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Modifications of ORNL's Computer Programs MSF-21 and VTE-21 for the Evaluation and Rapid Optimization of Multistage Flash and Vertical Tube Evaporators

P. Glueckstern
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OAK RIDGE NATIONAL LABORATORY
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Subject: Modifications of ORNL's Computer Programs MSF-21 and VTE-21 for the Evaluation and Rapid Optimization of Multistage Flash and Vertical Tube Evaporators

Please correct the following errors in your copy(ies) of subject report.

Page 3, 5th line from bottom -- change HERCØV to HRECØV.

Page 7, 14th line from bottom -- change with (LCØN) to width (LCØN).

Page 8, line 20 -- insert "The derivatives used in" before Newton's method.

Page 8, line 21 -- change WENØM to WFNØM.

Page 61, second line with *** at right -- change XØ(43)=8.DO to XØ(43)=1.DO.

We apologize for your inconvenience.

J L Langford
J. L. Langford
Laboratory Records Department
Information Division

ORNL/TM-5230

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Reactor Division

MODIFICATIONS OF ORNL'S COMPUTER PROGRAMS MSF-21 AND VTE-21 FOR THE EVALUATION AND RAPID OPTIMIZATION OF MULTISTAGE FLASH AND VERTICAL TUBE EVAPORATORS

P. Glueckstern
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JUNE 1976

NOTICE: This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report.

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ABSTRACT

Design and cost modifications were made to ORNL's Computer Programs MSF-21 and VTE-21 originally developed for the rapid calculation and design optimization of multistage flash (MSF) and multieffect vertical tube evaporator (VTE) desalination plants. The modifications include additional design options to make possible the evaluation of desalting plants based on current technology (the original programs were based on conceptual designs applying advanced and not yet proven technological developments and design features) and new materials and equipment costs updated to mid-1975.

1. INTRODUCTION

MSF-21 and VTE-21 are models of the multistage flash (MSF) and the vertical tube evaporator (VTE) processes developed at ORNL in the early 1970s for rapid calculation and design optimizaton of desalination plants. These programs were originally developed as subprograms of an overall system of programs termed ECON-21 consisting of six parts and documented under ORNL-TM-3535. MSF-21 is Part V and VTE-21 is Part VI of this set of documents.[1,2]

MSF-21 and VTE-21 were not developed for the purpose of making detailed design computations and therefore apply various computational approximations for more rapid calculation and overall design optimization. Thus the design computations of MSF plants are based on the first and last stages of each section (recovery and reject) and a typical middle recovery section. As a result of this procedure the program runs rapidly but does not give stage by stage parameters.

The basic designs applied in these programs are ORNL's conceptual designs[3,4] of advanced 250 Mgd MSF and VTE desalting plants, applying novel design features such as large train sizes of 62.5 Mgd, concrete evaporator shells, two-level brine flow (MSF), and very long tubing extending through half of all recovery section stages of the MSF plant.

Both programs comprise a number of subroutine which can be divided into four sections.

1. A main section (MAINM and MAINV for MSF and VTE respectively) where initialization is made, the structural units of the plant are defined, and all relevant other subroutines are called.
2. A design section comprising two subroutines, one for heat and mass balances (PLANTM and PLANTV for MSF and VTE respectively) and one for sizing of physical plant dimensions, equipment sizes, steam and electrical loads, and all other quantities which are necessary to compute the capital and product water costs (SIZEM and SIZEV for MSF and VTE respectively).

3. An economics section comprising three subroutines: (a) subroutine PRICES in which all unit equipment and materials costs for both the MSF and VTE are calculated, (b) subroutine FNANCE in which the overall economics parameters such as the fixed charge rate and the indirect capital cost component factors are calculated, and (c) a subroutine (COSTM and COSTV for MSF and VTE respectively) which finally calculates the capital and unit product water costs, based upon the values calculated in the two previous subroutines.
4. An output section, in which all output is printed.

The main purpose of the present modifications is twofold: to make possible the calculation and design optimization of desalting plants based on current technology and smaller sizes (rather than plants incorporating unproven design features) and to update the cost functions to the prices prevailing in mid-1975.

The design modifications made are mainly in the structural design and the design of the noncondensed gas removal (NCG) system and the feedwater pretreatment system. These modifications are described in Section 2, and the relevant changes in the Fortran statements of the programs are marked on the detailed listings given in Appendices A to H.

All costing modifications and updating are described in Section 3 and shown in the Fortran listing given in Appendices I to M. The changes made in the output subroutines are listed in Appendices N and O.

All notations used in this report are identical to those applied in the original programs documented in refs. 1 and 2. For ready understanding of the modifications described here, it is therefore necessary to read this report along with the original documents describing the programs MSF-21 and VTE-21.

2. CONCEPTUAL DESIGN MODIFICATIONS

2.1 PLANT STRUCTURAL DESIGN

2.1.1 MSF Plants

General — In MSF plants the evaporator shell and foundation cost is one of the two largest cost components, contributing about 30% of the total direct capital cost. This is, of course, a function of the plant dimensions which are determined by applying certain design criteria. In a long tube design, with a given tubing surface area (or performance ratio), the following factors affect the evaporator dimensions and total volume:

1. the maximum allowable mass flow per evaporator width (lb hr^{-1} ft^{-1}),
2. tube velocity and tube diameter,
3. maximum length of tubing or number of water boxes, and
4. evaporator height determined by the freeboard between the tube bundle and the evaporator floor and the geometric shape of the tube bundle.

While the first two factors can be varied by applying appropriate input values in the MSF-21 code, the later two factors were fixed in accordance with the criteria applied in ORNL's 250 Mgd MSF conceptual design.

In order to make the computer program more applicable to current design practice as well as to plant sizes much smaller than the 250 Mgd conceptual design, additional design options have been added.

Tube Bundle Design and Height of Evaporator Shell

The height of the MSF shell of the recovery section (HERCØV) and the reject section (HREJCT) is calculated by the original MSF-21 program as the sum of built-in values for the height of the tube bundle above the evaporator floor and the calculated height of the tubesheet. The latter is calculated by adding 0.5 ft to the height of the tube bundle (HBNDLE).

HBNDLE was calculated by assuming an elliptical tube bundle having a width (WBUNDL) equal to the width of the product tray less 0.5 ft.

This procedure was modified to allow a design with a specified geometric shape of the tube bundle. The new procedure is as follows:

WBUNDL = (XT(126)*APTSE1)**.5 ,

where APTSE1 is the calculated tube bundle area and XT(126) an input value defining the ratio WBUNDL/HBNDLE. APTSE1 is calculated by:

APTSE1 = XT(127)*ARTUBE ,

where ARTUBE is the area required to place the tubes at a defined pitch and XT(127) an input value >1 for allowances of additional area for non-condensable gas removal openings or baffles.

As for the height of tube bundle above the evaporator floor, the built-in fixed value has been replaced by an input parameter XT(120) for the recovery section and XT(129) for the reject section.

For a design specifying a number of brine flow levels in the evaporator (LEV), the additional height for each additional flow level was specified by built-in values. These values were replaced by XT(121) and XT(125) for the recovery and reject section respectively.

MSF Evaporator Width — The outside width at the hot end (WHOT) and at the cold end (WCOLD) were originally calculated by adding built-in values for the thickness of the external and internal walls to the internal evaporator width, calculated according to the allowable brine flow per width of the brine tray. The built-in values which were adequate for only a concrete evaporator shell were replaced by the following additional input parameters:

XT(122) = External wall thickness at the cold end of the evaporator, ft

XT(123) = Internal wall thickness, ft

XT(129) = Ratio of external wall thickness at the hot end to that at the cold end. This parameter is only applicable for a concrete evaporator shell.

Variation of Tube Length — This design variable affects the number of water boxes (and tube sheets) and, therefore, the total length of the evaporator, and consequently, the total pressure drop through the recovery stages (recycle brine) and the reject stages (makeup + reject flow). The maximum tube length is defined by a new input variable XT(200) and is applied to calculate the following:

a. Number of tube bundles in recovery section (ENRSS). ENRSS = ELE/XT(200) + 1 (truncated to an integer), where ELE is the total length of the tubes in the recovery section.
b. Total length (in ft) of recovery section (RECOLN). RECOLN = ELE + (ENRSS-1)*9.667 + 20.0.
c. Required head of recycle pump. To the previous function calculating this value, the additional pressure drop (ENRSS-1)*VHLR in the water boxes has been added; VHLR is the head loss per water box calculated by: XØ(204)*.0155*VE*VE, where VE is the tube velocity and XØ(204) an input parameter defining the number of velocity head losses in each water box.

The same variations have been made also for the reject section. All of the relevant Fortran statements are included in subroutine SIZEM. A full listing of this subroutine, indicating the new statements by asterisks, is given in Appendix E.

Structural Units of the Plant — In the original MSF-21 code the main structural units are defined according to the following criteria:

1. Number of tube bundles (BNDLS): BNDLS = FF/12.5 + .5 (truncated to an integer), where FF is the desalting plant capacity in Mgd.
2. Number of modules (MODU): MODU = 0.5*BNDLS. This implies that each repetitive structural unit or module contains two tube bundles. Half-modules containing only one tube bundle are also allowed whenever the BNDLS is an odd number.
3. Number of trains (TRAINS). TRAINS is computed so that each train contains a maximum of 2-1/2 modules but must not be smaller than a certain minimum defined by an input value (XØ(43)). Each train has enclosing walls and a set of pumps, a brine heater, and a deaerator.
4. Number of buildings (BLDGS). A building is defined as a separate structure with its own external walls and contains two trains. (Whenever TRAINS is an odd number, one of the buildings contains only one train.)

In order to make the program more flexible and allow it to compute specified designs (such as, for example given, BLDGS = TRAINS = MØDU = BNDLS), the following modifications were made in subroutine MAINM (Appendix A):

```
 BNDLS = XØ(208)*XØ(43)
  MØDU = BNDLS/XØ(209)
TRAINS = XØ(43)
 BLDGS = TRAINS/XØ(210)
```

By assigning appropriate values to the input parameters XØ(43), XØ(208), XØ(209) and XØ(210), a design having one bundle per module, one module per train, and one train per building can be specified. Half-modules and half-trains, however, cannot be specified. For a design of two trains per building and/or two modules per train, XØ(43) must be an even number. For a design of three trains per building and/or three modules per train, XØ(43) must be a multiple of 3, and so on. Basically, the above modifications require that the user predefine the design layout of the main structural units, if a design other than that defined by BNDLS = MØDU = TRAINS = BLDGS is desired.

2.1.2 VTE Plants

Structural Units of the Plant — VTE-21 defines the number of buildings, trains, and tube bundles similar to that defined in MSF-21. However, there is no definition of a module; but a train may contain, like a module in MSF-21, one or two tube bundles. The number of tube bundles is calculated as the nearest lower integer of FF/62.5 + .5.

In the modified VTE-21 program, BUNDLS, TRAINS and BLDGS are defined with the same set of input parameters as in MSF-21. The relevant Fortran statements in subroutine MAINV, shown in Appendix B, are marked by asterisks.

VTE-21 fits the VTE effects into a trapezoidal shell, in accordance with the proposed design layout defined in the 250 Mgd Conceptual Design.[4] The total length of the plant is calculated by adding the final condenser shell with (LCØN) to the calculated length of all VTE effects. The condenser tubes, calculated as a function of the heat load and the tubing parameters, are placed in the trapezoidal shell, containing the VTE effects, right after the last effect. If the width of the shell at the cold end is less than the calculated length of the condenser, the shell width at the cold end is enlarged accordingly. This layout, quite appropriate for large capacity trains, is not suitable for small capacity plants, or even for large plants composed of trains having 12.5 Mgd capacity. It was modified to contain a multiple-pass condenser having a length equal to the required width of the last VTE effect. This design will require a two-pass horizontal condenser for train sizes of 10 Mgd, or larger, and a three-pass horizontal or vertical condenser for train sizes smaller than 10 Mgd. The relevant new Fortran statements included in subroutine SIZEV are shown in Appendix F.

Preheater Design — The modifications concerning tube length, tube bundle design, and height of the preheater, identical to those made in the MSF-21 code, were also made in the MSF preheater section of the VTE-21 code. These modifications are included in subroutine SIZEV listed in Appendix F.

Change in Design Parameters — For parametric studies it is desirable to be able to specify the maximum brine concentration and the condenser temperature as part of the input data. VTE-21 was originally written to use heat rate and feed rate factors (QEFAC and FDFAC respectively) rather than the quantities above, so as to avoid certain iterative calculations. The program has now been modifed so that the desired values of maximum brine concentration and of condenser temperature are the input parameters XT(151) and XT(152). Subroutine PLANTV has been modified so that FDFAC and QEFAC are changed iteratively until the desired values of condenser temperature and maximum concentration are obtained. This thwarts the original intent to make the program run rapidly. In both cases Newton's method is used, and satisfactory convergence is normally achieved in fewer than six iterations. The modifications are included in subroutine PLANTV listed in Appendix D. Newton's method came from differentiating the equations defining QNØM and QESP in the case of QEFAC; and WFX and WENØM in the case of FDFAC.

2.2 FEEDWATER PRETREATMENT SYSTEM

The computer programs MSF-21 and VTE-21 considered the consumption of the following chemicals:

a. sulfuric acid (93% H_2SO_4)

b. caustic (NaOH)

c. antifoam

d. chlorine

The equipment cost of the sulfuric acid system is calculated (in subroutine PRICES) as a function of the daily consumption, which in turn is calculated as a function of the plant capacity, concentration ratio and total seawater salinity in subroutines SIZEM (MSF-21) and SIZEV (VTE-21). The equipment cost for the injection of the other chemicals is calculated as a function of the plant capacity, only.

The consumption of chemicals other than sulfuric acid is not calculated directly, but the annual cost for these chemicals is evaluated by using several input parameters, defining the specific cost per unit of water treated (see Section 3.4).

In the modified programs, the same systems are used for acid treated plant designs. The only exception is the addition of sodium sulfite for scavenging residual oxygen. It was assumed that this chemical will be injected by the antifoam injection pumps.

In order to make it possible to evaluate nonacid (polyphosphate or other additives) treated plants, the following modifications were made:

1. A selector switch NFEED has been incorporated. If NFEED = 1, acid treated plants are evaluated. If NFEED = 2, a threshold pretreatment system is evaluated.
2. An input parameter XO(207) defining the specific consumption of polyphosphates (or other additives) has been added.

For NFEED = 2, the daily consumption of polyphosphate is calculated by:

$$\text{TNACDY} = 12 \times 10^{-9} \times \text{XO}(207) \times (\text{WP} + \text{WB}) \ ,$$

where

TNACDY = daily consumption of polyphosphate or acid (if NFEED = 1), tons/day

XO(207) = specific consumption of polyphosphate, ppm

WP = product water flow rate, lb/hr

WB = blowdown flow rate, lb/hr

The relevant Fortran statements in subroutine SIZEM and SIZEV are indicated in Appendices E and F respectively.

2.3 NONCONDENSABLE GAS (NCG) REMOVAL SYSTEM

The original computer programs determined the energy consumption of the deaerator steam-ejector system applied in the 250 Mgd conceptual designs with the aid of an empirical curve. This curve was fitted to express the mechanical power required to pump the off-gas from acid treated seawater, saturated with air, from the deaerator vacuum to atmospheric pressure. This calculated mechanical power was then added to the pumping power consumption of the desalting plant used to calculate the cost of electrical power consumption.

In the modified programs the equivalent electric power consumption was replaced by the actual motive steam consumption of a two-stage steam-jet air ejector operated by saturated steam at a pressure of 100 psig.

For a specified ejector operation at a given suction pressure, the ejector steam consumption was assumed to be proportional to the total NCG load, which is calculated as a function of the following three parameters:

a. NCG concentration (ppm) in the makeup stream entering the deaerator,
b. total makeup flow rate, and
c. air inleakage into all vessels held under vacuum (deaerator and part of the evaporator stages or effects.)

The total makeup flow rate is calculated for each case as a function of the blowdown concentration ratio and, for the other two parameters, input values are applied.

Different input parameters were allocated for the acid and the threshold (i.e. polyphosphate or other additive) systems. For each of them, one variable defines the air inleakage (lb/hr) per evaporator train and a second variable defines the NCG concentration in the makeup water.

The plants applying threshold pretreatment obviously have a larger sea water makeup and a considerable larger amount of CO_2 will therefore be released in the evaporator.

The NCG load and the steam consumption is now calculated in subroutines SIZEM (MSF) and SIZEV (VTE) by the following equations:

for acid treated plant (NFEED = 1) —

XO(205) = XO(200)*TRAINS + XO(201)*(WP + WB) , and

for threshold pretreatment (NFEED = 2) —

XO(205) = XO(202)*TRAINS*XO(203)*(WP + WB) ,

where

XO(205) = total NCG load, lb/hr

XO(200) = inleakage per train, lb/hr (in acid treated plants)

XO(202) = same as XO(200), but for threshold pretreatment

XO(201) = NCG concentration in makeup of acid treated plants, ppm

XO(203) = same as XO(201), but for threshold pretreatment

WP = total product water flow rate, lb/hr

WB = total blowdown flow rate, lb/hr.

The total steam consumption is calculated by:

XO(206) = 9.6×10^{-3} XO(205) [10^6 Btu/hr] .

2.4 LISTING OF ADDITIONAL INPUT AND CALCULATED DESIGN VARIABLES

XO(200) = Air inleakage per evaporator train — acid treated plants, lb/hr

XO(201) = NCG concentration in makeup of acid treated plants, ppm

XO(202) = Air inleakage per evaporator train — nonphosphate treated plants, lb/hr

XO(203) = NCG concentration in makeup of phosphate treated plants, ppm

XO(204) = Number of velocity head losses per water box

XO(205) = Total calculated NCG load, lb/hr

XO(206) = Total calculated ejector steam consumption, 10^6 Btu/hr

XO(207) = Specific consumption of polyphosphates (or other additives), ppm in makeup

XO(208) = Number of tube bundles per evaporator train

XO(209) = Number of tube bundles per evaporator module

XO(210) = Number of evaporator trains per building

XT(120) = Height of recovery stages tube bundles above the evaporator floor, ft

XT(121) = Additional height of recovery stages for each additional brine flow level (LEV > 1), ft

XT(122) = External wall thickness at the cold end of the evaporator, ft

XT(123) = Internal wall thickness, ft

XT(124) = Ratio of external wall thickness at the hot end to that at the cold end (only applicable for concrete shells)

XT(125) = Additional height of reject stages for each additional brine flow level (LEV > 1), ft

XT(126) = Ratio of tube bundle width to height

XT(127) = Ratio of total tube sheet area to area calculated to contain tubes only

XT(200) = Maximum length of MSF tubing, ft

2.5 ADDITIONS TO GLOSSARY

A glossary of Fortran variables added to program MSF-21 or VTE-21 by the changes described above is given here.

APTSH = Tube sheet area of brine heater, ft^2

CØNPAS = Number of flow passes in final condenser

ENRJS = Number of applied tube lengths in reject stages

ENRSS = Number of applied tube lengths in recovery or preheater stages

ENRSSH = Number of applied tube lengths in hot section of recovery stages (concrete design only)

LPHE = Total length of preheater tubing, ft

NFEED = Selector switch defining pretreatment method

NFHS = ENRSS

NRJS = ENRJS

NRSS = ENRSS

NRSSH = ENRSSH

VHLR = Calculated head loss in recovery water box, psi

VHLRJ = Calculated head loss in reject water box, psi

VHLRS = Calculated head loss in preheater water box, psi

3. COST UPDATING AND OTHER COSTING MODIFICATIONS

3.1 GENERAL

All cost functions originally applied in the MSF-21 and VTE-21 computer programs were based on 1967 prices and, as already discussed, on the technology of large and advanced 250 Mgd conceptual designs. These functions were partially replaced by other cost functions and/or updated to mid-1975 prices by applying escalators based on commonly used cost indices. Indices published by the Bureau of Reclamation, *Chemical Engineering*, and the *Engineering News-Record* were applied for various equipment components detailed in the next subsection. For energy and operating materials costs, the computer programs have input variables so that any price levels can be applied. However, since some additional energy and materials consumptions were incorporated in the design modification, several new cost functions had to be added. All modified cost functions included in subroutines PRICES, COSTM and COSTV (Appendices I, J, and K) are marked by an asterisk, and all applied escalators are summarized in Table 1. All modified and new cost factors are also defined in a new subroutine (subroutine TITLER given in Appendix M).

3.2 MODIFICATIONS AND UPDATING OF DIRECT CAPITAL COST COMPONENTS

The following direct capital components are evaluated in the MSF-21 and VTE-21 computer programs:

(1) Condensing Surface
(2) Evaporator Shell and Foundation
(3) Brine Heater
(4) Final Condenser (VTE only)
(5) Valves and Piping
(6) Seawater Intake and Outfall
(7) Pumps and Motors
(8) Instrumentation
(9) Electrical Equipment
(10) Chemical Plant Equipment (Chemicals Injection Systems)

Table 1. Summary of escalators used for direct capital cost updating to mid-1975 prices

	XC multiplier	Escalator	Reference index or other basis
I. Unit costs common to MSF and VTE			
Steel shell, $/ft^2	9	1.988	CE + 25%
Excavation, $/ft^3	11	1.880	BuRec
Demisters, $/ft^2	12	1.760	Quotations (40%) + ENR skilled labor (60%)
Weirs, $/ft^2	13	3.180	CE + 100%
Pump motors, $/hp	16	1.681	CE
Auxiliary pumps and drivers, $/Mgd	17	1.912	CE
Submarine line, $/gpm	20	1.850	BuRec
Valves, $/gpm	23	1.912	CE
Plant piping and fittings, $/Mgd	24	1.912	CE
Train piping and fittings, $/Train	25	1.912	CE
Brine heater piping and fittings, $/gpm	26	1.912	CE
Vent piping and fittings, $/gpm	27	1.912	CE
Brine heater (BH) shell, $/ft^2	40	1.988	CE + 25%
BH tube sheets, $	215	1.590	CE (labor + materials)
BH tube sheet hole drilling, $/hole	216	1.460	CE (erection + instal. labor)
BH tube sheet installation, $/ft^2	217	2.000	ENR (skilled labor)
BH tubing installation, $/ft	218	2.000	ENR (skilled labor)
BH tube rolling, $/hole	219	1.460	CE (erection + instal. labor)
MSF tube sheets, $/ft^2	3	1.590	CE (labor + materials)
Hole drilling, $/hole	4	1.460	CE (erection + instal. labor)
Installing MSF tube sheets, $/ft^2	5	2.000	ENR (skilled labor)
Installing MSF tubing, $/ft	6	2.000	ENR (skilled labor)
Rolling MSF tubing, $/tube	7	1.460	CE (erection + instal. labor)
II. Unit costs common to MSF only			
Pumps, $/gpm	15	1.880	CE
Pump pits, $/gpm	18	1.900	BuRec
III. Unit costs common to VTE only			
VE tube sheets, $/ft^2	64	1.590	CE
VE hole drilling + rolling, $/hole	65	1.460	CE
Installing VE tubes, $/tube	66	2.000	ENR
VE bundle installation, $/bundle	67	2.000	ENR
Installing preheater tubing, $/ft	69	2.000	ENR
Horizontal tube sheets, $/ft^2	70	1.590	CE
Hole drilling, $/hole	71	1.460	CE
Installing horizontal tube sheets, $/ft^2	72	2.000	ENR
Rolling horizontal tubes, $/tube	73	1.460	CE
Pumps, $/gpm	128	1.880	CE
Pump pits, $/gpm	130	1.900	BuRec
Effect piping, $/effect	132	1.912	CE

(11) Noncondensable Gas (NCG) Removal Systems

(12) Site Preparation, Including Buildings and Cranes.

The cost updating and/or modifications made for the above listed direct capital cost components were as follows:

1. Condensing Surface

The cost of this component was composed of tubing surface material cost, which is evaluated as a function of tubing size and material, tube bundle fabrication and installation costs based on cost functions for:

(a) tube sheet material and fabrication,

(b) hole drilling and tube rolling,

(c) tube sheet installation, and

(d) installation of tubing.

The cost functions for uninstalled tubing surface material were deleted; and, presently, the program applies input values expressing these surface costs in $\$/ft^2$ for every defined tubing surface.

For VTE an additional cost for tube nozzles has been added. The built-in cost is $2 per nozzle. This cost can be varied by the XC cost multiplier XC(220).

The tube bundle fabrication and installation cost functions were updated to mid-1975 costs by applying the following escalators:

(a) Tube sheet fabrication — *Chemical Engineering* (CE) Index for erection and installation labor.

(b) Hole drilling and tube rolling — same as (a).

(c) Tube sheet installation — *Engineering News-Record* (ENR) Index for skilled labor.

(d) Tube installation — same as (c).

The basic difference between the CE and the ENR index computation method is that CE assumes gradual increase in productivity, and the resulting indices are therefore substantially lower than the ENR indices. Therefore, CE indices were applied only for work performed with the aid of machinery while ENR indices were applied for work where machinery is unlikely to be applied.

2. Evaporator Shell and Foundation

The following were included in calculating the capital cost of these items:

(a) all steel parts of the evaporator shell including brine and product trays, and a phenolic coating of internal steel areas,
(b) excavation proportional to the evaporator floor area,
(c) demisters and miscellaneous small shell items,
(d) brine flow weirs.

Each of the above components could be updated by applying escalators. For the steel work the CE index for buildings (materials and labor) was selected. The change from 1967 to mid-1975 of this index amounted to approximately 59%. This escalator would be suitable for the same design criteria applied in the original programs. However, as the phenolic coating was partially replaced by stainless steel (brine chambers) and copper-nickel (water boxes) linings, and the product trays were also assumed to be made of stainless steel, an additional cost increase factor had to be applied.

The effect of replacing only the phenolic coating was found to increase the cost of the steel work for a 12.5 Mgd size evaporator by about 15 to 20%. The escalator for the steel work was therefore increased by an additional 25%.

The cost escalator for the demisters was based on recently obtained quotations for stainless steel demisters and the ENR escalator for skilled labor.

The escalator for excavation was based on the index published by the Bureau of Reclamation.

The cost of the brine flow weirs was escalated according to the CE index for the steel work plus an additional 100% for replacing the phenolic coated steel by stainless steel.

3. Brine Heater

The brine heater cost was calculated by adding the cost of the shell and the cost of the installed heat transfer surface. The latter was estimated to be 143% of the tubing material cost. This estimate has been replaced by incorporating the cost functions applied for evaporator tube bundle fabrication and installation. The same escalators applied for the evaporator (condensing surface and shell cost) were also applied for the brine heater.

4. Final Condenser (VTE)

The appropriate shell cost and condensing surface cost applied for the evaporator were also used for the final condenser.

5. Valves and Piping

The CE index for pipe, valves, and fittings was applied for escalating the cost of this item.

6. Seawater Intake and Outfall

The Bureau of Reclamation's index for concrete pipelines was used to escalate this item.

7. Pumps and Motors

The CE indices for pumps and compressors and for electrical equipment and materials were used to escalate the cost of the pumps and the motors. The cost of pump pits was escalated by the Bureau of Reclamation's index for structures of pumping plants.

8. Instrumentation

The original programs applied the following cost function for the desalting plant unit instrumentation cost (UCI) in \$/gpd.

$$UCI(ff) = [2.29625 - 2.28269. \exp(-.0076527*FF)]/FF ,$$

where FF is the desalting plant capacity in Mgd.

Using this function and applying CE's index for process instrumentation, the cost for a 100-Mgd plant is calculated to be approximately $\$2.4 \times 10^6$, and for a 10-Mgd plant approximately \$285,000.

This function did not take into account the subdivision of the plant into several independently operating trains. Obviously, this, as well as the degree of automation incorporated, should be considered. For the time being, until a better cost function is obtained, UCI was replaced by:

$$UCI(FF,TRAINS) = 400,000\ (FF/TRAINS/10)^{0.3174}*TRAINS/FF .$$

For VTE plants an additional cost [set by the input variable XC(221)] proportional to the number of effects has been included.

9. Electrical Equipment

The original function was found to yield too low a cost for small units and was therefore replaced by a new function based on \$100/kW for a four-train plant with a total electrical power capacity of 40 MW. It has been assumed that 75% of this cost will be affected by the number of trains. As with the original function, a scale factor of 0.8 has been applied. The resulting function is

$$\mathrm{UCED(PMW,TRAINS)} = [7.5 \times 10^5 \times (\mathrm{PW/TRAINS/10})^{0.8} + 10^6 \times (\mathrm{PMW}/40)^{0.8}]/\mathrm{PMW} ,$$

where

UCEDK = the cost in \$/MW, and
PMW = electrical power capacity in MW .

The bases for this function were the escalated cost for the 250 Mgd VTE conceptual design[4] and the escalated cost for the 2.5 Mgd Universal Design.[5]

10. Chemical Plant Equipment

The cost functions for acid and caustic dispensing systems, as well as all other treatment systems originally applied in the programs, were escalated by using the CE index for chemical plant costs. Some of these functions were rearranged to modify some reference values, but without changing the originally applied scale factors.

11. NCG Removal System

This system is composed of the deaerator, the decarbonator, and the steam-jet air ejectors. Since the design of this system has been basically modified (see Section 2.3), new cost functions had to be applied. The bases for the deaerator and decarbonator were the costs applied in the 2.5 Mgd Universal Design[5] escalated to mid-1975 prices by applying the CE index for chemical plants.

The costs for the deaerator and decarbonator were correlated with the feedwater flow by applying a scale factor of 0.7.

The basis for the steam-jet air ejectors was Union Carbide cost data correlated to the NCG load.

12. Site Preparations, Buildings, and Cranes

The original programs correlated the costs of this component to $/acre for site preparation and total plant capacity for buildings and cranes. The resulting figures obtained with these functions escalated with the ENR Building Cost Index seemed much too low in comparison with current estimates. These costs were therefore modified by using only the original site preparation cost function plus a general function for site development, including buildings, presented in the OSW Desalting Handbook for Planners.[6] The assumption has been made that the cost for site development given by the Office of Saline Water (OSW) did not include an allowance for site preparation. Therefore the original site preparation function, suitably escalated, is used in conjunction with the OSW estimate to obtain the total site cost.

3.3 MODIFICATIONS IN ESTIMATING INDIRECT CAPITAL COST COMPONENTS

All indirect capital cost components are evaluated in Subroutine FNANCE (Appendix L). Originally the following components were evaluated:

(1) overhead for design and supervision,
(2) interest during construction,
(3) owners cost for training and startup,
(4) unusual construction cost, and
(5) contingency.

In the modified subroutine FNANCE, the first three indirect capital cost components were not changed, but the "unusual construction costs" were assumed to be included in contingency. The current built-in factor for contingency is 25% but can be varied to any desired value by the input multiplication factor XC(62). A new factor expressing escalation during construction has been added to the original indirect cost component.

The calculation of the factor was based on similar assumptions to those made for estimating interest during construction. The built-in value for annual escalation rate is 8%. This rate can be changed by inserting any desired multiplication factor to the input variable XC(56).

3.4 MODIFICATIONS IN OPERATING COST COMPONENTS

The following components were included in the costing subroutines PRICES, COSTM, and COSTV:

(1) process heat cost,
(2) operation and maintenance labor cost,
(3) cost of chemicals,
(4) electrical power cost, and
(5) cost of supplies and maintenance materials.

As already mentioned in Section 2.3, the energy consumption for the removal of noncondensable gases was expressed as equivalent electrical power consumption and was therefore included in the power cost. Currently, the heat consumption of steam-jet air ejectors is evaluated as a separate cost component as a function of the actual heat consumption, and the specified unit heat cost (appropriate to the thermodynamic parameters of the applied ejector steam) in the new input variable XC(210).

The modifications to the originally computed operating cost components included the following:

1. Process Heat Costs

   Originally, these costs were evaluated by use of two allocated costs, one for nuclear and one for conventional plants. Currently, the unit heat costs are calculated as a function of the process steam temperature. This function was derived by using current costs for a 1000 MW(e) dual-purpose pressurized water reactor and fuel cycle costs based on WASH-1174, UC-2.

2. Operation and Maintenance Labor Cost

This component was modified based on the following assumptions:

(a) A 100-Mgd plant will require a total O&M staff of 56 (38 operational and 18 maintenance).

(b) The average man-year cost = $16,000.

(c) The total overhead for general and administration = 40%.

(d) The scale factor for total O&M cost = 0.5.

3. Cost of Chemicals

The costs for consumption of chemicals were modified on the basis of the current unit costs and the specific consumptions listed in Table 2.

3.5 MODIFICATION OF ANNUAL FIXED CHARGE RATE AND PLANT OPERATING FACTOR

The cost functions used to evaluate the annual fixed charge rate are included in Subroutine FNANCE. The built-in values used in this function and the value of the plant operating factor were modified. The current built-in values are listed in Table 3.

Table 2. Summary of original and new input values used for the evaluation of operating costs

	Operating cost component	XC multiplier	Built-in value	Remarks
I.	Energy cost			
	Nuclear process heat cost, $\$/10^6$ Btu	45	-	New function
	Fossil plant process heat cost, $\$/10^6$ Btu	46	-	Function not available
	Ejector heat cost, $\$/10^6$ Btu	210	0.70	For 100 psig nuclear steam
	Nuclear electrical power cost, $/kWhr	54	0.020	
	Fossil plant electrical power cost, $/kWhr	55	0.025	
II.	Operation and maintenance labor	57	-	New function
III.	Supplies and maintenance materials	58	0.007	Proportional to total capital cost
IV.	Unit costs of chemicals			
	Sulfuric acid (93% H_2SO_4), $/ton	48	31.0	Consumption evaluated
	Chlorine, $/lb seawater intake	50	2.64×10^{-7}	Based on 3 ppm and $176/ton
	Caustic + sodium sulfite, $/lb makeup water	51	8.5×10^{-7}	Based on 10 ppm caustic at $170/ton + 2 ppm sulfite at $305/ton
	Antifoam, $/lb makeup	52	7.05×10^{-7}	Based on 0.5 ppm at $1600/ton
	Polyphosphate (or equivalent), $/ton	48	3000	Only for NFEED = 2

Table 3. Input variables for plant operating factor and evaluation of annual fixed charge rate

		XO value or XC multiplier	Built-in value
I.	Plant operating factor, %	XO(38)	0.85
II.	Fixed charge rate components:		
	Interest rate	XC(60)	0.10
	Taxes + insurances	XC(61)	0.01
	Desalting plant life, years	XO(33)	30.0

REFERENCES

1. W. G. S. Fort, *Computer Codes for Office of Saline Water Program Analysis. Part V: MSF-21: A Fortran Code for the Rapid Calculation or Optimization of Multistage Flash (MSF) Desalination Plants*, ORNL-TM-3535 (February 1972).

2. W. G. S. Fort, J. V. Wilson, Ibid., *Part VI: A Fortran Code for the Rapid Calculation or Optimization of Vertical Tube Evaporator (VTE) Desalination Plants.*

3. S. J. Senatore, J. A. Smith, *Study of 250-Mgd Multistage Flash Distillation Plant with Two Level Brine Flow*, Part One; Part Two: Bechtel Corp., *Preliminary Engineering Analysis and Capital Cost Estimate*, ORNL-4214 (Jan. 1969).

4. E. C. Hise, S. A. Thompson, *Conceptual Design Study of a 250-Million Gallons per Day Combined Vertical Tube — Flash Evaporator Desalination Plant*, ORNL-4260 (August 1968).

5. Burns and Roe, Inc., "Universal Design, Vol. I, Report on Design of a 2.5 Million Gallon Per Day Universal Desalting Plant," for Office of Saline Water, June 1969.

6. Desalting Handbook for Planners, U.S. Department of the Interior Office of Saline Water and the Bureau of Reclamation. 1st Ed. May 1972.

APPENDICES

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APPENDIX A

CHANGES MADE IN SUBROUTINE MAINM

```
      SUBROUTINE MAINM(FFF,IOPT,IOUT,CH2O,CAPITL)
      IMPLICIT REAL*8(A-H,O-Z)
C
      DOUBLE PRECISION MODU
      DOUBLE PRECISION LEV,LF2
C
      COMMON/BLOCM2/        P,           Q,          AH,          AK,          AN,
     1      AR,            FF,          GE,          GH,          GR,          HD,
     2      PB,            PE,       QX(5),          RP,          SE,          SH,
     3      SR,            TK,          VE,          VH,          VR,          WC,
     4     AME,           ATN,      BPX(5),         CCF,         HIH,         HLH,
     5     HNH,           HOH,      OMX(5),         PHE,         PO3,         RSE,
     6     RSH,           RSR,         TC1,         THF,      TKX(5),         TMC,
     7     TME,           TPE,      UEX(5),         UME,         UMH,         WPL,
     8    BKTE,          BKTH,        BKTR,     DTLS(5),     ELEX(5),     HIEX(5),
     9 HOEX(5),          MODU,        ROE1,        ROE2,       APTSE,      BDEPH,
     +   CAPI1,         HEADE,       HEADH,       HEADR,      POBLD,       PODEL,
     A  POPRD,       SUBEX(5),       WCOLD,       WMODC,      WMODH,      BHSHEL,
     B  CSLTBH,        CSLTBP,      HOTLEN,      HRECOV,     HREJCT,      RECOLN,
     C  VAPSPC,        WPRTRY,       POREC
      COMMON/COMNAM/       AJ,          CB,          CO,          CP,         CR,
     1      HB,            PI,          PO,          TB,          TO,         TP,
     2      TS,            WB,          WF,          WO,          WP,         WR,
     3     AXJ,           HBL,         HPR,         LEV,         LF2,        TCF,
     4    ENBH,          GPMB,        GPMD,        GPMH,        GPMO,       GPMP,
     5    GPMR,          HDEA,        RPMB,        RPMD,        RPMM,       RPMP,
     6    RPMR,          TSTH,        WHOT,        YEAR,       ACRES,      BHVOL,
     7   BLDGS,         BNDLS,       HOLES,       HPBLD,       HPDEA,      HPDEL,
     8   HPPRD,         HPREC,       PLPRD,       PLSEA,       PODEA,     ACNCEW,
     9  ACNCFL,        ACNCIW,      ACNCPH,      ACNCRF,      ACNCTR,     AEXCAV,
     +  ASTLEW,        ASTLFL,      ASTLIW,      ASTLPH,      ASTLRF,     ASTLTR,
     A  AWEIRS,        BHSURF,      DINTAK,      ENITSE,      ENPIPE,     ENSUPE,
     B  ENSUPR,        PIPELN,      PLSZMG,      REJLEN,      STLLEN,     STLTMP,
     C  TNACDY,        TRAINS,      TSAREA,      VOLCNC,      VOLSTL,     WOCEAN
       COMMON/SHARE/  IFLIP    ,ISPOT
       COMMON/BLOC12/ XT
       COMMON/BLOC13/ XO
      COMMON/INDEX/INC(40)
      COMMON/TAPE/ LTAPE2
C
      DIMENSION XO8(40),XL8(40),XH8(40)
      DIMENSION XT(300),XO(300)
      EXTERNAL PLANTM
C
      CALL ITIME(IZX,JZX)
      DATA PROC/'MSF'/
      IO = -2
      FF = FFF
      IFLIP = 1
      TSTH = XO(15)
      BDEPH = XO(18)
      BKTH = XO(19)
      BKTE = XO(20)
      BKTR = XO(21)
      RSH    = XT(101)
      RSE    = XT(102)
      RSR    = XT(103)
      SH = XO(22)
      SE = XO(23)
      SR = XO(24)
      HD = XO(28)
      HB = XO(29)
      HBL = XO(30)
      WPL = XO(33)
      CSLTBP = XO(34)
      CSLTBH = XO(35)
```

```
      CO = XO(36)                                                       PR 16240
      CP = XO(37)                                                       PR 16250
      LF2 = XO(38)                                                      PR 16260
      TS = XO(39)                                                       PR 16270
      TO = XO(40)                                                       PR 16280
      THF = XO(41)                                                      PR 16290
      YEAR = XO(79)                                                     PR 16300
      STLTMP= XO(83)                                                    PR 16310
      VOLSTL=0.D0                                                         ****
      VOLCNC=0.D0                                                         ****
      PIPELN = XO(87)                                                   PR 16320
      PLSZMG = FF                                                       PR 16330
      BNDLS=XO(208) *XO(43)                                               ****
      IF(XO(209).GT.2.D0) STOP 209                                        ****
      MODU=BNDLS/XO(209)                                                  ****
      TRAINS=XO(43)                                                       ****
      BLDGS=TRAINS/XO(210)                                                ****
      NBRHTR = FF*.032D0/TRAINS +.5                                     PR 16430
      ENBH = TRAINS * DFLOAT(NBRHTR)                                    PR 16440
      ENBH = DMAX1(TRAINS,ENBH)                                         PR 16450
      WP = FF*1.D6*DEN(CP,90.D0)*.00557D0                               PR 16460
      CALL VARSET(FF,PROC)                                              PR 16470
      DO 110 I=1,12                                                     PR 16480
      XO8(I)= XO(I)                                                     PR 16490
      XH8(I)= XT(2*I-1)                                                 PR 16500
      XL8(I)= XT(2*I)                                                   PR 16510
      IF(XL8(I) .GT. XH8(I)) XL8(I)=XH8(I)                              PR 16520
      IF(XO8(I) .LT. XL8(I)) XO8(I)=XL8(I)                              PR 16530
      IF(XO8(I) .GT. XH8(I)) XO8(I)=XH8(I)                              PR 16540
  110 CONTINUE                                                          PR 16550
C                                                                       PR 16560
      NCALLS = 0                                                        PR 16570
      IND(1) = 0                                                        PR 16580
      IF(IOPT .EQ. 0) GO TO 115                                         PR 16590
      IF(IO .GT. 0) WRITE(6,5) FF                                       PR 16600
    5 FORMAT(1H1,'MSF',F8.2,'  MGD')                                    PR 16610
      CALL SLIDE(12,XO8,XH8,XL8,PLANTM,IO,1,7,3,1,NCALLS)               PR 16620
      IF(IO .GT. 0) WRITE(6,6) FF                                       PR 16630
    6 FORMAT(1H0,'MSF',F8.2,'  MGD')                                    PR 16640
  115 CONTINUE                                                          PR 16650
      IND(13) = 1                                                       PR 16660
      CALL PLANTM(XO8,CH2O)                                             PR 16670
      NCALLS= NCALLS +1                                                 PR 16680
      CAPITL = CAPI1*1.D-6                                              PR 16690
      KOUT = LTAPE2                                                     PR 16700
      CALL RITEM(IOPT,IOUT,KOUT)                                        PR 16710
      WRITE(KOUT,15) NCALLS,IND(1)                                      PR 16720
   15 FORMAT(1H ,21HNUMBER OF PLANT CALLS ,I5,I10)                      PR 16730
      CALL ITIME(IZXX,JZXX)                                             PR 16740
      TCALC = DFLOAT(IZXX-IZX)*1.D-2                                    PR 16750
      WRITE(KOUT,4) TCALC                                               PR 16760
    4 FORMAT(1H ,18HTIME FOR THIS CASE,F8.2,2X7HSECONDS)                PR 16770
       RETURN                                                           PR 16780
      END                                                               PR 16790
```

