

*Application of a Simplified Design Mode
Feedwater Heater for Performance Analysis*

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Abstract

Santee Cooper's Winyah Generating Station requested modeling services to study the impact of plugging 175 of the 1,011 tubes in the No. 6 feedwater heater on Winyah unit 2. This heater was installed in November of 1991. A secondary request was made for the evaluation of the steam loading on this heater when the next lower heater is out of service.

A simplified design mode feedwater heater in a PEPSE turbine cycle model was used in this study. The simplified design mode feedwater heater was chosen due to time constraints. This paper shows how well PEPSE can simulate feedwater heater performance in the simplified design mode.

This example shows that for most uses, a simplified design feedwater heater can be an effective tool in estimating performance losses due to heater tube pluggage and flow path modifications. Although not as accurate as a full design mode feedwater heater model in the absolute sense, use of the simplified design mode model can provide representative results to meet management decision support requirements and schedule constraints with acceptable accuracy.

Introduction

Winyah 2 is one of the four 260 MW generators at Santee Cooper's Winyah Generating Station, located in Georgetown, South Carolina. It is a General Electric (GE) turbine rated at a maximum flow of 2,150,000 lb/hr, 1000/1000 F Temperature and 2400 psig.

This study was completed for the highest pressure heater (feedwater heater No. 6). The heater was installed new in November 1991, and designed to handle lower feedwater inlet temperatures and the resultant higher extraction flow, due to feedwater bypassing the next lower heater. This study estimates the higher extraction flow due to the lower inlet temperature, and the effect of plugging 175 of the 1,011 heater tubes.

Time constraints necessitated the decision to use a Simplified Design Heater Model for the analysis.

There were two goals for this study; 1) Quantify the effect of tube pluggage on unit performance, and 2) Provide the consultant enough information to help determine why this heater was failing prematurely. The change in heater performance due to the 175 plugged tubes was used to estimate the loss in turbine cycle heat rate when the unit returned to service. High extraction flow data was used for the vibration analysis of the No. 6 heater tubes.

PEPSE Modeling

A simplified design feedwater heater model was created and inserted into an existing Winyah 2 PEPSE turbine model. Using the simplified model over a full design model heater minimized the time required for this study. Required data for the simplified model were also readily available.

The modeling is straightforward. The most tedious task was calculating the open baffle areas in the desuperheating and drain cooling baffle plates. The initial No. 6 heater was modeled as follows:

```
703900 18, 0, 90, 4, 0.0, 2, 2, 1, 0, 1, 2, 2, 2, 2
703901 .473, .625, 612.6057, 1011.0, 10.5, .8125, 12.5, 12.5, 10.0, 8.0
```

The descriptions of the inputs are:

Card number=703900

Heater type=18, Desuperheating (DSH)
and drain cooling (DC)

Drain inlet=0, no inlet drains

Supply component=90

Run mode=4, simplified design mode

Heat transferred=0.0

Tube lattice flag=2, Tubes in hexagonal array

Flow flag=2, Counter flow

Penalty factor=1, No flooding penalty to be included

Heat transfer flag=0, laminar

Heater orientation=1, Horizontal

Desuperheating (DSH) and Drain Cooling (DC) inputs:

DSH lattice=2, Hexagonal array

DSH flow flag=2, Counter flow

DC lattice=2, Hexagonal array

DC flow flag=2, Counter flow

Card number=703901

ID of tubing=0.473

OD tubing=0.625

Mean free length of tubing=612.6057 inches

Number of tubes=1011

Thermal conductivity=10.5

Tubing pitch=0.8125

Feedwater inlet nozzle=12.5 inches

FW outlet nozzle=12.5 inches

Shell inlet nozzle=10.0 inches

Shell outlet nozzle=8.0 inches

After the new model was run, the terminal temperature difference (TTD) and drain cooler approach (DCA) did not match the design numbers of 0.0 °F and 10.0 °F respectively. It was determined from experience that some heat transfer bypass factors for the desuperheating zone and drain cooler sections could be applied. This can eliminate the task of calculating the open baffle areas for future models. Therefore, two controls were written to calculate the desuperheating zone and the drain cooler bypass factors. Appropriate card series were added and the feedwater heater update card inserted. The additional cards written are shown here:

703904 92.5, 0.0, 0.0, 1.0, 0.0, .53853
703906 71.9, 0.0, 0.0, 1.0, 0.0, 1.01492

The descriptions of the inputs are:

For the desuperheater:

Card number=703904

DSH mean free length XLDS=92.5 inches
Steam flow area around baffle plate SBFLDS=0.0
Number of baffle plates XBFLDS=0.0
Number of rows of tubes in section available for cross flow XNRWDS=1.0
Hydraulic bypass factor BPFDS=0.0 default
Heat transfer bypass factor BPHDS=.53853

For the drain cooler:

Card number=703906

DSH mean free length XLDC=71.9 inches
Steam flow area around baffle plate SBFLDC=0.0
Number of baffle plates XBFLDC=0.0
Number of rows of tubes in section available for cross flow XNRWDC=1.0
Hydraulic bypass factor BPFDC=0.0 default
Heat transfer bypass factor BPHDC=1.01492

The controls to find the above factors (.53853 and 1.01492) were:

```
840100 BPHDS, 390, 0.0, 0.0, 0.0, TTDOUT, 390  
840109 0.1, 2.25  
840200 BPHDC, 390, 10.0, 0.0, 0.0, DCAOUT, 390  
840209 0.1, 1.75
```

The descriptions of the inputs are:

Card number=840100

Heat transfer bypass factor= BPHDS, for the desuperheater control variable
Feedwater heater component number=390, identification of the control variable location.

VALYC=0.0, this is the goal value

YCNVRG=0.0, the convergence criteria

CYFCTR=0.0, coefficient factor to be used with CYVAR

CYVAR= TTDOUT, goal variable: terminal temperature difference

NYUIDC= 390, component identification of CYVAR

Card number=840109

XCLO=0.1, minimum value allowed for the control variable

XCHI=2.25, maximum value allowed for the control variable

Card number=840200

Heat transfer bypass factor= BPHDC, for the drain cooler control variable.

Feedwater heater component number=390 identification of the control variable location.

VALYC=10.0, this is the goal value

YCNVRG=0.0, the convergence criteria

CYFCTR=0.0, coefficient factor to be used with CYVAR

CYVAR= DCAOUT, goal variable: drain cooler approach difference

NYUIDC= 390, component identification of CYVAR

Card number=840209

XCLO=0.1, minimum value allowed for the control variable
XCHI=1.75, maximum value allowed for the control variable

These controls were tied to obtaining the correct TTD and DCA difference for the heater. With these changes made, the model ran with the design steam flow to obtain the design TTD and DCA on the heater. The model was run using data collected during the acceptance test. Acceptance test data included the following: main steam flow, No. 6 feedwater inlet temperature, extraction steam pressure, and extraction steam temperature. This resulted in a very close match to the actual test results of TTD and DCA, table 1.

Table 1

| Winyah 2 No. 6 FWH study | Units | PEPSE simplified design heater run | PEPSE simplified design heater with test Nos. | 1-29-94 Test results |
|--------------------------|--------|------------------------------------|---|----------------------|
| No. of Tubes | | 1,011 | 1,011 | 1,011 |
| Feedwater Flow | lbs/hr | 1,888,157 | 1,976,599 | 1,976,599 |
| No. 6 FWH inlet Press. | psia | 549.7 | 557.3 | 557.3 |
| Shell Sat. Temp. | °F | 476.9 | 478.3 | 478.3 |
| Steam inlet Temp. | °F | 628.7 | 640.0 | 640.0 |
| FW. inlet Temp | °F | 404.8 | 389.7 | 389.7 |
| FW. outlet Temp. | °F | 476.9 | 477.8 | 477.5 |
| Drains outlet Temp. | °F | 414.8 | 405.9 | 406.8 |
| Extraction Steam Flow | lbs/hr | 160,104 | 200,475 | 205,428 |
| TTD | °F | 0.0 | 0.5 | -1.2 |
| DCA | °F | 10.0 | 16.2 | 17.1 |

See Appendix I for the PEPSE Decks used.

