Methodology for Computerized Data Reduction/Management

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ABSTRACT

The plant performance program for TMI-1 utilizes a PEPSE model with seperately identified components and system strings. This model requires a large volume of input data. Although a model of this nature can offer several advantages over the less complex serial model, the data requirements may present major disadvantages. The larger the volume of input data used the greater the level of uncertainty obtained; additionally, large volumes of data require more time for data manipulation and preparation of required PEPSE input decks.

To overcome these disadvantages a data reduction/management program, in FORTRAN, was written. The program reads a complete set of plant data (not limited to PEPSE input data), determines and eliminates unreasonable data, manipulates data to conform to specific needs, calculates desired performance indicators, determines the quality of selected data from a design-comparison basis (absolute), determines the quality of selected data from a historical-trend-comparison basis (relative), prepares a complete detailed output listing, and generates the PEPSE input decks necessary to run a measured-data case and a design-conditions case. The program features complete ASME steam tables, provides diagnostic information, and contains sufficient logic to correctly reflect the case specific plant configuration.

Use of this program has reduced the total time required for manipulating the data and preparing the PEPSE input decks from hours to under two minutes. Computerization allows for more calculations to be performed, since time is no longer limiting, and the total process to be carried out with reduced levels of uncertainty, uniform methodology, and greater precision.

1.0 INTRODUCTION

The plant performance program for TMI-1 utilizes a PEPSE model with separately identified components and system strings. This model requires a large volume of input data. Although a model of this nature can offer several advantages over the less complex serial model, the data requirements may present major disadvantages. The larger the volume of input data used the greater the level of uncertainty obtained; additionally, large volumes of data require more time for data manipulation and preparation of required PEPSE input decks.

To overcome these disadvantages a data reduction/management program, in FORTRAN, was written. The program reads a complete set of plant data (not limited to PEPSE input data), determines and eliminates unreasonable data, manipulates the data to conform to specific needs, calculates desired performance indicators, determines the quality of selected data from a design-comparison basis (absolute), determines the quality of selected data from a historical-trend-comparison basis (relative), prepares a complete detailed output listing, and generates the PEPSE input decks necessary to run a measured-data case and a design-conditions case. The program features complete ASME steam tables, provides diagnostic information, and contains sufficient logic to correctly reflect the case specific plant configuration.

Use of this program has reduced the total time required for manipulating the data and preparing the PEPSE input decks from hours to under two minutes. Computerization allows for more calculations to be performed, since time is no longer limiting, and the total process to be carried out with reduced levels of uncertainty, uniform methodology, and greater precision.

2.0 METHODS

2.1 Preliminary Instrumentation Studies

Reference 5.1 concerns a study that was performed to determine the available performance instrumentation in the TMI-1 secondary plant. A list was generated indicating instrument identification, instrument type - computer or local, instrument description, instrument location, drawing number instrument found on, and the corresponding location on the PEPSE model.

From this list, reference 5.2 was generated to indicate the PEPSE input identification parameter corresponding to each instrument reading. Also, based on the instrument location and units of the instrument reading, guidelines on correcting or "massaging" the data to conform to the available input requirements for the PEPSE model were determined.

2.2 Main Program for Reading and Massaging Data

Based on identified needs in reference 5.2, a program was written in FORTRAN, GPROG.F77 - see Appendix A, to read a set of input data, massage the data to conform to the PEPSE input requirements, and to store the data in arrays for later use in reducing the data and generating output. GPROG.F77 reads from a sequential access read file that was generated from reference 5.2. The Plant Analysis engineer at TMI-1 collects the necessary data from the plant computer and local readings and enters the data into the read file. For data that is unreasonable, by inspection, and for equipment that is out-of-service, a value of zero is entered.

A DO-LOOP within GPROG.F77 is set up to read each input value and determine whether the value is zero or non-zero. Based on this determination and using computed-go-to statements, the value is then sent to the appropriate section of the program where it is massaged and stored according to the particular instrument source. The process continues until the entire data set is read. Refer to Figure 1 for a schematic representation of this process.

2.3 Performance Related Calculations

GPROG.F77 also performs several calculations of useful performance related parameters. A number of these calculations are presented in Table II of the output listing for the data reduction program as seen in Handout No. 1. Due to limited available time, certain performance related calculations which would assist in evaluation of plant thermal performance are not calculated. Computerization eliminates the time restriction and allows for more calculations to be performed, thus enhancing the ability of the engineer to evaluate plant thermal performance.

