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RCSLK9: Reactor Coolant System Leak Rate Determination for PWRs

User's Guide

U.S. Nuclear Regulatory Commission

Office of Inspection and Enforcement

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ABSTRACT

RCSLK9 is a computer program that was developed to analyze the leak tightness of the primary cooling system for any pressurized water reactor. From system conditions, water levels in tanks, and certain system design parameters, RCSLK9 calculates the loss of water from the cooling system and the increase of water in the leakage collection system during an arbitrary time interval. The program determines the system leak rates and displays or prints a report of the results. For initial application of the program at a reactor, RCSLK9 creates a file of system parameters and stores it for future use. RCSLK9 is written for use on the IBM PC.

TABLE OF CONTENTS

1 INTRODUCTION

RCSLK9 and an IBM Personal Computer (PC) provide the inspector with the capability to independently analyze the leak tightness of reactor coolant systems (RCSs) for pressurized water reactors (PWRs). Using operating data, RCSLK9 determines the water inventories in the RCS and in leak collection tanks. By taking two sets of data separated by a time interval and applying RCSLK9, the inspector can obtain the gross leak rate for the RCS and the rate at which leakage is being collected.

Collected or identified leakage comes from components such as valves and seals. Uncollected or unidentified leakage may come from components or from thru-wall flaws in reactor coolant piping. This leakage spills on containment building floors and will reach the containment sump sooner or later, depending on the location of the leak and the rate. To determine the unidentified leak rate, RCSLK9 subtracts the identified leak rate from the gross leak rate.

Thru-wall flaws may gradually grow until the critical flaw size is exceeded. If that were to happen, it is conceivable that the flaw might suddenly extend resulting in rapid loss of coolant. To provide assurance that thru-wall flaws will be detected early, a limiting condition for operation (LCO) in PWR technical specifications addresses unidentified leakage from the RCS. If the source of leakage from the RCS is unknown, then it must be assumed that the source may be from a thru-wall flaw. The LCO for unidentified leak rate is 1 gpm for most PWRs. Identified leakage is from sources other than thru-wall flaws, and the LCO for this leakage is more lenient.

To apply RCSLK9 to a specific unit for the first time, it is first necessary to obtain certain information about the plant and enter this information in the computer's memory. Once that is done, RCSLK9 commands the computer to store the information indefinitely on the RCSLK9 PROGRAM diskette. RCSLK9 can then be used to analyze the leak tightness of the unit's cooling system at any time. At the inspector's option, a report of the analysis can be displayed on the computer's monitor or can be printed with a compatible printer.

RCSLK9 was adapted from RCSLK8 which was written in CBASIC for use with an Osborne 1 computer. The Osborne computer had been selected for this application because it was portable, had adequate internal memory and diskette storage space for RCSLK8, and was likely to meet the staff's needs for other independent measurement programs for some time to come. After procurement of IBM PCs was initiated for resident inspectors, RCSLK8 was translated from CBASIC to Microsoft BASIC for use with the PC.

Certain modifications were incorporated in the program to make it easier to use.

Appendices A through D are presented in the order of execution of the RCSLK9 program. Appendix E presents the derivation of the differential equation used in the program to integrate the volumes of partially-filled horizontal tanks. The remaining appendices (F,G, and H) present results obtained from execution of the program.

2 PWR COOLING AND COLLECTION SYSTEMS

RCSLK9 is applicable to all PWRs; however, the nomenclature in this discussion is appropriate for PWRs designed by Westinghouse. For other nuclear steam system suppliers, the term makeup and purification system may be used instead of chemical and volume control system (CVCS), the term pressurizer quench tank may be used instead of pressurizer relief tank, and the term makeup tank may be used instead of volume control tank. In addition, some PWR pressurizers relieve to a reactor drain tank and not to a separate relief or quench tank. Except for these nomenclature differences, the discussion which follows applies to any PWR.

During normal power operation, reactor cooling water is contained in the reactor coolant system (RCS) and the CVCS. The RCS consists of the reactor vessel, pressurizer, pumps, steam generators, and connecting piping. The CVCS consists of the volume control tank, tanks for purifying coolant, letdown heat exchanger, and connecting piping.

The only free suface normally present in the RCS is located in the pressurizer. The height or level of this surface relative to an arbitrary reference point is determined by measuring the pressure differential (delta-P) between two taps on the pressurizer. One is located near the bottom of the pressurizer, beneath the normal water level, and the other is located near the top of the pressurizer, above the normal level. Because temperature and hence the density of water in the pressurizer vary with time, delta-P provides only a rough measure of the water level. In some PWRs, the pressurizer level instrumentation is compensated for temperature changes to provide a more accurate measure of level.

In the CVCS, the only free surface normally present is in the volume control tank. The level measuring instrumentation for this tank is usually not temperature compensated. If other water surfaces are present in either the CVCS or the RCS and if the level of any such surfaces is not constant with time, RCSLK9 will not give valid results.

The distribution of water in the RCS and the CVCS can vary significantly because of changes in water levels in the pressurizer and the volume control tank and because of changes in water density as a result of temperature and pressure variations in the RCS. The CVCS operates at relatively constant temperature and pressure. Because RCSLK9 only addresses mass changes as a function of time, the CVCS, except for the volume control tank, is neglected by the program.

The mass of water in the RCS and CVCS can change significantly because of leaks and because water can be supplied to and withdrawn from these systems. Water can be supplied to the CVCS through a totalizer or flow integrator. The total volume supplied in any period of time is determined by reading the totalizer at the beginning and end of the period and taking the difference. Water also may be withdrawn from the system for sampling purposes. This volume can be measured directly.

Leakage from certain RCS components is collected in either the pressurizer relief tank or the reactor drain tank. However, at some plants, water from sources other than the RCS and CVCS may be piped to the reactor drain tank. These lines must be valved off during a leak rate test.

Water levels in the pressurizer relief and reactor drain tanks also are determined by measuring delta-Ps between upper and lower taps. The level instruments for these tanks are not temperature compensated. Generally, these tanks are cylindrical with convex heads. Often, the tanks are oriented so that their axes are horizontal.

Level instrumentation may be calibrated by pneumatically applying a range of delta-Ps across the level instrument and reading its response. The applied delta-P is converted to head of water by dividing the delta-P by the density of water at the normal operating temperature of the tank. This temperature is called the calibration temperature. Either the volume or the mass of water corresponding to this head is calculated and the calibration curve is plotted. This curve is usually a plot of water mass or volume versus indicated level in inches or percent of full range. Uncompensated level instrumentation and a correct mass calibration curve give accurate results for the mass of water in the tank at any temperature. Uncompensated level instrumentation and a correct volume calibration curve give accurate results for the volume of water in the tank only when the water is at the calibration temperature. The reverse is true for compensated level instrumentation.

For a vertical tank, the calibration curve is linear for the cylindrical portion of the tank, and usually, the cyclindrical portion of the tank is long relative to the height of the heads. For a horizontal tank, the calibration curve is, in principle, nonlinear; however, the central part of the curve is essentially linear. For some tanks, the normal operating range falls within the linear part of the calibration curve, and for others it does not. If not, the mass of water in the tank must be calculated from tank dimensions, water level, and water density.

3 WATER INVENTORIES AND SYSTEM LEAK RATES

3.1 Gross Leak Rate

To determine the gross leak rate of reactor cooling water from the RCS and the CVCS, the inventory (mass) of reactor cooling water is needed at the beginning and end of an arbitrary period of time. The water inventory can be found by dividing the RCS and CVCS into three regions. Each region contains water having approximately constant density everywhere within the region. The water volume of each region multiplied by the density of water within it gives the mass of water in that region.

RCSLK9 assumes that the hot and cold legs of the RCS have equal volumes. If this is true, the reactor vessel, steam generators, pumps and connecting piping can be taken as one region. Water density for the region can be calculated from the average of the hot and cold leg temperatures (T ave) and pressurizer pressure using "ASME Steam Tables," Fourth Edition. In RCSLK9, this region is referred to as the vessel and piping. The other two regions are the pressurizer and the volume control tank.

For a PWR operating at 2200 psia with T ave at 585 F, the conditions and density of the reactor cooling water in the three regions are:

Region	Conditions	Density (lb/cu ft)
Pressurizer	saturated	37.5
Vessel & Piping	subcooled, hot	44.4
Volume Control Tank	subcooled, ambient	62.0

The sum of the inventory changes for these three regions is equal to the uncorrected loss of water from the RCS and CVCS. The corrected loss of water is obtained by subtracting the mass of water charged through the totalizer and adding the mass drained for sampling or any other reasons.

Results of calculations of this kind are shown in the examples in Appendix H. Under TEST RESULTS in the left-hand column, inventory changes and corrections are tabulated. Inventory losses are indicated by negative signs. The corrected inventory change for the cooling system, that is for the combined RCS and CVCS, is given.

To find the gross leak rate for the cooling system, RCSLK9 divides the inventory loss in pounds by the product of the elapsed time between inventories and the density of water. The quotient is converted to gallons per minute.

In principle, the density of water at the point of leakage should be used to convert from mass leak rate to volume leak rate; however, because the point of leakage is not known, the density is not known. Further, limiting conditions for operation do not specify the value of density that should be used in converting mass leak rate to volume leak rate. RCSLK9 asks the user to arbitrarily select the conditions that determine the density. RCSLK9 then calculates the gross leak rate. The result of the gross leak rate calculation is shown under TEST RESULTS, which includes a footnote giving the value of water density that was used in converting from mass to volume.

The input required for calculating the gross leak rate is given under TEST DATA and under DURATION. Test data that are needed are pressurizer pressure and level, T ave, volume control tank level, and the volumes of water charged and drained.

In addition to these data, the values of certain plant-specific parameters are needed before the gross leak rate can be calculated. These parameters are:

(1) water volume of the reactor vessel, pumps, steam generators, and connecting piping, including the piping to the pressurizer;

(2) slopes of the linear portions of the calibration curves for the pressurizer and the volume control tank; and

(3) upper and lower level limits for the linear portions of the calibration curves.

In addition, the inspector will need to know whether the level instrumentation for the pressurizer is temperature compensated, the tank to which the pressurizer relieves, the units of measurement for the level instrumentation, and whether the normal operating range for the volume control tank falls within the linear portion of its calibration curve. If the normal operating range does not fall within the linear portion of the calibration curve and if the tank is cylindrical and horizontal, then the inside dimensions of the tank and the density of water at the calibration temperature will be needed. The water volume can then be calculated using the method described in Appendix E.

3.2 Identified Leak Rate

To determine the identified leak rate for the RCS and CVCS during the test, the amount of water collected in the pressurizer relief tank and the reactor drain tank must be calculated. Before beginning the test, the inspector must make certain that no drains other than RCS and CVCS drains are connected to the reactor drain tank. If leakage is collected from other systems, then the identified leak rate will be too large and the unidentified leak rate will be too small.

Water inventories for the pressurizer relief tank and the reactor drain tank are determined from measured levels and the tank calibration curves or tank dimensions. In the examples in Appendix H, changes in inventories for these tanks are shown under TEST RESULTS in the right-hand column. Inventory gains are positive.

To find the identified leak rate for the cooling system, RCSLK9 divides the combined inventory gain in pounds for the reactor drain tank and the pressurizer relief tank by the product of the elapsed time between inventories and the density of water. RCSLK9 uses the same value of water density that was selected for converting the gross leak rate from mass rate to volume rate. The quotient is converted to gallons per minute.

The test data required for calculating the identified leak rate are the water levels in the tanks and the test duration that are given under TEST DATA and DURATION.

In addition to test data, the values of certain plant-specific parameters are needed before the identified leak rate can be calculated. These parameters are:

(1) slopes of the linear portion of the calibration curve for the pressurizer relief and the reactor drain tanks and

(2) upper and lower level limits for the linear portions of the calibration curves.

In addition, the inspector will need to know the level units and may need the dimensions of the tanks and the density of water at the calibration temperatures.

3.3 Unidentified Leak Rate

The unidentified leak rate is calculated by subtracting the identified leak rate from the gross leak rate.

For the unidentified leak rate to be accurate to about 0.2 gpm, the following precautions must be taken:

(1) all drains to the reactor drain tank must be valved off, except drains from the RCS and CVCS;

(2) values of variables should not be rounded off;

(3) T ave must be read to the nearest 0.1 F; and

(4) the duration of the test must be 4 hours or more.

If the inspector calculates the unidentified leak rate using the same test data that the licensee has used and if the results differ by more than 0.2 gpm, the inspector should try to determine the cause of the discrepancy. Assistance can be obtained from the Office of Inspection and Enforcement. After the cause for the discrepancy is determined, corrective action should be taken.

4 CREATION AND FUNCTION OF RCSLK9 SOFTWARE

RCSLK9 was written for IBM PCs equipped with one double-sided disk drive and 64 kilobytes of random access memory or better. RCSLK9 is stored on two 5-1/4-inch diskettes. One diskette, labeled RCSLK9 PROGRAM, stores all the subroutines necessary to run RCSLK9. The other diskette, labeled RCSLK9 USER'S GUIDE, stores this document.

RCSLK9 PROGRAM contains COMMAND.COM (a PC DOS routine), BASIC.COM (Version D2.00), LOGO.BAS, RCSLK9.BAS, CALC.BAS, AUTOEXEC.BAT, L.BAT, R.BAT, DOCKLIST, and files of PWR parameters created by running RCSLK9. As supplied to the regions with this issue of the User's Guide, the parameter files written on the RCSLK9 PROGRAM diskette are 255, 266, 282, 295, 301, 304, 305, 306, 312, 315, 316, 317, 318, 320, 344, 346 and 348. These file names are the last three digits of the docket numbers for the indicated PWRs. Users can create additional parameter files and correct existing parameter files by running RCSLK9.BAS.

When the machine is turned on with the RCSLK9 PROGRAM diskette in Drive A, AUTOEXEC.BAT runs automatically. This routine loads BASIC.COM and runs LOGO.BAS, which displays an NRC logo, identifies the program, loads RCSLK9.BAS, and runs it. RCSLK9.BAS is the main leak rate program. In conjunction with CALC.BAS, DOCKLIST, and the parameter files, RCSLK9.BAS calculates leak rates and performs other related functions. If the machine has already been turned on, if the RCSLK9 PROGRAM diskette is inserted in Drive A, and if the the machine is reset by simultaneously pressing the Ctrl, Alt, and Del keys, AUTOEXEC.BAT also will run automatically.

RCSLK9.BAS can also be started in other ways. With the machine turned on and with the PC DOS prompt A> or B> displayed on the monitor, the RCSLK9 PROGRAM diskette can be placed in the designated drive and run by pressing the L key or the R key and then pressing the enter or return key. This action runs L.BAT or R.BAT. L.BAT starts the program from LOGO.BAS, and R.BAT starts it from RCSLK9.BAS.

When running under BASIC.COM, the space in RAM available for an applications program is 61 kilobytes. Because of the length of the leak rate program, it was necessary to break it into two parts, RCSLK9.BAS and CALC.BAS. These routines contain approximately 52 and 23 kilobytes, respectively, when stored in binary code. When necessary to complete a user's command, RCSLK9.BAS chains to CALC.BAS and CALC.BAS chains back again.

As supplied to the user, the RCSLK9 PROGRAM diskette contains files with BAS extensions that are stored in binary instead of ASCII. For this reason, these files are loaded into RAM much faster when AUTOEXEC.BAT, L.BAT, or R.BAT are executed.

The parameter files are sequential. DOCKLIST sorts and otherwise manages these files. If DOCKLIST is inadvertently damaged or erased, then this essential capability is lost. However, DOCKLIST can be recreated by responding to RCSLK9.BAS's Data and Analysis Menu with an unlisted command. The unlisted command is DOCKLIST.BAK. After it is executed, DOCKLIST is recreated automatically, and RCSLK9 is again usable. Further, the DOCKLIST file can be viewed directly by typing DOCKLIST in response to the Data and Analysis Menu.

Outputs from RCSLK9.BAS and CALC.BAS to the monitor are displayed at low intensity. If a display is not shown on the monitor when expected, the contrast control on the monitor should be turned clockwise.

The RCSLK9 USER'S GUIDE diskette was created using WORDSTAR (Release 3.30) in the document mode. The files contained on the diskette are FOREWORD, TEXT, APPENDIX.COV, and APPENDIX.A, B, C, D, E, F, G, and H. Using WORDSTAR and the RCSLK9 USER'S GUIDE diskette, this document can be viewed on the monitor or reprinted on the printer.

5 RCSLK9 PROGRAM DISKETTE

5.1 Messages and Options

After the RCSLK9 PROGRAM diskette is placed in Drive A and the machine is turned on, RCSLK9.BAS is automatically loaded into computer memory. RCSLK.BAS then reads the contents of DOCKLIST into memory and displays on the monitor a series of messages that identify the program, tell the user how to obtain help, and provide notes on computer control. The user is then given the option of directing output to a printer for documenting results or using the monitor for displaying results. Information from DOCKLIST is used later in managing plant parameter files.

Next, the Data and Analysis Menu is presented and lists the following choices:

(1) Calculate leak rates,
(2) List plant parameters,
(3) Store plant parameters,
(4) Correct plant parameters,
(5) Delete a plant parameter file,
(6) List plants with parameters on file,
(7) Turn printer on or off,
(8) Calculate water density, and
(9) Exit from the program.

If any of the first five choices are selected, the computer asks for the docket number, runs the appropriate subroutine, prompts the user for input as necessary, displays or prints the results, and then displays the menu again. If any of the other choices are selected, the computer performs in the same way, except that there is no request for a docket number.

5.2 Storing Plant Parameters

When the user elects to store plant parameters, the computer will then ask for the following information:

(1) Plant name,
(2) Unit number,
(3) Nuclear steam system supplier,
(4) Volume of the RCS,
(5) Whether or not the pressurizer level instrumentation is temperature compensated,
(6) Whether the pressurizer relieves to the pressurizer relief (or quench) tank or the reactor drain tank,
(7) Proper name of the volume control or makeup tank, and
(8) Whether the user wishes to enter the dimensions of any horizontal tanks.

If the pressurizer level instrumentation is temperature compensated, the computer will ask for the following additional information about the pressurizer:

(1) Nominal operating level and
(2) Pressurizer volumes above and below the nominal operating level.

For each tank including the pressurizer, the computer will ask for:

(1) Units for level measurement,
(2) Slope of the linear portion of the calibration curve for volume or mass versus level, and
(3) Upper and lower level limits of the linear portion of the calibration curve.

For all tanks except the temperature-compensated pressurizer, the computer will ask for the slope in pounds of water per unit level change. If the licensee's calibration curve is in volume of water per unit level change, the inspector will need to convert from volume to mass of water. That should be done by obtaining from the licensee the density of water assumed for the calibration and using that value to convert the slope from volume per unit level change to mass per unit level change.

If the user wishes to enter the dimensions of any horizontal tank, the computer will ask for:

(1) Radius and length of the cylindrical part of the tank,
(2) Radius of the heads of the tank, and
(3) Density of water at the calibration temperature.

The computer will then calculate the mass of water between the upper and lower limits of the straight line portion of the calibration curve in two different ways. First, it will do the calculation using the calibration curve (calibration method), and second, it will do the calculation using the tank dimensions and the water density at the calibration temperature (geometric method). The computer will take the ratio of the first result to the second, label the ratio as the normalization factor, display the normalization factor, and store it for future use. Whenever, the user directs the computer to calculate the water inventory in a tank by using the geometric method, the computer will multiply the result by the normalization factor.

After keying each information item into the computer in response to its requests, the user must strike the RETURN key in order to continue. Once the RETURN key is struck, the entry cannot be corrected until after the plant parameter entry session is completed.

After values have been entered for each of the parameters, the computer creates a file and a file name for the parameter set. The file name is the last three digits, including any leading zeros, of the docket number. The computer stores the file on the RCSLK9 PROGRAM diskette. The computer also adds the docket number, plant name, and unit number to DOCKLIST, which is used in managing the parameter files.

When the user returns to the Data and Analysis Menu, corrections can be made with ease by invoking the correction subroutine. Before doing this, the user may want to list the plant parameters as entered. All values of parameters that are now stored on the RCSLK9 PROGRAM diskette are shown in Appendix G.

Users should note that, except for Three Mile Island 2, pressurizer volumes above nominal levels have not been stored for temperature-compensated pressurizers. For other PWRs with temperature-compensated pressurizers, the staff has assumed that there is zero volume above the nominal operating level. This is not correct and requires a correction to plant parameter files. Running the leak rate calculation for the example in Appendix H for Three Mile Island 2 with zero volume above the nominal level causes a 40% error in the inventory change for the pressurizer.

After completing this subroutine, the computer returns to the Data and Analysis Menu.

5.3 Correcting Plant Parameters

For a specific plant and unit, the subroutine for correcting plant parameters may be used at any time after the parameter file has been created. After the user is presented with the Data and Analysis Menu and directs the computer to go to the corrections subroutine, the computer first asks for the docket number. The computer then searches for the parameter file. If the file exists, the computer opens the file for input to the computer and reads the values stored on the RCSLK9 PROGRAM diskette into computer memory. If the file does not exist, the computer so states and asks for instructions.

After opening the file, the computer displays the Group Access Menu. The groups on this menu are:

(1) Unit identification,
(2) Vessel and piping,
(3) Pressurizer,
(4) Volume control (or makeup) tank,
(5) Reactor drain tank, and
(6) Relief (or quench) tank.

The user can select any group containing parameters that require correction, or the user can exit to the Data and Analysis Menu. If, for example, the user selects the reactor drain tank, the computer will present a menu that lists the following parameters and displays the current value of each parameter.

(1) Level units,
(2) Slope of the calibration curve,
(3) Upper and lower level limits for the curve,
(4) Whether the geometric method is available,
(5) Radius and length of the cylindrical part of the tank,
(6) Radius of the head, and
(7) Water density at the calibration density.

After the user selects the parameter to be corrected, the computer displays the original message requesting input of the value of that parameter. After the user responds, the computer again displays the menu and shows the new value of the parameter. For geometric method parameters, the computer also calculates or recalculates, displays, and stores the normalization factor. The user can then correct another parameter in the same group or return to the Group Access Menu. When the user exits from the correction subroutine, the corrected parameter set is rewritten to the program diskette.

RCSLK9.BAS permits the user to change the docket number of a plant parameter file. If this is done, a new file is created with the new docket number and the parameter values of the old file before the old file is destroyed.

If the user exits from the program while in the corrections mode, by simultaneously pressing the Ctrl and Break keys, then the corrected values of the parameters will be lost. The user should not break from the program while in the corrections mode. Instead, the user should return to the Data and Analysis Menu and select the exit option.

