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Computer Model for Economic Study of Unbleached Kraft Paperboard Production

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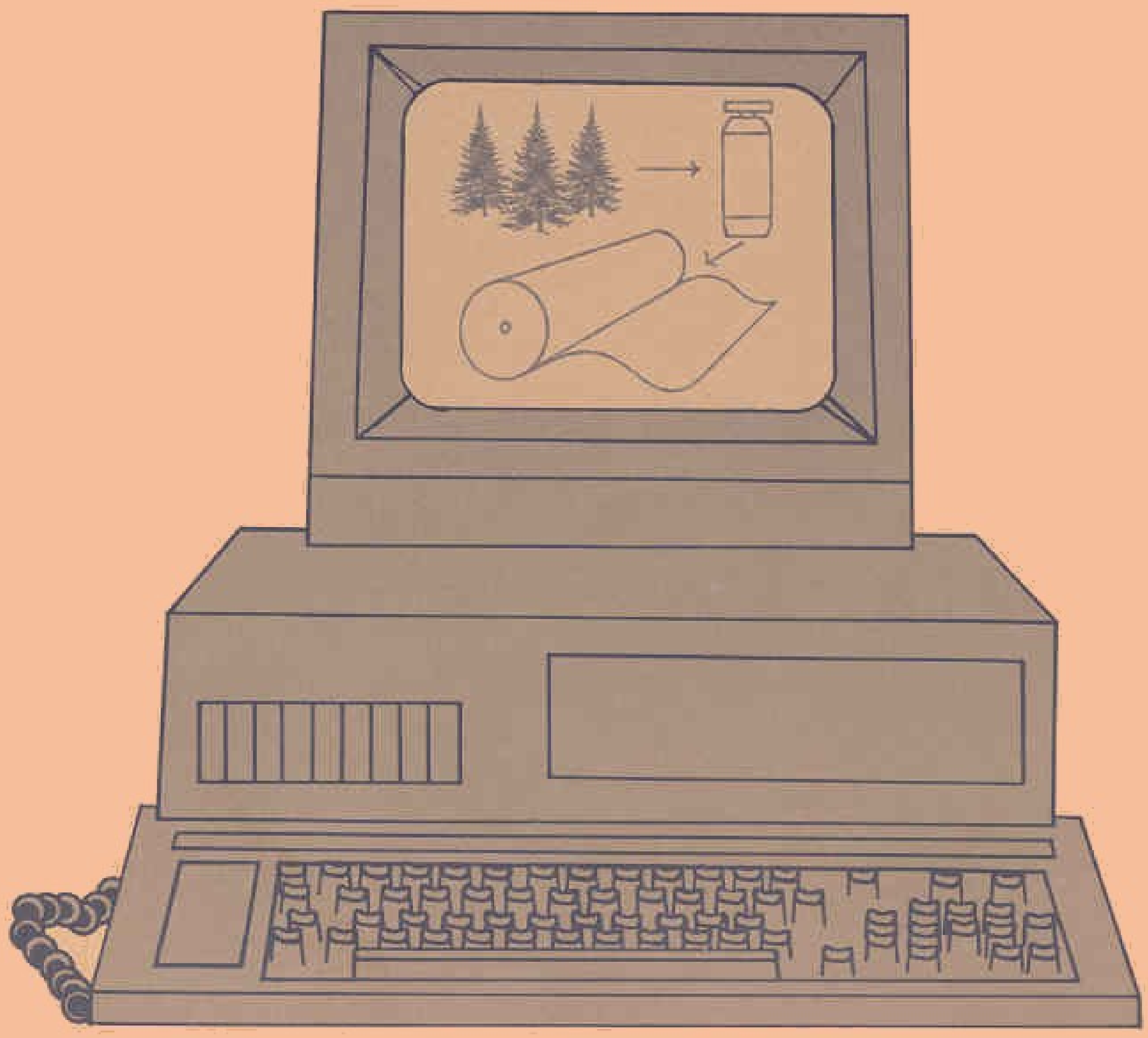

Abstract

Unbleached kraft paperboard is produced from wood fiber in an industrial papermaking process. A highly specific and detailed model of the process is presented. The model is also presented as a working computer program. A user of the computer program will provide data on physical parameters of the process and on prices of material inputs and outputs. The program is then used to calculate material and energy requirements of the process, and to calculate related revenues and variable costs. The program does not derive capital costs or fixed costs. The program is most useful in estimating precisely the economic impact of changes in physical parameters of the process, changes in technology, or changes in related prices. As such, the model can be used to estimate the economic effect, on revenues and costs, of technological changes or changes in prices.

Keywords: Economics, technology, unbleached kraft, paperboard, process, computer model.

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Foreword

The computer model described in this report was developed entirely at the Forest Products Laboratory, on the University of Wisconsin's UNIVAC 1110 computing system. The program is written in standard ANSI FORTRAN language. A prospective user should at least have (1) some basic experience or famillarity with FORTRAN computer language and (2) a goad working knowledge of parameters in the model, which are the major parameters in an unbleached kraft paperboard production process.

Acknowledgment

Cherllyn A. Hatfield, statistical assistant at the Forest Products Laboratory, transcribed the program; added many program statements necessary to run the program, and was largely responsible for debugging the program and checking for statistical accuracy.

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Introduction

Unbleached kraft paperboard is produced from wood fiber in fairly complex Industrial papermaking processes, typically in large paperboard mills. Such mills usually Include a wood preparation area, a kraft digester, a Chemical recovery process, a paper machine, steam and power system, and related facilities. Various publications and texts describe these processes.[1] Overall, in modern conventional mills there is a general similarity in process design and equipment configuration.

Because the production process is complex, any changes in supplies, equipment, or design may have far-reaching effects on material and energy requirements, and costs and revenues. We have designed a computer model to calculate those material and energy requirements of the unbleached kraft paperboard process and to estimate the associated revenues and variable costs. This paper describes that model.

The computer model uses a set of data consisting of about 180 physical variables of the process and also prices of various inputs and outputs. (It does not include capital costs or fixed costs, such as administrative overhead or maintenance.) The data include major process variables as well as many minor variables. As a result, the user is able to develop an understanding of the sensitivity of results to specific changes in the process, For example, the model can be used to study the potential economic impact of a specific new technological development. First, given a set of data that represent a "conventional" process, the user can operate the model on those data to obtain "base case" results, the conventional process material and energy requirements, revenues and variable costs. The user can then adjust all data variables that are likely to change as a result of the new technological development. The user can then again operate the model using the adjusted variables as data to obtain new results, new material and energy requirements, and new revenue and variable cost estimates. Results can be compared to the base case results to provide an understanding of the physical and economic impact of the new technology. Such results are useful in planning research, setting research goats and priorities, and in evaluating the economic potential of results of technical research and developments in pulping and papermaking.