2.4 ASME Steam Tables

Several of the calculations performed require steam tables calls. A complete set of routines for determining thermodynamic properties of water for all phases is provided in a routine called GSTMTB.F77. These routines are written in FORTRAN and are stored as functions for use in the program activities.

FORTRAN routines for determining thermodynamic properties of steam and water are directly available from References 5.7, 5.8, and 5.9. These routines have a high degree of accuracy and require minor debugging to get operational.

2.5 Design Comparison (Absolute) Quality Determinations

One of the functions the program provides in data reduction is determining the data quality from a design comparison, or comparison to an absolute quantity, basis. The main programs for performing this function are DESCHEK.COM, DCKCOMM.COM, and KDQUAL.F77 as described in Appendix A.

Quality for this program takes on a unique definition. The quality is based upon a specified range or acceptable tolerance about the design value. The range of acceptability is determined by multiplying the design value by the pre-established tolerance, as defined in Figure 2. This range is compared to the difference between the measured value and the design value; if the difference is within the range then the value has a "good" quality, if the difference is larger than the range, then the data value falls outside of the range of acceptability and is considered "unacceptable" data. KDQUAL.F77 was written to quantify a measure of quality in terms of an integer value; again, refer to Figure 2.

Design values used in these comparisons are obtained from several sources: calculation based on first principles, interpolation of design condition curves as generated from design PEPSE runs, or vendor technical information such as pump curves, etc.

It is also a feature of this program to represent a value that is "better" than design as a negative number with -1 being slightly better than design and -25 being extremely better than design and so on.

DCKCOMM.COM is a program for evaluating the quality and reporting diagnostic information to assist the engineer in evaluating the quality of the data. Basically this program defines the "reasonableness" of the data. For good quality data comments reflecting good quality are provided. For poor quality data, the program searches for possible explanations as to why the quality is poor. For example, the quality analysis shows the second stage extraction pressure is much lower than the design value and the quality analysis for feedwater flow indicates measured feedwater flow is in error - reading a high value. This would suggest that the error in measured feedwater flow induced the observed error in comparing extraction pressure versus flow. A comment reflecting this condition would be indicated to the engineer in the "Design Quality Comments" table in the putput listing.

2.6 Historical-Trend Comparison (Relative) Quality Determinations

Another function this program provides in data reduction is determining the data quality from a historical-trend comparison, or relative quality determination, basis. The main programs for performing this function are HISCHEK.COM, HCKCOMM.COM, and KHQUAL.F77 as described in Appendix A.

Quality for this program takes on its own unique definition. The quality is based upon a specified range of 3% deviation from a best fit curve of the data value over a narrow load range. The best fit curve is obtained via a linear regression technique. This range is compared to the difference between the measured value and the value located on the best-fit line at the measured abscissa; if the difference is within the range, then the value has a "good" quality, if the difference is larger than the range, then the data falls outside the range of acceptability and is considered "unacceptable" data.

The function KHQUAL.F77 is used for determining the quality of the data as compared to a historical trend for data value normalized to the same plant conditions, a relative reference. To maintain an accurate historical trend the program must be able to create the historical trend and discriminate out old and poor quality data.

The function KHQUAL.F77 is called as a function of "KEY", total feedwater flow, design based quality, abscissa, and the ordinate.

KHQUAL(KEY, FLOW, KDQ, XVAL, YVAL)

The historical trends for each value to be compared are stored in a direct-access read file, HTREND.DAT. For each value to be compared there exists four trends, each for a different load range. These files are accessed as directed by an integer variable "KEY". Each record in the file contains the following, in order:

NE: Number of plant data historical values in the record, maximum of ten.

AK: Slope of the best fit curve obtained by linear regression of the data for the load range.

BK: The Y-intercept of the best-fit curve

XLO:
YLO: The low value of the data file. This is present to prevent a cluster of data in the high end of the load range from biasing the slope of the best-fit curve.

XXVAL(I):
YYVAL(I):
ZZVAL(I): These are the X, Y, and Z values, I = 1 to 10, for the plant data values stored for comparison. The X value is the abscissa value, the Y value is the ordinate value, and the Z value is the historical quality of the data to be used in updating the record.