5.4 Listing Plant Parameters

By selecting from the Data and Analysis Menu the option for listing the values of plant parameters, the user can obtain a list for any unit for which a file has been created. The list either can be printed or displayed on the monitor. If it is displayed on the monitor, the computer will list the parameters on the screen until it fills the screen and then stops listing until the user directs the computer to resume. When the list is completed, the computer will return to the Data and Analysis Menu.

5.5 Identifying Plants With Parameters on File

When the options menu is displayed, the user can direct the computer to search the DOCKLIST file for all units for which parameter files have been created. The computer will respond by displaying the docket number, plant name, and unit number for each unit after sorting by docket number in ascending order. If plant name and unit number are not displayed, then a file for that unit does not exist. A list of parameter files on the RCSLK9 PROGRAM diskette when supplied with the User's Guide is given in Appendix F.

5.6 Calculating Leak Rates

After a parameter file has been created for a specific plant unit, the leak tightness of the RCS and CVCS can be analyzed by calculating the gross, identified, and unidentified leak rates. When the leak rate (data analysis) subroutine of RCSLK9.BAS is initiated, the computer first asks for the last three digits of the docket number and checks to make certain that the plant parameters are on file. If so, the values of the plant parameters are read into computer memory. Otherwise, an error message is displayed. RCSLK9.BAS then reads CALC.BAS into computer memory and transfers control of the computer to CALC.BAS.

CALC.BAS first asks for the test date and the start time for the test. This information is obtained for a printed report and for archival purposes. The user should note that test data are not saved on the diskette. The computer then asks for the duration of the test in hours. Because the accuracy of the test is directly proportional to the test duration, the minimum duration should be 4 hours.

After the duration is entered, the computer asks for the volumes of water charged and drained, that is, the amount of makeup water added to the volume control tank through the totalizer and the amount of water drained for sampling or other purposes. If leakage is being collected in a bucket for example, as identified leakage that volume should not be entered here. That would underestimate the identified leak rate. Instead, a penciled correction to identified and unidentified leak rates will be necessary after the computer run is completed.

The computer then checks the parameter file for the unit to determine whether dimensions are available for any of the tanks. If dimensions are available, the computer asks whether the user wishes to use the geometric method or the calibration method for determining the water inventories in these tanks. Selecting the geometric method will ensure that errors are not introduced by applying the calibration method when water level data are above or below the linear portion of the calibration curve.

Next, the computer asks for the initial and final values of the system variables, T ave and pressurizer pressure. Further, the computer indicates the permissible range of values of these parameters. Computed densities for other values will not be accurate. For T ave, the range is from 32 to 662 F. If the pressurizer level instrumentation is not temperature compensated, the pressure range is from the hot leg saturation pressure to 3200 psia. In other words, the analysis is accurate provided that there is no boiling in the hot leg. For compensated pressurizers, the pressure range is from 1400 psia (or hot leg saturation pressure, whichever is greater) to 2700 psia.

After asking for the system variables, the computer asks for the initial and final values of the water level in each tank in appropriate units. The computer displays the permissible range for water level data and uses appropriate tank nomenclature when asking for these data. If the system being analyzed does not have a pressurizer relief or quench tank, then the computer does not ask for those data.

When entry of input data is complete, the computer displays the input data on the monitor. The user may change input data by typing in the identification number for the parameter to be changed, and then entering the correct value. The display will be updated after each entry until the user enters 0 to signal that the values of input data are correct. When data correction is completed, the computer calculates the initial and final water inventories for the vessel and piping, for the pressurizer, for the volume control tank, and for each of the leakage collection tanks.

The water inventory in the vessel and piping is calculated from their combined volume and the average density of subcooled water. If there is a bubble in the vessel, the calculation will not be accurate. To determine the density of water in the vessel and piping, the computer runs the subroutine, Density of Water, shown in the Data Analysis section of Appendix D. This subroutine when appropriately formatted exactly reproduces the specific volume of subcooled water given in Table 3 of "ASME Steam Tables," Fourth Edition, for temperatures from 32 to 662 F and pressures from saturation to 14,000 psia.

The water inventory in temperature-compensated pressurizers is found by calculating the mass of water and the mass of steam in the pressurizer. The mass of water is found by assuming that it is saturated. The computer finds the saturation temperature of the water by running the subroutine, Saturation Temperature, shown in the Data Analysis section of Appendix D. This is an iterative subroutine which duplicates the values given in Table 2 of the steam tables for pressures from 14.7 psia to 3208.2 psia. The density of saturated water is found by substituting pressurizer pressure and the saturation temperature in the subcooled water subroutine. The density of saturated steam is found from the subroutine, Density of Saturated Steam. This is a curve fit to the steam tables with an accuracy of 1.0% or better in the range from 1400 to 2700 psia.

The inventories for other tanks are calculated from either the calibration curves or from the tank dimensions and the appropriate density. The rest of the analysis is performed as described in the section of the User's Guide titled Water Inventories and System Leak Rates.

After the analysis is completed, a report of the results is displayed on the monitor or is printed with the printer. The user then has the option to terminate the session or return to the Data and Analysis Menu in RCSLK9.BAS.

5.7 Calculating Water Density

Option (g) of the main options menu allows the user to calculate the density of subcooled water. The user first inputs the pressure, from which RCSLK9 calculates the saturation temperature. The user then enters the water temperature up to saturation temperature and both specific volume and density are displayed on the screen.

5.8 Deleting a Plant Parameter File

The user has the option, from the Data and Analysis Menu in RCSLK9.BAS, to delete a plant parameter file entirely. In addition to deleting the file, RCSLK9.BAS also updates DOCKLIST which is necessary for proper management of plant parameter files. The adventurous user can delete a plant parameter file by loading PC DOS and executing ERASE or by loading BASIC and executing KILL. However, if the user subsequently tries to restore the diskette to its original configuration, difficulties may be encountered.

5.9 Exiting From the Program

From the Data and Analysis Menu and other menus in RCSLK9.BAS, the user has the option to exit from the program. The program will ask if the user wishes to terminate the session. If so, the user can exit to the SYSTEM, that is to PC DOS, or to BASIC to run other BASIC programs. Usually, the user will exit to the SYSTEM and turn the machine off.

6 PROCEDURE

6.1 Running the Program

The following steps should be performed to run the program:

(1) To prepare to run RCSLK9, open the latch on the left disk drive (Drive A) and place the RCSLK9 PROGRAM diskette in the drive. The label of the diskette should be facing up, out, and to the right.

(2) Latch the drive. Turn on the computer.

(3) To run RCSLK9, follow the instructions displayed on the moniter.

(4) When the session is completed, turn off power to the printer, if it was used, and then the computer.

(5) Remove the diskette from the drive.

CAUTION

> Never remove a diskette from a drive while the red light is on. Loss of program or data may result.

6.2 Displaying the User's Guide

If WORDSTAR is available, the following steps can be performed to display the user's guide on the monitor:

(1) Place the WORDSTAR Diskette in drive A and the RCSLK9 USER'S GUIDE diskette in Drive B. Latch the drives.

(2) If the computer is not on, turn it on. If the A> prompt is displayed on the monitor, type WS. If the OK prompt is displayed, type SYSTEM to escape from BASIC and then type WS when the A> prompt appears. After typing WS, press the ENTER key (the broken left arrow key).

(3) The WORDSTAR Opening Menu will appear on the monitor.

(4) Press the L key. At the prompt message, press the B key and then the ENTER key. The directory for the RCSLK9 USER'S GUIDE will appear on the monitor.

(5) Press the D key. At the prompt message, type the name of any file listed in the directory. That file will be displayed on the monitor.

(6) Page through the file by pressing the Pg Dn and Pg Up keys.

(7) Terminate the session by holding down the CTRL key and pressing first the K key and then the Q key. Wait, then press the X key.

(9) After the B> prompt is displayed and the red lights for both drives are dark, remove the diskettes and turn the power off.

APPENDIX A

BATCH ROUTINES

Autoexec.bat

```
1:#BASIC LOGO/D
```

L.bat

```
1:#BASIC LOGO/D
```

R.bat

```
1:#BASIC RCSLK9/D
```

APPENDIX B

LOGO.BAS

```
10 '                                        ********
20 '                                        * LOGO *
30 '                                        ********
40 '
50 '                                        ** N **
60 '
70 N$="***" : CLS : COLOR 15,8
80 FOR I%=5 TO 13           : LOCATE I%,21    : PRINT N$ : LOCATE I%,29       : PRINT N$
90                          : LOCATE I%,I%+16 : PRINT N$                                 : NEXT I%
100 FOR I%=1 TO 200 : X=X+1 : NEXT I%
110 '
120 '
130 '                                       ** R **
140 '
150 FOR I%= 5 TO 13          : LOCATE I%,35    : PRINT N$                                 : NEXT I%
160 FOR J%= 9 TO 13          : LOCATE J%,J%+32 : PRINT N$                                 : NEXT J%
170 FOR K%=35 TO 41 STEP 2   : LOCATE  5,K%    : PRINT N$ : LOCATE  9,K%       : PRINT N$ : NEXT K%
180 FOR L%=5 TO 7            : LOCATE L%,37+L% : PRINT N$ : LOCATE 14-L%,37+L% : PRINT N$ : NEXT L%
190 FOR I%=1 TO 200          : X=X+1                                                      : NEXT I%
200 '
210 '
220 '                                       ** C **
230 '
240 FOR I%=52 TO 58  STEP 2 : LOCATE 5,I%     : PRINT N$ : LOCATE 13,I%       : PRINT N$ : NEXT I%
250 FOR J%=5 TO 13          : LOCATE J%,50    : PRINT N$                                 : NEXT J%
260                           LOCATE 5+1,58   : PRINT N$ : LOCATE 13-1,58     : PRINT N$
270 FOR I%=1 TO 300         : X=X+1                                                      : NEXT I%
280 '
290 '
300 '                                       ** I D **
310 '
320 LOCATE 16 : PRINT TAB(25) "INDEPENDENT MEASUREMENTS PROGRAM" : FOR I%=1 TO 300 : X=X+1 : NEXT I%
330 LOCATE 18 : PRINT TAB(24) "U.S. Nuclear Regulatory Commission"
340 LOCATE 19 : PRINT TAB(23) "Office of Inspection and Enforcement"
350 LOCATE 20 : PRINT TAB(29) "Washington, D.C.   20555" : FOR I%=1 TO 400 : X=X+1 : NEXT I%
360 LOCATE 1,1: PRINT "RCSLK9" : FOR I%=1 TO 300 : X=X+1 : NEXT I%
370 '
380 COLOR 15,8 : LOCATE 23,53,0 : PRINT " To continue, press any "; : COLOR 16,15 : PRINT "key"; : COLOR 15,8
390 PRINT ".";
400 Z$=INKEY$ : IF Z$="" THEN 400
410 '
420 '
430 '                                     ** BRIDGE **
440 '
450 CLS : LOCATE 12,29 : PRINT "RCSLK9 IS BEING LOADED" : RUN "RCSLK9"
460 END
```