Results

The heater was benchmarked to the design PEPSE performance run. Acceptance test data was then used in the model. The same data points were input into this deck as stated above. As shown in table 2, the results of this output compare well with the vendor predicted output for the given test conditions. This result was also very close to the actual acceptance test.

Table 2

| Winyah 2 No. 6 FWH study | Units | PEPSE simplified design Heater with test | Vendor predicted test results | 1-29-94 Test results |
|--------------------------|--------|--|-------------------------------|----------------------|
| No. of Tubes | | 1,011 | 1,011 | 1,011 |
| Feedwater Flow | lbs/hr | 1,976,599 | 1,976,599 | 1,976,599 |
| No. 6 FWH inlet Press. | psia | 557.3 | 557.3 | 557.3 |
| Shell Sat. Temp. | °F | 478.3 | 478.3 | 478.3 |
| Steam inlet Temp. | °F | 640.0 | 640.0 | 640.0 |
| FW. inlet Temp | °F | 389.7 | 389.7 | 389.7 |
| FW. outlet Temp. | °F | 477.8 | 477.5 | 477.5 |
| Drains outlet Temp. | °F | 405.9 | 406.9 | 406.8 |
| Extraction Steam Flow | lbs/hr | 200,475 | 200,292 | 205,428 |
| TTD | °F | 0.5 | 0.9 | -1.2 |
| DCA | °F | 16.2 | 17.2 | 17.1 |

These results added credibility to the new model.

Simplified Feedwater Heater

Other requested studies were completed and included the following:

- 1). Operating the unit with the No. 5 and No. 6 heaters out of service. This was to determine what the impact would be on gross turbine heat rate. The result of this study was a 241 Btu/kWhr increase in gross turbine heat rate.
- 2). Operating the unit with 175 plugged tubes in the No. 6 heater. This was to obtain a heat rate, TTD, DCA, and to determine the performance impact. Table 3 shows the results of this analysis.
- 3). The unit's preoutage operating performance with the No. 6 feedwater heater in leaking condition. This used data from the On-line System (OLS) to obtain operational TTD's and DCA's. Table 3 shows the results of this analysis.

Table 3

| Winyah 2 No. 6 FWH study | Units | PEPSE simplified design | Degraded heater run with 175 plugged tubes | No. 6 heater-OLS TTD & DCA with tubes leaking |
|--------------------------------|---------|-------------------------|--|---|
| No. of Tubes | | 1,011 | 836 | 1,011 |
| Feedwater Flow | lbs/hr | 1,888,157 | 1,888,157 | 1,888,157 |
| No. 6 FWH inlet Press. | psia | 549.3 | 550.9 | 554.3 |
| Shell Sat. Temp. | °F | 476.9 | 477.1 | 477.8 |
| Steam inlet Temp. | °F | 628.7 | 629.2 | 630.5 |
| FW. inlet Temp | °F | 404.8 | 405.0 | 405.5 |
| FW. outlet Temp. | °F | 476.9 | 475.3 | 471.0 |
| Drains outlet Temp. | °F | 414.8 | 417.6 | 417.8 |
| Extraction Steam Flow | lbs/hr | 160,104 | 156,477 | 145,449 |
| TTD | °F | 0.0 | 1.8 | 6.8 |
| DCA | °F | 10.0 | 12.6 | 12.3 |
| Gross Turbine heat rate change | Btu/kWh | 0.0 | 3.0 | 12.0 |

- 4). Analysis at four feedwater flows, design minimum, 50 percent load test, maximum flow with the No. 5 feedwater heater out of service, and full load with the No. 5 feedwater heater out of service. This was to determine extraction steam flow rates

Simplified Feedwater Heater

for the No. 6 feedwater heater during these conditions. Results were used to determine potential problems for this heater (Table 4).

Table 4

| Winyah No. 2 Feedwater Heater Study | Units | Design 69 MW | 50% load test 143 MW | Full load with No. 5 FWH bypassed | Max Flow with No. 5 FWH bypassed |
|-------------------------------------|--------|-----------------|-------------------------|--------------------------------------|-------------------------------------|
| FW Flow | lbs/hr | 460,000 | 1,116,297 | 1,976,600 | 2,150,000 |
| FW in Temp. | °F | 301.7 | 361.3 | 350.7 | 357.0 |
| FW out Temp | °F | 352.9 | 420.3 | 473.9 | 481.3 |
| Steam Flow | lbs/hr | 24,150 | 78,111 | 271,651 | 300,178 |
| Steam press. | psia | 139.7 | 320.3 | 542.5 | 588.1 |
| Steam Temp. | °F | 509.7 | 455.8 | 626.1 | 645.7 |
| Saturation Temp | °F | 352.9 | 423.4 | 475.5 | 484.1 |
| Degrees of Superheat | °F | 156.8 | 32.4 | 150.6 | 161.6 |
| Drain Temp. | °F | 311.7 | 366.2 | 382.5 | 392.1 |
| TTD | °F | 0.0 | 3.1 | 1.6 | 2.8 |
| DCA | °F | 10.0 | 4.9 | 31.8 | 35.1 |

Failure Mode Analysis Methods

The results of the simplified feedwater heater PEPSE analysis were used to evaluate the predominate failure mode(s) contributing to the premature tube failures.

The heater developed 22 tube failures by August 1994 with less than three years of service. The heater was subject to "overload" steam loading for the first 19 months of service, due to the degraded condition of the upstream No. 5 feedwater heater. That heater was subsequently replaced in June 1993. Data is not available to predict the extent of the "overload" condition caused by the adjacent heater's plugged tubes and bypass hole in the pass partition plate. The new No. 6 heater was to be designed to accept full bypass of the upstream No. 5 heater.

Seven of the failed tubes were pulled and eddy current testing was performed on the remaining tubes. Failures were located in the desuperheater at both of the outlet baffles of the dual flow design. All failed tubes and those indicating greater than 50% wall loss by eddy current were plugged.

Metallurgical analysis of the failed tubes indicated stress corrosion cracking as the mode of failure. The combination of residual stresses, elevated temperature and a corrosive agent, such as chlorides, are required for this type of failure to occur.

Santee Cooper retained a consultant to assist with the failure mode analysis. The following data was supplied:

1. Manufacturer's heater proposal
2. Manufacturer's design drawings
3. Failed tube metallurgical reports
4. PEPSE Simplified Design Heater performance predictions
5. Performance Services acceptance tests and low load heater data
6. Eddy Current data

PEPSE simplified design data was analyzed by the consultant to predict the potential for flow induced vibration and wet outside tube wall at low loads for corrosion potential. The consultant concluded that a combination of contributing failure modes caused the premature failures.

Analysis of the "overload" PEPSE data indicated that the heater design was marginal for vibration potential at full load and maximum feedwater flows. Their conclusion indicates that this vibration potential increased the stress level in the tubes and was one of the contributing factors to stress corrosion cracking.

A second contributing factor was a potential for wet tube wall in the desuperheater at low load with low superheat temperatures. The heater receives cold reheat extraction. During low load operation, the boiler is not capable of achieving 1000 degrees F superheat temperatures indicated on the turbine design heat balances. Analysis of actual test data at 50% load indicated the potential for a wet tube wall condition in the desuperheater.

There is a high potential for condensation to form on the outer tube wall at low loads. This moisture could then dry as load increased leaving mineral deposits. This condition allowed the potential for crevice corrosion in the tube to baffle interface leading to pitting and the concentration of chlorides to accumulate in the pits.

The consultant concluded that a combination of vibration at full load, and the possibility of poor manufacturing methods coupled with the potential for pitting corrosion at low load contributed to the potential for tube failures.

Conclusions

Use of the simplified design mode feedwater heater in this manner shortened the response time required for this request. It showed that a simplified design mode heater can be an effective tool in estimating changes in performance.