APPENDIX B

CHANGES MADE IN SUBROUTINE MAINV

```
      SUBROUTINE MAINV(FF,IOPI,IOUT,CH2O,CAPITL)
      IMPLICIT REAL*8(A-H,O-Z)
C
      DOUBLE PRECISION NTRAIN
      DOUBLE PRECISION    KBH,     KPH,     KVE,     LBH,     MGD,     NBH,
     1    NPH,    NVE,   KCON,   LMTD,   LVEP, LMTDBH, LMTDCN
      DOUBLE PRECISION    INT, INSTRD, INSTRK, INSTRY, MAINTK, MAINTY
      DOUBLE PRECISION LEV,LF2
C
      COMMON/BLOCV2/  A(30),          S,      AE(30),          QE,     TC(30),
     1    TE(30),         TR,     UE(30),     UH(3),           WM,     WT(30),
     2       ABH,        APH,    BPE(30),    CIE(30),     COE(30),    DPE(30),
     3       ELL,        GBH,        GPH,        GPM,         HOD,        KBH,
     4       KPH,        KVE,        LBH,        MGD,         NBH,        NPH,
     5   NVE(30),        QPH,        RBH,        RPH,         RVE,        TOO,
     6       UBH,        VBH,        VPH,   WPEX(30),        BHLF,       GCON,
     7      HIBH,    HIPH(3),       HOBH,    HOPH(3),        KCON,    LMTD(3),
     8      LVEP,       PHLF,    QMSF(3),       RCON,     SUBF(3),       TCON,
     9      UCON,       VCON,       VLEN,       VTLF,    WDTH(30),  ALFAE(30),
     +     CONLF,      HICON,      HOCON,      HOTE1,       PHHGT,      POBLO,
     A     POPRO,      POSEA,      SURFF,      VEHGT,       WALVE,     EFFSPC,
     BELBNDL(30),     HCOTCF,     HCOTOO,     HEADBH,      HEADCN,     HEADPH,
     C    LMTDBH,     LMTDCN,     PLNTLF,     PODEAS,      POFEED,     SUMWPE,
     D    SUMWPH,     TOTAVE,       QESP,VEFEED(30),      WBOOST,     WDCOLD,
     E        NE,       NTRN,     IFEED,      IRECYC
      COMMON/BLOCV3/      BHD,        BHK,        BHY,         INT,        PMD,
     1       PMK,        PMY,        VPD,        VPK,         VPY,       ACHR,
     2      DEAD,       DEAK,       DEAY,       ELEC,        HEAT,       SBCD,
     3      SBCK,       SBCY,      CHEMK,      CHEMY,       HEATK,      HEATY,
     4     OPERK,      OPERY,      PLDIN,      WAITD,       WAITK,      WAITY,
     5    ANCOMP,     CMCAPD,     CMCAPK,     CMCAPY,      CNDSRD,     CNDSRK,
     6    CNDSRY,     ELECTD,     ELECTK,     ELECTY,      INSTRD,     INSTRK,
     7    INSTRY,     MAINTK,     MAINTY,     PHTUBD,      PHTUBK,     PHTUBY,
     8    PLCAPD,     PLCAPK,     PLCAPY,     POWERK,      POWERY,     RETUBK,
     9    RETUBY,     SHELLD,     SHELLK,     SHELLY,      TOTALK,     TOTALY,
     +    TOTOPK,     TOTOPY,     TREPBH,     TREPCN,      TREPPH,     TREPVE,
     A    VETUBD,     VETUBK,     VETUBY,       CGPD
      COMMON/COMNAM/      AJ,         CB,         CO,          CP,         CR,
     1        HB,         PI,         PO,         TB,          TO,         TP,
     2        TS,         WB,         WF,         WO,          WP,         WR,
     3       AXJ,        HBL,        HPR,        LEV,         LF2,        TCF,
     4      ENBH,       GPMB,       GPMD,       GPMH,        GPMO,       GPMP,
     5      GPMR,       HDEA,       RPMB,       RPMD,        RPMM,       RPMP,
     6      RPMR,       TSTH,       WHOT,       YEAR,       ACRES,      BHVOL,
     7     BLDGS,      BNDLS,      HOLES,      HPBLD,       HPDEA,      HPDEL,
     8     HPPRD,      HPREC,     PLPRD,     PLSEA,       PODEA,     ACNCEW,
     9    ACNCFL,     ACNCIW,     ACNCPH,     ACNCRF,      ACNCTR,     AEXCAV,
     +    ASTLEW,     ASTLFL,     ASTLIW,     ASTLPH,      ASTLRF,     ASTLTR,
     A    AWEIRS,     BHSURF,     DINTAK,     ENITSE,      ENPIPE,     ENSUPE,
     B    ENSUPR,     PIPELN,     PLSZMG,     REJLEN,      STLLEN,     STLTMP,
     C    TNACDY,     TRAINS,     TSAREA,     VOLCNC,      VOLSTL,     WOCEAN
       COMMON/SHARE/  IFLIP    ,ISPOT
      COMMON/BLOC12/ XT
      COMMON/BLOC13/ XO
      COMMON/INDEX/ IND(40)
      COMMON/TAPE/ LTAPE2
C
      DIMENSION XC7(40),XH7(40),XL7(40) ,XO(300), XT(300)
      DIMENSION JB(13)
      EXTERNAL PLANTV
C
      CALL ITIME(IBGNX,JT)
      DATA PROC/'VTE'/
      DATA JB/3,5,9,11,25,13,15,27,29,31,33,35,37/
      DO 65 I=1,40
   65 IND(I) = 1
      IFLIP = 1
      IO = -2
```

```
      BNDLS=XO(208)*XO(43)                                              ****
      TRAINS=XO(43)                                                     ****
      BLDGS=TRAINS/XO(210)                                              ****
      NTRAIN=TRAINS                                                     ****
      NBRHTR = FF*.032D0/NTRAIN+.5
      ENBH = NTRAIN*DFLOAT(NBRHTR)
      ENBH = DMAX1(NTRAIN,ENBH)
      TRAINS = NTRAIN
      LEV =1.D0
      PLSZMG = FF
      TSTH = XO(15)
      CP = XO(37)
      PLNTLF = XO(33)
      BHLF = XO(35)
      CONLF = XO(34)
      PHLF = XO(34)
      HB = XO(29)
      CC = XO(36)
      LF2 = XO(38)
      TC = XO(40)
      TS = XO(39)
      HBL = XO(30)
      S = XO(23)
      STLTMP = XO(83)
      PIPELN = XO(87)
      RBH    = XT(101)
      RPH    = XT(102)
      RCCN   = XT(103)
      KPH = XO(20)
      KBH = XO(19)
      KCON = XO(21)
      WALVE = XO(70)
      RVE = XT(113)
      KVE = XO(72)
      SURFF = XO(74)
      VTLF = XO(76)
      YEAR = XO(79)
      MGD = FF
      WP =MGD*1.D6*DEN(CP,90.D0)*.00557D0
      CALL VARSET(FF,PROC)
      DO 100 I=1,13
      K=JB(I)
      XO7(I) =XO(I)
      XH7(I) =XT(K)
      XL7(I) =XT(K+1)
      IF(XL7(I) .GT. XH7(I)) XL7(I)=XH7(I)
      IF(XO7(I) .LT. XL7(I)) XO7(I)=XL7(I)
      IF(XO7(I) .GT. XH7(I)) XO7(I)=XH7(I)
  100 CONTINUE
C
      NCALLS = 0
      IND(1) = C
      IF(IOPT .EQ. 0) GO TO 105
      IF(IO .GT. 0) WRITE(6,5) FF
    5 FORMAT(1H1,'VTE',F8.2,'  MGD')
      CALL SLIDE(13,XO7,XH7,XL7,PLANTV,IO,6,13,7,1,NCALLS)
      IF(IO .GT. C) WRITE(6,6) FF
    6 FORMAT(1H0,'VTE',F8.2,'  MGD')
  105 CONTINUE
      IND(13)=1
      CALL PLANTV(XO7,CH2O)
      NCALLS = NCALLS +1
      CAPITL = PLCIN * 1.D-6
      KOUT = LTAPE2
      CALL RITEV(IOPT,IOUT,KOUT)
      WRITE(KOUT,15) NCALLS,IND(1)
   15 FORMAT(1H ,21HNUMBER OF PLANT CALLS ,I5,I10)
      CALL ITIME(IENDX,JT)
      TCASE =DFLOAT(IENDX-IBGNX)*.01
      WRITE(KOUT,10) TCASE
   10 FORMAT(1H ,25HTIME TO COMPUTE THIS CASE,F7.2,8H SECONDS)
      RETURN
      END
```

APPENDIX C

CHANGES MADE IN SUBROUTINE PLANTM

```
      SUBROUTINE PLANTM(X08,FFFFFF)
      IMPLICIT REAL*8(A-H,O-Z)
C
      DOUBLE PRECISION MODU
      DOUBLE PRECISION LEV,LF2
C
      COMMON/BLOCM1/     DIE,        DIH,        DIR,        DOE,        DOH,
     1      DOR,         ELE,        ENE,        RLR,        RNR,       HDEL,
     2     HREC,       APTSR,     ENITSR
      COMMON/BLOCM2/       P,          Q,         AH,         AK,         AN,
     1       AR,          FF,         GE,         GH,         GR,         HD,
     2       PB,          PE,      QX(5),         RP,         SE,         SH,
     3       SR,          TK,         VE,         VH,         VR,         WC,
     4      AME,         ATN,     BPX(5),        CCF,        HIH,        HLH,
     5      HNH,         HOH,     CMX(5),        PHE,        PO3,        RSE,
     6      RSH,         RSR,        TC1,        THF,     TKX(5),        TMC,
     7      TME,         TPE,     UEX(5),        UME,        UMH,        WPL,
     8     BKTE,        BKTH,       BKTR,    DTLS(5),    ELEX(5),    HIEX(5),
     9  HOEX(5),        MODU,       ROE1,       ROE2,      APTSE,      BDEPH,
     +    CAPI1,       HEADE,      HEADH,      HEADR,      POBLD,      PODEL,
     A    POPRD,    SUBEX(5),      WCOLD,      WMODC,      WMODH,     BHSHEL,
     B   CSLTBH,      CSLTBP,     HOTLEN,     HRECOV,     HREJCT,     RECOLN,
     C   VAPSPC,      WPRTRY,      POREC
      COMMON/COMNAM/      AJ,         CB,         CO,         CP,         CR,
     1       HB,          PI,         PO,         TB,         TO,         TP,
     2       TS,          WB,         WF,         WO,         WP,         WR,
     3      AXJ,         HBL,        HPR,        LEV,        LF2,        TCF,
     4     ENBH,        GPMB,       GPMD,       GPMH,       GPMO,       GPMP,
     5     GPMR,        HDEA,       RPMB,       RPMD,       RPMM,       RPMP,
     6     RPMR,        TSTH,       WHOT,       YEAR,      ACRES,      BHVOL,
     7    BLDGS,       BNDLS,      HOLES,      HPBLD,      HPDEA,      HPDEL,
     8    HPPRD,       HPREC,      PLPRD,      PLSEA,      PODEA,     ACNCEW,
     9   ACNCFL,      ACNCIW,     ACNCPH,     ACNCRF,     ACNCTR,     AEXCAV,
     +   ASTLEW,      ASTLFL,     ASTLIW,     ASTLPH,     ASTLRF,     ASTLTR,
     A   AWEIRS,      BHSURF,     DINTAK,     ENITSE,     ENPIPE,     ENSUPE,
     B   ENSUPR,      PIPELN,     PLSZMG,     REJLEN,     STLLEN,     STLTMP,
     C   TNACDY,      TRAINS,     TSAREA,     VOLCNC,     VOLSTL,     WOCEAN
       COMMON/SHARE/  IFLIP    ,ISPOT
       COMMON/BLOC12/ XT
       COMMON/BLOC13/ XO
      COMMON/INDEX/IND(40)
      COMMON/OVRLAY/ HOSAVE(15),CISAVE(15)
      COMMON/IMPOSS/ IMPOSE,IMPOSR
C
      DIMENSION   CEX(5),  DTX(5),  TCX(5)
      DIMENSION XT(300), XO(300)
      DIMENSION X08(40)
C
      EQUIVALENCE   (AE,AME),(TE, TME),(UE, UME),(UH, UMH),
     1              (TC, TMC)
C
      SMOOTH(YCAL,YMIN,RANGER)=YMIN+(YCAL-YMIN)*
     1                      (.5D0+DATAN(RANGER*(YCAL-YMIN))/PI)
C
C
      AK  = X08(1)
      VH  = X08(2)
      DOH = X08(3)
      LEV = X08(4)
      VR  = X08(5)
      DOR = X08(6)
      AN  = X08(7)
      VE  = X08(8)
      DOE = X08(9)
      RP  = X08(10)
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      TB = TO + XC8(11)
      CR  = XC8(12)
      CALL DXX8(DIE,DIH,DIR,DOE,DOH,DOR)
C****
C          INITIAL ESTIMATES
C***
      IF(IFLIP .GT. 1)GO TO 105
      CLOSR =1.D-8
      CCF = 1.9*CC
      CEX(2) = 1.9*CO
      VAPSPC = DMAX1(WP/BNDLS*2.164D-6,2.D0)
      WPTYMN=DMAX1(WP/(BNDLS*.54D0*XO(85)),XT(128))
      WMODMN = XC(209)*(WPTYMN +VAPSPC)
      HOO    = H(CO,TO)
      CSAV = XT(108)/VIS(2.*CO,150.D0,.14D0)
      DO 90 I=1,15
      HOSAVE(I) = 2.D3*XT(109)
   90 CISAVE(I) = CSAV
      TKES = TB+(THF-TB)/RP
      PEES = (THF-TKES)/(1.D3-TKES)
      DO 100  I=1,5
      ELEX(I) = 4.0*(FLOAT(I)+1.0)
      BPX(I) = 1.CDO
  100 CONTINUE
      GO TO 110
  105 CONTINUE
      TKES = TK
      PEES  = PE
C****
C         CHOOSE ENTRY POINT
C***
      IF((IND(10)+IND(11)+IND(12)+IND(13)) .GT. 0) GO TO 110
      IF(IND(7) .GT. 0) GO TO 130
      IF(IND(4) .GT. 0) GO TO 135
      IF((IND(8)+IND(9)) .GT. 0) GO TO 141
      IF(IND(1) .GT. 0) GO TO 150
      IF((IND(5)+IND(6)) .GT. 0) GO TO 152
      GO TO 170
  110 CONTINUE
      HTBU = HOO+1.D3/RP*(CR-1.D0)/CR
      TBMAX = HINV(CP,HTBU)
      IF(TB .GT. (TBMAX-1.D0))TB = TBMAX-DEXP(TBMAX-1.D0-TB)
      HOB = H(CO,TB)
      CB = CR*CO
      HBB = H(CB,TB)
      CALL BPRAT(TB,CB,BPX(5))
      DTX(5) = DTDP(TB)
      TP = TB-BPX(5)-(.5+.001623*(TB-92.))*DTX(5)
C****
C         OVERALL TRAY HEAT AND MATERIAL BALANCE
C***
      HVBAR2 = HVBR(THF,TB)
      DHV2 = HVBAR2-HBB
      DC2 = CB-CP
  115 CONTINUE
      HFF = H(CCF,THF)
      P=(HFF-HBB)/DHV2
      F = CCF+P*DC2-CB
      IF(DABS(F) .LE. CLOSR) GO TO 120
      CCF = CCF-F/(1.+DHDC(CCF,THF)*DC2/DHV2)
      GO TO 115
  120 CONTINUE
C****
C         BRINE HEATER TUBE SIDE HEAT AND MATERIAL BALANCE
C***
      HTHF = HFF -1.D3*P/RP
      TCF  = HINV(CCF,HTHF)
C****
C         RECYCLE MIX HEAT AND MATERIAL BALANCE
```

```
C***
      TC = TB
      PB = P*(CO-CP)/(CB-CO)
      HFTE = HBB + (P+PB)*(HOB-HBB)
      TE = HINV(CCF,HFTE)
      HTQ = HFF-HTHF-PB*HBB+(P+PB)*HOB
      Q = (HTQ-P*H(CP,TP))/(HOB-HOO)
      DENOO = DEN(CO,TC)
C****
C           RECOVERY SECTION HEAT AND MATERIAL BALANCE
C               COMPUTATION OF RECOVERY HEAT TRANSFER PARAMETERS
C***
      QTC  =HFTE+HFF-HTHF
      DENFE = DEN(CCF,TCF)
      HVBAR1 = HVBE(TKES)
  126 CONTINUE
      CEX(3)=(CCF -PEES*CP)/(1.-PEES)
      CALL BPRAT(TKES,CEX(3),BPX(3))
      DTX(3) = DTDP(TKES)
      TPE = TKES-BPX(3)-(.5+.001623*(TKES-92.))*DTX(3)
      CE = CEX(3)
      HCETK = H(CE,TKES)
      A11=HVBAR1-H(CP,TPE)
      A12=-.8*PEES
      CCEK = DHDC(CE,TKES)*(CCF-CP)/(1.-PEES)
      A21 = HVBAR1-HCETK+CCEK
      A22=1.+A12
      DL1=HFF-QTO-PEES*A11
      DL2 = HFF-PEES*HVBAR1-(1.-PEES)*HCETK
      TKX(3) = TKES+(DL2*A11-DL1*A21)/(A11*A22-A12*A21)
      TK = TKX(3)
      HVBAR1 = HVBE(TK)
      PE = PEES +(HFF-PEES*HVBAR1-(1.-PEES)*H(CE,TK))/A21
      IF(DABS((TKX(3)-TKES)/TKX(3)) .LE. CLOSR) GO TO 130
      PEES = PE
      TKES = TKX(3)
      GO TO 126
  130 CONTINUE
      DTK=TK-100.
      ROE1 = (THF-TK)/AN
      ROC1 =(TCF-TE)/AN
      CEX(1) = (CCF-PE*CP/AN)/(1.-PE/AN)
      TKX(1) =THF-ROE1
      TKX(2) = .5*(THF-ROE1+TK)
      TCX(1) = TCF-ROC1
      TCX(2) = TE+(TKX(2)-TK)*(TCF-TE)/(THF-TK)
      TCX(3) = TE
      HVBRK2 = HVBE(TKX(2))
  132 CONTINUE
      HEK2 = H(CEX(2),TKX(2))
      PK2 = (HFF-HEK2)/(HVBRK2-HEK2)
      F = CEX(2)*(1.-PK2)+CP*PK2-CCF
      IF(DABS(F) .LE. CLOSR) GO TO 135
      FP = (1.-PK2)*(1.+(CEX(2)-CP)/(HVBRK2-HEK2)*DHDC(CEX(2),TKX(2)))
      CEX(2) = CEX(2)-F/FP
      GO TO 132
  135 CONTINUE
      WMODCA =(WP/MODU*(1.-PE+PE/AN)/(P*XO(85))+VAPSPC*(LEV-1.))/LEV
      WMODC = SMOOTH(WMODCA,WMODMN,12.75D0)
      WPRTCA =     WMODC/XO(209)-VAPSPC
      WPRTRY = SMOOTH(WPRTCA,WPTYMN,25.D0)
      WMODMI = XO(209)*(WPRTRY + .7857*VAPSPC)
      WMODCA =(WP/(P*MODU*XO(84))+.7857*VAPSPC*(LEV-1.))/LEV
      WMODH = SMOOTH(WMODCA,WMODMI,12.75D0)
      RXH  =P*MODU*(LEV*(WMODH-.7857*VAPSPC)+.7857*VAPSPC)
      RXC  =P*MODU*(LEV*(WMODC-VAPSPC)+VAPSPC)
      QX(1)= WP/RXH
      QX(2)= WP*(1.-PK2+PE/AN)/RXC
      QX(3)= WP*(1.-PE+PE/AN)/RXC
      QX(4)= WP*(1.-PE)/RXC
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      DO 140 I=1,2                                                      PR 18830
      CALL BPRAT(TKX(I),CEX(I),BPX(I))                                  PR 18840
      DTX(I) = DTDP(TKX(I))                                             PR 18850
  140 CONTINUE                                                          PR 18860
  141 CONTINUE                                                          PR 18870
      GE = VE*DENFE                                                     PR 18880
      CONSLE = (DIE/12.)**2/4.*VE*3600.*DENFE/(DOE/12.)                 PR 18890
      IMPOSE = 0                                                        PR 18900
      DO 145  I=1,3                                                     PR 18910
      DHREC = H(CCF,TCX(I)+ROC1)-H(CCF,TCX(I))                          PR 18920
      TLX = TCX(I)+.5*ROC1                                              PR 18930
      CALL UBAR(0.D0,TLX,CCF,CP,GE,DIE,DOE,SE,RSE,OMX(I),BKTE,UEX(I),   PR 18940
     1            HIEX(I),HOEX(I))                                      PR 18950
      CALL SUB(ROE1,TKX(I),QX(I),ELEX(I),BDEPH,SUBEX(I))                PR 18960
      SMAX = TKX(I) - DTX(I) - BPX(I) -1.0 - TCX(I) - ROC1              PR 18963
      SUBEX(I) = DMIN1(SUBEX(I), SMAX)                                  PR 18967
      ISPOT = I                                                         PR 18970
      LAPS = 0                                                          PR 18980
  142 CONTINUE                                                          PR 18990
      SUBEES = SUBEX(I)                                                 PR 19000
      DTLS(I) = DTX(I)+BPX(I)+SUBEX(I)                                  PR 19010
      TPEX = TKX(I) - DTLS(I)                                           PR 19020
      TTD = TPEX-(TCX(I)+ROC1)                                          PR 19030
      IF(TTD .LT. .0625D0) TTD = .0625D0*DEXP(TTD/.0625D0-1.D0)         PR 19040
      OMX(I) = ROC1/DLOG(1.+ROC1/TTD)                                   PR 19050
      IF(LAPS .NE. 0) GO TO 143                                         PR 19060
      CALL UBAR1(TPEX,OMX(I),UEX(I),HIEX(I),HOEX(I))                    PR 19070
  143 CONTINUE                                                          PR 19080
      AEX = DHREC/(UEX(I)*OMX(I))                                       PR 19090
      ELEX(I) = AEX*CONSLE                                              PR 19100
      IF(TTD .LT. .0625D0) GO TO 144                                    PR 19110
      CALL SUBM(ELEX(I),SUBEX(I))                                       PR 19120
      CRIT = DABS(1.D0-SUBEES/SUBEX(I))                                 PR 19130
      IF((LAPS .EQ. 0) .AND. (CRIT .LE. CLOSR)) GO TO 145               PR 19140
      LAPS = LAPS+1                                                     PR 19150
      IF((LAPS .GT. 2) .OR. (CRIT .LE. CLOSR)) LAPS = 0                 PR 19160
      GO TO 142                                                         PR 19170
  144 IMPOSE = 1                                                        PR 19180
  145 CONTINUE                                                          PR 19190
C****                                                                   PR 19200
C           REJECT SECTION HEAT AND MATERIAL BALANCE                    PR 19210
C                COMPUTATION OF REJECT HEAT TRANSFER PARAMETERS         PR 19220
C***                                                                    PR 19230
  150 CONTINUE                                                          PR 19240
      QX(5)= WP*(1.-P +(P-PE)/AK)/RXC                                   PR 19250
      ROE2 =(TK-TB)/AK                                                  PR 19260
      ROC2 =(TC-TO)/AK                                                  PR 19270
      CEX(4)=((1.-PE)*CE -(P-PE)*CP/AK)/(1.-PE-(P-PE)/AK)               PR 19280
      CEX(5)= CB                                                        PR 19290
      TKX(4)= TK-ROE2                                                   PR 19300
      TKX(5)= TB                                                        PR 19310
      TCX(4)= TC -ROC2                                                  PR 19320
      TCX(5)= TO                                                        PR 19330
      CALL BPRAT(TKX(4),CEX(4),BPX(4))                                  PR 19340
      DTX(4) = DTDP(TKX(4))                                             PR 19350
  152 CONTINUE                                                          PR 19360
      GR = VR*DENCO                                                     PR 19370
      CONSLR = (DIR/12.)**2/4.*VR*3600.*DENOO/(DOR/12.)                 PR 19380
      IMPOSR = 0                                                        PR 19390
      DO 160  I= 4,5                                                    PR 19400
      DHREJ = H(CO,TCX(I)+ROC2)-H(CO,TCX(I))                            PR 19410
      TLX = TCX(I)+.5*ROC2                                              PR 19420
      CALL UBAR(0.D0,TLX,CO,CP,GR,DIR,DOR,SR,RSR,OMX(I),BKTR,UEX(I),    PR 19430
     1           HIEX(I),HOEX(I))                                       PR 19440
      CALL SUB(ROE2,TKX(I),QX(I),ELEX(I),BDEPH,SUBEX(I))                PR 19450
      SMAX = TKX(I) - DTX(I) - BPX(I) -1.0 - TCX(I) - ROC2              PR 19453
      SUBEX(I) = DMIN1(SUBEX(I), SMAX)                                  PR 19456
      ISPOT = I                                                         PR 19460
      LAPS = 0                                                          PR 19470
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  158 CONTINUE
      SUBEES = SUBEX(I)
      DTLS(I) = DTX(I)+BPX(I)+SUBEX(I)
      TPEX = TKX(I) -DTLS(I)
      TTD = TPEX-(TCX(I)+ROC2)
      IF(TTD .LT. .0625D0) TTD = .0625D0*DEXP(TTD/.0625D0-1.D0)
      OMX(I) = ROC2/DLOG(1.+ROC2/TTD)
      IF(LAPS .NE. 0) GO TO 159
      CALL UBAR1(TPEX,OMX(I),UEX(I),HIEX(I),HOEX(I))
  159 CONTINUE
      ARX = DHREJ/(UEX(I)*OMX(I))
      ELEX(I) = ARX*CONSLR
      IF(TTD .LT. .0625D0) GO TO 1591
      CALL SUBM(ELEX(I),SUBEX(I))
      CRIT = DABS(1.D0-SUBEES/SUBEX(I))
      IF((LAPS .EQ. 0) .AND. (CRIT .LE. CLOSR)) GO TO 160
      LAPS = LAPS+1
      IF((LAPS .GT. 2) .OR. (CRIT .LE. CLOSR)) LAPS = 0
      GO TO 158
 1591 IMPCSR = 1
  160 CONTINUE
C****
C          BRINE HEATER HEAT AND MATERIAL BALANCE
C              COMPUTATION OF BRINE HEATER HEAT TRANSFER PARAMETERS
C***
  170 CONTINUE
      GH = VH*DEN(CCF,THF)
      PHE =(THF-TCF)/DLOG((TS-TCF)/(TS-THF))
      TLH = .5*(THF+TCF)
      ISPCT = 6
      CALL UBAR(TS,TLH,CCF,0.D0,GH,DIH,DOH,SH,RSH,PHE,BKTH,UH,HIH,HOH)
C****
C          SIZE PLANT
C***
      CALL SIZEM
C****
C****
C          COST PLANT
C***
      CALL COSTM
      FFFFFF = TC1
      IFLIP = IFLIP+1
      RETURN
      END
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APPENDIX D

CHANGES MADE IN SUBROUTINE PLANTV

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      SUBROUTINE PLANTV(X07,GGG)                                        PR 06270
      IMPLICIT REAL*8(A-H,O-Z)                                          PR 06280
C                                                                       PR 06290
      DOUBLE PRECISION  M, LAM, LAMDAE,  IDVE,  MAVG                    PR 06300
      DOUBLE PRECISION    LPH,    LVE,   IDBH,   IDPH,   LCON,   NCON,  PR 06310
     1   NTPH,  IDCON                                                   PR 06320
      DOUBLE PRECISION    KBH,    KPH,    KVE,    LBH,    MGD,    NBH,  PR 06330
     1    NPH,    NVE,  KCON,   LMTD,   LVEP, LMTDBH, LMTDCN            PR 06340
      DOUBLE PRECISION    INT, INSTRD, INSTRK, INSTRY, MAINTK, MAINTY   PR 06350
      DOUBLE PRECISION LEV,LF2                                          PR 06360
C                                                                       PR 06370
      COMMON/BLOCV1/    ANE,       HVE,       LPH,       LVE,      ACON,PR 06380
     1       GPMV,     HPVE,      HSEA,      IDBH,      IDPH,      LCON,PR 06390
     2       NCON,     NTPH,      ODBH,      ODPH,      ODVE,      POVE,PR 06400
     3       RPMV,    HFEED,     IDCON,     ODCON,     SUMWT,     VETSA,PR 06410
     4     APTSCN,   APTSEP,    OVRHGT,    TOTNVE,    VEPMPS            PR 06420
      COMMON/BLOCV2/  A(30),         S,    AE(30),        QE,    TC(30),PR 06430
     1     TE(30),       TR,    UE(30),     UH(3),        WM,    WT(30),PR 06440
     2        ABH,      APH,   BPE(30),   CIE(30),   COE(30),   DPE(30),PR 06450
     3        ELL,      GBH,       GPH,       GPM,       HOO,       KBH,PR 06460
     4        KPH,      KVE,       LBH,       MGD,       NBH,       NPH,PR 06470
     5    NVE(30),      QPH,       RBH,       RPH,       RVE,       TOO,PR 06480
     6        UBH,      VBH,       VPH,  WPEX(30),      BHLF,      GCON,PR 06490
     7       HIBH,  HIPH(3),      HOBH,   HOPH(3),      KCON,   LMTD(3),PR 06500
     8       LVEP,     PHLF,   QMSF(3),      RCON,   SUBF(3),      TCON,PR 06510
     9       UCON,     VCON,      VLEN,      VTLF,  WDTH(30), ALFAE(30),PR 06520
     +      CONLF,    HICON,     HOCON,     HOTE1,     PHHGT,     POBLO,PR 06530
     A      POPRO,    POSEA,     SURFF,     VEHGT,     WALVE,    EFFSPC,PR 06540
     BELBNDL(30),   HCOTCF,    HCOTOO,    HEADBH,    HEADCN,    HEADPH,PR 06550
     C     LMTDBH,   LMTDCN,    PLNTLF,    PODEAS,    POFEED,    SUMWPE,PR 06560
     D     SUMWPH,   TOTAVE,      QESP,VEFEED(30),    WBOOST,    WDCOLD,PR 06570
     E         NE,     NTRN,     IFEED,    IRECYC                       PR 06580
      COMMON/BLOCV3/    BHD,       BHK,       BHY,       INT,       PMD,PR 06590
     1        PMK,      PMY,       VPD,       VPK,       VPY,      ACHR,PR 06600
     2       DEAD,     DEAK,      DEAY,      ELEC,      HEAT,      SBCD,PR 06610
     3       SBCK,     SBCY,     CHEMK,     CHEMY,     HEATK,     HEATY,PR 06620
     4      OPERK,    OPERY,     PLDIN,     WAITD,     WAITK,     WAITY,PR 06630
     5     ANCOMP,   CMCAPD,    CMCAPK,    CMCAPY,    CNDSRD,    CNDSRK,PR 06640
     6     CNDSRY,   ELECTD,    ELECTK,    ELECTY,    INSTRD,    INSTRK,PR 06650
     7     INSTRY,   MAINTK,    MAINTY,    PHTUBD,    PHTUBK,    PHTUBY,PR 06660
     8     PLCAPD,   PLCAPK,    PLCAPY,    POWERK,    POWERY,    RETUBK,PR 06670
     9     RETUBY,   SHELLD,    SHELLK,    SHELLY,    TOTALK,    TOTALY,PR 06680
     +     TOTCPK,   TOTOPY,    TREPBH,    TREPCN,    TREPPH,    TREPVE,PR 06690
     A     VETUBD,   VETUBK,    VETUBY,      CGPD                       PR 06700
      COMMON/COMNAM/     AJ,        CB,        CO,        CP,        CR,  PR 06710
     1         HB,       PI,        PO,        TB,        TO,        TP,  PR 06720
     2         TS,       WB,        WF,        WO,        WP,        WR,  PR 06730
     3        AXJ,      HBL,       HPR,       LEV,       LF2,       TCF,  PR 06740
     4       ENBH,     GPMB,      GPMD,      GPMH,      GPMO,      GPMP,  PR 06750
     5       GPMR,     HDEA,      RPMB,      RPMD,      RPMM,      RPMP,  PR 06760
     6       RPMR,     TSTH,      WHOT,      YEAR,     ACRES,     BHVOL,  PR 06770
     7      BLDGS,    BNDLS,     HOLES,     HPBLD,     HPDEA,     HPDEL,  PR 06780
     8      HPPRD,    HPREC,     PLPRD,     PLSEA,     PODEA,    ACNCEW,  PR 06790
     9     ACNCFL,   ACNCIW,    ACNCPH,    ACNCRF,    ACNCTR,    AEXCAV,  PR 06800
     +     ASTLEW,   ASTLFL,    ASTLIW,    ASTLPH,    ASTLRF,    ASTLTR,  PR 06810
     A     AWEIRS,   BHSURF,    DINTAK,    ENITSE,    ENPIPE,    ENSUPE,  PR 06820
     B     ENSUPR,   PIPELN,    PLSZMG,    REJLEN,    STLLEN,    STLTMP,  PR 06830
     C     TNACDY,   TRAINS,    TSAREA,    VOLCNC,    VOLSTL,    WOCEAN   PR 06840
       COMMON/SHARE/  IFLIP    ,ISPUT                                   PR 06850
      COMMON/BLOC12/ XT                                                 PR 06860
      COMMON/BLOC13/ XO                                                 PR 06870
      COMMON/INDEX/ IND(40)                                             PR 06880
      COMMON/OVRLAY/ HOSAVE(15),CISAVE(15)                              PR 06890
      COMMON/IMPOVE/ IVERT                                              PR 06900
      COMMON/BLKFAC/ FDFAC, QEFAC, TRFAC                                  ****
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C                                                                       PR 06910
      DIMENSION    M(30),     CAE(30),      GAM(3),    REFM(30),        PR 06920
     1             THTX(4),   WPPHX(30),    WPROD(3),  WTRAX(30),       PR 06930
     2          ABNDLV(30),  LAMDAE(30),    QBRINE(3),  RHOSTG(3),      PR 06940
     3            TPRODX(3),  BPEPH(3) ,    BPIE(30)                    PR 06950
      DIMENSION X07(40)                                                 PR 06960
      DIMENSION XC(300),XT(300)                                         PR 06970
C                                                                       PR 06980
      ABCISA(X3,X2,X1,Y3,Y2,Y1)= X3+((Y1*Y3-Y2*Y3)*(X3-X1)*(X2-X3))/    PR 06990
     1                     (Y1*Y2*(X1-X2)+Y1*Y3*(X3-X1)+Y2*Y3*(X2-X3))  PR 07000
C                                                                       PR 07010
       IERR=0                                                              ****
      DELTCF=10.                                                           ****
      VBH  = X07(1)                                                     PR 07020
      ODBH = X07(2)                                                     PR 07030
      VCON = X07(3)                                                     PR 07040
      ODCCN= X07(4)                                                     PR 07050
      TRFAC= X07(5)                                                     PR 07060
C                                                                          ****
      VPH  = X07(7)                                                     PR 07080
      ODPH = X07(8)                                                     PR 07090
      FDFAC = X07(9)                                                    PR 07100
      ODVE = X07(10)                                                    PR 07110
      LVE=X07(11)                                                           7120
      QEFAC = X07(12)                                                   PR 07130
      ANE  = X07(13)                                                    PR 07140
      NPH=X07(6)*ANE                                                       ****
      CALL DXX8(IDPH,IDBH,IDCCN,ODPH,ODBH,ODCON)                        PR 07150
      IF(IFLIP .GT. 1) GO TO 100                                        PR 07160
      TC(1) =TS                                                         PR 07170
      CIE(1) =CO                                                        PR 07180
      BPEB = 1.0D0                                                      PR 07190
      DO 85 I=1,3                                                       PR 07200
   85 BPEPH(I) = 1.D0                                                   PR 07210
      CSAV = XT(1C8)/VIS(CO,150.D0,.14D0)                               PR 07220
      DO 90 I=1,15                                                      PR 07230
      HOSAVE(I) = 2.D3*XT(109)                                          PR 07240
   90 CISAVE(I) = CSAV                                                  PR 07250
      ELREF = 3.+7.*DSQRT((MGD/TRAINS)/62.5)                            PR 07260
      EFFSPC = 3.+.75*ELREF                                             PR 07270
      DO 95 I=1,30                                                      PR 07280
      BPE(I) = 1.CD0                                                    PR 07290
      BPIE(I) = 1.D0                                                    PR 07300
   95 A(I) = 7.D0                                                       PR 07310
      HOO = H(CO,TO)                                                    PR 07320
      CLOSR = 1.C-8                                                     PR 07330
      MAVG = XO(88)                                                     PR 07340
      TEES = 100.D0                                                     PR 07350
      UE(1) = UVE(TS,KVE,WALVE,RVE,SLOPE)                               PR 07352
      UV2 = UVE(.5*(TS+TEES), KVE, WALVE, RVE, SLOPE)                   PR 07354
      UENE = UVE(TEES, KVE, WALVE, RVE, SLOPE)                          PR 07356
      UEBAX = (UE(1)+4.0*UV2+UENE)/6.0                                  PR 07358
      GO TO 105                                                         PR 07360
  100 IF(IND(13) .GT. 0) GO TO 105                                      PR 07370
      IF(IND(12).GT.0.)GO TO 105                                        PR 07380
      IF((IND(10)+IND(11)).GT.0) GO TO 130                                 ****
      IF(IND(9) .GT. 0) GO TO 135                                       PR 07400
      IF((IND(6)+IND(7)+IND(8)) .GT. 0) GO TO 180                       PR 07410
      IF((IND(3)+IND(4)+IND(5)) .GT. 0) GO TO 205                       PR 07420
      GO TO 210                                                         PR 07430
C****                                                                   PR 07440
C      VERTICAL TUBE SECTION                                            PR 07450
C****                                                                   PR 07460
  105 NE = ANE +.5                                                      PR 07470
      QNOM = (TS - (TO+10.0) - ANE*2.5)*UEBAX/ANE                       PR 07480
      IVERT = 0                                                         PR 07490
      M(NE) = XO(89)                                                    PR 07500
      DO 110 I=1,NE                                                     PR 07510
      AI = I                                                            PR 07520
      REFM(I) = 1.+(AI-1.)/(ANE-1.)*(.9072*(ANE-AI)-.061*(2*ANE-3*AI+2.)PR 07530
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     1              )/(ANE-2.)                                              PR 07540
      M(I) = 1.+(AI-1.)/(ANE-1.)*(6.*(MAVG-1.)*(ANE-AI)-(M(NE)-1.)          PR 07550
     1          *(2.*ANE-3.*AI+2.))/(ANE-2.)                                PR 07560
  110 CONTINUE                                                              PR 07570
  115 QESP = QNOM*(.6+.4*QEFAC)                                             PR 07580
  120 TE(1) = TS-A(1)                                                       PR 07590
      UE(1) = UVE(TE(1),KVE,WALVE,RVE,SLOPE)                                PR 07600
      F = QESP/UE(1)-A(1)                                                   PR 07610
      IF(DABS(F) .LE. CLOSR) GO TO 125                                      PR 07620
      A(1) = DABS(A(1) + F/(1.+ QESP*SLOPE))                                PR 07630
      GO TO 120                                                             PR 07640
  125 LAMDAE(1) = LAM(TE(1),PZVE,CO,BPIE(1))                                PR 07650
      QESPX = QESP*ANE/MAVG                                                 PR 07660
      TEX=TS-2.5*(ANE-1.)                                                   PR 07670
      KNTR = C                                                              PR 07675
  126 UV2 = UVE(.5*(TEES+TE(1)),KVE,WALVE,RVE,SLOP2)                        PR 07680
      UE(NE) = UVE(TEES,KVE,WALVE,RVE,SLOPE)                                PR 07690
      UEBAR = (UE(1)+4.*UV2+UE(NE))/6.                                      PR 07700
      F = TEES+QESPX/UEBAR-TEX                                              PR 07710
      IF(DABS(F) .LE. CLOSR) GO TO 127                                      PR 07720
      KNTR = KNTR+1                                                         PR 07723
      IF(KNTR .GE. 20) GO TO 127                                            PR 07726
      FP = 1.+QESPX*(2.*SLOP2*UV2*UV2+SLOPE*UE(NE)*UE(NE))                  PR 07730
     1     /(6.*UEBAR*UEBAR)                                                PR 07740
      TEES = DABS(TEES - F/FP)                                              PR 07750
      GO TO 126                                                             PR 07760
  127 CMX=XT(115)                                                             ****
      WFNOM=1.D-3*CMX*QESP*(ANE-1.)*(1.-5.D-4*(TE(1)-TEES))                 PR 07790
     1   /(CMX*(1.-1.D-3*(TE(1)-TEES))-CO)                                  PR 07800
  130 IDVE = CDVE -2.*WALVE                                                 PR 07810
      GPM = XC(75) *IDVE/2.902 *DSQRT(LVE/10.)                              PR 07820
      TERMN = 1./(PI*CDVE/12.*LVE*SURFF)                                    PR 07830
      TERMW = GPM *60./7.48                                                 PR 07840
  135 WFX = WFNOM*(1.+.4*FDFAC)                                             PR 07850
      IF(IVERT .GT. 0) GO TO 105                                            PR 07860
  136 CONTINUE                                                              PR 07870
      IRECYC = 0                                                            PR 07880
  137 CONTINUE                                                              PR 07890
      WTRAX(1) = WFX                                                        PR 07900
      SUMWPE = 0.D0                                                         PR 07910
      SUMWPH = 0.D0                                                         PR 07920
      DO 165 I=1,NE                                                         PR 07930
      WPEX(I) = QESP/LAMDAE(I)                                              PR 07940
      WPEX(I) = DMIN1(WPEX(I), WTRAX(I)*(.22-CIE(I))/(.22-CP))              PR 07945
      SUMWPE = SUMWPE +WPEX(I)                                              PR 07950
      VEFEED(I) = M(I)*TERMW*TERMN*DEN(CIE(I),TE(I))                        PR 07960
      CAE(I) = (VEFEED(I)*CIE(I) -.5*WPEX(I)*CP)/(VEFEED(I)-.5*WPEX(I))     PR 07970
      COE(I) = (WTRAX(I)*CIE(I)-WPEX(I)*CP)/(WTRAX(I)-WPEX(I))              PR 07980
      CALL BPRAT(TE(I),CAE(I),BPE(I))                                       PR 07990
      IF(I .GE. NE) GO TO 165                                               PR 08000
      AI = I+1                                                              PR 08010
      TC(I+1) = (TE(I)-BPE(I)-2.5667)/.991333                               PR 08020
  145 DPE(I) = 1.477798D0+TC(I+1)*(.003778D0-3.5556D-5*TC(I+1))             PR 08030
      ALFAE(I) = DPE(I)+BPE(I)                                              PR 08040
      F = TC(I+1)+ALFAE(I)-TE(I)                                            PR 08050
      IF(DABS(F) .LE. CLOSR) GO TO 150                                      PR 08060
      TC(I+1) = TC(I+1)-F/(1.003778D0-7.1112D-5*TC(I+1))                    PR 08070
      GO TO 145                                                             PR 08080
  150 QESPM = QESP/M(I+1)                                                   PR 08090
 1501 TE(I+1) = TC(I+1)-A(I+1)                                              PR 08100
      UE(I+1) = UVE(TE(I+1),KVE,WALVE,RVE,SLOPE)                            PR 08110
      F = QESPM/UE(I+1)-A(I+1)                                              PR 08120
      IF(DABS(F) .LE. CLOSR) GO TO 151                                      PR 08130
      A(I+1) = DABS(A(I+1) + F/(1.+QESPM*SLOPE))                            PR 08140
      GO TO 1501                                                            PR 08150
  151 TEX = TE(I+1)-(ANE-AI)*(TE(I)-TE(I+1))                                PR 08160
C****                                                                       PR 08170
C       IS PLANT PHYSICALLY REASONABLE WITH GIVEN M-VALUES?                 PR 08180
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C****                                                                   PR 08190
      IF(TEX .GE. (TO+20.)) GC TO 152                                   PR 08200
      IVERT = 1                                                         PR 08210
      TEZ = (TO+2C.+(ANE-AI)*TE(I))/(ANE-AI+1.)                         PR 08220
      TE(I+1) = DMIN1(TC(I+1)-1.,TEZ)                                   PR 08230
      A(I+1) = TC(I+1)-TE(I+1)                                          PR 08240
      UE(I+1) = UVE(TE(I+1),KVE,WALVE,RVE,SLOPE)                        PR 08250
      M(I+1) = QESP/(UE(I+1)*A(I+1))                                    PR 08260
  152 WTRAXO = WTRAX(I)-WPEX(I)                                         PR 08270
      CMAX=.1375-.000375*TE(I)                                            ****
      WPHMAX = WTRAXO*(CMAX-COE(I))/(CMAX-CP)                           PR 08300
      CIE(I+1) = WTRAXO*COE(I)/(WTRAXO-.15*WPEX(I))                     PR 08310
      HEII = H(CCE(I),TE(I))                                            PR 08320
      HVPH = HVBR(TE(I),TE(I+1))                                        PR 08330
      AZ1 = (HVPH*COE(I)-HEII*CP)/(HVPH-HEII)                           PR 08340
      AZ2 = (COE(I)-CP)/(HVPH-HEII)                                     PR 08350
  155 HEES = H(CIE(I+1),TE(I+1))                                        PR 08360
      F = CIE(I+1)-AZ1+AZ2*HEES                                         PR 08370
      IF(DABS(F) .LE. CLOSR) GO TO 160                                  PR 08380
      CIE(I+1) = CIE(I+1)-F/(1.+AZ2*DHDC(CIE(I+1),TE(I+1)))             PR 08390
      CIE(I+1) = DABS(CIE(I+1))                                         PR 08395
      GC TO 155                                                         PR 08400
  160 WPPHX(I) = WTRAXO*(HEII-HEES)/(HVPH-HEES)                         PR 08410
      WTRAX(I+1) = WTRAXO-WPPHX(I)                                      PR 08420
      SUMWPH = SUMWPH+WPPHX(I)                                          PR 08430
C****                                                                   PR 08440
C       IS CONC LOW ENOUGH TO PREVENT CA2S04 SCALING W/O PRODUCT LOSS?  PR 08450
C****                                                                   PR 08460
      IF(CIE(I+1) .LE. CMAX) GO TO 162                                  PR 08470
      IRECYC = IRECYC+1                                                 PR 08480
  161 SUMWPH = SUMWPH-WPPHX(I)+WPHMAX                                   PR 08490
      WPPHX(I) = WPHMAX                                                 PR 08500
      CIE(I+1) = CMAX                                                   PR 08510
      WTRAX(I+1) = WTRAXO-WPHMAX                                        PR 08520
  162 CONTINUE                                                          PR 08530
      LAMDAE(I+1) = LAM(TE(I+1),PZVE,CIE(I+1),BPIE(I+1))                PR 08540
  165 CONTINUE                                                          PR 08550
C    MODIFY FDFAC TO GET DESIRED CONCENTRATION RATIO                      ****
      IF(DABS(XT(151)-COE(NE)).LT.0.001000) GO TO 166                     ****
      FDFAC=FDFAC-(XT(151)-COE(NE))*CO*(1.+FDFAC)/(.4*XT(151)*(XT(151)-C  ****
     1O))                                                                 ****
 1820 FORMAT(' FDFAC=',F10.4,' COE(NE )=',F10.5)                          ****
      GO TO 135                                                           ****
  166 CONTINUE                                                            ****
      WPX = SUMWPE +SUMWPH                                              PR 08560
      WPXX= WPX-WPEX(NE)                                                PR 08570
      ALFAE(NE) = BPE(NE)+DTDP(TE(NE))                                  PR 08580
      TCCN = TE(NE)-ALFAE(NE)                                           PR 08590
C MODIFY QEFAC TO GET DESIRED TCON                                        ****
      IF(DABS(TCCN-XT(152)).LE.0.0500) GO TO 170                          ****
      QEFAC=QEFAC+(TCCN-XT(152))*(1.5+QEFAC)/(TS-TCON)                    ****
 1720 FORMAT(' QEFAC=',F10.4,' TCON=',F10.2)                              ****
      GO TO 115                                                           ****
  170 CONTINUE                                                            ****
      CALL BPRAT(TE(NE),COE(NE),BPEB)                                   PR 08600
      TPPH = TE(NE)-BPEB -(.5+.001623*(TE(NE)-92.))*DTDP(TE(NE))        PR 08610
C****                                                                   PR 08620
C       FIT VE EFFECTS INTO TRAPEZOIDAL SHELL AND FIND LENGTH OF VE PLANTPR 08630
C****                                                                   PR 08640
      AE(1) = WP/WPX                                                    PR 08650
      WF = WFX *AE(1)                                                   PR 08660
      DO 175 I=1,NE                                                     PR 08670
      AE(I) =AE(1)*M(I)                                                 PR 08680
      NVE(I)= AE(I)*TERMN                                               PR 08690
      RHOREF = 14.634 *(1.-DEXP(-(TC(I)-59.6)/69.17))                   PR 08700
      ABNCLV(I) = (NVE(I)/TRAINS *(ODVE/3.)*(ODVE/3.))/RHOREF           PR 08710
  175 CONTINUE                                                          PR 08720
      ELBNDL(1) = ELREF                                                 PR 08730
      ELBNDL(NE) = ELREF*M(NE)/REFM(NE)                                 PR 08740
      WDTH(1) = ABNDLV(1)/ELBNDL(1)                                     PR 08750
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      WDTH(NE)= ABNDLV(NE)/ELBNDL(NE)                                    PR 08760
      NEM2 = NE-2                                                        PR 08770
      VXLEN = (ANE-1.)*(ELREF+EFFSPC)                                    PR 08780
  176 VLEN = WDTH(1)+EFFSPC                                              PR 08790
      TNTHET = (WDTH(NE)-WDTH(1))/VXLEN                                  PR 08800
      DO 177 I=1,NEM2                                                    PR 08810
      WDTH(I+1) = WDTH(I)+(ELBNDL(I)+EFFSPC)*TNTHET                      PR 08820
      ELBNDL(I+1) = ABNDLV(I+1)/WDTH(I+1)                                PR 08830
  177 VLEN = VLEN+ELBNDL(I+1)+EFFSPC                                     PR 08840
      IF(DABS((VLEN-VXLEN)/VXLEN) .LE. CLOSR) GO TO 178                  PR 08850
      VXLEN = VLEN                                                       PR 08860
      GO TO 176                                                          PR 08870
  178 VLEN = VLEN+EFFSPC+ELBNDL(NE)                                      PR 08880
      LPH = VLEN                                                         PR 08890
      HOTE1 = H(CO,TE(1))                                                PR 08900
      HTOUT = (1.-WPXX/WFX)*H(CIE(NE),TE(NE)) +WPXX/WFX*H(CP,TPPH)       PR 08910
      QTRSP = HOTE1 - HTOUT                                              PR 08920
      NDEL = NE/2-2                                                      PR 08930
      SUMRHO = (TE(1)-TE(NE))                                            PR 08940
      TCFSAV=TE(1)-DELTCF                                                  ****
      DO 179 J=1,3                                                       PR 08960
      NJ = 2+(J-1)*NDEL                                                  PR 08970
      CALL BPRAT(TE(NJ),CIE(NJ),BPEPH(J))                                PR 08980
      DTPHX = DTDP(TE(NJ))                                               PR 08990
      TPRODX(J) = TE(NJ)-BPEPH(J)-(.5+.001623*(TE(NJ)-92.))*DTPHX        PR 09000
      THTX(J) = TE(NJ)-BPEPH(J)-DTPHX                                    PR 09010
      WPROD(J) = 1.-WTRAX(NJ)/WFX                                        PR 09020
      QBRINE(J) = HOTE1-WTRAX(NJ)/WFX*H(CIE(NJ),TE(NJ))                  PR 09025
     1         - WPROD(J)*H(CP,TPRODX(J))                                PR 09030
  179 CONTINUE                                                           PR 09040
C****                                                                    PR 09050
C       PREHEATER                                                        PR 09060
C****                                                                    PR 09070
  180 DO 185 J=1,3                                                       PR 09080
      RHOSTG(J) = (TE(1)-TE(NE))/NPH                                     PR 09090
  185 QMSF(J) = (WF/TRAINS)/(WDTH(NJ)-(WDTH(NE)-WDTH(1))/NPH)            PR 09100
      TCF=DMIN1(TCFSAV,TE(1)-DELTCF)                                       ****
      ELL = LPH/NPH                                                      PR 09120
      GXX = (ELL*ODPH/12.)/(3600.*(IDPH/12.)**2/4.)                      PR 09130
      CALL UBAR(-10.D0,TL,CO,CP,GPH,IDPH,ODPH,S,RPH,LMTD(I),KPH,UH(I),   PR 09140
     1          HIPH(I),HOPH(I))                                         PR 09150
      NITS = 0                                                           PR 09160
  190 GPH = VPH*DEN(CO,TCF)                                              PR 09170
      ABYWF = GXX/GPH                                                    PR 09180
      TCES =TCF                                                          PR 09190
      HCOTCF = H(CO,TCF)                                                 PR 09200
      HCOTOO = HCOTCF-QTRSP                                              PR 09210
      TOO = HINV(CO,HCOTOO)                                              PR 09220
      DO 195 I=1,3                                                       PR 09230
      RHOSTG(I) = RHOSTG(I)*(TCF-TOO)/SUMRHO                             PR 09240
      ROTRAY = (TE(1)-TE(NE))*RHOSTG(I)/(TCF-TOO)                        PR 09250
      NJ = 2+(I-1)*NDEL                                                  PR 09260
      CALL SUB(ROTRAY,TE(NJ),QMSF(I),ELL,XO(18),SUBF(I))                 PR 09270
      HCTUBE = HCOTCF-QBRINE(I)                                          PR 09280
      TCTUBE = HINV(CO,HCTUBE)                                           PR 09310
      TSRFCE = THTX(I)-SUBF(I)                                           PR 09320
      THTUBE = TCTUBE +RHOSTG(I)                                         PR 09330
      TL = .5*(TCTUBE +THTUBE)                                           PR 09340
      TTD = TSRFCE -THTUBE                                               PR 09350
      IF(TTD .LT. 1.D0) TTD = DEXP(TTD-1.)                               PR 09360
      LMTD(I) = RHOSTG(I)/DLOG(1.+RHOSTG(I)/TTD)                         PR 09370
      ISPCT = I+6                                                        PR 09380
      CALL UBARO(TSRFCE,TL,GPH,LMTD(I),UH(I),HIPH(I),HOPH(I))            PR 09390
      SPHT = (H(CO,THTUBE)-HCTUBE)/RHOSTG(I)                             PR 09400
      GAM(I) = 1.-DEXP(-ABYWF*UH(I)/SPHT)                                PR 09410
      RHOSTG(I) = (TSRFCE-TCTUBE)*GAM(I)                                 PR 09420
  195 CONTINUE                                                           PR 09430
      NITS = NITS+1                                                      PR 09440
      IF(NITS .GT. 3) NITS=3                                             PR 09450
      SUMRHO = NPH*(RHOSTG(1)+4.*RHOSTG(2)+RHOSTG(3))/6.                 PR 09460
      X1 = X2                                                            PR 09470
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      X2 = X3
      X3 = TCF
      Y1 = Y2
      Y2 = Y3
      Y3 = SUPRHC-(TCF-TOO)
      GO TO (196,197,198),NITS
  196 GRADES = -NPH*(GAM(1)+4.*GAM(2)+GAM(3))/6.
      DTCF = -Y3/GRADES
      GO TO 199
  197 DTCF = -Y3*(X3-X2)/(Y3-Y2)
      IF(Y2*Y3 .LT. 0.D0) GO TO 1991
      GO TO 199
  198 DTCF = ABCISA(X3,X2,X1,Y3,Y2,Y1)-X3
  199 DTCF = DTCF/DABS(DTCF)*DMIN1(DABS(DTCF),5.D0,.5*(TE(1)-TCES))
 1991 TCF = TCES+DTCF
      IF(DABS((TCF-TCES)/TCES) .LE. CLOSR) GO TO 200
      GO TO 190
  200 IFEED = 0
      TCFSAV = TCF
C****
C      IS REQUIRED FEED TEMPERATURE TCO LOW?
C****
      IF(TCO .GT. TO) GO TO 202
      IVERT = IVERT+1
      DO 201 I=2,NE
      AI = I
  201 M(I) = REFM(I)+.1*(AI-1.)/(ANE-1.)*DFLOAT(IVERT)
      IERR=IERR+1                                                       ****
      IF(IERR.LE.20) GO TO 136                                          ****
      PRINT 2200                                                        ****
 2200 FORMAT('0UNSATISFACTORY SOLUTION - TC <= TOO')                     ****
  202 CONTINUE
C****
C      IS AVAILABLE FEED TEMPERATURE HIGH ENOUGH?
C****
      IF((WFX*(HCOTOO-HOO)) .LE. QESP) GO TO 205
      IFEED = 1
      HCCTOO = HOO +QESP/WFX
      TOO = HINV(CO,HCOTOO)
      HCOTCF = HCCTOO +QTRSP
      TCF = HINV(CO,HCOTCF)
C****
C      CONDENSER
C****
  205 TR=TCON-XT(153)                                                   ****
      GCON =VCON *DEN(CO,TR)
      TL = .5*(TC+TR)
      TTD = TCON-TR
      LMTDCN = (TR-TC)/DLOG(1.+(TR-TO)/TTD)
      ISPCT = 12
      CALL UBAR(TCON,TL,CO,CP,GCON,IDCON,ODCON,XO(24),RCON,LMTDCN,KCON,
     1          UCON,HICON,HOCON)
C*****
C      BRINE HEATER
C****
  210 GBH = VBH*DEN(CC,TE(1))
      TL = .5*(TCF+TE(1))
      TTD = TS-TE(1)
      LMTDBH = (TE(1)-TCF)/DLOG(1.+(TE(1)-TCF)/TTD)
      ISPCT = 13
      CALL UBAR(TS,TL,CO,0.D0,GBH,IDBH,ODBH,XO(22),RBH,LMTDBH,KBH,UBH,
     1          HIBH,HOBH)
C****          SIZE PLANT
      CALL SIZEV
C
C****          COST PLANT
      CALL COSTV
C
      GGG = TOTALK
      IFLIP = IFLIP+1
      RETURN
      END
```