XAVAL:
YAVAL: These are the X and Y values for the average of the three previously thrown out values of the historical record. This is to dampen the effects of the changing data.

XHI:
YHI: The high value of the data file. This is present to prevent a cluster of data in the low end of the load range from biasing the slope of the best-fit curve.

XOVAL(I): These are the X and Y values, I = 1 to 3, of the three previously
YOVAL(I): thrown out values of the historical record. They are arranged in order from the most recent to the oldest.

The advantage of utilizing a direct access read/write file is that an individual record may be read and re-written without having to alter any other part of the file.

The first step in this program is to determine the relative power level for which the data is to be compared to. For each data value to be compared to a historical trend exists. The trend is broken up into 4 load ranges to facilitate the linear regression technique used to determine the trended value to be compared to. For each of the load ranges, a value of KKEY is assigned to the corresponding integer value of the load range, 1-4. This is used, with KEY, to determine the location of the exact record to be used for comparison.

$$LOC = ((KEY - 1) \times 4) + KKEY$$

The program discriminates against any data measured out of the load range or zero data.

One aspect of this program is that it enables the historical trend to be created as data is received. The file does not have to be prescreated. Simply running the program will create the file.

For NE less than 2, a quality will not be calculated due to the absence of enough data to perform a good check. For NE less than 2, the values of XVAL and YVAL will be placed in the first available storage location in the historical record. This will be done starting with the HI and LO values, following greater than/less than checks - regardless of the data quality. A quality of 99 will be assigned which will be followed up in the comment assignment routine. The engineer is acknowledged that the data was entered with no quality check and he should verify concurrence. Manual extraction of the data value would be necessary if the engineer does not want the data value entered. This process is for building up the data base.

For NE greater than 2 but less than 10, quality based on historical trends is calculated. If the design based quality for the value, KDQ is less than or equal to 15, the value is added to the historical record. Since some of the values may not have a calculated quality stored for them and the AK and BK values for the linear-regression function may not be calculated (not calculated for NE less than 2), these values are calculated first. Once these values are calculated for the data file, the new data file is evaluated for quality. For design quality greater than 15, the data is not added to the historical record and the engineer is flagged via the comment assignment routine to inspect the data and decide whether or not to manually load the data into the record. Once this is complete, the record is rewritten, provided KDQ is less than 15, and KHQUAL is returned. Note that checks for new HI and LO values are performed.

For NE equal to 10, historical trend based quality is calculated. A Y-value based on the read values of AK, BK and the argument XVAL is calculated. An acceptable tolerance range of 3% of this value is calculated. The absolute difference between the argument YVAL and the calculated Y value, based on the linear regression curve, is taken and compared to the range. Using these values and a method described in Figure 3, quality is calculated. Values outside of 150% of the acceptable tolerance range, quality of 8 or greater, are not used in updating the historical record. The engineer is flagged via the comment assignment routine to inspect the data to decide whether or not to manually load the data into the record. For values within the acceptable tolerance range, the following is performed:

1. Of the 10 X,Y values stored, the value with the poorest quality is determined. This value is stored in a temporary location and the new X, Y, Z value replaces this "old" value.

2. The three (or less) values of previously thrown out data are averaged and replace the previous X, Y average values in the XOVAL and YOVAL locations.

3. To "oldest" of the previously thrown out values is thrown out of the data record. The remaining two are arranged accending chronologically in the 2 and 3 locations. The most recent thrown out value (temporarily stored as discussed in 1 above) is placed in the 1 location.

4. The high and low of the ten XXVAL elements are determined and compared to XHI and XLO values. The appropriate value is replaced, or swapped, if sufficiently high or low.

5. New values of AK and BK are determined.

A Y-value based on the linear regression best fit line characteristics AK and BK, and the argument XVAL is calculated. An acceptable tolerance range of 3% of this value is calculated, TCK. The absolute difference between the argument YVAL and the calculated Y-value, CCK, is determined and is compared to TCK to determine the quality. The quality is returned to HISCHEK.COM.

HCKCOMM.COM is a program for evaluating the quality and reporting diagnostic information to assist the engineer in evaluating the quality of the data. Basically this program functions in the same fashion DCKCOMM.COM functions by defining the "reasonableness" of the data.