The preliminary results of the tube failure problem indicate that a combination of moisture corrosion in the desuperheater at low loads, and vibrations at the higher loads, were the primary contributing factors for the premature tube failures in this heater.

References

The following references were used during the course of the analysis and in preparation of this paper.

- 1 - PEPSE computer Code, NUS Inc, PO Box 50736, Idaho Falls, Idaho, Version 59E;1994
- 2 - PEPSE Manual: volumes I, II, III, and IV, NUS Inc, PO Box 50736, Idaho Falls, Idaho, Revisions 19, 1, 11, and 4.
- 3 - Santee Cooper Inter Office Correspondences dated: 5/25/92, 11/09/94, and 12/2/94
- 4 - Consultants' report dated 3/22/95

APPENDIX I

| | | | | | | | | | |
|----------|----------|----------|---------|----------|----------|----------|----|----------|----------|
| WW | WW | ZZZZZZZ | FFFFFTT | WW | WW | HH | HH | TTTTTTTT | KKKKKKK |
| WW | WW | 22222222 | FFFFFFF | WW | WW | HH | HH | TTTTTTTT | RRRRRRRR |
| WW | WW | 22 | 22 FF | WW | WW | HH | HH | TT | RR RR |
| WW | WW | 22 | 22 FF | WW | WW | HH | HH | TT | RR RR |
| WW | WW | 22 | 22 FF | WW | WW | HH | HH | TT | RR RR |
| WW | WW | 22222 | FFFFFF | WW | WW | HHHHHHHH | HH | TT | RRRRRRRR |
| WW | WW | 2222 | FFFFFF | WW | WW | HHHHHHHH | HH | TT | RRRRRRRR |
| WW | WW | 22 | FF | WW | WW | HH | HH | TT | RRRR |
| WWWWWWWW | WWWWWWWW | 22 | FF | WWWWWWWW | WWWWWWWW | HH | HH | TT | RR RR |
| WWW | WWW | 22 | FF | WWW | WWW | HH | HH | TT | RR RR |
| WW | WW | 22222222 | FF | WW | WW | HH | HH | TT | RR RR |
| W | W | 22222222 | FF | W | W | HH | HH | TT | RR RR |

| | | | | | | | | | | |
|---------|--------|-----|----------|------|----|---------|---------|-----|--------|---------|
| LL | M | M | SSSSSS | VV | VV | EEEEEEE | NN | NN | SSSSSS | EEEEEEE |
| LL | MM | MM | SSSSSSSS | VV | VV | EEEEEEE | NNN | NN | SSSSSS | EEEEEEE |
| LL | MMM | MMM | SS SS | VV | VV | EE | NNN | NN | SS | EE |
| LL | MMMMMM | MM | SS | VV | VV | EE | NNNN | NN | SS | EE |
| LL | MM | MM | MM | VV | VV | EE | NNNN | NN | SS | EE |
| LL | MM | MM | SSSS | VV | VV | EEEEEE | NN NN | NN | SSSS | EEEEEE |
| LL | MM | MM | SSSS | VV | VV | EEEEEE | NN NN | NN | SSSS | EEEEEE |
| LL | MM | MM | SSS | VV | VV | EE | NN NNNN | NN | SSS | EE |
| LL | MM | MM | SS | VV | VV | EE | NN NNNN | NN | SS | EE |
| LL | MM | MM | SS | VV | VV | EE | NN NNNN | NN | SS | EE |
| LLLLLLL | MM | MM | SSSSSS | VVVV | VV | EEEEEEE | NN | NNN | SSSSSS | EEEEEEE |
| LLLLLLL | MM | MM | SSSSSS | VV | VV | EEEEEEE | NN | NN | SSSSSS | EEEEEEE |

| | | | |
|----------|----------|----------|-----------|
| AAAAAA | 222222 | 000000 | 333333 |
| AAAAAAAA | 22222222 | 00000000 | 333333333 |
| AA AA | 22 | 22 00 | 00 33 |
| AA AA | | 22 00 | 00 33 |
| AA AA | | 22 00 | 00 33 |
| AAAAAAA | ----- | 22222 00 | 00 333 |
| AAAAAAA | ----- | 2222 00 | 00 333 |
| AA AA | 22 | 00 | 00 33 |
| AA AA | 22 | 00 | 00 33 |
| AA AA | 22 | 00 | 00 33 |
| AA AA | 22222222 | 00000000 | 33333333 |
| AA AA | 22222222 | 00000000 | 33333333 |

SPOOLID: 0151
 CLASS: P
 PRINTER: PSFRSCS
 SYSTEMID: XASP21
 PRINT DATE: 02/02/95
 PRINT TIME: 14:22:26

USER/NODEID: LMSVENSE XASP21
 FILENAME/TYPE: W2FWHTR SPF0677S
 FILE CREATE DATE: 02/02/95
 FILE CREATE TIME: 14:22:25
 DIST: A-203

START

010001 80 * 80 COLUMN OUTPUT SPECIFICATION FOR VERSION 55H
 *
 ****=
 * WINYAH UNIT 1&2
 *
 * TYPE: DESIGN MODEL
 * PROJECT: EVALUATE CURRENT PEPSE MODEL VS. GE HEAT BALANCE
 * FILE NAME: WIDESIGN
 * FILE CREATED: 01/01/90 JDR
 *
 ****=
 * GENERAL COMMENTS -- 1971 HEAT BALANCE
 * (1) VENDOR HEAT BALANCE BASED ON 1967 ASME STEAM TABLES
 *
 ****=
 * GENERIC DATA
 * NTGCYC NGEPRO NHOKUP NTURB NRHEAT
 010200 2, 3, 1, 1, 1
 ****=
 * SPECIFIED GENERATOR POWER HELD CONSTANT - ADJUST THROTTLE FLOW
 *
 011010 1, 2, 1, 0, 3600, 350000., 0.9, 59.7, 59.7, 175000.0
 *
 ****=
 * GENERATOR LOSSES
 011011 802.0, 0.0
 ****=
 * CONVERGENCE CRITERIA
 012000 45
 ****=
 * OUTPUT TABLE SUPPRESSION
 *
 * OPTIONAL OUTPUT TABLES
 ****=
 020002 NOPRNT, * GEOMETRY
 020004 NOPRNT, * STREAMS
 020013 NOPRNT, * SOURCE, SINK, VALVE
 020015 NOPRNT, * MIXERS
 020016 NOPRNT, * SPLITTERS
 020017 NOPRNT, * FURNACE/COMBUSTORS
 020021 NOPRNT, * SECOND LAW -- COMPONENTS
 020022 NOPRNT, * SECOND LAW -- STREAMS
 020024 NOPRNT, * MATERIAL DESCRIPTIONS
 020026 NOPRNT, * TURBINE EXPANSION CHARACTERISTICS
 ****=
 * STREAM GEOMETRY
 ****=
 * FROM PORT ID TO PORT ID
 500030 10, U, 12, I
 500050 12, U, 15, I
 500130 12, B, 285, IB
 500150 15, U, 20, I
 500220 20, B, 30, I
 500250 20, U, 40, I
 500310 30, U, 80, IB
 500320 30, B, 320, IB
 500350 40, U, 50, I
 500450 50, U, 60, I
 500520 50, B, 110, IB
 500550 60, U, 70, I
 500620 70, B, 140, I
 500650 70, U, 80, IA
 500750 80, U, 90, I
 500810 90, B, 390, S
 500850 90, U, 95, IAT
 500900 95, U, 100, T
 500950 100, T, 110, IA
 501050 110, U, 120, I
 501210 120, E, 380, S
 501250 120, U, 130, I
 501310 130, E, 150, IA
 501350 130, U, 160, I
 501420 160, B, 310, IB
 501430 140, B, 320, IA
 501440 140, U, 150, IB
 501450 160, U, 170, I
 501460 320, U, 310, IA
 501510 170, E, 350, S
 501540 150, U, 360, SI
 501550 170, U, 180, I