APPENDIX E

CHANGES MADE IN SUBROUTINE SIZEM

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      SUBROUTINE SIZEM                                                  PR 19920
      IMPLICIT REAL*8(A-H,O-Z)                                          PR 19930
C                                                                       PR 19940
      DOUBLE PRECISION MODU                                             PR 19950
      REAL*8 LPHE                                                           ****
      DOUBLE PRECISION LEV,LF2                                          PR 19960
C                                                                       PR 19970
      COMMON/PINPAS/APTSH,ENRSS,ENRJS,LPHE,DUMDUM(16),NFEED,IIIIII(9)       ****
      COMMON/BLOCM1/    DIE,      DIH,      DIR,      DUE,      DOH,PR 19980
     1      COR,      ELE,      ENE,      RLR,      RNR,     HDEL,PR 19990
     2     HREC,    APTSR,    ENITSR                                    PR 20000
      COMMON/BLOCP2/      P,        Q,       AH,       AK,       AN,PR 20010
     1       AR,       FF,       GE,       GH,       GR,       HD,PR 20020
     2       PB,       PE,    QX(5),       RP,       SE,       SH,PR 20030
     3       SR,       TK,       VE,       VH,       VR,       WC,PR 20040
     4      AME,      ATN,   BPX(5),      CCF,      HIH,      HLH,PR 20050
     5      FNH,      HOH,   OMX(5),      PHE,      PO3,      RSE,PR 20060
     6      RSH,      RSR,      TC1,      THF,   TKX(5),      TMC,PR 20070
     7      TME,      TPE,   UEX(5),      UME,      UMH,      WPL,PR 20080
     8     BKTE,     BKTH,     BKTR,  DTLS(5),  ELEX(5),  HIEX(5),PR 20090
     9  HOEX(5),     MODU,     ROE1,     ROE2,    APTSE,    BOEPH,PR 20100
     +    CAPI1,    HEADE,    HEADH,    HEADR,    POBLD,    PODEL,PR 20110
     A    POPRD, SUBEX(5),    WCOLD,   WMODC,    WMODH,   BHSHEL,PR 20120
     B   CSLTBH,   CSLTBP,   HOTLEN,   HRECOV,   HREJCT,   RECOLN,PR 20130
     C   VAPSPC,   WPRTRY,    POREC                                     PR 20140
      COMMON/CCMNAM/     AJ,       CB,       CO,       CP,       CR,  PR 20150
     1       HB,       PI,       PO,       TB,       TO,       TP,  PR 20160
     2       TS,       WB,       WF,       WO,       WP,       WR,  PR 20170
     3      AXJ,      HBL,      HPR,      LEV,      LF2,      TCF,  PR 20180
     4     ENBH,     GPMB,     GPMD,     GPMH,     GPMO,     GPMP,  PR 20190
     5     GPMR,     HDEA,     RPMB,     RPMD,     RPMM,     RPMP,  PR 20200
     6     RPMR,     TSTH,     WHOT,     YEAR,    ACRES,    BHVOL,  PR 20210
     7    BLDGS,    BNDLS,    HOLES,   HPBLD,    HPDEA,    HPDEL,  PR 20220
     8    HPPRD,    HPREC,    PLPRD,    PLSEA,    PODEA,   ACNCEW,  PR 20230
     9   ACNCFL,   ACNCIW,   ACNCPH,   ACNCRF,   ACNCTR,   AEXCAV,  PR 20240
     +   ASTLEW,   ASTLFL,   ASTLIW,   ASTLPH,   ASTLRF,   ASTLTR,  PR 20250
     A   AWEIRS,   BHSURF,   DINTAK,   ENITSE,   ENPIPE,   ENSUPE,  PR 20260
     B   ENSUPR,   PIPELN,   PLSZMG,   REJLEN,   STLLEN,   STLTMP,  PR 20270
     C   TNACDY,   TRAINS,   TSAREA,   VOLCNC,   VOLSTL,   WOCEAN   PR 20280
      COMMON/BLOC12/ XT                                                 PR 20290
      COMMON/BLOC13/ XO                                                 PR 20300
      COMMON/SHARE/IFLIP,ISPOT                                          PR 20310
      COMMON/INDEX/ IND(40)                                             PR 20320
C                                                                       PR 20330
      DIMENSION XT(300),XO(300)                                         PR 20340
      DIMENSION XL(3),XMTX(3,3)                                         PR 20350
C                                                                       PR 20360
      IF(IFLIP .EQ. 1) GO TO 90                                         PR 20370
      IF((IND(10)+IND(11)+IND(12)+IND(13)) .GT. 0) GO TO 90             PR 20380
      IF((IND(7)+IND(8)+IND(9)) .GT. 0) GO TO 96                        PR 20390
      IF(IND(4) .GT. 0) GO TO 116                                       PR 20400
      IF((IND(1)+IND(5)+IND(6)) .GT. 0) GO TO 120                       PR 20410
      GO TO 150                                                         PR 20420
   90 CONTINUE                                                          PR 20430
      WF = WP/P                                                         PR 20440
      WO = Q*WF                                                         PR 20450
      WB = PB*WF                                                        PR 20460
      WC = WO -WB -WP                                                   PR 20470
      WR = WF -WB -WP                                                   PR 20480
      WOCEAN = WO+.2*(WB+WP)                                            PR 20490
      GO TO (91,92),NFEED                                                   ****
   91 CONTINUE                                                              ****
      TNACDY = 15.68*FF*CO*CR/(CR-1.)                                   PR 20500
      GO TO 93                                                              ****
   92 CONTINUE                                                              ****
      TNACDY=12.D-9*XO(207)*(WP+WB)                                         ****
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 93 CONTINUE                                                           ****
    IF(IFLIP .GT. 1) GO TO 95                                      PR 20510
    DENOO = DEN(CO,TO)                                             PR 20520
    AMAX = PI * 18.**2/4.                                          PR 20530
    ANEED = WOCEAN/(DENOO *8.*3600.)                               PR 20540
    NPIPE = ANEED/AMAX +1.                                         PR 20550
    ENPIPE =NPIPE                                                  PR 20560
 95 CONTINUE                                                       PR 20570
    DINTAK = DSQRT((4.*WOCEAN)/(DENCO*ENPIPE*PI*2.88D4))           PR 20580
    HPR1 = XO(31) + XT(106)                                        PR 20590
    CALL HEADS(1.D0,1.D0,0.D0,CP,TP,1.D0,1.D0,TRAINS,WP,HPR1,HEADP,   PR 20600
   1          HPR,GPMP,RPMP,POPRD,HPPRD)                           PR 20610
    CALL HEADS(1.D0,1.D0,0.D0,CB,TB,1.D0,1.D0,TRAINS,WB,HBL,HEADB,HBL,PR 20620
   1          GPMB,RPMB,POBLD,HPBLD)                               PR 20630
    CALL HEADS(1.D0,1.D0,0.D0,CO,TB,1.D0,1.D0,TRAINS,WB+WP,XO(86),HDX,PR 20640
   1          HDEA,GPMD,RPMM,PODEA,HPDEA)                          PR 20650
 96 CONTINUE                                                       PR 20670
    DO 100 I=1,3                                                   PR 20680
    XL(I) = ELEX(I)                                                PR 20690
    DO 100 J=1,3                                                   PR 20700
    XMTX(I,J) = TKX(I)**(J-1)                                      PR 20710
100 CONTINUE                                                       PR 20720
    CALL DMATEQ(XMTX,XL,3,1,3)                                     PR 20730
    NAN =AN+.5                                                     PR 20740
    ELE = TSTH/12.                                                 PR 20750
    ELSTL = 0.0D0                                                  PR 20760
    STLLEN =0.0D0                                                  PR 20770
    STLSTG =0.0D0                                                  PR 20780
    TTRAY = THF                                                    PR 20790
    DO 110 I=1,NAN                                                 PR 20800
    AI = I                                                         PR 20810
    TTRAYX = TTRAY                                                 PR 20820
    ELESV = ELE                                                    PR 20830
    TTRAY = THF-AI*ROE1                                            PR 20840
    ELE = ELE +XL(1)+ TTRAY*(XL(2)+XL(3)*TTRAY) +TSTH/12.          PR 20850
    NRSS=ELE/XT(200)+1.                                                ****
    ENRSS=NRSS                                                         ****
    IF(STLTMP .GE. THF) GO TO 105                                  PR 20860
    IF(DABS(.5*(TTRAYX+TTRAY)-STLTMP) .GT. .5*ROE1) GO TO 105      PR 20870
    ELSTL = ELESV +(ELE-ELESV)*(TTRAYX-STLTMP)/ROE1                PR 20880
    STLLEN = ELSTL +10.667                                         PR 20890
    IF(STLTMP .LT. 170.D0) STLLEN = STLLEN + 9.667                 PR 20900
    STLSTG = AI-1.+.5*(1.+DCOS(PI*(STLTMP-TTRAY)/ROE1))            PR 20910
105 CONTINUE                                                       PR 20920
    IF(DABS(.5*(TTRAYX+TTRAY)-170.D0) .GT. .5*ROE1) GO TO 110      PR 20930
    ELEHOT = ELESV +(ELE-ELESV)*(TTRAYX-170.D0)/ROE1               PR 20940
    NRSSH=ELEHOT/XT(200)+1.                                            ****
    ENRSSH=NRSSH                                                       ****
    HOTLEN = ELEHOT +20.333                                        PR 20950
   1 +(ENRSSH-1.)*9.667                                                ****
    HOTSTG = AI-1.+.5*(1.+DCOS(PI*(170.D0-TTRAY)/ROE1))            PR 20960
110 CONTINUE                                                       PR 20970
    IF((STLTMP .GT. TKX(3)) .OR. (STLTMP .GE. THF)) GO TO 115      PR 20980
    ELSTL = ELE                                                    PR 20990
    STLLEN = ELSTL + 29.667                                        PR 21000
   1   +(ENRSS-2.)*9.667                                               ****
    STLSTG = AN                                                    PR 21010
115 CONTINUE                                                       PR 21020
    RECOLN = ELE + 29.667                                          PR 21030
   1   +(ENRSS-2.)*9.667                                               ****
    COLDLN = RECOLN -HOTLEN                                        PR 21040
    ENE = WF/(GE *3600.*PI*(DIE/12.)**2/4.)                        PR 21050
    AME = PI*(DOE/12.) *ELE *ENE                                   PR 21060
    ARTUBE = ENE/BNDLS *.866*(1.3*DOE/12.)**2                      PR 21070
    STXLEN = STLLEN                                                PR 21080
116 CONTINUE                                                       PR 21090
    STLLEN = STXLEN                                                PR 21100
    WBTRYH =WMODH                                                  PR 21110
    WBTRYC = WMODC                                                 PR 21120
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      APTSE1=XT(127)*ARTUBE
      WBUNDL=(XT(126)*APTSE1)**0.5
      HBNDLE=WBUNDL/XT(126)
      HTSHET=HBNDLE+0.5D0
      WTSHET=WBUNDL+0.5D0
      APTSE=WTSHET*HTSHET
      XTEST=DMAX1(VAPSPC,2.D0)
      IF(WTSHET+XTEST.LE.WMODH) GO TO 1161
      WTSHET=WMODH-XTEST
      HTSHET=APTSE/WTSHET
 1161 HRECOV=XT(120)+HTSHET+XT(121)*(LEV-1.D0)
      WPRTRY=WTSHET
      WALLTH=XT(122)*(MODU-BLDGS)+XT(123)*2.D0*BLDGS
      WHOT=WMODH*MODU+XT(124)*WALLTH
      WCOLD = WMODC*MODU+WALLTH
      AROOFE  = WHOT*HOTLEN + WCOLD*COLDLN
      STLRF = STLLEN*WHOT+DMAX1(0.D0,STLLEN-HOTLEN)*(WCOLD-WHOT)
      CNCRF = AROOFE -STLRF
      STLFL = STLRF
      CNCFL = CNCRF
      AWALLE = HRECOV*(RECOLN *2.*BLDGS +WCOLD)
      STLWL = HRECOV*STLLEN *2.*BLDGS
      IF(STLWL .GT. 0.D0) STLWL= STLWL +HRECOV*WHOT
      IF(STLLEN.GT.HOTLEN) STLWL=STLWL+HRECOV*(WCOLD-WHOT)
      CNCWL = AWALLE -STLWL
      ACWE  = HRECOV*RECOLN*(TRAINS-BLDGS)
      STLCW = HRECOV*STLLEN*(TRAINS-BLDGS)
      CNCCW = ACWE -STLCW
      ABTRYE = (ELEHOT*WBTRYH +(ELE-ELEHOT)*WBTRYC)*MODU*(LEV-1.)
      STLBT =(ELSTL*WBTRYH+DMAX1(0.D0,ELSTL-ELEHOT)*(WBTRYC-WBTRYH))
     1        *MODU*(LEV-1.)
      CNCBT = ABTRYE -STLBT
      APTRYE = ELE * WPRTRY *2.*MODU
      STLPT = ELSTL * WPRTRY *2.*MODU
      CNCPT = APTRYE -STLPT
      STLVOL = HRECOV *STLFL
      CNCVOL = HRECOV *CNCFL
      ASTGWL =((HOTSTG+1.)*WHOT+(AN-HOTSTG+1.)*WCOLD)*HRECOV
      STLSW  =0.0D0
      IF(STLSTG .GT. 0.D0) STLSW =(STLSTG+1.)*WHOT*HRECOV
      IF(STLSTG .GT. HOTSTG) STLSW =STLSW+((STLSTG-HOTSTG+1.)*(WCOLD-
     1                                WHOT) +WHOT)*HRECOV
      CNCSW = ASTGWL -STLSW
      STLPH = STLFL +STLBT + STLPT +(STLWL+(STLCW+STLSW)*2.)*5./HRECOV
      CNCPH = CNCFL + 5.*(CNCWL+2.*CNCCW)/HRECOV
      WEIRA =((WMODH+(LEV-1.)*WBTRYH)*(HOTSTG+1.)+(WMODC+(LEV-1.)*
     1         WBTRYC)*(AN-HOTSTG+1.)+WPRTRY*2.*(AN+1.))*MODU*1.
      PWD = WCOLD*(1.-1./TRAINS) +(BLDGS-1.)*2.*HRECOV
      NTRN = TRAINS +.1
      PLSEA= 0.D0
      DO 117 K =1,NTRN
      AIK = K-1
      ZWD = PWD*(.5 -AIK/TRAINS)
  117 PLSEA = PLSEA+DSQRT(ZWD**2 +250.D0**2 +HD**2)
      PLPRD =PWD +WCOLD/TRAINS +HRECOV
      TV1= THF-ROE1-BPX(1)
      CALL PSIA(TV1,PSTA1)
      VHLR=155.D-4*XO(204)*VE*VE
      CALL PSIA(TP,PSTAL)
      HREC1 = HRECOV+HB +XT(105) +2.3*(PSTA1-PSTAL)
     1 +(ENRSS+1.)*VHLR
      CALL HEADS(DIE,GE,ELE,CCF,TME,TCF,TME,TRAINS,WF,HREC1,HEADE,HREC2,
     1            GPMR,SPX,PWX,HPRX)
      ENITSE = (AN-ENRSS)*BNDLS
      ENSUPE = DMAX1(.5D0,(.15*ELE/DOE-AN)*BNDLS)
  120 CONTINUE
      STLLEN = STXLEN
      ATN = AN+AK
      RLR = (ELEX(4)+ELEX(5))/2.*AK +(AK+1.)*TSTH/12.
      RNR = WO/(GR*3600.*PI*(DIR/12.)**2/4.)
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      AR   = PI*(DOR/12.) *RLR *RNR
      ARTUBR = RNR/BNDLS *.866*(1.3*DOR/12.)**2
      HBNDLR = 4./PI*ARTUBR/WBUNDL
      HTSHRT = HBNDLR +.5
      APTSR  = WTSHET * HTSHRT
      HREJCT=XT(129)+HTSHRT+XT(125)*(LEV-1.D0)
      NRJS=RLR/XT(201)+1.
      ENRJS=NRJS
      REJLEN = RLR +(ENRJS+1.)*8.167
      IF(TKX(3)-STLTMP)125,130,130
  125 CONTINUE
      STLLNR =0.D0
      ELSTLR =0.D0
      STLSTR =0.D0
      GO TO 145
  130 CONTINUE
      IF(TKX(5)-STLTMP) 135,140,140
  135 CONTINUE
      STLLNR = 7.667 +(TKX(3)-STLTMP)/(TKX(3)-TKX(5)) *RLR
      ELSTLR = STLLNR -7.667
      STLSTR = DFLOAT(IFIX(SNGL(ELSTLR/RLR *AK)))
      GO TO 145
  140 CONTINUE
      STLLNR=REJLEN
      ELSTLR = RLR
      STLSTR = AK
  145 CONTINUE
      STLLEN = STXLEN+STLLNR
      AROOFR = WCOLD*REJLEN
      AWALLR = HREJCT*(REJLEN *2.*BLDGS +WCOLD)+ WCOLD*(HRECOV-HREJCT)
      STLWLR = HREJCT*STLLNR *2.*BLDGS
      IF(STLLNR .GT. 0.D0) STLWLR =STLWLR + WCOLD*(HRECOV-HREJCT)
      IF(STLLNR .EQ. REJLEN) STLWLR= AWALLR
      CNCWLR= AWALLR -STLWLR
      ACWR   = HREJCT *REJLEN *(TRAINS-BLDGS)
      STLCWR = HREJCT*STLLNR*(TRAINS-BLDGS)
      ASTLCW = STLCW + STLCWR
      CNCCWR = ACWR - STLCWR
      ACNCCW = CNCCW +CNCCWR
      ABTRYR = RLR *WBTRYC*MODU *(LEV-1.)
      STLBTR = ELSTLR*WBTRYC*MODU*(LEV-1.)
      CNCBTR = ABTRYR -STLBTR
      ASTLBT = STLBT +STLBTR
      ACNCBT = CNCBT +CNCBTR
      APTRYR = RLR *WPRTRY *2.*MODU
      STLPTR = ELSTLR *WPRTRY *2.*MODU
      CNCPTR = APTRYR -STLPTR
      ASTLPT = STLPT +STLPTR
      ACNCPT = CNCPT +CNCPTR
      STLVLR = HREJCT * WCOLD* STLLNR
      CNCVLR = HREJCT * WCOLD *(REJLEN -STLLNR)
      ASTGWR =(AK+1.)*HREJCT *WCOLD
      STLSWR = STLSTR *HREJCT*WCOLD
      IF(STLSTR .EQ. AK) STLSWR= STLSWR +HREJCT*WCOLD
      CNCSWR = ASTGWR - STLSWR
      ASTLSW = STLSW + STLSWR
      ACNCSW = CNCSW + CNCSWR
      STLPHR = WCOLD* STLLNR +STLBTR +STLPTR+(STLWLR+(STLCWR+STLSWR)*2.)
     1         *5./HREJCT
      CNCPHR = AROOFR -WCOLD*STLLNR+(CNCWLR+2.*CNCCWR)*5./HREJCT
      WEIRR  = (WMODC +(LEV-1.)*WBTRYC +2.*WPRTRY)*AK*MODU*1.
      ASTLRF = STLRF + WCOLD*STLLNR                             +1.D-3
      ACNCRF = CNCRF +AROOFR -WCOLD*STLLNR                      +1.D-3
      ASTLFL = ASTLRF
      ACNCFL = ACNCRF
      ASTLEW = STLWL + STLWLR                                   +1.D-3
      ACNCEW = CNCWL +CNCWLR                                    +1.D-3
      ASTLIW = ASTLCW + ASTLSW                                  +1.D-3
      ACNCIW = ACNCCW + ACNCSW                                  +1.D-3
      VOLCNC = CNCVOL+CNCVLR                                    +1.D-3
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      VOLSTL = STLVOL +STLVLR                                         +1.D-3PR 22420
      ASTLTR = ASTLBT + ASTLPI                                        +1.D-3PR 22430
      ACNCTR = ACNCBT+ACNCPT                                          +1.D-3PR 22440
      ASTLPH = STLPH +STLPHR                                          +1.D-3PR 22450
      ACNCPH = CNCPH +CNCPHR                                          +1.D-3PR 22460
      AWEIRS = WEIRA + WEIRR                                          +1.D-3PR 22470
      AEXCAV = ASTLFL + ACNCFL                                              PR 22480
      ACRES=(WCOLD+2.*BLDGS*HRECCV)*(RECCLN+REJLEN+350.)/43.56D3            PR 22490
      VHLRJ=155.D-4*XO(204)*VR*VR                                             ****
      HDEL1 = HREJCT+ HD + XT(104)                                          PR 22500
     1  +(ENRJS+1.)*VHLRJ                                                     ****
      CALL HEADS(DIR,GR,RLR,CC,TC,TB,TO,TRAINS,WOCEAN,HDEL1,HEADR,HDEL,     PR 22510
     1           GPMD,RPMD,PODEL,HPDEL)                                     PR 22520
      ENITSR = (AK-ENRJS)*BNDLS                                               ****
      ENSUPR = DMAX1(.5D0,(.15*RLR/DOR-AK)*BNDLS)                           PR 22540
      TSAREA = (ENITSE+ENSUPE+(ENRSS*2.)*BNDLS)*APTSE                         ****
     1 +(ENITSR+ENSUPR+2.*ENRJS*BNDLS) *APTSR                                 ****
      HOLES = ENE/BNDLS*(ENITSE+ENSUPE+(2.*ENRSS)*BNDLS)                    PR 22570
     1        +RNR/BNDLS*(ENITSR+ENSUPR+(2.*ENRJS)*BNDLS)                   PR 22580
  150 CONTINUE                                                              PR 22590
      AH = 1.D3/RP*WP/(UMH*PHE)                                             PR 22600
      HNH = WF/(PI*(DIH/12.)**2/4.*GH*3600.)                                PR 22610
      HLH = AH/(HNH*PI*DOH/12.)                                             PR 22620
      ARTUBH = HNH/ENBH  *.866*(1.3*DOH/12.)**2                             PR 22630
      DITUBH = DSQRT(4./PI*ARTUBH)+.5                                       PR 22640
      APTSH = PI*DITUBH**2/4.                                               PR 22650
      BHSURF = PI*DITUBH*(HLH +DITUBH)                                      PR 22660
      BHVOL = APTSH*HLH                                                     PR 22670
C**     COMPUTE PUMPING HEADS AND POWER AND MOTOR RPM                       PR 22680
      CALL HEADS(DIH,GH,HLH,CCF,TME,THF,TCF,TRAINS,WF,HREC2,HEADH,HREC,     PR 22690
     1           GPMH,RPMR,POREC,HPREC)                                     PR 22700
      PC = PODEL +POREC +POPRD +POBLD +PODEA                                PR 22710
      GO TO (160,170),NFEED                                                   ****
  160 XO(200)=350.                                                            ****
      XO(201)=30.D-6                                                          ****
      XO(205)=XO(200)*TRAINS+XO(201)*(WP+WB)                                  ****
       GO TO 180                                                              ****
  170 XO(202)=350.                                                            ****
      XO(203)=100.D-6                                                         ****
      XO(205)=XO(202)*TRAINS+XO(203)*(WP+WB)                                  ****
  180 XO(206)=XO(205)*9.6D-3                                                  ****
      RETURN                                                                PR 22720
      END                                                                   PR 22730
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APPENDIX F

