500090  301   U     103   I
500110  103   U     302   I
500120  302   U     104   I
500140  104   U     106   I
500180  106   U     107   I
```

500200	107	U	118	IA
500220	118	U	502	T
500230	502	T	201	IA
500240	201	U	202	IA
500050	101	B	102	I
500130	104	B	105	I
500280	303	U	304	I
501500	304	U	108	I
500300	108	U	109	I
500320	109	U	110	I
500360	110	U	127	I
501520	127	B	309	I
501530	309	U	310	I
501540	310	U	311	I
501550	311	U	312	I
501560	312	U	233	IB
500490	233	U	11	S
500520	11	D	601	I
500530	601	U	503	T
501330	204	U	406	S
500630	405	T	406	FW
500610	403	T	404	T
500620	404	T	405	T
500600	235	U	403	T
501020	403	D	130	I
501720	130	B	402	D
501590	402	T	235	IB
501770	237	U	402	S
501620	129	B	210	IB
500640	406	D	602	IP
500650	602	UP	120	I
500660	120	U	122	I
501800	122	U	407	T
500690	407	T	408	T
500710	408	T	203	IA
501820	203	U	52	I
501420	602	UT	12	S
501810	122	B	203	IB
500720	408	D	407	D
501060	33	U	12	T
501070	12	T	22	I
501040	405	D	404	D
501030	404	D	403	D
501410	232	U	602	IT
500290	304	E	204	IA
500740	309	E	405	S
501750	234	U	403	S
501630	310	E	234	IA
501740	401	D	238	IA
501730	402	D	238	IB
501580	128	B	402	T

501570	128	U	401	T
500550	503	T	128	I
501760	210	U	401	S
501600	401	T	235	IA
500910	230	U	11	D
500930	214	U	230	IB
500820	213	U	214	IB
500590	216	U	213	IA
500890	206	U	216	IA
500880	114	U	206	IA
500860	115	U	114	I
500840	207	U	115	I
501320	231	U	208	IA
500830	208	U	207	IA
501350	124	B	53	I
501340	123	B	231	IB
501400	115	B	503	S
501380	125	B	232	IB
500080	102	U	201	IB
500070	102	B	231	IA
500100	103	B	202	IB
500150	105	B	208	IB
500160	105	U	204	IB
500170	106	B	55	I
500270	303	E	407	S
500190	107	B	408	S
500210	120	B	118	IB
500250	202	U	303	I
500390	505	T	216	IB
500330	109	B	505	T
500310	108	B	232	IA
500350	110	B	207	IB
501510	127	U	305	I
500410	305	U	306	I
500420	306	U	307	I
500430	307	U	308	I
500440	308	U	233	IA
500750	305	E	404	S
501640	306	E	234	IB
500770	307	E	210	IA
501650	311	E	237	IA
500540	503	D	206	IB
500700	407	D	406	D
501430	12	D	230	IA
501710	130	U	401	D
501610	129	U	237	IB
500870	114	B	129	I
500810	238	U	214	IA
500940	54	U	213	IB
500510	603	U	11	T
500340	31	U	603	I

```
500500  150   B       36   I
501660  150   U       21   I
500260   11   T      150   I
*
* TY1 STRM TO SIMULATE CONDENSER HYDRAULIC DEL P
600500   1  0.902  39.802  0.0  116.529  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to DC Heater
600290   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to "D" Feedwater Heater
600740   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to "F" Feedwater Heater
600270   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to "G" Feedwater Heater
600190   2  0.05  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Intercept Valve Pressure Drop
600250   2  0.0032  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to "C" Feedwater Heater
600750   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to "A1" Feedwater Heater
600770   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to "A2" Feedwater Heater
601650   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Pressure Drop to "B" Feedwater Heater
601630   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Stream Spec for APH Drain
600390   5  14.7  210.
*
* Pressure Drop to "B" Feedwater Heater
601640   2  0.02  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
*  COMPONENTS
*
*
*
```

* Governing Stage
703010   4 1 1 1 1 1
703011   4 0 41.53
703012   0.0 0.0 0.0 0.0 0.0 0
*
* High Pressure Turbine Stage Group
703020   5 1 1 0 1 0.03
703021   1833. 1432.5 3900121. 600.5 352750.
703022   0.0 0.0 0.0 0.0
*
* IP Stage Group
703030   6 1 0 1 2 1 0.03
703031   540.5 1519.1 3569835. 294. 115288.