| | | | | |
|--------|------|----|------|----|
| 501610 | 180, | E, | 340, | S |
| 501650 | 180, | U, | 190, | I |
| 501710 | 190, | E, | 290, | IA |
| 501750 | 190, | U, | 200, | I |
| 501850 | 200, | U, | 210, | S |
| 501950 | 210, | D, | 240, | I |
| 502450 | 240, | U, | 250, | T |
| 502550 | 250, | T, | 300, | T |
| 502630 | 250, | D, | 260, | IA |
| 502670 | 260, | U, | 210, | D |
| 502720 | 270, | B, | 250, | S |
| 502730 | 270, | U, | 260, | IB |
| 502820 | 280, | B, | 270, | I |
| 502830 | 280, | U, | 290, | IB |
| 502860 | 285, | U, | 280, | I |
| 502960 | 290, | U, | 300, | S |
| 503050 | 300, | T, | 330, | IA |
| 503130 | 310, | U, | 285, | IA |
| 503230 | 300, | D, | 325, | I |
| 503270 | 325, | U, | 330, | IB |
| 503350 | 330, | U, | 340, | T |
| 503430 | 340, | D, | 300, | D |
| 503450 | 340, | T, | 350, | T |
| 503530 | 350, | D, | 340, | D |
| 503550 | 350, | T, | 360, | FW |
| 503650 | 360, | D, | 370, | I |
| 503750 | 370, | U, | 640, | I |
| 503830 | 380, | D, | 360, | D |
| 503850 | 380, | T, | 390, | T |
| 503930 | 390, | D, | 380, | D |
| 503950 | 390, | T, | 400, | IT |
| 506000 | 600, | U, | 380, | T |
| 506050 | 600, | B, | 95, | IB |
| 506400 | 640, | U, | 600, | I |
| 506450 | 640, | B, | 650, | I |
| 509000 | 220, | U, | 210, | T |
| 509100 | 210, | T, | 230, | I |

* (A) IS A CONSTANT AS IN THE EQUATION: A = DELTA P / P

* STREAM TYPE (A)

| | | |
|--------|----|------|
| 600810 | 2, | 0.04 |
| 601210 | 2, | 0.04 |
| 601540 | 2, | 0.04 |
| 601510 | 2, | 0.04 |
| 601610 | 2, | 0.04 |
| 601710 | 2, | 0.04 |
| 601050 | 2, | 0.02 |

* COMPONENT SPECIFICATIONS

* TURBINE DATA

| | |
|--------|--------------------------------|
| 700400 | 04, 1, 1, 1, 1, 0, 4, 0, 38.05 |
|--------|--------------------------------|

* GOVERNING STAGE

| | |
|--------|---|
| 700600 | 05, 1, 1, 0, 1, 0.0, 1909.0, 1437.0, 1848252., 572.5, 0.0 |
|--------|---|

* HP TURBINE

| | |
|--------|---|
| 701200 | 06, 1, 0, 1, 2, 1, 0.03, 505.0, 1518.2, 1712285., 264.8, 93952. |
|--------|---|

* LAST IP TURBINE

| | |
|--------|--|
| 701300 | 06, 1, 3, 1, 2, 1, 0.0, 264.8, 1437.7, 1618333., 123.6, 98779. |
|--------|--|

* 1ST LP TURBINE

| | |
|--------|--|
| 701700 | 07, 1, 0, 1, 3, 2, 0.03, 123.6, 1353.1, 1516646., 45.9, 89770. |
|--------|--|

* 2ND LP TURBINE

| | |
|--------|---|
| 701800 | 07, 1, 1, 1, 3, 2, 0.03, 45.9, 1258.8, 1426876., 14.8, 60847. |
|--------|---|

* 3RD LP TURBINE

| | |
|--------|---|
| 701900 | 07, 1, 1, 1, 3, 2, 0.03, 14.8, 1170.5, 1366029., 5.63, 67058. |
|--------|---|

* LAST LP TURBINE

| | |
|--------|---|
| 702000 | 07, 1, 3, 0, 3, 2, 0.0, 5.63, 1109.0, 1298971., .982, 0.0, 55.6 |
|--------|---|

* CONDENSER AND FEEDWATER HEATER DATA

* CTYPE IDRAIN IDXTGE NMDFW FRFWUT TTD DCA PPSH INE NO
 702100 10, 1, 190, 2, 0.0, 5.0 .982 *CON
 703000 17, 1, 180, 2, 0.0, 5.0, 10.0 *DA
 703400 16, 1, 170, 2, 0.0, 5.0, 10.0 **#1
 703500 16, 0, 130, 2, 0.0, 0.0, 0.0, 0.0, 10.0 **#2
 703600 15, 1, 120, 2, 0.0, -5.0, 10.0 **#3
 703800 18, 1, 90, 2, 0.0, 0.0, 10.0 **#5
 703900 18, 0, 0.0, 0.0, 0.0, 10.0 **#6

 * GLAND CONDENSER
 702500 20, 1.0E-08, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 14.7

 * REHEATER
 701000 25, 2, 1000., 0.10

 * THROTTLE VALVE
 700150 35, -2.00, -2.00, 0.35, 2414.7, 1460.4, 1888157.

 * PUMP DATA
 * CONDENSATE PUMP
 702400 41, 120.0
 * HEATER DRAIN PUMP
 703250 41, 120.0
 * BOILER FEED PUMP
 703700 41, 2900.0, 0., 0., 0., 0., 11.1

 * INPUT/OUTPUT
 * INLET CONDITIONS
 * CTYPE TTVSC PPVSC WWVSC
 700100 33, 1000., 2414.7, 1888157.
 *
 704000 32
 702200 31, 80., 30., 100000000.
 702300 30
 706500 30

 * SPLITTERS
 700120 60, 0.0, 0.0
 700200 68, 4871., 56.
 700300 68, 1027., 50.
 700500 64, 500.0
 700700 64, 620.0
 701400 64, 970.0, 4895.
 700900 60, 0.0, 160292.
 701600 64, 600.0
 702700 61, 0.0, 1400.0
 702800 67, 12, 0.0, 0.0, 2600.0
 *
 * REHEAT SPRAY -- WINYAH 2 ONLY
 706000 61, 0.0, 0.0
 *
 * SUPERHEAT SPRAY FLOW
 706400 61, 0.0, 0.0

 * MIXERS
 700800 50, 1
 700950 50, 1
 701100 50, 1
 701500 50, 1
 702600 50
 702850 50
 702900 50, 1
 703100 50
 703200 50
 703300 50

 * SCHEDULES

 800700 'ENTHALPY RISE 370 VS FW FLOW'
 810700 460003., 863331., 1301344., 1798245., 1888157.
 810710 0.0, 10.85, 10.98, 11.10, 11.10, 11.10
 830700 07, HDPUM, 370, WWVSC, 10