CHANGES MADE IN SUBROUTINE SIZEV

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      SUBROUTINE SIZEV                                                  PR 10720
      IMPLICIT REAL*8(A-H,O-Z)                                          PR 10730
      REAL*8 LPHE                                                         ****
      REAL*8 NCOOL,LCOOL                                                  ****
C                                                                       PR 10740
      DOUBLE PRECISION NTRAIN                                           PR 10750
      DOUBLE PRECISION    LPH,     LVE,    IDBH,    IDPH,   LCON,   NCON, PR 10760
     1   NTPH,  ICCON                                                   PR 10770
      DOUBLE PRECISION    KBH,     KPH,     KVE,     LBH,    MGD,    NBH, PR 10780
     1    NPH,     NVE,   KCON,    LMTD,    LVEP, LMTDBH, LMTDCN        PR 10790
      DOUBLE PRECISION LEV,LF2                                          PR 10800
C                                                                       PR 10810
      COMMON/BLOCV1/    ANE,         HVE,         LPH,         LVE,        ACON,PR 10820
     1       GPMV,       HPVE,        HSEA,        IDBH,        IDPH,        LCON,PR 10830
     2       NCON,       NTPH,        ODBH,        ODPH,        ODVE,        POVE,PR 10840
     3       RPMV,      HFEED,       IDCON,       ODCON,       SUMWT,       VETSA,PR 10850
     4     APTSCN,     APTSEP,      OVRHGT,      TOTNVE,      VEPMPS            PR 10860
      COMMCN/BLOCV2/  A(30),           S,      AE(30),          QE,      TC(30),PR 10870
     1     TE(30),         TR,      UE(30),       UH(3),          WM,      WT(30),PR 10880
     2        ABH,        APH,     BPE(30),     CIE(30),     COE(30),     DPE(30),PR 10890
     3        ELL,        GBH,         GPH,         GPM,         HOO,         KBH,PR 10900
     4        KPH,        KVE,         LBH,         MGD,         NBH,         NPH,PR 10910
     5    NVE(30),        QPH,         RBH,         RPH,         RVE,         TCC,PR 10920
     6        UBH,        VBH,         VPH,    WPEX(30),        BHLF,        GCON,PR 10930
     7       HIBH,    HIPH(3),        HLBH,     HLPH(3),        KCON,     LMTD(3),PR 10940
     8       LVEP,       PHLF,     QMSF(3),        RCON,     SUBF(3),        TCON,PR 10950
     9       UCON,       VCON,        VLEN,        VTLF,    WDTH(30), ALFAE(30),PR 10960
     +      CONLF,      HICON,       HOCON,       HOTE1,       PHHGT,       POBLO,PR 10970
     A      POPRO,      POSEA,       SURFF,       VEHGT,       WALVE,      EFFSPC,PR 10980
     BELBNDL(30),     HCOTCF,      HCUTOO,      HEADBH,      HEADCN,      HEADPH,PR 10990
     C     LMTDBH,     LMTDCN,      PLNTLF,      PODEAS,      POFEED,      SUMWPE,PR 11000
     D     SUMWPH,     TOTAVE,        QESP,VEFEED(30),       WBOOST,      WOCOLD,PR 11010
     E         NE,       NTRN,       IFEED,      IRECYC                         PR 11020
      COMMON/COMNAM/     AJ,          CB,          CO,          CP,          CR, PR 11030
     1         HB,         PI,          PO,          TB,          TO,          TP, PR 11040
     2         TS,         WB,          WF,          WO,          WP,          WR, PR 11050
     3        AXJ,        HBL,         HPR,         LEV,         LF2,         TCF, PR 11060
     4       ENBH,       GPMB,        GPMD,        GPMH,        GPMO,        GPMP, PR 11070
     5       GPMR,       HDEA,        RPMB,        RPMD,        RPMM,        RPMP, PR 11080
     6       RPMR,       TSTH,        WHOT,        YEAR,       ACRES,       BHVOL, PR 11090
     7      BLDGS,      BNDLS,       HOLES,       HPBLD,       HPDEA,       HPDEL, PR 11100
     8      HPPRD,      HPREC,       PLPRD,       PLSEA,       PODEA,      ACNCEW, PR 11110
     9     ACNCFL,     ACNCIW,      ACNCPH,      ACNCRF,      ACNCTR,      AEXCAV, PR 11120
     +     ASTLEW,     ASTLFL,      ASTLIW,      ASTLPH,      ASTLRF,      ASTLTR, PR 11130
     A     AWEIRS,     BHSURF,      DINTAK,      ENITSE,      ENPIPE,      ENSUPE, PR 11140
     B     ENSUPR,     PIPELN,      PLSZMG,      REJLEN,      STLLEN,      STLTMP, PR 11150
     C     TNACDY,     TRAINS,      TSAREA,      VOLCNC,      VOLSTL,      WOCEAN  PR 11160
       COMMON/SHARE/  IFLIP      ,ISPOT                                     PR 11170
      COMMON/PINHAS/APTSH,ENRSS,ENRJS,LPHE,DUMDUM(16),NFEED,IIIIII(9)         ****
      COMMON/BLOC12/ XT                                                 PR 11180
      COMMON/BLOC13/ XO                                                 PR 11190
      COMMON/INDEX/ IND(40)                                             PR 11200
C                                                                       PR 11210
      DIMENSION XO(300),XT(300)                                         PR 11220
C                                                                       PR 11230
      IF((IND(9)+IND(10)+IND(11)+IND(12)+IND(13)) .GT. 0) GO TO 90      PR 11240
      IF((IND(6)+IND(7)+IND(8)) .GT. 0) GO TO 130                       PR 11250
      IF((IND(3)+IND(4)+IND(5)) .GT. 0) GO TO 140                       PR 11260
      GO TO 210                                                         PR 11270
   90 CONTINUE                                                          PR 11280
      NTRAIN = TRAINS                                                   PR 11290
      WHOT = ((WDTH(1)+1.)*(VLEN-ELBNDL(NE))-(WDTH(NE)+1.)*EFFSPC)/     PR 11300
     1                     (VLEN-ELBNDL(NE)-EFFSPC)                     PR 11310
      WCOLD= WHOT + VLEN*(WDTH(NE)+1.-WHOT)/(VLEN-ELBNDL(NE))           PR 11320
      VEHGT = LVE +EFFSPC +3.5                                          PR 11330
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      TANGEN =(WCCLD-WHOT)/VLEN                                         PR 11340
      WALIVE = 0.D0                                                     PR 11350
      VXLEN =  0.D0                                                     PR 11360
      STLLEN = 0.D0                                                     PR 11370
      STLIW = 0.D0                                                      PR 11380
      DO 110 I=1,NE                                                     PR 11390
      VXLEN = EFFSPC +ELBNDL(I) +VXLEN                                  PR 11400
      WALIVE = WALIVE +(WHOT+VXLEN*TANGEN)*VEHGT*NTRAIN                 PR 11410
      IF((I .EQ. 1) .OR. (TC(1) .LE. STLTMP)) GO TO 110                 PR 11420
      IF((TC(I) .LE. STLTMP) .AND. (TC(I-1) .GT. STLTMP)) GO TO 100     PR 11430
      GO TO 110                                                         PR 11440
  100 STLLEN = VXLEN -(EFFSPC+ELBNDL(I))*(STLTMP-TC(I))/(TC(I-1)-TC(I)) PR 11450
      STLIW = WALIVE-((WHOT+VXLEN*TANGEN)*VEHGT*NTRAIN)*(STLTMP-TC(I))  PR 11460
     1                                                 /(TC(I-1) -TC(I)) PR 11470
  110 CONTINUE                                                          PR 11480
      IF(STLTMP .GT. TC(NE)) GO TO 115                                  PR 11490
      STLLEN = VLEN                                                     PR 11500
      STLIW = WALIVE                                                    PR 11510
  115 CONTINUE                                                          PR 11520
      STXLEN = STLLEN                                                   PR 11530
      TCTNVE =0.D0                                                      PR 11540
      VETSA  =0.D0                                                      PR 11550
      TOTAVE = 0.D0                                                     PR 11560
      SUMWT  =0.D0                                                      PR 11570
      DO 120 I=1,NE                                                     PR 11580
      TOTAVE = TOTAVE+AE(I)                                             PR 11590
      VETSA = VETSA +(WDTH(I)+1.)*(ELBNDL(I)+.5)*NTRAIN *2.             PR 11600
      WT(I) = VEFEED(I) *AE(I)                                          PR 11610
      SUMWT = SUMWT + WT(I)                                             PR 11620
  120 TCTNVE = TCTNVE + NVE(I)                                          PR 11630
      TB = TE(NE)                                                       PR 11640
      CB = COE(NE)                                                      PR 11650
      CR = CB/CO                                                        PR 11660
      WB = WF -WP                                                       PR 11670
      CALL HEADS(1.D0,1.D0,0.D0,CB,TB,1.D0,1.D0,NTRAIN,WB,XO(30),HEADB, PR 11680
     1          HBI,GPMB,RPMB,PDBLO,HPBLO)                              PR 11690
      QE = QESP * AE(1)                                                 PR 11700
      GO TO (91,92),NFEED                                                 ****
   91 CONTINUE                                                            ****
      TNACDY=15.68*MGD*CO*CR/(CR-1.)                                      ****
      GO TO 93                                                            ****
   92 CONTINUE                                                            ****
      TNACDY=12.D-9*XC(207)*(WP+WB)                                       ****
   93 CONTINUE                                                            ****
      TVE   = .5*(TE(1)+TB)                                             PR 11720
      CVE   = .5*(CO +CB)                                               PR 11730
      VEPMPS = NTRAIN *ANE                                              PR 11740
  130 CONTINUE                                                          PR 11750
      HCPTP = (WF*(HOTE1-HCOTCF+HCOTCO)-WB*H(CB,TB))/WP                 PR 11760
      TP = HINV(CP,HCPTP)                                               PR 11770
      HPR1 = XO(31) +XT(106)                                            PR 11780
      CALL HEADS(1.D0,1.D0,0.D0,CP,TP,1.D0,1.D0,NTRAIN,WP,HPR1,HEADP,   PR 11790
     1          HPR,GPMP,RPMP,PDPRD,HPPRD)                              PR 11800
      PODEAS = WF *DEXP(.0137*TOO -6.121)/.3466706                      PR 11810
      QPH =WF*(HOTE1-HCOTCF)                                            PR 11820
      NTPH = WF/(GPH*3600.*PI *(IDPH/12.)**2/4.)                        PR 11830
      NFHS=LPH/XT(200)+1.                                                 ****
      ENRSS=NFHS                                                          ****
      XY=ENRSS+1.                                                         ****
      LPHE=LPH-XY*9.                                                      ****
      APH = NTPH *(ODPH/12.)*PI *LPHE                                     ****
      ABNDLP = NTPH/BNDLS *.866 *(1.3*ODPH/12.)**2                      PR 11850
      HBNDL = DSQRT(ABNDLP/XT(127))                                      *****
      PHHGT=HBNDL+XT(120)+0.5D0                                           ****
      APTSEP = (HBNDL +.5)*(XT(127)*HBNDL +.5)                            ****
      OVRHGT = PHHGT +VEHGT                                             PR 11890
      APHIW  = PHHGT*(NPH*WHOT +.5*NPH*(NPH+1.)*TANGEN*ELL)*NTRAIN      PR 11900
      SPH = STXLEN/ELL                                                  PR 11910
      APHSTL=PHHGT*SPH*(WHOT+.5*(SPH+1.)*TANGEN*ELL)*NTRAIN             PR 11920
      AWEIRS = APHIW/PHHGT                                              PR 11930
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      ENITSE=(NPH-ENRSS)*BNDLS                                           ****
      ENSUPE = DMAX1(.5D0,(.15*LPH/ODPH -NPH)*BNDLS)                 PR 11950
      HVE1 = OVRHGT +XO(211)                                             ****
      CALL HEADS(1.D0,1.D0,0.D0,CVE,TVE,1.D0,1.D0,VEPMPS,SUMWT,HVE1, PR 11970
     1          HEADV,HVE,GPMV,RPMV,POVE,HPVE)                       PR 11980
      TV1 = TE(1)- (TE(1)-TB)/NPH -2.                                PR 11990
      CALL PSIA(TV1,PSTA1)                                           PR 12000
      CALL PSIA(TOO,PSTAL)                                           PR 12010
      VHLRS=155.D-4*XO(204)*VPH*VPH                                      ****
      HREC1 = HB +XT(105) +2.3*(PSTA1-PSTAL)                         PR 12020
     * +XY*VHLRS                                                         ****
      XY=2.*ENRSS                                                        ****
      CALL HEADS(IDPH,GPH,LPHE,CO,TOO,TCF,TOO,NTRAIN,WF,HREC1,HEADPH, PR12030
     1          HREC2,GPMR,SPX,PWX,HPRX)                             PR 12040
  140 CONTINUE                                                       PR 12050
      STLLEN = STXLEN                                                PR 12060
      HCOTR = H(CO,TR)                                               PR 12070
      WO = QE/(HCOTR-HOO)                                            PR 12080
      IF(MGD/NTRAIN.GE.10.D0) GO TO 142                                  ****
      CONPAS=3.DC                                                        ****
      GO TO 143                                                          ****
  142 CONPAS=2.DC                                                        ****
  143 CONTINUE                                                           ****
      NCON = WO/(PI*(IDCON/12.)**2/4. *GCON *3600.)*CONPAS               ****
      ACON = QE/(UCON*LMTDCN)                                        PR 12100
      LCON = ACON/(NCON*PI*ODCON/12.)                                PR 12110
      ABNDLC  = NCON/NTRAIN *.866*(1.3*ODCON/12.)**2                 PR 12120
      DBNDLC  = DSQRT(4.*ABNDLC/PI)                                  PR 12130
      APTSCN  = PI/4. *(DBNDLC +.5)**2                               PR 12140
      ENSUPR =DMAX1(.5D0,(.15*LCON/ODCON -1.)*NTRAIN)                PR 12150
      EXCCN=0.DC                                                         ****
      ELLCON=DBNDLC*XT(130)+3.0D0                                        ****
      LVEP = VLEN +ELLCON                                            PR 12190
      REJLEN = OVRHGT +ELLCON+EFFSPC                                 PR 12200
      WDCOLD = WCOLD                                                     ****
      WALSEP = DSQRT(LVEP**2 +(WDCOLD-WHOT)**2)                      PR 12220
      WALEVE = OVRHGT*((WHOT+WDCOLD)*NTRAIN +2.*BLDGS*(WALSEP+2.*EXCON))PR 12230
      AROOFV =  .5*(WDCOLD+WHOT)*NTRAIN*LVEP                             ****
      WALINV = WALIVE +OVRHGT*WALSEP*(NTRAIN-BLDGS)+AROOFV +APHIW     PR 12250
      IF(TC(1) .LE. STLTMP) GO TO 150                                PR 12260
      IF((STLTMP .LT. TC(NE)) .AND. (STLTMP .GT. TCON)) GO TO 160    PR 12270
      IF(STLTMP .LE. TCON) GO TO 170                                 PR 12280
      ASTLRF = STLLEN *.5*(WHOT +STLLEN*TANGEN+WHOT) *NTRAIN         PR 12290
      ASTLEW = OVRHGT *(WHOT*NTRAIN +2.*BLDGS*STLLEN/LVEP*WALSEP)    PR 12300
      GO TO 180                                                      PR 12310
  150 ASTLRF = 1.D-3                                                 PR 12320
      ASTLEW = 1.D-3                                                 PR 12330
      GO TO 180                                                      PR 12340
  160 STLIW = WALIVE                                                 PR 12350
      VEROOF = .5*(WHOT +WCOLD)*VLEN                                 PR 12360
      STLLEN = VLEN +ELLCON*(TC(NE)-STLTMP)/(TC(NE)-TCON)            PR 12370
      ASTLRF = VEROOF*NTRAIN                                             ****
      ASTLEW = OVRHGT*(WHOT*NTRAIN +2.*BLDGS*(STLLEN/LVEP*WALSEP+EXCON))PR 12390
      GO TO 180                                                      PR 12400
  170 STLIW = WALIVE                                                 PR 12410
      STLLEN = LVEP                                                  PR 12420
      ASTLRF  =AROOFV                                                PR 12430
      ASTLEW  =WALEVE                                                PR 12440
  180 CONTINUE                                                       PR 12450
      ASTLIW = STLIW +APHSTL +STLLEN/LVEP*OVRHGT*WALSEP*(NTRAIN-BLDGS) PR 12460
     1         +ASTLRF                                               PR 12470
      ACNCRF = AROOFV -ASTLRF +1.D-3                                 PR 12480
      ACNCIW = WALINV -ASTLIW +1.D-3                                 PR 12490
      ACNCEW = WALEVE -ASTLEW +1.D-3                                 PR 12500
      ASTLFL = ASTLRF                                                PR 12510
      ACNCFL = ACNCRF                                                PR 12520
      VOLSTL = ASTLRF *OVRHGT                                        PR 12530
      VOLCNC = ACNCRF *OVRHGT                                        PR 12540
      ASTLTR = 1.D-3                                                 PR 12550
      ACNCTR = 1.D-3                                                 PR 12560
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      AEXCAV = ASTLFL +ACNCFL                                           PR 12570
      ASTLPH = 2.*ASTLFL +5.*(2.*APHSTL/PHHGT +2.*STLIW/VEHGT +STLLEN   PR 12580
     1         /LVEP*WALSEP*(NTRAIN-BLDGS) + 2.*ASTLEW/OVRHGT)          PR 12590
      ACNCPH = 2.*ACNCFL +3.*(2.*(APHIW-APHSTL)/PHHGT +2.*(WALIVE-STLIW)PR 12600
     1         /VEHGT)+5.*((LVEP-STLLEN)/LVEP*WALSEP*(NTRAIN-BLDGS)     PR 12610
     2         +2.*ACNCEW/OVRHGT)                                       PR 12620
      ACRES = (WDCOLD*NTRAIN +2.*OVRHGT*BLDGS)*(LVEP +350.)/43.56D3     PR 12660
      PWD = WDCOLD *(NTRAIN -1.)+(BLDGS-1.)*2.*OVRHGT                   PR 12670
      NTRN =  NTRAIN +.1                                                PR 12680
      PLSEA = 0.D0                                                      PR 12690
      DO 190 K=1,NTRN                                                   PR 12700
      AIK = K-1                                                         PR 12710
      ZWD = PWD *(.5-AIK/NTRAIN)                                        PR 12720
  190 PLSEA = PLSEA +DSQRT(ZWD**2 +250.D0**2 +XO(28)**2)                PR 12730
      PLPRD = PWD +WDCOLD                                               PR 12740
      WM = WF*(HCOTR-HCOTOO)/(HCOTR-HOO)                                PR 12750
      WM = DMAX1(0.D0,WM)                                               PR 12760
      WBOOST = WF-WM +.2*WF                                             PR 12770
      WOCEAN = WO +WM +.2*WF                                            PR 12780
      HDEL1 = XO(28)+XT(104) +PHHGT +.5*VEHGT                           PR 12790
      CALL HEADS(IDCON,GCON,LCON,CO,TO,TR,TO,NTRAIN,WOCEAN,HDEL1,HEADCN,PR 12800
     1          HSEA,GPMD,RPMD,POSEA,HPDEL)                             PR 12810
      CALL HEADS(1.D0,1.D0,0.D0,CO,TO,TO,TO,NTRAIN,WBOOST,XO(86),HDX,   PR 12820
     1          HDEA,GPMD,RPMM,PODEA,HPDEA)                             PR 12830
      IF(IFLIP .GT. 1) GO TO 200                                        PR 12840
      DENOO = DEN(CO,TO)                                                PR 12850
      AMAX =  PI *18.**2/4.                                             PR 12860
      ANEED = WOCEAN/(DENOO *8.*3600.)                                  PR 12870
      NPIPE  = ANEED/AMAX + 1.                                          PR 12880
      ENPIPE  = NPIPE                                                   PR 12890
  200 DINTAK = DSQRT( 4.*WOCEAN/(DENOO*ENPIPE*PI *2.88D4))              PR 12900
      TSAREA = (ENITSE+ENSUPE +XY*BNDLS)*APTSEP +(ENSUPR+2.)*APTSCN      ****
      HOLES = NTPH/BNDLS*(ENITSE +ENSUPE +XY*BNDLS) +NCON/NTRAIN         ****
     1        *(ENSUPR+2.)                                              PR 12930
  210 CONTINUE                                                          PR 12940
      ABH= WF*(HOTE1-HCOTCF)/(UBH*LMTDBH)                               PR 12950
      NBH = 576.* WF/(PI*IDBH**2 *GBH *3600.)                           PR 12960
      LBH = ABH/(NBH *PI *ODBH/12.)                                     PR 12970
      ARTUBH = NBH/ENBH *.866*(1.3*ODBH/12.)**2                         PR 12980
      DITUBH = DSQRT( 4./PI *ARTUBH) +.5                                PR 12990
      APTSH  = PI * DITUBH**2/4.                                        PR 13000
      BHSURF = PI * DITUBH*(LBH +DITUBH)                                PR 13010
      BHVOL  = APTSH *LBH                                               PR 13020
      CALL HEADS(IDBH,GBH,LBH,CO,TO,TE(1),TCF,NTRAIN,WF,HREC2,HEADBH,   PR 13030
     1          HFEED,GPMH,RPMR,POFEED,HPREC)                           PR 13040
  230 PO = POFEED +POPRO +POBLO +POVE +POSEA +PODEA                     PR 13050
      GO TO (660,670),NFEED                                              ****
  660 XO(200)=350.                                                       ****
      XO(201)=30.D-6                                                     ****
      XO(205)=XO(200)*TRAINS+XO(201)*(WP+WB)                             ****
       GO TO 680                                                         ****
  670 XO(202)=350.                                                       ****
      XO(203)=100.D-6                                                    ****
      XO(205)=XO(202)*TRAINS+XO(203)*(WP+WB)                             ****
  680 XO(206)=XO(205)*9.6D-3                                             ****
      RETURN                                                            PR 13060
      END                                                               PR 13070
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APPENDIX G
CHANGES MADE IN SUBROUTINE TECPAR

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      SUBROUTINE TECPAR                                                  ********
C     SPECIAL FOR VTE ONLY
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/BLOC12/XT(300)
      XT( 3)=10.DC
      XT(4)=5.DO
      XT( 5)=.75DC
      XT( 6)=.75CO
      XT( 9)=10.DC
      XT(10)=5.5DO
      XT(11)=.75CO
      XT(12)=.75CC
      XT(13)=3.DO
      XT(14)=1.DC
      XT(15)=10.DC
      XT(16)=5.DC
      XT( 25)= 1.CDO
      XT( 26)= 0.0DO
      XT( 27)= .75DO
      XT( 28)= .75DO
      XT( 29)= 1.0DO
      XT( 30)= C.0DC
      XT( 31)= 4.0DO
      XT( 32)= 2.CDO
      XT(33)=100.
      XT(34)=-20.
      XT( 35)= 1.CDO
      XT( 36)= 0.0DO
      XT( 37)= 20.DO
      XT( 38)= 5.0DO
      XT(101)=.C005DO
      XT(102)=.0005DO
      XT(103)=.000700
      XT(104)=7.9DO
      XT(105)=16.7DO
      XT(106)=15.15DO
      XT(107)=1.DC
      XT(108)=1.DC
      XT(109)=1.DC
      XT(110)=1.DO
      XT(111)=1.DC
      XT(112)=1.DO
      XT(113)=0.DC
      XT(114)=1.DC
      XT(115)=.0840O
      XT(120)=5.DO
      XT(127)=1.5CO
      XT(130)=1.DC
      XT(151)=.08DO
      XT(152)=95.DO
      XT(153)=5.DO
      XT(200)=70.CO
      CALLT('UPPER LIMIT FOR VELOCITY IN PREHEATER TUBING     (VTE)',  3)
      CALLT('LOWER LIMIT FOR VELOCITY IN PREHEATER TUBING     (VTE)',  4)
      CALLT('UPPER LIMIT FOR CD OF PREHEATER TUBING           (VTE)',  5)
      CALLT('LOWER LIMIT FOR CD OF PREHEATER TUBING           (VTE)',  6)
      CALLT('UPPER LIMIT FOR VELOCITY IN CONDENSER TUBING     (VTE)',  9)
      CALLT('LOWER LIMIT FOR VELOCITY IN CONDENSER TUBING     (VTE)', 10)
      CALLT('UPPER LIMIT FOR CD CF CONDENSER TUBING           (VTE)', 11)
      CALLT('LOWER LIMIT FOR CD OF CONDENSER TUBING           (VTE)', 12)
      CALLT('UPPER LIMIT FOR PREHEATER STAGES/EFFECT          (VTE)', 13)
      CALLT('LOWER LIMIT FOR PREHEATER STAGES/EFFECT          (VTE)', 14)
      CALLT('UPPER LIMIT FOR VELOCITY IN PREHEATER TUBING     (VTE)', 15)
      CALLT('LOWER LIMIT FOR VELOCITY IN PREHEATER TUBING     (VTE)', 16)
      CALLT('UPPER LIMIT FOR XO(5) DEFINING COND. REJECT TEMP(VTE)', 25)
      CALLT('LOWER LIMIT FOR XO(5) DEFINING COND. REJECT TEMP(VTE)', 26)
      CALLT('UPPER LIMIT FOR CD OF PREHEATER TUBES            (VTE)', 27)
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      CALLT('LOWER LIMIT FOR OD OF PREHEATER TUBES            (VTE)', 28)
      CALLT('UPPER LIMIT FOR XO(9) DEFINING FEED FLOW RATE    (VTE)', 29)
      CALLT('LOWER LIMIT FOR XO(9) DEFINING FEED FLOW RATE    (VTE)', 30)
      CALLT('UPPER LIMIT FOR OD OF VERTICAL TUBES             (VTE)', 31)
      CALLT('LOWER LIMIT FOR OD OF VERTICAL TUBES             (VTE)', 32)
      CALLT('UPPER LIMIT FOR XO(11) DEFINING TE(NE)           (VTE)', 33)
      CALLT('LOWER LIMIT FOR XO(11) DEFINING TE(NE)           (VTE)', 34)
      CALLT('UPPER LIMIT FOR XO(12) DEFINING VE HEAT RATE     (VTE)', 35)
      CALLT('LOWER LIMIT FOR XO(12) DEFINING VE HEAT RATE     (VTE)', 36)
      CALLT('UPPER LIMIT FOR NUMBER OF VE EFFECTS             (VTE)', 37)
      CALLT('LOWER LIMIT FOR NUMBER OF VE EFFECTS             (VTE)', 38)
      CALLT(' FOULING FACTOR IN BRINE HEATER                  (VTE)',101)
      CALLT(' FOULING FACTOR IN PREHEATER                     (VTE)',102)
      CALLT(' FOULING FACTOR IN CONDENSER                     (VTE)',103)
      CALLT(' DUCTING HEAD LOSS IN SEAWATER SYSTEM, FEET      (VTE)',104)
      CALLT(' DUCTING HEAD LOSS IN PREHEATER SYSTEM,FEET      (VTE)',105)
      CALLT(' DUCTING HEAD LOSS IN PRODUCT SYSTEM,FEET        (VTE)',106)
      CALLT(' MULTIPLIER FOR FRICTION FACTOR                  (VTE)',107)
      CALLT(' MULTIPLIER FOR LIQUID FILM HEAT TRNSF COEFF     (VTE)',108)
      CALLT(' MULTIPLIER FOR CONDENSING HEAT TRNSF COEFF      (VTE)',109)
      CALLT(' MULTIPLIER FOR SUBMERGENCE SUPERHEAT            (VTE)',110)
      CALLT(' MULTIPLIER FOR DEMISTER AND BUNDLE SUPERHEAT    (VTE)',111)
      CALLT(' MULTIPLIER FOR WALL THICKNESS COEFF VE TUBES    (VTE)',112)
      CALLT(' FOULING FACTOR FOR VERTICAL EVAPORATOR TUBES    (VTE)',113)
      CALLT('MULTIPLIER FOR FILM HEAT TRNSFR COEFF VE TUBES   (VTE)',114)
      CALLT('CA2SO4 ANHYDRITE LIMITED CONCENTRATION           (VTE)',115)
      CALLT('PREHEATER VERTICAL  BELOW TUBES                  (VTE)',120)
      CALLT('PREHEATER BUNDLE WIDTH/HEIGHT RATIO              (VTE)',127)
      CALLT('LENGTH RATIO, CONDENSER TO LAST EFFECT           (VTE)',130)
      CALLT('CONCENTRATION IN LAST EFFECT                     (VTE)',151)
      CALLT('CONDENSING TEMPERATURE IN CONDENSER, F           (VTE)',152)
      CALLT('CONDENSER TTD, F                                 (VTE)',153)
      CALLT('MAXIMUM LENGTH OF TUBING, FT.                (MSF,VTE)',200)
      RETURN
      END
      SUBROUTINE TECPAR
C      SPECIAL FOR MSF75                                               ********
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/BLOC12/XT(300)
      CALLT('UPPER LIMIT FOR NUMBER OF REJECT STAGES          (MSF)',  1)
      CALLT('LOWER LIMIT FOR NUMBER OF REJECT STAGES          (MSF)',  2)
      CALLT('UPPER LIMIT FOR VELOCITY IN HEATER TUBING        (MSF)',  3)
      CALLT('LOWER LIMIT FOR VELOCITY IN HEATER TUBING        (MSF)',  4)
      CALLT('UPPER LIMIT FOR OD OF HEATER TUBING              (MSF)',  5)
      CALLT('LOWER LIMIT FOR OD OF HEATER TUBING              (MSF)',  6)
      CALLT('UPPER LIMIT FOR NUMBER OF PLANT LEVELS           (MSF)',  7)
      CALLT('LOWER LIMIT FOR NUMBER OF PLANT LEVELS           (MSF)',  8)
      CALLT('UPPER LIMIT FOR VELOCITY IN REJECT TUBING        (MSF)',  9)
      CALLT('LOWER LIMIT FOR VELOCITY IN REJECT TUBING        (MSF)', 10)
      CALLT('UPPER LIMIT FOR OD OF REJECT TUBING              (MSF)', 11)
      CALLT('LOWER LIMIT FOR OD OF REJECT TUBING              (MSF)', 12)
      CALLT('UPPER LIMIT FOR NUMBER OF RECOVERY STAGES        (MSF)', 13)
      CALLT('LOWER LIMIT FOR NUMBER OF RECOVERY STAGES        (MSF)', 14)
      CALLT('UPPER LIMIT FOR VELOCITY IN RECOVERY TUBING      (MSF)', 15)
      CALLT('LOWER LIMIT FOR VELOCITY IN RECOVERY TUBING      (MSF)', 16)
      CALLT('UPPER LIMIT FOR OD OF RECOVERY TUBING            (MSF)', 17)
      CALLT('LOWER LIMIT FOR OD OF RECOVERY TUBING            (MSF)', 18)
      CALLT('LOWER LIMIT FOR PERFORMANCE RATIO                (MSF)', 19)
      CALLT('LOWER LIMIT FOR PERFORMANCE RATIO                (MSF)', 20)
      CALLT('UPPER LIMIT FOR TEMP DIFF.(TBLOWDOWN-TOCEAN)     (MSF)', 21)
      CALLT('LOWER LIMIT FOR TEMP DIFF.(TBLOWDOWN-TOCEAN)     (MSF)', 22)
      CALLT('UPPER LIMIT FOR CONCENTRATION RATIO              (MSF)', 23)
      CALLT('LOWER LIMIT FOR CONCENTRATION RATIO              (MSF)', 24)
      CALLT(' FOULING FACTOR IN BRINE HEATER                  (MSF)',101)
      CALLT(' FOULING FACTOR IN RECOVERY                      (MSF)',102)
      CALLT(' FOULING FACTOR IN REJECT                        (MSF)',103)
      CALLT(' DUCTING HEAD LOSS IN SEAWATER SYSTEM,FEET       (MSF)',104)
      CALLT(' DUCTING HEAD LOSS IN RECYCLE                    (MSF)',105)
      CALLT(' DUCTING HEAD LOSS IN PRODUCT SYSTEM,FEET        (MSF)',106)
      CALLT(' MULTIPLIER FOR FRICTION FACTOR                  (MSF)',107)
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CALLT(' MULTIPLIER FOR LIQUID FILM HEAT TRNSF COEFF      (MSF)',108)
CALLT(' MULTIPLIER FOR CONDENSING  HEAT TRNSF COEFF      (MSF)',109)
CALLT(' MULTIPLIER FOR SUBMERGENCE SUPERHEAT             (MSF)',110)
CALLT(' MULTIPLIER FOR DEMISTER AND BUNDLE SUPERHEAT     (MSF)',111)
CALLT('MAXIMUM LENGTH OF TUBING,FT                       (MSF)',200)
XT( 1)=10.D0
XT( 2)=2.0D0
XT( 3)=10.D0
XT(4)=5.D0
XT( 5)=.75D0
XT( 6)=.75D0
XT( 7)=1.0D0
XT( 8)=1.0D0
XT( 9)=10.D0
XT(10)=5.5D0
XT(11)=.75D0
XT(12)=.75D0
XT(13)=70.D0
XT(14)=10.D0
XT(15)=10.D0
XT(16)=5.D0
XT(17)=.75D0
XT(18)=.75D0
XT(19)=30.D0
XT(20)=5.0D0
XT(21)=50.D0
XT(22)=10.D0
XT(23)=3.D0
XT(24)=1.8D0
XT(101)=.0005D0
XT(102)=.0005D0
XT(103)=.0007D0
XT(104)=7.9D0
XT(105)=16.7D0
XT(106)=15.15D0
XT(107)=1.D0
XT(108)=1.D0
XT(109)=1.D0
XT(110)=1.D0
XT(111)=1.D0
XT(112)=1.D0
XT(113)=1.D0
XT(114)=1.D0
XT(115)=1.D0
XT(120)=7.2D0
XT(121)=5.D0
XT(122)=.05D0
XT(123)=.1D0
XT(124)=1.D0
XT(125)=4.D0
XT(126)=1.5D0
XT(127)=1.25D0
XT(128)=3.D0
XT(129)=4.D0
RETURN
END
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APPENDIX H

CHANGES MADE IN SUBROUTINE OTHPAR

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      SUBROUTINE  OTHPAR
      IMPLICIT REAL*8(A-H,O-Z)
       COMMON/BLOC13/ XO
      DIMENSION  XO(300)
C
C****
C     THE FIRST FOURTEEN XO'S ARE RESERVED FOR VARIABLES OF OPTIMIZATION
C       THESE XO'S ARE ASSIGNED VALUES IN SUBROUTINE VARSET,DEPENDING
C       UPON PROCESS AND PLANT SIZE - THESE FOURTEEN XO'S MAY BE
C       ASSIGNED VALUES BY INPUT ONLY BY SETTING THE XT'S CORRESPONDING
C       TO THE UPPER AND LOWER LIMITS OF THE VARIABLE TO THE VALUE WHICH
C       THE VARIABLE IN QUESTION IS TO ASSUME.
C     FOR A MULTI-STAGE FLASH PLANT,THESE XO'S REPRESENT THE FOLLOWING
C       VARIABLES-
C
C     XO(1) = NUMBER OF HEAT REJECT STAGES
C             UPPER LIMIT, XT( 1)  -  LOWER LIMIT, XT( 2)        XO( 1)
C     XO(2) = VELOCITY IN BRINE HEATER TUBING,FPS
C             UPPER LIMIT, XT( 3)  -  LOWER LIMIT, XT( 4)        XO( 2)
C     XO(3) = OUTSIDE DIAMETER OF BRINE HEATER TUBING, INCHES
C             UPPER LIMIT, XT( 5)  -  LOWER LIMIT, XT( 6)        XO( 3)
C     XO(4) = NUMBER OF PLANT LEVELS
C             UPPER LIMIT, XT( 7)  -  LOWER LIMIT, XT( 8)        XO( 4)
C     XO(5) = VELOCITY IN HEAT REJECT TUBING,FPS
C             UPPER LIMIT, XT( 9)  -  LOWER LIMIT, XT(10)        XO( 5)
C     XO(6) = OUTSIDE DIAMETER OF HEAT REJECT TUBING,INCHES
C             UPPER LIMIT, XT(11)  -  LOWER LIMIT, XT(12)        XO( 6)
C     XO(7) = NUMBER OF HEAT RECOVERY STAGES
C             UPPER LIMIT, XT(13)  -  LOWER LIMIT, XT(14)        XO( 7)
C     XO(8) = VELOCITY IN HEAT RECOVERY TUBING,FPS
C             UPPER LIMIT, XT(15)  -  LOWER LIMIT, XT(16)        XO( 8)
C     XO(9) = OUTSIDE DIAMETER OF HEAT RECOVERY TUBING,INCHES
C             UPPER LIMIT, XT(17)  -  LOWER LIMIT, XT(18)        XO( 9)
C     XO(10)= PERFORMANCE RATIO ,LB PRODUCT WATER PER THOUSAND BTU
C             UPPER LIMIT, XT(19)  -  LOWER LIMIT, XT(20)        XO(10)
C     XO(11)= TEMPERATURE DIFFERENCE,(TBLOWDOWN -TOCEAN)
C             UPPER LIMIT, XT(21)  -  LOWER LIMIT, XT(22)        XO(11)
C     XO(12)= CONCENTRATION RATIO,  BLOWDOWN TO FEED CONCENTRATIONS
C             UPPER LIMIT, XT(23)  -  LOWER LIMIT, XT(24)        XO(12)
C     XO(13)= NOT USED
C     XO(14)= NOT USED
C***
C     FOR A VERTICAL TUBE EVAPORATOR PLANT,
C
C     XO(1) = VELOCITY IN BRINE HEATER TUBING, FPS
C             UPPER LIMIT, XT(3)   - LOWER LIMIT, XT(4)           XO(1)
C     XO(2) = OUTSIDE DIAMETER OF BRINE HEATER TUBING, INCHES
C             UPPER LIMIT, XT(5)   - LOWER LIMIT, XT(6)           XO(2)
C     XO(3) = VELOCITY IN CONDENSER TUBING, FPS
C             UPPER LIMIT, XT(9)   - LOWER LIMIT, XT(10)          XO(3)
C     XO(4) = OUTSIDE DIAMETER OF CONDENSER TUBING, INCHES
C             UPPER LIMIT, XT(11) - LOWER LIMIT, XT(12)           XO(4)
C     XO(5) = DEFINES CONDENSER REJECT TEMP BY TR =TFEED+X*(TCON-TFEED)
C             UPPER LIMIT, XT(25) - LOWER LIMIT, XT(26)           XO(5)
C     XO(6) = NUMBER OF STAGES IN MSF PREHEATER PER EFFECT          ****
C             UPPER LIMIT, XT(13) - LOWER LIMIT, XT(14)           XO(6)
C     XO(7) = VELOCITY IN PREHEATER TUBING, FPS
C             UPPER LIMIT, XT(15) - LOWER LIMIT, XT(16)           XO(7)
C     XO(8) = OUTSIDE DIAMETER OF PREHEATER TUBES, INCHES
C             UPPER LIMIT, XT(27) - LOWER LIMIT, XT(28)           XO(8)
C     XO(9) = DEFINES FEED RATE  BY WF =WFMIN +X*(WFMAX-WFMIN)
C             UPPER LIMIT, XT(29) - LOWER LIMIT, XT(30)           XO(9)
C     XO(10)= OUTSIDE DIAMETER OF VERTICAL EVAPORATOR TUBES, INCHES
C             UPPER LIMIT, XT(31) - LOWER LIMIT, XT(32)          XO(10)
C     XO(11)= LENGTH OF A VERTICLE EVAPORATOR TUBE, FEET
C             UPPER LIMIT, XT(33) - LOWER LIMIT, XT(34)          XO(11)
C     XO(12)= DEFINES HEAT FLOW DOWN VERT. EVAP. BY  Q = X*QNOMINAL
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C          UPPER LIMIT, XT(35) - LOWER LIMIT, XT(36)                XO(12)
C     XO(13)= NUMBER OF VERTICAL TUBE EFFECTS
C          UPPER LIMIT, XT(37) - LOWER LIMIT, XT(38)                XO(13)
C     XO(14)= NOT USED
C****
C
      CALLO('INTERMEDIATE TUBE SHEET THICKNESS,INCHES     (VTE,MSF)', 15)
               XO(15) = .75D0
C
      CALLO('DEPTH OF FLASHING BRINE,MSF PLANT,FEET       (VTE,MSF)', 18)
               XO(18) = 1.25D0
C
      CALLO('THERMAL CONDUCTIVITY OF BRINE HEATER TUBING (VTE,MSF)', 19)
C          BTU/HR/FT/DEG F
               XO(19) = 26.D0
C
      CALLO('THERMAL COND.,RECOVRY(MSF),PRHTR(VTE) TUBING(VTE,MSF)', 20)
C          BTU/HR/FT/DEG F
               XO(20) = 26.D0
C
      CALLO('THERMAL COND.,REJECT(MSF),CONDSR(VTE) TUBING(VTE,MSF)', 21)
C          BTU/HR/FT/DEG F
               XO(21) = 26.D0
C
      CALLO('FLOODING FACTOR IN BRINE HEATER              (VTE,MSF)', 22)
               XO(22) = 19.D0
C
      CALLO('FLOODING FACTOR IN RECOVRY(MSF),PRHTR(VTE)   (VTE,MSF)', 23)
               XO(23) = 19.D0
C
      CALLO('FLOODING FACTOR IN REJECT(MSF),CONDSR(VTE)   (VTE,MSF)', 24)
               XO(24) = 19.D0
C
      CALLO('WALL THICKNESS OF BRINE HEATER TUBING,INCHES(VTE,MSF)', 25)
      XO(25)=.049D0                                                     ****
C
      CALLO('WALL THKNESS, RECOVRY(MSF),PRHTR(VTE) TUBING(VTE,MSF)', 26)
C          INCHES
      XO(26)=.035D0                                                     ****
C
      CALLO('WALL THKNESS, REJECT(MSF),CONDSR(VTE) TUBING(VTE,MSF)', 27)
C          INCHES
      XO(27)=.049D0                                                     ****
C
      CALLO('PUMPING HEAD,FEED SOURCE TO PLANT SITE,FEET       (ALL)', 28)
               XO(28) = 35.D0
C
      CALLO('PUMPING HEAD,PLANT TO BRINE HEATER,FEET      (VTE,MSF)', 29)
               XO(29) = 25.D0
C
      CALLO('BLOWDOWN PUMPING HEAD, FEET                       (ALL)', 30)
               XO(30) = 4C.D0
C
      CALLO('PRODUCT PUMPING HEAD, FEET                        (ALL)', 31)
               XO(31) = 92.D0
C
      CALLO('PUMP AND MOTOR EFFICIENCY                         (ALL)', 32)
               XO(32) = .827D0
C
      CALLO('DESALTING PLANT LIFE,YEARS                        (ALL)', 33)
               XO(33) = 30.D0
C
      CALLO('TUBING(EXCEPT BRINE HTR AND VERT)LIFE,YEARS (VTE,MSF)', 34)
               XO(34) = 3C.D0
C
      CALLO('BRINE HEATER TUBING LIFE, YEARS              (VTE,MSF)', 35)
               XO(35) = 30.D0
C
      CALLO('OCEAN SALT CONCENTRATION, WT. FRACTION       (VTE,MSF)', 36)
               XO(36) = .0336D0
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C                                                                           PR 35450
      CALLO('PRODUCT SALT CONCENTRATION, WT. FRACTION    (VTE,MSF)', 37)PR 35460
                XO(37) = 25.D-6                                             PR 35470
C                                                                           PR 35480
      CALLO('DESALTING PLANT LOAD FACTOR                      (ALL)', 38)PR 35490
      XO(38)=.85DO                                                              ****
C                                                                           PR 35510
      CALLO('STEAM TEMPERATURE, DEG F                     (VTE,MSF)', 39)PR 35520
                XO(39) = 258.DO                                             PR 35530
C                                                                           PR 35540
      CALLO('TEMPERATURE OF FEEDWATER, DEG F                  (ALL)', 40)PR 35550
                XO(40) = 65.DO                                              PR 35560
C                                                                           PR 35570
      CALLO('MAXIMUM BRINE TEMPERATURE, DEG F                 (MSF)', 41)PR 35580
                XO(41) = 250.DO                                             PR 35590
C                                                                           PR 35600
      CALLO('THE MINIMUM NUMBER OF TRAINS ALLOWED             (ALL)', 43)PR 35610
      XO(43)=8.DO                                                               ****
C                                                                           PR 35630
      CALLO('WALL THICKNESS,VERTICAL EVAPORATOR TUBING,IN.   (VTE)', 70)PR 35640
                XO(70) = .049DO                                             PR 35650
C                                                                           PR 35660
      CALLO('THERMAL CONDUCTIVITY,VERTICAL EVAP. TUBES       (VTE)', 72)PR 35670
C           BTU/HR/FT/DEG F                                                 PR 35680
      XO(72)=26.DO                                                              ****
C                                                                           PR 35700
      CALLO('RATIO OF ACTUAL TO RUBBER BAND AREAS,VE TUBES   (VTE)', 74)PR 35710
                XO(74) = 1.273DO                                            PR 35720
C                                                                           PR 35730
      CALLO('FEED RATE TO A 3 INCH OD,10 FT LONG VE TUBE,GPM (VTE)', 75)PR 35740
                XO(75) = 2.0DO                                              PR 35750
C                                                                           PR 35760
      CALLO('VERTICAL EVAPORATOR TUBE LIFE, YEARS             (VTE)', 76)PR 35770
                XO(76) = 15.DO                                              PR 35780
C                                                                           PR 35790
      CALLO('YEAR PLANT CONSTRUCTION BEGINS                   (ALL)', 79)PR 35800
      XO(79)=1976.                                                              ****
C                                                                           PR 35820
      CALLO('MINIMUM PLANT SIZE(MGD) WITH ON-SITE ACID PLANT (ALL)', 80)PR 35830
      XO(80)=1000.DO                                                            ****
C                                                                           PR 35850
      CALLO('MINIMUM PLANT SIZE(MGD) USING NUCLEAR HEAT+PWR  (ALL)', 81)PR 35860
                XO(81) = 50.DO                                              PR 35870
C                                                                           PR 35880
      CALLO('MAXIMUM PLANT SIZE(MGD) WITH SUPPLIERS BURDEN   (ALL)', 82)PR 35890
                XO(82) = 10.DO                                              PR 35900
C                                                                           PR 35910
      CALLO('MAXIMUM TEMPERATURE FOR CONCRETE SHELL      (MSF,VTE)', 83)PR 35920
      XO(83)=0.DO                                                               ****
C                                                                           PR 35940
      CALLO('MAX SPEC TRAY FLOW RATE AT HOT END OF RECOVERY  (MSF)', 84)PR 35950
                XO(84) =1.D6                                                PR 35960
C                                                                           PR 35970
      CALLO('MAX SPEC TRAY FLOW RATE AT COLD END OF RECOVERY (MSF)', 85)PR 35980
                XO(85) =.8D6                                                PR 35990
C                                                                           PR 36000
      CALLO('DEAERATOR PUMPING HEAD,FEET                 (MSF,VTE)', 86)PR 36010
                XO(86) =24.DO                                               PR 36020
C                                                                           PR 36030
      CALLO('TOTAL LENGTH OF INTAKE AND OUTFALL PIPING,FT(MSF,VTE)', 87)PR 36040
                XO(87) = 6000.DO                                            PR 36050
C                                                                           PR 36060
      CALLO('RATIO OF VE SURFACES,AVG OF ALL TO HOTTEST EFF. (VTE)', 88)PR 36070
                XO(88) = 1.1512DO                                           PR 36080
C                                                                           PR 36090
      CALLO('RATIO OF VE SURFACES, COLDEST TO HOTTEST EFFECT (VTE)', 89)PR 36100
                XO(89) = 1.061DO                                            PR 36110
      CALLO('CONCENTRATION OF PRODUCT WATER, PPM              (ED )',140)PR 36810
                XO(140) = 500.DO                                            PR 36820
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CALLO('AIR LEAKAGE PER TRAIN, LB/HR (ACID)         (VTE,MSF)',200)   ****
CALLO('PPM OF NCG FROM MAKE-UP FLOW IN EVAP.(ACID) (VTE,MSF)',201)   ****
CALLO('AIR LEAKAGE PER TRAIN, LB/HR (POLY)         (VTE,MSF)',202)   ****
CALLO('PPM OF NCG FROM MAKE-UP FLOW IN EVAP.(POLY) (VTE,MSF)',203)   ****
CALLO('NO. OF VELOCITY HEADS LOST IN WATER BOXES   (VTE,MSF)',204)   ****
XO(204)=2.DO                                                         ****
CALLO('TOTAL NCG LOAD ON EJECTORS, LB/HR           (VTE,MSF)',205)   ****
CALLO('HEAT REQUIRMENT FOR SJAE UNITS,MMBTU/HR     (VTE,MSF)',206)   ****
CALLO('PPM POLYPHOSPHATE IN MAKE-UP STREAM         (VTE,MSF)',207)   ****
XO(207)=3.DO                                                         ****
CALLO('BUNDLES PER TRAIN                               (ALL)',208)   ****
XO(208)=1.DO                                                         ****
CALLO('BUNDLES PER MODULE                              (ALL)',209)   ****
XO(209)=1.DO                                                         ****
CALLO('TRAINS PER BUILDING                             (ALL)',210)   ****
XO(210)=1.DO                                                         ****
CALLO('PRESSURE DROP IN VTE NOZZLES, FT.               (VTE)',211)   ****
XO(211)=30.DO                                                        ****
RETURN                                                            PR 36830
END                                                               PR 36840
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APPENDIX I
CHANGES MADE IN SUBROUTINE PRICES