703032   0.0 0.0 0.0 0.0 0.0 0.0 0.0
*
* IP Stage Group
703040   6 1 3 1 2 1 0.03
703041   294. 1444.2 3454547. 178.9 236969.
703042   0.0 0.0 0.0 0.0 0.0 0.0 0.0
*
* LP Stage Group
703090   7 1 0 1 3 2 0.03
703091   178.9 1387. 1489497.5 67.6 86207. 0.0
703092   0.0 0.0 0.0 0.0 0.0
703093   0 0.0 0.0
*
* LP Stage Group
703100   7 1 1 1 3 2 0.03
703101   67.6 1288.5 1403291. 12.8 55802.5 0.0
703102   0.0 0.0 0.0 0.0 0.0
703103   0 0.0 0.0
*
* LP Stage Group
703110   7 1 1 1 3 2 0.03
703111   12.8 1156.7 1347488. 5.5 84247.5 0.0
703112   0.0 0.0 0.0 0.0 0.0
703113   0 0.0 0.0
*
* LP Turbine Stage
703120   7 1 3 0 3 2 0.0
703121   5.5 1103.3 1263240.5 0.737 0.0 55.6
703122   0.0 0.0 0.0 0.0 0.0
703123   0 0.0 0.0
*
* LP Turbine Stage
703050   7 1 0 1 3 2 0.03
703051   178.9 1387. 1599841. 43.8 196550. 0.0
703052   0.0 0.0 0.0 0.0 0.0
703053   0 0.0 0.0
*

```
* LP Turbine Stage
703060   7  1  1  1  3  2  0.03
703061   43.8  1249.8  1403290.5  12.8  55802.5  0.0
703062   0.0  0.0  0.0  0.0  0.0
703063   0  0.0  0.0
*
* LP Turbine Stage
703070   7  1  1  1  3  2  0.03
703071   12.8  1156.7  1347488.  5.5  84247.5  0.0
703072   0.0  0.0  0.0  0.0  0.0
703073   0  0.0  0.0
*
* LP Turbine Stage
703080   7  1  3  0  3  2  0.0
703081   5.5  1103.3  1263240.5  0.737  0.0  55.6
703082   0.0  0.0  0.0  0.0  0.0
703083   0  0.0  0.0
*
* Main Condenser
700110   10  1  5  0.0  -1.5
700115   1  0.0  1.  477.624  31660.  2  -0.9  0  0.0  18  0
*
* Auxiliary Condenser
700120   10  0  2  0.0  0.982
700121   0.0  0.0  0.0  0.0  0.0  0.0
700122   0.0  0.0  0.0  0.0  0.0
*
* Deaerating Heater
704060   15  1  304  0.0  0.0
704061   0.0  0.0  0.0  0.0  0.0  0.0
704062   0.0  0.0  0.0  0.0  0  0.0  0.0  0
*
* "D" Feedwater Heater
704050   16  0  309  3  0.0  5.  10.
704051   0.0  0.0  0.0  0.0  0.0  0.0
704052   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0
*
* "C" Feedwater Heater
704040   16  1  305  3  0.0  5.  10.
704041   0.0  0.0  0.0  0.0  0.0  0.0
704042   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0
*
* "B" Feedwater Heater
704030   16  1  234  3  0.0  5.  10.
704031   0.0  0.0  0.0  0.0  0.0  0.0
704032   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0
*
* "1A2" Feedwater Heater
704020   16  1  311  3  0.0  5.  10.
704021   0.0  0.0  0.0  0.0  0.0  0.0
704022   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0
```

```
*
* “1A1 Feedwater Heater
704010   16  1  307  3  0.0  5.  10.
704011   0.0  0.0  0.0  0.0  0.0  0.0
704012   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0
*
* “F” Feedwater Heater
704070   18  1  303  3  0.0  0.0  10.
704071   0.0  0.0  0.0  0.0  0.0  0.0
704072   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0
*
* “G” Feedwater Heater
704080   18  0  107  3  0.0  -3.  10.
704081   0.0  0.0  0.0  0.0  0.0  0.0
704082   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0
*
* Steam Packing Exhauster
705030   20  210.
705031   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Reheater
705020   25  2  1000.