APPENDIX C

RCSLK9.BAS

TABLE OF CONTENTS

TABLE OF CONTENTS Continued

```
10   '                                   **************
20   '                                   ** RCSLK9.BAS **
30   '                                   **************
40   '
50   DEFDBL A-Z : DIM X%(80),D$(80),P$(80),U$(80),BB(45),BB$(15),F(1) : KEY OFF : ON ERROR GOTO 130
60   COLOR 7,0 : CLS : OPEN "SCRN:" FOR OUTPUT AS #2 : GOTO 360
70   '
80   '
90   '                                  *****************
100  '                                  * PRELIMINARIES *
110  '                                  *****************
120  '
130  '                                   ** ERROR TRAP **
140  '
150  '                              * File Not Found Errors *
160  '
170  IF ERR=53 AND ERL=360 THEN OPEN "DOCKLIST" FOR OUTPUT AS #3 : WRITE #3,"000","NONE","0" ELSE 190
180  CLOSE #3 : RESUME :                                         REM: DOCKLIST not on disk
190  IF ERR=53 AND ERL=11260 THEN RESUME 11290 :                 REM: DOCKLIST backup routine search
200  IF ERR=53 AND (ERL=4890 OR ERL=5980 OR ERL=9040) THEN NUM.PLANTS.ON.FILE=NUM.PLANTS.ON.FILE-1 ELSE 260
210  FOR I%=N% TO NUM.PLANTS.ON.FILE : D$(I%)=D$(I%+1) : P$(I%)=P$(I%+1) : U$(I%)=U$(I%+1) : NEXT I%
220  OPEN "DOCKLIST" FOR OUTPUT AS #3 : FOR I%=0 TO NUM.PLANTS.ON.FILE : WRITE #3, D$(I%),P$(I%),U$(I%)
230  NEXT I% : CLOSE #3 : RESUME 1430 :                          REM: File not found, DOCKLIST revised
240  '
250  '
260  '                                   * Printer Errors *
270  '
280  IF ERR=24 OR ERR=25 OR ERR=27 THEN 290 ELSE 310
290  CLS : LOCATE 12,17 : COLOR 7,0 : PRINT "Check printer power, Online switch, and paper." : RESUME
300  '                                                           REM: Printer not online or out of paper
310  ON ERROR GOTO 0                                             REM: All other errors stop program
320  '
330  '
340  '                                   ** DOCKET LIST **
350  '
360  OPEN "DOCKLIST" FOR INPUT AS #3
370  IF EOF(3) THEN 390
380  INPUT #3 ,DOCKET$,PLANT$,UNIT$ : D$(I%)=DOCKET$ : P$(I%)=PLANT$ : U$(I%)=UNIT$ : I%=I%+1 : GOTO 370
390  CLOSE #3 : NUM.PLANTS.ON.FILE = I%-1
400  '
410  '
420  '                                   **  MESSAGES  **
430  '
440  L= 7 : C=24 : GOSUB 500 : F=28        : GOSUB 990 : CLS
450  L= 2 : C= 3 : GOSUB 500 : M= 9 : D=33 : GOSUB 610 : F=52        : GOSUB 990 : CLS
460  L= 2 : C=43 : GOSUB 500 : M= 5 : D=32 : GOSUB 610 : N= 9 : E= 1 : GOSUB 740 : F=52 : GOSUB 990 : CLS
470  M=-1 : D=31 : GOSUB 610 : N= 3 : E= 1 : GOSUB 740 : L=14 : C=31 : GOSUB 890 : F=27 : GOSUB 990
480  GOTO 1070
490  '
```

```
500   COLOR 0,7
510   LOCATE L+1,C : PRINT "                                        "
520   LOCATE L+2,C : PRINT "                 RCSLK9                 "
530   LOCATE L+3,C : PRINT "                                        "
540   LOCATE L+4,C : PRINT "        REACTOR COOLANT SYSTEM          "
550   LOCATE L+5,C : PRINT "       LEAK RATE  DETERMINATION         "
560   LOCATE L+6,C : PRINT "                FOR PWRs                "
570   LOCATE L+7,C : PRINT "                                        "
580   LOCATE L+8,C : PRINT "           DECEMBER 1, 1984             "
590   LOCATE L+9,C : PRINT "                                        " : RETURN
600
610   COLOR 7,0
620   LOCATE M+ 2,D : PRINT " * * * * * * * * * **** * * * * * * * * * "
630   LOCATE M+ 3,D : PRINT " *                                     * "
640   LOCATE M+ 4,D : PRINT " *            For help, call:          * "
650   LOCATE M+ 5,D : PRINT " *                                     * "
660   LOCATE M+ 6,D : PRINT " *  Roger Woodruff     (301) 492-4507  * "
670   LOCATE M+ 7,D : PRINT " *  Don Kirkpatrick    (301) 492-4510  * "
680   LOCATE M+ 8,D : PRINT " *                                     * "
690   LOCATE M+ 9,D : PRINT " *     After working hours, call on    * "
700   LOCATE M+10,D : PRINT " *           (301)  492-7000           * "
710   LOCATE M+11,D : PRINT " *                                     * "
720   LOCATE M+12,D : PRINT " * * * * * * * * * **** * * * * * * * * * " : RETURN
730   '
740   COLOR 0,7
750   LOCATE N+ 1,E : PRINT "                                                   "
760   LOCATE N+ 2,E : PRINT "                       NOTE                        "
770   LOCATE N+ 3,E : PRINT "                                                   "
780   LOCATE N+ 4,E : PRINT " 1  To delete input characters,  press the left    "
790   LOCATE N+ 5,E : PRINT "    arrow key in the top row of keys.              "
800   LOCATE N+ 6,E : PRINT "                                                   "
810   LOCATE N+ 7,E : PRINT " 2. To halt execution, simultaneously press Ctrl   "
820   LOCATE N+ 8,E : PRINT "    and Num Lock.  To restart, press any key.      "
830   LOCATE N+ 9,E : PRINT "                                                   "
840   LOCATE N+10,E : PRINT " 3. To escape from the program,  simultaneously    "
850   LOCATE N+11,E : PRINT "    press CTRL and Scroll Lock; however, loss of   "
860   LOCATE N+12,E : PRINT "    data may result.                               "
870   LOCATE N+13,E : PRINT "                                                   " : RETURN
880   '
890   COLOR 7,0
900   LOCATE L+1,C : PRINT " * * * * * * * * * * * * * * * * * * * * * * * * *"
910   LOCATE L+2,C : PRINT " *                ENTERING INSTRUCTIONS           *"
920   LOCATE L+3,C : PRINT " *                                                *"
930   LOCATE L+4,C : PRINT " * In the next frame,  you  will be asked to re-  *"
940   LOCATE L+5,C : PRINT " * spond with yes or no.   Press Y or N and then  *"
950   LOCATE L+6,C : PRINT " * the "; : COLOR 0,7 : PRINT " ENTER "; : COLOR 7,0
960   PRINT " key (the broken left arrow key).  *"
970   LOCATE L+7,C : PRINT " * * * * * * * * * * * * * * * * * * * * * * * * *" : RETURN
980   '
990   COLOR 0,7 : LOCATE 23,F,0 : PRINT " To continue, press any "; : COLOR 16,7 : PRINT "key"; : COLOR 0,7
1000  PRINT "." : COLOR 7,0
1010  Z$=INKEY$ : IF Z$="" THEN 1010
1020  RETURN
```

```
1030 '                                      !!!!!!!!!!!!!!!!!!!!!!
1040 '                                      ! OPTION SELECTIONS !
1050 '                                      !!!!!!!!!!!!!!!!!!!!!!
1060 '
1070 '                                          !! PRINTER !!
1080 '
1090 CLS : N= 1 : E=22 : GOSUB 740 : L=12 : C=1: GOSUB 890 : M=18 : D=38 : COLOR 0,7
1100 LOCATE M+1,D : PRINT "                                        "
1110 LOCATE M+2,D : PRINT "   Will you use the printer during this   "
1120 LOCATE M+3,D : PRINT "   session ("; : COLOR 16,7 : PRINT "Y/N"; : COLOR 0,7
1130               PRINT ")
1140 LOCATE M+4,D : PRINT "                                        " : LOCATE M+3,D+16 : INPUT PRINT.FLAG$
1150 COLOR 7,0
1160 '
1170 IF PRINT.FLAG$="y" THEN PRINT.FLAG$="Y"
1180 IF PRINT.FLAG$<>"Y" AND PRINT.FLAG$<>"N" AND PRINT.FLAG$<>"n" THEN COLOR 7,0 :CLS :COLOR 0,7 :GOTO 1100
1190 '
1200 '
1210 '                                 !! DATA AND ANALYSIS MENU !!
1220 '
1230 DEFDBL A-Z : CLS : LOCATE 7,20 : PRINT "You have the following options:" : PRINT
1240 PRINT TAB(22) "(A) Calculate leak rates,"          : PRINT TAB(22) "(B) List plant parameters,"
1250 PRINT TAB(22) "(C) Store plant parameters,"        : PRINT TAB(22) "(D) Correct plant parameters,"
1260 PRINT TAB(22) "(E) Delete a plant parameter file,"
1270 PRINT TAB(22) "(F) List plants with parameters on file,"
1280 PRINT TAB(22) "(G) Turn printer on or off,"        : PRINT TAB(22) "(H) Calculate water density, or"
1290 PRINT TAB(22) "(I) Exit from program."              : PRINT
1300 PRINT TAB(20) "Which would you like (A/B/C/D/E/F/G/H/I)"; : INPUT X$
1310 '
1320 FOR I%=1 TO 14 : BB$(I%)="" : NEXT I% : FOR I%=15 TO 45 : BB(I%)=0 : NEXT I%
1330 '
1340 IF X$="A" OR X$="a" OR X$="B" OR X$="b" OR X$="C" OR X$="c" THEN 1400
1350 IF X$="D" OR X$="d" OR X$="E" OR X$="e"                     THEN 1400
1360 IF X$="F" OR X$="f" THEN  1510 ELSE IF X$="G" OR X$="g" THEN 1080 ELSE IF X$="H" OR X$="h" THEN 1970
1370 IF X$="I" OR X$="i" THEN 10690 ELSE IF X$="DOCKLIST" OR X$="docklist" THEN 11030
1380 IF X$="DOCKLIST.BAK" OR X$="docklist.bak" THEN 11150 ELSE 1210
1390 '
1400 CLS : LOCATE 12,16 : PRINT "Type the last three digits of the docket number"; : INPUT ": ",DOCKET$
1410 FOR N%=1 TO NUM.PLANTS.ON.FILE   : IF DOCKET$ =D$(N%) THEN 1460 ELSE NEXT N%
1420 IF X$="C" OR X$="c" THEN 2090
1430 CLS : LOCATE 12,29 : COLOR 16,7  : PRINT; "ERROR"; : COLOR 7,0 : PRINT "  File does not exist. "
1440 GOTO 10690 :                                            REM: Continuation or Termination
1450 '
1460 IF X$="A" OR X$="a" THEN 8940 ELSE IF X$="B" OR X$="b" THEN 4860 ELSE IF X$="C" OR X$="c" THEN 2090
1470 IF X$="D" OR X$="d" THEN 5950 ELSE IF X$="E" OR X$="e" THEN 10880 ELSE 1300
```

```
1480 '                                  ***************
1490 '                                  * PLANT LIST *
1500 '                                  ***************
1510 '
1520 '                                ** INTRODUCTION **
1530 '
1540 CLS : IF NUM.PLANTS.ON.FILE=0 THEN LOCATE 12 : PRINT TAB(26) "There are no plants on file" : GOTO 10700
1550 '                                                          REM: Continuation or Termination
1560 IF PRINT.FLAG$= "Y" THEN PRINT.FLAG%=1 : CLOSE #2 : OPEN "LPT1:" FOR OUTPUT AS #2
1570 IF PRINT.FLAG$<>"Y" THEN PRINT.FLAG%=2 : ROW%=5
1580 '
1590 PRINT #2, " " : PRINT #2, " " : PRINT #2, " "
1600 PRINT #2, TAB(25) "Plants With Parameters on File" : PRINT #2, " "
1610 '
1620 '
1630 '                                     ** SORT **
1640 '
1650 X%(1)=VAL(D$(1))
1660 FOR I% = 2 TO NUM.PLANTS.ON.FILE : X%(I%)=VAL(D$(I%))
1670 IF X%(I%)=>X%(I%-1) THEN 1720 ELSE IF X%(I%)<=X%(1) THEN J%=1 : GOTO 1690 ELSE J%=I%/2 : U%=I% : L%=0
1680 IF X%(I%) <= X%(J%) AND X%(I%) > X%(J%-1) THEN 1690 ELSE 1700
1690 HOLD% = X%(I%) : FOR K%=I% TO J%+1 STEP -1: X%(K%) = X%(K%-1) : NEXT K% : X%(J%) = HOLD% : GOTO 1720
1700 IF X%(I%) > X%(J%) THEN L%=J% : J%=J%+(U%-J%)/2 ELSE U%=J% : J%=J%-(J%-L%)/2
1710 GOTO 1680
1720 NEXT I%
1730 '
1740 '
1750 '                                   ** DISPLAY **
1760 '
1770 FOR I%=1 TO NUM.PLANTS.ON.FILE : FOR J%=1 TO NUM.PLANTS.ON.FILE
1780 IF X%(I%)=VAL(D$(J%)) THEN ON PRINT.FLAG% GOTO 1870,1880
1790 NEXT J%
1800 NEXT I%
1810 '
1820 IF PRINT.FLAG$="Y" THEN LPRINT CHR$(12)
1830 LOCATE 21,31 : PRINT "End of Plant List" : GOSUB 10620 :       REM: Interrupt
1840 CLOSE #2 : OPEN "SCRN:" FOR OUTPUT AS #2
1850 '
1860 PAGE.LINE%=0 : CLS : GOTO 1210                         REM: Data and Analysis Menu
1870 PRINT #2,TAB(30) "50-"; D$(J%); "  "; P$(J%); " "; U$(J%) : GOTO 1800
1880 ROW%=ROW%+1 : IF ROW%<19 THEN 1920
1890 ROW%=5 : GOSUB 10620 :                      REM: Interrupt
1900 '
1910 CLS : LOCATE 3,24 : PRINT"Plant List Continued ..."
1920 LOCATE ROW%,30 : PRINT "50-"; D$(J%); " "; P$(J%); " "; U$(J%) : GOTO 1800
```

```
1930 '                              ##################
1940 '                              # WATER DENSITY #
1950 '                              ##################
1960 '
1970 CLS : LOCATE 11,17 : PRINT "Type pressure (0.12 to 15,500) in psia -> "; : INPUT "", PRES
1980 IF PRES<2398.2 THEN GOSUB 9110  ELSE TEMP.SAT=662 :            REM: Saturation Temperature
1990 CLS : LOCATE 11,14 : PRINT "Type temperature (32 to "; : PRINT USING "###.##"; TEMP.SAT;
2000 INPUT ") in degrees F -> ",TEMP
2010 GOSUB 9340 : CLS :                                             REM: Density of Water
2020 LOCATE 11,19 : PRINT "Specific Volume is "; : PRINT USING "#.#####"; SPECIFIC.VOL;
2030 PRINT " cubic foot/pound"
2040 PRINT TAB(19) "and density is "; : PRINT USING "##.##"; DENSITY.WTR; : PRINT " pounds/cubic foot"
2050 PRINT TAB(19) "at"; TEMP; "degrees F and"; PRES; "psia."
2060 LOCATE 18,13 : PRINT "Do you need water density at other "; : PRINT "conditions (Y/N)"; : INPUT X$
2070 IF X$="Y" OR X$="y" THEN 1940 ELSE IF X$="N" OR X$="n" THEN CLS : GOTO 1210 ELSE 2060
```

```
2080 '                                 *****************************
2090 '                                 * ENTRY OF PLANT PARAMETERS *
2100 '                                 *****************************
2110 '
2120 '
2130 IF N% > NUM.PLANTS.ON.FILE THEN 2250
2140 '
2150 CLS : LOCATE 11,16 : COLOR 16,7 : PRINT " CAUTION "; : COLOR 7,0
2160 PRINT " Parameter File 50-" ; DOCKET$; " exists.  If you"
2170 PRINT TAB(26); "wish to preserve the existing file,"
2180 PRINT TAB(26); "return to the options menu."
2190 LOCATE 20,16 : PRINT "Do you wish to return to the options menu "; : COLOR 16,7 : PRINT"(Y/N)";
2200 COLOR 7,0    : INPUT X$
2210 '
2220 IF X$="Y" OR X$="y" THEN 1210 ELSE IF X$<>"N" AND X$<>"n" THEN 2150
2230 '
2240 '
2250 '                                   ** UNIT IDENTIFICATION **
2260 '
2270 GOSUB 2310 : BB$(1)=PLANT$ : GOSUB 2370 : BB$(2)= UNIT$
2280 GOSUB 2420 : BB$(3)=NSSS$  : GOTO 2560
2290 '
2300 '
2310 '                                         * Plant Name *
2320 '
2330 CLS : LOCATE 12,12 : PRINT "Type plant name (excluding unit number) ->"; : INPUT " ",PLANT$
2340 RETURN
2350 '
2360 '
2370 '                                        * Unit Number *
2380 '
2390 CLS : LOCATE 12,29 : PRINT "Type unit number ->"; : INPUT " ",UNIT$ : RETURN
2400 '
2410 '
2420 '                                * Nuclear Steam System Supplier *
2430 '
2440 CLS : LOCATE 10
2450 PRINT TAB(24) "The nuclear steam system suppliers are " : PRINT
2460 PRINT TAB(26) "(1) Babcock & Wilcox," : PRINT TAB(26)"(2) Combustion Engineering, and"
2470 PRINT TAB(26) "(3) Westinghouse."   : PRINT
2480 PRINT TAB(24) "Who supplied the system (1/2/3)"; : INPUT X$
2490 '
2500 CLS
2510 IF X$="1" THEN NSSS$= "Babcock & Wilcox"       : RETURN
2520 IF X$="2" THEN NSSS$= "Combustion Engineering" : RETURN
2530 IF X$="3" THEN NSSS$= "Westinghouse"           : RETURN ELSE 2440
2540 '
2550 '
2560 '                                     ** VESSEL AND PIPING **
2570 '
2580 GOSUB 2600 : BB(45)=VP.VOL : GOTO 2670
2590 '
2600 CLS : LOCATE 10
2610 PRINT TAB(16) "Type the water volume in cubic feet for the reactor vessel"
```

```
2620  PRINT TAB(16) "pumps and connected piping, including piping to the  pres-"
2630  PRINT TAB(16) "surizer  and the inlet side of the letdown heat exchanger." : LOCATE 14,37
2640  INPUT " -> ",VP.VOL : RETURN
2650  '
2660  '
2670  '                                     ** PRESSURIZER **
2680  '
2690  CLS : TANK$="Pressurizer" :GOSUB 3960 : BB$(5)=UNITS$ : PZR.UNITS$=UNITS$ :GOSUB 2780 : BB$(6)=PZR.COMP$
2700  IF PZR.COMP$="No" THEN 2740
2710  '
2720  GOSUB 2890 : GOSUB 2980 : GOSUB 3030 : BB(39)=PZR.LVL.NOM : BB(34)=PZR.BTM.VOL : BB(28)=PZR.TOP.VOL
2730  '
2740  GOSUB 4080 : BB(24)=SLOPE  : PZR.SLOPE =SLOPE  : GOSUB 4180 : BB(18)=UP.LMT : PZR.UP.LMT=UP.LMT
2750  GOSUB 4230 : BB(35)=LO.LMT : PZR.LO.LMT=LO.LMT : GOSUB 3070 : GOTO 3190
2760  '
2770  '
2780  '                               * Temperature Compensation *
2790  '
2800  CLS : LOCATE 10
2810  PRINT TAB(24) "Pressurizer level instrumentation may be " : PRINT
2820  PRINT TAB(26) "(1) Temperature Compensated or"
2830  PRINT TAB(26) "(2) Uncompensated." : PRINT
2840  PRINT TAB(24) "Which is it (1/2)"; : INPUT Y$
2850  '
2860  IF Y$="1" THEN PZR.COMP$="Yes" : RETURN ELSE IF Y$="2" THEN PZR.COMP$="No"  : RETURN ELSE 2780
2870  '
2880  '
2890  '                                     * Nominal Level *
2900  '
2910  CLS : LOCATE 11,20 : PRINT "For the pressurizer, type the nominal operating"
2920  IF PZR.UNITS$="%" THEN 2950
2930  '
2940  PRINT TAB(20) "level in inches"; : INPUT " -> ",PZR.LVL.NOM : RETURN
2950  PRINT TAB(20) "level in %";      : INPUT " -> ",PZR.LVL.NOM : RETURN
2960  '
2970  '
2980  '                                        * Volumes *
2990  '
3000  CLS : LOCATE 11 : PRINT TAB(20) "Type the Pressurizer volume in cubic feet below"
3010              PRINT TAB(20) "the nominal level"; : INPUT " -> ",PZR.BTM.VOL : RETURN
3020  '
3030  CLS : LOCATE 11 : PRINT TAB(20) "Type the Pressurizer volume in cubic feet above"
3040              PRINT TAB(20) "the nominal level"; : INPUT " -> ",PZR.TOP.VOL : RETURN
3050  '
3060  '
3070  '                                        * Relief *
3080  '
3090  CLS : LOCATE 10
3100  PRINT TAB(24) "Pressurizers relieve to either the "      : PRINT
3110  PRINT TAB(26) "(1) Relief Tank,"                          : PRINT TAB(26) "(2) Quench Tank, or"
3120  PRINT TAB(26) "(3) Drain Tank."                           : PRINT
3130  PRINT TAB(24) "Which is the case for this unit (1/2/3)"; : INPUT X$
3140  CLS
```

```
3150 IF X$="1" THEN RQ.TANK$ ="Relief Tank" : RETURN ELSE IF X$="2" THEN RQ.TANK$ ="Quench Tank" : RETURN
3160 IF X$="3" THEN RQ.TANK$ ="Drain Tank"  : RETURN ELSE 3070
3170 '
3180 '
3190 '                              ** VOLUME CONTROL OR MAKEUP TANK **
3200 '
3210 GOSUB 4820 :                                                      REM: Clear Geometric Variables
3220 '
3230 GOSUB 3340 : TANK$ =LD.TANK$ : BB$(13)   =TANK$  : GOSUB 3960 : BB$(14)=UNITS$ : LDT.UNITS$=UNITS$
3240 GOSUB 4080 : BB(15)=SLOPE    : LDT.SLOPE =SLOPE  : GOSUB 4180 : BB(16) =UP.LMT : LDT.UP.LMT=UP.LMT
3250 GOSUB 4230 : BB(17)=LO.LMT   : LDT.LO.LMT=LO.LMT : GOSUB 4290 : BB$(11)=GEO$   : LDT.GEO$  =GEO$
3260 '
3270 IF GEO$="No" THEN 3440 ELSE GOSUB 4430 : GOSUB 4470 : GOSUB 4510 : GOSUB 4580
3280 '
3290 BB(19)=CYL.RAD : LDT.CYL.RAD=CYL.RAD : BB(20)=CYL.LEN : LDT.CYL.LEN=CYL.LEN
3300 BB(21)=CVX.RAD : LDT.CYL.RAD=CYL.RAD : BB(22)=DENSITY : LDT.DENSITY=DENSITY
3310 '
3320 BB(23)=NORMFAC : LDT.NORMFAC=NORMFAC : GOTO 3440
3330 '
3340 CLS : LOCATE 10
3350 PRINT TAB(18) "Common names for the tank in the letdown system are" : PRINT
3360 PRINT TAB(26) "(1) Volume Control Tank or"
3370 PRINT TAB(26) "(2) Makeup Tank."                                  : PRINT
3380 PRINT TAB(18) "Which is more appropriate (1/2)";                  : INPUT X$
3390 '
3400 IF X$="1" THEN LD.TANK$="Volume Control Tank" : RETURN
3410 IF X$="2" THEN LD.TANK$="Makeup Tank"         : RETURN ELSE 3340
3420 '
3430 '
3440 '                                   ** DRAIN TANK **
3450 '
3460 TANK$ ="Drain Tank"
3470 '
3480 GOSUB 4820 :                                                      REM: Clear Geometric Variables
3490 '
3500 GOSUB 3960 : BB$(10)=UNITS$ : DT.UNITS$=UNITS$ : GOSUB 4080 : BB(25)=SLOPE  : DT.SLOPE =SLOPE
3510 GOSUB 4180 : BB(26) =UP.LMT : DT.UP.LMT=UP.LMT : GOSUB 4230 : BB(27)=LO.LMT : DT.LO.LMT=LO.LMT
3520 GOSUB 4290 : BB$(9) =GEO$   : DT.GEO$  =GEO$
3530 '
3540 IF GEO$="No" THEN 3610 ELSE GOSUB 4430 : GOSUB 4470 : GOSUB 4510 : GOSUB 4580
3550 '
3560 BB(29)=CYL.RAD : DT.CYL.RAD=CYL.RAD : BB(30)=CYL.LEN : DT.CYL.LEN=CYL.LEN
3570 BB(31)=CVX.RAD : DT.CVX.RAD=CVX.RAD : BB(32)=DENSITY : DT.DENSITY=DENSITY
3580 BB(33)=NORMFAC : DT.NORMFAC=NORMFAC
3590 '
3600 '
3610 '                              ** RELIEF OR QUENCH TANK **
3620 '
3630 TANK$ =RQ.TANK$ : BB$(8)=RQ.TANK$
3640 '