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[1]The Technical Association of the Pulp and Paper Industry (TAPPI) has recommended texts on these processes, of which two are:

Joint Textbook Committee of the Paper Industry. Pulp and Paper Manufacture Series, Vol. I, II, and III. 2d ed. (MacDonald, Ronald G., ed.; Franklin, John J., technical ed.) McGraw-HilI, New York; 1969. (Available from Teppi.)

Casey, James P., ed. Pulp and Paper, VoI. I, II, and III. Wiley Interscience, New York: 1968.

Scope of Model

The computer model is a detailed representation of a modern unbleached kraft paperboard production process. A general diagram of the process Is shown in figure 1. The model itself consists of nine separate elements or subroutines. The subroutines are as follows, in the order in which they are referenced by the main program:

STPREP, which models stock preparation, additives, paper machine, finishing, and shipping areas of the process;
DIG, which models the digester, pulp washers, black liquor evaporators, and concentrators area of the process;
WDPREP, which models the wood preparation, debarking, chipping, and chip-screening area of the process;
RECBLR, which models the recovery boiler, lime kiln, and recausticizing area of the process;
ELEC, which models electric power requirements of the overall process;
STEAM, which models the steam system and electrical cogeneration;
PWRBLR, which models the power boiler, coal handling, and desulfurizing area of the process;
WATER, which models water supply and wastewater treatment; and
SALES, which models sales revenues, material, energy, and labor costs associated with the process.

The nine subroutines are described separately in detail. Each subroutine requires a specific separate set of data input, which is provided along with sample values. A list of the mathematical calculations contained in each subroutine is also included. A flow diagram, showing the physical material and energy flows and process areas associated with each subroutine, is given whenever appropriate. Finally, a sample printout from the computer model, based on the sample input data, is provided as are user notes and guidelines for application of the model. A complete listing of the FORTRAN program Is Included in the Appendix.

Model Subroutines

Subroutine STPREP Stock preparation, paper machine, finishing, and shipping area

This subroutine calculates the quantities of various inputs required in the stock preparation, paper machine, finishing, and shipping area of the overall process. It also reads prices of various inputs to that area. The data required for this subroutine include total finished paper or paperboard product output (in dry tons per day), rates of use of chemicals and sizing additives in stock preparation, moisture content of sheet into and out of the paper machine dryer, and so on. Altogether, 26 items of data are required. The specific parameters, each assigned a four-letter code name, are listed in alphabetical order:

ACID -Quantity of concentrated sulfuric acid added to system in stock preparation (pounds/dry ton of paper or paperboard produced).
ALUM -Quantity of alum added in stock preparation as dry alum solids in liquid slurry (pounds/dry ton of paper or paperboard produced).
DBKT -Paper or paperboard recycled as dry “broke” and trim to stock preparation (ratio of total paper or paperboard production).
DFOM -Quantity of defoamer additives in stock preparation and machine areas (pounds/dry ton of paper or paperboard produced).
DSMC -Moisture content of sheet entering heated dryer section (ratio of total weight of sheet).
PACD -Purchase price, f.o.b. mill, of sulfuric acid ($/ton).
PALM -Purchase price, f.o.b. mill, of alum ($/ton).
PCOR -Price of recycled old corrugated, used as raw material furnish in stock preparation ($/dry ton).
PDFM -Purchase price, f.o.b. mill, of defoamer ($/ton).
PMNO -Minimum density of paper or paperboard product (dry pounds/1,000 $feet^2$).
PPAP -Price of other recycled paper used as raw material in stock preparation ($/dry ton).
PPDN -Average density of paper or paperboard product (dry pounds/1,000 $feet^2$).
PPMC -Average reel moisture content of paper or paperboard product (total weight basis).
PPRD -Paper or paperboard production volume of the mill (dry tons/day).
PRSN -Purchase price, f.o.b. mill, of rosin ($/ton).
PSLM -Purchase price, f.o.b. mill, of slimicide ($/ton).
PSTC -Purchase price, f.o.b. mill, of starch ($/ton).
RCOR -Recycled old corrugated raw material as a ratio of total weight of paper (board) product (decimal ratio of dry product weight). Recycled furnish enters in stockprep.
RCYD -Yield or recovery weight for recycled old corrugated (ratio of raw material dry weight recovered in product),
RPAP -Recycled paper raw material as a ratio of total weight of paper (board) product (decimal ratio of dry product weight).