705021   0.1  0.0  0.0  0.0  0.0
705029   0.0
*
* Air Preheater
705050   27  0.0  0.0  0.0  0.0
705051   0.0
705059   0.0
*
* Condenser Circulating Water Outlet
700210   30
700212   0
*
* Auxiliary Condenser Circ Water Outlet
700220   30
700222   0
*
* Seconadary Sootblower Sink
700530   30
700532   0
*
* Primary Sootblower Sink
700550   30
700552   0
*
* SINK
700360   30
700362   0
*
```

```
* Condenser Circulating Water Inlet
700310   31  64.  14.7  -210000.  0.0  0.0  0
700312  0  0  0
*
* Aux. Cond. Circ. Water Source
700330   31  64.  49.5  15994000.  0.0  0.0  0
700332  0  0  0
*
* Makeup Source
700540   31  64.  32.4  0.0  0.0  0.0  0
700542  0  0  0
*
* Output Comp. - Econ Inlet
700520   32
700522   0
*
* Main Steam
700510   33  1000.  2414.7  3938761.  0.0  0.0  0
700512  0  0
*
* Standard Valve
707010   34  0.0  0.0  0.0  0.0  0.0  0.0  0.0
*
* Throttle Valve
707020   35 -2.0 -2.0 -2.0  0.6  2414.7  1460.4  3938761.
707021   2414.7  1460.4  3938761.
707029   0.0  0.0  0.0
*
* Boiler Feed Pump
706020   40  108  2864.  0.982  1059.9  0.63
706021   0.0  0.84  0.0  0.0  0.0  0.0  0.0  0.0
706029   0.0  0  0.0
*
* Condensate Pump
706010   41  490.  0.0  0.0  0.0
706011   0.0  0.0  0.0  0.0  0.0  0.0
*
*
706030   41  49.5  0.0  0.0  0.0
706031   0.0  0.0  0.0  0.0  0.0  0.0
*
* Standard Mixer
701180   50  0  0.0
*
* Standard Mixer
702010   50  1  0.0
*
* Standard Mixer
702020   50  0  0.0
*
```

* Standard Mixer
702330   50 0 0.0
*
* Standard Mixer
702040   50 1 0.0
*
* Standard Mixer
702350   50 0 0.0
*
* Standard Mixer
702370   50 1 0.0
*
* Standard Mixer
702100   50 1 0.0
*
* Superheat Attemperator Mixer
702030   50 0 0.0
*
* Standard Mixer
702320   50 0 0.0
*
* Standard Mixer
702380   50 0 0.0
*
* Special Mixer
702300   51 0 0.0
*
* Special Mixer
702140   51 0 0.0
*
* Special Mixer
702130   51 0 0.0
*
* Special Mixer
702160   51 0 0.0
*
* Special Mixer
702060   51 0 0.0
*
* Special Mixer
702070   51 0 0.0
*
* Special Mixer
702080   51 0 0.0
*
* Special Mixer
702310   51 0 0.0
*
* Dual Extracting Mixer
702340   52 310 306 0 0.0
*

```
* Demand Flow Splitter - Leakage #7
701230   60  0.0  0.0  0.0  0  0.0
701231   0
*
* Demand Flow Splitter to BFPT
701250   60  0.0  0.0  0.0  0  0.0
701251   0
*
* Demand Flow Splitter to Heater G
701070   60  0.0  352750.  0.0  0  0.0
701071   0
*
* Demand Flow Split (To BFPT)
701080   60  0.0  146724.  0.0  0  0.0
701081   0
*
* Fixed Flow Split (To Sec Soot Blower)
701240   61  0.0  0.0
*
* Fixed Flow Split (To Prim Soot Blower)
701060   61  0.0  0.0
*
* Fixed Flow Split (To Air Preheater)
701090   61  0.0  0.0
*
* Fixed Flow Split (Reheat Attemp.)
701200   61  0.0  0.0
*
* Superheat Attemperation
701220   61  0.0  0.0
*
* Fixed Flow Split (To  Steam Pack Exhauster)
701150   61  0.0  2800.
*
* Fixed Percent Split (A & B Hood)
701270   63  0.0  0.4744
*
* Fixed Perc. Split Drains from B to A HTR
701300   63  0.0  0.5
*
* Fixed Perc. Split (SSR Overflow to HTRS)
701290   63  0.0  0.5
*
* Fixed Percent Split (1A1 & 1A2 HTRS)
701280   63  0.0  0.5
*
* Split to Simulate Flow in a Single Condenser Tube
701500   63  0.0  0.0
*
* Turb. Shaft Leak. Split. (N2 Pack Leak)
701030   64  500.  0.0  0.0
```

```
*
* Turbine Shaft Leakage Splitter
701040   64  620.  0.0  0.0
*
* Turb. Shaft Pack Leak Split (L#4 & L#5)
701050   64  970.  0.0  0.0
*
* Turbine Shaft Leak Split (L#6)
701100   64  600.  0.0  0.0
*
* Steam Seal Regulator
701140   67  123  0.0  17.7  2400.