 * INVOKE SPECIAL OPTION # 1
 *850000 1

```

* END OF BASE DECK
/
= DESIGN #6 FEEDWATER HEATER
*703900 18, 0, 90, 2, 0.0, 0.0,10.0      *#6 PERFORMANCE CARD
703900 18, 0, 90, 4, 0.0, 2, 2, 1, 0, 1, 2, 2, 2, 2, 2 **SIMPLIFIED DESIGN
***** ID, OD, LENGTH", # TUBE, K, PITCH, ID, ID, ID, ID:FWI, FWI, STM, DRN ***
703901 .473, 0.625, 612.6057, 1011.0, 10.5, .8125, 12.5, 12.5, 10.0, 8.0
703904 92.5, 0.0,0.0, 1.0, 0.0, 1.53853, * 1.0, 1.0, 1.0, 127.0
703906 71.9, 0.0,0.0, 1.0, 0.0, 1.01492, * 1.0, 1.0, 1.0, 1.0, 376.0
703909 2
*CONTROLS TO OBTAIN BYPASS FACTORS FOR THE DSH & DC TO USE IN ABOVE CARDS
*840100 BPHDS, 390, 0.00, 0.0, 0., TTDOUT, 390
*840109 0.1,2.25
*840200 BPHDC, 390, 10.0, 0.0, 0., DCAOUT, 390
*840209 0.1, 1.75
/
= DESIGN #6 HEATER AT HIGHER FLOW OF 1976599.0
700100 33, 1000., 2414.7, 1976599.
890010 'TTFI FROM TEST'
890011 TTFI,390,389.7,I
890020 'TTSI FROM TEST'
890021 TTSI,390,640.0,I
890030 'PPSIFROM TEST'
890031 PPSI,390,557.3,I
/
890018 DELETE
890028 DELETE
890038 DELETE
= DESIGN #6 FEEDWATER HEATER DEGRADED BY 175 TUBES @ DESIGN STM FLOW
700100 33, 1000., 2414.7, 1888157.
***** ID, OD, LENGTH", # TUBE, K, PITCH, ID, ID, ID, ID:FWI, FWI, STM, DRN ***
703901 .473, 0.625, 612.6057, 836.0, 10.5, .8125,12.5, 12.5, 10.0, 8.0
/
*****RUN WITH 5 & 6 HTRS OUT OF SERVICE***DESIGN HEATER*****
703901 .473, 0.625, 612.6057, 1011.0, 10.5, .8125, 12.5, 12.5, 10.0, 8.0
600810 2, 0.04
601210 2, 0.04
600816 CLOSE
601216 CLOSE
*****
/
*****RUN WITH 5 HTR OUT OF SERVICE** 1,888,157 LBS/HR*****
700100 33, 1000., 2414.7, 1888157.
600810 2, 0.04
601210 2, 0.04
600816 OPEN
601216 CLOSE
*****
/
*****RUN WITH 5 HTR OUT OF SERVICE** 2,150,000 LBS/HR*****
700100 33, 1000., 2414.7, 2150000.
600810 2, 0.04
601210 2, 0.04
600816 OPEN
601216 CLOSE
*****
/
*****RUN WITH 5 HTR OUT OF SERVICE** 1,976,599 LBS/HR*****
700100 33, 1000., 2414.7, 1976599.
600810 2, 0.04
601210 2, 0.04
600816 OPEN
601216 CLOSE
*****
/
= DESIGN #6 FEEDWATER HEATER
*703900 18, 0, 90, 2, 0.0, 0.0,10.0      *#6 PERFORMANCE CARD
703900 18, 0, 90, 4, 0.0, 2, 2, 1, 0, 1, 2, 2, 2, 2, 2 **SIMPLIFIED DESIGN
***** ID, OD, LENGTH", # TUBE, K, PITCH, ID, ID, ID, ID:FWI, FWI, STM, DRN ***
703901 .473, 0.625, 612.6057, 1011.0, 10.5, .8125, 12.5, 12.5, 10.0, 8.0
703904 92.5, 0.0,0.0, 1.0, 0.0, 1.53853, * 1.0, 1.0, 1.0, 127.0
703906 71.9, 0.0,0.0, 1.0, 0.0, 1.01492, * 1.0, 1.0, 1.0, 1.0, 376.0
703909 2
/
*****RUN WITH * 460,000 LBS/HR**DESIGN HEATER NO DEGRADE*****
700100 33, 1000., 2414.7, 460000.
600810 2, 0.04
601210 2, 0.04
600816 OPEN
601216 OPEN

```

=RUN WITH * WITH #5 HEATER OUT OF SERVICE 460,000 LBS/HR*****
700100 33, 1000., 2414.7, 460000.
600810 2, 0.04
601210 2, 0.04
600816 OPEN
601216 CLOSE
/
=RUN WITH DEGRADED #6 HTR LEAKING CONDITION TTD DCA FROM OLS AVG
600810 2, 0.04
601210 2, 0.04
600816 OPEN
602126 OPEN
703800 18, 1, 120, 2, 0.0, -5.0, 10.0 *#5
703900 18, 0, 90, 2, 0.0, 6.8, 12.3 *#6
*
*

| | | | | | | | | | | |
|------------|-----|----------|----------|-----|-----|----------|----------|----------|------------|-----|
| WW | WW | ZZZZZZZ | FFFFFFF | WW | WW | HH | HH | TTTTTTTT | KKKKKKK | 11 |
| WW | WW | 22222222 | FFFFFFF | WW | WW | HH | HH | TTTTTTTT | RRRRRRRR | 111 |
| WW | WW | 22 | 22 | FF | WW | WW | HH | TT | RR | RR |
| WW | WW | 22 | 22 | FF | WW | WW | HH | TT | RR | RR |
| WW | WW | 22 | 22 | FF | WW | WW | HH | TT | RR | RR |
| WW | WW | 22222 | FFFFF | WW | WW | HHHHHHHH | HHHHHHHH | TT | RRRRRRRR | 11 |
| WW | WW | 2222 | FFFFF | WW | WW | HHHHHHHH | HHHHHHHH | TT | RRRRRRRR | 11 |
| WW | WW | 22 | FF | WW | WW | HH | HH | TT | RRRR | 11 |
| WWWWWWWWWW | 22 | FF | WWWWWWWW | HH | HH | TT | RR | RR | 11 | |
| WWW | WWW | 22 | FF | WWW | WWW | HH | HH | TT | RR | RR |
| WW | WW | 22222222 | FF | WW | WW | HH | HH | TT | RR | RR |
| W | W | 22222222 | FF | W | W | HH | HH | TT | RR | RR |
| | | | | | | | | | 1111111111 | |

| | | | | | | | | | | |
|-----|--------|-----|----------|------|------|---------|------|------|----------|---------|
| LL | M | M | SSSSSS | VV | VV | EEEEEEE | NN | NN | SSSSSS | EEEEEEE |
| LL | MM | MM | SSSSSSSS | VV | VV | EEEEEEE | NNN | NN | SSSSSSSS | EEEEEEE |
| LL | MMM | MMM | SS | VV | VV | EE | NNN | NN | SS | EE |
| LL | MMMMMM | MM | SS | VV | VV | EE | NNNN | NN | SS | EE |
| LL | MM | MM | MM | VV | VV | EE | NNNN | NN | SSS | EE |
| LL | MM | MM | SSSS | VV | VV | EEEEEE | NN | NN | SSSS | EEEEEE |
| LL | MM | MM | SSSS | VV | VV | EEEEEE | NN | NN | SSSS | EEEEEE |
| LL | MM | MM | SSS | VV | VV | EE | NN | NNNN | SSS | EE |
| LL | MM | MM | SS | VV | VV | EE | NN | NNNN | SS | EE |
| LL | MM | MM | SS | VV | VV | EE | NN | NNNN | SS | EE |
| LLL | MM | MM | SSSSSS | VVVV | VVVV | EEEEEEE | NN | NNNN | SSSSSSSS | EEEEEEE |
| LLL | MM | MM | SSSSSS | VV | VV | EEEEEEE | NN | NNNN | SSSSSS | EEEEEEE |

| | | | |
|----------|----------|-------------|----------|
| AAAAAA | 222222 | 000000 | 333333 |
| AAAAAAAA | 22222222 | 00000000 | 33333333 |
| AA AA | 22 | 22 00 00 | 33 33 |
| AA AA | 22 | 00 00 | 33 |
| AA AA | 22 | 00 00 | 33 |
| AAAAAAA | ----- | 22222 00 00 | 3333 |
| AAAAAAA | ----- | 2222 00 00 | 3333 |
| AA AA | 22 | 00 00 | 33 |
| AA AA | 22 | 00 00 | 33 |
| AA AA | 22 | 00 00 | 33 33 |
| AA AA | 22222222 | 00000000 | 33333333 |
| AA AA | 22222222 | 00000000 | 33333333 |

SPOOLID: 0152
 CLASS: P
 PRINTER: PSFRSCS
 SYSTEMID: XASP21
 PRINT DATE: 02/02/95
 PRINT TIME: 14:22:37

USER/NODEID: LMSVENSE XASP21
 FILENAME/TYPE: W2FWHTR1 SPF0677S
 FILE CREATE DATE: 02/02/95
 FILE CREATE TIME: 14:22:36
 DIST: A-203