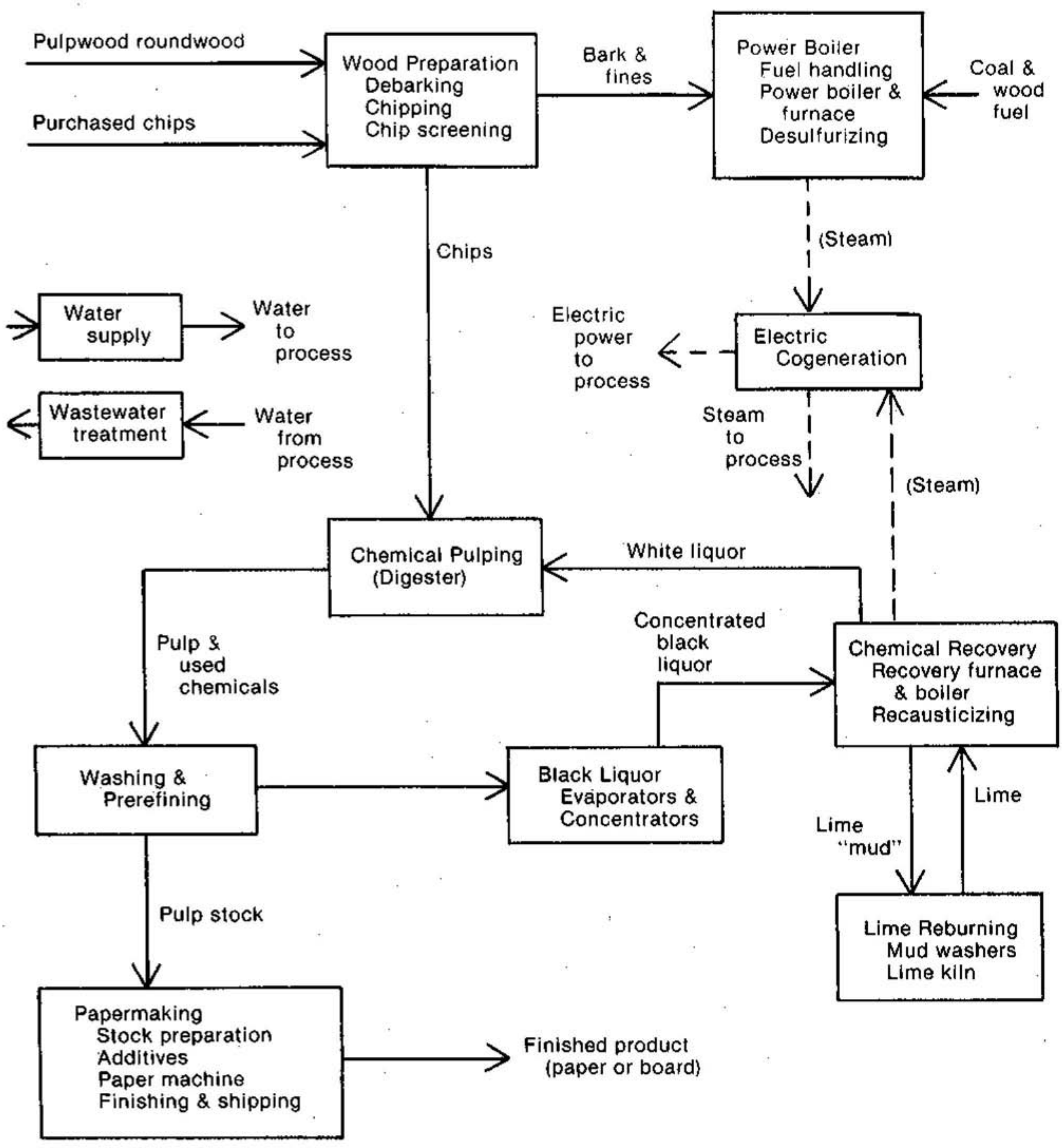

Figure 1.—Schematic of an unbleached kraft papermaking process

RPYO -Yield or recovery rate for recycled paper raw material (ratio of raw material dry weight recovered in product).
ROSN -Quantity of rosin added in stock preparation as rosin solids (pounds/dry ton of paper or paperboard produced).
SLIM -Quantity of slimicide additives (pounds/dry ton of product).
STRC Quantity of starch additives in stock preparation as dry solids (pounds/dry ton of paper board product).
SVAL -Average sales value, f.o.b. mill, of paper or paperboard product ($/dry ton).
TRWD -Trimmed reel width on sheet roll winder (inches).

Calculations in Subroutine STPREP are:

Calculate total dry weight of chemical and sizing additives, assuming all of alum, starch, and rosin additives are in final product, plus one-half of acid, defoamer, and slimicide additives, by weight (pounds/dry ton of product).

ADTV = ALUM + STRC + ROSN + 0.5x(ACID + DFOM + SLIM)

Calculate quantity of recycled old corrugated used (dry tons/day):

RCRT = RCOR x ((PPRD - (PPRD x ADTV/2000.0))/RGYD)

Calculate quantity of recycled paper used (dry tons/day):

RPPT = RPAP x ((PPRD - (PPRD x ADTV/2000.0))/RPYD)

Calculate wood pulp production quantity required (dry tons of pulp/day):

PROD = PPRD - (PPRD x ADTV/2000.0) - (RCRT x RCYD). (RPPT x RPYD)

Calculate total dry paper throughput of paper machine, including product plus dry broke and dry trims volume recycled (dry tons/day):

TDPT = PPRD + (PPRD x DBKT)

Calculate average operational paper machine speed (lineal feet of finished paper sheet/min):

ASPD = ((PPRD/1440.0) x (2000.0)/(PPDN/1000.0))/(TRWD/12.0)

Calculate maximum operational paper machine speed (lineal feet of finished product/min):

MSPD = ((PPAD/1440.0) x (2000.0)/(PMND/1000.0))/(TRWD12.0)

Calculate total water removal in heated dryer section of paper machine (tons/day):

TWRD = (TDPT/(1.0 - DSMC)) - (TDPT/(1.0 - PPMC))

Calculate each additive required (tons/day):

TALM = PPRD x ALUM/2000.0
TACD = PPRD x ACID/2000.0
TSTC = PPRD x STRC/2000.0
TDFM = PPRD x DFOM/2000.0
TRSN = PPRD x ROSN/2000.0
TSLM = PPRD x SLIM/2000.0

A flow diagram (fig. 2) Illustrates the process areas and parameters modeled in this subroutine. The data parameters are underlined and parameters calculated (see list of calculations) in this subroutine are shown in parentheses. Note that figure 2 includes parameters related to steam demands and electric power factors used in later subroutines,

Subroutine DIG: Digester, pulp washers, black liquor evaporators, and concentrators area

This subroutine calculates the quantities of Inputs and outputs in the digester(s), pulp washers, black liquor evaporators, and concentrators area. Results are based in part on the quantity of wood pulp required in stock preparation, as derived by the previous subroutine. Fourteen additional items of data are required for this subroutine:

AACN -Active alkali concentration in white liquor (pounds/cubic foot white liquor).
AALK -Active alkali (in white liquor entering digester), sodium hydroxide and sodium sulfide in white liquor, in sodium oxide weight equlvalent (decimal ratio of dry wood weight).
BSDS -Black liquor solids In weak black liquor from digester and washers to evaporators (tons of dry solids/dry ton of pulp).
CCBL -Solids content of concentrated black liquor, exiting concentrators to salt cake mix tank in recovery boiler area (liquor solids weight ratio of total liquor).
CEBL -Solids content of evaporated black liquor, exiting evaporators and entering concentrators (liquor solids weight ratlo of total liquor).
CNBL -Solids content of weak black liquor exiting washers to evaporators (black liquor solids weight ratlo of total black liquor weight).
PWMC -Pulpwood moisture content entering chip feed (decimal ratlo of wet weight).
PYLD -Pulp yield, ovendry weight of pulp to dry weight of pulp chip raw material entering digester (decimal ratio).
SCLS -Total salt cake (sodium sulfate) losses, or “makeup chemical” requirements (salt cake added In recovery) (pounds/dry ton of pulp).
SCPL -Salt cake loss in pulp out of washers (ratio of total salt cake losses). (Remaining salt cake losses are assumed to occur in evaporators, recovery furnace, and recausticizing areas.)