3650 GOSUB 4820 :                                                      REM: Clear Geometric Variables
3660 '
3670 IF RQ.TANK$="Drain Tank" THEN 3790
3680 '
```

```
3690  GOSUB 3960 : BB$(12)=UNITS$ : RQT.UNITS$=UNITS$ : GOSUB 4080 : BB(36)=SLOPE  : RQT.SLOPE =SLOPE
3700  GOSUB 4180 : BB(37) =UP.LMT : RQT.UP.LMT=UP.LMT : GOSUB 4230 : BB(38)=LO.LMT : RQT.LO.LMT=LO.LMT
3710  GOSUB 4290 : BB$(7) =GEO$   : RQT.GEO$  =GEO$
3720  '
3730  IF GEO$="No" THEN 3790 ELSE GOSUB 4430 : GOSUB 4470 : GOSUB 4510 : GOSUB 4580
3740  '
3750  BB(40)=CYL.RAD : RQT.CYL.RAD=CYL.RAD : BB(41)=CYL.LEN : RQT.CYL.LEN=CYL.LEN
3760  BB(42)=CVX.RAD : RQT.CVX.RAD=CVX.RAD : BB(43)=DENSITY : RQT.DENSITY=DENSITY
3770  BB(44)=NORMFAC : RQT.NORMFAC=NORMFAC
3780  '
3790  BB$(4)=DOCKET$
3800  '
3810  '
3820  '                                  ** PARAMETER STORAGE **
3830  '
3840  OPEN DOCKET$ FOR OUTPUT AS #1
3850  FOR I%=1 TO 14  : WRITE #1,BB$(I%)                          : NEXT I%
3860  FOR I%=15 TO 45 : PRINT #1,USING"########.########";BB(I%) : NEXT I%
3870  CLOSE #1
3880  '
3890  IF N% > NUM.PLANTS.ON.FILE THEN 3900 ELSE 3920
3900  OPEN "DOCKLIST" FOR APPEND AS #3 : WRITE #3, DOCKET$, PLANT$,  UNIT$ : CLOSE #3
3910  NUM.PLANTS.ON.FILE=N%          : D$(N%)=DOCKET$  : P$(N%)=PLANT$   : U$(N%)=UNIT$       : GOTO 1210
3920  P$(N%)=PLANT$  : U$(N%)=UNIT$  : OPEN "DOCKLIST" FOR OUTPUT AS #3
3930  FOR I%=0 TO NUM.PLANTS.ON.FILE : WRITE #3,  D$(I%), P$(I%), U$(I%) : NEXT I% : CLOSE #3 : GOTO 1210
3940  '
3950  '
3960  '                                  ** TANK SUBROUTINES **
3970  '
3980  '                                       * Level Units *
3990  '
4000  CLS : LOCATE 10
4010  PRINT TAB(27) "The ";TANK$;" level units may be "        : PRINT
4020  PRINT TAB(29) "(1) inches or"  : PRINT TAB(29) "(2) %."  : PRINT
4030  PRINT TAB(27) "Which will you use (1/2)";                 : INPUT X$
4040  '
4050  IF X$="1" THEN UNITS$="inches" : RETURN ELSE IF X$="2" THEN UNITS$="%"      : RETURN ELSE 3980
4060  '
4070  '
4080  '                          * Calibration Curve Slope and Limits *
4090  '
4100  CLS : LOCATE 11 : IF TANK$="Pressurizer" AND PZR.COMP$="Yes" THEN 4120 ELSE 4140
4110  '
4120  PRINT TAB(20) "For the Pressurizer, type the slope (cubic feet" : GOTO 4150
4130  '
4140  PRINT TAB(20) "For the "; TANK$; ", type the slope (pounds"
4150  PRINT TAB(20) "per "; LEFT$(UNITS$,4); ") of the straight line portion of the"
4160  PRINT TAB(20) "water versus level calibration curve"; : INPUT " -> ",SLOPE : RETURN
4170  '
4180  CLS : LOCATE 11
4190  PRINT TAB(20) "For the " TANK$; ", type the upper level"
4200  PRINT TAB(20) "limit (";UNITS$;") of the straight line portion of the"
4210  PRINT TAB(20) "calibration curve";                        : INPUT " -> ",UP.LMT : RETURN
4220  '
```

```
4230 CLS : LOCATE 11
4240 PRINT TAB(20) "For the "; TANK$; ", type the lower level"
4250 PRINT TAB(20) "limit (";UNITS$;") of the straight line portion of the"
4260 PRINT TAB(20) "calibration curve";                    : INPUT " -> ",LO.LMT : RETURN
4270 '
4280 '
4290 '                              * Tank Dimensions *
4300 '
4310 CLS : LOCATE 11
4320 PRINT TAB(20) "If the range between the upper and lower level"
4330 PRINT TAB(20) "limits is too narrow and if the tank is horizontal,"
4340 PRINT TAB(20) "the geometric method can be used.  This requires"
4350 PRINT TAB(20) "that the tank dimensions be entered.  Do you wish"
4360 PRINT TAB(20) "to enter the tank dimensions (Y/N)"; : INPUT Y$
4370 '
4380 CLS
4390 IF Y$<>"Y" AND Y$<>"N" AND Y$<>"y" AND Y$<>"n" THEN 4290
4400 IF Y$="Y" OR Y$="y" THEN GEO$="Yes" ELSE GEO$="No"
4410 RETURN
4420 '
4430 CLS : LOCATE 11
4440 PRINT TAB(20) "For the ";TANK$;", type the radius (feet)"
4450 PRINT TAB(20) "of the cylindrical part of the tank"; : INPUT " -> ",CYL.RAD : GOSUB 4630 : RETURN
4460 '
4470 CLS : LOCATE 11
4480 PRINT TAB(20) "For the ";TANK$;", type the length (feet)"
4490 PRINT TAB(20) "of the cylindrical part of the tank"; : INPUT " -> ",CYL.LEN : GOSUB 4630 : RETURN
4500 '
4510 CLS : LOCATE 11
4520 PRINT TAB(20) "For the ";TANK$;", type the radius (feet)"
4530 PRINT TAB(20) "of the convex head"; : INPUT " -> ",CVX.RAD : GOSUB 4630 : RETURN
4540 '
4550 '
4560 '                        * Water Density for Calibration *
4570 '
4580 CLS : LOCATE 11
4590 PRINT TAB(20) "For the ";TANK$;", type the density (pounds per"
4600 PRINT TAB(20) "cubic foot) of water assumed for the tank cali-"
4610 PRINT TAB(20) "bration"; : INPUT " -> ",DENSITY : GOSUB 4630 : CLS : RETURN
4620 '
4630 IF CYL.RAD=0 OR CYL.LEN=0 OR CVX.RAD=0 OR DENSITY=0 THEN NORMFAC=0 : RETURN ELSE 4680
4640 '
4650 '
4660 '                           * Normalization Factor *
4670 '
4680 IF UNITS$="inches"THEN UP.LMT.FRAC=UP.LMT/(12*2*CYL.RAD) ELSE UP.LMT.FRAC=UP.LMT/100
4690 IF UNITS$="inches"THEN LO.LMT.FRAC=LO.LMT/(12*2*CYL.RAD) ELSE LO.LMT.FRAC=LO.LMT/100
4700 '
4710 LVL.FRAC.I = LO.LMT.FRAC  :  LVL.FRAC.F = UP.LMT.FRAC : GOSUB 10080
4720 '
4730 INV.CHG.GEO = INV.CHG
4740 INV.CHG.CAL = SLOPE*(UP.LMT-LO.LMT)
4750 '
```

```
4760  NORMFAC = INV.CHG.CAL/INV.CHG.GEO
4770  CLS : LOCATE 12,16 : PRINT TANK$; " Normalization Factor is ";
4780  PRINT USING "#.####"; NORMFAC
4790  GOSUB 10650  : RETURN :                                  REM: Interrupt
4800  '
4810  '
4820  '                              * Clear Geometric Variables *
4830  '
4840  CYL.RAD=0 : CYL.LEN=0 : CVX.RAD=0 : DENSITY=0 : NORMFAC=0 : RETURN
```

```
4850 '                                      ###################
4860 '                                      # PARAMETER LIST #
4870 '                                      ###################
4880 '
4890 OPEN DOCKET$ FOR INPUT AS #1 : GOSUB 10380 : CLOSE #1 : R%=5 :           REM : Plant Parameters File
4900 IF PRINT.FLAG$="Y" THEN 4920 ELSE 4930
4910 '
4920 CLOSE #2 : OPEN "LPT1:" FOR OUTPUT AS #2 : A%=11 : B%=13 : C%=15    : D%=49 : E%=D%-1 : GOTO 4960
4930 A%=14 : B%=15 : C%=16 : D%=50 : E%=D%-1  : CLS   : LOCATE 5 : PRINT TAB(33); "PARAMETER LIST"
4940 PRINT : GOTO 5010
4950 '
4960 PRINT #2," " : PRINT #2," " : PRINT #2, TAB(35);"PARAMETER LIST" : PRINT #2," " : PRINT #2," "
4970 '
4980 '
4990 '                                 ## UNIT IDENTIFICATION ##
5000 '
5010 PRINT #2, TAB(A%); "Unit Identification:"
5020 PRINT #2, TAB(B%); "Plant Name"                    ; TAB(D%); PLANT$
5030 PRINT #2, TAB(B%); "Unit Number"                   ; TAB(D%); UNIT$
5040 PRINT #2, TAB(B%); "Docket Number"                 ; TAB(D%); "50-" ; DOCKET$
5050 PRINT #2, TAB(B%); "Nuclear Steam System Supplier"; TAB(D%); NSSS$ : PRINT #2," "
5060 '
5070 '
5080 '                                  ## VESSEL AND PIPING ##
5090 '
5100 PRINT #2, TAB(A%); "Vessel and Piping:"
5110 PRINT #2, TAB(B%); "Volume"; TAB(E%); VP.VOL; "cubic feet" : PRINT #2," "
5120 GOSUB 10620                : LOCATE R%
5130 '
5140 '
5150 '                                     ## PRESSURIZER ##
5160 '
5170 PRINT #2, TAB(A%); "Pressurizer:"
5180 PRINT #2, TAB(B%); "Level Units"; TAB(D%)    ; PZR.UNITS$
5190 PRINT #2, TAB(B%); "Temperature Compensated"; TAB(D%) ; PZR.COMP$
5200 '
5210 IF PZR.COMP$<>"Yes" THEN 5260
5220 '
5230 PRINT #2, TAB(B%); "Nominal Level"; TAB(E%); PZR.LVL.NOM; PZR.UNITS$
5240 PRINT #2, TAB(B%); "Volume Below Nominal Level"; TAB(E%); PZR.BTM.VOL; "cubic feet"
5250 PRINT #2, TAB(B%); "Volume Above Nominal Level"; TAB(E%); PZR.TOP.VOL; "cubic feet"
5260 PRINT #2, TAB(B%); "Calibration Curve"
5270 PRINT #2, TAB(C%); "Slope"; TAB(E%); PZR.SLOPE;
5280 '
5290 IF PZR.COMP$="Yes" THEN PRINT #2, "cubic feet per "; LEFT$(PZR.UNITS$,4) : GOTO 5320
5300                     PRINT #2, "pounds per "    ; LEFT$(PZR.UNITS$,4)
5310 '
5320 PRINT #2, TAB(C%); "Upper Level Limit"; TAB(E%); PZR.UP.LMT; PZR.UNITS$
5330 PRINT #2, TAB(C%); "Lower level Limit"; TAB(E%); PZR.LO.LMT; PZR.UNITS$
5340 PRINT #2, TAB(B%); "Relief"           ; TAB(D%); RQ.TANK$  : PRINT #2," "
5350 GOSUB 10620 : LOCATE R%
5360 '
5370 '
```

```
5380 '                          ** VOLUME CONTROL OR MAKEUP TANK **
5390 '
5400 PRINT #2, TAB(A%); LD.TANK$;":" : UNITS$ =LDT.UNITS$
5410 '
5420 SLOPE   =LDT.SLOPE    : UP.LMT  =LDT.UP.LMT  : LO.LMT  =LDT.LO.LMT  : GEO$    =LDT.GEO$
5430 CYL.RAD =LDT.CYL.RAD  : CYL.LEN =LDT.CYL.LEN : CVX.RAD =LDT.CVX.RAD : DENSITY =LDT.DENSITY
5440 NORMFAC =LDT.NORMFAC  : GOSUB 5730           : GOSUB 10620          : LOCATE R%
5450 '
5460 '
5470 '                                    ** DRAIN TANK **
5480 '
5490 PRINT #2, TAB(A%); "Drain Tank:"; : UNITS$ =DT.UNITS$
5500 '
5510 SLOPE   =DT.SLOPE   : UP.LMT  =DT.UP.LMT       : LO.LMT  =DT.LO.LMT  : GEO$    =DT.GEO$
5520 CYL.RAD =DT.CYL.RAD : CYL.LEN =DT.CYL.LEN      : CVX.RAD =DT.CVX.RAD : DENSITY =DT.DENSITY
5530 NORMFAC =DT.NORMFAC : GOSUB 5730 : IF RQ.TANK$="Drain Tank" THEN 5670 ELSE GOSUB 10620 : LOCATE R%
5540 '
5550 '
5560 '                               ** RELIEF OR QUENCH TANK **
5570 '
5580 IF PRINT.FLAG$<>"Y" OR LDT.GEO$="No" OR RQT.GEO$="No" OR DT.GEO$="No" THEN 5610
5590 LPRINT CHR$(12) : PRINT #2, : PRINT #2, : PRINT #2, TAB(29) "Parameter list continued"
5600 PRINT #2,       : PRINT #2, : PRINT #2,
5610 PRINT #2, TAB(A%); RQ.TANK$; ":" : UNITS$ =RQT.UNITS$
5620 '
5630 SLOPE   =RQT.SLOPE   : UP.LMT  =RQT.UP.LMT  : LO.LMT  =RQT.LO.LMT  : GEO$    =RQT.GEO$
5640 CYL.RAD =RQT.CYL.RAD : CYL.LEN =RQT.CYL.LEN : CVX.RAD =RQT.CVX.RAD : DENSITY =RQT.DENSITY
5650 NORMFAC =RQT.NORMFAC : GOSUB 5750
5660 '
5670 CLOSE #2 : OPEN "SCRN:" FOR OUTPUT AS #2
5680 '
5690 IF PRINT.FLAG$="Y" THEN LPRINT CHR$(12)
5700 GOSUB 10650 : GOTO 1210
5710 '
5720 '
5730 '                                  ** TANK SUBROUTINE **
5740 '
5750 PRINT #2, TAB(B%); "Level Units"      ; TAB(D%); UNITS$
5760 PRINT #2, TAB(B%); "Calibration Curve"
5770 PRINT #2, TAB(C%); "Slope"            ; TAB(E%); SLOPE ; "pounds per "; LEFT$(UNITS$,4)
5780 PRINT #2, TAB(C%); "Upper Level Limit"; TAB(E%); UP.LMT; UNITS$
5790 PRINT #2, TAB(C%); "Lower level limit"; TAB(E%); LO.LMT; UNITS$
5800 '
5810 IF GEO$<>"Yes" THEN 5840
5820 '
5830 PRINT #2, TAB(C%); "Water Density"; TAB(E%); DENSITY; "pounds per cubic foot"
5840 PRINT #2, TAB(B%); "Geometric Method Available"; TAB(D%); GEO$
5850 '
5860 IF GEO$<>"Yes" THEN PRINT #2, : RETURN
5870 '
5880 PRINT #2, TAB(B%); "Dimensions"
5890 PRINT #2, TAB(C%); "Cylinder Radius"; TAB(E%)     ; CYL.RAD; "feet"
5900 PRINT #2, TAB(C%); "Cylinder Length"; TAB(E%)     ; CYL.LEN; "feet"
5910 PRINT #2, TAB(C%); "Head Radius"    ; TAB(E%)     ; CVX.RAD; "feet"
```

```
5920 PRINT #2, TAB(B%); "Normalization Factor"; TAB(D%);
5930 PRINT #2,USING "#.####"; NORMFAC : PRINT #2," " : RETURN
```

```
5940 '                                         ***************
5950 '                                         * CORRECTIONS *
5960 '                                         ***************
5970 '
5980 OPEN DOCKET$ FOR INPUT AS #1 : GOSUB 10380 : CLOSE #1 :        REM: Plant Parameters File
5990 '
6000 '
6010 '                                      ** GROUP ACCESS MENU **
6020 '
6030 CLS : LOCATE 6,22 : PRINT "For access, parameter groups are:" : PRINT
6040 PRINT TAB(24) "(1) Unit Identification,"
6050 PRINT TAB(24) "(2) Vessel and Piping,"
6060 PRINT TAB(24) "(3) Pressurizer,"
6070 PRINT TAB(24) "(4) Volume Control or Makeup Tank,"
6080 PRINT TAB(24) "(5) Drain Tank,"
6090 PRINT TAB(24) "(6) Relief or Quench Tank, or"
6100 PRINT TAB(24) "(0) Exit to Data and Analysis Menu."  : PRINT
6110 PRINT TAB(22) "What is your choice (1/2/3/4/5/6/0)"; : INPUT X$
6120 CLS
6130 IF X$="1" THEN 6210 ELSE IF X$="2" THEN 6780 ELSE IF X$="3" THEN 6910 ELSE IF X$="4" THEN 7410
6140 IF X$="5" THEN 7840 ELSE IF X$="6" THEN 8260 ELSE IF X$="0" THEN 8870 ELSE 6010
6150 '
6160 '
6170 '                                   ** PARAMETER  ACCESS MENUS **
6180 '
6190 '                                      * Unit Identification *
6200 '
6210 ID% =1 : OLD.DOCKET$=DOCKET$
6220 '
6230 CLS : LOCATE 7,10 : PRINT "The parameters in this group and current values are:" : PRINT
6240 PRINT TAB(12) "(1) Plant Name                     -> "     ; PLANT$
6250 PRINT TAB(12) "(2) Unit Number                    -> "     ; UNIT$
6260 PRINT TAB(12) "(3) Nuclear Steam System Supplier -> "      ; NSSS$
6270 PRINT TAB(12) "(4) Docket Number                  -> "     ; DOCKET$
6280 PRINT TAB(12) "(0) Exit to the Group Access Menu."         : PRINT
6290 PRINT TAB(10) "What is your choice (1/2/3/4/0)";           : INPUT X$
6300 '
6310 IF X$="0" THEN 6420 ELSE IF X$<>"1" THEN 6330
6320 CLS : LOCATE 12,18 : PRINT "Type in the new plant name";  : INPUT " -> ", PLANT$ : GOTO 6230
6330 IF X$<>"2" THEN 6350
6340 CLS : LOCATE 12,24 : PRINT "Type in the new unit number"; : INPUT " -> ", UNIT$  : GOTO 6230
6350 IF X$<>"3" THEN 6370
6360 GOSUB 2420 : GOTO 6230 :                                  REM: Nuclear Steam System Supplier
6370 IF X$<>"4" THEN 6230 ELSE CLS    : LOCATE 10,24 : PRINT "The old docket number is 50-"; OLD.DOCKET$
6380 LOCATE 12
6390 PRINT TAB(24) "Type in the last three digits of "
6400 PRINT TAB(24) "the new docket number"; : INPUT " -> ", DOCKET$ : CLS : GOTO 6230
6410 '
6420 BB$(1)=PLANT$ : BB$(2)=UNIT$ : BB$(3)=NSSS$ : BB$(4)=DOCKET$ : IF DOCKET$=OLD.DOCKET$ THEN 6660
6430 '
6440 IF N%=1 THEN 6460
6450 FOR J%=1 TO N%-1 : IF DOCKET$=D$(J%) THEN 6490 ELSE NEXT J%
6460 FOR J%=N%+1 TO NUM.PLANTS.ON.FILE  : IF DOCKET$=D$(J%) THEN 6490 ELSE NEXT J%
6470 KILL OLD.DOCKET$ : GOTO 6660
```

```
6480  '
6490  CLS : COLOR 16,7  : LOCATE 6,16 : PRINT " CAUTION " ; : COLOR 7,0
6500  PRINT" Docket 50-"; DOCKET$; " already exists as "  ; P$(J%); " "; U$(J%)
6510  LOCATE  8,20 : PRINT "You have two options. You may: "
6520  LOCATE 10,20 : PRINT " (1) Delete file 50-";D$(J%);" ";P$(J%);" ";U$(J%);" "
6530  LOCATE 11,20 : PRINT "     and replace it with"
6540  LOCATE 12,20 : PRINT "     50-";DOCKET$;" ";PLANT$;" ";UNIT$;" ,or"
6550  LOCATE 13,20 : PRINT " (2) Preserve all files as they were under the old "
6560  LOCATE 14,20 : PRINT "     docket numbers and return to the previous menu."
6570  LOCATE 15,20 : PRINT "What is your choice "; : INPUT X$
6580  IF X$="1" THEN 6610
6590  IF X$="2" THEN DOCKET$=OLD.DOCKET$ : GOTO 6230 ELSE 6490
6600  '
6610  KILL OLD.DOCKET$ : NUM.PLANTS.ON.FILE=NUM.PLANTS.ON.FILE-1
6620  FOR I%=N% TO NUM.PLANTS.ON.FILE : D$(I%)=D$(I%+1) : P$(I%)=P$(I%+1) : U$(I%)=U$(I%+1) : NEXT I%
6630  IF J%>N% THEN J%=J%-1
6640  N%=J%
6650  '
6660  D$(N%)=DOCKET$ : P$(N%)=PLANT$ : U$(N%)=UNIT$
6670  OPEN "DOCKLIST" FOR OUTPUT AS #3
6680  FOR I%=0 TO NUM.PLANTS.ON.FILE : WRITE #3, D$(I%),P$(I%),U$(I%) : NEXT I%
6690  CLOSE #3
6700  '
6710  OPEN DOCKET$ FOR OUTPUT AS #1
6720  FOR I%=1  TO 14 : WRITE #1,BB$(I%) : NEXT I%
6730  FOR I%=15 TO 45 : PRINT #1, USING "########.########"; BB(I%) : NEXT I%
6740  CLOSE #1 : OLD.DOCKET$=DOCKET$
6750  '
6760  CLS : GOTO 6010
6770  '
6780  '                                   ! Vessel and Piping !
6790  '
6800  ID% = 2
6810  '
6820  CLS : LOCATE 10
6830  PRINT TAB(15) "The only parameter in this group is the Vessel and"
6840  PRINT TAB(15) "Piping Volume.  The current value is " ;   BB(45); " cubic"
6850  PRINT TAB(15) "feet.  Is correction needed (Y/N)"; : INPUT X$
6860  '
6870  IF X$="Y" OR X$="y" THEN GOSUB 2600 : BB(45)= VP.VOL : GOTO 6030
6880  IF X$="N" OR X$="n" THEN 6010 ELSE 6820
6890  '
6900  '
6910  '                                   ! Pressurizer !
6920  '
6930  ID%=3 : TANK$="Pressurizer" : UNITS$=BB$(5) : PZR.COMP$=BB$(6) : OLD.COMP$=PZR.COMP$
6940  IF PZR.COMP$="Yes" THEN CURVE.UNITS$="cubic feet per " ELSE CURVE.UNITS$="pounds per "
6950  MESSAGE$=" Not Applicable"
6960  '
6970  CLS : LOCATE 4,10 : PRINT "The Pressurizer parameters and current values are:"      :PRINT
6980  PRINT TAB(12) "(1) Level Units                    -> "; UNITS$
6990  PRINT TAB(12) "(2) Temperature Compensation       -> "; PZR.COMP$
7000  PRINT TAB(12) "(3) Nominal Level                  ->" ;
7010  IF PZR.COMP$="No" THEN PRINT MESSAGE$ ELSE PRINT BB(39); UNITS$
```

```
7020 PRINT TAB(12) "(4) Bottom Volume                   ->" ;
7030 IF PZR.COMP$="No" THEN PRINT MESSAGE$ ELSE PRINT BB(34); "cubic feet"
7040 PRINT TAB(12) "(5) Top Volume                      ->" ;
7050 IF PZR.COMP$="No" THEN PRINT MESSAGE$ ELSE PRINT BB(28); "cubic feet"
7060 PRINT TAB(12) "(6) Slope of the Calibration Curve ->" ; BB(24); CURVE.UNITS$; LEFT$(UNITS$,4)
7070 PRINT TAB(12) "(7) Its upper level limit           ->" ; BB(18); : PRINT UNITS$
7080 PRINT TAB(12) "(8) Its lower level limit           ->" ; BB(35); : PRINT UNITS$
7090 PRINT TAB(12) "(9) Relieving Tank                  -> "; RQ.TANK$
7100 PRINT TAB(12) "(0) Exit to Group Access Menu."          : PRINT
7110 LOCATE ,12 : COLOR 0,7 : PRINT "NOTE"; : COLOR 7,0
7120 PRINT " First correct (1) then (2) and then any other parameter(s)."           : PRINT
7130 PRINT TAB(10) "Which do you wish to access (1/2/3/4/5/6/7/8/9/0)"; : INPUT X$
7140 '
7150 CLS : IF X$="0" THEN 6010
7160 '
7170 IF X$ ="1" THEN GOSUB 3980 : PZR.UNITS$=UNITS$ : BB$(5)=UNITS$ : GOTO 6910
7180 IF X$<>"2" THEN 7230 ELSE GOSUB 2780 : IF PZR.COMP$=OLD.COMP$ THEN 6910
7190 BB$(6)=PZR.COMP$ : IF PZR.COMP$="No" THEN 7220
7200 GOSUB 2910 : BB(39)=PZR.LVL.NOM  : GOSUB 3000 : BB(34)=PZR.BTM.VOL
7210 GOSUB 3030 : BB(28) =PZR.TOP.VOL : GOTO 6910
7220 BB(39)=0 : BB(34)=0 : BB(28)=0   : GOTO 6910
7230 IF X$ ="3" THEN GOSUB 2910 : BB(39)=PZR.LVL.NOM : GOTO 6910
7240 IF X$ ="4" THEN GOSUB 3000 : BB(34)=PZR.BTM.VOL : GOTO 6910
7250 IF X$ ="5" THEN GOSUB 3030 : BB(28)=PZR.TOP.VOL : GOTO 6910
7260 IF X$ ="6" THEN GOSUB 4100 : PZR.SLOPE=SLOPE    : BB(24)=SLOPE  : GOTO 6910
7270 IF X$ ="7" THEN GOSUB 4180 : PZR.UP.LMT=UP.LMT  : BB(18)=UP.LMT : GOTO 6910
7280 IF X$ ="8" THEN GOSUB 4230 : PZR.LO.LMT=LO.LMT  : BB(35)=LO.LMT : GOTO 6910
7290 IF X$ ="9" THEN GOSUB 3070 : BB$(8)=RQ.TANK$ ELSE 6910
7300 '
7310 IF RQ.TANK$="Drain Tank" THEN 6910
7320 '
7330 TANK$=RQ.TANK$ : GOSUB 3980     : BB$(12)=UNITS$
7340 GOSUB 4080     : BB(36)=SLOPE   : GOSUB 4180
7350 BB(37)=UP.LMT  : GOSUB 4230     : BB(38)=LO.LMT
7360 GOSUB 4290     : BB$(7)=GEO$    : IF GEO$<>"Yes" THEN 6910
7370 GOSUB 4430     : BB(40)=CYL.RAD : GOSUB 4470 : BB(41)=CYL.LEN : GOSUB 4510 : BB(42)=CVX.RAD
7380 GOSUB 4580     : BB(43)=DENSITY : BB(44)=NORMFAC : GOTO 6910
7390 '
7400 '
7410 '                            * Volume Control or Makeup Tank *
7420 '
7430 IDX=4 : TANK$=LDT.TANK$ : UNITS$=LDT.UNITS$ : CLS
7440 '
7450 LOCATE 4,10 : PRINT "The Volume Control or Makeup Tank parameters and current values are:" : PRINT
7460 PRINT TAB(12) " (1) Tank Name                       -> "; BB$(13)
7470 PRINT TAB(12) " (2) Level Units                     -> "; BB$(14)
7480 PRINT TAB(12) " (3) Slope of the Calibration Curve ->" ; BB(15); "pounds per "; LEFT$(BB$(14),4)
7490 PRINT TAB(12) " (4) Its Upper Level Limit           ->" ; BB(16); BB$(14)
7500 PRINT TAB(12) " (5) Its Lower Level Limit           ->" ; BB(17); BB$(14)
7510 PRINT TAB(12) " (6) Geometric Method                -> "; BB$(11)
