Integration of PEPSE® With A Turbine Testing System

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ABSTRACT

Accurate turbine performance testing is constrained by both test equipment and power plant limitations. This means that the integrity of results depends on the timely discovery of problems in order that they may be resolved during the testing period. PEPSE is a very useful tool for detecting these problems. This paper describes the steps taken by SaskPower to simplify the turbine test set up and to fully integrate the data acquisition, test data reduction, and data analysis using PEPSE. Using this system tests can be performed within hours of arriving at site and results are obtained within ten minutes after a test run.

1. INTRODUCTION

Turbine testing within SaskPower began in 1973 with the commissioning of the last of three 150 MW coal fired units built at the Boundary Dam Power Station. Acceptance tests were performed on three new 300 MW units (Unit 6 at Boundary Dam and Units 1 and 2 at the Poplar River Power Station) over the next ten years. A program of regular turbine testing based on the ASME Simplified Test Code, was started in 1984 with the goal of testing our six major units on a semi-annual basis.

The SaskPower testing system has undergone an evolutionary process. System additions have included: better test elements, computerized data acquisition, and PEPSE performance analysis software. The additions have helped to reduce setup time, increase accuracy, and simplify analysis.

This paper describes the current turbine testing system. The paper focuses on the simplified setup procedure and on the automation of data handling. A major feature of this automation is the integration of PEPSE into the system.

It should be noted that the overall system is not software intensive. Standard software packages are used and altogether there are only four 'macros' used which control the flow of data. The system was purposely kept simple in order to minimize maintenance and training requirements. The test system is not an end in itself but is only a tool to be used for any type of plant performance test.

2. GENERAL DATA FLOW

An overview of the information flow structure is given in Figure 1. The field inputs consist of temperatures, pressures, flows, and power. Inputs are connected through a Fluke data acquisition system (DAS) controlled by a Compaq 286 or 386 portable computer (PC). Data is collected on the PC using Labtech Notebook software. The raw data files created by Labtech are then imported into a Lotus 1-2-3 spreadsheet. The raw data is then averaged and converted to the correct units with Lotus and entered into a PEPSE model. PEPSE analysis is performed on the Compaq 386 portable. Results are entered into another Lotus file where graphical trends are produced for reports. Reporting of test results and a follow-up meeting are the final steps in the turbine testing information flow.

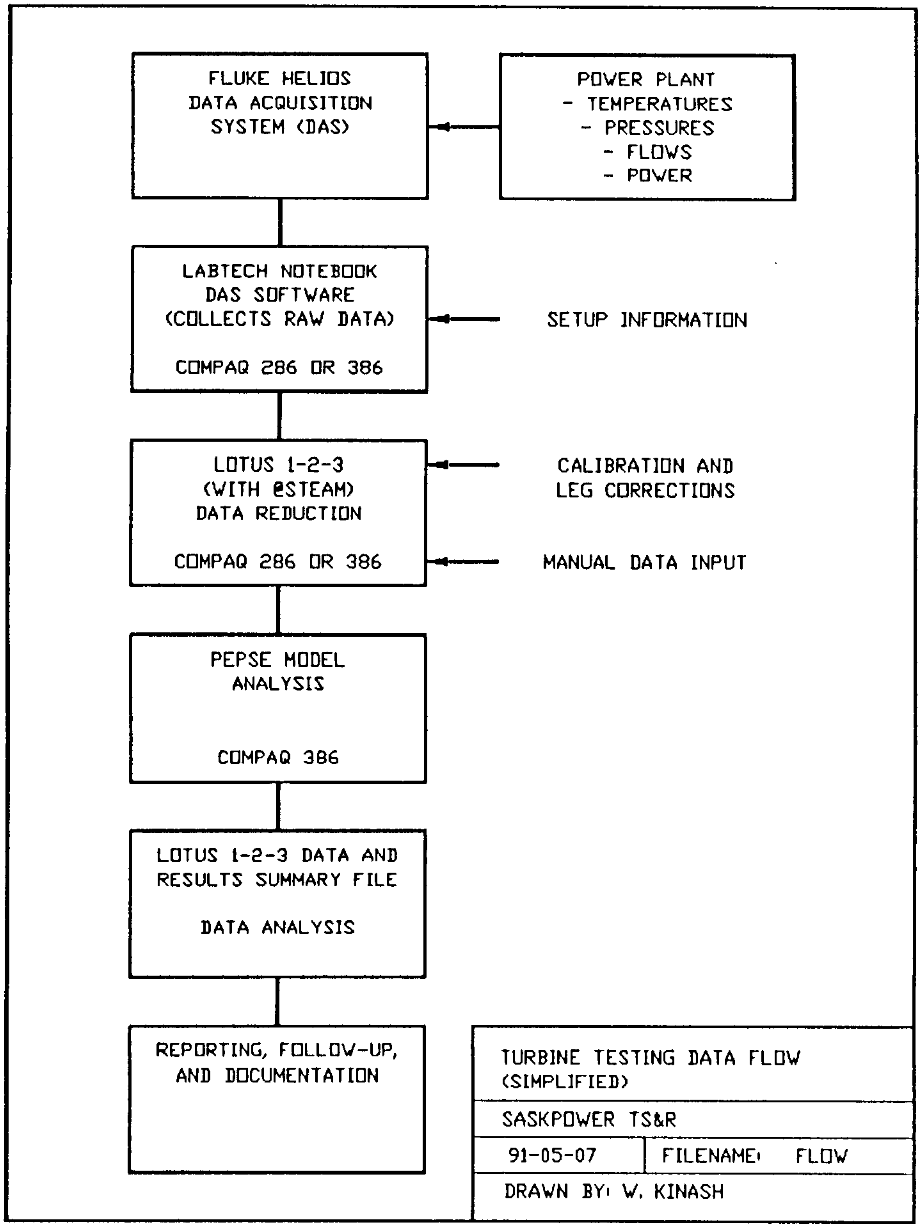


FIGURE 1

3. TURBINE TEST SYSTEM HARDWARE SETUP

The Plant Performance group is located in Regina which is a two hour drive from either power plant. Calibrations are performed in Regina as required. Since equipment must be packed and moved for tests, an effort was made to minimize the total amount of equipment required for each test. The system configuration is shown in Figure 2 and described below.

Test Elements (typical quantities in brackets)

- Type E special thermocouples (25)
- Minco FG113-1 spring-loaded thermocouple holders (25)
- Heise 622 and 623 pressure transmitters (14)
- Rosemont 3051C smart flow transmitter (1)
- Scientific Columbus JEM1 watthour meter (1)
- Plant datalogger spray flow signal (4)

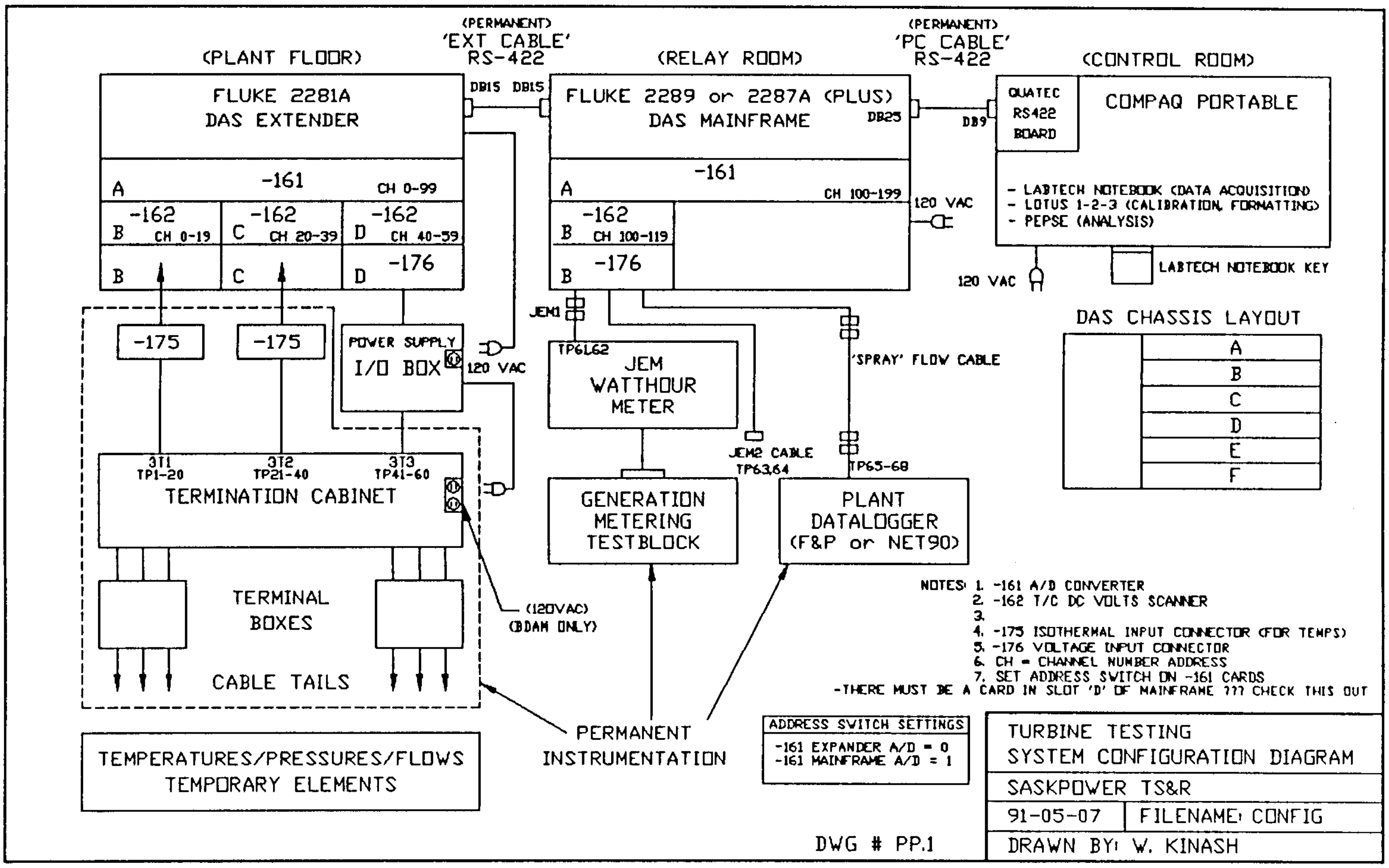


FIGURE 2

Data Acquisition

- Fluke 2289 or 2287A mainframe
- Fluke 2281A extender
- A/D, input, and scanner cards for above
- Power supply box for 4-20 ma transmitters
- Compaq portable 286 or 386 computer with RS 422 communication board
- HP ThinkJet screen printer