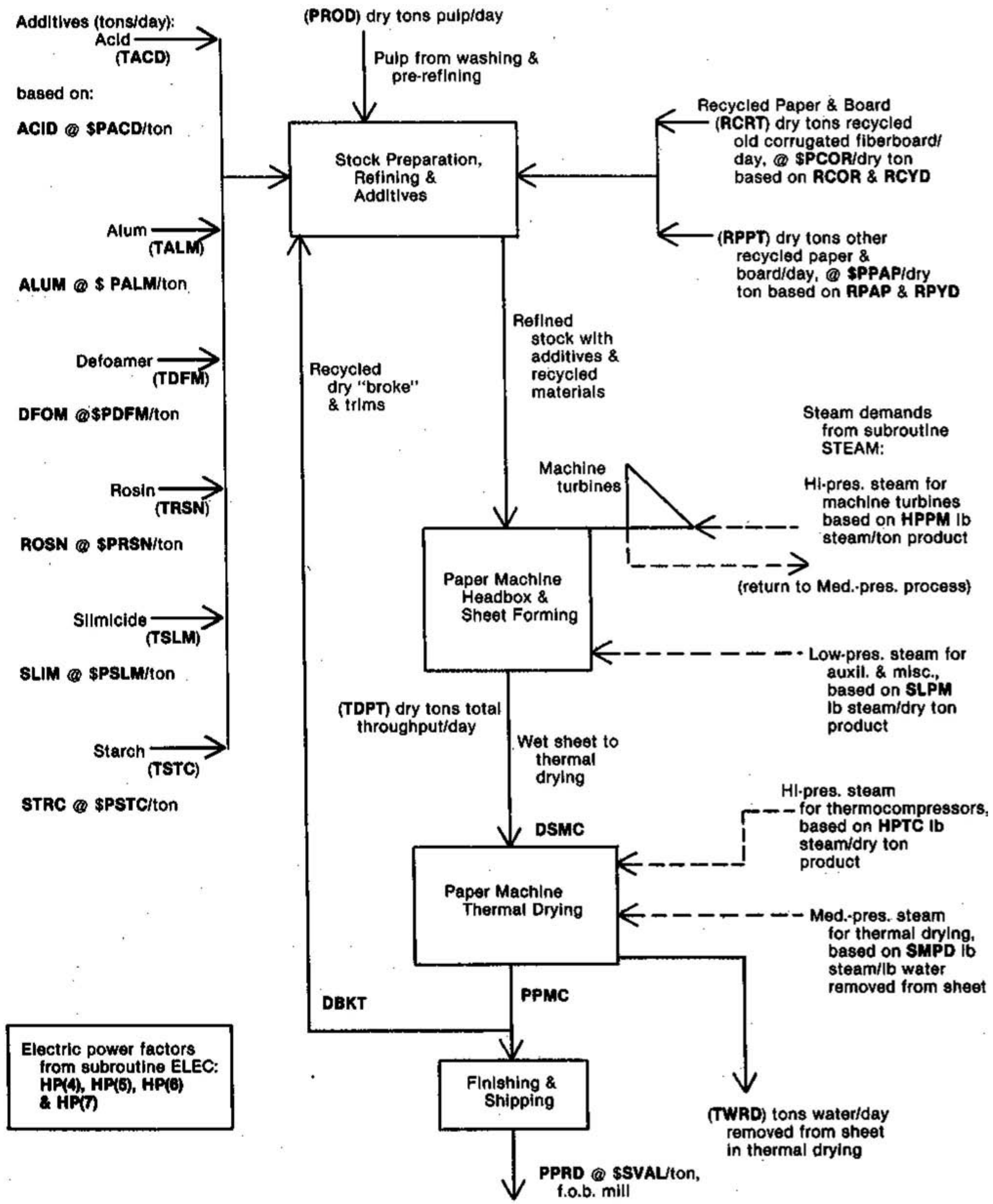

Figure 2.–Stock preparation, paper machine, finishing and shipping area: Subroutine STPREP.

SOAP -Quantity of saponifled fatty acids (soap) recovered in soap skimmer in evaporator area (soap will go to external tall oil plant) (dry pounds/ton of wood chips into digester).
SOPP -Sales value, f.0.b. mill, of soap skimmings ($/ton).
TPSV -Turpentine sales value, f.0.b. mill ($/gallon),
TURP -Turpentine recovery (gallons/ton of wood chips into digester).

Calculations for Subroutine DIG are:

Calculate quantity of pulpwood chips required as input to digester (dry tons/day):

PPWD = PROD/PYLD

Calculate turpentine recovery from wood chips:

(A) Calculate recovery (gallons/day):

TRPD = TUAP x PPWD

(B) Turpentine specific gravity:

TSPG = 0.6

(C) Turpentine recovery (tons/day):

TRTD = TRPD x (0.13368) x (62.4) x TSPG/2000.0

Calculate black liquor solids to evaporators in weak black liquor (tons/day).

TBLS = PROD x BSDS

Calculate water to evaporators in weak black liquor (tons/day):

WBLW = (TBLS/CNBL) - TBLS

Calculate soap recovery and black liquor solids remaining after soap recovery (tons/day):

SOPR = SOAP x PPWD/2000.0
TBLS = TBLS - SOPR

Calculate active alkali required in sodium oxide weight equivalent (in white liquor to digester) (tons/day):

TDAA = AALK x PPWD

Calculate wet weight of pulpwood chips into digester (tons/day):

PWIN = PPWD/(1.0 - PWMC)

Calculate water In evaporated liquor to black liquor concentrators (tons/day):

EBLW = (TBLS/CEBL) - TBLS

Calculate water removal In evaporators (tons/day):

WREV = WBLW-EBLW

Calculate water in concentrated black liquor to recovery area (tons/day):

CBLW = (TBLS/CCBL) - TBLS

Calculate water removal in black liquor concentrators (tons/day);

WRCN = EBLW - CBLW

Calculate white liquor volume to digester (thousand gallons/day):

TWLV = ((TDAA x 2000.0)/AACN)/133.68058

A flow diagram (fig. 3) shows the process area and parameters modeled in this subroutine. Parameters calculated in this subroutine are in parentheses. Note also that figure 3 includes parameters related to steam demands and electric power factors used in later subroutines.