*
* Throttle Valve Stem Leakage Splitter
701010   68  0.0  0.0  0.0
*
* Throttle Valve Leak. Split. L#1 & L#2
701020   68  0.0  0.0  0.0
*
*  SPECIAL FEATURES
*
*
*
*
800100 “SCHEDULE OF PUMP DP VALUES”
* X VALUES
810100   0.0  30000000.  60000000.  82500000. 1.05000000E+008
* Z AND Y VALUES
810110   0.0  55.4  51.93  47.61  43.28  38.08
*
* VARIABLES FOR PUMP PRESSUE VERSUS FLOW CURVE
830100   1  PDPUM  603  WW  34
830105    5  0
*
*
*
* Control Circ Water Flow for tube out P=14.7
840100 WWVSC  31  14.7  0.0  1.  PP  50
840105    5  0
840109    -240000.  -100000.
*
*
*
* BASELINE NUMBER OF CONDENSER TUBES
871010   31660.
*
* BASELINE FRACTION OF TUBES PLUGGED
871020   0.0
*
*
```

```
*
* FRAC OF NORMAL TUBES
880010   XNC  11   DIV   ONE  0   OPVB  1
880011   0.0  31660.  0.0
880015   999  -1
*
* ADJUST INITIAL CIRC WATER FLOW PER NUMBER TUBES
880020   OPVB  1   MUL   WWVSC  31   WWVSC  31
880025   999  -1
*
* CALCULATE FRAC FLOW SPLIT TO A SINGLE TUBE
881010   ONE  0   DIV   XNC  11   FRSPL  150
881011   2.  0.0  0.0
*
* ONE MINUS FRAC TUBES PLUGGED
881030   ONE  0   SUB   OPVB  102   OPVB  103
*
* NUMBER OF TUBES ACTIVE
881040   OPVB  103   MUL   OPVB  101   XNC  11
*
* CALC CONDENSER PRESSURE DROP
881110   PP  -50   SUB   PP  50   OPVB  111
*
* CALCULATE TUBE CROSS SECTIONAL AREA, SQ FT
881210   'DD'  50   SQR   OPVB  121
*
* TUBE FLOW AREA, SQ FT X 3600
881220   PI4IN2  0   MUL   OPVB  121   OPVB  122
881221   0.0  0.0  3600.
*
* TUBE VELOCITY, FT/SEC
881230   WV  50   DIV   OPVB  122   OPVB  123
*
* CONDENSER SHELL PRESSURE, IN. HGA
881240   PP  -52   DIV   PSIHGA  0   OPVB  124
*
*
*   SPECIAL OPTIONS
```

```
*
*
*
850000
*
*
*
*
*
```

```
* OUTPUT GLOBAL SUPPRESSION CARD
020000 PRINT    PRINT    NOPRNT
020002 NOPRNT   * Geometry Configuration of Model
020004 NOPRNT   * Stream Properties
020005 NOPRNT   * Comparison of Component Port Test Data With Stream Properties
020015 NOPRNT   * Detailed Mixer Performance Output
020016 NOPRNT   * Detailed Splitter Performance Output
020021 NOPRNT   * Second Law of Thermodynamics Performance - Components
020022 NOPRNT   * Second Law of Thermodynamics Performance - Streams
020023 NOPRNT   * Second Law of Thermodynamics Performance - System
020024 NOPRNT   * Material Descriptions Used in the Model
020025 NOPRNT   * First Law of Thermodynamics Performance - Envelope
020032 NOPRNT   * Input Schedule Number N Table of Values
020033 NOPRNT   * Variable Sets Which Reference Schedules
020034 NOPRNT   * Controls Input
020037 NOPRNT   * Definitions of Special Operations Specified
020078 NOPRNT   * Nonzero Operational Variables
*
*  FILE UGMSYSSS
*
*  ACTIVATE SENSITIVITY STUDY FEATURE
*
*    NSWSNS PRNSNS
930000  1    NOPRNT
*930008  DELETE
*       XTISNS
930001  'CONDENSER FRAC TUBES PLUGGED'
*      XCSNS IDXSNS XVSNS1 XVSNS2 NPTSNS
930002   OPVB   102    0.    .5      11
*       YTISNS
930011  'CONDENSER SHELL PRESSURE, IN.HGA'
*      YCSNS IDYSNS
930012    OPVB  124
*
930021  'CONDENSER CIRC WATER FLOW'
*
930022    WW    34
*
930031  'CONDENSER PRESSURE DROP'
*
930032    OPVB  111
*
930041  'CONDENSER TTD'
*
930042    TTDOUT  11
*
930051  'PUMP PRESSURE RISE'
*
930052    PDUPMP  603
*
930061  'PUMP POWER'
```

```
*
930062    BKUPMP  603
*
930071  'SYSTEM GROSS GENERATION'
*
930072    BKGROS  0
*
930081  'CONDENSER TUBE VELOCITY, FT/SEC'
*
930082    OPVB    123
*
*
*    END OF BASE DECK
*
*
.