Permanent Cabling

Properly grounded, permanently installed thermocouple and instrument cables are installed at each unit. Test cables are run from field boxes to a central termination cabinet. The last 10 to 30 feet of cable, called a cable 'tail', is rolled up and stored in the field boxes when not in use.

AC power and computer communication cables are also permanently installed, as are fluke input cards. A spray flow voltage signal from the plant data acquisition system is wired to a connector for each unit.

Miscellaneous Improvements

Generation metering test blocks have been rewired according to a standard. High level reserve feedwater tank level is measured with a pressure transmitter in order to calculate makeup flow. Atmospheric pressure is measured with an absolute pressure transmitter. Isolation valves are left permanently in place for quick installation of pressure transmitters. Instrument connection locations are tagged with test identification.

Setup Procedure

A test setup now can be completed by two people in less than half a day. Setting up for a test involves inserting thermocouples in testwells, installing pressure and flow transmitters, plugging in the wattmeter, and connecting the entire DAS system by unrolling cable 'tails' and plugging everything together.

4. PC SOFTWARE SETUP

Software currently used for turbine testing is listed below.

Standard SaskPower Software (located on the PC 'C' Drive)

- DOS Version 3.3
- Lotus 1-2-3 V2.2
- Quick Dos V2.0
- Word V5.0 (for documentation and reporting use only)
- SaskPower menu software

Additional Packaged Software

- Labtech Notebook V6.1 with Fluke Helios Driver
- @STEAM (Lotus add-in)
- PEPSE/PC 386 V56
- AutoCad V10 (for documentation use only)

Unit Specific Software (Loaded from backup diskette for tests)

- Labtech Notebook DAS setup
- Raw test data files (created during test run)
- Lotus test data reduction template
- Lotus template for building PEPSE option 6 model with new test data.
- PEPSE input and output files
- Lotus file with test data and results summaries

QuickDos is a menu driven package which speeds up the use of DOS. The Labtech Notebook and PEPSE programs are located on the 'D' drive of the PC. Unit specific files are grouped in subdirectories on the 'D' drive and standard naming conventions were developed to make file identification easy. Files are backed up on 3 1/2" diskettes with color coded labels. The @STEAM Lotus add-in is a product which contains the steam tables. The @STEAM functions can be used within spreadsheet equations just like any other at-sign function. Software preparation procedures are described in Appendix A.

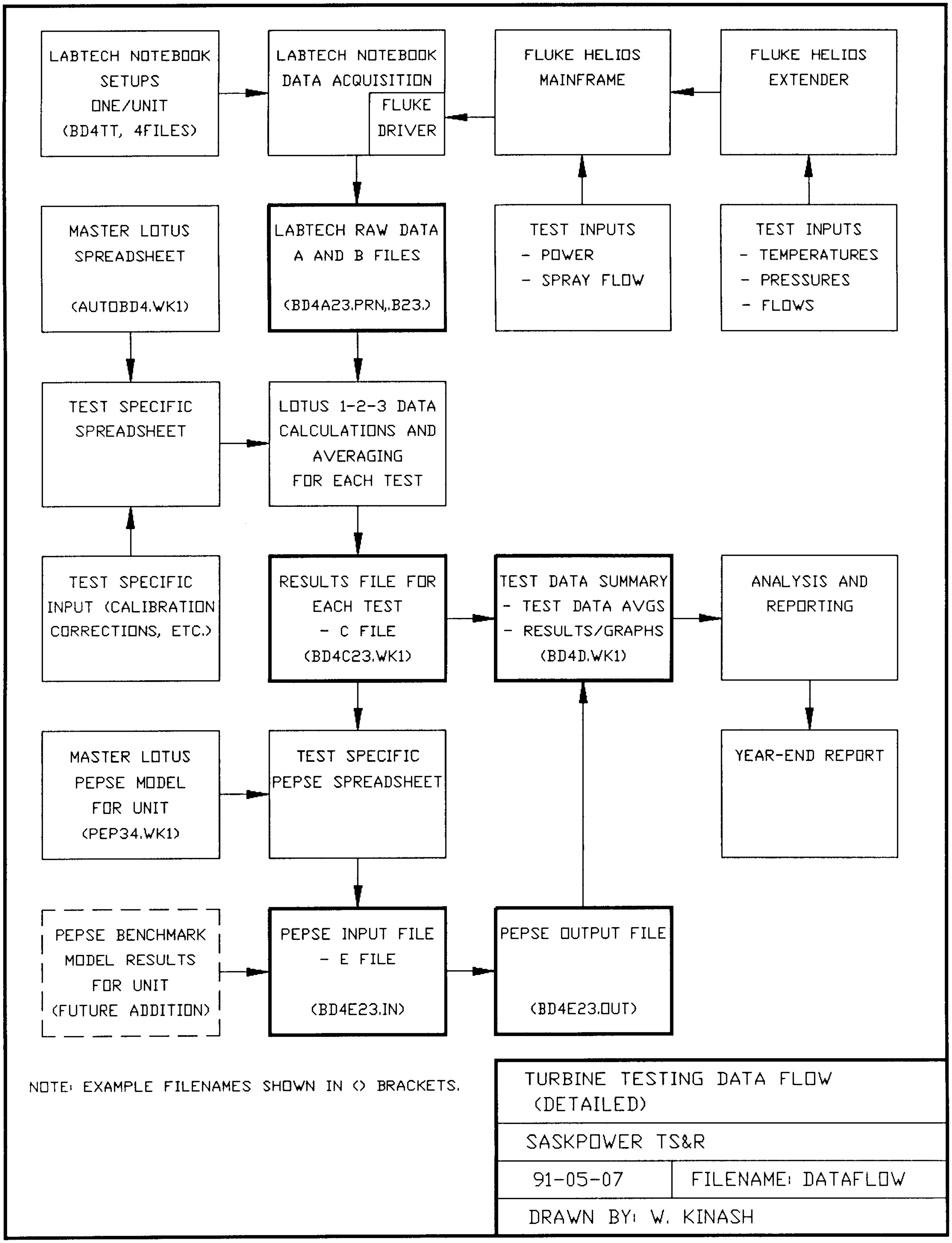

LABTECH NOTEBOOK SETUPS ONE/UNIT (BD4TT, 4FILES)
LABTECH NOTEBOOK DATA ACQUISITION
FLUKE DRIVER
FLUKE HELIOS MAINFRAME
FLUKE HELIOS EXTENDER
MASTER LOTUS SPREADSHEET (AUTOBD4.WK1)
LABTECH RAW DATA A AND B FILES (BD4A23.PRN,.B23.)
TEST INPUTS - POWER - SPRAY FLOW
TEST INPUTS - TEMPERATURES - PRESSURES - FLOWS
TEST SPECIFIC SPREADSHEET
LOTUS 1-2-3 DATA CALCULATIONS AND AVERAGING FOR EACH TEST
TEST SPECIFIC INPUT (CALIBRATION CORRECTIONS, ETC.)
RESULTS FILE FOR EACH TEST - C FILE (BD4C23.WK1)
TEST DATA SUMMARY - TEST DATA AVGS - RESULTS/GRAPHS (BD4D.WK1)
ANALYSIS AND REPORTING
MASTER LOTUS PEPSE MODEL FOR UNIT (PEP34.WK1)
TEST SPECIFIC PEPSE SPREADSHEET
YEAR-END REPORT
PEPSE BENCHMARK MODEL RESULTS FOR UNIT (FUTURE ADDITION)
PEPSE INPUT FILE - E FILE (BD4E23.IN)
PEPSE OUTPUT FILE (BD4E23.OUT)
NOTE: EXAMPLE FILENAMES SHOWN IN () BRACKETS.
TURBINE TESTING DATA FLOW (DETAILED)
SASKPOWER TS&R
91-05-07
FILENAME: DATAFLOW
DRAWN BY: W. KINASH