Subroutine WDPREP: Wood preparation area

This subroutine calculates the quantities of various kinds of pulpwood required as input to the wood preparation area. Six kinds of pulpwood are included in the model: hardwood species–roundwood, purchased whole-tree chips and purchased “clean” chips; and softwood species-roundwood, purchased whole-tree chips and purchased ”clean” chips. This subroutine also calculates the quantities of wood “residues,” bark and fines, generated in the wood preparation area. A total of 27 items of data is required by this subroutine:

HBPC -Weight ratio removed as bark in debarking hardwood roundwood pulpwood (ratio of total dry weight of purchased roundwood including bark).
HCHM - Moisture content of hardwood purchased “clean” chip pulpwood (decimal ratio of wet weight, average).
HTCF -Fines removed In screening hardwood purchased “clean” chips (ratio of total dry weight of chips).
HWCD -Total weight per cord of hardwood roundwood pulpwood, wet weight basis (pounds/cord including bark, as purchased).
HWFR - Fines removed in screening hardwood roundwood chips (ratlo of total dry weight of hardwood roundwood chips before screening).
HWMC -Average moisture content in hardwood roundwood pulpwood (ratio of total wet weight of pulpwood as purchased, including bark).
HWPC -Hardwood purchased chip furnish (whole-tree and “dean”) as a ratio of total hardwood into digester (fraction of total dry weight of hardwood purchased chip and roundwood furnish).

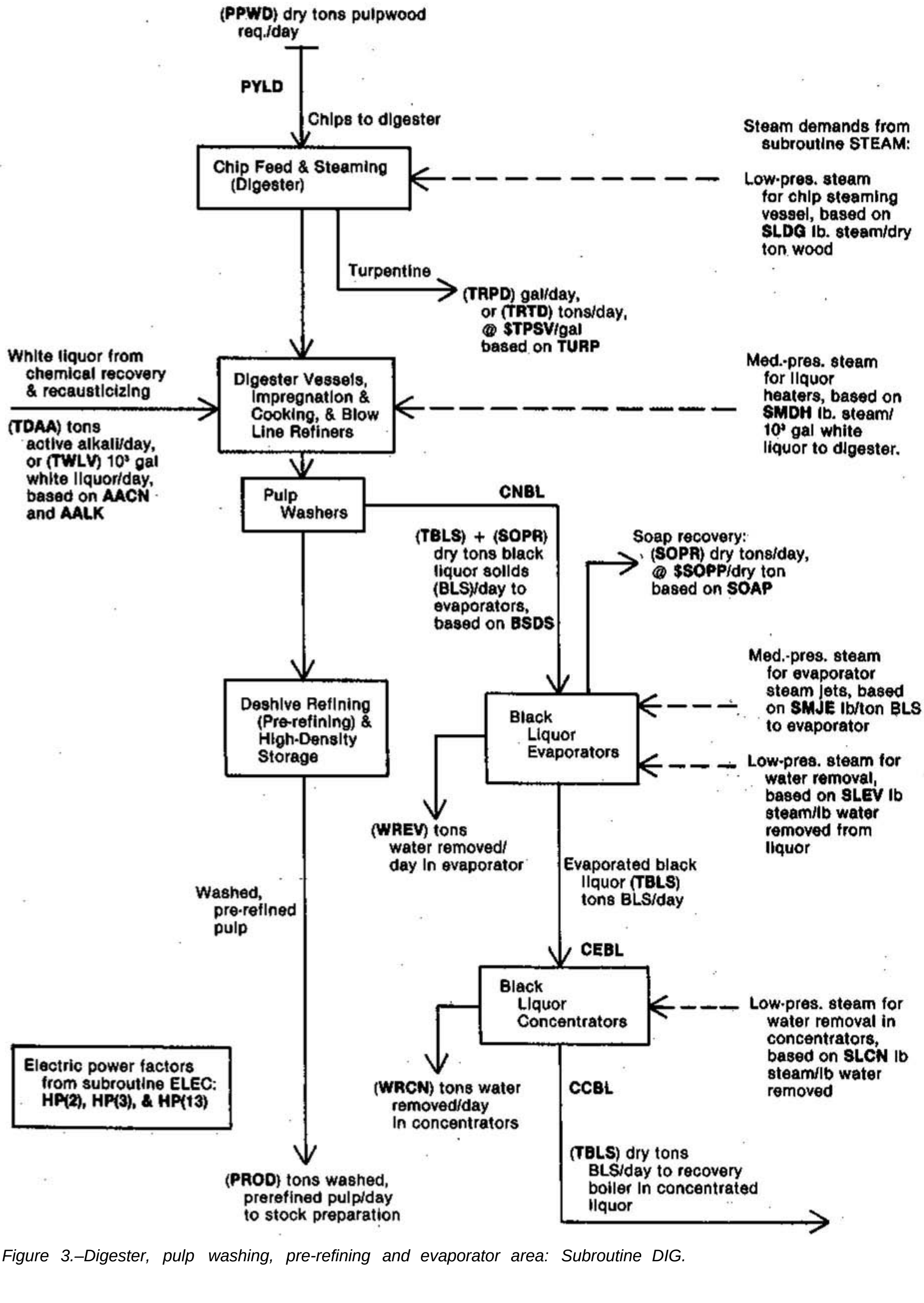

Figure 3.–Digester, pulp washing, pre-refining and evaporator area: Subroutine DIG.

HWTC -Hardwood whole-tree chips as a ratio of total hardwood purchased chips (ratio of total dry weight of hardwood purchased chips).

HWTF -Bark and fines removed in screening hardwood whole-tree chips (decimal ratio of total dry weight of hardwood wholetree chips).

HWTM -Moisture content of hardwood purchased whole-tree chips (decimal ratlo of wet weight, average).

PHPC -Price or value of hardwood purchased "clean" chips ($/ton as purchased, average).

PHRW -Purchase price, f.o.b. mill, of hardwood roundwood ($/cord, average).

PHWC -Purchase price, f.o.b. mill, of hardwood whole-tree chips ($/ton as purchased, average).

PSPC -Price or value of softwood purchased "clean" chips ($/ton as purchased, average).

PSHW -Purchase price, f.o.b. mill, of softwood roundwood ($/cord, average).

PSWC -Purchase price, f.o.b. mill, of softwood whole tree chips ($/ton as purchased, average).

SBPC -Weight ratio removed as bark in debarking softwood roundwood pulpwood (ratio of total dry weight of purchased roundwood, including bark).

SCHM -Moisture content of softwood purchased "clean" chip pulpwood (decimal ratio of wet weight, average),

SFWD -Softwood ratio of total pulpwood furnish into digester (decimal ratio of total dry weight of furnish).