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      SUBROUTINE PRICES(PROC)                                           PR 54370
      IMPLICIT REAL*8(A-H,O-Z)                                          PR 54380
C                                                                       PR 54390
      DOUBLE PRECISION MSF                                              PR 54400
      DOUBLE PRECISION    LPH,     LVE,    IDBH,    IDPH,   LCON,   NCON, PR 54410
     1   NTPH,  IDCON                                                   PR 54420
      REAL*8 LPHE                                                           ****
      REAL*8 KBH,KPH,KVE,LBH,MGD,NBH,NPH,NVE,KCON                           ****
      DOUBLE PRECISION MODU                                             PR 54430
      DOUBLE PRECISION LEV,LF2                                          PR 54440
C                                                                       PR 54450
      COMMON/PINHAS/APTSH,ENRSS,ENRJS,LPHE,DUMDUM(16),NFEED,IIIIII(9)
       COMMON/BLOC13/ XO(300)
      COMMON/BLOCM1/    DIE,      DIH,      DIR,      DOE,      DOH,PR 54460
     1       DOR,       ELE,      ENE,      RLR,      RNR,     HDEL,PR 54470
     2      HREC,     APTSR,   ENITSR                                   PR 54480
      COMMON/BLOCM2/      P,        Q,       AH,       AK,       AN,PR 54490
     1        AR,        FF,       GE,       GH,       GR,       HD,PR 54500
     2        PB,        PE,    QX(5),       RP,       SE,       SH,PR 54510
     3        SR,        TK,       VE,       VH,       VR,       WC,PR 54520
     4       AME,       ATN,   BPX(5),      CCF,      HIH,      HLH,PR 54530
     5       HNH,       HOH,   OMX(5),      PHE,      PO3,      RSE,PR 54540
     6       RSH,       RSR,      TC1,      THF,   TKX(5),      TMC,PR 54550
     7       TME,       TPE,   UEX(5),      UME,      UMH,      WPL,PR 54560
     8      BKTE,      BKTH,     BKTR,  DTLS(5),  ELEX(5),  HIEX(5),PR 54570
     9   HOEX(5),      MODU,     ROE1,     ROE2,    APTSE,    BDEPH,PR 54580
     +     CAPI1,     HEADE,    HEADH,    HEADR,    POBLD,    PODEL,PR 54590
     A     POPRD,  SUBEX(5),    WCOLD,    WMUDC,    WMODH,   BHSHEL,PR 54600
     B    CSLTBH,    CSLTBP,   HOTLEN,   HRECOV,   HREJCT,   RECOLN,PR 54610
     C    VAPSPC,    WPRTRY,    POREC                                 PR 54620
      COMMON/BLOCV1/    ANE,      HVE,      LPH,      LVE,     ACON,PR 54630
     1      GPMV,      HPVE,     HSEA,     IDBH,     IDPH,     LCON,PR 54640
     2      NCON,      NTPH,     ODBH,     ODPH,     ODVE,     POVE,PR 54650
     3      RPMV,     HFEED,    IDCON,    ODCON,    SUMWT,    VETSA,PR 54660
     4    APTSCN,    APTSEP,   OVRHGT,   TOTNVE,   VEPMPS              PR 54670
      COMMON/BLOCV2/  A(30),        S,   AE(30),       QE,   TC(30),    ****
)    1    TE(30),        TR,   UE(30),    UH(3),       WM,   WT(30),    ****
     2       ABH,       APH,  BPE(30),  CIE(30),  COE(30),  DPE(30),    ****
     3       ELL,       GBH,      GPH,      GPM,      HOO,      KBH,    ****
     4       KPH,       KVE,      LBH,      MGD,      NBH,      NPH,    ****
     5   NVE(30),       QPH,      RBH,      RPH,      RVE,      TOO,    ****
     6       UBH,       VBH,      VPH, WPEX(30),     BHLF,     GCON,    ****
     7      HIBH,   HIPH(3),     HOBH,  HOPH(3),     KCON,  LMTD(3),    ****
     8      LVEP,      PHLF,  QMSF(3),     RCON,  SUBF(3),     TCON,    ****
     9      UCON,      VCON,     VLEN,     VTLF, WDTH(30), ALFAE(30),   ****
     +     CONLF,     HICON,    HOCON,    HOTE1,    PHHGT,    POBLO,    ****
     A     POPRO,     POSEA,    SURFF,    VEHGT,    WALVE,   EFFSPC,    ****
     BELBNDL(30),    HCOTCF,   HCOTOO,   HEADBH,   HEADCN,   HEADPH,    ****
     C    LMTDBH,    LMTDCN,   PLNTLF,   PODEAS,   POFEED,   SUMWPE,    ****
     D    SUMWPH,    TOTAVE,     QESP,VEFEED(30),  WBOOST,   WDCOLD,    ****
     E        NE,      NTRN,    IFEED,   IRECYC                            ****
      COMMON/COMNAM/     AJ,       CB,       CO,       CP,       CR,  PR 54680
     1        HB,        PI,       PO,       TB,       TO,       TP,  PR 54690
     2        TS,        WB,       WF,       WO,       WP,       WR,  PR 54700
     3       AXJ,       HBL,      HPR,      LEV,      LF2,      TCF,  PR 54710
     4      ENBH,      GPMB,     GPMD,     GPMH,     GPMO,     GPMP,  PR 54720
     5      GPMR,      HDEA,     RPMB,     RPMD,     RPMM,     RPMP,  PR 54730
     6      RPMR,      TSTH,     WHOT,     YEAR,    ACRES,    BHVOL,  PR 54740
     7     BLDGS,     BNDLS,    HOLES,    HPBLD,    HPDEA,    HPDEL,  PR 54750
     8     HPPRD,     HPREC,    PLPRD,    PLSEA,    PODEA,   ACNCEW,  PR 54760
     9    ACNCFL,    ACNCIW,   ACNCPH,   ACNCRF,   ACNCTR,   AEXCAV,  PR 54770
     +    ASTLEW,    ASTLFL,   ASTLIW,   ASTLPH,   ASTLRF,   ASTLTR,  PR 54780
     A    AWEIRS,    BHSURF,   DINTAK,   ENITSE,   ENPIPE,   ENSUPE,  PR 54790
     B    ENSUPR,    PIPELN,   PLSZMG,   REJLEN,   STLLEN,   STLTMP,  PR 54800
     C    TNACDY,    TRAINS,   TSAREA,   VOLCNC,   VOLSTL,   WOCEAN   PR 54810
       COMMON/BLOC14/ XC                                                PR 54820
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```
      COMMON/SHARE/ IFLIP,ISPOT
C
      DIMENSION XC(500)
      DATA MSF,VTE,ED/'MSF','VTE','ED'/
C
      UFHEAC(TS)=  1.
      UNHEAC(TS)=(-78.5331+.644544*TS-.000608477*TS*TS )*0.01
C            UNIT COSTS ARE FOR THIRD QUARTER OF 1975
C     NOTE REORDERING OF CARDS HERE
C                ************************************
C
C    UNIT COSTS FOR THIRD QUARTER 1967
C
C
C****    UNIT COSTS OF HORIZONTAL TUBE BUNDLE FABRICATION
C**        UNIT COST OF TUBE SHEETS, $/SHEET - TUBE SHEETS ARE STEEL
C            WITH 1/8 INCH CU-NI CLADDING
             UCSHET(TKNS,AREA) = 9.929*TKNS*AREA
C**          UNIT COST OF HOLE DRILLING AND TUBE ROLLING,$/HOLE
             UCDRIL(TSTH,DIA) = .0449 + .1538*(TSTH*DIA)**2
C**        UNIT COST OF TUBE SHEET INSTALLATION,$/TUBE SHEET
             UCTSIN(TSTH,AREA,RFSNO,SHETNO)= 2.676*TSTH*AREA*
     1                                     (RFSNO/SHETNO)**.1
C**        UNIT COST OF INSTALLING TUBING, $/LINEAR FT.
             UCTUIN(REFEET,FEET) = .07277*(REFEET/FEET)**.1
C
C                ************************************
C
C
C****    UNIT COSTS OF STEEL SHELL
C          UNIT COST OF ROOF, $/SQ FT
      USTLRF(AREA) = 13.53*(54601./AREA)**.1
C          UNIT COST OF FLOOR AND FOUNDATION, $/SQ FT
      USTLFL(AREA) = 5.373*(54601./AREA)**.1 +11.27*(54601./AREA)**.03
C          UNIT COST OF EXTERIOR WALLS, $/SQ FT
      USTLEW(AREA) = 18.36*(21120./AREA)**.1
C          UNIT COST OF INTERIOR WALLS, $/SQ FT
      USTLIW(AREA) = 12.22*(154160./AREA)**.1
C          UNIT COST OF INTERIOR FRAMING, $/CU FT SHELL VOLUME
      USTLIF(VOLUME) = 1.238*(1.4162D6/VOLUME)**.1
C          UNIT COST OF TRAYS, $/SQ FT
      USTLTR(AREA) = 26.16*(67684./AREA)**.1
C          UNIT COST OF PHENOLIC COATING, $/SQ FT
      USTLPH(AREA) = 1.338*(180200./AREA)**.03
C
C****    UNIT COSTS OF CONCRETE SHELL
C          UNIT COST OF ROOF, $/SQ FT
      UCNCRF(AREA) =11.11*(185497./AREA)**.03+5.17*(185497./AREA)**.1
C          UNIT COST OF FLOOR AND FOUNDATION, $/SQ FT
      UCNCFL(AREA) =12.54*(185497./AREA)**.03+5.29*(185497./AREA)**.1
C          UNIT COST OF EXTERIOR WALLS, $/SQ FT
      UCNCEW(AREA) =14.22*( 48291./AREA)**.03+13.26*(48291./AREA)**.1
C          UNIT COST OF INTERIOR WALLS, $/SQ FT
      UCNCIW(AREA) = 6.96*(376165./AREA)**.03
C          UNIT COST OF INTERIOR FRAMING, $/CU FT SHELL VOLUME
      UCNCIF(VOL)=.261*(5.39306/VOL)**.03+.109*(5.39306/VOL)**.1
C          UNIT COST OF TRAYS, $/SQ FT
      UCNCTR(AREA) =8.28*(224140./AREA)**.03
C          UNIT COST OF PHENOLIC COATING ON STEEL, $/SQ FT
      UCNCPH(AREA) =1.577*(2.05/AREA)**.03
C
C**      UNIT COST OF EXCAVATION, $/SQ FT FLOOR AREA
      UEXCAV(AREA) =.5461*(240100./AREA)**.03
C**      UNIT COST OF DEMISTERS AND MISC SMALL SHELL ITEMS, $/MGD
      UMISCI(PLCAP)= 10200.*(250./PLCAP)**.03
C**      UNIT COST OF WEIRS, $/SQ FT WEIR AREA
      UWEIRS(AREA) = 59.36*(19860./AREA)**.03
C
C
C                ************************************
```

```
C
C****     UNIT COST OF PUMPS , $/GPM  -PUMPS HAVE NI-RESIST CASINGS AND
C           316 SS IMPELLERS AND SHAFTS.
            UCPUMP(GPM,HEAD) = 23.762*(1.-.8696*DEXP(-.004426*HEAD))
     1                        /GPM**.15
C
C
C****     UNIT COST OF MOTORS ,$/HP -MOTORS OF 500 OR MORE HORSEPOWER
C           ARE SYNCHRONOUS -SMALLER MOTORS ARE INDUCTION
            UCMOTR(HP,RPM) = 28.309*(1.+56.8D3 *RPM**(-.972)/HP**.736)
     1                      *(1.-.954*DEXP(-.004*HP))
C
C****     UNIT COST OF AUXILIARY PUMPS AND DRIVES,$/MGD PLANT CAPACITY
            UCPAUP(PLCAP) =140.*(250./PLCAP)**.2
C
C****     UNIT COST OF PITS FOR RECYCLE,MAKE-UP,PRODUCT AND BLOWDOWN
C                PUMPS, $/GPM PUMP CAPACITY
            UCPPIT(GPMP) = 1.17*(2.25906/GPMP)**.2
C
C                  **************************************
C
C****     UNIT COSTS OF SUBMARINE LINE INTAKE AND OUTFALL SYSTEM
             UCINSL(GO,DIA,TRAINS,PIPENO,PIPELN)=
C**         UNIT COST OF SCREENS, $/GPM SEAWATER INTAKE
     1       1.511D0
C**         UNIT COST OF INTAKE CAPS, $/GPM
     2       + 2696.D0/GO *PIPENO * DIA**1.9
C**         UNIT COST CF DRAFT TUBES, $/GPM
     3       + 94.12 *(TRAINS/GO)**.35
C**         UNIT COST OF MATERIAL, $/GPM
     4       +4.08*PIPELN*DIA**1.9*PIPENO**.97/GO
C**         UNIT COST OF LABOR ,$/GPM
     5       +20.85*PIPELN *DIA**1.1*PIPENO**.8/GO
C
C                  **************************************
C
C****     UNIT COST OF HYDRAULICALLY OPERATED BUTTERFLY VALVES ,$/GPM
            UCVALV(GPM) =(248.6+.008588*GPM**1.2)/GPM
C
C****     UNIT COST OF PLANT (SEAWATER,REJECT,AND INTERTRAIN) PIPING AND
C          FITTINGS, $/GPM SEAWATER FLOW FOR DISTILLATION PLANTS.
            UCPLPF(PLSEA,GPMO,GPMP,PLPRD,TRAINS) =
C**        UNIT COST OF SEAWATER INTAKE PIPING ,$/GPM SEAWATER FLOW
     1          .0481*PLSEA*(GPMO/TRAINS)**.5/GPMO
C**        UNIT COST OF SEAWATER INTAKE FITTINGS,$/GPM SEAWATER FLOW
     2          +1.488*(GPMO/TRAINS)**.8 *TRAINS/GPMO
C**        UNIT COST OF PLANT REJECT PIPING ,$/GPM SEAWATER FLOW
     3          +.0481*PLSEA*((GPMO-GPMP)/TRAINS)**.5/GPMO
C**        UNIT COST OF PLANT REJECT FITTINGS,$/GPM SEAWATER FLOW
     4          +1.326*((GPMO-GPMP)/TRAINS)**.8 *TRAINS/GPMO
C**        UNIT COST OF INTERTRAIN PIPING ,$/GPM SEAWATER FLOW
     5          +.0481*GPMP**.5/GPMO*PLPRD
C**        UNIT COST OF INTERTRAIN FITTINGS, $/GPM SEAWATER FLOW
     6          +.4302*GPMP**.8*TRAINS/GPMO
C
C****     UNIT COSTS OF INTRA-TRAIN PIPING AND FITTINGS FOR MSF PLANT,
C          $/TRAIN
            UCTRPF(PLCAP,TRAINS,PLEVEL,REJLEN) =
C**        UNIT COST OF TRAIN PIPING, $/TRAIN
     1          3.2804*(PLCAP/TRAINS)**.5*(.95+.05*(PLEVEL-1.))
     2               *(.95+.05*REJLEN/90.33)
C**        UNIT COST OF TRAIN FITTINGS, $/TRAIN
     3          +12.103*(PLCAP/TRAINS)**.8
C
C****     UNIT COSTS OF BRINE HEATER PIPING AND FITTINGS,$/GPM BH FLOW
           UCBHPF(ENBH,GPMH,PLEVEL)=
C**        UNIT COST OF BRINE HEATER PIPING,$/GPM BH FLOW
     1          88.00*ENBH*(GPMH/ENBH)**.5*(.9+.1*(PLEVEL-1.))/GPMH
C**        UNIT COST OF BRINE HEATER FITTINGS,$/GPM BRINE HEATER FLOW
     2          +1.455*ENBH*(GPMH/ENBH)**.8*(.9+.1*(PLEVEL-1.))/GPMH
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C                                                                       PR 56290
C****     UNIT COST OF VENT AND DRAIN PIPING, $/GPM MAKE-UP FLOW        PR 56300
            UCVNTD(GPMMU,PLCAP) =2.205*(3.472D5/GPMMU)**.03             PR 56310
     1                          +2984.*(PLCAP/250.)**.2/GPMMU           PR 56320
C                                                                       PR 56330
C                 ************************************                  PR 56340
C    NOTE REORDERING OF CARDS HERE                                        ****
C                                                                       PR 56720
C****      UNIT COST OF BRINE HEATER SHELL AND INSTALLATION, $/SQ FT    PR 56730
C          SHELL SURFACE                                                PR 56740
             UCBHSH(SURF,VOL,RFSURF,RFVOL) = 136.85*(RFSURF/SURF)**.1   PR 56750
     1                             +34.87*VOL/SURF*(VOL/RFVOL)**.1      PR 56760
C                                                                       PR 56770
C                 ************************************                  PR 56780
C     UNIT COSTS FOR THIRD QUARTER 1975                                   ****
C     NOTE RE-ORDERING OF CARDS HERE                                      ****
C
C                 ************************************
C                                                                       PR 56350
C**         UNIT COST OF ACID DISPENSING AND CAUSTIC TREATMENT SYSTEMS, PR 56390
C          $/TON OF H2SO4 PER DAY.                                      PR 56400
      UCACCT(TNACDY,TRAINS)=8.04*(TNACDY/TRAINS/13.15)**.3*TRAINS/TNACDY  ****
C**         UNIT COST OF CHLORINATION EQUIPMENT, $/GPM SEAWATER INTAKE  PR 56420
             UCCHLO(GPMO) = 1.108*(2.205/GPMO)**.3                      PR 56430
C      ANTIFOAM + SULFITE OR POLYPHOSPHATE, $/GPM                         ****
      UCAFSS(GPMMU,TRAINS)=20.D3*(GPMMU/TRAINS/1735.)**.3*TRAINS/GPMMU    ****
C**         UNIT COST OF PRODUCT WATER TREATMENT,CHEMICAL BLDG.,AND     PR 56470
C          MISC AIR AND HYDRAULIC SYSTEMS, $/MGD PLANT CAPACITY         PR 56480
           UCPAUX(PLCAP) = 12840.*(100.D0/PLCAP)**.3                      ****
C                                                                       PR 56500
C                 ************************************                  PR 56510
C                                                                       PR 56520
C*****   UNIT COST OF INSTRUMENTATION                                   PR 56530
      UCI(FF,TRAINS)=400.D3*(FF/TRAINS/10.)**.3174*TRAINS/FF              ****
C                                                                       PR 56550
C                 ************************************                  PR 56560
C                                                                       PR 56570
C****     UNIT COST OF ELECTRICAL DISTRIBUTION EQUIPMENT, $/MW          PR 56580
      UCEDK(PMW,TRAINS)=(750.D3*(PMW/TRAINS/10.)**.8*TRAINS+              ****
     1 1000.D3*(PMW/40.)**.8)/PMW                                         ****
C                                                                       PR 56630
C                 ************************************                  PR 56640
C                                                                       PR 56650
C**** UNIT COST OF DECARBONATOR AND STEAM EJECTORS AND DEAERATOR          ****
C       DEAERATOR  ,  $/GPM                                               ****
      UCDEA(FLOW,TRAINS)=100.D3*(FLOW/TRAINS/4.2D3)**.7*TRAINS/FLOW       ****
C       DECARBCNATOR, $/GPM                                               ****
       UCDCR(FLOW,TRAINS)=46.D3*(FLOW/TRAINS/4.2D3)**.7*TRAINS/FLOW       ****
C           STEAM EJECTORS,  $/LB/HR NCG                                  ****
      UCSJAE(GL,TRAINS)=(78.D3*(GL/TRAINS/500.)**.453                     ****
     1 +6.D3*(GL/TRAINS/500.)**.83+40.D3)*TRAINS/GL                       ****
C                                                                       PR 56700
C                 ************************************                  PR 56710
C                                                                       PR 56790
C****       UNIT COST OF SITE PREPARATION, $/ACRE                       PR 56800
      UCSITS(ACRES)=75.D3*(11.4/ACRES)**.03                               ****
C                                                                       PR 56820
C****       UNIT COST OF BUILDINGS AND CRANES,$/MGD PLANT CAPACITY      PR 56830
      UCBLCR(PLCAP)=30.D3*(10C./PLCAP)**.35                               ****
C                                                                       PR 56850
C                 ************************************                  PR 56860
C                                                                       PR 56870
C****      UNIT COST OF OPERATING AND MAINTENANCE LABOR,$/YR PER MGD    PR 56880
      UCOPAN(PLCAP)=12.5D3*(100./PLCAP)**.5                               ****
C                                                                       PR 56900
C                                                                       PR 56910
C**                                                                     PR 56920
C****    CCST FACTCRS WHICH APPLY TO ALL PROCESSES                      PR 56930
C**                                                                     PR 56940
C                                                                       PR 57000
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      GO TO (95,96),NFEED                                                ****
   95 XC(48)=31.D0                                                       ****
      GO TO 97                                                           ****
   96 XC(48)=3000.D0                                                     ****
   97 CONTINUE                                                           ****
      XC(49)=25.D0                                                       ****
C                                                                    PR 57950
      XC(50)=2.64D-7                                                     ****
C                                                                    PR 58010
      XC(54)=.02D0                                                       ****
C                                                                    PR 57030
      XC(55)=.025D0                                                      ****
C                                                                    PR 57060
      XC(56)=.08D0                                                       ****
C                                                                    PR 57090
      XC(58)=.007D0                                                      ****
C                                                                    PR 58130
      XC(60)=.1D0                                                        ****
C                                                                    PR 57120
      XC(61) = .01D0                                                 PR 57140
C                                                                    PR 57150
      XC(62) = .25D0                                                     ****
C                                                                    PR 57180
      IF(IFLIP .EQ. 0) GO TO 100                                     PR 57190
      IF((PROC .NE. MSF) .AND.  (PROC .NE. VTE)) GO TO 400           PR 57200
  100 CONTINUE                                                       PR 57210
C**                                                                  PR 57220
C****    COST FACTORS WHICH APPLY TO BOTH MSF AND VTE PROCESSES      PR 57230
C**                                                                  PR 57240
      IF(VOLSTL .LT. 5.D0) GO TO 110                                 PR 57260
      XC(9)   =(USTLRF(ASTLRF)*ASTLRF +USTLFL(ASTLFL)*ASTLFL         PR 57270
     1         +USTLEW(ASTLEW)*ASTLEW +USTLIW(ASTLIW)*ASTLIW         PR 57280
     2         +USTLIF(VOLSTL)*VOLSTL +USTLTR(ASTLTR)*ASTLTR         PR 57290
     3         +USTLPH(ASTLPH)*ASTLPH)/VOLSTL                        PR 57300
  110 CONTINUE                                                       PR 57310
C                                                                    PR 57320
      IF(VOLCNC .LT. 5.D0) GO TO 120                                 PR 57340
      XC(10) =(UCNCRF(ACNCRF)*ACNCRF +UCNCFL(ACNCFL)*ACNCFL          PR 57350
     1         +UCNCEW(ACNCEW)*ACNCEW +UCNCIW(ACNCIW)*ACNCIW         PR 57360
     2         +UCNCIF(VOLCNC)*VOLCNC +UCNCTR(ACNCTR)*ACNCTR         PR 57370
     3         +UCNCPH(ACNCPH)*ACNCPH)/VOLCNC                        PR 57380
  120 CONTINUE                                                       PR 57390
C                                                                    PR 57400
      XC(11) = UEXCAV(AEXCAV)                                        PR 57420
C                                                                    PR 57430
      XC(12)  = UMISCI(PLSZMG)                                       PR 57450
C                                                                    PR 57460
      XC(13)  =UWEIRS(AWEIRS)                                        PR 57480
C                                                                    PR 57490
      XC(17) = UCPAUP(PLSZMG)                                        PR 57510
C                                                                    PR 57520
      XC(20)=UCINSL(GPMO,DINTAK,TRAINS,ENPIPE,PIPELN)                PR 57540
C                                                                    PR 57550
      XC(24) = UCPLPF(PLSEA,GPMO,GPMP,PLPRD,TRAINS)                  PR 57570
C                                                                    PR 57580
      XC(25) = UCTRPF(PLSZMG,TRAINS,LEV,REJLEN)                      PR 57600
C                                                                    PR 57610
      XC(26) = UCBHPF(ENBH,GPMH,LEV)                                 PR 57630
C                                                                    PR 57640
      XC(27) = UCVNTD(GPMB+GPMP,PLSZMG)                              PR 57660
C                                                                    PR 57670
      GO TO (121,122),NFEED                                              ****
  121 CONTINUE                                                           ****
      XC(30) =(UCADCT(TNACDY,TRAINS)*TNACDY+UCAFSS(GPMB+GPMP,TRAINS)*    ****
     1(GPMB+GPMP)                                                        ****
     1         +UCCHLO(GPMO)*GPMO)/PLSZMG +UCPAUX(PLSZMG)                ****
      GO TO 123                                                          ****
  122 XC(30)=(UCAFSS(GPMB+GPMP,TRAINS)*(GPMB+GPMP)                       ****
     1         +UCCHLO(GPMO)*GPMO)/PLSZMG +UCPAUX(PLSZMG)                ****
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  123 CONTINUE                                                          ****
C                                                                       PR 57710
      XC(32) = UCI(PLSZMG,TRAINS)                                       PR 57730
C                                                                       PR 57740
      GO TO (130,140),NFEED                                             ****
  130 XC(36)=UCDEA(GPMB+GPMP,TRAINS)+UCDCR(GPMB+GPMP,TRAINS)            ****
      GO TO 150                                                         ****
  140 XC(36)=UCDEA(GPMB+GPMP,TRAINS)                                    ****
  150 XC(200)=UCSJAE(XO(205),TRAINS)                                    ****
C                                                                       PR 57770
      XC(40) = UCBHSH(BHSURF,BHVOL,1935.D0,6526.3D0)                    PR 57790
C                                                                       PR 57800
      XC(42)= UCSITS(ACRES)                                             PR 57820
C                                                                       PR 57830
      XC(43) = UCBLCR(PLSZMG)                                           PR 57850
C                                                                       PR 57860
                XC(45)=UNHEAC(TS)                                       PR 57880
C                                                                       PR 57890
      XC(46)= UFHEAC(TS)                                                ****
C                                                                       PR 57920
C                                                                       PR 57980
      XC(51) = 8.5D-7                                                   ****
C                                                                       PR 58040
      XC(52) = 7.05D-7                                                  ****
C                                                                       PR 58070
      XC(57) = UCCPAN(PLSZMG)                                           PR 58090
      XC(210)=.70D0                                                     ****
C                                                                       PR 58100
      IF(IFLIP .EQ. 0) GO TO 200                                        PR 58140
      IF(PROC .NE. MSF) GO TO 300                                       PR 58150
  200 CONTINUE                                                          PR 58160
C**                                                                     PR 58170
C****   COST FACTORS WHICH APPLY TO MSF PROCESS ONLY                    PR 58180
C**                                                                     PR 58190
      XC(1) = 1.849D0                                                   ****
C                                                                       PR 58220
      XC(2) = 2.552                                                     ****
C                                                                       PR 58250
      XC(3) = (UCSHET(TSTH,APTSE)*ENITSE +UCSHET(.5*TSTH,APTSE)*ENSUPE  PR 58270
     1        +UCSHET(3.0833*TSTH,APTSE)*2.*BNDLS*ENRSS                 ****
     2        +UCSHET(TSTH,APTSR)*ENITSR +UCSHET(.5*TSTH,APTSR)*ENSUPR  PR 58290
     3        +UCSHET(3.0833*TSTH,APTSR)*2.*ENRJS*BNDLS)/TSAREA         ****
C                                                                       PR 58310
      XC(4) = ((UCDRIL(TSTH,DOE)*ENITSE +UCDRIL(.5*TSTH,DOE)*ENSUPE     PR 58330
     1        +UCDRIL(3.0833*TSTH,DOE)*2.*ENRSS*BNDLS)*ENE/BNDLS        ****
     2        +(UCDRIL(TSTH,DOR)*ENITSR +UCDRIL(.5*TSTH,DOR)*ENSUPR     PR 58350
     3        +UCDRIL(3.0833*TSTH,DOR)*2.*ENRJS*BNDLS)*RNR/BNDLS)/HOLES ****
C                                                                       PR 58370
      TX=2.*ENRSS                                                       ****
      TY=2.*ENRJS                                                       ****
      XC(5) = (UCTSIN(TSTH,APTSE,940.D0,ENITSE)*ENITSE                  PR 58390
     1        +UCTSIN(.5*TSTH,APTSE,937.D0,ENSUPE)*ENSUPE               PR 58400
     2        +UCTSIN(3.0833*TSTH,APTSE,80.0D0,TX*BNDLS)*TX*BNDLS       ****
     3        +UCTSIN(TSTH,APTSR,20.D0,ENITSR)*ENITSR                   PR 58420
     4        +UCTSIN(.5*TSTH,APTSR,256.D0,ENSUPR)*ENSUPR               PR 58430
     5        +UCTSIN(3.0833*TSTH,APTSR,40.D0,TY*BNDLS)*TY*BNDLS)/TSAREA ****
C                                                                       PR 58450
      XC(6) = (UCTUIN(116.86D6,ELE*ENE)*ELE*ENE                         PR 58470
     1        +UCTUIN(7.536D6,RLR*RNR) *RLR*RNR)/(ELE*ENE+RLR*RNR)      PR 58480
C                                                                       PR 58490
      XC(7) = (UCDRIL(3.0833*TSTH,DOE)*TX*ENE                           PR 58510
     1        +UCDRIL(3.0833*TSTH,DOR)*TY*RNR)/(ENE+RNR)                PR 58520
C                                                                       PR 58530
      XC(15)=(UCPUMP(GPMO/TRAINS,HDEL)*GPMO                             PR 58550
     1        +UCPUMP(GPMR/TRAINS,HREC)*GPMR                            PR 58560
     2        +UCPUMP(GPMP/TRAINS,HPR) *GPMP                            PR 58570
     3        +UCPUMP(GPMB/TRAINS,HBL) *GPMB                            PR 58580
     4        +UCPUMP(GPMD/TRAINS,HDEA)*GPMD)/                          PR 58590
     5        (GPMO+GPMR+GPMP+GPMB+GPMD)                                PR 58600
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C                                                                       PR 58610
      XC(16)  =(UCMOTR(HPDEL,RPMD)*HPDEL +UCMOTR(HPREC,RPMR)*HPREC      PR 58630
     1          +UCMOTR(HPPRD,RPMP)*HPPRD +UCMOTR(HPBLD,RPMB)*HPBLD     PR 58640
     2        +UCMOTR(HPDEA,RPMM)*HPDEA)/(HPDEL+HPREC+HPPRD+HPBLD+HPDEA) PR 58650
C                                                                       PR 58660
      XC(18) =UCPPIT(GPMR+GPMP+GPMB+GPMD)                               PR 58680
C                                                                       PR 58690
                GPMM1 = DMAX1(1.D0,GPMO-GPMD)                           PR 58710
      XC(23) =(UCVALV(GPMO/TRAINS)*GPMO +UCVALV(GPMD/TRAINS)*GPMD       PR 58720
     1          +2.*UCVALV(GPMR/TRAINS)*GPMR +UCVALV(GPMM1/TRAINS)*GPMM1 PR 58730
     2          +2.*UCVALV(GPMB/TRAINS)*GPMB                            PR 58740
     3         +3.*UCVALV(GPMP/TRAINS)*GPMP +2.*UCVALV(GPMH/ENBH)*GPMH) PR 58750
     4         /(2.*(GPMO+GPMR+GPMB+GPMH) +3.*GPMP)                     PR 58760
C                                                                       PR 58770
      XC(34) = 1.D-3*UCEDK(PO,TRAINS)                                   PR 58790
C                                                                       PR 58800
      XC(38)= 2.552                                                       ****
C                                                                       PR 58830
      HLH = AH/(HNH*PI*DOH/12.)                                           ****
      ENSUPH=.15*HLH*ENBH/DOH                                             ****
      XC(215)=UCSHET(3.0833*TSTH,APTSH)*2.*ENBH+                          ****
     1 UCSHET(0.5*TSTH,APTSH)*ENSUPH                                      ****
      XC(216)=(UCDRIL(3.0833*TSTH,DOH)*2.+                                ****
     1 UCDRIL(0.5*TSTH,DOH )*ENSUPH/ENBH)*HNH                             ****
      XC(217)=UCTSIN(3.0833*TSTH,APTSH,100.D0,2.*ENBH)*2.*ENBH+           ****
     1 UCTSIN(0.5*TSTH,APTSH,1000.D0,ENSUPH)*ENSUPH                       ****
      XC(218)=UCTUIN(100.D6,HNH*HLH)*HNH*HLH                              ****
      XC(219)=UCDRIL(3.0833*TSTH,DOH )*HNH*2.                             ****
      XC(39)=(XC(215)+XC(216)+XC(217)+XC(218)+XC(219))/AH                 ****
      RETURN                                                            PR 58870
  300 CONTINUE                                                          PR 58890
C**                                                                     PR 58900
C****    COST FACTORS WHICH APPLY TO VTE PROCESS ONLY                   PR 58910
C**                                                                     PR 58920
      XC(63) = 3.776D0                                                    ****
C                                                                       PR 58950
      XC(64) = UCSHET(1.D0,1.D0)                                        PR 58970
C                                                                       PR 58980
      XC(65) = UCDRIL(1.D0,ODVE)                                        PR 59000
C                                                                       PR 59010
      XC(66) = UCTUIN(2.614D6,TOTNVE*LVE)                               PR 59030
C                                                                       PR 59040
      XC(67) = 2.*UCTSIN(1.D0,VETSA/(2.*ANE*TRAINS),60.D0,2.*ANE*TRAINS)PR 59060
C                                                                       PR 59070
      XC(68) = 1.899D0                                                    ****
C                                                                       PR 59100
      XC(69) = (UCTUIN(116.86D6,LPH*NTPH)*LPH*NTPH                      PR 59120
     1          +UCTUIN(7.536D6,LCON*NCON)*LCON*NCON)/                  PR 59130
     2          (LPH*NTPH + LCON*NCON)                                  PR 59140
C                                                                       PR 59150
      TX=2.*ENRSS
      XC(70) =(UCSHET(TSTH,APTSEP)*ENITSE +UCSHET(.5*TSTH,APTSEP)*ENSUPEPR 59170
     1         +UCSHET(3.0833*TSTH,APTSEP)*TX*BNDLS                     PR 59180
     2         +UCSHET(.5*TSTH,APTSCN)*ENSUPR                           PR 59190
     3         +UCSHET(3.0833*TSTH,APTSCN)*2.*TRAINS)/TSAREA            PR 59200
C                                                                       PR 59210
      XC(71) =((UCDRIL(TSTH,ODPH)*ENITSE +UCDRIL(.5*TSTH,ODPH)*ENSUPE   PR 59230
     1          +UCDRIL(3.0833*TSTH,ODPH)*TX*BNDLS)*NTPH/BNDLS          PR 59240
     2         +(UCDRIL(.5*TSTH,ODCON)*ENSUPR                           PR 59250
     3          +UCDRIL(3.0833*TSTH,ODCON)*2.*TRAINS)*NCON/TRAINS )/HOLESPR 59260
C                                                                       PR 59270
      XC(72) = (UCTSIN(TSTH,APTSEP,940.D0,ENITSE)*ENITSE                PR 59290
     1          +UCTSIN(.5*TSTH,APTSEP,937.D0,ENSUPE)*ENSUPE            PR 59300
     2          +UCTSIN(3.0833*TSTH,APTSEP,40.D0,TX*BNDLS)*TX*BNDLS     PR 59310
     3          +UCTSIN(.5*TSTH,APTSCN,256.D0,ENSUPR)*ENSUPR            PR 59320
     4          +UCTSIN(3.0833*TSTH,APTSCN,40.D0,2.*TRAINS)*2.*TRAINS)  PR 59330
     5          /TSAREA                                                 PR 59340
C                                                                       PR 59350
      XC(73) = (UCDRIL(3.0833*TSTH,ODPH)*NTPH                           PR 59370
     1          +UCDRIL(3.0833*TSTH,ODCON)*NCON)/(NTPH +NCON)           PR 59380
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C                                                                       PR 59390
      XC(74) = 2.552                                                      ****
C                                                                       PR 59420
      XC(126) = 2.552                                                     ****
C                                                                       PR 59450
      XC(34) = 1.D-3*UCEDK(PO,TRAINS)                                   PR 59470
      XC(127) = XC(34)+54.*POVE/PO*(VEPMPS/60.)**.1                     PR 59480
C                                                                       PR 59490
      XC(128) = (UCPUMP(GPMO/TRAINS,HSEA)   *GPMO                       PR 59510
     1           +UCPUMP(GPMR/TRAINS,HFEED) *GPMR                       PR 59520
     2           +UCPUMP(GPMP/TRAINS,HPR)   *GPMP                       PR 59530
     3           +UCPUMP(GPMB/TRAINS,HBL)   *GPMB                       PR 59540
     4           +UCPUMP(GPMD/TRAINS,HDEA)  *GPMD                       PR 59550
     5           +UCPUMP(GPMV/VEPMPS,HVE)   *GPMV)                      PR 59560
     6           /(GPMO +GPMR +GPMP +GPMB +GPMD +GPMV)                  PR 59570
C                                                                       PR 59580
      XC(16)  =(UCMOTR(HPDEL,RPMD)*HPDEL +UCMOTR(HPREC,RPMR)*HPREC      PR 59600
     1         +UCMOTR(HPPRD,RPMP)*HPPRD +UCMOTR(HPBLD,RPMB)*HPBLD      PR 59610
     2        +UCMOTR(HPDEA,RPMM)*HPDEA)/(HPDEL+HPREC+HPPRD+HPBLD+HPDEA) PR 59620
      XC(129) = (XC(16)*(HPDEL+HPREC+HPPRD+HPBLD+HPDEA)*TRAINS          PR 59630
     1           +UCMOTR(HPVE,RPMV)*HPVE*VEPMPS)                        PR 59640
     2           /((HPDEL+HPREC+HPPRD+HPBLD+HPDEA)*TRAINS+HPVE*VEPMPS)  PR 59650
C                                                                       PR 59660
      XC(130) = UCPPIT(GPMV+GPMR+GPMP+GPMB+GPMD)                        PR 59680
C                                                                       PR 59690
                 GPMM1 = DMAX1(1.D0,GPMD-.2*GPMR)                       PR 59710
      XC(23) =(UCVALV(GPMO/TRAINS)*GPMO +UCVALV(GPMD/TRAINS)*GPMD       PR 59720
     1         +2.*UCVALV(GPMR/TRAINS)*GPMR +UCVALV(GPMM1/TRAINS)*GPMM1 PR 59730
     2         +2.*UCVALV(GPMB/TRAINS)*GPMB                             PR 59740
     3        +3.*UCVALV(GPMP/TRAINS)*GPMP +2.*UCVALV(GPMH/ENBH)*GPMH)  PR 59750
     4        /(2.*(GPMO+GPMR+GPMB+GPMH) +3.*GPMP)                      PR 59760
      XC(131) = (XC(23)*(2.*(GPMO+GPMR+GPMB+GPMH)+3.*GPMP)              PR 59770
     1           +UCVALV(GPMM1/TRAINS)*GPMM1                            PR 59780
     2           +UCVALV(GPMV/VEPMPS)*GPMV)                             PR 59790
     3           /(2.*(GPMO+GPMB+GPMH)+3.*GPMP+1.8*GPMR+GPMV)           PR 59800
C                                                                       PR 59810
      XC(132) = 2.46D4*(SUMWT/VEPMPS *60./6.45D8 *OVRHGT/32.845)**.8    PR 59830
C                                                                       PR 59840
      ENSUPH=.15*HLH*ENBH/DOH                                             ****
      XC(215)=UCSHET(3.0833*TSTH,APTSH)*2.*ENBH+                          ****
     1 UCSHET(0.5*TSTH,APTSH)*ENSUPH                                      ****
      XC(216)=(UCDRIL(3.0833*TSTH,ODBH)*2.+                               ****
     1 UCDRIL(0.5*TSTH,ODBH)*ENSUPH/ENBH)*NBH                             ****
      XC(217)=UCTSIN(3.0833*TSTH,APTSH,100.D0,2.*ENBH)*2.*ENBH+           ****
     1 UCTSIN(0.5*TSTH,APTSH,1000.D0,ENSUPH)*ENSUPH                       ****
      XC(218)=UCTUIN(100.D6,NBH*LBH)*LBH*NBH                              ****
      XC(219)=UCDRIL(3.0833*TSTH,ODBH)*NBH*2.                             ****
       XC(133)=(XC(215)+XC(216)+XC(217)+XC(218)+XC(219))/ABH              ****
      XC(220)=2.D0                                                        ****
      XC(221)=15000.D0                                                    ****
C                                                                       PR 59870
  400 RETURN                                                            PR 60800
      END                                                               PR 60810
```

APPENDIX J

CHANGES MADE IN SUBROUTINE COSTM