FIGURE 3

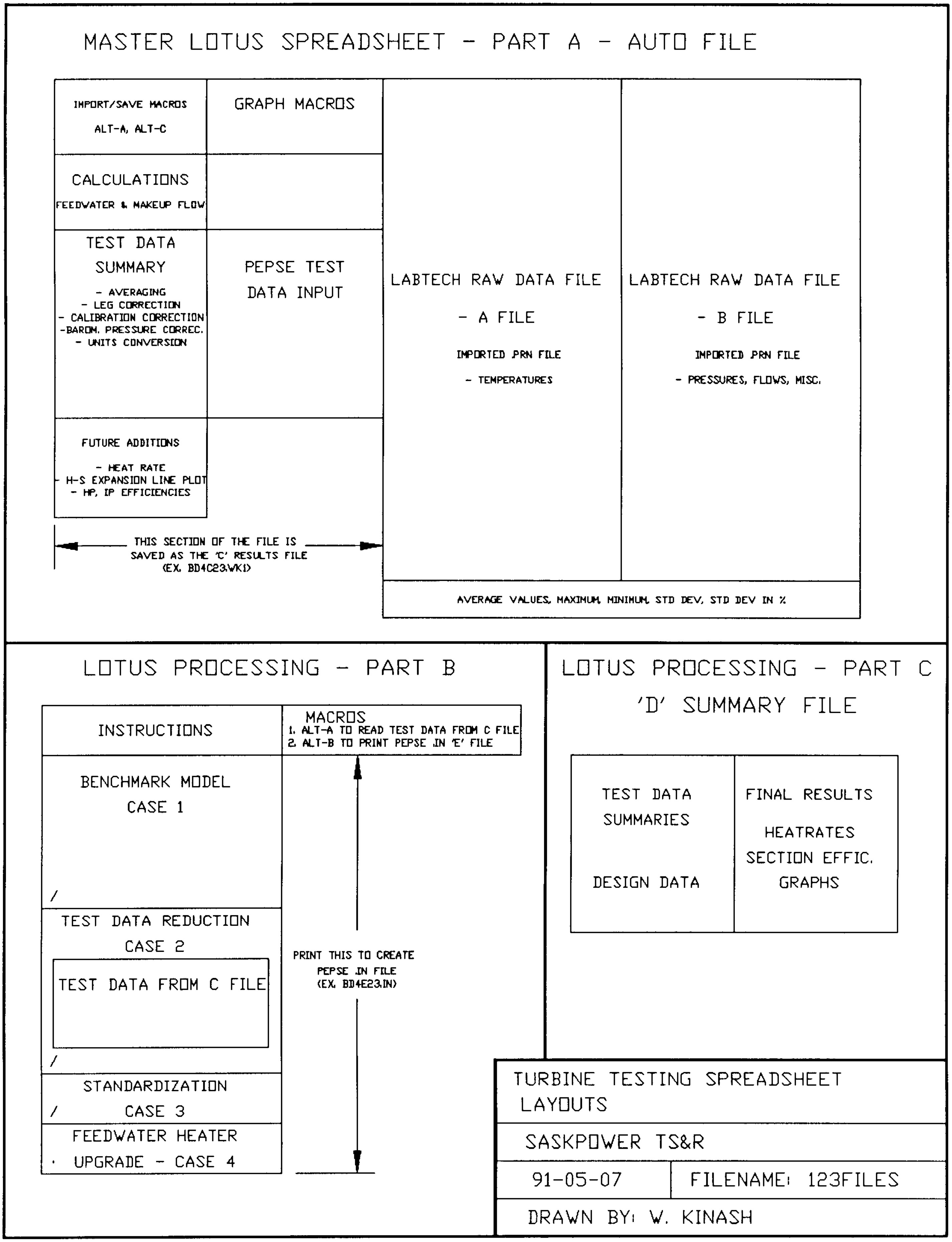

MASTER LOTUS SPREADSHEET - PART A - AUTO FILE
IMPORT/SAVE MACROS
ALT-A, ALT-C
GRAPH MACROS
CALCULATIONS
FEEDWATER & MAKEUP FLOW
TEST DATA SUMMARY
- AVERAGING
- LEG CORRECTION
- CALIBRATION CORRECTION
-BAROM. PRESSURE CORREC.
- UNITS CONVERSION
PEPSE TEST DATA INPUT
LABTECH RAW DATA FILE - A FILE
IMPORTED .PRN FILE
- TEMPERATURES
LABTECH RAW DATA FILE - B FILE
IMPORTED .PRN FILE
- PRESSURES, FLOWS, MISC.
FUTURE ADDITIONS
- HEAT RATE
- H-S EXPANSION LINE PLOT
- HP, IP EFFICIENCIES
THIS SECTION OF THE FILE IS SAVED AS THE 'C' RESULTS FILE (EX. BD4C23.WK1)
AVERAGE VALUES, MAXIMUM, MINIMUM, STD DEV, STD DEV IN %
LOTUS PROCESSING - PART B
INSTRUCTIONS
MACROS
1. ALT-A TO READ TEST DATA FROM C FILE
2. ALT-B TO PRINT PEPSE .IN 'E' FILE
BENCHMARK MODEL
CASE 1
TEST DATA REDUCTION
CASE 2
TEST DATA FROM C FILE
STANDARDIZATION
CASE 3
FEEDWATER HEATER
UPGRADE - CASE 4
PRINT THIS TO CREATE PEPSE .IN FILE (EX. BD4E23.IN)
LOTUS PROCESSING - PART C
'D' SUMMARY FILE
TEST DATA SUMMARIES
DESIGN DATA
FINAL RESULTS
HEATRATES
SECTION EFFIC.
GRAPHS
TURBINE TESTING SPREADSHEET LAYOUTS
SASKPOWER TS&R
91-05-07
FILENAME: 123FILES
DRAWN BY: W. KINASH

FIGURE 4

5. TEST SYSTEM INTEGRATION

The previous two sections described the hardware and software components which make up the testing system as well as steps taken to simplify the system. The fully integrated data flow structure (Figure 3) is described in this section. Detailed procedures are given in Appendix A.

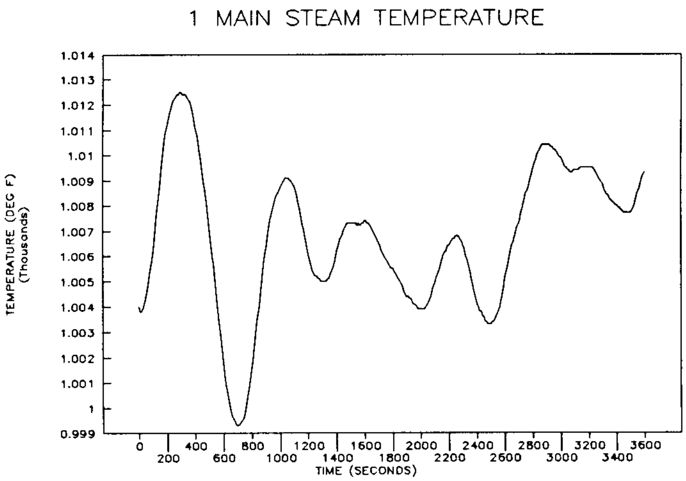
Labtech Notebook Data Acquisition

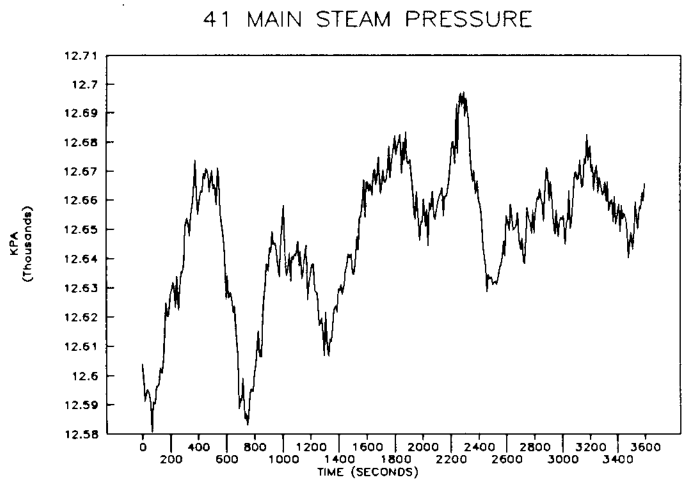
Labtech Notebook software working in combination with Fluke Helios hardware has proven to be an excellent system for raw data collection. Labtech Notebook contains a Fluke 'driver' which is software required for control of the DAS. We typically scan inputs every 10 seconds for one hour during turbine tests. Labtech 'logs' data in two Lotus compatible .PRN files. These raw data files are called the A and B files. Labtech also provides a display of up to 50 quantities during test runs.