STGF -Fines removed in screening softwood purchased "clean" chips (ratio of total dry weight of softwood purchased "clean" chips).

SWCD -Total weight per cord of softwood roundwood pulpwood, wet weight basis (pounds/cord including bark, as purchased).

SWFR -Fines removed in screening softwood roundwood chips (ratio of total dry weight of softwood roundwood chips before screening).

SWMC "Average moisture content in softwood roundwood pulpwood (ratio of total wet weight of pulpwood as purchased, including bark).

SWPC -Softwood purchased chip furnish (whole-tree and "clean") as a ratio of total softwood into digester (fraction of total dry weight of softwood purchased chip and roundwood furnish).

SWTC -Softwood whole-tree chips as a ratlo of total softwood purchased chips (ratio of total dry weight of softwood purchased chips).

SWTF -Bark and fines removed in screening softwood whole-tree chips (decimal ratio of total dry weight of softwood wholetree chips).

SWTM -Moisture content of softwood purchased whole-tree chips (decimal ratlo of wet weight, average).

Calculations for Subroutine WDPREP are:

Calculate quantity of softwood chips into digester (dry tons/day):

SPWD = PPWD x SFWD

Calculate quantity of hardwood chips into digester (dry tons/day):

HPWD = PPWD x (1.0 - SFWD)

Calculate quantity of softwood roundwood chips into digester (dry tons/day):

SRPW = SPWD x (1.0 - SWPC)

Calculate quantity of hardwood roundwood chips into digester (dry tons/day):

HRPW = HPWD x (1.0 - HWPC)

Calculate quantity of softwood fines removed in screening softwood roundwood pulpwood chips (fines go to power boiler) (dry tons/day):

SRFR = (SRPW/(1.0 - SWFR)) x SWFR

Calculate quantity of hardwood fines removed in screening hardwood roundwood pulpwood chips (fines go to power boiler) (dry tons/day):

HRFR = (HRPW/(1.0 - HWFR)) x HWFR

Calculate quantity of softwood bark removed from softwood roundwood (to power boiler) (dry tons/day):

SBRK = ((SRPW + SRFR)/(1.0 - SBPC)) x SBPC

Calculate quantity of hardwood bark. removed from hardwood roundwood (to power boiler)(dry tons/day):

HBRK = ((HRPW + HRFR)/(1.0 - HBPC)) x HBPC

Calculate required quantity of softwood roundwood pulpwood (cords/day):

CDSW = ((SRPW + SRFR + SBRK)/(1.0 - SWMC))/(SWCD/2000.0)

Calculate required quantity of hardwood roundwood pulpwood (cords/day):

COHW = (HRPW + HRFR + HBRK)/(1.0 - HWMC))/(HWCD/2000.0)

Calculate quantity of screened softwood purchased chips into digester (dry tons/day):

SPCH = SPWD x SWPC

Calculate quantity of screened hardwood purchased chips into digester (dry tons/day):

HPCH = HPWD x HWPC

Calculate quantity of softwood fines, including fines from whole-tree chips and "clean" chips screening (fines to power boiler) (dry tons/day):

SWCF = ((SPCH x SWTC)/(1.0 - SWTF)) x SWTF
SPCF = ((SPCH x (1.0 - SWTC))/(1.0 - STCF)) x STCF

Calculate quantity of hardwood fines, including fines from wholetree chip and "clean" chip screening (fines to power boiler) (dry tons/day):

HWCF = ((HPCH x HWTC)/(1.0 - HWTF)) x HWTF
HPCF = ((HPCH x (1.0 - HWTC))/(1.0 - HTCF)) x HTCF

Calculate quantity of "clean" softwood chips including fines (dry tons/day):

SPCC = (SPCH x (1.0 - SWTC)) + SPCF

Calculate quantity of softwood whole-tree chips including fines (dry tons/day):

SPWC = (SPCH x SWTC) + SWCF

Calculate quantity of "clean" hardwood chips including fines (dry tons/day):

HPCC = (HPCH x (1.0 - HWTC)) + HPCF

Calculate quantity of hardwood whole-tree chips including fines (dry tons/day):

HPWC = (HPCH x HWTC) + HWCF

Calculate quantity of "clean" softwood chips as received (tons/day) (wet weight basis):

SCCW = SPCC/(1.0 - SCHM)

Calculate quantity of softwood whole-tree chips as received (tons/day) (wet weight basis):

SWCW = SPWC/(1.0 - SWTM)

Calculate quantity of "clean" hardwood chips as received (tons/day) (wet weight basis):

HCCW = HPCC/(1.0 - HCHM)

Calculate quantity of hardwood whole-tree chips as received (tons/day) (wet weight basis):

HWCW = HPWC/(1.0 - HWTM)

A flow diagram (fig. 4) illustrates the process area modeled in this subroutine. Parameters calculated in this subroutine are shown in parentheses. Note also that the results obtained in this subroutine will be based in part on the quantity of pulpwood required in the digester, as calculated in subroutine DIG.

Subroutine RECBLR: Recovery boiler, lime kiln, and recausticizing area

This subroutine calculates the quantity of steam heat energy generated in the recovery boiler, with concentrated black liquor as fuel, and calculates the quantities of various other inputs required in the chemical recovery, recausticizing, and lime system area. A total of 16 items of data is required for this subroutine:

ACTV -Activity of white liquor (ratio of active alkali to total alkali, in sodium oxide weight equivalents).
AVLM -Lime availability (active calcium oxide weight ratio of total lime to slaker) (Remainder is assumed to be inert material in causticizing reaction.)
CAUS -Causticizing efficiency of causticizing reaction (measured as the weight ratio of sodium hydroxide to sodium hydroxide plus sodium carbonate in white liquor, expressed in sodium oxide weight equivalents, and in which the sodium hydroxide content of green liquor has been subtracted from the white liquor content (standard TAPPI definition)).
CNMD -Consistency of the filtered lime mud entering the lime kiln (dry weight of lime mud solids ratio of total weight of filtered lime mud).
EFKF -Average combustion heating efficiency of kiln fuel (ratio of higher heating value of fuel which is not lost in combustion gases and excess air exiting the kiln).
FLMR -Weight fraction of total lime mud recycled to the mud washer, representing uncalcined material captured in the lime kiln flue gas scrubber and emissions separator.
HHKF -Average higher heating value of kiln fuel (million Btu/fuel unit).
HRRB -Effective heat recovery ratio of recovery boiler (decimal ratio of gross heat energy value of black liquor solids recovered as steam heat energy (adjusted for total heat inputs to furnace and heat of reaction correction, as well as for combustion heat losses). (Not to be confused with combustion heat recovery efficiency of recovery boiler.))
HVBL -Gross heat energy value (higher heating value) of black liquor solids (Btu/dry pound).
PLMU -Purchased lime make-up (average weight ratio of total lime to slaker which is purchased or "make-up" lime).
PPKF -Average purchase price of kiln fuel ($/fuel unit).
PPLM -Purchase price, f.o.b. mill, of purchased lime ($/ton).
SVSC -Sales value, f.o.b. mill, of surplus salt cake generated in chemical recovery. and desulfurization areas ($/dry ton of surplus saltcake).