START

010001 80 * 80 COLUMN OUTPUT SPECIFICATION FOR VERSION 55H
 *
 * WINYAH UNIT 1&2
 *
 * TYPE: DESIGN MODEL
 * PROJECT: EVALUATE CURRENT PEPSE MODEL VS. GE HEAT BALANCE
 * FILE NAME: WIDESIGN
 * FILE CREATED: 01/01/90 JDR
 *
 * GENERAL COMMENTS --- 1971 HEAT BALANCE
 * (1) VENDOR HEAT BALANCE BASED ON 1967 ASME STEAM TABLES
 *
 * GENERIC DATA
 * NTGCYC NGEPRO NHOKUP NTURB NRHEAT
 010200 2, 3, 1, 1, 1
 * SPECIFIED GENERATOR POWER HELD CONSTANT - ADJUST THROTTLE FLOW
 *
 011010 1, 2, 1, 0, 3600, 350000., 0.9, 59.7, 59.7, 175000.0
 *
 * GENERATOR LOSSES
 011011 802.0, 0.0
 * CONVERGENCE CRITERIA
 012000 45
 *
 * OUTPUT TABLE SUPPRESSION
 *
 * OPTIONAL OUTPUT TABLES
 * 020002 NOPRNT, * GEOMETRY
 * 020004 NOPRNT, * STREAMS
 * 020013 NOPRNT, * SOURCE, SINK, VALVE
 * 020015 NOPRNT, * MIXERS
 * 020016 NOPRNT, * SPLITTERS
 * 020017 NOPRNT, * FURNACE/COMBUSTORS
 * 020021 NOPRNT, * SECOND LAW -- COMPONENTS
 * 020022 NOPRNT, * SECOND LAW -- STREAMS
 * 020024 NOPRNT, * MATERIAL DESCRIPTIONS
 * 020026 NOPRNT, * TURBINE EXPANSION CHARACTERISTICS
 *
 * STREAM GEOMETRY
 *
 * FROM PORT ID TO PORT ID
 500030 10, U, 12, I
 500050 12, U, 15, I
 500130 12, B, 285, IB
 500150 15, U, 20, I
 500220 20, B, 30, I
 500250 20, U, 40, I
 500310 30, U, 80, IB
 500320 30, B, 320, IB
 500350 40, U, 50, I
 500450 50, U, 60, I
 500520 50, B, 110, IB
 500550 60, U, 70, I
 500620 70, B, 140, I
 500650 70, U, 80, IA
 500750 80, U, 90, I
 500810 90, B, 390, S
 500850 90, U, 95, IAT
 500900 95, U, 100, IT
 500950 100, T, 110, IA
 501050 110, U, 120, I
 501210 120, E, 380, S
 501250 120, U, 130, I
 501310 130, E, 150, IA
 501350 130, U, 160, I
 501420 160, B, 310, IB
 501430 140, B, 320, IA
 501440 140, U, 150, IB
 501450 160, U, 170, I
 501460 320, U, 310, IA
 501510 170, E, 350, S
 501540 150, U, 360, S
 501550 170, U, 180, I

| | | | | |
|--------|------|-----|------|----|
| 501610 | 180, | E, | 340, | S |
| 501650 | 180, | UU, | 190, | I |
| 501710 | 190, | E, | 290, | IA |
| 501750 | 190, | UU, | 200, | I |
| 501850 | 200, | UU, | 210, | S |
| 501950 | 210, | D, | 240, | I |
| 502450 | 240, | UU, | 250, | T |
| 502550 | 250, | T, | 300, | T |
| 502630 | 250, | D, | 260, | IA |
| 502670 | 260, | UU, | 210, | D |
| 502720 | 270, | B, | 250, | S |
| 502730 | 270, | UU, | 260, | IB |
| 502820 | 280, | B, | 270, | I |
| 502830 | 280, | UU, | 290, | IB |
| 502860 | 285, | UU, | 280, | I |
| 502960 | 290, | UU, | 300, | S |
| 503050 | 300, | T, | 330, | IA |
| 503130 | 310, | UU, | 285, | IA |
| 503230 | 300, | D, | 325, | I |
| 503270 | 325, | UU, | 330, | IB |
| 503350 | 330, | UU, | 340, | T |
| 503430 | 340, | D, | 300, | D |
| 503450 | 340, | T, | 350, | T |
| 503530 | 350, | D, | 340, | DD |
| 503550 | 350, | T, | 360, | FW |
| 503650 | 360, | D, | 370, | I |
| 503750 | 370, | UU, | 640, | D |
| 503830 | 380, | D, | 360, | DT |
| 503850 | 380, | T, | 390, | TT |
| 503930 | 390, | D, | 380, | DI |
| 503950 | 390, | T, | 400, | IT |
| 506000 | 600, | UU, | 380, | IT |
| 506050 | 600, | B, | 95, | IB |
| 506400 | 640, | UU, | 600, | I |
| 506450 | 640, | B, | 650, | I |
| 509000 | 220, | UU, | 210, | T |
| 509100 | 210, | T, | 230, | I |

* (A) IS A CONSTANT AS IN THE EQUATION: A = DELTA P / P

* STREAM TYPE (A)

| | | |
|--------|----|------|
| 600810 | 2, | 0.04 |
| 601210 | 2, | 0.04 |
| 601540 | 2, | 0.04 |
| 601510 | 2, | 0.04 |
| 601610 | 2, | 0.04 |
| 601710 | 2, | 0.04 |
| 601050 | 2, | 0.02 |

* COMPONENT SPECIFICATIONS

* TURBINE DATA

| | |
|--------|--------------------------------|
| 700400 | 04, 1, 1, 1, 1, 0, 4, 0, 38.05 |
|--------|--------------------------------|

* GOVERNING STAGE

| | |
|--------|---|
| 700600 | 05, 1, 1, 0, 1, 0.0, 1909.0, 1437.0, 1848252., 572.5, 0.0 |
|--------|---|

* HP TURBINE

| | |
|--------|---|
| 701200 | 06, 1, 0, 1, 2, 1, 0.03, 505.0, 1518.2, 1712285., 264.8, 93952. |
|--------|---|

* LAST IP TURBINE

| | |
|--------|--|
| 701300 | 06, 1, 3, 1, 2, 1, 0.0, 264.8, 1437.7, 1618333., 123.6, 98779. |
|--------|--|

* 1ST LP TURBINE

| | |
|--------|--|
| 701700 | 07, 1, 0, 1, 3, 2, 0.03, 123.6, 1353.1, 1516646., 45.9, 89770. |
|--------|--|

* 2ND LP TURBINE

| | |
|--------|---|
| 701800 | 07, 1, 1, 1, 3, 2, 0.03, 45.9, 1258.8, 1426876., 14.8, 60847. |
|--------|---|

* 3RD LP TURBINE

| | |
|--------|---|
| 701900 | 07, 1, 1, 1, 3, 2, 0.03, 14.8, 1170.5, 1366029., 5.63, 67058. |
|--------|---|

* LAST LP TURBINE

| | |
|--------|---|
| 702000 | 07, 1, 3, 0, 3, 2, 0.0, 5.63, 1109.0, 1298971., .982, 0.0, 55.6 |
|--------|---|