```

Table 4 - Sensitivity Study Results for Steam Turbine Cycle at Full Load and Hydraulically Balanced Scenario

VERSION GT97 CREATED 19 MAY 00 DATE 05/19/00. PAGE 25
SENSITIVITY STUDY CASE 11, X = 5.00000E-01; X IS OPVB (102)
** SAVE CASE **

SENSITIVITY STUDY CALCULATION RESULTS
TG SYSTEM AT FULL LOAD, CIRC FLOW SET FOR DELTA P BALANCE

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 1	
	X INDEPENDENT	VARIABLE:	
0.0000E+00	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.5327E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
1.0501E+08	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
3.8078E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
3.8078E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.4782E+03	BKUPMP(603),	PUMP POWER	KW
5.9123E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.6823E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 2	
	X INDEPENDENT	VARIABLE:	
5.0000E-02	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.5777E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
1.0098E+08	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
3.9009E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
3.9008E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.4265E+03	BKUPMP(603),	PUMP POWER	KW
5.9119E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.7655E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 3	
	X INDEPENDENT	VARIABLE:	
1.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.6290E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
9.6853E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
3.9970E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
3.9963E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.3668E+03	BKUPMP(603),	PUMP POWER	KW
5.9113E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.8504E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 4	
	X INDEPENDENT	VARIABLE:	
1.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.6983E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
9.2591E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.0943E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.1864E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.0948E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.2980E+03	BKUPMP(603),	PUMP POWER	KW
5.9104E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.9357E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 5	
	X INDEPENDENT	VARIABLE:	
2.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.7858E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
8.8226E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.1956E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.5169E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.1957E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.2199E+03	BKUPMP(603),	PUMP POWER	KW

VALUE	DESCRIPTION		UNITS
5.9092E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.0235E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 6	
	X INDEPENDENT	VARIABLE:	
2.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.8901E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
8.3738E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.2993E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.8919E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.2994E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.1317E+03	BKUPMP(603),	PUMP POWER	KW
5.9072E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.1125E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 7	
	X INDEPENDENT	VARIABLE:	
3.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
2.0191E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
7.9025E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.3947E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
6.3215E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.3949E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.0210E+03	BKUPMP(603),	PUMP POWER	KW
5.9031E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.1941E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 8	
	X INDEPENDENT	VARIABLE:	
3.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
2.1796E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
7.4156E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.4873E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
6.8194E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F

VALUE	DESCRIPTION		UNITS
4.4886E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
2.8953E+03	BKUPMP(603),	PUMP POWER	KW
5.8963E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.2731E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

ANALYSIS CASE 9

	X INDEPENDENT	VARIABLE:	
4.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
2.3818E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
6.9191E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.5841E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
7.4036E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.5841E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
2.7590E+03	BKUPMP(603),	PUMP POWER	KW
5.8861E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.3552E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

ANALYSIS CASE 10

	X INDEPENDENT	VARIABLE:	
4.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
2.6448E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
6.4094E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.6808E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
8.0991E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.6822E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
2.6104E+03	BKUPMP(603),	PUMP POWER	KW
5.8710E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.4373E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

ANALYSIS CASE 11

	X INDEPENDENT	VARIABLE:	
5.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
3.0009E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
5.8860E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR

VALUE	DESCRIPTION		UNITS
4.7765E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
8.9463E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.7774E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