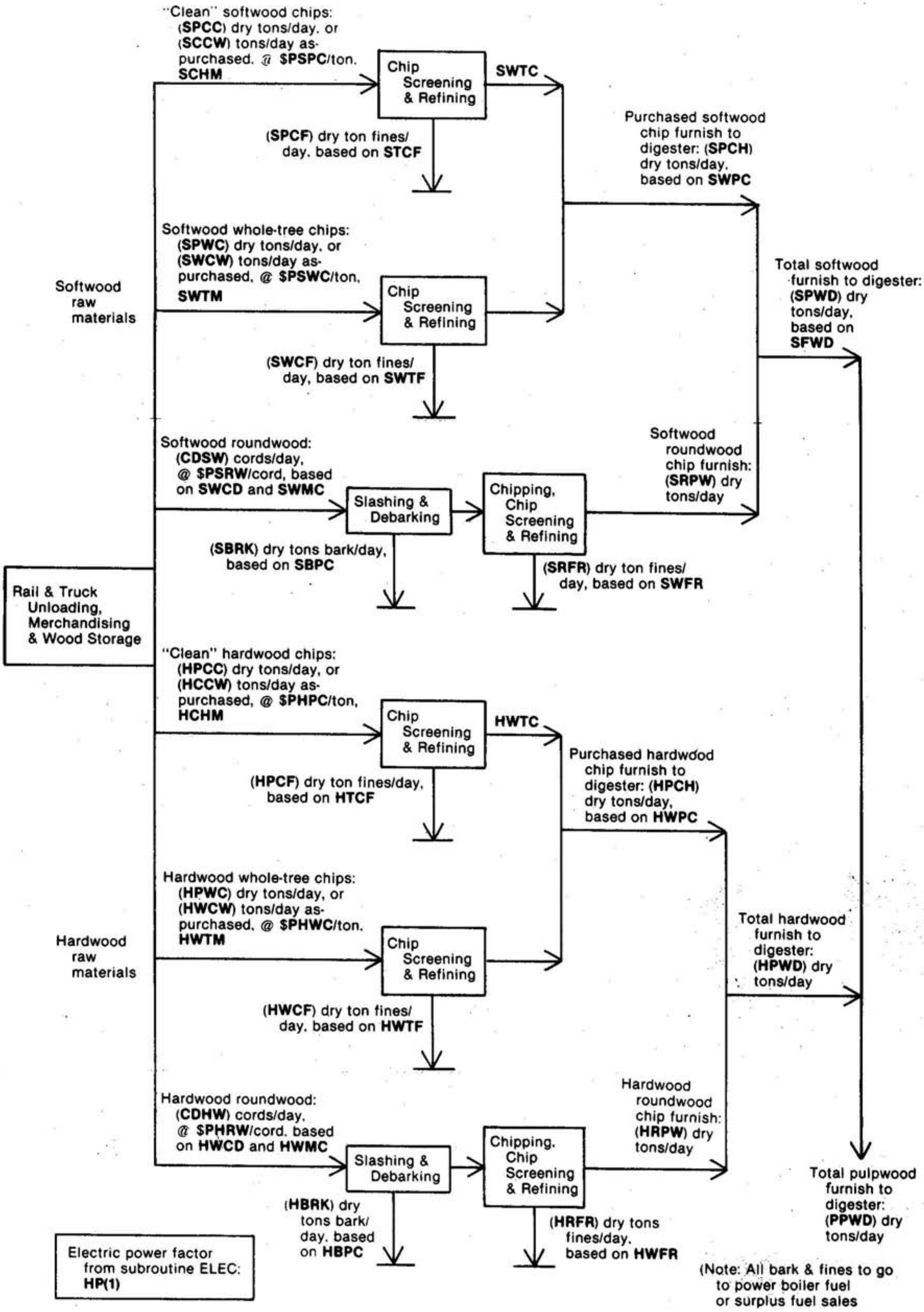

Figure 4.–Wood preparation area: Subroutine WDPREP.

SSWL -Sodium sulfate ratio of total alkali in white liquor (one-half weight ratio in sodium oxide equivalents).
TKEG -Temperature of kiln exit gases (°F, average).
TKPD -Average temperature of kiln product solids exiting kiln (°F).

Calculations for Subroutine RECBLR are:

Calculate heat energy to steam in recovery boiler (million Btu/day):

HSRB = TBLS x (0.002) x HVBL x HRRB

Calculate weight equivalent of total alkali (total sodium compounds) in white liquor, in sodium oxide weight equivalent (tons/day):

TALK = TDAA/ACTV

Calculate weight equivalent of sodium sulfate in white liquor, in sodium oxide weight equivalent (tons/day):

SDSL = TALK x SSWL

Calculate weight equivalent of sodium carbonate in white liquor, in sodium oxide weight equivalent (tons/day):

SDCA = TALK - (TDAA + SDSL)

Calculate weight equivalent of sodium hydroxide produced in causticizing reaction, in sodium oxide weight equivalent, corrected for sodium hydroxide present in green liquor, based on TAPPI definition of causticizing efficiency (tons/day):

SODH = (CAUS x SDCA)/(1.0 - CAUS)

Calculate actual weight of calcium oxide needed in causticizing reaction (tons/day):

CAOX = SODH x (56.0162.0)

Calculate quantity of purchased lime required (tons/day):

PLRQ = (CAOX x PLMU)/(AVLM)

Calculate total weight of lime produced in lime kiln to slaker (tons/day):

TWLP = (CAOX/AVLM) - PLRQ

Calculate weight of inert material in lime from lime kiln to slaker (tons/day):

WINR = TWLP x (1.0 - AVLM)

Calculate theoretical dry weight of lime mud to lime kiln (tons/day):

WTLM = ((TWLP - WINR) x (100.0156.0)) + WINR

Calculate actual dry weight of lime mud to lime kiln after correcting for particulate emissions and recycled fraction (to mud washer) (tons/day):