7520 IF BB$(11)<>"Yes" THEN 7570
7530 PRINT TAB(12) " (7) Cylinder Radius                 ->" ; BB(19); "feet"
7540 PRINT TAB(12) " (8) Cylinder Length                 ->" ; BB(20); "feet"
7550 PRINT TAB(12) " (9) Head Radius                     ->" , BB(21); "feet"
```

```
7560  PRINT TAB(12) "(10) Water Density                  ->" ; BB(22); "pounds per cubic foot"
7570  PRINT TAB(12) " (0) Exit to Group Access Menu."  : PRINT
7580  LOCATE ,13 : COLOR 0,7 :PRINT "NOTE"; : COLOR 7,0
7590  PRINT " First correct (1) then (2) and then any other parameter(s)." : PRINT
7600  PRINT TAB(10) "Which do you wish to access (1/2/3/4/5/6"; : IF BB$(11)="Yes" THEN PRINT "/7/8/9/10";
7610  INPUT "/0)"; X$
7620  IF X$ ="0" THEN 6010
7630  IF X$ ="1" THEN GOSUB 3340 : BB$(13) =LD.TANK$ : GOTO 7410
7640  TANK$ =LD.TANK$
7650  '
7660  SLOPE   =BB(15) : UP.LMT  =BB(16) : LO.LMT =BB(17) : GEO$ =BB$(11) : CYL.RAD =BB(19) : CYL.LEN =BB(20)
7670  CVX.RAD =BB(21) : DENSITY =BB(22) : UNITS$ =BB$(14)
7680  '
7690  IF X$="2" THEN GOSUB 3980 : BB$(14)=UNITS$   : GOTO 7410
7700  IF X$="3" THEN GOSUB 4080 : BB(15) =SLOPE
7710  IF X$="4" THEN GOSUB 4180 : BB(16) =UP.LMT
7720  IF X$="5" THEN GOSUB 4230 : BB(17) =LO.LMT
7730  IF GEO$="No"  AND (X$="3" OR X$="4" OR X$="5") THEN GOTO 7410
7740  IF GEO$="Yes" AND (X$="3" OR X$="4" OR X$="5") THEN GOSUB 4680 : GOSUB 7810 : GOTO 7410
7750  IF X$="6"  THEN GOSUB 8740 : GOTO 7410
7760  IF X$="7"  THEN GOSUB 4430 : BB(19) =CYL.RAD  : GOSUB 7810 : GOTO 7410
7770  IF X$="8"  THEN GOSUB 4470 : BB(20) =CYL.LEN  : GOSUB 7810 : GOTO 7410
7780  IF X$="9"  THEN GOSUB 4510 : BB(21) =CVX.RAD  : GOSUB 7810 : GOTO 7410
7790  IF X$="10" THEN GOSUB 4580 : BB(22) =DENSITY  : GOSUB 7810
7800  GOTO 7410
7810  BB(23)= NORMFAC : CLS : RETURN
7820  '
7830  '
7840  '                                       * Drain Tank *
7850  '
7860  ID% = 5  : TANK$="Drain Tank" : UNITS$=DT.UNITS$ : CLS
7870  '
7880  LOCATE 4,10 : PRINT "The Drain Tank parameters and current values are:" : PRINT
7890  PRINT TAB(12) "(1) Level Units                     -> "; BB$(10)
7900  PRINT TAB(12) "(2) Slope of the Calibration Curve  ->" ; BB(25); "pounds per "; LEFT$(BB$(10),4)
7910  PRINT TAB(12) "(3) Its Upper Level Limit           ->" ; BB(26); BB$(10)
7920  PRINT TAB(12) "(4) Its Lower Level Limit           ->" ; BB(27); BB$(10)
7930  PRINT TAB(12) "(5) Geometric Method                -> "; BB$(9)
7940  IF BB$(9)<>"Yes" THEN 7990
7950  PRINT TAB(12) "(6) Cylinder Radius                 ->" ; BB(29); "feet"
7960  PRINT TAB(12) "(7) Cylinder Length                 ->" ; BB(30); "feet"
7970  PRINT TAB(12) "(8) Head Radius                     ->" ; BB(31); "feet"
7980  PRINT TAB(12) "(9) Water Density                   ->" ; BB(32); "pounds per cubic foot"
7990  PRINT TAB(12) "(0) Exit to Group Access Menu."    : PRINT
8000  LOCATE ,12 : COLOR 0,7 : PRINT "NOTE"; : COLOR 7,0
8010  PRINT " First correct (1) and then any other parameter(s)." : PRINT
8020  PRINT TAB(10) "Which do you wish to access (1/2/3/4/5"; : IF BB$(9)="Yes" THEN PRINT "/6/7/8/9";
8030  PRINT "/0)"; : INPUT X$
8040  '
8050  CLS : IF X$="0" THEN 6010
8060  '
8070  SLOPE  =BB(25) : UP.LMT =BB(26) : LO.LMT =BB(27) : GEO$   =BB$(9) : CYL.RAD=BB(29) : CYL.LEN=BB(30)
8080  CVX.RAD=BB(31) : DENSITY=BB(32) : UNITS$ =BB$(10)
8090  '
```

```
8100  IF X$="1" THEN GOSUB 3980 : BB$(10)=UNITS$ : GOTO 7840
8110  IF X$="2" THEN GOSUB 4080 : BB(25) =SLOPE
8120  IF X$="3" THEN GOSUB 4180 : BB(26) =UP.LMT
8130  IF X$="4" THEN GOSUB 4230 : BB(27) =LO.LMT
8140  '
8150  IF GEO$="No"  AND (X$="2" OR X$="3" OR X$="4") THEN 7840
8160  IF GEO$="Yes" AND (X$="2" OR X$="3" OR X$="4") THEN GOSUB 4680 : GOSUB 8230 : GOTO 7840
8170  IF X$="5" THEN GOSUB 8740 : GOTO 7840
8180  IF X$="6" THEN GOSUB 4430 : BB(29) =CYL.RAD : GOSUB 8230 : GOTO 7840
8190  IF X$="7" THEN GOSUB 4470 : BB(30) =CYL.LEN : GOSUB 8230 : GOTO 7840
8200  IF X$="8" THEN GOSUB 4510 : BB(31) =CVX.RAD : GOSUB 8230 : GOTO 7840
8210  IF X$="9" THEN GOSUB 4580 : BB(32) =DENSITY : GOSUB 8230
8220  GOTO 7840
8230  BB(33)=NORMFAC : CLS : RETURN
8240  '
8250  '
8260  '                              ! Relief or Quench Tank !
8270  '
8280  ID% = 6 : TANK$=RQ.TANK$ : UNITS$=RQT.UNITS$ : IF TANK$="Drain Tank" THEN 7860
8290  '
8300  CLS : LOCATE 4,10 : PRINT "The Relief or Quench Tank parameters are:" :  PRINT
8310  PRINT TAB(12) "(1) Tank Name                         -> "; BB$(8)
8320  PRINT TAB(12) "(2) Level Units                        -> "; BB$(12)
8330  PRINT TAB(12) "(3) Slope of the Calibration Curve  ->" ; BB(36); "pounds per "; LEFT$(BB$(12),4)
8340  PRINT TAB(12) "(4) Its Upper Level Limit            ->" ; BB(37); BB$(12)
8350  PRINT TAB(12) "(5) Its Lower Level Limit            ->" ; BB(38); BB$(12)
8360  PRINT TAB(12) "(6) Geometric Method                 -> "; BB$(7)
8370  IF BB$(7)<>"Yes" THEN 8420
8380  PRINT TAB(12) "(7) Cylinder Radius                  ->" ; BB(40); "feet"
8390  PRINT TAB(12) "(8) Cylinder Length                  ->" ; BB(41); "feet"
8400  PRINT TAB(12) "(9) Head Radius                      ->" ; BB(42); "feet"
8410  PRINT TAB(12) "(10) Water Density                   ->" ; BB(43); "pounds per cubic foot"
8420  PRINT TAB(12) "(0) Exit to the Group Access Menu."     : PRINT
8430  LOCATE ,12 : COLOR 0,7 : PRINT "NOTE"; : COLOR 7,0
8440  PRINT " First correct (1) then (2) and then any other parameter(s)." : PRINT
8450  PRINT TAB(12-2) "Which do you wish to access (1/2/3/4/5/6"; : IF BB$(7)="Yes" THEN PRINT "/7/8/9/10";
8460  INPUT "/0)"; X$
8470  '
8480  CLS  :IF X$="0" THEN 6010
8490  '
8500  IF X$="1" THEN GOSUB 3070 : BB$(8)=TANK$ : GOTO 8260
8510  '
8520  SLOPE  =BB(36) : UP.LMT =BB(37) : LO.LMT=BB(38) : GEO$=BB$(7) : CYL.RAD=BB(40) : CYL.LEN=BB(41)
8530  CVX.RAD=BB(42) : DENSITY=BB(43) : UNITS$=BB$(12)
8540  '
8550  IF X$ ="2" THEN GOSUB 3980 : BB$(12)=UNITS$ : GOTO 8260
8560  IF X$ ="3" THEN GOSUB 4080 : BB(36) =SLOPE
8570  IF X$ ="4" THEN GOSUB 4180 : BB(37) =UP.LMT
8580  IF X$ ="5" THEN GOSUB 4230 : BB(38) =LO.LMT
8590  '
8600  IF GEO$="No"  AND (X$="3" OR X$="4" OR X$="5") THEN 8260
8610  IF GEO$="Yes" AND (X$="3" OR X$="4" OR X$="5") THEN GOSUB 4680 : GOSUB 8690 : GOTO 8260
8620  '
8630  IF X$ ="6" THEN GOSUB 8740 : GOTO 8260
```

```
8640  IF X$ ="7" THEN GOSUB 4430 : BB(40)=CYL.RAD : GOSUB 8690 : GOTO 8260
8650  IF X$ ="8" THEN GOSUB 4470 : BB(41)=CYL.LEN : GOSUB 8690 : GOTO 8260
8660  IF X$ ="9" THEN GOSUB 4510 : BB(42)=CVX.RAD : GOSUB 8690 : GOTO 8260
8670  IF X$="10" THEN GOSUB 4580 : BB(43)=DENSITY : GOSUB 8690
8680  GOTO 8260
8690  BB(44)=NORMFAC  : CLS : RETURN
8700  '
8710  '
8720  '                                 ** CORRECTION SUBROUTINES **
8730  '
8740  '                                     * Geometric  Method *
8750  '
8760  IF ID%=4 THEN BBB%=11 : B%=18
8770  IF ID%=5 THEN BBB%=9  : B%=28
8780  IF ID%=6 THEN BBB%=7  : B%=39
8790  OLD.GEO$=GEO$
8800  GOSUB 4290 : BB$(BBB%)=GEO$   : IF GEO$=OLD.GEO$ THEN RETURN ELSE IF GEO$="No" THEN 8840
8810  GOSUB 4430 : BB(B%+1)=CYL.RAD : GOSUB 4470 : BB(B%+2)=CYL.LEN : GOSUB 4510 : BB(B%+3)=CVX.RAD
8820  GOSUB 4580 : BB(B%+4)=DENSITY : BB(B%+5)=NORMFAC              : RETURN
8830  '
8840  BB(B%+1)=0 : BB(B%+2)=0 : BB(B%+3)=0 : BB(B%+4)=0 : BB(B%+5)=0 : RETURN
8850  '
8860  '
8870  '                                          * Storage *
8880  '
8890  OPEN DOCKET$ FOR OUTPUT AS #1
8900  FOR I%=1 TO 14  : WRITE #1,BB$(I%) : NEXT I%
8910  FOR I%=15 TO 45 : PRINT #1, USING "########.#########"; BB(I%) : NEXT I%
8920  CLOSE #1        : GOTO 1210                                   REM: Data and Analysis Menu
```

```
8930 '                                  *******************
8940 '                                  * DATA  ANALYSIS *
8950 '                                  *******************
8960 '
8970 ' References:
8980 '   (1)  "ASME Steam Tables," Fourth Edition.
8990 '   (2)  "Horizontal Tanks," Note to J. Chung from R. Woodruff, May 22, 1981.
9000 '
9010 '
9020 '                                     ** DATA INPUT **
9030 '
9040 OPEN DOCKET$ FOR INPUT AS #1 : GOSUB 10380 : CLOSE #1
9050 '
9060 CHAIN "CALC.BAS",,ALL
9070 '
9080 '
9090 '                              ** ANALYTICAL SUBROUTINES **
9100 '
9110 '                                * Saturation Temperature *
9120 '
9130 ' Note: This calculation is based on Page 17, Section 5, Reduced saturation pressure, of Reference (1).
9140 '       It duplicates saturation temperature as given in Table 2 of Reference (1) for pressures from
9150 '       14.696 psia to 3208.2 psia.
9160 '
9170 BETA  = PRES*9.80665*.45359237#/22120000#/.0254/.0254
9180 PRINT TAB(16) "Calculating Saturation Temperature for";PRES;"psia."
9190 THETA = .5  :  THETA1 = .25
9200 SK1 =-7.691234564#   :  SK2 =-26.08023696#  :  SK3 =-168.1706546#   :  SK4 = 64.23285504#
9210 SK5 =-118.9646225#   :  SK6 = 4.167117320#  :  SK7 = 20.9750676#     :  SK8 = 1E+09
9220 SK9 = 6
9230 '
9240 T1 =1-THETA : T2 =T1*T1 : T3 =T1*T2 : T4 =T1*T3 : T5 =T1*T4
9250 BETA1 = 1+SK6*T1+SK7*T2
9260 BETA1 = EXP(1/THETA*(SK1*T1+SK2*T2+SK3*T3+SK4*T4+SK5*T5)/BETA1-T1/(SK8*T2+SK9))
9270 IF ABS(BETA-BETA1)<5E-08 THEN GOTO 9300
9280 IF BETA>BETA1 THEN THETA=THETA+THETA1 ELSE THETA=THETA-THETA1
9290 THETA1 = THETA1/2! : GOTO 9200
9300 TEMP.SAT = (THETA*647.3-273.15)*1.8+32
9310 RETURN
9320 '
9330 '
9340 '                                     * Density of Water *
9350 ' Note: This calculation is based on the following sections of Reference (1)--
9360 '                    Page 23; Section 9.1; Sub-region 1, Reduced volume;
9370 '                    Page 14; Section 2.1; Reduced dimensionless quantities;
9380 '                    Page 14; Section 1.3; Defined constant quantities; and
9390 '                    Page  9; Chapter IV ; Units, Notation, and Constants.
9400 '       It duplicates specific volume as given in Table 3 for temperature from 32 to 662 F and for pressure
9410 '       from saturation to 14,000 psia.
9420 '
9430 PRINT TAB(16) "Calculating the Density of Water at "; : PRINT USING "###.##"; TEMP; : PRINT" F and ";
9440 PRINT USING "###.##"; PRES; : PRINT" psia."
9450 '
```

```
9460 SA1 = .8438375405#    : SA2 = .0005362162162# : SA3 = 1.72           : SA4 = .07342278489#
9470 SA5 = .04975858887#   : SA6 = .65371543#      : SA7 = 1.15E-06       : SA8 = 1.5108E-05
9480 SA9 = .14188          : SA10= 7.002753165#    : SA11= .0002995284926#
9490 A11 = 7.982692717#    : A12 =-.02616571843#   : A13 = .001522411798#   : A14 = .02284279054#
9500 A15 = 242.1647003#    : A16 = 1.269716088D-10 : A17 = .0000020748383328# : A18 = .0000000217402035#
9510 A19 = 1.105710498D-09 : A20 = 12.93441934#    : A21 = .000013081190072#  : A22 = 6.047626338D-14
9520 '
9530 THETA   = ((TEMP-32)/1.8+273.15)/647.3
9540 THETA2  = THETA*THETA           : THETA6 = THETA2*THETA2*THETA2
9550 THETA11 = THETA6*THETA6/THETA
9560 THETA18 = THETA6*THETA6*THETA6  : THETA19 = THETA*THETA18
9570 THETA20 = THETA*THETA19
9580 '
9590 BETA  = PRES*9.80665*.45359237#/22120000#/.0254/.0254
9600 BETA2 = BETA*BETA : BETA3=BETA*BETA2
9610 '
9620 Y = 1-SA1*THETA2-SA2/THETA6
9630 Z = Y+SQR(SA3*Y*Y-2*SA4*THETA+2*SA5*BETA)
9640 '
9650 CHI1 = A11 *SA5/EXP(LOG(Z)*5/17)
9660 CHI1 = CHI1 + (A12+A13*THETA+A14*THETA2+A15*EXP(LOG(ABS(SA6-THETA))*10) + A16/(SA7+THETA19))
9670 CHI1 = CHI1 - 1/(SA8+THETA11)*(A17+2*A18*BETA+3*A19*BETA2)
9680 CHI1 = CHI1 - A20*THETA18*(SA9+THETA2)*(-3/EXP(LOG(SA10+BETA)*4)+SA11)
9690 CHI1 = CHI1 + 3*A21*(SA12-THET[illegible]ETA2 + 4*A22/THETA20*BETA3
9700 '
9710 SPECIFIC.VOL=CHI1*3.17*.0160184634#
9720 '
9730 DENSITY.WTR = 1/SPECIFIC.VOL  : RETURN :  ' lb/ft3
9740 '
9750 '
9760 '                        * Density of Saturated Steam *
9770 '
9780 ' Note: The following equation is a curve fit to the density of saturated steam as given on pages 90 and
9790 '       91 of Reference (1).  It is accurate to 1.0% or better in the range from 1400 to 2700 psia.
9800 '
9810 PRINT TAB(12) "      Calculating the Density of Saturated"
9820 PRINT TAB(12) "      Steam at "; PRES; "psia"
9830 '
9840 P = PRES-2000
9850 '
9860 DENSITY.STM = 5.3104+.0038887*P+1.2782E-06*P*P+6.240002E-10*P*P*P
9870 '
9880 RETURN
9890 '
9900 '                             * Tank Inventory *
9910 '
9920 '                             Calibration Method
9930 '
9940 INV.CHG = SLOPE * (LVL.F - LVL.I)  :  RETURN
9950 '
9960 '
```

```
9970 '                                  Geometric Method
9980 '
9990 IF CVX.RAD=>CYL.RAD THEN GOTO 10050
10000 '
10010 PRINT : PRINT : PRINT
10020 PRINT TAB(16) "ERROR: Radius of Convex Head is less than"
10030 PRINT TAB(23) "Radius of Tank." :CLOSE #1 : GOTO 10690
10040 '
10050 IF UNITS$="inches" THEN LVL.FRAC.I=LVL.I/12/2/CYL.RAD ELSE LVL.FRAC.I=LVL.I/100
10060 IF UNITS$="inches" THEN LVL.FRAC.F=LVL.F/12/2/CYL.RAD ELSE LVL.FRAC.F=LVL.F/100
10070 '
10080 LVL.CHG.FRAC = LVL.FRAC.F - LVL.FRAC.I : NMBR.INCRMNTS = INT(ABS(LVL.CHG.FRAC)/.01+1)
10090 LVL.INCRMNT = LVL.CHG.FRAC / NMBR.INCRMNTS
10100 '
10110 A = LVL.FRAC.I : F = 0! : PRINT : PRINT : PRINT : IF TANK$="Volume Control Tank" THEN G%=22 ELSE G%=26
10120 PRINT TAB(G%) ; "Integrating ";TANK$;" Volume " : PRINT
10130 '
10140 FOR M%=1 TO NMBR.INCRMNTS
10150 COUNT = NMBR.INCRMNTS - M% + 1
10160 IF COUNT > 9 THEN F%=39 ELSE F%=40
10170 PRINT TAB(F%); COUNT
10180 FOR I% = 0 TO 1
10190 T1 = 4*A*(1-A) :IF T1<0 THEN T1=0
10200 T2 = (CVX.RAD*CVX.RAD)/(CYL.RAD*CYL.RAD)-1  :IF T2<0 THEN T2=0
10210 T3 = SQR(T1/T2)
10220 T4 = T1+T2
10230 T5 = SQR(T1*T2)
10240 T6 = 4*CYL.RAD*CYL.RAD*CYL.RAD
10250 T7 = T6*CYL.LEN/CYL.RAD
10260 F(I%) = T7*SQR(T1)-T6*T5+T6*T4*ATN(T3)
10270 A = A + LVL.INCRMNT
10280 NEXT I%
10290 F = F+(F(0)+F(1))*LVL.INCRMNT/2
10300 A = A-LVL.INCRMNT
10310 NEXT M%
10320 INV.CHG = F*DENSITY
10330 PRINT  :  RETURN
```

```
10340 '                                          ********************
10350 '                                          * SUPPORT MODULES *
10360 '                                          ********************
10370 '
10380 '                                   ** PLANT PARAMETERS FILE **
10390 '
10400 FOR I%=1 TO 14 : INPUT #1, BB$(I%) : NEXT I% : FOR I%=15 TO 45 : INPUT #1,BB(I%) : NEXT I%
10410 '
10420 '
10430 PLANT$=BB$(1)       : UNIT$=BB$(2)       : NSSS$=BB$(3)        : VP.VOL=BB(45)
10440 '
10450 PZR.UNITS$ =BB$(5)  : PZR.COMP$  =BB$(6)  : PZR.LVL.NOM =BB(39) : PZR.BTM.VOL =BB(34)
10460 PZR.TOP.VOL=BB(28)  : PZR.SLOPE  =BB(24)  : PZR.UP.LMT  =BB(18) : PZR.LO.LMT  =BB(35)
10470 '
10480 LD.TANK$   =BB$(13) : LDT.UNITS$ =BB$(14) : LDT.SLOPE   =BB(15) : LDT.UP.LMT  =BB(16)
10490 LDT.LO.LMT =BB(17)  : LDT.GEO$   =BB$(11) : LDT.CYL.RAD =BB(19) : LDT.CYL.LEN =BB(20)
10500 LDT.CVX.RAD=BB(21)  : LDT.DENSITY=BB(22)  : LDT.NORMFAC =BB(23)
10510 '
10520 DT.UNITS$  =BB$(10) : DT.SLOPE   =BB(25)  : DT.UP.LMT   =BB(26) : DT.LO.LMT   =BB(27)
10530 DT.GEO$    =BB$(9)  : DT.CYL.RAD =BB(29)  : DT.CYL.LEN  =BB(30) : DT.CVX.RAD  =BB(31)
10540 DT.DENSITY =BB(32)  : DT.NORMFAC =BB(33)
10550 '
10560 RQ.TANK$   =BB$(8)  : RQT.UNITS$ =BB$(12) : RQT.SLOPE   =BB(36) : RQT.UP.LMT  =BB(37)
10570 RQT.LO.LMT =BB(38)  : RQT.GEO$   =BB$(7)  : RQT.CYL.RAD =BB(40) : RQT.CYL.LEN =BB(41)
10580 RQT.CVX.RAD=BB(42)  : RQT.DENSITY=BB(43)  : RQT.NORMFAC =BB(44)
10590 DOCKET$    =BB$(4)  : RETURN
10600 '
10610 '
10620 '                                        ** INTERRUPTS **
10630 '
10640 IF PRINT.FLAG$="N" OR PRINT.FLAG$="n" OR DOCKLIST.FLAG$="Y" THEN GOTO 10650 ELSE RETURN
10650 COLOR 0,7 : LOCATE 23,65,0 :PRINT " Press any "; : COLOR 16,7 : PRINT "key"; : COLOR 0,7
10660 PRINT "." : COLOR 7,0 : DOCKLIST.FLAG$="N"
10670 A$=INKEY$ : IF A$="" THEN 10670 ELSE CLS : RETURN
10680 '
10690 '
10700 '                              ** CONTINUATION OR TERMINATION **
10710 '
10720 LOCATE 22
10730 '
10740 PRINT TAB(20) "Do you wish to terminate this session "; : COLOR 16,7 : PRINT "(Y/N)"; : COLOR 7,0
10750 INPUT X$
10760 '
10770 IF X$<>"Y" AND X$<>"N" AND X$<>"y" AND X$<>"n" THEN 10690
10780 IF X$="N" OR X$="n" THEN 1230
10790 '
10800 CLS : LOCATE 22,12 : PRINT "Do you wish to exit to the SYSTEM or"; : PRINT " exit to BASIC ";
10810 COLOR 16,7 : PRINT "(S/B)"; : COLOR 7,0 : INPUT X$
10820 '
10830 IF X$="B" OR X$="b" THEN CLS : STOP ELSE IF X$="S" OR X$="s" THEN 10850 ELSE 10800
10840 '
10850 CLS : SYSTEM : STOP
10860 '
10870 '
```

```
10880 '                              ** DELETION OF PLANT PARAMETER FILE **
10890 '
10900 CLS : LOCATE 10,20 : PRINT "The file which you have chosen to delete is "
10910 C%=(68-LEN(P$(N%)))/2 : LOCATE 12,C%
10920 COLOR 0,7    : PRINT " 50-"; D$(N%); ": "; P$(N%); " "; U$(N%);" " : COLOR 7,0
10930 LOCATE 14,16 : COLOR 7,0 : PRINT "Are you sure you wish to "; : COLOR 0,7  : PRINT " DELETE ";
10940 COLOR 7,0    : PRINT " this file (Y/N)"; : INPUT X$ : IF X$="Y" OR X$="y" THEN 10970
10950 IF X$<>"N" AND X$<>"n" THEN 10900 ELSE 1230
10960 '
10970 KILL DOCKET$       : NUM.PLANTS.ON.FILE =NUM.PLANTS.ON.FILE-1         : FOR I%=N% TO NUM.PLANTS.ON.FILE
10980 D$(I%)=D$(I%+1)    : P$(I%)=P$(I%+1) : U$(J%)=U$(I%+1)                : NEXT I%
10990 OPEN "DOCKLIST" FOR OUTPUT AS #3     : FOR I%=0 TO NUM.PLANTS.ON.FILE : WRITE #3,D$(I%),P$(I%),U$(I%)
11000 NEXT I% : CLOSE #3 : GOSUB 10650     : GOTO 1230
11010 '
11020 '
11030 '                                     ** DOCKLIST READOUT **
11040 '
11050 CLS : IF PRINT.FLAG$="Y" THEN CLOSE #2 : OPEN "LPT1:" FOR OUTPUT AS #2
11060 OPEN "DOCKLIST" FOR INPUT AS #3 : I%=-1
11070 I%=I%+1 : IF EOF(3) THEN 11090
11080 INPUT #3,D$(I%),P$(I%),U$(I%) : GOTO 11070
11090 CLOSE #3
11100 FOR M%=0 TO I%-1 : PRINT #2,D$(M%);P$(M%);U$(M%); : NEXT M%
11110 IF PRINT.FLAG$="Y" THEN LPRINT CHR$(12) : CLOSE #2 : OPEN "SCRN:" FOR OUTPUT AS #2
11120 GOSUB 10620 : GOTO 1230
11130 '
11140 '
11150 '                                   ** DOCKLIST REPLACEMENT **
11160 '
11170 CLS : LOCATE 11,19 : PRINT "Input lowest three digit filename on disk"
11180 PRINT TAB(19) "or press RETURN for default ->"; : INPUT " ", LB%  : IF LB%=0 THEN LB%=28
11190 CLS : LOCATE 11,19 : PRINT "Input highest three digit filename on disk";
11200 PRINT TAB(19) "or press RETURN for default ->"; : INPUT " ",UB%
11210 IF UB%=0 THEN UB%=599 ELSE IF UB%<LB% THEN 11150
11220 CLS : LOCATE 11 : PRINT TAB(12) "The computer is searching the disk for plant parameter files."
11230 L%=0 : I%=LB%-1 : UB%=UB%+1
11240 X$=STR$(I%) : O%=LEN(X$) : X$=RIGHT$(X$,O%-1)
11250 IF I%<10 THEN X$="00"+X$ ELSE IF I%<100 THEN X$="0"+X$
11260 OPEN X$ FOR INPUT AS #1
11270 INPUT #1,PLANT$,UNIT$ : L%=L%+1 : D$(L%)=X$ : P$(L%)=PLANT$ : U$(L%)=UNIT$
11280 LOCATE 15,28 : PRINT "Number of files found: "; : COLOR 0,7 : PRINT L% : COLOR 7,0
11290 CLOSE #1 : I%=I%+1 : LOCATE 13,39 : PRINT I% : IF I% <UB% THEN 11240
11300 NUM.PLANTS.ON.FILE=L% : OPEN "DOCKLIST" FOR OUTPUT AS #3 : FOR I%=0 TO NUM.PLANTS.ON.FILE
11310 WRITE #3, D$(I%),P$(I%),U$(I%) : NEXT I% : CLOSE #3 : DOCKLIST.FLAG$="Y"
11320 CLS : LOCATE 12 : PRINT TAB(34) "Job Complete" : GOSUB 10620 : GOTO 1230
11330 END
```