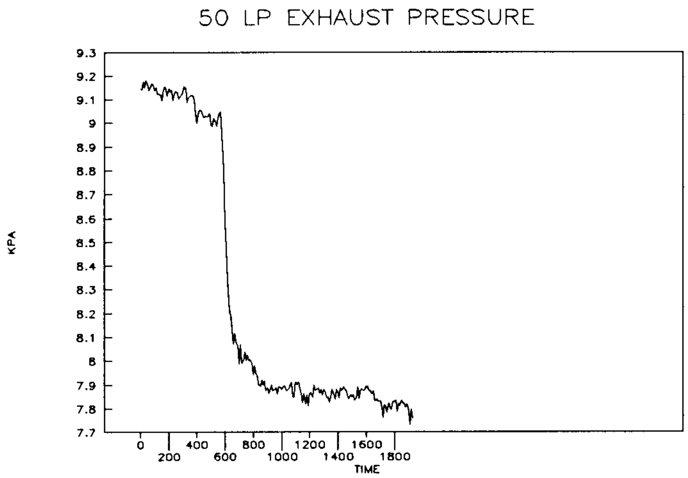
Lotus Test Data Reduction

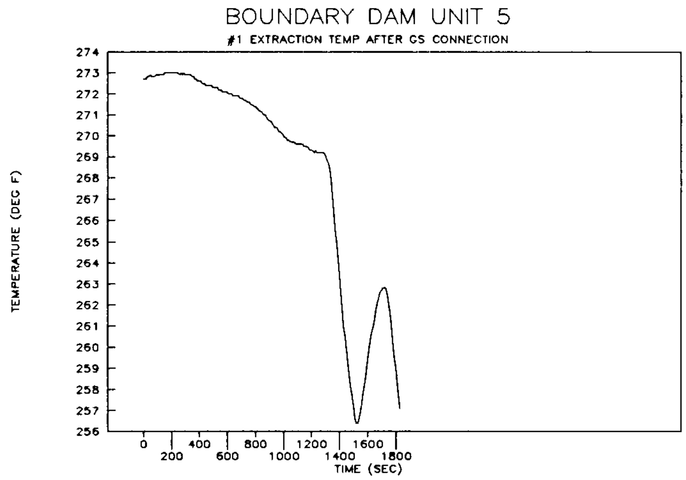
Raw test data is **F**ile **I**mported into a master Lotus spreadsheet. The layout of this spreadsheet is shown in Figure 4. Every unit has a unique spreadsheet containing unit specific information. The following functions are performed within this spreadsheet in order to prepare test data for PEPSE.

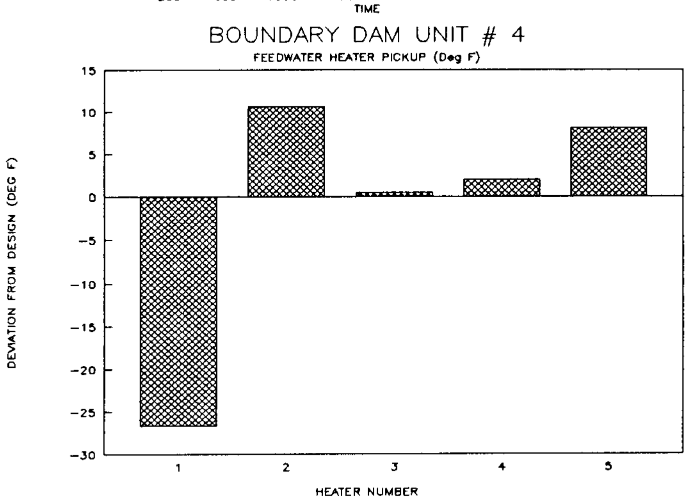
- raw test data is imported with a macro named 'A'
- possible periods of unsteady test data at the start or end of the test are erased
- raw data is averaged
- calibration corrections are made
- leg and atmospheric pressure corrections are made
- units conversion is made as required
- makeup flow is calculated from tank level change
- feedwater/condensate flow is calculated

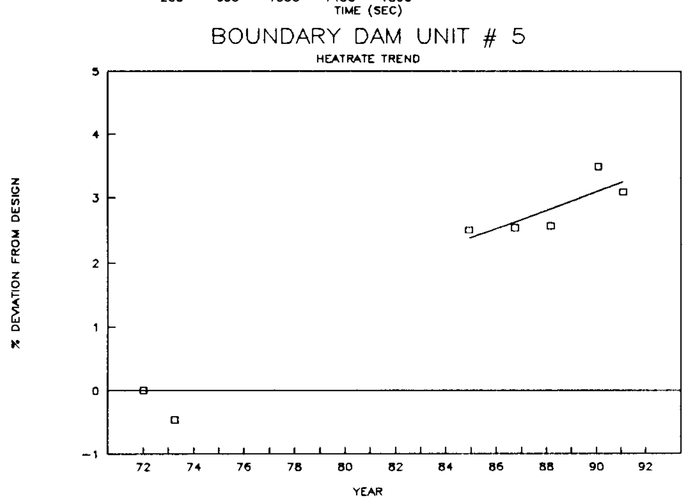












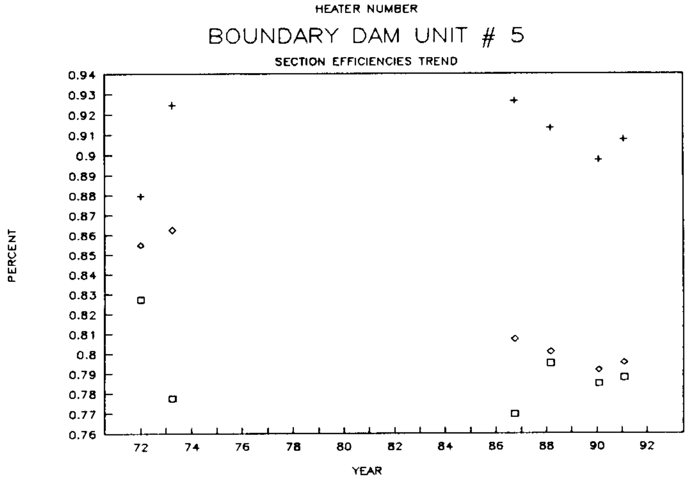


FIGURE 5 - EXAMPLE LOTUS GRAPHS

- final converted data is entered in PEPSE special input format in a section of the spreadsheet
- corrections and comments are manually entered as required
- an intermediate results file, called the 'C' file, is saved by executing a macro named 'C' (see Appendix B for an example 'C' file).

The above processing of test data takes one to two minutes to complete. However, additional data integrity checks can be made before leaving this spreadsheet. These checks may include:

- Review of all raw data by graphing quantities one by one. Test data and/or control system anomalies are identified in this way. Graph macros are set up for quick review. The third example in Figure 5 shows the LP Exhaust Pressure measured during a test. A cooling water pump as started during the test causing the drop in pressure. (The test was subsequently repeated.) The fourth example shows the effect of closing a gland seal leak connection.
- Averaged data is compared with expected values to check for abnormal operation.
- Raw data standard deviations can be compared with expected values.
- Feedwater heater drains cooler approach temperatures DCA's are calculated to check heater performance.
- Throttle flow coefficient/ratio is calculated to check feedwater flow with respect to valve position.
- As-found heat rate, HP and IP section efficiencies, and a partial expansion line plot are calculated using @STEAM functions and are compared with expected values.

Many test equipment and plant cycle problems can be detected and corrected as described above within minutes of testing. However, in order to fully analyze turbine performance the power of PEPSE analysis is also required.

Lotus Preparation of PEPSE Input File

A second Lotus spreadsheet containing the PEPSE special option 6 model is loaded next (Figure 4). This model could have been contained within the previous master Lotus spreadsheet to reduce the steps required but was separated for two reasons. The spreadsheet is simply too big for the old version of Lotus 1-2-3 (Version 2.01). Also, it is more logical to keep the PEPSE model in a file by itself.

New test data is **F**ile **C**opy **C**ombined from the **N**amed range **PEPSE** of the selected C file created in the previous Lotus spreadsheet. A macro named 'A' simplifies this task. Any changes to the model (i.e. print table suppression, closed streams for feedwater heaters out of service, etc.) for test specific reasons are made in this spreadsheet. The model is now complete and must be **P**rinted to a **F**ile to change from worksheet format to print format for input to PEPSE. The printed file is called the 'E' file and has a '.IN' extension. A unique 'E' file is created for each test run. This entire procedure can be executed in less than one minute if there are no model revisions.

PEPSE Execution

PEPSE .IN files can be run individually by executing PEPSE and entering the full input file name. Alternately, when running a series of PEPSE jobs a DOS batch file can be created which will sequentially process PEPSE .IN files. PEPSE .OUT listing are analyzed and provide a wealth of information.

Results

A third Lotus file (called the 'D' file) for each unit is used for storing results. This file has two parts as shown in Figure 4. In part A test data summaries are compiled along with previous test summaries and design information. This spreadsheet is very useful in the detection of trends and problems. New data is added to part A by **F**ile **C**opy **C**ombining the **N**amed range **DATA** from selected C files.

Part B of the file contains a results history of heat rates, efficiencies, output, etc. Graphs of the data are also available and are used in reports (see Figure 5). Information in this section is currently extracted manually from PEPSE .OUT listings. An example 'D' file is given in Appendix C.

The final step in the turbine testing system includes preparation of reports, filing of documentation, and holding of follow-up meetings.

6. RESULTS AND DISCUSSION

Improvements made to our hardware setup have resulted in a number of benefits. Two people can now pack up, drive to site, and set up for a test in less than a day. Manual recording of test data has been almost eliminated. Accuracy and reliability are also improved.

Improvements made to the software have given us additional benefits. Complete on-site analysis has enabled us to discover and correct test equipment problems which otherwise may have gone undetected. Execution of PEPSE is a key component used in the analysis process. Plant isolation and leaks are identified through the PEPSE results and are corrected, or accounted for, as testing proceeds.

In summary, a simplified integrated turbine testing system has reduced setup time and increased accuracy and reliability. Two people can now test and analyze two units in one week. While testing we are now able to focus attention on the plant cycle operation and test procedures. The data acquisition system has become nothing more than a powerful tool.

7. ACKNOWLEDGEMENT

The writer wishes to acknowledge the contribution made by Guy Bruce towards the development of our testing system. Guy was responsible for the wise selection of hardware and software and provided the direction necessary to develop an integrated testing system.