2.7 Discussion of Quality

Two qualities are available for data from this program, a design comparison based and a historical trend comparison based. The design comparison based quality indicates the quality of the data as it compares to an absolute value. The historical trend comparison based quality indicates the quality of the data as it compares to a relative value. The two qualities, when used together, represent a clear indication of the data quality.

For example, if the design quality is poor and the historical quality is good, this will tell the engineer that the data may be off design but the plant has been operating at or near this condition for some time. Another example: following a modification it is noted that the historical quality is poor but the design quality is good, this would tell us that the modification improved the condition to within design standards. The engineer is no longer at the mercy of confusing data trends.

2.8 Accurately Determining LP Feedwater Heater Shell Pressures

Based on experience gained in Cycle 5, it was observed that in the low pressure feedwater heaters, occasionally, the measured heater drains out temperature was greater than the saturation temperature of the shell inlet steam.

This was causing reverse heat transfer to occur in the PEPSE runs and subsequently causing the program to crash. The time spent on locating the problem, deciding on how to correct the identified problem, making the appropriate changes, and turnaround was considerable. For these reasons, subroutine FWHTR.F77 was written.

Based on trends observed on the instrumentation it was concluded the pressure instrument variations were responsible for the problems indicated above. FWHTR.F77 is a subroutine designed to check the low pressure feedwater heaters' shell pressure to ensure the corresponding saturation temperature is greater than the entered drains out temperature. The program starts with the average of the measured shell pressures, determines the corresponding saturation temperature and compares it to the drains out temperature for the individual heater. If it [the saturation temperature] is greater than the measured drains out temperature, the average shell pressure is used; if less, the program incrementally adjusts the shell pressure until the corresponding saturation temperature is greater than the drains outlet temperature. Comments indicating the modification are provided in the output listing and the PEPSE input deck is changed accordingly.

2.9 Output Listing

Handout No. 1 provides a sample output listing from the data reduction program. The output is sectioned by various systems within the turbine generating cycle. Each system is further sectioned into (up to) three tables:

Table I - lists the data source, description, raw data value and units, corrected data value and units, history based quality and comments, and the design based quality and comments for each data value in the system.

Table II - provides the various calculated values for the particular system.

Table III - provides any error messages associated with the data in the system.

Also contained in the output are legends for the historical-trend-based quality comments and the design-based quality comments, and the subroutine FWHTR.F77 results.

OUTFILE.F77 is the program for writing the output listing and, along with its associated programs, is discussed in Appendix A.

2.10 PEPSE Model Input Decks

Another function this program provides is the preparation of the input decks necessary to run the measured data case and design conditions case PEPSE runs. Programs PEPRITE.F77 and DESRITE.F77 along with their associated programs provide this function. Program descriptions are provided in Appendix A.

These programs obtain data from GPROG.F77 and FWHTR.F77, arrange the data into arrays structured such to facilitate the printing of the input decks. The programs contain sufficient logic to distinguish which components are operating vs. out of service.

These data files are copied into the end of the TMI-1 PEPSE model. The model is then ready to run.

Examples of these input decks are provided in Handout Nos. II and III.

3.0 RESULTS

Use of this program has shown to be an effective tool for analyzing plant performance. Use of this program can reduce the total time required for manipulating the data and preparing the necessary PEPSE input decks from hours to under two minutes (actual runtime < 30 seconds). Computerization allows for more calculations to be performed, since time is no longer limiting, and the total process to be carried out with reduced levels of uncertainty, uniform methodology, and greater precision.

Appendix B provides a justification of the time savings obtained from use of this program versus the time spent on preparing and documenting this program.

In summary the time spent on developing this program will be returned after 2 1/2 years of use of this program.

4.0 CONCLUSION

In conclusion, use of this data reduction/management program can be an effective means of obtaining fast and accurate input cases to run the PEPSE model. Use of this program reduces a large amount of time spent on tedious activities and allows more time for the performance engineer to use for evaluating plant performance.

5.0 REFERENCES

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5.2 GPUN Memorandum, PA-85-578, "Instrument Readings Necessary as Inputs to Run PEPSE As-built Model," G. A. Boerschig to R.E. Masoero, 6/17/85.

5.3 Energy Incorporated, "PEPSE Manual - User Input Description," Volume I, Rev. 12, 1986.

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5.18 Worthington Corporation, Characteristic Curve Sheet for Moisture Separator Drain Pumps, Curve No. ER-3019, 1968.