* CONDENSER AND FEEDWATER HEATER DATA

*
* END OF BASE DECK
/
=RUN WITH DEGRADED #6 HTR LEAKING CONDITION TTD DCA FROM OLS AVG
600810 2, 0.04
601210 2, 0.04
600816 OPEN
602126 OPEN
703800 18, 1, 120, 2, 0.0, -5.0, 10.0 *#5
703900 18, 0, 90, 2, 0.0, 6.8, 12.3 *#6
*
*

| | | | | | | | | | | |
|------------|-----|----------|------------|------------|------------|----------|----------|--------|----------|----------|
| WW | WW | ZZZZZZ | FFFFFF | WW | WW | HH | HH | TTTTTT | KKKKKK | ZZZ222 |
| WW | WW | 22222222 | FFFFFFFFFF | WW | WW | HH | HH | TTTTTT | RRRRRRRR | 22222222 |
| WW | WW | 22 | 22 FF | WW | WW | HH | HH | TT | RR | 22 |
| WW | WW | 22 | FF | WW | WW | HH | HH | TT | RR | 22 |
| WW | WW | 22 | FF | WW | WW | HH | HH | TT | RR | 22 |
| WW | WW | 222222 | FFFFFF | WW | WW | HHHHHHHH | HHHHHHHH | TT | RRRRRRRR | 222222 |
| WW | WW | 2222 | FFFFFF | WW | WW | HHHHHHHH | HHHHHHHH | TT | RRRRRRRR | 2222 |
| WW | WW | 22 | FF | WW | WW | HH | HH | TT | RRRR | 22 |
| WWWWWWWWWW | WW | 22 | FF | WWWWWWWWWW | WWWWWWWWWW | HH | HH | TT | RR RR | 22 |
| WWW | WWW | 22 | FF | WWW | WWW | HH | HH | TT | RR RR | 22 |
| WW | WW | 22222222 | FF | WW | WW | HH | HH | TT | RR RR | 22222222 |
| W | W | 22222222 | FF | W | W | HH | HH | TT | RR RR | 22222222 |

| | | | | | | | | | | |
|----------|--------|----|----------|------|------|-----------|-----------|--------|----------|-----------|
| LL | M | M | SSSSSS | VV | VV | EEEEEEEEE | NN | NN | SSSSSS | EEEEEEEEE |
| LL | MM | MM | SSSSSSSS | VV | VV | EEEEEEEEE | NNN | NN | SSSSSSSS | EEEEEEEEE |
| LL | MMM | MM | SS SS | VV | VV | EE | NNN | NN | SS SS | EE |
| LL | MMMMMM | MM | SS | VV | VV | EE | NNNN | NN | SS | EE |
| LL | MM | MM | MM | SSS | VV | EE | NNNN | NN | SSS | EE |
| LL | MM | MM | MM | SSSS | VV | EEEEEE | NN | NN NN | SSSS | EEEEEE |
| LL | MM | MM | MM | SSSS | VV | EEEEEE | NN | NN NN | SSSS | EEEEEE |
| LL | MM | MM | MM | SSS | VV | EE | NN | NNNN | SSS | EE |
| LL | MM | MM | MM | SS | VV | EE | NN | NNNN | SS | EE |
| LL | MM | MM | SS | SS | VV | EE | NN | NN | SS | EE |
| LLLLLLLL | MM | MM | SSSSSSSS | SS | VVVV | EE | EEEEEEEEE | NN | NNN SS | EEEEEEEEE |
| LLLLLLLL | MM | MM | SSSSSS | | VV | EEEEEEEEE | NN | NNN SS | SSSSSS | EEEEEEEEE |

| | | | |
|----------|----------|----------|-------------------|
| AAAAAA | 222222 | 000000 | 333333 |
| AAAAAAAA | 22222222 | 00000000 | 33333333 |
| AA | 22 | 22 00 | 00 33 |
| AA | AA | 22 00 | 00 33 |
| AA | AA | 22 00 | 00 33 |
| AAAAAAA | ----- | 22222 | 00 3333 |
| AAAAAAA | ----- | 2222 | 00 3333 |
| AA | AA | 22 | 00 33 |
| AA | AA | 22 | 00 33 |
| AA | AA | 22 | 00 33 |
| AA | AA | 22222222 | 00000000 33333333 |
| AA | AA | 22222222 | 00000000 33333333 |

SPOOLID: 0153
 CLASS: P
 PRINTER: PSFRSCS
 SYSTEMID: XASP21
 PRINT DATE: 02/02/95
 PRINT TIME: 14:22:48

USER/NODEID: LMSVENSE XASP21
 FILENAME/TYPE: W2FWHTR2 SPF0677S
 FILE CREATE DATE: 02/02/95
 FILE CREATE TIME: 14:22:47
 DIST: A-203

START

010001 80 * 80 COLUMN OUTPUT SPECIFICATION FOR VERSION 55H
 *
 * WINYAH UNIT 1&2
 *
 * TYPE: DESIGN MODEL
 * PROJECT: EVALUATE CURRENT PEPSE MODEL VS. GE HEAT BALANCE
 * FILE NAME: WIDESIGN
 * FILE CREATED: 01/01/90 JDR
 *
 * GENERAL COMMENTS --- 1971 HEAT BALLANCE
 * (1) VENDOR HEAT BALLANCE BASED ON 1967 ASME STEAM TABLES
 *
 * GENERIC DATA
 * NTGCYC NGEPRO NHOKUP NTURB NRHEAT
 010200 2, 3, 1, 1, 1
 * SPECIFIED GENERATOR POWER HELD CONSTANT - ADJUST THROTTLE FLOW
 *
 011010 1, 2, 1, 0, 3600, 350000., 0.9, 59.7, 59.7, 175000.0
 *
 * GENERATOR LOSSES
 011011 802.0, 0.0
 * CONVERGENCE CRITERIA
 012000 45
 *
 * OUTPUT TABLE SUPPRESSION
 *
 * OPTIONAL OUTPUT TABLES
 * 020002 NOPRNT, * GEOMETRY
 * 020004 NOPRNT, * STREAMS
 * 020013 NOPRNT, * SOURCE, SINK, VALVE
 * 020015 NOPRNT, * MIXERS
 * 020016 NOPRNT, * SPLITTERS
 * 020017 NOPRNT, * FURNACE/COMBUSTORS
 * 020021 NOPRNT, * SECOND LAW -- COMPONENTS
 * 020022 NOPRNT, * SECOND LAW -- STREAMS
 * 020024 NOPRNT, * MATERIAL DESCRIPTIONS
 * 020026 NOPRNT, * TURBINE EXPANSION CHARACTERISTICS
 *
 * STREAM GEOMETRY
 *
 * FROM PORT ID TO PORT ID
 500030 10, U, 12, I
 500050 12, U, 15, I
 500130 12, B, 285, IB
 500150 15, U, 20, I
 500220 20, B, 30, I
 500250 20, U, 40, I
 500310 30, U, 80, IB
 500320 30, B, 320, IB
 500350 40, U, 50, I
 500450 50, U, 60, I
 500520 50, B, 110, IB
 500550 60, U, 70, I
 500620 70, B, 140, I
 500650 70, U, 80, IA
 500750 80, U, 90, I
 500810 90, B, 390, S
 500850 90, U, 95, IAT
 500900 95, U, 100, IT
 500950 100, T, 110, IA
 501050 110, U, 120, I
 501210 120, E, 380, S
 501250 120, U, 130, I
 501310 130, E, 150, IA
 501350 130, U, 160, I
 501420 160, B, 310, IB
 501430 140, B, 320, IA
 501440 140, U, 150, IB
 501450 160, U, 170, I
 501460 320, U, 310, IAS
 501510 170, E, 350, ISS
 501540 150, U, 360, S
 501550 170, U, 180, I

| | | | | |
|--------|------|-----|------|-----|
| 501610 | 180, | E, | 340, | S |
| 501650 | 180, | UU, | 190, | I |
| 501710 | 190, | E, | 290, | A |
| 501750 | 190, | UU, | 200, | I |
| 501850 | 200, | UU, | 210, | S |
| 501950 | 210, | D, | 240, | I |
| 502450 | 240, | UU, | 250, | T |
| 502550 | 250, | T, | 300, | T |
| 502630 | 250, | D, | 260, | IA |
| 502670 | 260, | UU, | 210, | D |
| 502720 | 270, | B, | 250, | S |
| 502730 | 270, | UU, | 260, | IB |
| 502820 | 280, | B, | 270, | I |
| 502830 | 280, | UU, | 290, | IB |
| 502860 | 285, | UU, | 280, | I |
| 502960 | 290, | UU, | 300, | S |
| 503050 | 300, | T, | 330, | IA |
| 503130 | 310, | UU, | 285, | IAI |
| 503230 | 300, | D, | 325, | I |
| 503270 | 325, | UU, | 330, | IB |
| 503350 | 330, | UU, | 340, | T |
| 503430 | 340, | D, | 300, | D |
| 503450 | 340, | T, | 350, | T |
| 503530 | 350, | D, | 340, | D |
| 503550 | 350, | T, | 360, | FW |
| 503650 | 360, | D, | 370, | I |
| 503750 | 370, | UU, | 640, | I |
| 503830 | 380, | D, | 360, | D |
| 503850 | 380, | T, | 390, | T |
| 503930 | 390, | D, | 380, | D |
| 503950 | 390, | T, | 400, | I |
| 506000 | 600, | UU, | 380, | T |
| 506050 | 600, | B, | 95, | IB |
| 506400 | 640, | UU, | 600, | I |
| 506450 | 640, | B, | 650, | I |
| 509000 | 220, | UU, | 210, | T |
| 509100 | 210, | T, | 230, | I |