APPENDICES

STEP 1 ----- SOFTWARE PREPARATION BEFORE TESTS BEGIN -------------

CHECK THAT THE PC SOFTWARE IS SET UP CORRECTLY (EXAMPLES ARE FOR BD4)

1. CREATE THE FOLLOWING DIRECTORIES

```
D:\NB\SETUP\BD4TT\            * FOR LABTECH SETUP FILES
D:\NB\BD4AB\                  * FOR RAW LABTECH DATA FILES (A AND B)
D:\123FILES\BD4C\             * FOR RESULTS 'C' FILES
D:\123FILES\BD4D\             * FOR RESULTS SUMMARY 'D' FILE
D:\PEP386\BD4E\               * FOR PEPSE 'E' .IN AND .OUT FILES
```

2. RESTORE THE FOLLOWING FILES FROM DISKETTE

```
D:\NB\SETUP\BD4TT\(4 FILES)   * FOUR FILES CONTAIN LABTECH SETUP
D:\123FILES\AUTOBD4.WK1       * MASTER LOTUS SPREADSHEET FOR DATA
                              * REDUCTION AND CALCULATIONS
D:\123FILES\PEPSE\PEP34.WK1   * LOTUS TEMPLATE WITH PEPSE MODEL
D:\123FILES\DFILES\BD4D.WK1   * RESULTS SUMMARY FILE
```

3. MODIFY SOFTWARE AS REQUIRED. THIS MAY INCLUDE ADDING ADDITIONAL CHANNELS TO THE LABTECH SYSTEM, ADDING ADDITIONAL CALCULATIONS TO THE SPREADSHEET FOR ANALYSIS, OR MODIFICATIONS TO THE PEPSE MODEL. THIS STEP ALSO INCLUDES MODIFICATION TO THE AUTOBD4 FILE FOR TEST SPECIFIC PRESSURE AND TEMPERATURE CALIBRATION CORRECTIONS. (NOTE: SAVE THE LABTECH SETUP EVERY 5 MINUTES WHEN MAKING CHANGES BECAUSE NOTEBOOK WILL HANG UP IF TO MANY CHANGES ARE MADE)
4. TEST SOFTWARE MODIFICATIONS
   THE SOFTWARE MODIFICATIONS SHOULD BE TESTED FULLY WHEN SETTING UP FOR TESTS AT THE PLANT BY RUNNING THROUGH A COMPLETE TEST-ANALYZE CYCLE.

STEP 2 -------- COLLECTING TEST DATA WITH LABTECH NOTEBOOK ----------

1. EXECUTE LABTECH NOTEBOOK FROM THE SASKPOWER MENU OR FROM DOS.
2. THE FIRST TIME YOU RUN LNB SELECT SETUP, SAVE/RECALL, AND RECALL THE REQUIRED SETUP. MODIFY THE SETUP (CHANNELS,FILES,DISPLAY) AS REQUIRED AND SAVE. (THIS STEP NEEDS TO ONLY BE DONE ONCE FOR A SET OF TESTS)
3. PRESS 'GO' IN THE LABTECH MENU TO START DATA COLLECTION.
4. THE SETUPS ARE CONFIGURED SO THAT THE TWO .PRN RAW DATA FILES ARE AUTOMATICALLY SEQUENTIALLY NUMBERED. THESE ARE THE A AND B FILES (EX. BD4A35.PRN AND BD4B35.PRN). MAKE NOTE OF THE START TIME AND DATE OF EACH TEST AND THE SEQUENTIAL FILE NUMBER.
5. DURING THE TEST PERIOD ADDITIONAL DATA COLLECTION MAY BE REQUIRED USING ALTERNATE SOURCES (IE. CONTROL DESK DATA, CONTROL VALVE POSITION, DATALOGGER DATA, TANK LEVELS, VALVE POSITIONS, EXTRACTION PUMP A OR B RUNNING, ETC.) MAKE NOTE OF THIS INFORMATION IN THE TESTING NOTEBOOK.
6. MONITOR THE LABTECH SCREEN PERIODICALLY TO CHECK FOR ANY PROBLEMS.
7. STOP COLLECTION BY TYPING ESC AND SPACE OR WAIT ONE HOUR FOR DEFAULT TERMINATION OF COLLECTION.
8. LEAVE LABTECH NOTEBOOK BY SELECTING QUIT. (YOU CAN GO DIRECTLY TO LOTUS 1-2-3 BY SELECTING ANALYZE FROM THE LNB MENU BUT LNB STAYS MEMORY RESIDENT AND YOU MAY NOT HAVE ENOUGH MEMORY IN 1-2-3.)
9. ONCE A TEST IS COMPLETE EITHER 1. PROCESS AND ANALYZE THE DATA WITH LOTUS/PEPSE OR COLLECT MORE DATA BY STAYING IN LABTECH.

APPENDIX A

TURBINE TEST PROCEDURES

STEP 3 -------- PROCESSING TEST DATA WITH LOTUS 1-2-3 -------- PART 1 -

1. START LOTUS 1-2-3 THROUGH THE SASKPOWER MENU.

2. / File Retrieve D:\123FILES\AUTOBD4.WK1 THIS IS THE MASTER PROCESSING SPREADSHEET.

3. ENTER THE CURRENT TEST NUMBER LEFT JUSTIFIED 'XX AT THE A--> CELL THIS NUMBER MATCHES THE A & B .PRN FILES NUMBER CREATED BY LABTECH

4. PRESS THE F9 KEY TO SET UP THE MACROS. (MACROS STORED AT CELL J1)

5. PRESS ALT-A TO IMPORT RAW TEST DATA. (HOLD DOWN ALT KEY AND PRESS A)

6. PRESS THE F9 KEY TO CALCULATE AVERAGES, CORRECTIONS, ETC.

7. CHECK THE DATA
   - LOOK AT GRAPHS OF EACH TESTPOINT FOR ANOMOLIES. INDIVIDUAL GRAPHS CAN BE CALLED BY TYPING /GNUxx WHERE xx IS THE TESTPOINT NUMBER. OR TYPE ALT-T TO SEQUENTIALLY STEP THROUGH THE TEMPERATURES, ALT-P FOR THE PRESSURES, ALT-M FOR THE FLOWS, ALT-X FOR EXTRA GRAPHS. PRESS ANY KEY TO SEQUENTIALLY VIEW GRAPHS.
   - ERASE MAKEUP TANK LEVELS BETWEEN THE FIRST AND LAST READING. ??
   - COMPARE AVERAGE VALUES WITH EXPECTED VALUES.
   - MODIFY RAW DATA OR RESULTS AS REQUIRED.
   - CHECK THE PEPSE INPUT DATA AND MODIFY AS REQUIRED.

8. ENTER THE 'TEST TYPE' (MCR, VWO, etc.) AT H3.

9. ENTER THE CONTROL VALVE STROKE AT E50 IF DESIRED.

10. ENTER ANY OTHER MANUAL CHANGES TO TEST DATA AS REQUIRED.

11. PRESS THE F9 KEY AGAIN TO RECALCULATE THE SUMMARY.

12. PRESS ALT-C TO SAVE THE RESULTS AS A 'C' FILE (EX. BD4C23.WK1).

STEP 4 -------- PROCESSING TEST DATA WITH LOTUS 1-2-3 -------- PART 2 -

1. / File Retrieve THE PEPSE MODEL D:\123FILES\PEPSE\PEP34.WK1 .

2. ENTER TEST # LEFT JUSTIFIED AT CELL F3.

3. PRESS ALT-A TO INSERT NEW TEST DATA INTO THE MODEL.

4. CHECK THE TEST DATA AND MODIFY THE PEPSE MODEL AS REQUIRED.

5. PRESS ALT-B TO PRINT THE PEPSE 'E' FILE (EX. BD5EXX.IN). THIS MACRO IS NOT COMPLETE. ENTER 'RGQ' IF THE FILE ALREADY EXISTS AND NEEDS REPLACING, OR ENTER 'GQ' IF CREATING THE 'E' FILE FOR THE FIRST TIME.

6. QUIT LOTUS (SAVE THE PEPSE MODEL IF CHANGES WILL BE USED AGAIN).

PLANT PERFORMANCE TURBINE TESTING SOFTWARE PROCEDURES

STEP 5 -------- EXECUTING PEPSE ---------------

1. PROCESS THE PEPSE 'E' FILES INDIVIDUALLY BY RUNNING PEPSE AND BY ENTERING THE .IN FILE NAME. FOR MULTIPLE FILE RUNS IT IS FASTER TO CREATE A BATCH FILE (SEE A.BAT).