```
      SUBROUTINE COSTM                                                PR 22740
      IMPLICIT REAL*8(A-H,O-Z)                                        PR 22750
C                                                                     PR 22760
      DOUBLE PRECISION MODU                                           PR 22770
      DOUBLE PRECISION LEV,LF2                                        PR 22780
C                                                                     PR 22790
      COMMON/BLOCM1/     DIE,       DIH,       DIR,       DOE,        DOH,PR 22800
     1       DOR,       ELE,       ENE,       RLR,       RNR,        HDEL,PR 22810
     2      HREC,     APTSR,    ENITSR                                    PR 22820
      COMMON/BLOCM2/       P,         Q,        AH,        AK,         AN,PR 22830
     1        AR,        FF,        GE,        GH,        GR,         HD,PR 22840
     2        PB,        PE,     QX(5),        RP,        SE,         SH,PR 22850
     3        SR,        TK,        VE,        VH,        VR,         WC,PR 22860
     4       AME,       ATN,    BPX(5),       CCF,       HIH,        HLH,PR 22870
     5       HNH,       HOH,    OMX(5),       PHE,       PO3,        RSE,PR 22880
     6       RSH,       RSR,       TC1,       THF,    TKX(5),        TMC,PR 22890
     7       TME,       TPE,    UEX(5),       UME,       UMH,        WPL,PR 22900
     8      BKTE,      BKTH,      BKTR,   DTLS(5),   ELEX(5),    HIEX(5),PR 22910
     9   HOEX(5),      MODU,      ROE1,      ROE2,     APTSE,      BDEPH,PR 22920
     +     CAPI1,     HEADE,     HEADH,     HEADR,     POBLD,      PODEL,PR 22930
     A     POPRD,  SUBEX(5),     WCOLD,     WMODC,     WMODH,     BHSHEL,PR 22940
     B    CSLTBH,    CSLTBP,    HOTLEN,    HRECOV,    HREJCT,     RECOLN,PR 22950
     C    VAPSPC,    WPRTRY,     POREC                                    PR 22960
      COMMON/BLOCM3/      EA,        ES,       CC1,       CC2,        EA1,PR 22970
     1       EA2,       EEC,       HC1,       HC2,       OC1,        OC2,PR 22980
     2       PMC,       TC2,       VPC,      BHC1,      BHC2,       CIBC,PR 22990
     3      DEA1,      DEA2,      EEC1,      EEC2,      PMC1,       PMC2,PR 23000
     4      SITE,      SMAP,      VPC1,      VPC2,      WAIT,      AMSC1,PR 23010
     5     AMSC2,     CAPI2,     CAPI3,     CAPI4,     CIBC1,      CIBC2,PR 23020
     6     SITE1,     SITE2,     WAIT1,     WAIT2,    CHMPTC,     CHMPT1,PR 23030
     7    CHMPT2,    CINSTC,    CINST1,    CINST2,    DEACST,     POCST1,PR 23040
     8    POCST2,    RATEIN,    RETUB1,    RETUB2,    SMAPPH,     SMAPPP,PR 23050
     9        CD,       BHC,       ES1,       ES2                         PR 23060
      COMMON/COMNAM/      AJ,        CB,        CO,        CP,        CR, PR 23070
     1        HB,        PI,        PC,        TB,        TO,        TP, PR 23080
     2        TS,        WB,        WF,        WO,        WP,        WR, PR 23090
     3       AXJ,       HBL,       HPR,       LEV,       LF2,       TCF, PR 23100
     4      ENBH,      GPMB,      GPMD,      GPMH,      GPMO,      GPMP, PR 23110
     5      GPMR,      HDEA,      RPMB,      RPMD,      RPMH,      RPMP, PR 23120
     6      RPMR,      TSTH,      WHOT,      YEAR,     ACRES,     BHVOL, PR 23130
     7     BLDGS,     BNDLS,     HOLES,     HPBLD,     HPDEA,     HPDEL, PR 23140
     8     HPPRD,     HPREC,     PLPRD,     PLSEA,     PODEA,    ACNCEW, PR 23150
     9    ACNCFL,    ACNCIW,    ACNCPH,    ACNCRF,    ACNCTR,    AEXCAV, PR 23160
     +    ASTLEW,    ASTLFL,    ASTLIW,    ASTLPH,    ASTLRF,    ASTLTR, PR 23170
     A    AWEIRS,    BHSURF,    DINTAK,    ENITSE,    ENPIPE,    ENSUPE, PR 23180
     B    ENSUPR,    PIPELN,    PLSZMG,    REJLEN,    STLLEN,    STLTMP, PR 23190
     C    TNACDY,    TRAINS,    TSAREA,    VOLCNC,    VOLSTL,    WOCEAN  PR 23200
       COMMON/BLOCK6/ FC                                              PR 23210
      COMMON/BLOC13/ XO                                               PR 23220
       COMMON/BLOC14/ XC                                              PR 23230
      COMMON/SHARE/ IFLIP, ISPOT                                      PR 23240
C                                                                     PR 23250
      DIMENSION XC(300)                                               PR 23260
      DIMENSION XC(500), FC(500)                                      PR 23270
C                                                                     PR 23280
      EQUIVALENCE   (AE,AME)                                          PR 23290
      EQUIVALENCE (SMAP,SSMAP),(AJ,ASJ),(RATEIN,RTEIN)                PR 23300
      DATA PROC/'MSF'/                                                PR 23310
C                                                                     PR 23320
      CALL PRICES(PROC)                                               PR 23330
      DO 100 J=1,300                                                    ****
      XC(J) = XC(J) * FC(J)                                           PR 23350
  100 CONTINUE                                                        PR 23360
C                                                                     PR 23370
      IF(IFLIP .GT. 1) GO TO 120                                      PR 23380
```

```
C**          SMALL PLANT COST FACTORS
      FEA = .892738D0*(FF/10.)**(-.133287D-1)
      FES = .102442D1*(FF/10.)**(.273939D0)
      FPMC = .112693D1*(FF/10.)**(-.268731D-1)
      FVPC = .141143D1*(FF/10.)**(-.104263D0)
      FCHMPT = .603586D0*(FF/10.)**(.309530D0)
      FINSTC = .943099D0*(FF/10.)**(-.716862D0)
      FEEC = .974915D0*(FF/10.)**(.105992D-1)
      FDEA = .175801D1*(FF/10.)**(-.361163D0)
      FBHC = .952672D0*(FF/10.)**(.235263D0)
C**          TUBING REPLACEMENT FACTORS
      CALL TUBREP(WPL,CSLTBP,XC(60),SMAPPP)
      CALL TUBREP(WPL,CSLTBH,XC(60),SMAPPH)
  120 CONTINUE
C****
C              CALCULATE COST OF COMPONENTS,  $ - DIRECT
C**
         TSHETS = XC(3) *TSAREA + XC(4)*HOLES + XC(5)*TSAREA
         TUBING = XC(1)*AME + XC(2)*AR + XC(6)*(ELE*ENE+RLR*RNR)
     1           + XC(7)*(ENE+RNR)
      EA = TSHETS + TUBING
      ES = XC(9) * VOLSTL +XC( 10)*VOLCNC +XC( 11)*(ASTLFL+ACNCFL)
     1    +XC( 12)*FF +XC( 13)*AWEIRS
      PUMPS = XC(15)*(GPMO+GPMR+GPMP+GPMB+GPMD)
      PMOTR = XC(16)*(HPDEL+HPREC+HPPRD+HPBLD+HPDEA)*TRAINS
      PTAUX = XC(17)*FF +XC(18)*(GPMR+GPMP+GPMB+GPMD)
      PMC = PUMPS+PMOTR +PTAUX
      WAIT =XC(20)*GPMO
      VALVES = XC(23)*(2.*(GPMO+GPMR+GPMB+GPMH)+3.*GPMP)
      PLNTPF = XC(24)*GPMO
      TRANPF = XC(25)*TRAINS
      BHTRPF = XC(26)*GPMH
      VPC = VALVES +PLNTPF +TRANPF +BHTRPF +XC(27)*(GPMB+GPMP)
      CHMPTC = XC(30)*FF
      IF(FF .GT. XO(80)) CHMPTC = CHMPTC+XC(29)*TNACDY
      CINSTC = XC(32)*FF
      EEC = XC(34)*PO*1.D3
      DEACST =XC(36)*(GPMB+GPMP)+XC(200)*XO(205)
        BHTUB = (XC(38) + XC(39))*AH
        BHSHEL = XC(40)*BHSURF*ENBH
      BHC = BHTUB + BHSHEL
      SITE = (XC(31)+XC(42))*ACRES
      CIBC  = XC(43)*FF
      IF(FF .GT. XO(82)) GO TO 130
C          CORRECT CAPITAL COSTS TO SMALL PLANT RANGE
      EA = EA*FEA
      ES = ES*FES
      PMC = PMC*FPMC
      VPC = VPC*FVPC
      CHMPTC = CHMPTC*FCHMPT
      CINSTC = CINSTC*FINSTC
      EEC = EEC*FEEC
      DEACST = DEACST*FDEA
      BHC = BHC*FBHC
  130 CONTINUE
C
C              DIRECT CAPITAL COST, MILLIONS OF $
      CD=1.D-6*(EA+ES+PMC+WAIT+VPC+CHMPTC+CINSTC
     1      +EEC+DEACST+BHC+SITE+CIBC)
C****
C              CALCULATE HIGHER COST FACTOR
C**
      AXJ = 1.D0
      CALL FNANCE(CD,ASJ,SSMAP,PSAJ,RTEIN,AJBR,WPL,YEAR)
      IF(FF .GT. XO(82)) GO TO 200
C              ADD SUPPLIERS BURDEN FOR SMALL PLANTS
      AXJ = ASJ/(AJBR*1.06995)
      EA = EA*AXJ
      ES = ES*AXJ
      PMC = PMC*AXJ
```

```
      WAIT = WAIT*AXJ
      VPC = VPC*AXJ
      CHMPTC = CHMPTC*AXJ
      CINSTC = CINSTC*AXJ
      EEC = EEC*AXJ
      DEACST = DEACST*AXJ
      BHC = BHC*AXJ
      SITE = SITE*AXJ
      CIBC = CIBC*AXJ
      CD=1.D-6*(EA+ES+PMC+WAIT+VPC+CHMPTC+CINSTC
     1      +EEC+DEACST+BHC+SITE+CIBC)
      ASJ = AJBR
      PSAJ = SSMAP*ASJ
  200 CONTINUE
C
C              DIRECT + INDIRECT CAPITAL, $
      CAPI1 = CD *1.0D6 * ASJ
C              SPECIFIC INVESTMENT, $/GPD
      CAPI2 = CAPI1/(FF*1D6)
C****
C              CALCULATE COST OF COMPONENTS, $/YEAR
C**
      EA2 = EA*PSAJ
      ES2 = ES *  PSAJ
      PMC2 = PMC * PSAJ
      WAIT2 = WAIT*PSAJ
      VPC2 = VPC * PSAJ
      CHMPT2 = CHMPTC * PSAJ
      CINST2 = CINSTC * PSAJ
      EEC2 = EEC * PSAJ
      DEA2 = DEACST * PSAJ
      BHC2 = BHC * PSAJ
      SITE2 = SITE * PSAJ
      CIBC2 = CIBC * PSAJ
      RETUB2 = EA*SMAPPP + BHTUB*SMAPPH
C****
C              CALCULATE COST OF COMPONENTS, CENTS/KGAL
C**
      CFG = .365*LF2 *FF *1D4
C
      EA1 = EA2/CFG
      ES1 = ES2/CFG
      PMC1 = PMC2/CFG
      WAIT1 = WAIT2/CFG
      VPC1 = VPC2/CFG
      CHMPT1 = CHMPT2/CFG
      CINST1 = CINST2/CFG
      EEC1 = EEC2/CFG
      DEA1 = DEA2/CFG
      BHC1 = BHC2/CFG
      SITE1 = SITE2/CFG
      CIBC1 = CIBC2/CFG
      RETUB1 = RETUB2/CFG
C
C              COST OF CAPITAL ITEMS, CENTS/KGAL
      CAPI3 = EA1+ES1+PMC1+WAIT1+VPC1+CHMPT1+CINST1+EEC1+DEA1+BHC1+SITE1
     1      +CIBC1
C              COST OF CAPITAL ITEMS, $/YEAR
      CAPI4 = CAPI3*CFG
C****
C              CALCULATE OPERATING COSTS
C**
C                OPERATING COSTS, $/YEAR
      HC2 = 8.76*LF2*WP/RP*XC(45)
      IF(FF .LT. XO(81)) HC2 = HC2*XC(46)/XC(45)
      ACID = 365.*LF2*TNACDY*XC(49)
      IF(FF .LE. XO(80)) ACID = ACID*XC(48)/XC(49)
      CLORIN = 8760.*WOCEAN*LF2*XC(50)
      CAUSTC = 8760.*(WB+WP)*LF2*XC(51)
      DEFOM = 8760.*(WB+WP)*LF2*XC(52)
```

```
      CC2 = ACID + CLORIN + CAUSTC + DEFOM                              PR 24790
      POCST2=8760.*LF2*PO*XC(54)*1000.                                    ****
      IF(FF .LT. XO(81)) POCST2 = POCST2*XC(55)/XC(54)                  PR 24810
      OC2 = XC(57)*FF                                                   PR 24820
      AMSC2 = XC(58) * CAPI1                                            PR 24830
C                                                                       PR 24840
C                 CPERATING COSTS, CENTS/KGAL                           PR 24850
      HC1 = HC2/CFG                                                     PR 24860
      CC1 = CC2/CFG                                                     PR 24870
      POCST1 = POCST2/CFG                                               PR 24880
      OC1 = OC2/CFG                                                     PR 24890
      CC1=CC1+WB/WP                                                       ****
C    ALLOWS 1 CENT/KGAL FOR REMOVING COPPER IONS FORM BRINE               ****
      CC2=CC1*CFG                                                         ****
      AMSC1 = AMSC2/CFG                                                 PR 24900
C                                                                       PR 24910
C               COST OF PRODUCT WATER, CENTS/KGAL                       PR 24920
      XC(211)=8760.*LF2*XO(206)*XC(210)                                   ****
      XC(212)=XC(211)/CFG                                                 ****
      TC1 = CAPI3 +AMSC1+POCST1+HC1+OC1+CC1+RETUB1                      PR 24930
     1 +XC(212)                                                           ****
C               COST OF PRODUCT WATER, $/YEAR                           PR 24940
      TC2 = TC1 * CFG                                                   PR 24950
C****                                                                   PR 24960
      RETURN                                                            PR 24970
      END                                                               PR 24980
```

APPENDIX K

CHANGES MADE IN SUBROUTINE COSTV

```
      SUBROUTINE COSTV
C*****
C         COST VARIABLES ARE OF THE FORM, 'NAME*', WHERE
C         * = Y FOR COST $/YEAR,
C         * = K FOR COST, CENTS/KGAL,
C         * = D FOR COST $ - DIRECT
C*****
C*****
      IMPLICIT REAL*8(A-H,O-Z)
C
      DOUBLE PRECISION    LPH,    LVE,    IDBH,    IDPH,    LCON,    NCON,
     1  NTPH,  IDCON
      DOUBLE PRECISION    KBH,    KPH,    KVE,    LBH,    MGD,    NBH,
     1    NPH,    NVE,   KCON,   LMTD,   LVEP, LMTDBH, LMTDCN
      DOUBLE PRECISION    INT, INSTRD, INSTRK, INSTRY, MAINTK, MAINTY
      DOUBLE PRECISION LEV,LF2
C
      COMMON/BLOCV1/    ANE,        HVE,        LPH,        LVE,       ACON,
     1      GPMV,      HPVE,       HSEA,       IDBH,       IDPH,       LCON,
     2      NCON,      NTPH,       ODBH,       ODPH,       ODVE,       POVE,
     3      RPMV,     HFEED,      IDCON,      ODCON,      SUMWT,      VETSA,
     4    APTSCN,    APTSEP,     OVRHGT,     TOTNVE,     VEPMPS
      COMMON/BLOCV2/  A(30),          S,     AE(30),         QE,     TC(30),
     1    TE(30),        TR,     UE(30),      UH(3),         WM,     WT(30),
     2       ABH,       APH,    BPE(30),    CIE(30),    COE(30),    OPE(30),
     3       ELL,       GBH,        GPH,        GPM,        HOO,        KBH,
     4       KPH,       KVE,        LBH,        MGD,        NBH,        NPH,
     5   NVE(30),       QPH,        RBH,        RPH,        RVE,        TOO,
     6       UBH,       VBH,        VPH,   WPEX(30),       BHLF,       GCON,
     7      HIBH,   HIPH(3),       HOBH,    HOPH(3),       KCON,    LMTD(3),
     8      LVEP,      PHLF,    QMSF(3),       RCON,    SUBF(3),       TCON,
     9      UCON,      VCON,       VLEN,       VTLF,   WDTH(30), ALFAE(30),
     +    CONLF,     HICON,      HOCON,      HOTEL,      PHHGT,      POBLO,
     A     POPRO,     POSEA,      SURFF,      VEHGT,      WALVE,     EFFSPC,
     BELBNDL(30),   HCOTCF,     HCOTOO,     HEADBH,     HEADCN,     HEADPH,
     C    LMTDBH,    LMTDCN,     PLNTLF,     PODEAS,     POFEED,     SUMWPE,
     D    SUMWPH,    TOTAVE,       QESP,VEFEED(30),     WBOOST,     WDCOLD,
     E        NE,      NTRN,      IFEED,     IRECYC
      COMMON/BLOCV3/    BHD,        BHK,        BHY,        INT,        PMD,
     1       PMK,       PMY,        VPD,        VPK,        VPY,       ACHR,
     2      DEAD,      DEAK,       DEAY,       ELEC,       HEAT,       SBCD,
     3      SBCK,      SBCY,      CHEMK,      CHEMY,      HEATK,      HEATY,
     4     OPERK,     OPERY,      PLDIN,      WAITD,      WAITK,      WAITY,
     5    ANCCMP,    CMCAPD,     CMCAPK,     CMCAPY,     CNDSRD,     CNDSRK,
     6    CNDSRY,    ELECTD,     ELECTK,     ELECTY,     INSTRD,     INSTRK,
     7    INSTRY,    MAINTK,     MAINTY,     PHTUBD,     PHTUBK,     PHTUBY,
     8    PLCAPD,    PLCAPK,     PLCAPY,     POWERK,     POWERY,     RETUBK,
     9    RETUBY,    SHELLD,     SHELLK,     SHELLY,     TOTALK,     TOTALY,
     +    TOTOPK,    TOTOPY,     TREPBH,     TREPCN,     TREPPH,     TREPVE,
     A    VETUBD,    VETUBK,     VETUBY,       CGPD
      COMMON/COMNAM/     AJ,         CB,         CO,         CP,         CR,
     1        HB,        PI,         PO,         TB,         TO,         TP,
     2        TS,        WB,         WF,         WO,         WP,         WR,
     3       AXJ,       HBL,        HPR,        LEV,        LF2,        TCF,
     4      ENBH,      GPMB,       GPMD,       GPMH,       GPMO,       GPMP,
     5      GPMR,      HDEA,       RPMB,       RPMD,       RPMH,       RPMP,
     6      RPMR,      TSTH,       WHOT,       YEAR,      ACRES,      BHVOL,
     7     BLDGS,     BNDLS,      HOLES,      HPBLD,      HPDEA,      HPDEL,
     8     HPPRD,     HPREC,      PLPRD,      PLSEA,      PODEA,     ACNCEW,
     9    ACNCFL,    ACNCIW,     ACNCPH,     ACNCRF,     ACNCTR,     AEXCAV,
     +    ASTLEW,    ASTLFL,     ASTLIW,     ASTLPH,     ASTLRF,     ASTLTR,
     A    AWEIRS,    BHSURF,     DINTAK,     ENITSE,     ENPIPE,     ENSUPE,
     B    ENSUPR,    PIPELN,     PLSZMG,     REJLEN,     STLLEN,     STLTMP,
     C    TNACDY,    TRAINS,     TSAREA,     VOLCNC,     VOLSTL,     WOCEAN
      COMMON/BLOCK6/ FC
```

```
      COMMON/BLOC13/ XO
      COMMON/BLOC14/ XC
      COMMON/SHARE/ IFLIP, ISPOT
C
      DIMENSION XC(300)
      DIMENSION XC(500), FC(500)
      DATA PROC/'VTE'/
C*****
      PLF = LF2
      CALL PRICES(PROC)
      DO 105 I=1,300
  105 XC(I) = XC(I)*FC(I)
C
      IF(IFLIP .GT. 1) GO TO 106
      INT = XC(60)
      FF = MGD
C**          SMALL PLANT COST FACTORS
      FEA = .892738D0*(FF/10.)**(-.133287D-1)
      FES = .102442D1*(FF/10.)**(.273939D0)
      FPMC = .112693D1*(FF/10.)**(-.268731D-1)
      FVPC = .141143D1*(FF/10.)**(-.104263D0)
      FCHMPT = .603586D0*(FF/10.)**(.309530D0)
      FINSTC = .943099D0*(FF/10.)**(-.716862D0)
      FEEC = .974915D0*(FF/10.)**(.105992D-1)
      FDEA = .175801D1*(FF/10.)**(-.361163D0)
      FBHC = .952672D0*(FF/10.)**(.235263D0)
C         TUBING REPLACEMENT FACTOR
      CALL TUBREP(PLNTLF,VTLF,INT,TREPVE)
      CALL TUBREP(PLNTLF,PHLF,INT,TREPPH)
      CALL TUBREP(PLNTLF,CONLF,INT,TREPCN)
      CALL TUBREP(PLNTLF,BHLF,INT,TREPBH)
  106 CONTINUE
C*****
C         CALCULATE COST OF COMPONENTS, $ - DIRECT
      VETUBD = XC(63)*TOTAVE +XC(64)*VETSA +XC(65)*4.*TOTNVE
     *+XC(220)*TOTNVE
     1          +XC(66)*TOTNVE*LVE +XC(67)*TRAINS*ANE
      PHTUBD = XC(68)*APH +XC(69)*LPH*NTPH +(XC(70)+XC(72))*(ENITSE
     1           +ENSUPE+2.*BNDLS)*APTSEP +XC(71)*(NPH+1.)*NTPH
     2           +XC(73)*2.*NTPH
      SHELLD = XC(9)*VOLSTL +XC(10)*VOLCNC +XC(11)*AEXCAV +XC(12)*MGD
     1          +XC(13)*AWEIRS
      PUMPSD = XC(128)*(GPMO +GPMR +GPMP +GPMB +GPMD +GPMV)
      PMTRSD = XC(129)*((HPDEL +HPREC +HPPRD +HPBLD +HPDEA)*TRAINS
     1          +HPVE*VEPMPS)
      PTAUXD = XC(17)*MGD + XC(130)*(GPMR +GPMP +GPMV +GPMB +GPMD)
      PMD = PUMPSD +PMTRSD +PTAUXD
      WAITD = XC(20)*GPMO
      VALVD = XC(131)*(2.*(GPMO+GPMB+GPMH)+3.*GPMP+1.8*GPMR+GPMV)
      EFFPD = XC(132)*ANE*TRAINS
      PLNTPD = XC(24)*GPMO
      TRANPD = XC(25)*TRAINS
      BHTRPD = XC(26)*GPMH
      VENTPD = XC(27)*(GPMB+GPMP)
      VPD  = VALVD +EFFPD +PLNTPD +TRANPD +BHTRPD +VENTPD
      CMCAPD = XC(30)*MGD
      IF(MGD .GT. XO(80)) CMCAPD = CMCAPD +XC(29)*TNACDY
      DEAD = XC(36)*(GPMP+GPMB)+XC(200)*XO(205)
      CNDSRD = XC(74)*ACON +XC(69)*LCON*NCON +(XC(70)+XC(72))*(ENSUPR
     1         +2.*TRAINS)*APTSCN +XC(71)*(ENSUPR *NCON/TRAINS+2.*NCON)
     2         +XC(73)*2.*NCON
      BHD = (XC(133)+XC(126))*ABH +XC(40)*BHSURF*ENBH
      INSTRD = XC(32)*MGD
     * +XC(221)*TRAINS*ANE
      ELECTD = XC(127)*PO*1.D3
      SBCD = (XC(31)+XC(42))*ACRES+XC(43)*MGD
      IF(MGD .GT. XO(82)) GO TO 108
C         CORRECT CAPITAL COSTS TO SMALL PLANT RANGE
      VETUBD = VETUBD*FEA
      PHTUBD = PHTUBD*FEA
```

```
      SHELLD = SHELLD*FES
      PMD = PMD*FPMC
      VPD = VPD*FVPC
      CMCAPD = CMCAPD*FCHMPT
      DEAD = DEAD*FDEA
      CNDSRD = CNDSRD*FEA
      BHD = BHD*FBHC
      INSTRD = INSTRD*FINSTC
      ELECTD = ELECTD*FEEC
  108 CONTINUE
C
C*****    DIRECT CAPITAL COST OF PLANT
      PLCAPD = VETUBD +PHTUBD +SHELLD +PMD +WAITD +VPD +CMCAPD +DEAD
     1        +CNDSRD +BHD    +INSTRD +ELECTD     +SBCD
      DC     = PLCAPD*1.D-6
C*****
C*****
C         CALCULATE AJ, HIGHER COST FACTOR
      AXJ    = 1.C
      CALL FNANCE(DC,AJ,ACHR,ANCOMP,INT,AJBR,PLNTLF,YEAR)
      IF(MGD .GT. XO(82)) GO TO 110
C**       ADD SUPPLIERS BURDEN FOR SMALL PLANTS
      AXJ = AJ/(AJBR*1.06995)
      VETUBD = VETUBD*AXJ
      PHTUBD = PHTUBD*AXJ
      SHELLD = SHELLD* AXJ
      PMD = PMD*AXJ
      WAITD = WAITD*AXJ
      VPD    = VPD* AXJ
      CMCAPD = CMCAPD*AXJ
      DEAD   = DEAD* AXJ
      CNDSRD = CNDSRD*AXJ
      BHD    = BHD* AXJ
      INSTRD = INSTRD*AXJ
      ELECTD = ELECTD*AXJ
      SBCD = SBCD*AXJ
      PLCAPD = VETUBD +PHTUBD +SHELLD +PMD +WAITD +VPD +CMCAPD +DEAD
     1        +CNDSRD +BHD    +INSTRD +ELECTD     +SBCD
      DC     = PLCAPD*1.D-6
      AJ = AJBR
      ANCOMP = AJ*ACHR
  110 CONTINUE
C*****
C*****    PLANT COST, DIRECTS + INDIRECTS
      PLDIN=AJ*PLCAPD
C*****
C         CALCULATE COST OF COMPONENTS, $/YEAR
      VETUBY=ANCOMP*VETUBD
      PHTUBY=ANCOMP*PHTUBD
      SHELLY=ANCOMP*SHELLD
      PMY    =ANCOMP*PMD
      WAITY  =ANCOMP*WAITD
      VPY    =ANCOMP*VPD
      CMCAPY=ANCOMP*CMCAPD
      INSTRY=ANCOMP*INSTRD
      ELECTY=ANCOMP*ELECTD
      DEAY   =ANCOMP*DEAD
      CNDSRY=ANCOMP*CNDSRD
      BHY    =ANCOMP*BHD
      SBCY   =ANCOMP*SBCD
      PLCAPY=ANCOMP*PLCAPD
      RETUBY = TREPVE*VETUBD +TREPPH*PHTUBD +TREPCN*CNDSRD
     1          +(XC(133)+XC(126))*ABH*TREPBH
C*****
C*****
C         COST OF COMPONENTS, CENTS/KGAL
      CKGAL = 1.D5/(PLF*MGD*365.D6)
      PHTUBK=CKGAL*PHTUBY
      VETUBK=CKGAL*VETUBY
      SHELLK=CKGAL*SHELLY
```

```
      PMK    =CKGAL*PMY
      WAITK =CKGAL*WAITY
      VPK    =CKGAL*VPY
      CMCAPK=CKGAL*CMCAPY
      INSTRK=CKGAL*INSTRY
      ELECTK=CKGAL*ELECTY
      DEAK   =CKGAL*DEAY
      CNDSRK=CKGAL*CNDSRY
      BHK    =CKGAL*BHY
      SBCK   =CKGAL*SBCY
      PLCAPK=CKGAL*PLCAPY
      RETUBK=CKGAL*RETUBY
C*****
      CGPD= PLDIN/(MGD*1.D6)
C*****
C**********
C          CALCULATE OPERATING COSTS
C*****
      HEAT = XC(45)
      IF(MGD .LT. XO(81)) HEAT = XC(46)
      HEATY=HEAT*(QE+QPH)*PLF*8760.0D-6
      ACID = 365.*PLF *TNACDY* XC(49)
      IF(MGD .LE. XO(80)) ACID =ACID*XC(48)/XC(49)
      CLORIN = 8760.* WOCEAN*PLF * XC(50)
      CAUSTC = 8760.*(WB+WP)*PLF * XC(51)
      DEFOM  = 8760.*(WB+WP)*PLF * XC(52)
      CHEMY  = ACID+ CLORIN+ CAUSTC+ DEFOM
      ELEC   = XC(54)
      IF(MGD .LT. XO(81)) ELEC = XC(55)
      POWERY = 8.76D6*ELEC*PO
      OPERY  = XC(57) *MGD
      MAINTY = XC(58) * PLDIN
      HEATK =CKGAL*HEATY
      CHEMK =CKGAL*CHEMY
      POWERK=CKGAL*POWERY
      OPERK =CKGAL*OPERY
      MAINTK=CKGAL*MAINTY
C**********
C          TOTAL OPERATING COST
      TOTOPY=HEATY+CHEMY+POWERY+OPERY+MAINTY
      TOTOPK=CKGAL*TOTOPY
C**********
C          TOTAL
      XC(211)=8760.*LF2*XC(206)*XC(210)
      TOTALY=PLCAPY+RETUBY+TOTOPY
     1 +XC(211)
      XC(212)=XC(211)*CKGAL
      TOTALK=PLCAPK+RETUBK+TOTOPK
     1 +XC(212)
      RETURN
      END
```

APPENDIX L

CHANGES MADE IN SUBROUTINE FNANCE

```
      SUBROUTINE FNANCE(CD,ASJ,SSMAP,PSAJ,RTEIN,AJBR,WPL,YEAR)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION XC(500)
       COMMON/BLOC14/ XC
C
C        OVERHEAD FOR DESIGN AND JOB SUPERVISION
C          AJSD = 'OAK RIDGE'
C          ABSD = 'BURNS AND ROE'
      AJSD = 1.05+.17582*DEXP(-2.089D-2*CD)
      ABSD = .4977*(AJSD-1.)+1.
      AJSDCT = AJSD
C        CONSTRUCTION TIME IN MONTHS
      TIME = 54.1*(1.-(.006*CD+1.1)**(-2.632))
C        INTEREST RATE
      RTEIN = XC(60)
C        INTEREST DURING CONSTRUCTION
      AJIC = 1.+.0399*TIME*RTEIN
C         ESCALATION DURING CONSTRUCTION
      AJESC=1.+.0434*TIME*XC(56)
C        UNUSUAL CONSTRUCTION EXPENSE AND CONTINGENCY
      AJFOR = 1.D0+XC(62)
C        OWNERS COST (TRAINING AND STARTUP)
      AJOWN = 1.019
C
C        HIGHER COST FACTOR
C          ASJ  = 'OAK RIDGE'
C          AJBR = 'BURNS AND ROE'
      ASJ = AJSDCT*AJIC*AJESC*AJFOR*AJOWN
      AJBR = ABSD*AJIC*AJESC
C
C        ANNUAL CHARGE FACTOR ON TOTAL CAPITAL
      SSMAP = XC(61)+RTEIN/(1.-1./(1.+RTEIN)**WPL)
C
C        ANNUAL CHARGE FACTOR ON DIRECT CAPITAL
      PSAJ = SSMAP *ASJ
C
      RETURN
      END
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APPENDIX M

CHANGES MADE IN SUBROUTINE TITLER

```
SUBROUTINE TITLER
CALLC('UNIT COST OF RECOVERY TUBING, $/SQ.FT.         (MSF)',   1)PR 58200
CALLC('UNIT COST OF REJECT TUBING, $/SQ FT            (MSF)',   2)PR 58230
CALLC('UNIT COST OF TUBE SHEETS, $/SQ FT              (MSF)',   3)PR 58260
CALLC('UNIT COST OF HOLE DRILLING, $/HOLE             (MSF)',   4)PR 58320
CALLC('UNIT COST OF INSTALLING TUBE SHEETS, $/SQ FT   (MSF)',   5)PR 58380
CALLC('UNIT COST OF INSTALLING TUBING, $/LINEAR FOOT  (MSF)',   6)PR 58460
CALLC('UNIT COST OF ROLLING TUBING, $/TUBE            (MSF)',   7)PR 58500
CALLC('UNIT COST OF STEEL SHELL, $/CUBIC FOOT     (MSF,VTE)',   9)PR 57250
CALLC('UNIT COST OF CONCRETE SHELL,$/CUBIC FOOT   (MSF,VTE)',  10)PR 57330
CALLC('UNIT COST OF EXCAVATION FOR SHELL,$/SQ FT  (MSF,VTE)',  11)PR 57410
CALLC('UNIT COST OF DEMISTERS +MISC EQUIP, $/MGD  (MSF,VTE)',  12)PR 57440
CALLC('UNIT COST OF WEIRS ,$/SQ FT                (MSF,VTE)',  13)PR 57470
CALLC('UNIT COST OF PUMPS ,$/GPM                      (MSF)',  15)PR 58540
CALLC('UNIT COST OF PUMP MOTORS, $/HP                 (MSF)',  16)PR 58620
CALLC('UNIT COST OF AUXILIARY PUMPS +DRIVES,$/MGD (MSF,VTE)',  17)PR 57500
CALLC('UNIT COST OF PUMP PITS,$/GPM PIT FLOW          (MSF)',  18)PR 58670
CALLC('UNIT COST OF SUBMARINE LINE INTAKE,$/GPM   (MSF,VTE)',  20)PR 57530
CALLC('UNIT COST OF VALVES ,$/GPM VALVE FLOW          (MSF)',  23)PR 58700
CALLC('UNIT COST OF PLANT PIPING AND FITTINGS,$/GPM(MSF,VTE)', 24)PR 57560
CALLC('UNIT COST OF TRAIN PIPING +FITTINGS,$/TRAIN (MSF,VTE)', 25)PR 57590
CALLC('UNIT COST OF BRINE HTR PIPING+FITTINGS,$/GPM(MSF,VTE)', 26)PR 57620
CALLC('UNIT COST OF VENT AND DRAIN PIPING,$/GPM MU (MSF,VTE)', 27)PR 57650
CALLC('UNIT COST OF CHEM,AIR,HYDRAULIC EQUIP,$/MGD (MSF,VTE)', 30)PR 57680
CALLC('UNIT COST OF INSTRUMENTATION,$/MGD PRODUCT  (VTE,MSF)', 32)PR 57720
CALLC('UNIT COST OF ELECTRICAL DISTRIBUTION EQUIP.,$/KW(MSF)', 34)PR 58780
CALLC('UNIT COST OF BRINE HEATER TUBING, $/SQ FT      (MSF)',  38)PR 58810
CALLC('UNIT COST OF BH BUNDLE FABRICATION,$/FT2 BH AREA(MSF)', 39)PR 58840
CALLC('UNIT COST OF BRINE HEATER SHELL,$/FT2 SHELL (MSF,VTE)', 40)PR 57780
CALLC('UNIT COST OF SITE PREPARATION ,$/ACRE       (MSF,VTE)', 42)PR 57810
CALLC('UNIT COST OF BLDGS AND CRANES , $/MGD       (MSF,VTE)', 43)PR 57840
CALLC('UNIT COST OF STEAM HEAT,NUCLEAR, $/MMBTU    (VTE,MSF)', 45)PR 57870
CALLC('UNIT COST OF STEAM HEAT,FOSSIL , $/MMBTU    (VTE,MSF)', 46)PR 57900
CALLC('UNIT COST OF 93PC H2SO4, OR PHOSPHATE, $/TON   (ALL)',  48)PR 57930
CALLC('UNIT COST OF CHLORINE TREATMENT,$/LB WATER     (ALL)',  50)PR 57990
CALLC('UNIT COST OF CAUSTIC TREATMENT, $/LB WATER  (VTE,MSF)', 51)PR 58020
CALLC('UNIT COST OF DEFOAM + SULFITE TREAT., $/LB  (VTE,MSF)', 52)PR 58050
CALLC('UNIT COST OF ELECTRICITY,NUCLEAR, $/KWH        (ALL)',  54)PR 57010
CALLC('UNIT COST OF ELECTRICITY,FOSSIL , $/KWH        (ALL)',  55)PR 57040
CALLC('ANNUAL ESCALATION RATE, FRACTION               (ALL)',  56)PR 57070
CALLC('UNIT COST OF O AND M LABOR,$/YEAR PER MGD   (MSF,VTE)', 57)PR 58080
CALLC('UNIT COST OF MAINT.+SUPPLIES,$/YR/$ CAPITAL    (ALL)',  58)PR 58110
CALLC('INTEREST RATE                                  (ALL)',  60)PR 57100
CALLC('UNIT COST OF TAXES,INSURANCE,ETC,$/YR/$ CAPITAL (ALL)', 61)PR 57130
CALLC('FRACTION OF CAPITAL FOR UNUSUAL CONST. EXPENSE  (ALL)', 62)PR 57160
CALLC('UNIT COST OF VERTICAL TUBE SURFACE, $/SQ FT    (VTE)',  63)PR 58930
CALLC('UNIT COST OF VE TUBE SHEETS, $/SQ FT           (VTE)',  64)PR 58960
CALLC('UNIT COST OF VE HOLE DRILLING AND ROLLING,$/HOLE(VTE)', 65)PR 58990
CALLC('UNIT COST OF INSTALLING VE TUBES, $/FOOT       (VTE)',  66)PR 59020
CALLC('UNIT COST OF VE BUNDLE INSTALLATION, $/BUNDLE  (VTE)',  67)PR 59050
CALLC('UNIT COST OF PREHEATER TUBING ,$/SQ FT         (VTE)',  68)PR 59080
CALLC('UNIT COST OF INSTALLING HORIZONTAL TUBING,$/FT (VTE)',  69)PR 59110
CALLC('UNIT COST OF HORIZONTAL TUBE SHEETS, $/SQ FT   (VTE)',  70)PR 59160
CALLC('UNIT COST OF HOLE DRILLING,HORIZ. TUBES,$/HOLE (VTE)',  71)PR 59220
CALLC('UNIT COST OF INSTALLING HORIZ. TUBE SHEETS,$/FT2(VTE)', 72)PR 59280
CALLC('UNIT COST OF ROLLING HORIZONTAL TUBES, $/TUBE  (VTE)',  73)PR 59360
CALLC('UNIT COST OF CONDENSER TUBING, $/SQ FT         (VTE)',  74)PR 59400
CALLC('UNIT COST OF BRINE HEATER TUBING, $/SQ FT      (VTE)',126)PR 59430
CALLC('UNIT COST OF ELECTRICAL DISTRIBUTION EQPT ,$/KW (VTE)',127)PR 59460
CALLC('UNIT COST OF PUMPS ,$/GPM                      (VTE)',128)PR 59500
CALLC('UNIT COST OF PUMP MOTORS ,$/HP                 (VTE)',129)PR 59590
CALLC('UNIT COST OF PUMP PITS ,$/GPM                  (VTE)',130)PR 59670
CALLC('UNIT COST OF VALVES ,$/GPM                     (VTE)',131)PR 59700
CALLC('UNIT COST OF EFFECT PIPING ,$/EFFECT           (VTE)',132)PR 59820
CALLC('UNIT COST OF BH BUNDLE FABRICATION,$/FT2 BH AREA(VTE)',133)PR 59850
CALLC('COST OF SJAE SYSTEM , $                    (VTE,MSF)',200)
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      CALLC('UNIT COST OF EJECTOR STEAM,$/MMBT         (MSF,VTE)',210)PR 58105
      CALLC('UNIT COST OF EJECTOR STEAM, $/MMBTU       (VTE,MSF)',210)
      CALLC('ANNUAL COST OF EJECTOR STEAM, $/YR        (VTE,MSF)',211)
      CALLC('COST OF EJECTOR STEAM PER 1000 GAL, $     (VTE,MSF)',212)
      CALLC('COST OF BRINE HEATER TUBE SHEETS, $       (MSF,VTE)',215)
      CALLC('COST OF BRINE HEATER SHEETS HOLE DRILLING (MSF,VTE)',216)
      CALLC('COST OF BRINE HEATER SHEET INSTALLATION   (MSF,VTE)',217)
      CALLC('COST OF BRINE HEATER TUBING INSTALLATION  (MSF,VTE)',218)
      CALLC('COST OF BRINE HEATER TUBE ROLLING         (MSF,VTE)',219)
      CALLC('UNIT COST OF NOZZLES                          (VTE)',220)
      CALLC('COST OF INSTRUMENTATION FOR ONE EFFECT        (VTE)',220)
      RETURN
      END
```