2.4460E+03	BKUPMP(603),	PUMP POWER	KW
5.8456E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.5187E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

Table 5 - Sensitivity Study Results for Steam Turbine Cycle at Half Load and Hydraulically Balanced Scenario

VERSION GT97 CREATED 19 MAY 00 DATE 05/19/00. PAGE 25
SENSITIVITY STUDY CASE 11, X = 5.00000E-01; X IS OPVB (102)
** SAVE CASE **

SENSITIVITY STUDY CALCULATION RESULTS
TG SYSTEM AT HALF LOAD, CIRC FLOW SET BY DELTA P BALANCE

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 1	
	X INDEPENDENT	VARIABLE:	
0.0000E+00	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.0740E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
1.0498E+08	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
3.8085E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
3.8085E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.4778E+03	BKUPMP(603),	PUMP POWER	KW
2.9559E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.6687E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 2	
	X INDEPENDENT	VARIABLE:	
5.0000E-02	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.0911E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
1.0096E+08	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
3.9015E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
3.9015E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.4261E+03	BKUPMP(603),	PUMP POWER	KW
2.9552E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.7511E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

VALUE	DESCRIPTION		UNITS
		ANALYSIS CASE 3	
	X INDEPENDENT	VARIABLE:	
1.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.1104E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
9.6826E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
3.9976E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
3.9969E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.3664E+03	BKUPMP(603),	PUMP POWER	KW
2.9542E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.8352E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 4	
	X INDEPENDENT	VARIABLE:	
1.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.1326E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
9.2566E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.0949E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.0954E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.2975E+03	BKUPMP(603),	PUMP POWER	KW
2.9532E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
6.9194E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 5	
	X INDEPENDENT	VARIABLE:	
2.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.1580E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
8.8204E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.1962E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.1962E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.2195E+03	BKUPMP(603),	PUMP POWER	KW
2.9519E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW

VALUE	DESCRIPTION		UNITS
7.0062E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 6	
	X INDEPENDENT	VARIABLE:	
2.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.1875E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
8.3718E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.2998E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.2999E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.1312E+03	BKUPMP(603),	PUMP POWER	KW
2.9503E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.0940E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 7	
	X INDEPENDENT	VARIABLE:	
3.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.2229E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
7.9008E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.3950E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.3952E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
3.0206E+03	BKUPMP(603),	PUMP POWER	KW
2.9484E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.1741E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB
		ANALYSIS CASE 8	
	X INDEPENDENT	VARIABLE:	
3.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB
	Y DEPENDENT	VARIABLES:	
1.2655E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
7.4143E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.4876E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.4888E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA

VALUE	DESCRIPTION		UNITS
2.8950E+03	BKUPMP(603),	PUMP POWER	KW
2.9460E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.2514E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

ANALYSIS CASE 9

X INDEPENDENT VARIABLE:

4.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB

Y DEPENDENT VARIABLES:

1.3169E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
6.9183E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.5843E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.5843E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
2.7587E+03	BKUPMP(603),	PUMP POWER	KW
2.9428E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.3316E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

ANALYSIS CASE 10

X INDEPENDENT VARIABLE:

4.5000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB

Y DEPENDENT VARIABLES:

1.3804E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
6.4099E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.6822E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.6821E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
2.6106E+03	BKUPMP(603),	PUMP POWER	KW
2.9386E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.4122E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB

ANALYSIS CASE 11

X INDEPENDENT VARIABLE:

5.0000E-01	OPVB (102),	CONDENSER FRAC TUBES PLUGGED	OPVB

Y DEPENDENT VARIABLES:

1.4611E+00	OPVB (124),	CONDENSER SHELL PRESSURE, IN.HGA	OPVB
5.8870E+07	WW (34),	CONDENSER CIRC WATER FLOW	LBM/HR
4.7775E+01	OPVB (111),	CONDENSER PRESSURE DROP	OPVB

VALUE	DESCRIPTION		UNITS
5.0000E+00	TTDOUT(11),	CONDENSER TTD	DEL DEG F
4.7773E+01	PDUPMP(603),	PUMP PRESSURE RISE	PSIA
2.4463E+03	BKUPMP(603),	PUMP POWER	KW
2.9325E+02	BKGROS(0),	SYSTEM GROSS GENERATION	MW
7.4905E+00	OPVB (123),	CONDENSER TUBE VELOCITY, FT/SEC	OPVB