2. VIEW THE PEPSE OUTPUT LISTINGS .OUT FILES (USE QDOS2) AND WRITE DOWN REQUIRED RESULTS.

STEP 6 -------- PROCESSING RESULTS ---------------

1. START LOTUS 1-2-3 THROUGH THE SASKPOWER MENU.

2. / File Retrieve THE SUMMARY FILE (EX. D:\123FILES\DFILES\BD4D.WK1

3. ADD THE NEW TEST DATA FOR THE BEST TESTS TO THE SUMMARY FILE PART A

4. ADD THE NEW PEPSE RESULTS TO THE SUMMARY FILE PART B AND FIX UP THE GRAPHS

5. COMPLETE ANALYSIS USING THE NEW SUMMARY FILE.

6. DISCUSS RESULTS, WRITE REPORT AND DISTRIBUTE, COMPLETE DOCUMENTION AND ANY FOLLOW-UP REQUIRED.

```
BOUNDARY DAM UNIT 5 PEPSE MODEL WITH OPTION 6.

 STEP 1. ENTER TEST # LEFT JUSTIFIED HERE --> 5
 STEP 2. PRESS ALT-A              * THIS WILL READ IN NEW TEST DATA
 STEP 3. CHECK TEST DATA AND MODIFY PEPSE FILE AS REQUIRED.
 STEP 4. PRESS ALT-B              * THIS PRINT THE .IN FILE BD5EXX.IN
         NOTE: THIS MACRO PRINTS THE 'E' FILE BUT IS NOT COMPLETE.
         ENTER rgq IF 'E' FILE ALREADY EXISTS, OR gq IF CREATING
         THE 'E' FILE FOR THE FIRST TIME.
 STEP 5. QUIT LOTUS (SAVE THE PEPSE MODEL IF CHANGES WILL BE USED AGAIN
 STEP 6. RUN PEPSE USING THE NEWLY CREATED INPUT FILE
*-------------------------------------------------------------------
*      BD5 TEST DATA REDUCTION MODEL USING SPECIAL OPTION 6
*-----------------------------------------------------------
*       =BD5 TEST5        2-27-1991
=BD5 TURBINE CYCLE MCR DESIGN MODEL
*------------------------ CASE 1 ------------- BENCHMARK ----
*         GENERIC INPUT DATA
*
010000,ENGLISH
010200,2,3,1,5,1,50
011010,1,2,5,0,3600,166667.0,0.9,45.0,45.0
012000,25,50.0,50.0,0.0,0.0,100.0,5,5000.0
*--------------------------------------------------------
*        HEAT RATE DEFINITION
* HEAT RATE=(MAKEUP+THROTTLE IN - FW OUT + REHEAT)/GEN PWR
*
052015   2 3 -5 9       *GROSS HEAT SUPPLIED
```

```
MACROS

ALT A MACRO
/reTESTDATA~{goto}TESTDATA~/fccnPEPSE~{esc}{esc}
D:\123FILES\BD5C\BD5C
5
~{home}

ALT B MACRO
/ppoouqq/pf{esc}{esc}D:\PEP386\BD5E\BD5E
5
.IN~
```

APPENDIX A

TURBINE TEST PROCEDURES

BOUNDARY DAM UNIT 5 - TURBINE TEST DATA REDUCTION - LOTUS 'C' FILE

BD5 TURBINE TEST 2-28-1991 07:12:24.16 TEST TYPE

```
ALT A TO IMPORT      /reRAWDATA~{goto}R1~/fin{esc}{esc}D:\NB\BD5AB\BD5A
RAW DATA FROM  A -> 10
A AND B FILES        ~{goto}AS1~/fin{esc}{esc}D:\NB\BD5AB\BD5B
               B -> 10
                     ~{HOME}{calc}
```

```
ALT C TO SAVE        {goto}BH8~/re{end}{d}{up 1}~{home}    *fix makeup
C FILE RESULTS       /fxv{esc}{esc}D:\123FILES\BD5C\BD5C
               C -> 10
                     ~A1..Q150~
```

```
ALT E TO ERASE RAW  /reRAWDATA~
DATA FOR SAVING
AUTO123 FILE
```

BD5 TURBINE TEST 2-28-1991 07:12:24.16 ---- UNIT 5 -----

---------- CALCULATIONS --

BAROMETRIC PRESSURE (FROM TRANSMITTER) = 93.3655 KPAA

MAKEUP TANK	START	119.9	INCHES	=	4025.06	FT^3
LEVEL	END	112.65	INCHES	=	3796.64	FT^3
LENGTH=	40 FT	FLOW=20430.51	LBS/HR	1-HS/R =	-0.6652	
RADIUS=	6 FT			1-HE/R =	-0.5645	

CONTROL VALVE STROKE --> INCHES

FLOW CALCULATIONS	FA=	GAMMA=	HW=	CALIB C=	FLOW=	
1. FEEDWATER FLOW =	1.0024	60.79	123.33	1.0000	679043	SMART DP
2. CONDENSATE FLOW =	1.0022	60.46	223.67		648387	SMART DP
			IN H2O		LBS/HR	

DEARATOR FLOW	MAX		INCHES	=	0
SAME AS BD4 ???????	MIN		INCHES	=	0
LENGTH=	37.8 FT	FLOW=	0 LBS/HR	1-HS/R =	1
RADIUS=	5.5 FT	TIME =	2500 SEC	1-HE/R =	1

BD5 TURBINE TEST 2-28-1991 07:12:24.16

-- TEMPERATURES --

		UNITS	UNCORR. VALUE	CORREC. VALUE	UNITS	CALIB. CORREC.
1	MS T	DEG F	1003.7	1007.6	DEG F	3.9
2						
3	HRH T	DEG F	986.1	989.7	DEG F	3.6
4						
5	CRH Tmz	DEG F	631.7	631.9	DEG F	0.2
6	CRH Top	DEG F	612.5	612.5	DEG F	0.0
7	6 OUT	DEG F	409.5	408.8	DEG F	-0.7
8	6 DRNS	DEG F	346.6	345.8	DEG F	-0.8
9	5 OUT	DEG F	346.1	345.3	DEG F	-0.8
10	5 EXT	DEG F	836.9	838.8	DEG F	1.9
11	5 DRNS	DEG F	295.3	294.5	DEG F	-0.8
12	4 OUT	DEG F	287.5	286.7	DEG F	-0.8
13	4 EXT	DEG F	698.1	698.7	DEG F	0.6
14						
15	4 DRNS	DEG F	244.1	243.4	DEG F	-0.7
16	4 IN	DEG F	192.7	192.1	DEG F	-0.6
17	3 EXT	DEG F	351.5	350.8	DEG F	-0.8
18						
19	2 OUT	DEG F	199.6	198.9	DEG F	-0.6
20	2 EXT	DEG F	331.5	330.7	DEG F	-0.8
21	2 DRNS	DEG F	172.7	172.2	DEG F	-0.5
22	1 OUT	DEG F	168.2	167.7	DEG F	-0.5

ALT T FOR TEMPERATURE GRAPHS

```
/GNU61~NU1~NU3~NU5~NU7~NU8~NU9~NU10~NU11~NU12~NU13~NU15~NU16~
NU17~NU19~NU20~NU21~NU22~NU23~NU24~NU25~NU26~
{ESC}{ESC}
```

ALT P FOR PRESSURE GRAPHS (TP 41 - 52)

```
/GNU61~NU41~NU42~NU43~NU44~NU45~NU46~NU47~NU48~NU49~NU50~NU51
{ESC}{ESC}
```

ALT M FOR MISCELLANEOUS GRAPHS (FW FLOW, MAKEUP, POWER, SPRAY

```
/GNU61~NU55~NU56~NU61~NU62~NU66~NU67~NU68~
{ESC}{ESC}
```

ALT X FOR EXTRA TESTPOINTS (CONDENSATE T,P,Q, BAROM, BFP PWR,

```
/GNU61~NU27~NU57~NU58~NU59~NU60~NU63~
{ESC}{ESC}
```

THROTTLE FLOW COEFFICIENTS

TFC REFERENCE	TESTDATA	VWO	MCR THO
TFC=W/(P/V)^.5			
THRTL FLOW COEFF.	10193	16098	14399.6
TFR=TFC/TFCref =		0.6332	0.7079

PEPSE DATA

=BD5 TEST10 2-28-1991 07:12:24.16

*------------ TEMPERATURES ---------------------------------

890011	TTVSC	10	1007.6	I	*	1	MS T
*						2	
890031	TTTORH	140	989.7	I	*	3	HRH T
*						4	
890051	TEXIP	80	631.9	I	*	5	CRH Tmz
*			612.5	I	*	6	CRH Top
890071	TTFO	380	408.8	I	*	7	6 OUT
890081	TTDO	380	345.8	I	*	8	6 DRNS
890091	TTFO	370	345.3	I	*	9	5 OUT
890101	TEXIP	160	838.8	I	*	10	5 EXT
890111	TTDO	370	294.5	I	*	11	5 DRNS
890121	TTFO	360	286.7	I	*	12	4 OUT
890131	TEXIP	170	698.7	I	*	13	4 EXT
*						14	
890151	TTDO	360	243.4	I	*	15	4 DRNS
890161	TTDISP	330	192.1	I	*	16	4 IN
890171	TEXIP	180	350.8	I	*	17	3 EXT
*						18	
890191	TTFO	300	198.9	I	*	19	2 OUT
890201	TEXIP	200	330.7	I	*	20	2 EXT
890211	TTDO	300	172.2	I	*	21	2 DRNS
890221	TTFO	290	167.7	I	*	22	1 OUT