APPENDIX N

CHANGES MADE IN SUBROUTINE RITEM

```
      SUBROUTINE RITEM(IOPT,IOUT,L)                                     PR 65590
       IMPLICIT REAL*8(A-H,O-Z)                                         PR 65600
C                                                                       PR 65610
      DOUBLE PRECISION LAM,MSFID,LAMSTM                                 PR 65620
      DOUBLE PRECISION MODU                                             PR 65630
      REAL*8 LPHE                                                           ****
      DOUBLE PRECISION LEV,LF2                                          PR 65640
C                                                                       PR 65650
      COMMON/PINHAS/APTSH,ENRSS,ENRJS,LPHE,DUMDUM(16),NFEED,IIIIII(9)       ****
      COMMON/BLOCM1/     DIE,      DIH,      DIR,      DOE,      DOH,PR 65660
     1     DOR,      ELE,      ENE,      RLR,      RNR,     HDEL,PR 65670
     2    HREC,    APTSR,   ENITSR                                      PR 65680
      COMMON/BLOCM2/       P,        Q,       AH,       AK,       AN,PR 65690
     1      AR,       FF,       GE,       GH,       GR,       HO,PR 65700
     2      PB,       PE,    QX(5),       RP,       SE,       SH,PR 65710
     3      SR,       TK,       VE,       VH,       VR,       WC,PR 65720
     4     AME,      ATN,   BPX(5),      CCF,      HIH,      HLH,PR 65730
     5     HNH,      HOH,   OMX(5),      PHE,      PO3,      RSE,PR 65740
     6     RSH,      RSR,      TC1,      THF,   TKX(5),      TMC,PR 65750
     7     TME,      TPE,   UEX(5),      UME,      UMH,      WPL,PR 65760
     8    BKTE,     BKTH,     BKTR,  DTLS(5),  ELEX(5),  HIEX(5),PR 65770
     9  HOEX(5),    MODU,     ROE1,     RUE2,    APTSE,    BDEPH,PR 65780
     +   CAPI1,    HEADE,    HEADH,    HEADR,    POBLD,    PODEL,PR 65790
     A   POPRD, SUBEX(5),    WCOLD,    WMODC,    WMODH,   BHSHEL,PR 65800
     B  CSLTBH,   CSLTBP,   HOTLEN,   HRECOV,   HREJCT,   RECOLN,PR 65810
     C  VAPSPC,   WPRTRY,    POREC                                      PR 65820
      COMMON/BLOCM3/      EA,       ES,      CC1,      CC2,      EA1,PR 65830
     1     EA2,      EEC,      HC1,      HC2,      OC1,      OC2,PR 65840
     2     PMC,      TC2,      VPC,     BHC1,     BHC2,     CIBC,PR 65850
     3    DEA1,     DEA2,     EEC1,     EEC2,     PMC1,     PMC2,PR 65860
     4    SITE,     SMAP,     VPC1,     VPC2,     WAIT,    AMSC1,PR 65870
     5   AMSC2,    CAPI2,    CAPI3,    CAPI4,    CIBC1,    CIBC2,PR 65880
     6   SITE1,    SITE2,    WAIT1,    WAIT2,   CHMPTC,   CHMPT1,PR 65890
     7  CHMPT2,   CINSTC,   CINST1,   CINST2,   DEACST,   POCST1,PR 65900
     8  POCST2,   RATEIN,   RETUB1,   RETUB2,   SMAPPH,   SMAPPP,PR 65910
     9      CD,      BHC,      ES1,      ES2                           PR 65920
      COMMON/COMNAM/      AJ,       CB,       CO,       CP,       CR,  PR 65930
     1      HB,       PI,       PO,       TB,       TO,       TP,  PR 65940
     2      TS,       WB,       WF,       WO,       WP,       WR,  PR 65950
     3     AXJ,      HBL,      HPR,      LEV,      LF2,      TCF,  PR 65960
     4    ENBH,     GPMB,     GPMD,     GPMH,     GPMO,     GPMP,  PR 65970
     5    GPMR,     HDEA,     RPMB,     RPMD,     RPMH,     RPMP,  PR 65980
     6    RPMR,     TSTH,     WHOT,     YEAR,    ACRES,    BHVOL,  PR 65990
     7   BLDGS,    BNDLS,    HOLES,    HPBLD,    HPDEA,    HPDEL,  PR 66000
     8   HPPRD,    HPREC,    PLPRD,    PLSEA,    PODEA,   ACNCEW,  PR 66010
     9  ACNCFL,   ACNCIW,   ACNCPH,   ACNCRF,   ACNCTR,   AEXCAV,  PR 66020
     +  ASTLEW,   ASTLFL,   ASTLIW,   ASTLPH,   ASTLRF,   ASTLTR,  PR 66030
     A  AWEIRS,   BHSURF,   DINTAK,   ENITSE,   ENPIPE,   ENSUPE,  PR 66040
     B  ENSUPR,   PIPELN,   PLSZMG,   REJLEN,   STLLEN,   STLTMP,  PR 66050
     C  TNACCY,   TRAINS,   TSAREA,   VOLCNC,   VOLSTL,   WOCEAN   PR 66060
       COMMON/BLOC12/ XT                                                PR 66070
       COMMON/BLOC13/ XO                                                PR 66080
      COMMON/BLOC14/ XC                                                 PR 66090
      COMMON/NAME/ ANAME(10), AMONTH, IDAY, IYEAR                       PR 66100
      COMMON/DECKID/ MSFID(10), VTEID(10), EDID(10)                     PR 66110
      COMMON/IMPOSS/ IMPOSE,IMPOSR                                      PR 66120
C                                                                       PR 66130
      DIMENSION XT(300),XO(300)                                         PR 66140
      DIMENSION XC(500)                                                 PR 66150
C                                                                       PR 66160
       EQUIVALENCE   (AE,AME)   ,(TC,TMC)   ,(TE,TME)   ,(UE,UME)   ,   PR 66170
     1               (UH,UMH)                                           PR 66180
C****                                                                   PR 66190
C         SOME QUANTITIES FOR OUTPUT                                    PR 66200
C***                                                                    PR 66210
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```
      SITEC = SITE + CIBC
      SITEC1= SITE1+ CIBC1
      SITEC2= SITE2+ CIBC2
      TOC2 = HC2 +CC2 + POCST2 +OC2 +AMSC2+XC(211)
      TOC1 = HC1 +CC1 + POCST1 +OC1 +AMSC1 +XC(212)
      EFF = XO(32)
      LAMSTM = LAM(TS,PSTM,0.D0,0.D0)
      WS = 1.D3/RP*WP/LAMSTM
      CDMM = CD*1.D6
      CPPPM = CP*1.0D6
      WSMM = WS *1.D-6
      WPMM = WP *1.D-6
      WBMM = WB *1.D-6
      WOMM = WO *1.D-6
      WCMM = (WC-WP-WB)* 1.D-6
      WRMM = WR *1.D-6
      WFMM = WF *1.D-6
      ENRK = 1.D-3 *DFLOAT(IFIX(SNGL(RNR)))
      ENEK = 1.D-3 *DFLOAT(IFIX(SNGL(ENE)))
      ENHK = 1.D-3 *DFLOAT(IFIX(SNGL(HNH)))
      ARKK = 1.D-3*AR
      AEKK = 1.D-3*AE
      AHKK = 1.D-3*AH
      WOCMM = 1.D-6*WOCEAN
      VOMTOT = (VOLSTL+VOLCNC)*1.D-6
      HIE =(HIEX(1)+ 4.*HIEX(2) +HIEX(3))/6.
      HOE =(HOEX(1)+ 4.*HOEX(2) +HOEX(3))/6.
      UE  =(UEX(1) + 4.*UEX(2)  +UEX(3) )/6.
      SUBE=(SUBEX(1)+4.*SUBEX(2)+SUBEX(3))/6.
      DTLSE =(DTLS(1)+4.*DTLS(2)+DTLS(3))/6.
      OM1 = (OMX(1) +4.*OMX(2) +OMX(3))/6.
      HIR = .5*(HIEX(4) +HIEX(5))
      HOR = .5*(HOEX(4) +HOEX(5))
      UR  = .5*(UEX(4) +UEX(5))
      SUBR =.5*(SUBEX(4)+SUBEX(5))
      DTLSR=.5*(DTLS(4)+DTLS(5))
      OM2  =.5*(OMX(4)+OMX(5))
      UNARAE = EA/(AME+AR)
      UNPUMP = XC(15)
      UNDRVE = XC(16)
      USHELV = ES/VOMTOT*1.D-6
      UFC = XC(55)*100.D0
      IF(FF .GE. XO(81)) UFC = XC(54)*100.D0
      EXSTM = XC(46)*100.D0
      IF(FF .GE. XO(81)) EXSTM = XC(45)*100.D0
      EACHG = XC(1)
      RACHG = XC(2)
      HACHG = XC(38)
      WPE  = WF*PE
      WPR  = WP-WPE
      TOTLEN = RECOLN+REJLEN
      WALLE  = XO(26)
      STFEJ=XC(210)*100.D0
      EJC2=XC(211)
      EJC1=XC(212)
      WALLR  = XO(27)
      WALLH  = XO(25)
      ESTGL  = (ELEX(1)+4.*ELEX(2)+ELEX(3))/6.
      RSTGL  = .5*(ELEX(4)+ELEX(5))
      QEL  = (QX(1)+4.*QX(2)+QX(3))/6.
      QRL  = .5*(QX(4) +QX(5))
      BPRE  = (BPX(1) +4.*BPX(2) +BPX(3))/6.
      BPRR  = .5*(BPX(4)+BPX(5))
      POTCT = PO +PO3
      PSAJ  = AJ *SMAP
      UNELCT = XC(34)
      UNARHI = XC(38)+XC(39)
      UNSHLS = XC(9)
      UNSHLC = XC(10)
C
```

```
      NPAGE = 1
      WRITE(L,1) NPAGE
      WRITE(L,115) MSFID
      WRITE(L,202) AMONTH
  202 FORMAT(1H ,A8,13,',',I5)
      CCC = CAPI1 *1.D-6
      WRITE(L,2) (ANAME(KK),KK=1,10),FF,TC1,CCC
    2 FORMAT(////////////////////1H ,10A8////1H ,'                   PLA
     1NT CAPACITY - MGD',F29.3/1H0,'UNIT COST OF DESALTED WATER - CENTS
     2PER KILOGALLON',F19.3/1H0,'CAPITAL COST OF PLANT(DIRECT+INDIRECT)-
     3 MILLIONS OF DOLLARS',F10.3)
      IF(IOPT .EQ. 0) WRITE(L,200)
      IF(IOPT .NE. 0) WRITE(L,201)
  200 FORMAT(1H0,/1H0,'THE PLANT HAS NOT BEEN OPTIMIZED')
  201 FORMAT(1H0,/1H0,'THE PLANT HAS BEEN OPTIMIZED')
      IF(IMPOSE .GT. 0) WRITE(L,203)
      IF(IMPOSR .GT. 0) WRITE(L,204)
  203 FORMAT(1H0,' THE INPUT DATA SPECIFY PHYSICALLY IMPOSSIBLE CONDITIO
     1NS IN THE RECOVERY SECTION'/8X' OUTPUT VALUES ARE MEANINGLESS')
  204 FORMAT(1H0,' THE INPUT DATA SPECIFY PHYSICALLY IMPOSSIBLE CONDITIO
     1NS IN THE REJECT SECTION'/8X' OUTPUT VALUES ARE MEANINGLESS')
C
      IF(IOUT .EQ. 0) GO TO 1000
C
      NPAGE = 2
      WRITE(L,1) NPAGE
      WRITE(L,115) MSFID
      WRITE(L,202) AMONTH
    1 FORMAT(1H1,46HRECYCLE MULTISTAGE FLASH PLANT - ROUTINE MSF21,7X,
     15HPAGE ,I1)
      WRITE(L,3) (ANAME(KK),KK=1,10)
    3 FORMAT(1H0,10A8)
      WRITE(L,4)
    4 FORMAT(1H0,31X,17HCOST SUMMARY PAGE )
      WRITE(L,5)
    5 FORMAT(1H0,18HCAPITAL COMPONENTS     ,8X,9HCOST-$/YR,7X,11HCOST-C/K
     1GAL,5X,12HCOST-$DIRECT )
      WRITE(L,6)
    6 FORMAT(1H ,18H------- ----------     8X,9H---------,7X,11H--------
     1---,5X,12H------------ )
      WRITE(L,7) EA2,EA1,EA
    7 FORMAT(1H0,20HCONDENSING SURFACE    ,F15.2,F16.4,F19.2)
      WRITE(L,8) ES2,ES1,ES
    8 FORMAT(1H ,20HSHELL AND FOUNDATION ,F15.2,F16.4,F19.2)
      WRITE(L,9) PMC2,PMC1,PMC
    9 FORMAT(1H ,20HPUMPS AND MOTORS      ,F15.2,F16.4,F19.2)
      WRITE(L,10) WAIT2,WAIT1,WAIT
   10 FORMAT(1H ,20HSEA-WATER INTAKE      ,F15.2,F16.4,F19.2)
      WRITE(L,11) VPC2,VPC1,VPC
   11 FORMAT(1H ,20HVALVES AND PIPING     ,F15.2,F16.4,F19.2)
      WRITE(L,12) CHMPT2,CHMPT1,CHMPTC
   12 FORMAT(1H ,20HCHEMICAL CAPITAL      ,F15.2,F16.4,F19.2)
      WRITE(L,13) CINST2,CINST1,CINSTC
   13 FORMAT(1H ,20HINSTRUMENTS           ,F15.2,F16.4,F19.2)
      WRITE(L,14) EEC2,EEC1,EEC
   14 FORMAT(1H ,20HELECTRICAL            ,F15.2,F16.4,F19.2)
      WRITE(L,15) DEA2,DEA1,DEACST
   15 FORMAT(1H ,20HNCG REMOVAL SYSTEM    ,F15.2,F16.4,F19.2)
      WRITE(L,16) BHC2,BHC1,BHC
   16 FORMAT(1H ,20HBRINE HEATER          ,F15.2,F16.4,F19.2)
      WRITE(L,17) SITEC2,SITEC1,SITEC
   17 FORMAT(1H ,20HSITE, BLDGS, CRANES   ,F15.2,F16.4,F19.2)
      WRITE(L,18) CAPI4,CAPI3,COMM
   18 FORMAT(1H0,20H    TOTAL CAPITAL     ,F15.2,F16.4,F19.2)
      WRITE(L,19)
   19 FORMAT(1H0,20HTOTAL INVESTMENT,          )
      WRITE(L,20) CAPI1
   20 FORMAT(1H ,20H          $DIR+IND    ,31X,F19.2)
      WRITE(L,21)
   21 FORMAT(1H ,20HSPECIFIC INVESTMENT,       )
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      WRITE(L,22) CAPI2                                                  PR 67590
   22 FORMAT(1H ,20H             $/GPD  ,31X,F16.5)                      PR 67600
      WRITE(L,23) RETUB2, RETUB1                                         PR 67610
   23 FORMAT(1H0,20H    RETUBING        ,F15.2,F16.4)                    PR 67620
      WRITE(L,24)                                                        PR 67630
   24 FORMAT(1H0,20HOPERATING COMPONENTS        )                        PR 67640
      WRITE(L,25)                                                        PR 67650
   25 FORMAT(1H ,20H--------- ----------        )                        PR 67660
      WRITE(L,26) HC2, HC1                                               PR 67670
   26 FORMAT(1H0,20HPROCESS HEAT        ,F15.2,F16.4)                      ****
      WRITE(6,271) EJC2,EJC1                                               ****
  271 FORMAT(1HC,20HSTEAM TO EJECTORS   ,F15.2,F16.4)                      ****
      WRITE(L,27) CC2,CC1                                                PR 67690
   27 FORMAT(1H ,20HCHEMICALS           ,F15.2,F16.4)                    PR 67700
      WRITE(L,28) POCST2,POCST1                                          PR 67710
   28 FORMAT(1H ,20HPOWER               ,F15.2,F16.4)                    PR 67720
      WRITE(L,29) OC2, OC1                                               PR 67730
   29 FORMAT(1H ,20HOPERATING           ,F15.2,F16.4)                    PR 67740
      WRITE(L,30) AMSC2, AMSC1                                           PR 67750
   30 FORMAT(1H ,20HMAINT. + SUPPLIES   ,F15.2,F16.4)                    PR 67760
      WRITE(L,31) TOC2, TOC1                                             PR 67770
   31 FORMAT(1H0,20H    TOTAL OPERATING ,F15.2,F16.4)                    PR 67780
      WRITE(L,32) TC2, TC1                                               PR 67790
   32 FORMAT(1H0,20HTOTAL(CAP+RETUB+OP) ,F15.2,F16.4)                    PR 67800
      WRITE(L,33)                                                        PR 67810
   33 FORMAT(1H0,20HCOST FACTORS                )                        PR 67820
      WRITE(L,34) UFC                                                    PR 67830
   34 FORMAT(1H0,20HCOST OF POWER,C/KWHR , F15.6)                        PR 67840
      WRITE(L,35) EXSTM                                                  PR 67850
   35 FORMAT(1H ,20HCOST OF HEAT,C/MMBTU , F15.6)                        PR 67860
       WRITE(L,831) STFEJ                                                  ****
  831 FORMAT(21H EJECT. STEAM,C/MMBTU ,F15.6)                              ****
      WRITE(L,36) SMAP                                                   PR 67870
   36 FORMAT(1H ,20HANNUAL CHARGE RATE   , F15.6)                        PR 67880
      WRITE(L,37) RATEIN                                                 PR 67890
   37 FORMAT(1H ,20HINTEREST RATE        , F15.6)                        PR 67900
      WRITE(L,38) AJ                                                     PR 67910
   38 FORMAT(1H ,20HHIGHER COST FACTOR   , F15.6)                        PR 67920
      WRITE(L,39) EFF                                                    PR 67930
   39 FORMAT(1H ,20HPUMP AND MOTOR EFF.  , F15.6)                        PR 67940
      WRITE(L,40) LF2                                                    PR 67950
   40 FORMAT(1H ,20HPLANT LOAD FACTOR    , F15.6)                        PR 67960
      WRITE(L,41) WPL                                                    PR 67970
   41 FORMAT(1H ,20HPLANT LIFE,YEARS     , F15.6)                        PR 67980
      WRITE(L,42)                                                        PR 67990
   42 FORMAT(1H0,28X,6HREJECT,10X,8HRECOVERY,7X,12HBRINE HEATER )        PR 68000
      WRITE(L,43) CSLTBP, CSLTBP, CSLTBH                                 PR 68010
   43 FORMAT(1H0,20HTUBE LIFE,YEARS     ,F14.3,2F17.3)                   PR 68020
      WRITE(L,44) RACHG,EACHG,HACHG                                      PR 68030
   44 FORMAT(1H ,20HAREA COST,$/SQ.FT.   ,F14.3,2F17.3)                  PR 68040
      WRITE(L,441) UNARAE                                                PR 68050
  441 FORMAT(1H ,43HINSTALLED EVAPORATOR SURFACE COST,$/SQ.FT.  ,F8.3)   PR 68060
C                                                                        PR 68070
      NPAGE = 3                                                          PR 68080
      WRITE(L,1) NPAGE                                                   PR 68090
      WRITE(L,115) MSFID                                                 PR 68100
      WRITE(L,202) AMONTH                                                PR 68110
      WRITE(L,3) (ANAME(KK),KK=1,10)                                     PR 68120
      WRITE(L,45)                                                        PR 68130
   45 FORMAT(1H0,27H  I  SUMMARY OF PLANT DATA   )                       PR 68140
      WRITE(L,46)                                                        PR 68150
   46 FORMAT(1H0,14H     GENERAL    )                                    PR 68160
      WRITE(L,47) FF                                                     PR 68170
   47 FORMAT(1H ,35H         PLANT CAPACITY, MGD          ,F16.4)        PR 68180
      WRITE(L,471) RP                                                    PR 68190
  471 FORMAT(1H ,35H         PERFORMANCE RATIO            ,F16.4)        PR 68200
      WRITE(L,48) CU                                                     PR 68210
   48 FORMAT(1H ,35H         SEA WATER CONCENTRATION      ,F16.4)        PR 68220
      WRITE(L,49) CPPPM                                                  PR 68230
   49 FORMAT(1H ,35H         PRODUCT CONCENTRATION, PPM ,F16.4)          PR 68240
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      WRITE(L,50) CR                                                      PR 68250
   50 FORMAT(1H ,35H        CONCENTRATION RATIO          ,F16.4)          PR 68260
      WRITE(L,51) AK                                                      PR 68270
   51 FORMAT(1H ,35H        NO OF REJECT STAGES          ,F16.4)          PR 68280
      WRITE(L,52) AN                                                      PR 68290
   52 FORMAT(1H ,35H        NO OF RECOVERY STAGES       ,F16.4)           PR 68300
   53 FORMAT(1H ,35H        PERFORMANCE RATIO            ,F16.4)          PR 68310
      WRITE(L,531) YEAR                                                   PR 68320
  531 FORMAT(1H ,35H        YEAR CONSTRUCTION STARTED    ,F16.4)          PR 68330
      WRITE(L,54)                                                         PR 68340
   54 FORMAT(1H0,26H    TEMPERATURES - DEG F   )                          PR 68350
      WRITE(L,55) TS                                                      PR 68360
   55 FORMAT(1H ,35H        STEAM                        ,F16.4)          PR 68370
      WRITE(L,56) THF                                                     PR 68380
   56 FORMAT(1H ,35H        MAXIMUM BRINE                ,F16.4)          PR 68390
      WRITE(L,57) TB                                                      PR 68400
   57 FORMAT(1H ,35H        BLOWDOWN                     ,F16.4)          PR 68410
      WRITE(L,58) TP                                                      PR 68420
   58 FORMAT(1H ,35H        PRODUCT                      ,F16.4)          PR 68430
      WRITE(L,59) TO                                                      PR 68440
   59 FORMAT(1H ,35H        OCEAN                        ,F16.4)          PR 68450
      WRITE(L,60)                                                         PR 68460
   60 FORMAT(1H0,34H    FLOW RATES, MILLIONS OF LB/HR)                    PR 68470
      WRITE(L,61) WSMM                                                    PR 68480
   61 FORMAT(1H ,35H        STEAM                        ,F16.4)          PR 68490
      WRITE(L,62) WPMM                                                    PR 68500
   62 FORMAT(1H ,35H        PRODUCT                      ,F16.4)          PR 68510
      WRITE(L,63) WBMM                                                    PR 68520
   63 FORMAT(1H ,35H        BLOWDOWN                     ,F16.4)          PR 68530
      WRITE(L,64) WOCMM                                                   PR 68540
   64 FORMAT(1H ,35H        SEA INTAKE                   ,F16.4)          PR 68550
      WRITE(L,65) WCMM                                                    PR 68560
   65 FORMAT(1H ,35H        HEAT REJECT                  ,F16.4)          PR 68570
      WRITE(L,66) WRMM                                                    PR 68580
   66 FORMAT(1H ,35H        RECYCLE                      ,F16.4)          PR 68590
      WRITE(L,67) WFMM                                                    PR 68600
   67 FORMAT(1H ,35H        RECOV. TUBING, BRINE HTR.    ,F16.4)          PR 68610
      WRITE(L,68) WOMM                                                    PR 68620
   68 FORMAT(1H ,35H        REJECT TUBING                ,F16.4)          PR 68630
      WRITE(L,69)                                                         PR 68640
   69 FORMAT(1HC,34H II  DESCRIPTION OF PHYSICAL PLANT )                  PR 68650
      WRITE(L,691) BLDGS                                                  PR 68660
  691 FORMAT(1H0,35H        NO OF BUILDINGS              ,F16.4)          PR 68670
      WRITE(L,70) TRAINS                                                  PR 68680
   70 FORMAT(1H ,35H        NO OF TRAINS                 ,F16.4)          PR 68690
      WRITE(L,71) MODU                                                    PR 68700
   71 FORMAT(1H ,35H        NO OF MODULES                ,F16.4)          PR 68710
      WRITE(L,711)LEV                                                     PR 68720
  711 FORMAT(1H ,35H        NO OF LEVELS                 ,F16.4)          PR 68730
      WRITE(L,72) HRECOV                                                  PR 68740
   72 FORMAT(1H ,35H        RECOVERY HEIGHT, FT          ,F16.4)          PR 68750
      WRITE(L,721) STLLEN                                                 PR 68760
  721 FORMAT(1H ,35H        LENGTH OF STEEL SECTION,FT   ,F16.4)          PR 68770
      WRITE(L,722) HOTLEN                                                 PR 68780
  722 FORMAT(1H ,35H        HI-FLOW LENGTH, FT           ,F16.4)          PR 68790
      WRITE(L,73) RECCLN                                                  PR 68800
   73 FORMAT(1H ,35H        RECOVERY LENGTH, FT          ,F16.4)          PR 68810
      WRITE(L,731) WHOT                                                   PR 68820
  731 FORMAT(1H ,35H        HI-FLOW WIDTH, FT            ,F16.4)          PR 68830
      WRITE(L,74) WCOLD                                                   PR 68840
   74 FORMAT(1H ,35H        LO-FLOW WIDTH, FT            ,F16.4)          PR 68850
      WRITE(L,741) HREJCT                                                 PR 68860
  741 FORMAT(1H ,35H        REJECT HEIGHT, FT            ,F16.4)          PR 68870
      WRITE(L,75) REJLEN                                                  PR 68880
   75 FORMAT(1H ,35H        REJECT LENGTH, FT            ,F16.4)          PR 68890
      WRITE(L,76)                                                         PR 68900
   76 FORMAT(1H ,35H        TOTAL PLANT VOLUME,              )            PR 68910
      WRITE(L,77) VOMTOT                                                  PR 68920
   77 FORMAT(1H ,35H           MILLIONS OF CUBIC FEET    ,F16.4)          PR 68930
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C                                                                       PR 68940
      NPAGE = 4                                                         PR 68950
      WRITE(L,1) NPAGE                                                  PR 68960
      WRITE(L,115) MSFID                                                PR 68970
      WRITE(L,202) AMONTH                                               PR 68980
      WRITE(L,3) (ANAME(KK),KK=1,10)                                    PR 68990
      WRITE(L,78)                                                       PR 69000
   78 FORMAT(1H0,22HIII  TUBING PARAMETERS )                            PR 69010
      WRITE(L,79)                                                       PR 69020
   79 FORMAT(1H0,40X,6HREJECT,8X,8HRECOVERY,4X,12HBRINE HEATER)         PR 69030
      WRITE(L,80) DOR ,DOE, DOH                                         PR 69040
   80 FORMAT(1H ,32H         OUTSIDE DIAMETER, IN.    ,3F15.5)          PR 69050
      WRITE(L,90) XO(27), XO(26), XO(25)                                PR 69060
   90 FORMAT(1H ,32H         WALL THICKNESS, IN.      ,3F15.5)          PR 69070
      WRITE(L,91) XO(21), XO(20), XO(19)                                PR 69080
   91 FORMAT(1H ,32H         K,BTU/HR FT2 F           ,3F15.5)          PR 69090
      WRITE(L,92) XT(103),XT(102),XT(101)                               PR 69100
   92 FORMAT(1H ,32H         FOULING RESISTANCE       ,3F15.5)          PR 69110
      WRITE(L,93) XO(24), XO(23), XO(22)                                PR 69120
   93 FORMAT(1H ,32H         FLOODING FACTOR          ,3F15.5)          PR 69130
      WRITE(L,94) ENRK ,ENEK, ENHK                                      PR 69140
   94 FORMAT(1H ,32H         NO OF TUBES (THOUSANDS)  ,3F15.5)          PR 69150
      WRITE(L,95) RLR, ELE, HLH                                         PR 69160
   95 FORMAT(1H ,32H         TUBE LENGTH, FT          ,3F15.5)          PR 69170
      WRITE(L,96) ARKK, AEKK, AHKK                                      PR 69180
   96 FORMAT(1H ,32H         AREA,THOUSANDS OF SQ FT  ,3F15.5)          PR 69190
      WRITE(L,97) VR, VE, VH                                            PR 69200
   97 FORMAT(1H0,32H         VELOCITY, FPS            ,3F15.5)          PR 69210
      WRITE(L,98) HEADR, HEADE, HEADH                                   PR 69220
   98 FORMAT(1H ,32H         FRICTIONAL HEAD, FT      ,3F15.5)          PR 69230
      WRITE(L,99) UR, UE, UH                                            PR 69240
   99 FORMAT(1H0,32H         OVERALL U, B/HR-FT2-F    ,3F15.5)          PR 69250
      WRITE(L,100) HIR, HIE, HIH                                        PR 69260
  100 FORMAT(1H ,32H         H INSIDE . B/HR-FT2-F    ,3F15.5)          PR 69270
      WRITE(L,101) HOR, HOE, HOH                                        PR 69280
  101 FORMAT(1H ,32H         H OUTSIDE, B/HR-FT2-F    ,3F15.5)          PR 69290
      WRITE(L,102) OM2, OM1, PHE                                        PR 69300
  102 FORMAT(1H ,32H         AVG LMTD, DEG F          ,3F15.5)          PR 69310
      WRITE(L,103) TO,  TE,  TCF                                        PR 69320
  103 FORMAT(1H0,32H         TEMPERATURE IN, DEG F    ,3F15.5)          PR 69330
      WRITE(L,104) TB ,TCF, THF                                         PR 69340
  104 FORMAT(1H ,32H         TEMPERATURE OUT, DEG F   ,3F15.5)          PR 69350
      WRITE(L,105)                                                      PR 69360
  105 FORMAT(1H0,23H IV  PUMPING PARAMETERS )                           PR 69370
      WRITE(L,106)                                                      PR 69380
  106 FORMAT(1H0, 38X,8HFLOW-GPM,8X,7HHEAD-FT, 8X,8HPOWER-MW)           PR 69390
      WRITE(L,107) GPMO,HDEL,PODEL                                      PR 69400
  107 FORMAT(1H ,32H         SEA-WATER DELIVERY       ,3F15.5)          PR 69410
      WRITE(L,108) GPMR,HREC,POREC                                      PR 69420
  108 FORMAT(1H ,32H         RECYCLE                  ,3F15.5)          PR 69430
      WRITE(L,109) GPMB,HBL,POBLD                                       PR 69440
  109 FORMAT(1H ,32H         BLOWDOWN                 ,3F15.5)          PR 69450
      WRITE(L,110) GPMP,HPR,POPRD                                       PR 69460
  110 FORMAT(1H ,32H         PRODUCT                  ,3F15.5)          PR 69470
      WRITE(L,111) GPMD,HDEA,PODEA                                      PR 69480
  111 FORMAT(1H ,32H         DEAERATOR                ,3F15.5)          PR 69490
      WRITE(L,1111) PO                                                  PR 69500
 1111 FORMAT(1H0,32H      TOTAL (ELECTRICAL)          ,30X,F15.5)       PR 69510
C                                                                       PR 69560
 1000 CONTINUE                                                          PR 69570
      NPAGE = 5                                                         PR 69580
      WRITE(L,113) NPAGE                                                PR 69590
  113 FORMAT(1H1,46HRECYCLE MULTISTAGE FLASH PLANT - ROUTINE MSF21,7X,  PR 69600
     131HCONDENSED SUMMARY OF PLANT DATA,25X,5HPAGE ,I1)                PR 69610
      WRITE(L,115) MSFID                                                PR 69620
115   FORMAT(1H ,10A8)                                                  PR 69630
      WRITE(L,202) AMONTH
      WRITE(L,3) (ANAME(KK),KK=1,10)                                    PR 69650
      WRITE(L,8000) FF     ,RP      ,P      ,PE      ,Q      ,CR     ,  PR 69660
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     1              CC      ,CP      ,CCF     ,CB      ,LF2     ,YEAR
      WRITE(L,8005) TS      ,THF     ,TCF     ,TK      ,TPE     ,TB      ,
     1              TE      ,TP      ,TO                        ,STLTMP
      WRITE(L,8010) WS      ,WF      ,WR      ,WPE     ,WPR     ,WP      ,
     1              WB      ,WO      ,WC      ,WOCEAN
      WRITE(L,8015) AN      ,ESTGL   ,RECOLN  ,HRECOV  ,VOLSTL  ,STLLEN  ,
     1              AK      ,RSTGL   ,REJLEN  ,HREJCT  ,VOLCNC  ,HOTLEN
      WRITE(L,8020) WHOT    ,WCOLD   ,ATN     ,ENBH    ,BLDGS   ,TRAINS  ,
     1              TOTLEN  ,VCMTOT  ,         ACRES   ,MODU    ,LEV
      WRITE(L,8025) DOE     ,WALLE   ,ELE     ,ENE     ,AE      ,VE      ,
     1              DOR     ,WALLR   ,RLR     ,RNR     ,AR      ,VR      ,
     2              DOH     ,WALLH   ,HLH     ,HNH     ,AH      ,VH
      WRITE(L,8030) UE      ,HIE     ,HOE     ,BKTE    ,RSE     ,OM1     ,
     1              UR      ,HIR     ,HOR     ,BKTR    ,RSR     ,OM2     ,
     2              UH      ,HIH     ,HOH     ,BKTH    ,RSH     ,PHE
      WRITE(L,8035) QEL     ,SUBE    ,DTLSE   ,BPRE    ,ROE1    ,BDEPH   ,
     1              QRL     ,SUBR    ,DTLSR   ,BPRR    ,ROE2
      WRITE(L,8040) HREC    ,HDEL    ,HDEA    ,HPR     ,HBL     ,
     1              RPMR    ,RPMD    ,RPMM    ,RPMP    ,RPMB    ,
     2              HPREC   ,HPDEL   ,HPDEA   ,HPPRD   ,HPBLD   ,
     3              POREC   ,PODEL   ,PODEA   ,POPRD   ,POBLD   ,PO      ,
     4              HEADE   ,HEADR   ,HEADH   ,         PO3     ,POTOT
      WRITE(L,8045) AJ      ,AXJ     ,RATEIN  ,SMAP    ,PSAJ    ,EXSTM   ,
     1              WPL     ,CSLTBP  ,CSLTBH  ,SMAPPP  ,SMAPPH  ,UFC
      WRITE(L,8050) EACHG   ,HACHG   ,RACHG   ,UNPUMP  ,UNDRVE  ,UNELCT  ,
     1              UNARAE  ,UNARHI  ,XC(56)  ,UNSHLS  ,UNSHLC  ,USHELV
      WRITE(L,8055) EA      ,ES      ,PMC     ,WAIT    ,VPC     ,CHMPTC  ,
     1              CINSTC  ,EEC     ,DEACST  ,BHC     ,SITE    ,CIBC
      WRITE(L,8060) EA1     ,ES1     ,PMC1    ,WAIT1   ,VPC1    ,CHMPT1  ,
     1              CINST1  ,EEC1    ,DEA1    ,BHC1    ,SITE1   ,CIBC1   ,
     2              RETUB1  ,HC1     ,CC1     ,POCST1  ,OC1     ,AMSC1
      WRITE(L,8065) EA2     ,ES2     ,PMC2    ,WAIT2   ,VPC2    ,CHMPT2  ,
     1              CINST2  ,EEC2    ,DEA2    ,BHC2    ,SITE2   ,CIBC2   ,
     2              RETUB2  ,HC2     ,CC2     ,POCST2  ,OC2     ,AMSC2
      WRITE(L,8070) COMM    ,CAPI1   ,CAPI2   ,
     1                                CAPI4   ,RETUB2  ,TOC2    ,TC2     ,
     2                                CAPI3   ,RETUB1  ,TOC1    ,TC1
 8000 FORMAT(1H0,'FF        RP        P         PE        Q         CR        ',6D14.6/
     1          ' CO        CP        CCF       CB        LF2       YEAR      ',6D14.6)
 8005 FORMAT(1H0,'TS        THF       TCF       TK        TPE       TB        ',6D14.6/
     1          ' TE        TP        TO                            STLTMP    ',3D14.6,28X
     2 D14.6)
 8010 FORMAT(1H0,'WS        WF        WR        WPE       WPR       WP        ',6D14.6/
     1          ' WB        WO        WC        WOCEAN                        ',4D14.6)
 8015 FORMAT(1H0,'AN        ESTGL     RECOLN    HRECOV    VOLSTL    STLLEN    ',6D14.6/
     1          ' AK        RSTGL     REJLEN    HREJCT    VOLCNC    HOTLEN    ',6D14.6)
 8020 FORMAT(1H0,'WHOT      WCOLD     ATN       ENBH      BLDGS     TRAINS    ',6D14.6/
     1          ' TOTLEN    VOMTOT              ACRES     MODU      LEV       ',2D14.6,14X
     2 3D14.6)
 8025 FORMAT(1H0,'DOE       WALLE     ELE       ENE       AE        VE        ',6D14.6/
     1          ' DOR       WALLR     RLR       RNR       AR        VR        ',6D14.6/
     2          ' DOH       WALLH     HLH       HNH       AH        VH        ',6D14.6)
 8030 FORMAT(1H0,'UE        HIE       HOE       BKTE      RSE       OM1       ',6D14.6/
     1          ' UR        HIR       HOR       BKTR      RSR       OM2       ',6D14.6/
     2          ' UH        HIH       HOH       BKTH      RSH       PHE       ',6D14.6)
 8035 FORMAT(1H0,'QEL       SUBE      DTLSE     BPRE      ROE1      BDEPH     ',6D14.6/
     1          ' QRL       SUBR      DTLSR     BPRR      ROE2                ',5D14.6)
 8040 FORMAT(1H0,'HREC      HDEL      HDEA      HPR       HBL                 ',5D14.6/
     1          ' RPMR      RPMD      RPMM      RPMP      RPMB                ',5D14.6/
     2          ' HPREC     HPDEL     HPDEA     HPPRD     HPBLD               ',5D14.6/
     3          ' POREC     PODEL     PODEA     POPRD     POBLD     PO        ',6D14.6/
     4          ' HEADE     HEADR     HEADH               PO3       POTOT     ',3D14.6,14X
     5 2D14.6)
 8045 FORMAT(1H0,'AJ        AXJ       RATEIN    SMAP      PSAJ      HEAT      ',6D14.6/
     1          ' WPL       CSLTBP    CSLTBH    SMAPPP    SMAPPH    ELEC      ',6D14.6)
 8050 FORMAT(1H0,'EACHG     HACHG     RACHG     UNPUMP    UNDRVE    UNELCT    ',6D14.6/
     1          ' UNARAF    UNARHI    AERTE     UNSHLS    UNSHLC    USHELV    ',6D14.6)
 8055 FORMAT(1H0,'EA        ES        PMC       WAIT      VPC       CHMPTC    ',6D14.6/
     1          ' CINSTC    EEC       DEACST    BHC       SITE      CIBC      ',6D14.6)
 8060 FORMAT(1H0,'EA1       ES1       PMC1      WAIT1     VPC1      CHMPT1    ',6D14.6/
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    1           ' CINST1 EEC1    DEA1    BHC1    SITE1   CIBC1   ',6D14.6/     PR 70380
    2           ' RETUB1 HC1     CC1     POCST1  OC1     AMSC1   ',6D14.6)     PR 70390
8065 FORMAT(1H0,'EA2     ES2     PMC2    WAIT2   VPC2    CHMPT2  ',6D14.6/     PR 70400
    1           ' CINST2 EEC2    DEA2    BHC2    SITE2   CIBC2   ',6D14.6/     PR 70410
    2           ' RETUB2 HC2     CC2     POCST2  OC2     AMSC2   ',6D14.6)     PR 70420
8070 FORMAT(1H0,'COMM    CAPI1   CAPI2                           ',3D14.6/     PR 70430
    1           '                CAPI4   RETUB2  TOC2    TC2     ',28X,        PR 70440
    2 4D14.6/                                                                  PR 70450
    3           '                CAPI3   RETUB1  TOC1    TC1     ',28X,        PR 70460
    4 4D14.6)                                                                  PR 70470
     RETURN                                                                    PR 70480
     END                                                                       PR 70490
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APPENDIX D

CHANGES MADE IN SUBROUTINE RITEV