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5.20 GPUN Technical Data Report, TMI-1 Feedwater Heater PEPSE Sub-Models, TDR No. 715, Rev.0, 9/24/85.

5.21 GPUN Technical Data Report, PEPSE As-built Model Description for TMI-1 Turbine Generator Cycle, TDR No. 676, Rev. 0, 6/5/85.

6.0 FIGURES AND APPENDICES

Figure 1

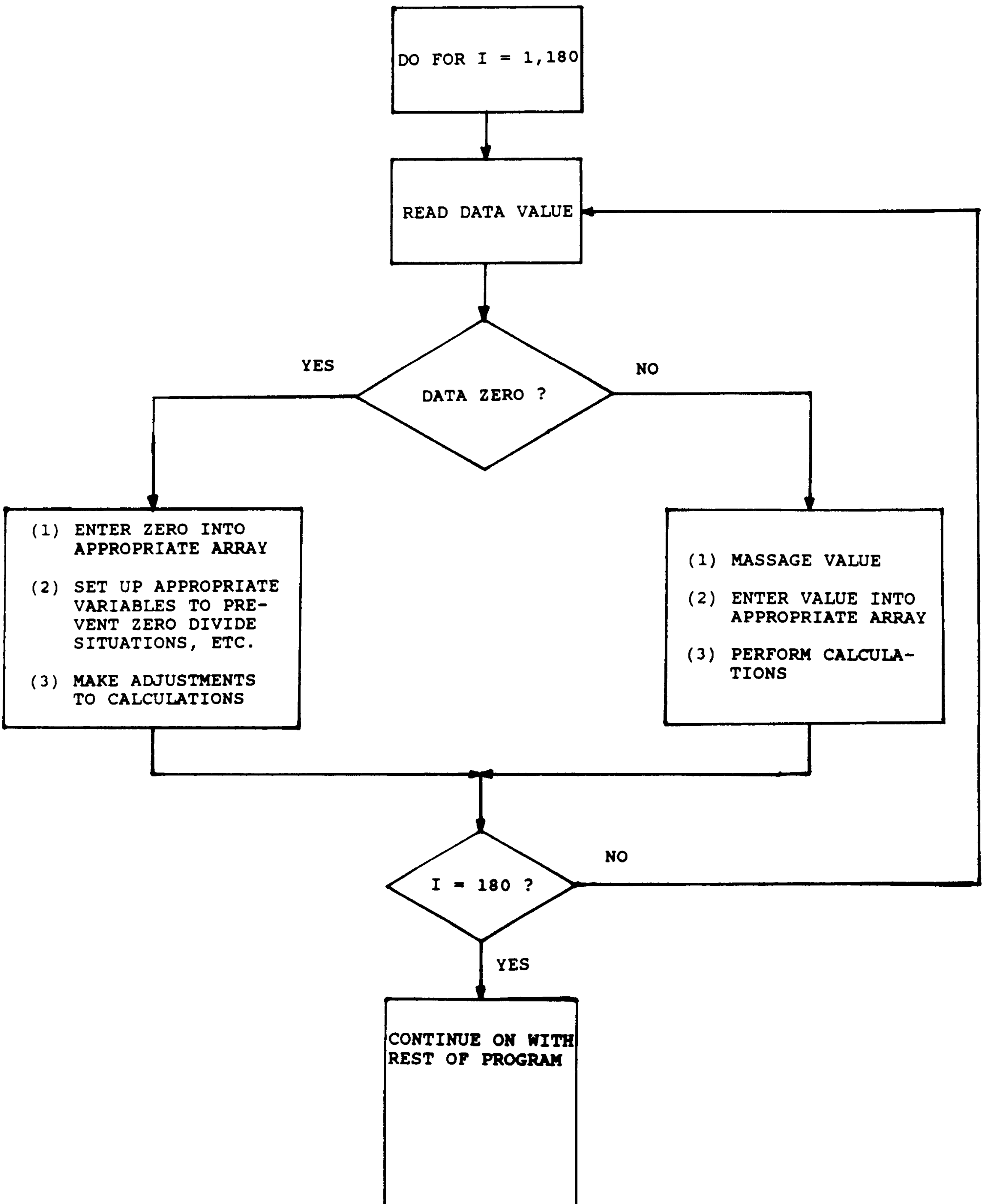

DO FOR I = 1,180
READ DATA VALUE
DATA ZERO ?
YES
NO
(1) ENTER ZERO INTO APPROPRIATE ARRAY
(2) SET UP APPROPRIATE VARIABLES TO PRE- VENT ZERO DIVIDE SITUATIONS, ETC.
(3) MAKE ADJUSTMENTS TO CALCULATIONS
(1) MASSAGE VALUE
(2) ENTER VALUE INTO APPROPRIATE ARRAY
(3) PERFORM CALCULA- TIONS
I = 180 ?
NO
YES
CONTINUE ON WITH REST OF PROGRAM

Figure 2

I. Range of Acceptability:

RANGE = FR x DESVAL

where: RANGE - Range of Acceptabilty
FR - Predetermined Fraction
DESVAL - Design Value

II. Quality Determination:

DELTA = ABS(DESVAL - ACTVAL)

where: DELTA - Absolute Value of the Difference Between Design and Measured Values
ACTVAL - Measured Value

COUNT = RANGE / 5

where: COUNT - Increment for Use in Quantifying the Closeness of the Measured Value to the Design Value