APPENDIX B

EXAMPLE LOTUS 'C' FILE

```
 23  1 EXT     DEG F     249.2     248.5 DEG F      -0.7
 24  DC OUT    DEG F     103.0     102.7 DEG F      -0.3
 25  DC DRNS   DEG F     102.7     102.4 DEG F      -0.3
 26  DC IN     DEG F      99.0      98.8 DEG F      -0.3
 27  COND T    DEG F     186.0     185.5 DEG F      -0.6
-- PRESSURES AND FLOWS ----------------------------- CORRECTIONS -----
               UNITS  UNCORR.   CORREC.  UNITS   CALIB.   LEG CORRECTION
                      VALUE     VALUE            COR(KPA)  KPA    INCHES
 41  MS P      KPA     12523.9    1826.3 PSIA      21    -46.5     -187
 42  1ST STG   KPA      5311.4     767.5 PSIA     -10   -103.2     -415
 43  CRH P     KPA      1794.8     273.6 PSIA       5     -6.8    -27.5
 44  HRH P     KPA      1738.3     258.8 PSIA      -5    -42.5     -171
 45  5 EXT P   KPA       779.8     125.2 PSIA      -3     -6.7      -27
 46  4 EXT P   KPA       361.4      64.7 PSIA    -2.3     -6.2      -25
 47  3 EXT P   KPA       136.2      30.4 PSIA    -1.5    -18.7      -75
 48  2 EXT P   KPA         0.9      12.2 PSIA       3    -13.2      -53
 49  1 EXT P   KPA        59.3       7.9 PSIA       0     -5.1    -20.5
 50  LP EXH    KPA        4.75      0.69 PSIA       0
 51  FW NOZZ   KPA     17426.5    2540.3 PSIA      26    -31.3     -126
 52  CEP DIS   KPA      1732.2     256.0 PSIA     -46    -14.6    -58.5
 53
 54
 55  FW FLOW   IN H2O    123.7    679043 PPH     -0.35 IN H20
 56  MAKEUP    IN H20              20431 PPH        11 INCHES
 57  BAROM     KPAA                 93.4 KPAA
 58  BFP SP    KPA      -150.0      -8.2 PSIA       0      0.0        0
 59  COND FLO  IN H2O    223.7    648387 PPH        0 IN H20
 60  COND SP   KPA       333.5      61.9 PSIA       0      0.0        0
-- MISC ------------------------------------- CORRECTIONS ----------
 61  POWER     MW                  100.6 MW
 62  REACT     MVAR                 24.6 MVARS
 63  BFP PWR   KW                    0.0 KW
 64
 65  TIME      SEC                  2500 SEC
 66  SHS A     KPPH       12.6     12584 PPH        0.0 KLBS/HR
 67  SHS B     KPPH        8.1      8083 PPH        0.0 KLBS/HR
 68  RHS       KPPH        0.2       242 PPH        0.0 KLBS/HR
 69
 70  CV POS'N                            INCHES
-- DCA TEMPS -------------------------------------------------------
 85  #6 DCA T                        0.5 DEG F
 86  #5 DCA T                        7.8 DEG F
 87  #4 DCA T                       51.3 DEG F
 88  #2 DCA T                        4.5 DEG F
 89  DC DCA T                        3.7 DEG F
```

```
|890231    TEXIP        210      248.5 I *        23    1 EXT
|890241    TTFI         290      102.7 I *        24    DC OUT
|890251    DCAEXC       280        3.7 I *     25-26    DC DCA
|*                                                26
|*                                                27    COND T
|*
|*
|*------------ PRESSURES AND FLOWS ----------------------------
|890411    PPVSC         10     1826.3 I *        41    MS P
|890421    PSIPV         60      767.5 I *        42    1ST STG
|890431    PSIPV         80      273.6 I *        43    CRH P
|890441    PPTORH       140      258.8 I *        44    HRH P
|890451    PSIPV        160      125.2 I *        45    5 EXT P
|890461    PSIPV        170       64.7 I *        46    4 EXT P
|890471    PSIPV        180       30.4 I *        47    3 EXT P
|890481    PSIPV        200       12.2 I *        48    2 EXT P
|890491    PSIPV        210       7.87 I *        49    1 EXT P
|890501    PPSI         230       0.69 I *        50    LP EXH
|890511    PMPDIS       330   2540.309 I *        51    FW NOZZ
|*                                                52    CEP DIS
|*CHOOSE ONLY ONE OF THE FLOWS (TP55 OR TP59)     53
|*                                                54
|890551    WWSPEL       345   679042.6 I *    *   55    FW FLOW
|890561    WWVSC        930    20430.5 I *        56    MAKEUP
|*                                                57    BAROM
|*                                                58    BFP SP
|*890591   WWSPEL       305   648387.1 I *    *   59    COND FL
|*                                                60    COND SP
|*------------- MISC ------------------------------------------
|890611    POWER          1   100562.4 I *        61    POWER
|*                                24.6            62    REACT
|*                                                63    BFP PWR
|*                                                64
|*                                2500            65    TIME
|890661    WWFIXB       350    20666.4 I *        66    SHS A+B
|*                                                67
|890681    WWFIXB       340      242.4 I *        68    RHS
|*                                                69
|890701    WWFIXB       250    38177.0 I *    BFP GS LEAKAGE
|/
|=BD5 STDZN TEST # 10        2-28-1991
```

APPENDIX B

EXAMPLE LOTUS 'C' FILE

BOUNDARY DAM UNIT 5 - TURBINE TEST RESULTS

		DESIGN	1973 AT	1986	--- 1988-03 ---		----- 1990-02-22 ------			-------------- 1991-02-26 ---------			
		TEST 1	TEST 2	TEST 3	TEST 4A	TEST 4B	TEST 13	TEST 16	TEST 18	TEST 3	TEST 4	TEST 18	TEST 19
	UNITS	MCR	MCR	VWO	VWO	VWO	MCR	VWO	VWO	MCR	VWO	MCR	VWO
1 MS T	DEG F	1000.0	999.3	1000.5	1010.8	1005.5	1002.1	1006.7	1004.9	1010.7	1014.0	1007.0	1011.2
3 HRH T	DEG F	1000.0	999.3	1000.2	994.6	999.5	991.7	989.8	993.6	993.2	993.0	1001.8	1010.3
5 CRHmezz	DEG F	651.5	661.2	682.4	686.9	679.6	662.4	682.6	682.3	663.3	689.0	660.5	688.7
6 CRHmain	DEG F									659.0	686.2	656.5	686.0
7 6 OUT	DEG F	449.2	450.7	457.3	448.2	448.3	445.4	448.6	449.0	443.3	443.6	443.5	446.7
8 6 DRNS	DEG F	385.9	393.8		390.4	390.4	384.2	386.6	387.1	382.3	381.9	382.1	384.9
9 5 OUT	DEG F	375.9	382.5	381.0	379.2	378.4	376.2	378.6	379.0	375.8	375.8	376.1	378.6
10 5 EXT	DEG F	823.4	834.3	856.6	846.1	850.4	844.6	843.4	846.7	850.2	851.2	857.9	867.8
11 5 DRNS	DEG F	341.9	343.4		343.0	342.7	340.8	343.1	343.5	341.5	341.4	341.7	344.2
12 4 OUT	DEG F	331.9	333.4	331.5	330.5	329.7	327.1	329.0	329.3	327.0	327.2	327.4	329.8
13 4 EXT	DEG F	689.6	694.5	728.0	720.9	724.3	724.4	723.9	727.2	722.3	724.0	729.9	739.5
15 4 DRNS	DEG F	289.8	283.7		281.9	281.9	283.8	285.6	285.8	282.9	282.9	283.3	285.6
16 4 IN	DEG F	279.8	4 272.1	4 272.7	4 272.0	4 272.0	269.9	271.6	271.7	268.8	269.4	269.5	271.7
17 3 EXT	DEG F	505.3	464.5	481.6	477.6	480.8	475.9	475.0	477.6	475.1	476.2	480.9	489.0
19 2 OUT	DEG F	215.1	217.2	222.6	221.2	220.9	220.0	221.1	221.3	219.1	219.1	219.5	221.0
20 2 EXT	DEG F	332.1	333.1	346.4	339.0	341.8	339.9	339.1	341.5	339.5	339.6	344.9	352.7
21 2 DRNS	DEG F	194.3	215.9		194.6	194.6	193.3		194.8	192.3	192.2	192.6	194.1
22 1 OUT	DEG F	184.3	186.6	190.2	187.1	187.2	185.8	186.6	186.6	186.5	186.6	186.8	188.0
23 1 EXT	DEG F	232.3	217.8	251.9	243.4	247.7	241.8	239.5	242.1	246.3	246.1	251.9	258.8
24 DC OUT	DEG F	112.1	169.8DRN	121.1	108.4	109.5	105.3	104.1	104.0	115.2	115.2	115.4	116.5
25 DC DRNS	DEG F	114.5					106.5	105.6	105.7	115.3	115.3	115.5	116.7
26 DC IN	DEG F	104.5					99.1	97.5	97.5	110.2	110.3	110.3	111.4
27 COND T	DEG F									205.7	205.9	208.9	207.5
-- PRESSURES AND FLOWS ----------													
41 MS P	PSIA	1815.0	1820.7	1687.3	1601.0	1624.0	1843.8	1671.4	1668.9	1844.3	1562.4	1834.4	1591.2
42 1ST STG	PSIA	(1245)	1290.5	1278.3	1278.3	1278.3	1238.5	1257.4	1255.9	1177.5	1174.0	1169.2	1196.7
43 CRH	PSIA	441.2	438.1	438.8	422.0	421.0	416.2	426.0	427.8	406.7	403.6	405.3	416.4
44 HRH	PSIA	397.1	415.4	412.7	396.9	396.0	395.5	404.8	406.5	385.0	381.9	383.9	394.4
45 5 EXT	PSIA	200.3	204.4	211.3	199.3	198.5	192.9	197.7	198.6	192.2	191.0	192.0	197.6
46 4 EXT	PSIA	113.8	113.5	117.6	112.7	112.1	110.9	113.8	114.3	108.4	107.9	108.4	111.7
47 3 EXT	PSIA	47.7	46.1	50.7	46.6	46.3	44.7	45.8	46.0	44.3	44.2	44.6	45.9
48 2 EXT	PSIA	18.5	MAN 19.	20.56	18.7	19.0	18.7	19.1	19.1	18.2	18.2	18.3	18.9
49 1 EXT	PSIA	9.9	MAN 12.	9.59	MAN 11.0	MAN 11.	11.3	11.5	11.5	11.2	11.2	11.2	11.5
50 LP EXH	PSIA	0.98	1.00	1.23	0.80	0.84	0.81	0.78	0.78	1.05	1.04	1.05	1.09
51 FW NOZZ	PSIA	(2300.0)	2460.4	2387.6	2387.6	2387.6	2380.0	2372.8	2370.9	2378.0	2386.4	2382.1	2370.5
52 CEP DIS	PSIA						260.3	258.3	257.5	247.7	248.5	244.5	242.1
55 FW FLOW	PPH	984911	*797162	1064521	998879	1012094	(1035042)			968418	951962	961289	978080
56 MAKEUP	PPH	0	8125	18945	4566	4566	17098	15944	16698	16739	7338	15899	14437
59 COND FLO	PPH									781512	769046	775573	797500
60 COND SP	PSIA									97.3	96.8	97.7	99.7
-- MISC. ----------													
61 POWER	MW	150.0	154.7	155.9	150.2	150.8	151.1	153.4	153.8	146.0	143.9	145.8	148.4
62 REACT	MVARS						28.4	8.2	12.8	21.9	18.4	22.8	26.7
65 TIME	SEC						3600	3600	3600	3600	3600	2480	2400
66 SHS A	PPH	0	24353	37430	48734	33647	3	5901	6606	10520	16031	12602	19142
67 SHS B	PPH						-3	7181	7711	7636	12174	9812	17858
68 RHS	PPH	0	342	21510	11290	11404	6919	21258	26923	33822	31381	32746	39135
-- DCA TEMPS ----------													
85 #6 DCA	DEG F	10.0	11.3		11.2	12.0	8.0	8.1	8.1	6.4	6.1	6.0	6.3
86 #5 DCA	DEG F	10.0	10.0		12.5	13.0	13.7	14.1	14.1	14.5	14.2	14.4	14.4
87 #4 DCA	DEG F	10.0					13.9	14.0	14.1	14.2	13.5	13.8	13.9
88 #2 DCA	DEG F	10.0	29.3		7.5	7.4	7.5	8.1	8.2	5.8	5.6	5.8	6.1
89 DC DCA	DEG F	0.0					7.4	8.1	8.1	5.1	5.1	5.1	5.3