APPENDIX D

CALC.BAS

TABLE OF CONTENTS

```
10  '                                        ************
20  '                                        * CALC.BAS *
30  '                                        ************
40  '
50  ' This module is chained from RCSLK9.BAS, Data Analysis, Line 9060, and chains to RCSLK9, Data and
60  ' Analysis Menu, Line 1210, from Continuation Options, Line 5490.
70  '
80  '
90  '                                     ** ERROR TRAP **
100 '
110 DEFDBL A-Z     :    ON ERROR GOTO 120    :    GOTO 190
120 IF ERR<>27 AND ERR<>24 AND ERR<>25 THEN ON ERROR GOTO 0
130 CLS  :  LOCATE 12,15  :  COLOR 7,0  :  PRINT "Check printer for power and paper." : GOSUB 4680
140 CLS : RESUME
150 '
160 '
170 '                                     ** DATA INPUT **
180 '
190 CLS  : LOCATE 11
200 PRINT TAB(19) "Type test date in quotes";    : INPUT " -> ",T.DATE$
210 PRINT TAB(19) "Type test start time";        : INPUT " -> ",T.TIME$
220 PRINT TAB(19) "Type test duration in hours"; : INPUT " -> ",DURATION
230 '
240 CLS  : LOCATE 10
250 PRINT TAB(23) "Type the quantity of water in gallons:" : PRINT
260 PRINT TAB(35) "Charged";     : INPUT " -> ",GAL.CHARGED
270 PRINT TAB(31) "and Drained"; : INPUT " -> ",GAL.DRAINED
280 '
290 CLS
300 LDT.METHOD$ ="Cal" : DT.METHOD$ ="Cal" : RQT.METHOD$ ="Cal"
310 LDT.NOTE$   ="(1)" : DT.NOTE$   ="(1)" : RQT.NOTE$   ="(1)"
320 '
330 IF LDT.GEO$<>"Yes" AND DT.GEO$<>"Yes" AND RQT.GEO$<>"Yes" THEN 590
340 '
350 LOCATE 10
360 PRINT TAB(18) "For  the  following tank(s), select either  the"
370 PRINT TAB(18) "Calibration (C) or the Geometric (G) Method for"
380 PRINT TAB(18) "calculating water inventories:" : PRINT
390 '
400 IF LDT.GEO$="Yes" THEN PRINT TAB(26); LD.TANK$; " "; ELSE 460
410 PRINT"(C/G)"; : INPUT " -> ",X$
420 '
430 IF X$ ="C" OR X$ ="c" THEN LDT.METHOD$ ="Cal" ELSE LDT.NOTE$ ="(2)"
440 IF X$ ="G" OR X$ ="g" THEN LDT.METHOD$ ="Geo" ELSE IF X$<>"C" OR X$<>"c" THEN 350
450 '
460 IF DT.GEO$ ="Yes" THEN PRINT TAB(26) "Drain Tank "; ELSE 530
470 PRINT "(C/G)"; : INPUT " -> ",X$
480 '
490 IF X$ ="C" OR X$ ="c" THEN DT.METHOD$ ="Cal" ELSE DT.NOTE$ ="(2)"
500 IF X$ ="G" OR X$ ="g" THEN DT.METHOD$ ="Geo"
510 IF X$<>"C" AND X$<>"G" AND X$<>"c" AND X$<>"g" THEN 460
520 '
530 IF RQT.GEO$="Yes" AND RQ.TANK$<>"Drain Tank" THEN PRINT TAB(26); RQ.TANK$; " "; ELSE 590
540 INPUT "(C/G) -> ",X$
```

```
550  '
560  IF X$ ="C" OR X$ ="c" THEN RQT.METHOD$ ="Cal" ELSE RQT.NOTE$ ="(2)"
570  IF X$ ="G" OR X$ ="g" THEN RQT.METHOD$ ="Geo" ELSE IF X$<>"C" AND X$<>"c" THEN 530
580  '
590  CLS : LOCATE 9 : A% = 12
600  PRINT TAB(19) "Type values for the following system variables:" : PRINT : PRINT
610  '
620  IF PZR.COMP$<>"Yes" THEN 650
630  PRINT TAB(23) "Pressure, psia  ( 1400 < Range < 2700 )"         : PRINT : GOTO 660
640  '
650  PRINT TAB(18) "Pressure, psia   ( Hot Leg P sat < Range < 3200 )" : PRINT
660  PRINT TAB(29); : INPUT "Initial Value -> ",PRES.I
670  PRINT TAB(29); : INPUT "Final  Value  -> ",PRES.F
680  '
690  CLS : LOCATE 12
700  PRINT TAB(22) "T Ave, degrees F  ( 32 < Range < 662 )" : PRINT
710  PRINT TAB(29); : INPUT "Initial Value -> ",T.AVE.I
720  PRINT TAB(29); : INPUT "Final  Value  -> ",T.AVE.F
730  '
740  CLS :LOCATE 12 : PRINT TAB(18) "Pressurizer Level, ";LEFT$(PZR.UNITS$,6);"    ("; PZR.LO.LMT;
750                   PRINT "< Range <";PZR.UP.LMT;")"  : PRINT
760  PRINT TAB(29); : INPUT "Initial Value -> ",PZR.LVL.I
770  PRINT TAB(29); : INPUT "Final  Value  -> ",PZR.LVL.F
780  '
790  IF RQ.TANK$="Drain Tank" THEN 910
800  '
810  CLS : LOCATE 12
820  PRINT TAB(18) RQ.TANK$;" Level, ";LEFT$(RQT.UNITS$,6);
830  IF RQT.METHOD$="Cal" THEN PRINT "  (";RQT.LO.LMT;"< Range <";RQT.UP.LMT;")"          : GOTO 870
840  IF RQT.METHOD$="Geo" AND RQT.UNITS$="%"      THEN PRINT "  ( 0 < Range < 100 )" : GOTO 870
850  IF RQT.METHOD$="Geo" AND RQT.UNITS$="inches" THEN PRINT "  ( 0 < Range <";12*2*RQT.CYL.RAD;")"
860  '
870  PRINT
880  PRINT TAB(29); : INPUT "Initial Value -> ",RQT.LVL.I
890  PRINT TAB(29); : INPUT "Final  Value  -> ",RQT.LVL.F
900  '
910  CLS : LOCATE 12
920  PRINT TAB(18); LD.TANK$; " Level, "; LEFT$(LDT.UNITS$,6);
930  IF LDT.METHOD$="Cal" THEN PRINT "  (";LDT.LO.LMT;"< Range <";LDT.UP.LMT;")"          : GOTO 970
940  IF LDT.METHOD$="Geo" AND LDT.UNITS$="%"      THEN PRINT "  ( 0 < Range < 100 )" : GOTO 970
950  IF LDT.METHOD$="Geo" AND LDT.UNITS$="inches" THEN PRINT "  ( 0 < Range <";12*2*LDT.CYL.RAD;"
960  '
970  PRINT
980  PRINT TAB(29); : INPUT "Initial Value -> ",LDT.LVL.I
990  PRINT TAB(29); : INPUT "Final  Value  -> ",LDT.LVL.F
1000 '
1010 CLS : LOCATE 12
1020 PRINT TAB(18) "Drain Tank Level, ";DT.UNITS$;
1030 IF DT.METHOD$="Cal" THEN PRINT "  (";DT.LO.LMT;"< Range <";DT.UP.LMT;")"        : GOTO 1070
1040 IF DT.METHOD$="Geo" AND DT.UNITS$="%"      THEN PRINT "  ( 0 < Range < 100 )"   : GOTO 1070
1050 IF DT.METHOD$="Geo" AND DT.UNITS$="inches" THEN PRINT "  ( 0 < Range <";12*2*DT.CYL.RAD;")"
1060 '
```

```
1070 PRINT
1080 PRINT TAB(29); : INPUT "Initial Value -> ",DT.LVL.I
1090 PRINT TAB(29); : INPUT "Final  Value  -> ",DT.LVL.F
1100 '
1110 CLS : LOCATE 7
1120 PRINT TAB(18) "Choose the temperature and pressure conditions  to"
1130 PRINT TAB(18) "establish the density of the leakage.  The choices"
1140 PRINT TAB(18) "are "  :  PRINT
1150 PRINT TAB(18) "  (1) Standard Conditions,"
1160 PRINT TAB(18) "  (2) Average Reactor Cooling System Conditions,"
1170 PRINT TAB(18) "  (3) Other."  :  PRINT
1180 PRINT TAB(18) "Which would you like (1/2/3)"; : INPUT X$
1190 '
1200 IF X$<>"1" AND X$<>"2" AND X$<>"3" THEN 1110
1210 IF X$ ="1" THEN LEAK.COND$ ="Standard" : LEAK.TEMP=70 : LEAK.PRES=14.7 : LEAK.PRES=14.7
1220 IF X$ ="2" THEN LEAK.COND$ ="Ave RCS"  : LEAK.TEMP=(T.AVE.I+T.AVE.F)/2 : LEAK.PRES=(PRES.I+PRES.F)/2
1230 IF X$ ="3" THEN LEAK.COND$ ="Other"      ELSE 1280
1240 '
1250 LOCATE 18 : PRINT TAB(18) "Type the selected temperature in degrees F"; : INPUT " -> ",LEAK.TEMP
1260 LOCATE 19 : PRINT TAB(18) "Type the selected pressure in psia        ";          : INPUT " -> ",LEAK.PRES
1270 '
1280 GOSUB 4760 : CLS :                                          REM: Input Check
1290 '
1300 '
1310 '                                  ** CALCULATIONS **
1320 '
1330 ' References:
1340 '    (1) "ASME Steam Tables," Fourth Edition.
1350 '    (2) "Horizontal Tanks," Note to J. Chung from R. Woodruff, May 22, 1981.
1360 '
1370 LOCATE 12,24 :PRINT"Performing leak rate calculations"
1380 '
1390 IF PZR.COMP$<>"No" THEN 1490
1400 '
1410 '
1420 '                              * Uncompensated Pressurizer *
1430 '
1440 PZR.INV.I = PZR.SLOPE * PZR.LVL.I
1450 PZR.INV.F = PZR.SLOPE * PZR.LVL.F
1460 GOTO 1650
1470 '
1480 '
1490 '                               * Compensated Pressurizer *
1500 '
1510 PRES = PRES.I   : GOSUB 3460  :                             REM: Saturation Temperature
1520 TEMP = TEMP.SAT : GOSUB 3790  :                             REM: Density of water
1530 '
1540 GOSUB 4180                    :                             REM: Density of Saturated Steam
1550 '
1560 PZR.INV.I =DENSITY.WTR*PZR.BTM.VOL
1570 PZR.INV.I =PZR.INV.I+DENSITY.STM*PZR.TOP.VOL+(DENSITY.WTR-DENSITY.STM)*(PZR.LVL.I-PZR.LVL.NOM)*PZR.SLOPE
1580 PRES = PRES.F    :  GOSUB 3460
1590 TEMP = TEMP.SAT  :  GOSUB 3790
1600 '
```

```
1610 GOSUB 4180
1620 '
1630 PZR.INV.F = DENSITY.WTR * PZR.BTM.VOL + DENSITY.STM *PZR.TOP.VOL
1640 PZR.INV.F = PZR.INV.F + (DENSITY.WTR - DENSITY.STM)*(PZR.LVL.F - PZR.LVL.NOM) * PZR.SLOPE
1650 PZR.INV.CHG = PZR.INV.F - PZR.INV.I
1660 '
1670 '
1680 '                                    * Vessel and Piping *
1690 '
1700 PRES=PRES.I : TEMP=T.AVE.I : GOSUB 3790 :                          REM: Density of Water
1710 '
1720 VP.INV.I = DENSITY.WTR * VP.VOL
1730 '
1740 PRES=PRES.F : TEMP=T.AVE.F : GOSUB 3790
1750 '
1760 VP.INV.F = DENSITY.WTR * VP.VOL
1770 VP.INV.CHG = VP.INV.F - VP.INV.I
1780 '
1790 '
1800 '                              * Volume Control (or Makeup) Tank *
1810 '
1820 TANK$  =LD.TANK$    : DENSITY=LDT.DENSITY : UNITS$=LDT.UNITS$ : CYL.RAD=LDT.CYL.RAD
1830 CYL.LEN=LDT.CYL.LEN : CVX.RAD=LDT.CVX.RAD : LVL.I =LDT.LVL.I  : LVL.F  =LDT.LVL.F : SLOPE=LDT.SLOPE
1840 '
1850 IF LDT.METHOD$="Cal" THEN GOSUB 4300 :                             REM: Calibration Method
1860 IF LDT.METHOD$="Geo" THEN GOSUB 4350 :                             REM: Geometric Method
1870 IF LDT.METHOD$="Geo" THEN INV.CHG = INV.CHG * LDT.NORMFAC
1880 '
1890 LDT.INV.CHG = INV.CHG
1900 '
1910 '
1920 '                                 * Quench (or Relief) Tank *
1930 '
1940 IF LEFT$(RQ.TANK$,1) ="D" THEN 2050
1950 TANK$  =RQ.TANK$    : DENSITY=RQT.DENSITY : UNITS$=RQT.UNITS$ : CYL.RAD=RQT.CYL.RAD : SLOPE=RQT.SLOPE
1960 CYL.LEN=RQT.CYL.LEN : CVX.RAD=RQT.CVX.RAD : LVL.I =RQT.LVL.I  : LVL.F  =RQT.LVL.F
1970 '
1980 IF RQT.METHOD$="Cal" THEN GOSUB 4300
1990 IF RQT.METHOD$="Geo" THEN GOSUB 4350
2000 IF RQT.METHOD$="Geo" THEN INV.CHG = INV.CHG * RQT.NORMFAC
2010 '
2020 RQT.INV.CHG = INV.CHG
2030 '
2040 '
2050 '                                        * Drain Tank *
2060 '
2070 TANK$  ="Drain Tank" : DENSITY=DT.DENSITY : UNITS$=DT.UNITS$ : CYL.RAD=DT.CYL.RAD : CYL.LEN=DT.CYL.LEN
2080 CVX.RAD=DT.CVX.RAD   : LVL.I  =DT.LVL.I   : LVL.F =DT.LVL.F  : SLOPE  =DT.SLOPE
2090 '
2100 IF DT.METHOD$="Cal" THEN GOSUB 4300
2110 IF DT.METHOD$="Geo" THEN GOSUB 4350
2120 IF DT.METHOD$="Geo" THEN INV.CHG = INV.CHG * DT.NORMFAC
2130 '
2140 DT.INV.CHG =INV.CHG
```

```
2150 '
2160 '
2170 '                                    * Water Charged and Drained *
2180 '
2190 MASS.CHARGED = 8.3238 * GAL.CHARGED :                          REM: Mass in Pounds
2200 MASS.DRAINED = 8.3238 * GAL.DRAINED
2210 '
2220 '                                       * Leakage Density *
2230 '
2240 '
2250 PRES = LEAK.PRES  :  TEMP = LEAK.TEMP
2260 GOSUB 3790        :                                           REM: Density of Water
2270 LEAK.DENSITY = DENSITY.WTR
2280 '
2290 '
2300 '                                          * Leak Rates *
2310 '
2320 RCS.INV.CHG = VP.INV.CHG + PZR.INV.CHG + LDT.INV.CHG - MASS.CHARGED + MASS.DRAINED
2330 '
2340 GROSS.LEAK.RATE = -RCS.INV.CHG/LEAK.DENSITY*7.481/DURATION/60
2350 '
2360 IDENT.LEAK.RATE = (RQT.INV.CHG + DT.INV.CHG)/LEAK.DENSITY
2370 IDENT.LEAK.RATE = IDENT.LEAK.RATE*7.481/DURATION/60!
2380 UNIDENT.LEAK.RATE = GROSS.LEAK.RATE - IDENT.LEAK.RATE
2390 '
2400 '
2410 '                                         ** DATA OUTPUT **
2420 '
2430 CLOSE 2 : IF PRINT.FLAG$<>"Y" THEN  OPEN "SCRN:" FOR OUTPUT AS 2 ELSE OPEN "LPT1:" FOR OUTPUT AS 2
2440 '
2450 CLS : LOCATE 3 : PRINT #2, : PRINT #2, : PRINT #2, TAB(42); "NRC" : PRINT #2,
2460 '
2470 PRINT #2, TAB(27); "INDEPENDENT MEASUREMENTS PROGRAM"  : PRINT #2,
2480 PRINT #2, TAB(27); "REACTOR COOLING SYSTEM LEAK RATES" : PRINT #2,          : PRINT #2,
2490 PRINT #2, TAB(11); "STATION: "; PLANT$;     TAB(48);    "TEST DATE : ";      : PRINT #2, T.DATE$
2500 PRINT #2, TAB(11); "UNIT    : "; UNIT$ ;     TAB(48);    "START TIME: ";      : PRINT #2, T.TIME$
2510 PRINT #2, TAB(11); "DOCKET : 50-"; DOCKET$; TAB(48);   : PRINT #2,   "DURATION   "; DURATION; "Hours"
2520 PRINT #2, : PRINT #2,
2530 '
2540 GOSUB 4670 :                                                  REM: Conditional Stop
2550 '
2560 PRINT #2, TAB(39); "TEST DATA" :  PRINT #2, : PRINT #2, TAB(48); "Initial"; TAB(63); "Final"
2570 PRINT #2, TAB(16); "System Parameters "     : PRINT #2,
2580 PRINT #2, TAB(17); "Pressure, psia"         ; TAB(48);  PRES.I ; TAB(62)  ; PRES.F
2590 PRINT #2, TAB(17); "T Ave, degrees F"       ; TAB(48);  T.AVE.I; TAB(62)  ; T.AVE.F : PRINT #2,
2600 PRINT #2, TAB(16); "Water Levels "          : PRINT #2,
2610 PRINT #2, TAB(17); "Pressurizer, "          ; PZR.UNITS$       ; TAB(48)  ;
2620 PRINT #2, PZR.LVL.I; TAB(62)                ; PZR.LVL.F
2630 '
2640 IF RQ.TANK$="Drain Tank" THEN 2680
2650 '
2660 PRINT #2, TAB(17); RQ.TANK$           ; ", " ; RQT.UNITS$; TAB(48); RQT.LVL.I;
2670 PRINT #2, TAB(62): RQT.LVL.F
2680 PRINT #2, TAB(17); LD.TANK$           ; ", " ; LDT.UNITS$; TAB(48); LDT.LVL.I;
```

```
2690 PRINT #2, TAB(62); LDT.LVL.F
2700 PRINT #2, TAB(17); "Drain Tank, "    ; DT.UNITS$        ; TAB(48); DT.LVL.I;
2710 PRINT #2, TAB(62); DT.LVL.F          :  PRINT #2,
2720 PRINT #2, TAB(16); "Water Charged ="; GAL.CHARGED      ; "gal";
2730 PRINT #2, TAB(46); "Water Drained ="; GAL.DRAINED      ; "gal"
2740 '
2750 GOSUB 4670 : PRINT #2, : PRINT #2,
2760 '
2770 PRINT #2, TAB(38); "TEST RESULTS"                          : PRINT #2,
2780 PRINT #2, TAB(11); "Change in Water Inventory in pounds:" : PRINT #2,
2790 '
2800 IF RQ.TANK$="Drain Tank" THEN 2970
2810 '
2820 PRINT #2, TAB(12)       ; "Vessel & Piping"; TAB(35);
2830 PRINT #2, USING "######"; VP.INV.CHG       ;
2840 PRINT #2, TAB(44)       ; RQ.TANK$         ; " "      ; RQT.NOTE$; TAB(67);
2850 PRINT #2, USING "######"; RQT.INV.CHG
2860 PRINT #2, TAB(12)       ; "Pressurizer"    ; TAB(35)  ;
2870 PRINT #2, USING "######"; PZR.INV.CHG;
2880 PRINT #2, TAB(44)       ; "Drain Tank"; " "; DT.NOTE$ ; TAB(67);
2890 PRINT #2, USING "######"; DT.INV.CHG
2900 PRINT #2, TAB(12)       ; LD.TANK$    ; " "; LDT.NOTE$; TAB(35);
2910 PRINT #2, USING "######"; LDT.INV.CHG ;
2920 PRINT #2, TAB(67)       ; "------"
2930 PRINT #2, TAB(12)       ; "Less: Water Charged"       ; TAB(35);
2940 PRINT #2, USING "######"; MASS.CHARGED;
2950 PRINT #2, TAB(44)       ; "Collected Leakage"         ; TAB(67);
2960 PRINT #2, USING "######"; RQT.INV.CHG +DT.INV.CHG     : GOTO 3070
2970 PRINT #2, TAB(12)       ; "Vessel & Piping"           ; TAB(35);
2980 PRINT #2, USING "######"; VP.INV.CHG  ;
2990 PRINT #2, TAB(44)       ; "Drain Tank"; " "; DT.NOTE$ ; TAB(68);
3000 PRINT #2, USING "######"; DT.INV.CHG
3010 PRINT #2, TAB(12)       ; "Pressurizer"               ; TAB(35);
3020 PRINT #2, USING "######"; PZR.INV.CHG ;
3030 PRINT #2, TAB(12)       ; LD.TANK$    ; " "; LDT.NOTE$; TAB(35);
3040 PRINT #2, USING "######"; LDT.INV.CHG
3050 PRINT #2, TAB(12)       ; "Less: Water Charged"       ; TAB(35);
3060 PRINT #2, USING "######"; MASS.CHARGED
3070 PRINT #2, TAB(12)       ;"Plus: Water Drained"        ; TAB(35);
3080 PRINT #2, USING "######"; MASS.DRAINED
3090 PRINT #2, TAB(35)       ; "------"
3100 PRINT #2, TAB(12)       ; "Cooling System"            ; TAB(34);
3110 PRINT #2, USING "#######"; RCS.INV.CHG
3120 PRINT #2,               : PRINT #2,
3130 '
3140 GOSUB 4670 :                                                REM: Conditional Stop
3150 '
3160 PRINT #2, TAB(11)       ; "Leak Rates in gpm (3):"    : PRINT #2,
3170 PRINT #2, TAB(33)       ; "Gross"                     ; TAB(46);
3180 PRINT #2, USING "###.##"; GROSS.LEAK.RATE;
3190 PRINT #2, TAB(33)       ; "Identified"                ; TAB(46);
3200 PRINT #2, USING "###.##"; IDENT.LEAK.RATE
3210 PRINT #2, TAB(33)       ; "Unidentified"              ; TAB(46);
3220 PRINT #2, USING "###.##"; UNIDENT.LEAK.RATE
```

```
3230 PRINT #2,                : PRINT #2,
3240 PRINT #2, TAB(11)        ; "(1)  Determined from tank calibration curve."
3250 PRINT #2, TAB(11)        ; "(2)  Determined from tank dimensions."
3260 PRINT #2, TAB(11)        ; "(3)  The density used for converting inventory ";
3270 PRINT #2, "change to leak"  :  PRINT #2, TAB(16);"rate was ";
3280 PRINT #2, USING "##.##" ; LEAK.DENSITY;                : PRINT #2, " pounds/cubic foot based on";
3290 '
3300 IF LEAK.COND$="Standard"                      THEN PRINT #2, " standard"
3310 IF LEAK.COND$="Ave RCS"                       THEN PRINT #2, " average RCS"
3320 IF LEAK.COND$="Standard" OR LEAK.COND$="Ave RCS" THEN PRINT #2, TAB(16);"conditions."
3330 IF LEAK.COND$="Other"                         THEN PRINT #2, LEAK.TEMP; "degrees F and"
3340 IF LEAK.COND$="Other"                         THEN PRINT #2, TAB(16)  ; "and"; LEAK.PRES; "psia."
3350 '
3360 PRINT #2, : PRINT #2, : GOSUB 4670  :  '    Conditional Stop
3370 '
3380 IF PRINT.FLAG$ ="Y" THEN LPRINT CHR$(12)
3390 GOSUB 5380 :                                              REM: Continuation Options
3400 '
3410 CLOSE 2 : OPEN "SCRN:" FOR OUTPUT AS 2 : GOTO 4800
3420 '
3430 '
3440 '                                ** ANALYTICAL SUBROUTINES **
3450 '
3460 '                                 * Saturation Temperature *
3470 '
3480 ' Note: This calculation is based on Page 17, Section 5, Reduced saturation pressure, of Reference (1).
3490 '       It duplicates saturation temperature as given in Table 2 of Reference (1) for pressures from
3500 '       14.696 psia to 3208.2 psia.
3510 '
3520 BETA  = PRES*9.80665*.45359237#/22120000#/.0254/.0254
3530 THETA = .5 : THETA1 = .25
3540 '
3550 SK1 =-7.691234564# : SK2 =-26.08023696# : SK3 =-168.1706546# : SK4 = 64.23285504# : SK5 =-118.9646225#
3560 SK6 = 4.167117320#  : SK7 = 20.9750676#  : SK8 = 1E+09        : SK9 = 6
3570 '
3580 T1 =1-THETA : T2 =T1*T1 : T3 =T1*T2 : T4 =T1*T3 : T5 =T1*T4
3590 '
3600 BETA1 = 1+SK6*T1+SK7*T2
3610 BETA1 = EXP(1/THETA*(SK1*T1+SK2*T2+SK3*T3+SK4*T4+SK5*T5)/BETA1-T1/(SK8*T2+SK9))
3620 '
3630 IF ABS(BETA-BETA1)<5E-08 THEN 3670
3640 IF BETA>BETA1 THEN THETA=THETA+THETA1 ELSE THETA=THETA-THETA1
3650 '
3660 THETA1 = THETA1/2! : GOTO 3550
3670 TEMP.SAT = (THETA*647.3-273.15)*1.8+32
3680 '
3690 IF TEMP.SAT <= 662 THEN 3760
3700 '
3710 CLS : LOCATE 10
3720 PRINT TAB(16) "WARNING! Saturation Temperature exceeds"
3730 PRINT TAB(23) "662 F. Water density for pressurizer is"
3740 PRINT TAB(23) "inaccurate."
3750 GOSUB 4680
3760 RETURN
```

```
3770 '
3780 '
3790 '                                    * Density of Water *
3800 '
3810 ' Note:  This calculation is based on the following sections of Reference (1)--
3820 '                    Page 23; Section 9.1; Sub-region 1, Reduced volume;
3830 '                    Page 14; Section 2.1; Reduced dimensionless quantities;
3840 '                    Page 14; Section 1.3; Defined constant quantities; and
3850 '                    Page  9; Chapter IV ; Units, Notation, and Constants.
3860 '         It duplicates specific volume as given in Table 3 for temperature from 32 to 662 F and for
3870 '         pressure from saturation to 14,000 psia.
3880 '
3890 '
3900 SA1 =.8438375405# : SA2 =.0005362162162# : SA3 =1.72       : SA4 =.07342278489# : SA5 =.0497585887#
3910 SA6 =.65371543#   : SA7 =1.15E-06        : SA8 =1.5108E-05 : SA9 =.14188        : SA10=7.002753165#
3920 SA11=.0002995284926#
3930 '
3940 A11 =7.982692717#     : A12 =-.02616571843#  : A13 =.00152241179#      : A14 =.02284279054#
3950 A15 =242.1647003#     : A16 =1.2697160880-10 : A17 =.0000002074838328# : A18 =.0000000217402035#
3960 A19 =1.105710498D-09  : A20 =12.934419348    : A21 =.00001308119072#   : A22 =6.047626338D-14
3970 '
3980 THETA   =((TEMP-32)/1.8+273.15)/647.3 : THETA2  =THETA*THETA           : THETA6  =THETA2*THETA2*THETA2
3990 THETA11 =THETA6*THETA6/THETA          : THETA18 =THETA6*THETA6*THETA6  : THETA19 =THETA*THETA18
4000 THETA20 =THETA*THETA19
4010 '
4020 BETA  = PRES*9.80665*.45359237#/22120000#/.0254/.0254
4030 BETA2 = BETA*BETA : BETA3=BETA*BETA2
4040 '
4050 Y = 1-SA1*THETA2-SA2/THETA6
4060 Z = Y+SQR(SA3*Y*Y-2*SA4*THETA+2*SA5*BETA)
4070 '
4080 CHI1 = A11*SA5/EXP(LOG(Z)*5/17)+(A12+A13*THETA+A14*THETA2+A15*EXP(LOG(ABS(SA6-THETA))*10)+A16/(SA7+THETA19))
4090 CHI1 = CHI1 - 1/(SA8+THETA11)*(A17+2*A18*BETA+3*A19*BETA2)
4100 CHI1 = CHI1 - A20*THETA18*(SA9+THETA2)*(-3/EXP(LOG(SA10+BETA)*4)+SA11)
4110 CHI1 = CHI1 + 3*A21*(SA12-THETA)*BETA2 + 4*A22/THETA20*BETA3
4120 '
4130 SPECIFIC.VOL=CHI1*3.17*.0160184634#
4140 '
4150 DENSITY.WTR = 1/SPECIFIC.VOL  :  RETURN :                        REM: lb/ft3
4160 '
4170 '
4180 '                               * Density of Saturated Steam *
4190 '
4200 ' Note: The following equation is a curve fit to the density of saturated steam as given on pages 90 and
4210 '        91 of Reference (1).  It is accurate to 1.0% or better in the range from 1400 to 2700 psia.
4220 '
4230 P = PRES-2000
4240 DENSITY.STM = 5.3104+.0038887*P+1.2782E-06*P*P+6.24E-10*P*P*P
4250 RETURN
4260 '
4270 '
```

```
4280 '                                   * Tank Inventory *
4290 '
4300 '                                   Calibration Method
4310 '
4320 INV.CHG = SLOPE * (LVL.F - LVL.I)  :  RETURN
4330 '
4340 '
4350 '                                   Geometric Method
4360 '
4370 IF CVX.RAD=>CYL.RAD THEN GOTO 4430
4380 '
4390 PRINT : PRINT : PRINT
4400 PRINT TAB(16) "ERROR: Radius of Convex Head is less than"
4410 PRINT TAB(23) "Radius of Tank." :CLOSE 1 : GOTO 4800
4420 '
4430 IF UNITS$="inches" THEN LVL.FRAC.I=LVL.I/12/2/CYL.RAD ELSE LVL.FRAC.I=LVL.I/100
4440 IF UNITS$="inches" THEN LVL.FRAC.F=LVL.F/12/2/CYL.RAD ELSE LVL.FRAC.F=LVL.F/100
4450 '
4460 LVL.CHG.FRAC = LVL.FRAC.F - LVL.FRAC.I
4470 NMBR.INCRMNTS = INT(ABS(LVL.CHG.FRAC)/.01+1)
4480 LVL.INCRMNT = LVL.CHG.FRAC / NMBR.INCRMNTS
4490 A = LVL.FRAC.I : F = 0! : PRINT : PRINT : PRINT
4500 '
4510 FOR M%=1 TO NMBR.INCRMNTS
4520 COUNT = NMBR.INCRMNTS - M% + 1
4530 FOR N% = 0 TO 1
4540 T1 = 4*A*(1-A)  : T2 = (CVX.RAD*CVX.RAD)/(CYL.RAD*CYL.RAD)-1 : T3 = SQR(T1/T2)         : T4 = T1+T2
4550 T5 = SQR(T1*T2) : T6 = 4*CYL.RAD*CYL.RAD*CYL.RAD              : T7 = T6*CYL.LEN/CYL.RAD
4560 F(N%) = T7*SQR(T1)-T6*T5+T6*T4*ATN(T3)
4570 A = A + LVL.INCRMNT
4580 NEXT N%
4590 F = F+(F(0)+F(1))*LVL.INCRMNT/2
4600 A = A-LVL.INCRMNT
4610 NEXT M%
4620 INV.CHG = F*DENSITY : RETURN
4630 '
4640 '
4650 '                                   ** INTERRUPTS **
4660 '
4670 PRINT      : IF PRINT.FLAG$ ="Y" THEN RETURN ELSE 4680
4680 COLOR 0,7  : LOCATE 23,29  :  PRINT " To Continue, press any ";
4690 COLOR 16,7 : PRINT "key";  :  COLOR 0,7 : PRINT "." : COLOR 7,0
4700 '
4710 A$=INKEY$ : IF A$ ="" THEN 4710
4720 '
4730 CLS :LOCATE 5 :RETURN
4740 '
4750 '
```

```
4760 '                                   ** INPUT CHECK **
4770 '
4780 '                                    * Corrections *
4790 '
4800 CLS : LOCATE 1,18
4810 PRINT "You may change the following data input to"
4820 LOCATE  2,18 : PRINT "perform the leakrate calculation. "
4830 LOCATE  4,20 : PRINT "(1) Test Duration ( in hours ) -> " ; DURATION
4840 LOCATE  5, 2 : PRINT "Quantity of water, gallons"
4850 LOCATE  6, 2 : PRINT "          (2) charged: "          ; GAL.CHARGED
4860 LOCATE  7, 2 : PRINT "          (3) drained: "          ; GAL.DRAINED
4870 LOCATE  9, 2 : PRINT "Pressure, psia "
4880 LOCATE 10, 2 : PRINT "          (4) initial: "          ; PRES.I
4890 LOCATE 11, 2 : PRINT "          (5)   final: "          ; PRES.F
4900 LOCATE 13, 2 : PRINT "T Ave ,degrees F "
4910 LOCATE 14, 2 : PRINT "          (6) initial: "           ; T.AVE.I
4920 LOCATE 15, 2 : PRINT "          (7)   final: "          ; T.AVE.F : J%=43
4930 LOCATE  5,43 : PRINT LD.TANK$;" level,"                  ; LEFT$(LDT.UNITS$,6)
4940 LOCATE  6,43 : PRINT "          (8) initial: "          ; LDT.LVL.I
4950 LOCATE  7,43 : PRINT "          (9)   final: "          ; LDT.LVL.F
4960 LOCATE  9,43 : PRINT "Drain tank level, "                ; LEFT$(DT.UNITS$,6)
4970 LOCATE 10,43 : PRINT "         (10) initial: "           ; DT.LVL.I
4980 LOCATE 11,43 : PRINT "         (11)   final: "          ; DT.LVL.F
4990 LOCATE 13,43 : PRINT "Pressurizer level, "               ; LEFT$(PZR.UNITS$,6)
5000 LOCATE 14,43 : PRINT "         (12) initial: "          ; PZR.LVL.I
5010 LOCATE 15,43 : PRINT "         (13)   final: "          ; PZR.LVL.F : J%=T2%+2
5020 '
5030 IF RQ.TANK$="Drain Tank" THEN R%=19 :GOTO 5080 ELSE R%=21
5040 '
5050 LOCATE 17,22   : PRINT RQ.TANK$;" level, "                   ; LEFT$(RQT.UNITS$,6)
5060 LOCATE 18,22   : PRINT "         (14) initial: "              ; RQT.LVL.I
5070 LOCATE 19,22   : PRINT "         (15)   final: "              ; RQT.LVL.F
5080 LOCATE R%,14   : PRINT "To change the value of a parameter type its number."
5090 LOCATE R%+1,14 : PRINT "When paramters are correct type 0 ";
5100 INPUT" -> ",X%
5110 '
5120 IF X%=0 THEN RETURN
5130 '
5140 LOCATE R%,14   : PRINT "                                                    "
5150 LOCATE R%+1,14 : PRINT "                                                    "
5160 LOCATE R%+1,14 : PRINT "Type in the value for item number "; X%;
5170 INPUT " -> ",NEW.VALUE
5180 '
5190 ON X% GOTO 5210,5220,5230,5240,5250,5260,5270,5300,5310,5320,5330,5340,5350,5280,5290
5200 '
5210 DURATION    = NEW.VALUE : GOTO 4800
5220 GAL.CHARGED = NEW.VALUE : GOTO 4800
5230 GAL.DRAINED = NEW.VALUE : GOTO 4800
5240 PRES.I      = NEW.VALUE : GOTO 4800
5250 PRES.F      = NEW.VALUE : GOTO 4800
5260 T.AVE.I     = NEW.VALUE : GOTO 4800
5270 T.AVE.F     = NEW.VALUE : GOTO 4800
5280 RQT.LVL.I   = NEW.VALUE : GOTO 4800
5290 RQT.LVL.F   = NEW.VALUE : GOTO 4800
```

```
5300 LDT.LVL.I   = NEW.VALUE : GOTO 4800
5310 LDT.LVL.F   = NEW.VALUE : GOTO 4800
5320 DT.LVL.I    = NEW.VALUE : GOTO 4800
5330 DT.LVL.F    = NEW.VALUE : GOTO 4800
5340 PZR.LVL.I   = NEW.VALUE : GOTO 4800
5350 PZR.LVL.F   = NEW.VALUE : GOTO 4800
5360 '
5370 '
5380 '                              ** CONTINUATION OPTIONS **
5390 '
5400 VP.INV.CHG=0   : PZR.INV.CHG=0  : LDT.INV.CHG =0    : MASS.CHARGED=0  : RQT.INV.CHG=0
5410 MASS.DRAINED=0 : RCS.INV.CHG=0  : GROSS.LEAK.RATE=0 : IDENT.LEAK.RATE=0 : RQT.LVL.I=0 : RQT.LVL.F=0
5420 '
5430 CLS : LOCATE 9,18 : PRINT "You have three options, you may"
5440 LOCATE 11 : PRINT TAB(20) "(1) Exit the program entirely,"
5450            PRINT TAB(20) "(2) Return to the Data and Analysis Menu or "
5460            PRINT TAB(20) "(3) Perform another leak rate for this plant." : PRINT
5470            PRINT TAB(18) "What is your choice (1/2/3)"; : INPUT X$
5480 '
5490 IF X$ ="1" THEN 5520 ELSE IF X$ ="2" THEN CHAIN "RCSLK9.BAS",1210,ALL
5500 IF X$ ="3" THEN 190 ELSE 5430  : STOP
5510 '
5520 CLS : LOCATE 12,10 : PRINT "Do you wish to exit to the SYSTEM or";
5530 PRINT " exit to BASIC "; : COLOR 16,7 : PRINT"(S/B)"; : COLOR 7,0 : INPUT X$
5540 '
5550 IF X$ ="B" OR X$ ="b" THEN CLS : STOP ELSE IF X$ ="S" OR X$ ="s" THEN 5560 ELSE 5520
5560 CLS    :  SYSTEM  :  STOP
5570 END
```