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      SUBROUTINE RITEV(IOPT,IOUT,L)                                     PR 60930
      IMPLICIT REAL*8(A-H,O-Z)                                          PR 60940
C                                                                       PR 60950
      REAL*8 LPHE                                                         ****
      DOUBLE PRECISION LAM,LAMDAS,MAVG                                  PR 60960
      DOUBLE PRECISION    LPH,     LVE,    IDBH,    IDPH,    LCON,    NCON,  PR 60970
     1   NTPH,  IDCCN                                                   PR 60980
      DOUBLE PRECISION     KBH,     KPH,     KVE,     LBH,     MGD,     NBH,  PR 60990
     1    NPH,     NVE,    KCON,    LMTD,   LVEP, LMTDBH, LMTDCN         PR 61000
      DOUBLE PRECISION     INT, INSTRD, INSTRK, INSTRY, MAINTK, MAINTY  PR 61010
      DOUBLE PRECISION LEV, LF2, MSFID                                  PR 61020
C                                                                       PR 61030
      COMMON/BLOCV1/    ANE,        HVE,        LPH,        LVE,     ACON,PR 61040
     1     GPMV,      HPVE,       HSEA,       IDBH,       IDPH,      LCON,PR 61050
     2     NCON,      NTPH,       ODBH,       ODPH,       ODVE,      POVE,PR 61060
     3     RPMV,     HFEED,      IDCON,      ODCON,      SUMWT,     VETSA,PR 61070
     4   APTSCN,    APTSEP,     OVRHGT,     TOTNVE,     VEPMPS            PR 61080
      COMMON/PINHAS/APTSH,ENRSS,ENRJS,LPHE,DUMDUM(16),NFEED,IIIII(9)      ****
      COMMON/BLOCV2/  A(30),          S,     AE(30),         QE,     TC(30),PR 61090
     1   TE(30),        TR,     UE(30),      UH(3),         WM,     WT(30),PR 61100
     2      ABH,       APH,    BPE(30),    CIE(30),    COE(30),    DPE(30),PR 61110
     3      ELL,       GBH,        GPH,        GPM,        HOO,       KBH,PR 61120
     4      KPH,       KVE,        LBH,        MGD,        NBH,       NPH,PR 61130
     5  NVE(30),       QPH,        RBH,        RPH,        RVE,       TOO,PR 61140
     6      UBH,       VBH,        VPH,   WPEX(30),       BHLF,      GCON,PR 61150
     7     HIBH,   HIPH(3),       HOBH,    HOPH(3),       KCON,   LMTD(3),PR 61160
     8     LVEP,      PHLF,    QMSF(3),       RCON,    SUBF(3),      TCON,PR 61170
     9     UCON,      VCON,       VLEN,       VTLF,   WDTH(30), ALFAE(30),PR 61180
     +    CONLF,     HICON,      HOCON,      HOTE1,      PHHGT,    POBLO,PR 61190
     A    POPRO,     POSEA,      SURFF,      VEHGT,      WALVE,    EFFSPC,PR 61200
     BELBNDL(30),   HCOTCF,     HCOTUO,     HEADBH,     HEADCN,    HEADPH,PR 61210
     C   LMTDBH,    LMTDCN,     PLNTLF,     PODEAS,     POFEED,    SUMWPE,PR 61220
     D   SUMWPH,    TOTAVE,       QESP,VEFEED(30),      WBOOST,    WDCOLD,PR 61230
     E       NE,      NTRN,      IFEED,     IRECYC                        PR 61240
      COMMON/BLOCV3/     BHD,        BHK,        BHY,        INT,       PMD,PR 61250
     1      PMK,       PMY,        VPD,        VPK,        VPY,      ACHR,PR 61260
     2     DEAD,      DEAK,       DEAY,       ELEC,       HEAT,      SBCD,PR 61270
     3     SBCK,      SBCY,      CHEMK,      CHEMY,      HEATK,     HEATY,PR 61280
     4    OPERK,     OPERY,      PLDIN,      WAITD,      WAITK,     WAITY,PR 61290
     5   ANCCMP,    CMCAPD,     CMCAPK,     CMCAPY,     CNDSRD,    CNDSRK,PR 61300
     6   CNDSRY,    ELECTD,     ELECTK,     ELECTY,     INSTRD,    INSTRK,PR 61310
     7   INSTRY,    MAINTK,     MAINTY,     PHTUBD,     PHTUBK,    PHTUBY,PR 61320
     8   PLCAPD,    PLCAPK,     PLCAPY,     POWERK,     POWERY,    RETUBK,PR 61330
     9   RETUBY,    SHELLD,     SHELLK,     SHELLY,     TOTALK,    TOTALY,PR 61340
     +   TOTOPK,    TOTOPY,     TREPBH,     TREPCN,     TREPPH,    TREPVE,PR 61350
     A   VETUBD,    VETUBK,     VETUBY,       CGPD                        PR 61360
      COMMON/COMNAM/      AJ,         CB,         CO,         CP,        CR,  PR 61370
     1       FB,        PI,         PO,         TB,         TO,        TP,  PR 61380
     2       TS,        WB,         WF,         WO,         WP,        WR,  PR 61390
     3      AXJ,       HBL,        HPR,        LEV,        LF2,       TCF,  PR 61400
     4     ENBH,      GPMB,       GPMD,       GPMH,       GPMO,      GPMP,  PR 61410
     5     GPMR,      HDEA,       RPMB,       RPMD,       RPMM,      RPMP,  PR 61420
     6     RPMR,      TSTH,       WHOT,       YEAR,      ACRES,     BHVOL,  PR 61430
     7    BLDGS,     BNDLS,      HOLES,      HPBLD,      HPDEA,     HPDEL,  PR 61440
     8    HPPRD,     HPREC,      PLPRD,      PLSEA,      PODEA,    ACNCEW,  PR 61450
     9   ACNCFL,    ACNCIW,     ACNCPH,     ACNCRF,     ACNCTR,    AEXCAV,  PR 61460
     +   ASTLEW,    ASTLFL,     ASTLIW,     ASTLPH,     ASTLRF,    ASTLTR,  PR 61470
     A   AWEIRS,    BHSURF,     DINTAK,     ENITSE,     ENPIPE,    ENSUPE,  PR 61480
     B   ENSUPR,    PIPELN,     PLSZMG,     REJLEN,     STLLEN,    STLTMP,  PR 61490
     C   TNACDY,    TRAINS,     TSAREA,     VOLCNC,     VOLSTL,    WOCEAN   PR 61500
      COMMON/BLOC13/ XO(300)                                            PR 61510
      COMMON/BLOC14/ XC(500)                                            PR 61520
      COMMON/NAME/ ANAME(10), AMONTH, IDAY, IYEAR                       PR 61530
      COMMON/DECKID/ MSFID(10),VTEID(10),EDID(10)                       PR 61540
      COMMON/IMPOVE/ IVERT                                              PR 61550
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      COMMON/BLKFAC/ FDFAC, QEFAC, TRFAC
C
      DIMENSION WPEI(30)
C
      EFF = XC(32)
      WALCON = XO(27)
      WALPH = XO(26)
      WALBH = XC(25)
      WPE = SUMWPE *AE(1)
      WPPH = SUMWPH *AE(1)
      PRP = 1.D3 *WP/(QE+QPH)
      PRVE =1.D3*WPE/QE
      PRPH =1.D3*WPPH/QPH
      LAMDAS = LAM(TS,PS,0.D0,0.D0)
      WSE = QE/LAMDAS
      WSPH = QPH/LAMDAS
      WS = WSE +WSPH
      TM = TE(1)
      DELTC = TCON -TR
      WR = DMAX1(0.D0,WO-WF+WM)
      VEVOL = AEXCAV *VEHGT
      PHVOL = AEXCAV *PHHGT
      AVGUPH = (UH(1)+4.*UH(2)+UH(3))/6.
      AVHIPH = (HIPH(1)+4.*HIPH(2)+HIPH(3))/6.
      AVHOPH = (HOPH(1)+4.*HOPH(2)+HOPH(3))/6.
      AVLTPH = (LMTD(1)+4.*LMTD(2)+LMTD(3))/6.
      AVGSUB = (SUBF(1)+4.*SUBF(2)+SUBF(3))/6.
      AVQMSF = (QMSF(1)+4.*QMSF(2)+QMSF(3))/6.
      CAPF = LF2
      CFVEI  = VETUBD/TOTAVE
      CFPHI  = PHTUBD/APH
      CFBHI = XC(133)+XC(126)
      CFCONI = CNDSRD/ACON
      CRVE = CIE(NE)/CO
      EFFL  = VLEN/ANE
      WVEMAX = WDLULD
      WVEMIN = WHCT
      TOTVOL = VOLCNC +VOLSTL
      QTR   = WF*(HCOTCF-HCOTOC)
      ROA = (TCF-TOO)/NPH
      CFSHEL = SHELLD/TOTVOL
      CFVE   = XC(63)
      CFPH   = XC(68)
      CFCCN = XC(74)
      CFBH   = XC(126)
      CFPUMP = XC(128)
      POTCT  = PO +POCEAS
      AVDPE = 0.0D0
      DPE(NE)=0.D0
      AVBPE = 0.0D0
      AVGUE=0.0D0
      AVDTVE = 0.0D0
      MAVG = 0.D0
      DO 100 I=1,NE
      AVGUE=AVGUE+UE(I)
      WPEI(I) = WPEX(I)*AE(1)
      AVDTVE = AVDTVE+A(I)
      AVDPE = AVDPE+DPE(I)
      AVBPE = AVBPE+BPE(I)
      MAVG = MAVG+AE(I)/AE(1)
  100 CONTINUE
      AVGUE=AVGUE/ANE
      AVDTVE = AVDTVE/ANE
      AVDPE = AVDPE/(ANE-1.D0)
      AVBPE = AVBPE/ANE
      MAVG = MAVG/ANE
      ELEC = 100.D0*ELEC
      HEAT = 100.D0*HEAT
C
      WRITE(L,200)
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      WRITE(L,115) VTEID                                                PR 62240
  115 FORMAT(1H ,10A8)                                                  PR 62250
      WRITE(L,202)AMONTH                                                PR 62260
  202 FORMAT(1H ,A8)                                                    PR 62270
      CCC = PLDIN*1.0-6                                                 PR 62280
      WRITE(L,2) (ANAME(KK),KK=1,10),MGD,TOTALK,CCC                     PR 62290
    2 FORMAT(///////////////////1H ,10A8////1H ,'                   PLAPR 62300
     1NT CAPACITY - MGD',F29.3/1H0,'UNIT COST OF DESALTED WATER - CENTS PR 62310
     2PER KILOGALLON',F19.3/1H0,'CAPITAL COST OF PLANT(DIRECT+INDIRECT)-PR 62320
     3 MILLIONS OF DOLLARS',F10.3)                                      PR 62330
      IF(IOPT .EQ. 0) WRITE(L,4)                                        PR 62340
      IF(IOPT .NE. 0) WRITE(L,5)                                        PR 62350
    4 FORMAT(1H0,/1H0,'THE PLANT HAS NOT BEEN OPTIMIZED')               PR 62360
    5 FORMAT(1H0,/1H0,'THE PLANT HAS BEEN OPTIMIZED')                   PR 62370
      IF(IFEED .GT. 0) WRITE(L,6)                                       PR 62380
    6 FORMAT(1H0,'THE DESIGN CONSTRAINTS HAVE REQUIRED AN INEFFICIENT USPR 62390
     1E OF CONDENSING SURFACE IN THE PREHEATER')                        PR 62400
      IF(IRECYC .GT. 0) WRITE(L,7)                                      PR 62410
    7 FORMAT(1H0,'THE CA2SO4 SOLUBILITY CONSTRAINT HAS REDUCED THE PRODUPR 62420
     1CT FROM THE PREHEATER')                                           PR 62430
      IF(IVERT .GT. 0) WRITE(L,8)                                       PR 62440
    8 FORMAT(1H0,'THE INPUT DATA HAVE REQUIRED THAT THE STANDARD M-VALUEPR 62450
     1S BE REVISED TO KEEP THE PLANT PHYSICALLY REASONABLE')            PR 62460
      IF(IOUT .EQ. 0) GO TO 1000                                        PR 62470
C                                                                       PR 62480
      WRITE(L,200)                                                      PR 62490
  200 FORMAT(1H1,'VERTICAL TUBE EVAPORATOR PLANT - ROUTINE VTE21')      PR 62500
      WRITE(L,115) VTEID                                                PR 62510
      WRITE(L,202)AMONTH                                                PR 62260
C         I. SUMMARY OF PLANT DATA                                      PR 62530
C            GENERAL                                                    PR 62540
      WRITE(L,8005) MGD    ,PRP    ,                                    PR 62550
     1              CO     ,PRVE   ,                                    PR 62560
     2              CP     ,PRPH   ,                                    PR 62570
     4              CR     ,                                            PR 62580
     5              NE     ,                                            PR 62590
     6              NPH,    YEAR                                        PR 62600
C           TEMPERATURES - DEG.F                                        PR 62610
      WRITE(L,8010) TS     ,WS     ,                                    PR 62620
     1              TM     ,WSE    ,                                    PR 62630
     2              TE(NE),WSPH    ,                                    PR 62640
     3              TB     ,WP     ,                                    PR 62650
     4              TP     ,WPE    ,                                    PR 62660
     5              TOO    ,WPPH   ,                                    PR 62670
     6              TC     ,WB     ,                                    PR 62680
     7                      WOCEAN,                                     PR 62690
     8              DELTC  ,WR     ,                                    PR 62700
     9                      VPH                                         PR 62710
C         II. DESCRIPTION OF PHYSICAL PLANT                             PR 62720
C            PLANT DIMENSIONS, FT.                                      PR 62730
      WRITE(L,8015) LVEP    ,OVRHGT ,                                   PR 62740
     1              LPH     ,VEHGT  ,                                   PR 62750
     2              WVEMIN  ,PHHGT  ,                                   PR 62760
     3              WVEMAX  ,VEVOL  ,                                   PR 62770
     4              NTRN    ,PHVOL  ,                                   PR 62780
     5              STLLEN  ,STLTMP                                     PR 62790
C           TUBING DESCRIPTION                                          PR 62800
      WRITE(L,8020) ODVE   ,ODPH   ,ODCON  ,                            PR 62810
     1              WALVE  ,WALPH  ,WALCON,                             PR 62820
     2              KVE    ,KPH    ,KCON   ,                            PR 62830
     3              RVE    ,RPH    ,RCON   ,                            PR 62840
     4                      XO(23),XO(24),                              PR 62850
     5              TCTNVE,NTPH    ,NCON   ,                            PR 62860
     6              LVE    ,LPHE   ,LCON   ,                            PR 62870
     7              TOTAVE,APH     ,ACON   ,                            PR 62880
     8              AVGUE  ,AVGUPH,UCON                                 PR 62890
C        III. HEAD REQUIREMENTS AND PUMPING REQUIREMENTS                PR 62900
      WRITE(L,8030) HSEA    ,POSEA   ,                                  PR 62910
     1              HFEED   ,POFEED  ,                                  PR 62920
     2              HPR     ,POPRO   ,                                  PR 62930
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      3              HBL     ,POBLO  ,                                       PR 62940
      4              HVE     ,PCVE   ,                                       PR 62950
      5              HDEA    ,PODEA  ,                                       PR 62960
      6                        PC                                            PR 62970
       WRITE(L,660)                                                          PR 63000
       WRITE(L,115) VTEID                                                    PR 63010
C        IV. SUBSICIARY SECTIONS                                             PR 63020
       WRITE(L,8035) LMTDBH,LMTDCN,                                          PR 63030
      1              HIBH    ,HICON ,                                        PR 63040
      2              HOBH    ,HOCON ,                                        PR 63050
      3              UBH     ,UCCN  ,                                        PR 63060
      4              QPH     ,QE    ,                                        PR 63070
      5              RBH     ,RCON  ,                                        PR 63080
      6              ABH     ,ACCN  ,                                        PR 63090
      A              NBH     ,NCCN  ,                                        PR 63100
      7              LBH     ,LCON  ,                                        PR 63110
      A              TCF     ,TO    ,                                        PR 63120
      8              TM      ,TR    ,                                        PR 63130
      9              WF      ,WO                                             PR 63140
       WRITE(L,200)                                                          PR 63150
       WRITE(L,115) VTEID                                                    PR 63160
       WRITE(L,202)AMONTH                                                    PR 62260
       WRITE(L,3) (ANAME(KK),KK=1,10)                                        PR 63180
    3 FCRMAT(1H0,10A8)                                                       PR 63190
       WRITE(L,650)                                                          PR 63200
       WRITE(L,655) (I,UE(I),WT(I),CIE(I),TE(I),TC(I),WPEI(I),               PR 63210
      1                 AE(I),NVE(I),A(I),ALFAE(I),I=1,NE)                   PR 63220
       WRITE(L,665) TCON                                                     PR 63230
  650 FCRMAT(1HC,53X,14HVE EFFECT DATA/                                      PR 63240
      1        1H0,6HEFFECT,4X,4HUBAR,10X,2HWT,9X,3HCIE,7X,2HTE,             PR 63250
      2             7X,2HTC,9X,3HWPE,8X,10HAREA (FT2),4X,                    PR 63260
      3             10HNUM. TUBES,4X,7HDELTA-T,4X,5HALPHA/)                  PR 63270
  655 FORMAT(1H ,I4,2X,F10.2,E14.4,F10.5,2F9.2,3E14.4,F9.2,F11.4)            PR 63280
  660 FORMAT('1')                                                            PR 63290
  665 FORMAT(50X,F9.2)                                                       PR 63300
 8005 FORMAT(  3HC I 2X 21HSUMMARY CF PLANT DATA/1H0 3X  7HGENERAL 48X      PR 63310
     118HPERFORMANCE RATIOS/ 8X 20HPLANT CAPACITY, MGD 1CX F10.2, 16X        PR 63320
     27HOVERALL 19X  F10.4/  8X 23HSEA WATER CONCENTRATION 7X F10.5,16X      PR 63330
     33HVTE     23X  F1C.4/  8X 23HPRODUCT CONCENTRATION   7X F10.6, 16XPR 63340
     412HPHTR(ACTUAL)  14X  F10.4/                                           PR 63350
     5     8X, 19HCONCENTRATION RATIO  ,11X, F10.4/                          PR 63360
     6         8X 17HNUMBER OF EFFECTS 13X I10  /8X 25HNO STAGES IN PREHEAPR 63370
     7TER     5X,F10.0/8X 25HYEAR CONSTRUCTION STARTED 5X,F10.0)             PR 63380
 8010 FORMAT(1HC 3X 20HTEMPERATURES - DEG F   37X 13HFLOWS, LBS/HR /8X       PR 63390
     1 5HSTEAM  25X F10.3, 16X 11HTCTAL STEAM 10X E15.6/8X 13HMAXIMUM BRPR 63400
     2INE 17X F10.3, 16X  8HVE STEAM 13X E15.6/8X 12HFINAL EFFECT 18X       PR 63410
     3F1C.3, 16X 10HPHTR STEAM11X E15.6/8X 8HBLOWDOWN 22X F10.3,16X          PR 63420
     413HTCTAL PRCDUCT 8X E15.6/                                             PR 63430
     5 8X 7HPRODUCT 23X F10.3, 16X 10HVE PRODUCT 11X E15.6 /                 PR 63440
     6 8X 14HDEAERATEC FEED 16X F10.3, 16X 12HPHTR PRODUCT 9X E15.6 /        PR 63450
     7 8X 5HOCEAN 25X F10.3, 16X 8HBLOWDOWN 13X E15.6 /                      PR 63460
     7 64X 16HSEA INTAKE          5X E15.6/                                  PR 63470
     8 8X 18HCONDENSER APPROACH 12X F10.3 , 16X 16HCONDENSER REJECT 5X       PR 63480
     9 E15.6 / 64X 18HTUBE VELOCITY, FPS F18.3 )                             PR 63490
 8015 FORMAT(33HOII DESCRIPTICN OF PHYSICAL PLANT /1H0 3X 20HPLANT DIMENPR 63500
     1SICNS, FT /8X 20HOVERALL PLANT LENGTH 10X F10.3, 16X 14HOVERALL HEPR 63510
     2IGHT 7X F15.3/8X 18HVE AND PHTR LENGTH 12X F10.3, 16X 9HVE HEIGHT PR 63520
     312X F15.3/8X 15HMIN TRAIN WIDTH 15X F10.3, 16X 11HPHTR HEIGHT 10X PR 63530
     4F15.3/8X 15HMAX TRAIN WIDTH 15X F1C.3, 16X 20HVE SHELL VOLUME, FT3PR 63540
     5D16.6/8X 12HNO OF TRAINS 18X I10, 16X 22HPHTR SHELL VOLUME, FT3   PR 63550
     6D14.6/8X 21HLENGTH OF STEEL SHELL 9X F10.3, 16X 25HTEMP AT STL-CNCPR 63560
     7 INTERFACE F11.3)                                                      PR 63570
 8020 FORMAT(1HO 3X 18HTUBING DESCRIPTION/ 43X 2HVE 21X  9HPREHEATER         PR 63580
     116X  9HCONDENSER / 8X 19HOUTSIDE DIA, INCHES F21.3,2F26.3/8X           PR 63590
     222HWALL THICKNESS, INCHES,F18.3,2F26.3/ 8X 14HK,BTU/HR FT2 F           PR 63600
     33F26.3/ 8X 18HFOULING RESISTANCE F22.5,2F26.5/8X 15HFLOODING FACTOPR 63610
     4R  9X 16X 2F26.3/ 8X 11HNO OF TUBES 3X,3F26.0      / 8X 15HTUBE LPR 63620
     1ENGTH FT                                                               PR 63630
     5             9X F16.3, 2F26.3/ 8X 17HSURFACE AREA, FT2  E23.8,2E26.8/PR 63640
     6 8X 18HAVG CVERALL UBAR        F22.3, 2F26.3)                          PR 63650
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 8030 FORMAT(26H0III HEAD REQUIREMENTS, FT 33X 30HPUMPING POWER REQUIREMPR 63660
     1ENTS, MW//8X 18HSEA WATER DELIVERY 12X  F10.3, 16X 12HINTAKE PUMPSPR 63670
     215XF10.4/ 8X 14HPREHEATER FEED16X F10.3, 16X 15HPHTR FEED PUMPS12XPR 63680
     3F10.4/8X 16HPRODUCT DELIVERY14X F10.3, 16X 13HPRODUCT PUMPS 14X   PR 63690
     4F10.4/8X 18HBLOWDOWN DISCHARGE12X F10.3,16X 15HBLOWDOWN PUMPS  12XPR 63700
     6F10.4/8X 16HVERTICAL EFFECTS 14X F10.3, 16X 12HEFFECT PUMPS 15X   PR 63710
     7F10.4/8X 17HBOOSTER-DEAERATOR 13X F10.3, 16X 13HBOOSTER PUMPS 14X PR 63720
     8F10.4/64X 18HTOTAL (ELECTRICAL) 9X F10.4)                         PR 63730
 8035 FORMAT(24H0 IV SUBSIDIARY SECTIONS / 35X 12HBRINE HEATER  10X     PR 63750
     1 9HCONDENSER                       / 1H0 7X 7HLMDT, F 17X 2F16.3/     PR 63760
     2                              8X 20HH INSIDE, B/HR FT2 F  4X2F16.2/PR 63770
     3                              8X 21HH OUTSIDE, B/HR FT2 F 3X 2F16.2PR 63780
     4/                             8X 21HOVERALL U, B/HR-FT2-F    3X     PR 63790
     52F16.3/                                  8X 17HHEAT RATE, BTU/HR  7XPR 63800
     62E16.6/                                     8X 18HFOULING RESISTANPR 63810
     7CE  6X  2F16.5/                                     8X 17HSURFACE APR 63820
     8REA, FT2  7X 2E16.6/                                   8X 11HNO OF TPR 63830
     9UBES 13X2F16.0/                                 8X 15HTUBE LENGTH,PR 63840
     A FT,9X,2F16.3/                                                    PR 63850
     B8X,20HTEMP-COOLANT IN, F   ,4X,2F16.3/                            PR 63860
     C8X,20HTEMP-COOLANT EXIT, F,4X,2F16.3/                             PR 63870
     D8X,9HTUBE FLOW,15X,2E16.6)                                        PR 63880
C*****    OUTPUT COST CALCULATIONS                                      PR 63890
      WRITE(L,200)                                                      PR 63900
      WRITE(L,115) VTEID                                                PR 63910
      WRITE(L,202)AMONTH                                                PR 62260
      WRITE(L,3) (ANAME(KK),KK=1,10)                                    PR 63930
      WRITE(L,605)                                                      PR 63940
      WRITE(L,610)   VETUBY,VETUBK,VETUBD,PHTUBY,PHTUBK,PHTUBD,         PR 63950
     1               SHELLY,SHELLK,SHELLD,PMY   ,PMK   ,PMD   ,         PR 63960
     2               WAITY ,WAITK ,WAITD ,VPY   ,VPK   ,VPD   ,         PR 63970
     3               CMCAPY ,CMCAPK,CMCAPD,INSTRY,INSTRK,INSTRD,        PR 63980
     4               ELECTY,ELECTK,ELECTD,DEAY  ,DEAK  ,DEAD  ,         PR 63990
     5               CNDSRY,CNDSRK,CNDSRD,BHY   ,BHK   ,BHD   ,         PR 64000
     6               SBCY  ,SBCK  ,SBCD                                 PR 64010
      WRITE(L,615)   PLCAPY,PLCAPK,PLCAPD,PLDIN ,CGPD  ,                PR 64020
     1               RETUBY,RETUBK                                      PR 64030
      STFEJ=XC(210)*100.D0                                                ****
      EJC2=XC(211)                                                        ****
      EJC1=XC(212)                                                        ****
      WRITE(L,620)   HEATY ,HEATK ,EJC2,EJC1,CHEMY,CHEMK ,              PR 64040
     1               POWERY,POWERK,OPERY ,OPERK ,                       PR 64050
     2               MAINTY,MAINTK                                      PR 64060
      WRITE(L,625) TOTOPY,TOTOPK,TOTALY,TOTALK                          PR 64070
      WRITE(L,630) ELEC  ,HEAT,STFEJ      ,ACHR  ,INT   ,AJ    ,          ****
     1             EFF    ,CAPF  ,PLNTLF                                PR 64090
      WRITE(L,635) VTLF  ,PHLF  ,BHLF  ,CONLF ,                         PR 64100
     1              TREPVE,TREPPH,TREPBH,TREPCN,                        PR 64110
     2              CFVEI ,CFPHI ,CFBHI ,CFCONI                         PR 64120
  605 FORMAT(1H0,57X,17HCOST SUMMARY PAGE /                             PR 64130
     1        1H0,15X,10HCOMPONENTS,19X,9HCOST-$/YR,                    PR 64140
     2             7X,11HCOST-C/KGAL,7X,13HCOST-$ DIRECT/               PR 64150
     3        1H ,15X,10H----------,19X,9H---------,                    PR 64160
     4             7X,11H-----------,7X,13H-------------)               PR 64170
  610 FORMAT(1H0,4X,21HEFFECT TUBES + SHEETS ,13X,F15.2,F16.4,F21.2/    PR 64180
     1        1H ,4X,21HPHTR TUBES + SHEETS   ,13X,F15.2,F16.4,F21.2/   PR 64190
     2        1H ,4X,21HVE + PHTR SHELL       ,13X,F15.2,F16.4,F21.2/   PR 64200
     3        1H ,4X,21HPUMPS AND MOTORS      ,13X,F15.2,F16.4,F21.2/   PR 64210
     4        1H ,4X,21HSEA-WATER INTAKE      ,13X,F15.2,F16.4,F21.2/   PR 64220
     5        1H ,4X,21HVALVES AND PIPING     ,13X,F15.2,F16.4,F21.2/   PR 64230
     6        1H ,4X,21HCHEMICAL CAPITAL      ,13X,F15.2,F16.4,F21.2/   PR 64240
     7        1H ,4X,21HINSTRUMENTS           ,13X,F15.2,F16.4,F21.2/   PR 64250
     8        1H ,4X,21HELECTRICAL            ,13X,F15.2,F16.4,F21.2/   PR 64260
     9        1H ,4X,21HNCG REMOVAL SYSTEM    ,13X,F15.2,F16.4,F21.2/   PR 64270
     A        1H ,4X,21HCONDENSER             ,13X,F15.2,F16.4,F21.2/   PR 64280
     B        1H ,4X,21HBRINE HEATER          ,13X,F15.2,F16.4,F21.2/   PR 64290
     C        1H ,4X,21HSITE, BLDGS., CRANES  ,13X,F15.2,F16.4,F21.2/   PR 64300
     D        1H ,93X,13HCOST-$DIR+IND,7X,5H$/GPD,/                     PR 64310
     E        1H ,93X,25H-------------       -----)                     PR 64320
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615 FORMAT(1H ,8X,13HTOTAL CAPITAL,17X,F15.2,F16.4,F21.2,F15.2,F12.4/ PR 64330
   1        1H0,8X,13HRETUBING       ,17X,F15.2,F16.4)                 PR 64340
 620 FORMAT(1H0,4X,19HPROCESS HEAT        ,15X,F15.2,F16.4/            PR 64350
   *        1H ,4X,19HSTEAM TO EJECTORS  ,15X,F15.2,F16.4/               ****
   1        1H ,4X,19HCHEMICAL           ,15X,F15.2,F16.4/             PR 64360
   2        1H ,4X,19HPOWER              ,15X,F15.2,F16.4/             PR 64370
   3        1H ,4X,19HOPERATING          ,15X,F15.2,F16.4/             PR 64380
   4        1H ,4X,19HMAINT. + SUPPLIES  ,15X,F15.2,F16.4)             PR 64390
 625 FORMAT(1H0,8X,15HTOTAL OPERATING,15X,F15.2,F16.4/                 PR 64400
   1        1H0,33HTOTAL(CAPITAL+RETUBING+OPERATING),5X,F15.2,F16.4)   PR 64410
 630 FORMAT(13H0COST FACTORS/                                          PR 64420
   1        35H0COST OF ELECTRICITY, C/KWHR        ,F16.6/             PR 64430
   2        35H COST OF PROCESS HEAT, C/MBTU       ,F16.6/               ****
   *        35H COST OF EJECTOR STEAM, C/MBTU      ,F16.6/               ****
   3        35H ANNUAL CHARGE RATE                 ,F16.6/             PR 64450
   4        35H INTEREST RATE                      ,F16.6/             PR 64460
   5        35H HIGHER COST FACTOR                 ,F16.6/             PR 64470
   6        35H PUMP AND MOTOR EFFICIENCY          ,F16.6/             PR 64480
   7        35H PLANT LOAD FACTOR                  ,F16.6/             PR 64490
   8        35H PLANT LIFE, YEARS                  ,F16.6)             PR 64500
 635 FORMAT(1H0,27X,16H VERTICAL EVAP. ,16H   PREHEATER     ,          PR 64510
   1                16H  BRINE HEATER  ,16H   CONDENSER    /           PR 64520
   2        21H0TUBE LIFE, YEARS    ,5X,4F16.8/                        PR 64530
   3        21H RETUBING CHARGE RATE,5X,4F16.8/                        PR 64540
   4        21H AREA COST, $/SQ.FT. ,5X,4F16.8/3X 11H(INSTALLED) )     PR 64550
C                                                                      PR 64560
 1000 CONTINUE                                                         PR 64570
C                                                                      PR 64580
      WRITE(L,7000)                                                    PR 64590
      WRITE(L,115) VTEID                                               PR 64600
      WRITE(L,202)AMCNTH                                               PR 62260
      WRITE(L,3) (ANAME(KK),KK=1,10)                                   PR 64620
      WRITE(L,7005) MGD    ,PRP    ,PRVE   ,PRPH   ,CRVE   ,CR     ,   PR 64630
     1              CO     ,CP     ,CB     ,CIE(NE),MAVG   ,CAPF       PR 64640
      WRITE(L,7010) TS     ,TM     ,TCF    ,TE(NE) ,TCON   ,STLTMP ,   PR 64650
     1              TO     ,TOO    ,TB     ,TP     ,TR     ,STLLEN     PR 64660
      WRITE(L,7015) WP     ,WPE    ,WPPH           ,WOCEAN ,WF     ,   PR 64670
     1              WC     ,WR     ,WM     ,WSE    ,WSPH   ,WS         PR 64680
      WRITE(L,7020) ANE    ,EFFL   ,LVEP   ,VEHGT  ,VEVOL  ,TRAINS ,   PR 64690
     1              NPH    ,ELL    ,LPH    ,PHHGT  ,PHVOL  ,BLDGS  ,   PR 64700
     2              WVEMAX ,WVEMIN ,ACRES  ,OVRHGT ,TOTVOL ,FNBH       PR 64710
      WRITE(L,7025) ODBH   ,WALBH  ,LBH    ,NBH    ,ABH    ,VBH    ,   PR 64720
     1              OCPH   ,WALPH  ,LPH    ,NTPH   ,APH    ,VPH    ,   PR 64730
     2              ODCON  ,WALCON ,LCON   ,NCON   ,ACON   ,VCON   ,   PR 64740
     3              ODVE   ,WALVE  ,LVE    ,TOTNVE ,TOTAVE ,GPM        PR 64750
      WRITE(L,7030) UBH    ,HIBH   ,HOBH   ,KBH    ,RBH    ,LMTDBH ,   PR 64760
     1              AVGUPH ,AVHIPH ,AVHOPH ,KPH    ,RPH    ,AVLTPH ,   PR 64770
     2              UCON   ,HICON  ,HOCON  ,KCON   ,RCON   ,LMTDCN ,   PR 64780
     3              AVGUE  ,               KVE    ,RVE    ,AVDTVE      PR 64790
      WRITE(L,7035) QE             ,AVDPE  ,AVBPE  ,                   PR 64800
     1              QPH    ,QTR            ,AVQMSF ,AVGSUB ,ROA        PR 64810
      WRITE(L,7040) HSEA   ,HFEED  ,HPR    ,HBL    ,HVE    ,HDEA   ,   PR 64820
     1              RPMD   ,RPMR   ,RPMP   ,RPMB   ,RPMV   ,RPMM   ,   PR 64830
     2              POSEA  ,POFEED ,POPRO  ,POBLO  ,POVE   ,PODEA  ,   PR 64840
     3              HEADPH ,HEADBH ,HEADCN ,EFF    ,PODEAS ,PO         PR 64850
      WRITE(L,7045) AJ     ,AXJ    ,INT    ,ACHR   ,ANCOMP ,FDFAC,       ****
     1              VTLF   ,PHLF   ,BHLF   ,CONLF  ,PLNTLF ,QEFAC ,      ****
     2              TREPVE ,TREPPH ,TREPBH ,TREPCN ,XC(56)  ,TRFAC       ****
      WRITE(L,7050) CFVE   ,CFPH   ,CFBH   ,CFCON  ,CFSHEL ,HEAT   ,   PR 64890
     1              CFVEI  ,CFPHI  ,CFBHI  ,CFCONI ,CFPUMP ,ELEC       PR 64900
      WRITE(L,7055) VETUBD ,PHTUBD ,SHELLD ,PMD    ,WAITD  ,           PR 64910
     1              VPD    ,CMCAPD ,DEAD   ,CNDSRD ,BHD    ,PLCAPD ,   PR 64920
     2              INSTRD ,ELECTD ,SBCD                   ,PLDIN      PR 64930
      WRITE(L,7060) VETUBY ,PHTUBY ,SHELLY ,PMY    ,WAITY  ,           PR 64940
     1              VPY    ,CMCAPY ,DEAY   ,CNDSRY ,BHY    ,RETUBY ,   PR 64950
     2              INSTRY ,ELECTY ,SBCY                   ,PLCAPY ,   PR 64960
     3              HEATY  ,CHEMY  ,POWERY ,OPERY  ,MAINTY ,TOTOPY ,   PR 64970
     4              TCTALY                                             PR 64980
      WRITE(L,7065) VETUBK ,PHTUBK ,SHELLK ,PMK    ,WAITK  ,           PR 64990
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     1                VPK     ,CMCAPK ,DEAK    ,CNDSRK ,BHK     ,RETUBK ,
     2                INSTRK ,ELECTK ,SBCK                       ,PLCAPK ,
     3                HEATK  ,CHEMK  ,POWERK ,OPERK  ,MAINTK ,TOTOPK ,
     4                YEAR   ,CGPD   ,TOTALK
C
C  OUTPUT FORMATS FOR CONDENSED SUMMARY PAGE
C
 7000 FORMAT(1H1,'VERTICAL TUBE EVAPORATOR PLANT - ROUTINE VTE21',7X,
     1      '  CONDENSED SUMMARY OF PLANT DATA')
 7005 FORMAT(1H0,'MGD     PRP     PRVE    PRPH    CRVE    CR      ',6D14.6/
     1          ' CO      CP      CB     CIE(NE) MAVG    CAPF    ',6D14.6)
 7010 FORMAT(1H0,'TS      TM      TCF     TE(NE) TCON    STLTMP ',6D14.6/
     1          ' TO      TOO     TB      TP      TR      STLLEN ',6D14.6)
 7015 FORMAT(1H0,'WP      WPE     WPPH            WOCEAN WF      ',3D14.6,14X
     A2D14.6/
     1          ' WO      WR      WM      WSE     WSPH    WS      ',6D14.6)
 7020 FORMAT(1H0,'ANE     EFFL    LVEP    VEHGT   VEVOL   TRAINS ',6D14.6/
     1          ' NPH     ELL     LPH     PHHGT   PHVOL   BLDGS  ',6D14.6/
     2          ' WVEMAX WVEMIN ACRES   OVRHGT TOTVOL ENBH   ',6D14.6)
 7025 FORMAT(1H0,'ODBH    WALBH   LBH     NBH     ABH     VBH    ',6D14.6/
     1          ' ODPH    WALPH   LPH     NTPH    APH     VPH    ',6D14.6/
     2          ' ODCCN   WALCCN LCON    NCON    ACON    VCON   ',6D14.6/
     3          ' ODVE    WALVE   LVE     TOTNVE TOTAVE GPM    ',6D14.6)
 7030 FORMAT(1H0,'UBH     HIBH    HOBH    KBH     RBH     LMTDBH ',6D14.6/
     1          ' AVGUPH AVHIPH AVHOPH KPH     RPH     AVLTPH ',6D14.6/
     2          ' UCON    HICON   HOCON   KCON    RCON    LMTDCN ',6D14.6/
     3          ' AVGUE                   KVE     RVE     AVDTVE ',D14.6,28X
     4  3D14.6)
 7035 FORMAT(1H0,'QE              AVDPE   AVBPE                  ',D14.6,14X,
     12D14.6/
     2          ' QPH     QTR             AVQMSF AVGSUB ROA    ',2D14.6,14X
     33D14.6)
 7040 FORMAT(1H0,'HSEA    HFEED   HPR     HBL     HVE     HDEA   ',6D14.6/
     1          ' RPMD    RPMR    RPMP    RPMB    RPMV    RPMM   ',6D14.6/
     2          ' POSEA   POFEED POPRO   POBLO   POVE    PODEA  ',6D14.6/
     3          ' HEADPH HEADBH HEADCN EFF     PODEAS PO     ',6D14.6)
 7045 FORMAT(1H0,'AJ      AXJ     INT     ACHR    ANCOMP  FDFAC ',6D14.6/
     1          ' VTLF    PHLF    BHLF    CCNLF   PLNTLF  QEFAC ',6D14.6/
     2          ' TREPVE TREPPH TREPBH TREPCN AERTE   TRFAC ',6D14.6)
 7050 FORMAT(1H0,'CFVE    CFPH    CFBH    CFCON   CFSHEL HEAT   ',6D14.6/
     1          ' CFVEI   CFPHI   CFBHI   CFCONI CFPUMP ELEC   ',6D14.6)
 7055 FORMAT(1H0,'VETUBD PHTUBD SHELLD PMD     WAITD          ',5D14.6/
     1          ' VPD     CMCAPD DEAD    CNDSRD BHD     PLCAPD ',6D14.6/
     2          ' INSTRD ELECTD SBCD                    PLDIN  ',3D14.6,
     A28X,D14.6)
 7060 FORMAT(1H0,'VETUBY PHTUBY SHELLY PMY     WAITY          ',5D14.6/
     1          ' VPY     CMCAPY DEAY    CNDSRY BHY     RETUBY ',6D14.6/
     2          ' INSTRY ELECTY SBCY                    PLCAPY ',3D14.6,
     A28X,D14.6/
     3          ' HEATY   CHEMY   POWERY OPERY   MAINTY TOTOPY ',6D14.6/
     4          '                                       TOTALY '70X, D14.6)
 7065 FORMAT(1H0,'VETUBK PHTUBK SHELLK PMK     WAITK          ',5D14.6/
     1          ' VPK     CMCAPK DEAK    CNDSRK BHK     RETUBK ',6D14.6/
     2          ' INSTRK ELECTK SBCK                    PLCAPK ',3D14.6,
     A28X,D14.6/
     3          ' HEATK   CHEMK   POWERK OPERK   MAINTK TOTOPK ',6D14.6/
     4          '                         YEAR    CGPD    TOTALK '42X,3D14.6)
      RETURN
      END
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