NOTES:
1. 'MAN' MEANS MANUAL ENTRY BECAUSE TEST DATA NOT AVAILABLE
2 NUMBERS IN BRACKETS ( ) ARE CALCULATED
3 1990 FEEDWATER FLOW WAS CALCULATED USING OPTION 1 AND 86 REF. MCR FLOW CALCULATED FROM RATIO OF VWO TESTS MEASURED/OP1
4 '78 TO 88 #4IN WAS MEASURED AT #3OUT
5 '73 AT FLOW IS CONDENSATE FLOW
6 1991 TEMPERATURES CORRECTED WITH NEW T/C CALIBRATIONS. 1990 TEMPERATURES WERE NOT CORRECTED.
7 FEEDWATER FLOWS ARE NOT CORRECTED WITH 1.0075 CORRECTION

APPENDIX C - EXAMPLE RESULTS 'D' FILE - PART A

BD5 RESULTS SUMMARY

TEST	DESIGN	AT			AVG	AVG	AVG	--- 1988 ----		------ 1990-02	---------------			1991-02 -------------			TES
DATE/FILE	72.0	73.3	*	86.8	88.2	90.1	91.1	TEST4A	TEST4B	TEST13	TEST16	TEST18	TEST 3	TEST 4	TEST 18	TEST 19	DAT
TEST TYPE	MCR	MCR		MVWO AVG	VWO AVG	VWO AVG	VWO AVG	VWO	VWO	MCR	VWO	VWO	MCR	VWO	MCR	VWO	TES
FW FLOW		FW FLOW			FW FLOW	OPT 1	FW FLOW	FW FLOW	FW FLOW	OPT 1	OPT 1	OPT 1	FW FLOW	FW FLOW	FW FLOW	FW FLOW	FW
TFLOW RATIO	1.000	1.024		1.155	1.163	1.155	1.137	1.156	1.152	CALC.	1.146	1.146	0.955	1.128	0.952	1.128	TFL
CV POSITION										227	250	250		250	219	251	CV
MCR AF HR	7986	7922		8232	8232	8310	8245	8163	8228	8171	8262	8286	8218		8200		MCR
STDZN HR	7986	7952		8183	8187	8288	8229	8112	8190	8220	8244	8259	8211	8195	8195	8190	STD
DEV DESIGN	0	-34		197	201	302	243	126	204	234	258	273	225	209	209	204	DEV
DES FWH HR	7986	7949	*	8189	8191	8265	8233	8116	8195	8219	8198	8259	8212	8199	8198	8194	DES
FWH LOSS	0	3		-6	-5	23	-4	-4	-5	1	46	0	-1	-4	-3	-4	FWH
HR %DEV DES	0.0	-0.5	*	2.5	2.6	3.5	3.1	1.6	2.6	2.9	2.7	3.4	2.8	2.7	2.7	2.6	HR
DES FWH MW	150.0	152.7		164.8	166.2	163.3	162.2	167.1	165.3	147.6	163.4	163.1	139.9	162.17	139.82	162.3	DES
CORREC. MW	150.0	149.1		142.6	142.9		142.7	144.6	143.5		142.6	142.3	146.5	143.7	146.8	143.9	COR
HP EFF(REL)	0.827	0.778		0.770	0.795	0.785	0.788	0.797	0.793		0.774	0.774	0.749	0.788	0.749	0.788	HP
IP EFF	0.880	0.924		0.927	0.913	0.898	0.908	0.918	0.917		0.902	0.902	0.910	0.912	0.914	0.912	IP
LP EFF	0.855	0.863		0.807	0.801	0.792	0.796	0.810	0.789		0.793	0.788	0.818	0.793	0.821	0.795	LP
CYCLE LOSSES						-48	4			-48			6		2		CYC

PARTIAL HISTORY OF OVERHAULS AND OTHER TEST RESULTS AS REPORT
1984-04 TURBINE OVERHAUL
1984-07 TURBINE TEST, HEAT RATE = 8080
1984-11 TURBINE TEST, HEAT RATE = 8033 (PEPSE SAYS 8150,SEE A
1991-08 PLANNED TURBINE OVERHAUL

THE FOLLOWING CORRECTIONS WERE MADE TO AVERAGE VALUES ONLY ('86 TO '
CORRECTIONS ARE FOR FW FLOW NOZZLE CALIBRATION AND 2X DESIGN N2 PACK

HEATRATE	*1.0044
IP EFFIC.	-.0044
LP EFFIC.	+.0013
TFR	*1.0081

DESCRIPTION OF TERMS

DATE/FILE = DATE IN DECIMAL FOR PLOTTING / TEST FILE NUMBER(NAME)
TEST TYPE = VWO (VALVE WIDE OPEN), MCR(MAXIMUM CONTINOUS RATING), AVG(AVERAGE OF TESTS)
FW FLOW = LOCATION OF FEEDWATER FLOW MEASUREMENT (FW FLOW NOZZLE, CONDENSATE FLOW NOZZLE, OPTION 1)
TFLOW RATIO= THROTTLE FLOW RATIO, THIS IS A RATIO OF THROTTLE FLOW COEFF. VS DESIGN TFC.
CV POSITION= CONTROL VALVE POSITION, THIS IS A MEASURE OF CAM ARM MOVEMENT
MCR AF HR = MCR AS FOUND (PEPSE CASE 2) HEATRATE NB: ALL HEATRATES IN BTU/KWH.
STDZD HR = STANDARDIZATION CASE (CASE 3) PEPSE HEATRATE (CORRECTED FOR OFF-DESIGN BOUNDARY CONDITIONS)
DEV DESIGN = HEATRATE DEVIATION FROM DESIGN (BTU/KWH)
DES FWH HR = DESIGN FEEDWATER HEATER (CASE 4) HEATRATE (CORRECTED FOR OFF-DESIGN FWH OPERATION)
FWH LOSS = FEEDWATER HEATER LOSS, (BTU/KWH) LOSS DUE TO FWH SYSTEM
HR %DEV DES= FEEDWATER HEATER HEATRATE DEVIATION FROM DESIGN IN PERCENT
DES FWH MW = DESIGN FEEDWATER HEATER (CASE 4) OUTPUT (MWATTS)
CORREC. MW = MEGAWATTS CORRECTED TO THROTTLE FLOW RATIO OF 1.0.
HP EFF(REL)= HIGH PRESSURE TURBINE SECTION EFFICIENCY (RELATIVE TO THROTTLE INLET)
IP EFF = INTERMEDIATE PRESSURE TURBINE SECTION EFFICIENCY
LP EFF = LOW PRESSURE TURBINE EFFICIENCY
CYCLE LOSSES = MCR CASE 2-4 H= HEATRATE LOSS DUE TO THERMAL CYCLE LOSSES AND OFF-DESIGN BOUNDARY CONDITIONS

1988,1990,1991 AVERAGE OF VALVE WIDE OPEN RESULTS
DES FWH HEATRATE 8230
DEVIATION FROM DES 3.0

APPENDIX C - EXAMPLE RESULTS 'D' FILE - PART B