APPENDIX E

PARTIAL TANK VOLUMES

PARTIAL TANK VOLUMES

As suggested by J.W. Chung, the volume of water, V, in a partially filled, horizontal tank with convex heads can be calculated by integrating Sdh where S is the surface area and dh is the thickness of a horizontal, incremental slab of water located at height h above the bottom of the tank.

The surface of the slab has the shape and dimensions shown in Figure 1. The area of the surface can be calculated by dividing it into a rectangle and two circular segments. The area of the retangle is 2cL and the combined area of the two circular segments is bbB - ac where angle B is expressed in radians and is equal to arctan(c/a). Term bbB is twice the area of the smallest circular sector containing one of the segments, and term ac is twice the area of the largest isosceles triangle contained in the sector.

The volume of the incremental slab is

$$dV = [\ 2cL + bb * \arctan(c/a) - ac\ ]\ dh$$

Before this expression can be integrated, a, b, and c must be expressed in terms of h and the tank dimensions, R, H, and L,

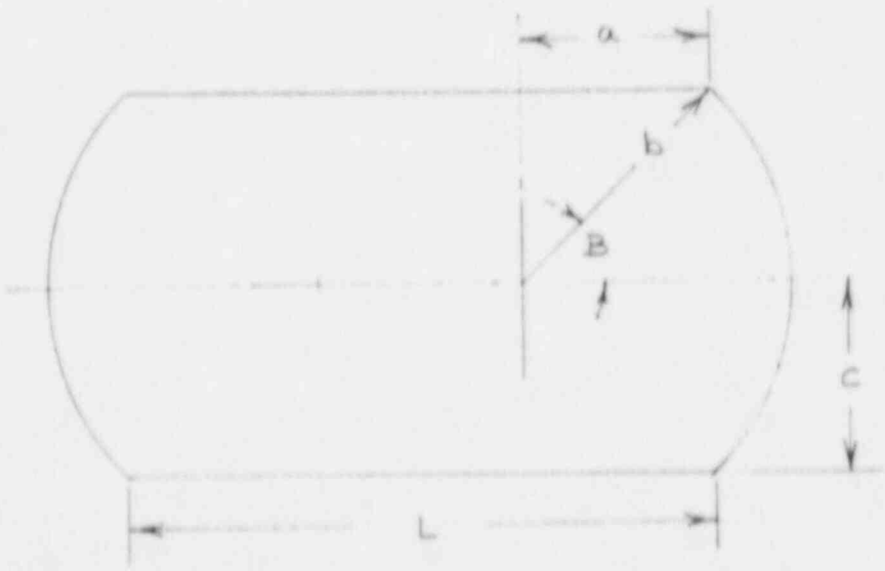

Figure 1: Slab Surface

where R and H are the radii of the cylindrical part of the tank and the heads and L is the length of the cyclindrical part of the tank. The relationships between R, H, L, and h and the dimensions of the incremental slab surface are shown in Figure 2.