QUALITY = DELTA / COUNT

where: QUALITY is an Integer Value and is a Measure of the Closeness a Value is to the Design Value

III. Evaluation of QUALITY

0 - Quality Not Determined

1 - 5 - Quality Within the Range of Acceptibility

6 - 10 - Quality Outside the Range of Acceptibility and Datum Should be Checked

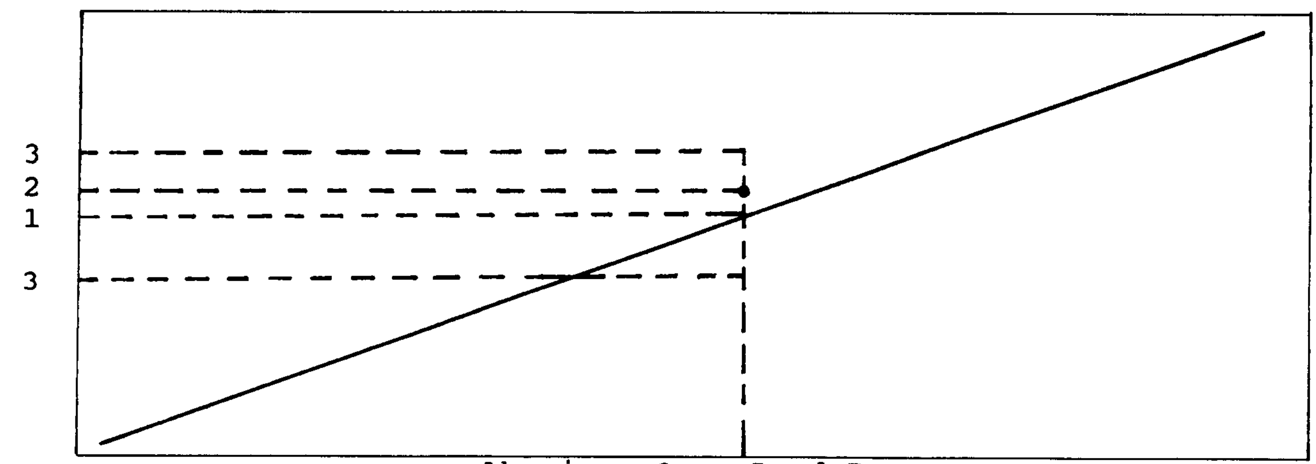
11 - 25 - Quality Way Outside the Range of Acceptibility and Datum Should Not be Used

25 - Maximum (Poorest) Quality

Figure 3

I. Range of Acceptability:

Best Fit Approximation Obtained From Linear Regression Technique



Abscissa Over Load Range

(1) - Best Fit Value of Ordinate For Given Abscissa

(2) - Measured Ordinate

(3) - Outer Limits of Range of Acceptability Defined as 3%(+/-) of the Best Fit Value

II. Quality Determination:

DELTA = ABS((2) - (1))

where: DELTA - Absolute Value of the Difference Between Best Fit and Measured Ordinate Values

COUNT = (3) / 5

where: COUNT - Increment for Use in Quantifying the Closeness of the Measured Value to the Best Fit Value