* (A) IS A CONSTANT AS IN THE EQUATION: A = DELTA P / P

| * | STREAM TYPE | (A) |
|--------|-------------|------|
| 600810 | 2, | 0.04 |
| 601210 | 2, | 0.04 |
| 601540 | 2, | 0.04 |
| 601510 | 2, | 0.04 |
| 601610 | 2, | 0.04 |
| 601710 | 2, | 0.04 |
| 601050 | 2, | 0.02 |

*

* COMPONENT SPECIFICATIONS

* TURBINE DATA

* GOVERNING STAGE

700400 04, 1, 1, 1, 0, 4, 0, 38.05

*

* HP TURBINE

700600 05, 1, 1, 0, 1, 0.0, 1909.0, 1437.0, 1848252., 572.5, 0.0

*

* 1ST IP TURBINE

701200 06, 1, 0, 1, 2, 1, 0.03, 505.0, 1518.2, 1712285., 264.8, 93952.

*

* LAST IP TURBINE

701300 06, 1, 3, 1, 2, 1, 0.0, 264.8, 1437.7, 1618333., 123.6, 98779.

*

* 1ST LP TURBINE

701700 07, 1, 0, 1, 3, 2, 0.03, 123.6, 1353.1, 1516646., 45.9, 89770.

*

* 2ND LP TURBINE

701800 07, 1, 1, 1, 3, 2, 0.03, 45.9, 1258.8, 1426876., 14.8, 60847.

*

* 3RD LP TURBINE

701900 07, 1, 1, 1, 3, 2, 0.03, 14.8, 1170.5, 1366029., 5.63, 67058.

*

* LAST LP TURBINE

702000 07, 1, 3, 0, 3, 2, 0.0, 5.63, 1109.0, 1298971., .982, 0.0, 55.6

* CONDENSER AND FEEDWATER HEATER DATA

*

* CTYPE IDRAIN>IDXTGE NMDFW FRFWUT TTD DCA PPSH INE NO
 702100 10, 1, 2, 0.0, .982 *CON
 703000 17, 1, 190, 2, 0.0, 5.0 *DA
 703400 16, 1, 180, 2, 0.0, 5.0, 10.0 *#1
 703500 16, 0, 170, 2, 0.0, 5.0, 10.0 *#2
 703600 15, 1, 130, 0.0, 0.0 *#3
 703800 18, 1, 120, 2, 0.0, -5.0, 10.0 *#5
 703900 18, 0, 90, 2, 0.0, 0.0, 10.0 *#6

 * GLAND CONDENSER
 702500 20, 1.0E-08, 0.0, 0.0, 0.0, 0.0, 0.0, 14.7

 * REHEATER
 701000 25, 2, 1000., 0.10

 * THROTTLE VALVE
 700150 35, -2.00, -2.00, 0.35, 2414.7, 1460.4, 1888157.

 * PUMP DATA
 *
 * CONDENSATE PUMP
 702400 41, 120.0
 * HEATER DRAIN PUMP
 703250 41, 120.0
 * BOILER FEED PUMP
 703700 41, 2900.0, 0., 0., 0., 0., 11.1

 * INPUT/OUTPUT
 *
 * INLET CONDITIONS
 * CTYPE TTIVSC PPVSC WWWSC
 700100 33, 1000., 2414.7, 1888157.
 *
 704000 32
 702200 31, 80., 30., 100000000.
 702300 30
 706500 30

 * SPLITTERS
 700120 60, 0.0, 0.0
 700200 68, 4871., 56.
 700300 68, 1027., 50.
 700500 64, 500.0
 700700 64, 620.0
 701400 64, 970.0, 4895.
 700900 60, 0.0, 160292.
 701600 64, 600.0
 702700 61, 0.0, 1400.0
 702800 67, 12, 0.0, 0.0, 2600.0
 *
 * REHEAT SPRAY -- WINYAH 2 ONLY
 706000 61, 0.0, 0.0
 *
 * SUPERHEAT SPRAY FLOW
 706400 61, 0.0, 0.0

 * MIXERS
 700800 50, 1
 700950 50, 1
 701100 50, 1
 701500 50, 1
 702600 50
 702850 50
 702900 50, 1
 703100 50
 703200 50
 703300 50

 * SCHEDULES

 800700 'ENTHALPY RISE 370 VS FW FLOW'
 810700 460003., 863331., 1301344., 1798245., 1888157.
 810710 0.0, 10.85, 10.98, 11.10, 11.10, 11.10
 830700 07, HDPUM, 370, WWWSC, 10

 *
 * INVOKE SPECIAL OPTION # 1
 *850000 1

```

*
* END OF BASE DECK
/
= DESIGN #6 FEEDWATER HEATER
*703900 18, 0, 90, 2, 0.0, 0.0,10.0      *#6 PERFORMANCE CARD
703900 18, 0, 90, 4, 0.0, 2, 2, 1, 0, 1, 2, 2, 2, 2, 2 **SIMPLIFIED DESIGN
***** ID, OD, LENGTH", # TUBE, K, PITCH, ID, ID, ID, ID:FWI, FWI, STM, DRN*** 
703901 .473, 0.625, 612.6057, 1011.0, 10.5, .8125, 12.5, 12.5, 10.0, 8.0
703904 92.5, 0.0,0.0, 1.0, 0.0, .53853, * 1.0, 1.0, 1.0, 1.0, 127.0
703906 71.9, 0.0,0.0, 1.0, 0.0, 1.01492, * 1.0, 1.0, 1.0, 1.0, 376.0
703909 2
*CONTROLS TO OBTAIN BYPASS FACTORS FOR THE DSH & DC TO USE IN ABOVE CARDS
*840100 BPHDS, 390, 0.00, 0.0, 0., TTDOUT, 390
*840109 0.1,2.25
*840200 BPHDC, 390, 10.0, 0.0, 0., DCAOUT, 390
*840209 0.1, 1.75
/
= DESIGN #6 HEATER AT LOW NOX TEST 50% FLOW OF 1,116,406 LBS/HR*****
***** WITH TEST TEMPS AND PRESSURES
700100      33,      1000.,    2414.7,    1116406.
890010 'TTFI FROM TEST'
890011 TTFI,390,361.34,I
890020 'TTSI FROM TEST'
890021 TTSI,390,454.1,I
890030 'PPSI FROM TEST'
890031 PPSI,390,320.3,I
890040 'GENERATION GROSS'
890041 POWER,1, 143080.0,I
890050 'THROTTLE TEMP'
890051 TTVSC, 10, 870.65,I
890060 'HOT REHEAT TEMP'
890061 TTTORH, 100, 808.65, I
890070 'COLD REHEAT TEMP'
890071 TEXIP, 60, 455.41, I
890080 'HOT REHAET PRESS'
890081 PPTORH, 100, 288.21, I
890090 'COLD REHEAT PRESS.'
890091 PSIPV, 60, 322.47, I

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