From Figure 2, the following expressions can be derived for the dimensions of the slab surface.

$$a = (H^2 - R^2)^{1/2}$$

$$b = [H^2 - (R - h)^2]^{1/2}$$

$$c = [R^2 - (R - h)^2]^{1/2}$$

The height, h, can be expresed as a fraction, A, of the tank diameter by substituting

$$A = h/2R$$

and

$$dA = dh/2R$$

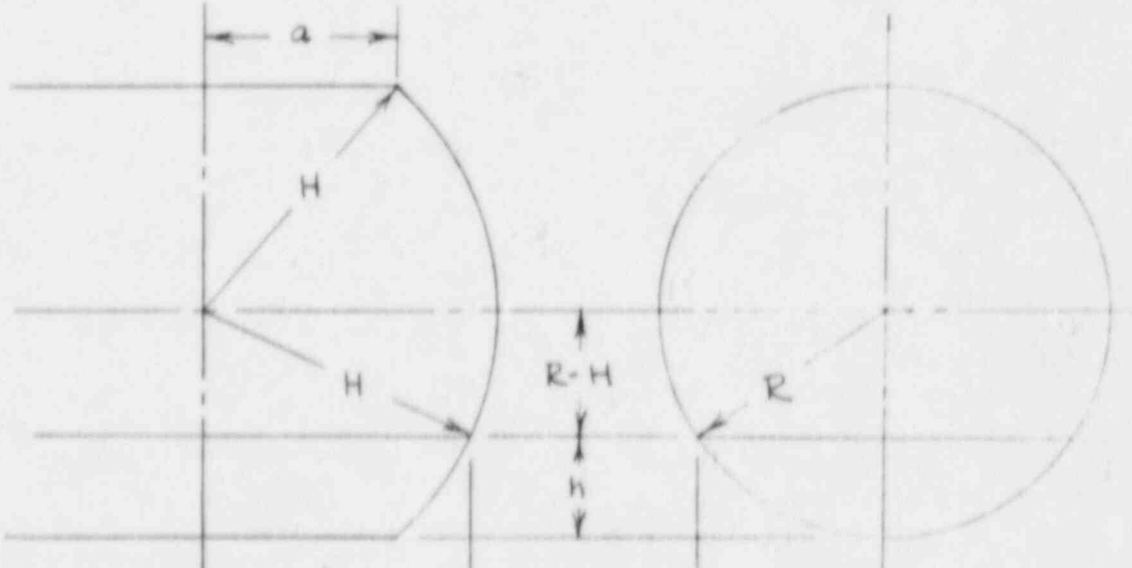

Figure 2: Dimensional Relationships

in the expression for dV. If this is done, the volume of the incremental slab is

$$dV = 8R^2 L\,[A(1-A)]^{1/2}\,dA - 4R^3\,[4A(1-A)]^{1/2}\,[(H/R)^2 - 1]^{1/2}\,dA$$

$$+\ 4R^3\,[4A(1-A) + (H/R)^2 - 1]\ \arctan\,\{[4A(1-A)]/[(H/R)^2 - 1]\}^{1/2}\,dA$$

This expression for dV is the basis for the numerical integration in the Tank Inventory subroutine using the geometric method which is given in Appendices C and D. In the subroutine, the height increment is set at 1% or less of the tank diameter and the surface area is the mean of the upper and lower surfaces of the slab. Slab volumes are calculated and summed from the initial surface level to the final surface level.

APPENDIX F

CURRENT PLANT LIST

PLANTS WITH PARAMETERS ON FILE

50-255	Palisades 1
50-266	Point Beach 1
50-282	Prairie Island 1
50-295	Zion 1
50-301	Point Beach 2
50-304	Zion 2
50-305	Kewaunee 1
50-306	Prairie Island 2
50-312	Rancho Seco 1
50-315	D. C. Cook 1
50-316	D. C. Cook 2
50-317	Calvert Cliffs 1
50-318	Calvert Cliffs 2
50-320	Three Mile Island 2
50-344	Trojan 1
50-346	Davis-Besse 1
50-348	Farley 1

APPENDIX G

CURRENT PARAMETER LISTS

TABLE OF CONTENTS

PARAMETER LIST

Unit Identification:	
Plant Name	Calvert Cliffs
Unit Number	1
Docket Number	50-317
Nuclear Steam System Supplier	Combustion Engineering
Vessel and Piping:	
Volume	9601 cubic feet
Pressurizer:	
Level Units	inches
Temperature Compensated	No
Calibration Curve	
Slope	139.82 pounds per inch
Upper Level Limit	375 inches
Lower Level Limit	32 inches
Relief	Quench Tank
Volume Control Tank:	
Level Units	inches
Calibration Curve	
Slope	230.389 pounds per inch
Upper Level Limit	168 inches
Lower Level Limit	0 inches
Geometric Method Available	No
Drain Tank:	
Level Units	inches
Calibration Curve	
Slope	174.513 pounds per inch
Upper Level Limit	40 inches
Lower Level Limit	15 inches
Water Density	62.27 pounds per cubic foot
Geometric Method Available	Yes
Dimensions	
Cylinder Radius	2.2422 feet
Cylinder Length	7.2292 feet
Head Radius	4.4844 feet
Normalization Factor	0.9755
Quench Tank:	
Level Units	inches
Calibration Curve	
Slope	291.513 pounds per inch
Upper Level Limit	40 inches
Lower Level Limit	15 inches
Water Density	62.27 pounds per cubic foot
Geometric Method Available	Yes
Dimensions	
Cylinder Radius	2.474 feet
Cylinder Length	10.494 feet
Head Radius	4.4459 feet
Normalization Factor	1.0254

PARAMETER LIST

Unit Identification:	
Plant Name	Calvert Cliffs
Unit Number	2
Docket Number	50-318
Nuclear Steam System Supplier	Combustion Engineering
Vessel and Piping:	
Volume	9601 cubic feet
Pressurizer:	
Level Units	inches
Temperature Compensated	No
Calibration Curve	
Slope	139.82 pounds per inch
Upper Level Limit	375 inches
Lower Level Limit	32 inches
Relief	Quench Tank
Volume Control Tank:	
Level Units	inches
Calibration Curve	
Slope	230.389 pounds per inch
Upper Level Limit	168 inches
Lower Level Limit	0 inches
Geometric Method Available	No
Drain Tank:	
Level Units	inches
Calibration Curve	
Slope	174.513 pounds per inch
Upper Level Limit	40 inches
Lower Level Limit	15 inches
Water Density	62.27 pounds per cubic foot
Geometric Method Available	Yes
Dimensions	
Cylinder Radius	2.2422 feet
Cylinder Length	7.2292 feet
Head Radius	4.4844 feet
Normalization Factor	0.9755
Quench Tank:	
Level Units	inches
Calibration Curve	
Slope	291.513 pounds per inch
Upper Level Limit	40 inches
Lower Level Limit	15 inches
Water Density	62.27 pounds per cubic foot
Geometric Method Available	Yes
Dimensions	
Cylinder Radius	2.474 feet
Cylinder Length	10.494 feet
Head Radius	4.4459 feet
Normalization Factor	1.0254

PARAMETER LIST

Unit Identification:	
Plant Name	D.C. Cook
Unit Number	1
Docket Number	50-315
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	10812 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	No
Calibration Curve	
Slope	579.367 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	161.619 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	30.144 pounds per %
Upper Level Limit	75 %
Lower Level Limit	25 %
Geometric Method Available	No
Releif Tank:	
Level Units	%
Calibration Curve	
Slope	1209.88 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	D.C. Cook
Unit Number	2
Docket Number	50-316
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	10812 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	No
Calibration Curve	
Slope	579.367 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	161.619 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	30.144 pounds per %
Upper Level Limit	75 %
Lower Level Limit	25 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	1209.88 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Davis-Besse
Unit Number	1
Docket Number	50-346
Nuclear Steam System Supplier	Babcock & Wilcox
Vessel and Piping:	
Volume	10040 cubic feet
Pressurizer:	
Level Units	inches
Temperature Compensated	Yes
Nominal Level	200 inches
Volume Below Nominal Level	681.87 cubic feet
Volume Above Nominal Level	0 cubic feet
Calibration Curve	
Slope	3.1865 cubic feet per inch
Upper Level Limit	456 inches
Lower Level Limit	48 inches
Relief	Relief Tank
Makeup Tank:	
Level Units	inches
Calibration Curve	
Slope	258.221 pounds per inch
Upper Level Limit	100 inches
Lower Level Limit	0 inches
Geometric Method Available	No
Drain Tank:	
Level Units	inches
Calibration Curve	
Slope	62.473 pounds per inch
Upper Level Limit	80 inches
Lower Level Limit	15 inches
Geometric Method Available	No
Relief Tank:	
Level Units	inches
Calibration Curve	
Slope	368.034 pounds per inch
Upper Level Limit	120 inches
Lower Level Limit	48 inches
Geometric Method Available	No

PARAMETER LIST

Unit Idnetification:	
Plant Name	Farley
Unit Number	1
Docket Number	50-348
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	8306 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	No
Calibration Curve	
Slope	395.88 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	114.63 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	31.606 pounds per %
Upper Level Limit	85 %
Lower Level Limit	15 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	830.074 pounds per %
Upper Level Limit	79 %
Lower Level Limit	67 %
Geometric Method Available	No

PARAMETER LIST

Unit Identificaiton:	
Plant Name	Kewaunee
Unit Number	1
Docket Number	50-305
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	5591 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	No
Calibration Curve	
Slope	327.8 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	105.6 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	29.33 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	557.74 pounds per %
Upper Level Limit	74 %
Lower Level Limit	72 %
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Palisades
Unit Number	1
Docket Number	50-255
Nuclear Steam System Supplier	Combustion Engineering
Vessel and Piping:	
Volume	10100 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	Yes
Nominal Level	53 %
Volume Below Nominal Level	800 cubic feet
Volume Above Nominal Level	0 cubic feet
Calibration Curve	
Slope	14.33 cubic feet per %
Upper Level Limit	88 %
Lower Level Limit	12 %
Relief	Quench Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	286.48 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	65.39 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Quench Tank:	
Level Units	%
Calibration Curve	
Slope	451.52 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Point Beach
Unit Number	1
Docket Number	50-266
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	5440 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	Yes
Nominal Level	50 %
Volume Below Nominal Level	500 cubic feet
Volume Above Nominal Level	0 cubic feet
Calibration Curve	
Slope	8.56 cubic feet per %
Upper Level Limit	61 %
Lower Level Limit	38 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	107.25 pounds per %
Upper Level Limit	78 %
Lower Level Limit	8 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	33.27 pounds per %
Upper Level Limit	50 %
Lower Level Limit	7 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	519.89 pounds per %
Upper Level Limit	76 %
Lower Level Limit	66 %
Geometric Method Available	No

PARAMTER LIST

Unit Identification:	
Plant Name	Point Beach
Unit Number	2
Docket Number	50-301
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	5440 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	Yes
Nominal Level	50 %
Volume Below Nominal Level	500 cubic feet per %
Volume Above Nominal Level	0 cubic feet
Calibration Curve	
Slope	8.56 cubic feet per %
Upper Level Limit	61%
Lower Level Limit	38%
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	107.25 pounds per %
Upper Level Limit	78 %
Lower Level Limit	8 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	33.27 pounds per %
Upper Level Limit	50 %
Lower Level Limit	7 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	519.89 pounds per %
Upper Level Limit	76 %
Lower Level Limit	66 %
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Prairie Island
Unit Number	1
Docket Number	50-282
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	5591 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	Yes
Nominal Level	35 %
Volume Below Nominal Level	372.944 cubic feet
Volume Above Nominal Level	0 cubic feet
Calibration Curve	
Slope	8.637 cubic feet per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	104.954 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	28.599 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	527.548 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Prairie Island
Unit Number	2
Docket Number	50-306
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	5591 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	Yes
Nominal Level	35 %
Volume Below Nominal Level	372.944 cubic feet
Volume Above Nominal Level	0 cubic feet
Calibration Curve	
Slope	8.637 cubic feet per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	104.954 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	28.599 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	527.548 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Rancho Seco
Unit Number	1
Docket Number	50-312
Nuclear Steam System Supplier	Babcock & Wilcox
Vessel and Piping:	
Volume	10578.2 cubic feet
Pressurizer:	
Level Units	inches
Temperature Compensated	Yes
Nominal Level	200 inches
Volume Below Nominal Level	872.6 cubic feet
Volume Above Nominal Level	0 cubic feet
Calibration Curve	
Slope	3.16678 cubic feet per inch
Upper Level Limit	320 inches
Lower Level Limit	0 inches
Relief	Drain Tank
Makeup Tank:	
Level Units	inches
Calibration Curve	
Slope	256 pounds per inch
Upper Level Limit	100 inches
Lower Level Limit	0 inches
Geometric Method Available	No
Drain Tank:	
Level Units	inches
Calibration Curve	
Slope	280 pounds per inch
Upper Level Limit	120 inches
Lower Level Limit	48 inches
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Three Mile Island
Unit Number	2
Docket Number	50-320
Nuclear Steam System Supplier	Babcock & Wilcox
Vessel and Piping:	
Volume	10346 cubic feet
Pressurizer:	
Level Units	inches
Temperature Compensated	Yes
Nominal Level	200 inches
Volume Below Nominal Level	800 cubic feet
Volume Above Nominal Level	700 cubic feet
Calibration Curve	
Slope	3.208 cubic feet per inch
Upper Level Limit	400 inches
Lower Level Limit	0 inches
Relief	Drain Tank
Makeup Tank:	
Level Units	inches
Calibration Curve	
Slope	257 pounds per inch
Upper Level Limit	100 inches
Lower Level Limit	0 inches
Geometric Method Available	No
Drain Tank:	
Level Units	inches
Calibration Curve	
Slope	610.8 pounds per inch
Upper Level Limit	81 inches
Lower Level Limit	73 inches
Geometric Method Available	No

PARAMETER LIST

Unit Identification:	
Plant Name	Trojan
Unit Number	1
Docket Number	50-344
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	10811 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	No
Calibration Curve	
Slope	1215 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	158.9 pounds per %
Upper Level Limit	100 %
Lower Level Limit	40 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	33.7 pounds per %
Upper Level Limit	70 %
Lower Level Limit	20 %
Water Density	62.27 pounds per cubic foot
Geometric Method Available	Yes
Dimensions	
Cylinder Radius	1.4821 feet
Cylinder Length	6.2756 feet
Head Radius	2.1695 feet
Normalization Factor	0.9234
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	1176 pounds per %
Upper Level Limit	70 %
Lower Level Limit	30 %
Water Density	62.27 pounds per cubic foot
Geometric Method Available	Yes
Dimensions	
Cylinder Radius	4.75 feet
Cylinder Length	23.315 feet
Head Radius	6.5276 feet
Normalization Factor	0.8269

PARAMETER LIST

Unit Identification:	
Plant Name	Zion
Unit Number	1
Docket Number	50-295
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	10938 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	No
Calibration Curve	
Slope	597.59 pounds per %
Upper Level Limit	100 %
lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	159.95 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	29.75 pounds per %
Upper Level Limit	90 %
Lower Level Limit	10 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	1205.62 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No

PARAMETER LIST

Unit Idensification:	
Plant Name	Zion
Unit Number	2
Docket Number	50-304
Nuclear Steam System Supplier	Westinghouse
Vessel and Piping:	
Volume	10938 cubic feet
Pressurizer:	
Level Units	%
Temperature Compensated	No
Calibration Curve	
Slope	597.59 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Relief	Relief Tank
Volume Control Tank:	
Level Units	%
Calibration Curve	
Slope	159.95 pounds per %
Upper Level Limit	100 %
Lower Level Limit	0 %
Geometric Method Available	No
Drain Tank:	
Level Units	%
Calibration Curve	
Slope	29.75 pounds per %
Upper Level Limit	90 %
Lower Level Limit	10 %
Geometric Method Available	No
Relief Tank:	
Level Units	%
Calibration Curve	
Slope	1205.62 pounds per %
Upper Level Limit	80 %
Lower Level Limit	20 %
Geometric Method Available	No

APPENDIX H

EXAMPLES

TABLE OF CONTENTS

NRC

INDEPENDENT MEASUREMENTS PROGRAM

REACTOR COOLING SYSTEM LEAK RATES

STATION: Calvert Cliffs	TEST DATE : March 18, 1983
UNIT : 1	START TIME: Software Test
DOCKET : 50-317	DURATION : 2 hours

TEST DATA

	Initial	Final
System Parameters:		
Pressure, psia	2140	2135
T Ave, degrees F	581	582
Water Levels:		
Pressurizer, inches	43	44
Quench Tank, inches	30	31
Volume Control Tank, inches	60	59
Drain Tank, inches	21	22

Water Charged = 10 gal   Water Drained = 2 gal

TEST RESULTS

Change in water inventory in pounds:

Vessel & Piping	-785	Quench Tank (1)	292
Pressurizer	140	Drain Tank (1)	175
Volume Control Tank (1)	-230		------
Less: Water Charged	83	Collected Leakage	466
Plus: Water Drained	17		

Cooling System	-943		

Leak Rates in gpm (3):

Gross	0.94
Identified	0.47
Unidentified	0.48

(1) Determined from tank calibration curves.
(2) Determined from tank dimensions.
(3) The density used for converting inventory change to leak rate was 62.31 pounds/cubic foot based on standard conditions.

NRC

INDEPENDENT MEASUREMENTS PROGRAM

REACTOR COOLING SYSTEM LEAK RATES

STATION: Calvert Cliffs
UNIT : 1
DOCKET : 50-317

TEST DATE : March 18, 1983
START TIME: Software Test
DURATION : 2 hours

TEST DATA

	Initial	Final
System Parameters:		
Pressure, psia	2140	2135
T Ave, degrees F	581	582
Water Levels:		
Pressurizer, inches	43	44
Quench Tank, inches	30	31
Volume Control Tank, inches	60	59
Drain Tank, inches	21	22

Water Charged = 10 gal   Water Drained = 2 gal

TEST RESULTS

Change in water inventory in pounds:

Vessel & Piping	-785
Pressurizer	140
Volume Control Tank (2)	-230
Less: Water Charged	83
Plus: Water Drained	17
Cooling System	-943

Quench Tank (2)	303
Drain Tank (2)	178
Collected Leakage	481

Leak Rates in gpm (3):

Gross	0.94
Identified	0.48
Unidentified	0.46

(1) Determined from tank calibration curves.
(2) Determined from tank dimensions.
(3) The density used for converting inventory change to leak rate was 62.31 pounds/cubic foot based on standard conditions.

NRC

INDEPENDENT MEASUREMENTS PROGRAM

REACTOR COOLING SYSTEM LEAK RATES

STATION: Farley
UNIT : 1
DOCKET : 50-343

TEST DATE : March 18, 1983
START TIME: Software Test
DURATION : 2 hours

TEST DATA

	Initial	Final
System Parameters:		
Pressure, psia	2138	2128
T Ave, degrees F	581	582
Water Levels:		
Presurizer, %	44	43
Relief Tank, %	70	71
Volume Control Tank, %	60	59
Drain Tank, %	21	22

Water Charged = 10 gal   Water Drained = 2 gal

TEST RESULTS

Change in water inventory in pounds:

Vessel & piping	-718
Pressurizer	-396
Volume Control Tank (1)	-115
Less: Water Charged	83
Plus: Water Drained	17
Cooling System	-1295

Relief Tank (1)	830
Drain Tank (1)	32
Collected Leakage	862

Leak Rates in gpm (3):

Gross	1.30
Identified	0.86
Unidetified	0.43

(1) Determined from tank calibration curves.
(2) Determined from tank dimensions.
(3) The density used for converting inventory change to leak rate was 62.31 pounds/cubic foot based on standard conditions.

NRC

INDEPENDENT MEASUREMENTS PROGRAM

REACTOR COOLING SYSTEM LEAK RATES

STATION: Farley	TEST DATE : March 18, 1983
UNIT : 1	START TIME: Software Test
DOCKET : 50-348	DURATION : 2 hours

TEST DATA

	Initial	Final
System Parameters:		
Pressure, psia	2138	2128
T Ave, degrees F	581	582
Water Levels:		
Pressurizer, %	44	43
Relief Tank, %	70	71
Volume Control Tank, %	60	59
Drain Tank, %	21	22

Water Charged = 10 gal   Water Drained = 2 gal

TEST RESULTS

Change in water inventory in pounds:

Vessel & Piping	-718
Pressurizer	-396
Volume Control Tank (1)	-115
Less: Water Charged	83
Plus: Water Drained	17
Cooling System	-1295

Relief Tank (1)	830
Drain Tank (1)	32
Collected Leakage	862

Leak Rates in gpm:

Gross	1.81
Identified	1.21
Unidentified	0.61

(1) Determined from tank calibration curves.
(2) Determined from tank dimensions.
(3) The density used for converting inventory change to leak rate was 44.56 pounds/cubic foot based on average RCS conditions.

NRC

INDEPENDENT MEASUREMENTS PROGRAM

REACTOR COOLING SYSTEM LEAK RATES

STATION: Three Mile Island	TEST DATE : March 18, 1983
UNIT : 2	START TIME: Software Test
DOCKET : 50-320	DURATION : 4 hours

TEST DATA

	Initial	Final
System Parameters:		
Pressure, psia	2100	2000
T Ave, degrees F	570	580
Water Levels:		
Pressurizer, inches	230	220
Makeup Tank, inches	60	70
Drain Tank, inches	73	80

Water Charged = 100 gal   Water Drained = 0 gal

TEST RESULTS

Change in water inventory in pounds:

Vessel & Piping	-8669	Drain Tank (1)	4276
Pressurizer	-648		
Makeup Tank (1)	2570		
Less: Water Charged	832		
Plus: Water Drained	0		

Cooling System	-7579		

Leak Rates in gpm (3):

Gross	3.79
Identified	2.14
Unidentified	1.65

(1) Determined from tank calibration curves.
(2) Determined from tank dimensions.
(3) The density used for converting inventory change to leak rate was 62.31 pounds/ cubic foot based on standard conditions.

NRC

INDEPENDENT MEASUREMENTS PROGRAM

REACTOR COOLING SYSTEM LEAK RATES

STATION: Three Mile Island	TEST DATE : March 18, 1983
UNIT : 2	START TIME: Software Test
DOCKET : 50-320	DURATION : 4 hours

TEST DATA

	Initial	Final
System Parameters:		
Pressure, psia	2100	2000
T Ave, degrees F	570	580
Water Levels:		
Pressuizer, inches	230	220
Makeup Tank, inches	60	70
Drain Tank, inches	73	80

Water Charged = 100 gal   Water Drained = 0 gal

TEST RESULTS

Change in water inventory in pounds:

Vessel & Piping	-8669	Drain Tank (1)	4276
Pressurizer	-648		
Makeup Tank (1)	2570		
Less: Water Charged	832		
Plus: Water Drained	0		

Cooling System	-7579		

Leak Rates in gpm (3):

Gross	5.56
Identified	3.14
Undentified	2.42

(1) Determined from tank calibration curves.
(2) Determined from tank dimensions.
(3) The density used for converting inventory change to leak rate was 42.49 pounds/cubic foot based on 605 degrees F and 2050 psia.

NRC FORM 335 (2-84) NRCM 1102, 3201, 3202

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BIBLIOGRAPHIC DATA SHEET

SEE INSTRUCTIONS ON THE REVERSE

1. REPORT NUMBER (Assigned by TIDC, add Vol. No., if any): NUREG-1107	
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	4. DATE REPORT COMPLETED: MONTH December; YEAR 1984
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12. SUPPLEMENTARY NOTES

Prepared in cooperation with Nuclear Energy Consultants, Inc. working under NRC Contract No. 05-82-249, Task Authorization No. TA-62.

13. ABSTRACT (200 words or less)

RCSLK9 is a computer program that was developed to analyze the leak tightness of the primary coolant system for any pressurized water reactor. From system conditions, water levels in tanks, and certain system design parameters, RCSLK9 calculates the loss of water from the cooling system and the increase of water in the leakage collection system during an arbitrary time interval. The program determines the system leak rates and displays or prints a report of the results. For initial application of the program at a reactor, RCSLK9 creates a file of system parameters and stores it for future use. RCSLK9 is written for use on the IBM PC.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS: Computer program, PWRs, reactor coolant system, Independent Measurements Program, leak rate measurement	15. AVAILABILITY STATEMENT: Unlimited
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