QUALITY = DELTA / COUNT

where: QUALITY is an Integer Value and is a Measure of the Closeness a Value is to the Best Fit Value

III. Evaluation of QUALITY

Same as for Design Comparison

APPENDIX A

Programs and Descriptions

PROGRAMS AND DESCRIPTIONS

Index	File	Description
A.1	INIT.COM	File for declaring/initializing GPROG.F77.
A.2	GPROG.F77	This file is the main program in the total data reduction program. This file performs the following functions:

I. Reads the input data:

A. Performs any necessary data manipulation to convert the data into a form which can be used by PEPSE or to units consistent with those used in the performance parameters calculations (i.e., psig to psia, line losses, etc.)

B. Checks for zero input data.

1. To prevent zero divide situations.

2. To prevent zero data from entering the PEPSE input decks.

II. Performs calculations of various necessary performance parameters:

A. Calculation of design conditions for use in the design case input deck.

B. Calculates parameters used for evaluating performance.

III. Stores data in arrays for use in the remaining functions of this program:

A. Design quality checks.
B. Historical trend quality checks.
C. Output listing preparation.
D. PEPSE input deck preparation.
E. PEPSE design case input deck preparation.

Index	File	Description
A.3	INIT2.COM	This file is used to declare/initialize OUTFILE.F77. Contained within OUTFILE.F77 and are also initialized herein are:

1. DESCHEK.COM
2. DCKCOMM.COM

3. HISCHEK.COM
4. HCKCOMM.COM
5. STORE.COM
6. UNITS.COM

A.4	DESCHEK.COM	File for performing design comparison quality checks. This file compares input data (corrected) to design values. With KDQUAL.F77, a quality is determined. Comparison is made by the following: 1. Basic principles calculations. 2. Interpolation of design data schedules obtained from PEPSE. 3. Interpolation of design data schedules obtained from vendor data (i.e., pump curves, etc.)
A.5	DCKCOMM.COM	File for assigning design quality comments. This file reviews the design quality and compares this value to a standard acceptance criteria and to other data qualities for the data set. Based on this evaluation - provides diagnostic information to assist the engineer in evaluating the data quality.
A.6	HISCHEK.COM	File for calculating historical-trend based quality. Using KHQUAL.F77, this file compares various input data (corrected) with a trend of previous values of the same data point relative to a defined abscissa. The trends are restricted to predefined load ranges defined in KHQUAL.F77 and a linear regression technique is used. The trends are continually updated.
A.7	HCKCOMM.COM	File for assigning historical quality comments. This file reviews the historical quality and compares this value to a standard acceptance criteria and to other data quality for the data set. Based on this evaluation - provides diagnostic information to assist the engineer in evaluating the data quality.
A.8	STORE.COM	File for storing data in arrays for use in creating output listing.
A.9	UNITS.COM	This file is used to initialize and store the units assignments for the data and corrected data points to be written in the output listing.
A.10	OUTFILE.F77	This subroutine is used to write stored data in tabular form as output.

A.11	PEPINIT.COM	Declaration/initialization file for PEPSE input deck preparation program, PEPRITE.F77.
A.12	PEPDATA.COM	This file is used to set up data and character strings for use in preparing the PEPSE input/output deck to run the "Actual Data" case in PEPSE, PEPRITE.F77.
A.13	PEPSTOR.COM	This file is used for storing data obtained from GPROG.F77 (and FWHTR.F77) and sets up the necessary arrays to be used in PEPRITE.F77 for preparing the PEPSE "Actual Case' input deck.
A.14	PEPRITE.F77	Subroutine to write the PEPSE case specific input/output deck.
A.15	DESINIT.COM	Declaration/initialization file for the design case PEPSE deck preparation file DESRITE.F77.
A.16	DESDATA.COM	This file is used to set up data and character strings for use in preparing the PEPSE input/output deck to run the design case in PEPSE, DESRITE.F77.
A.17	DESSTOR.COM	This file is used for storing data obtained from GPROG.F77 and sets up the necessary arrays to be used in DESRITE.F77 for preparing the PEPSE design case input deck.
A.18	DESRITE.F77	File to write PEPSE design case input/output deck.
A.19	GSTMTB.F77	ASME Steam Tables - functions and subroutines. This file contains the routines for accessing the ASME Steam Tables and associated functions.
A.20	XINTP.F77	Function for interpolating data. This file contains pre-entered values for X_1 and Y_1. X and Y variables are assigned as functions of the variable "KEY" which directs to the appropriate section of the code which contains the associated X & Y values for the specific data value. Interpolation follows at the end of the routine.
A.21	TURBC.F77	Function for obtaining design turbine pressures based on main steam flow by interpolation of pre-entered values obtained from PEPSE design case runs.
A.22	CDSTE.F77	Function for interpolating design condensate system parameters for use in the design quality checking program, DESCHEK.COM.

A.23	HDP.F77	Function for interpolating design heater drain pump data to be used in the design checking program, DESCHEK.COM.
A.24	FWSYS.F77	Function for interpolating design feedwater system parameters for use in the design quality checking program, DESCHEK.COM.
A.25	KDQUAL.F77	Function for determining a design basis quality as a function of the allowable (design) tolerance and the actual (measured) tolerance.
A.26	KHQUAL.F77	Function for determining a historical-trend-comparison based quality as a function of the allowable tolerance and the actual tolerance. This file uses a direct access read file, HTREND.F77, to store the various ordinates and abscissas. The files are broken down into four load ranges to enable a linear regression technique to be used with greater precision. The file contains sufficient logic to discriminate unacceptable data values and update the trends.
A.27	FWHTR.F77	This subroutine is designed to check the low pressure feedwater heaters' (12th stage thru 8th stage) shell pressure to ensure the corresponding saturation temperature is greater than the entered drains out temperature. The program starts with the average of the measured shell pressures (local instrumentation), determines the corresponding saturation temperature and compares it to the drains out temperature for the individual heater. If it is greater than the measured, the average shell pressure is used, if less, the program incrementally adjusts the pressure until the corresponding saturation temperature is greater than the drains outlet temperature. The PEPSE input deck is changed to reflect the adjustment.

APPENDIX B

Project Justification

B.1 MAN-HOURS JUSTIFICATION FOR DATA REDUCTION PROGRAM

Item	Description	Manhours
1	Total time spent on project	832
2	Time savings based on present activity	156
3	Time would be spent on data reduction	104
4	Time would be spent on performance calculations	78
5	Time spent on human error - turnaround delay	48
6	Time spent on emergency runs for abnormal conditions	14.9
	Total Hours saved per year	400.9

$$\text{Time of payoff} = \frac{832}{400.9} = 2.08 \text{ years}$$

B.2. EXPLANATION OF TERMS

1. Total Time Spent on Project - the total time spent on this project was 40% of one man year. That figure includes research, coding, testing, and documentation.

$$0.40 \times (40 \times 52) = 832$$

2. Time Savings Based on Present Activity - This is the time presently spent on preparing a PEPSE run for performance evaluation. This is the activity the program will replace. This number is based on 3 hours per run, one run per week.

$$3 \times 52 = 156$$

3. Time Would be Sent on Data Reduction - Presently, data reduction is not performed. This is not done due to the time necessary to reduce data. To do this activity by hand-calculation would take 2 hours per run. This is a conservative estimate.

$$2 \times 52 = 104$$

4. Time would be spent on Additional Calculations: The program contains several useful calculations that are not presently performed due to the time involved. These calculations will prove to be valuable in performance evaluations. The conservatively estimated time to perform these calculations by hand is 1.5 hours per run.

$$1.5 \times 52 = 78$$

5. Time Spent on Human Error/Turnaround Delay - Occasionally errors are made to the input deck. The time wasted in turnaround time (waiting for output until next run) plus the time spent on debugging the input deck is estimated at 4 hours. Since the program does things uniformly and contains features such as FWHTR.F77, these mistakes are minimized. This is based on one mistake per month.

$$4 \times 12 = 48$$

6. Time spent on Emergency Runs for Abnormal Conditions - Occasionally the plant will request information regarding the plant conditions that will require a PEPSE run. This number is based on two such requests per year and the time spent per each run is the effective time per run for items 2 through 5.

$$2 \times 7.43 = 14.9$$

Total Hours per Year Saved - The sum of items 2 through 6.

Time of Payoff - The total time after this program is instituted until the time spent on the project equals the time saved. Item 1 divided by the sum of items 2 through 6.