WTLM = WTLM/(1.0 - FLMR)

Calculate weight of water entering lime kiln with filtered lime mud (tons/day):

WIMK = (WTLM/CNMD) x (1.0 - CNMD)

Calculate heat energy requirements for lime kiln (million Btu/day) (assuming ambient temperature of 70 °F):

(A) Energy required to evaporate water in lime mud entering kiln:

WTEN = WIMK x (0.002) x (970.0 + (212.0 - 70.0) + (0.46 x (TKEG-212.0)))

(B) Energy into kiln product, assuming a specific heat of 0.25 Btu/pound of kiln product/°F above ambient temperature:

PLEN = TWLP x (0.002) x (TKPD - 70.0) x 0.25

(C) Energy required for dissociation of calcium carbonate in lime kiln, assuming a heat of dissociation of 1,390 Btu/pound of active calcium oxide in lime kiln product:

HDEN = (TWLP x AVLM) x (0.002) x (1390.0)

(D) Energy into carbon dioxide produced in dissociation reaction, assuming a specific heat of 0.25 Btu/pound of carbon dioxide gas/°F above ambient temperature:

CDEN = (TWLP x AVLM) x (44.0156.0) x (0.002) x (0.25) x (TKEG - 70.0)

(E) Calculate energy into recycled lime mud (e.g. flue gas dust) captured in scrubber and separators, assuming a specific heat of 0.25 Btu/pound of "dust"/°F above ambient:

EMEN = (WTLM x FLMR) x (0.002) x (TKEG - 70.0) x 0.25

(F) Calculate total heat energy requirements including a 15.0% factor for thermal radiation heat losses:

THEN = (WTEN + PLEN + HDEN + CDEN + EMEN) x 1.15

Calculate gross energy input requirements in kiln fuel (million Btu/day):

GHEN = THEN/EFKF

Calculate kiln fuel required (units/day):

TKFR = GHEN/-HHKF

A flow diagram (fig. 5) shows the process area modeled in this subroutine. Parameters calculated in this subroutine are in parentheses. Note that figure 5 includes parameters related to steam demands and electric power factors used in later subroutines. Note also that the results of this subroutine depend on the quantity of black liquor solids, as calculated in subroutine DIG.

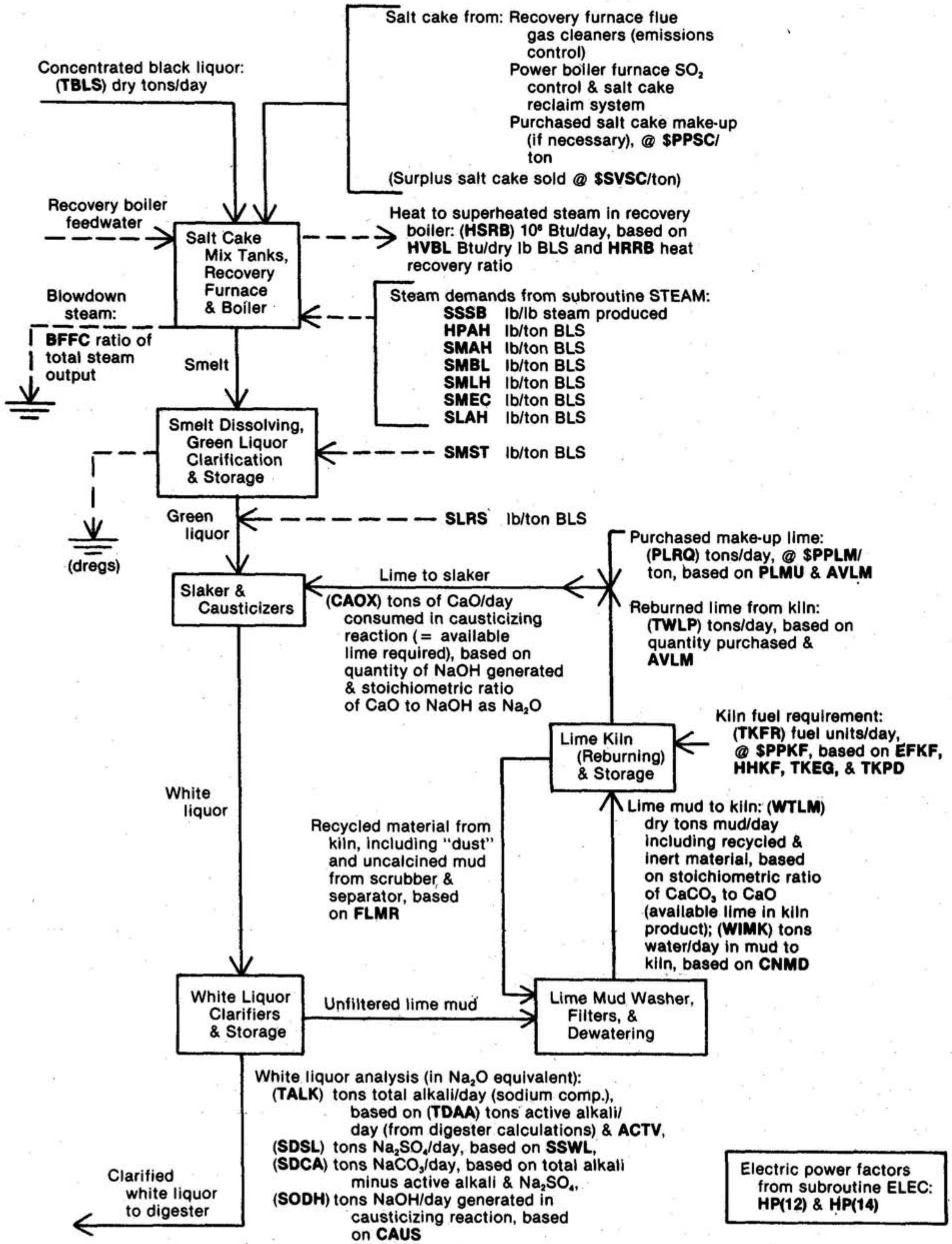

Figure 5.–Chemical recovery, lime kiln end recausticizing area: Subroutine RECBLR.

Subroutine ELEC: Electric power requirements

This subroutine calculates total electric power requirements of the overall process. A total of 19 items of data is required:

(Total connected horsepower of machines and equipment by mill area):

HP (1) - Wood preparation
HP(2) - Digester and turpentine area
HP(3) - Washing and refining
HP (4) - Stock preparation
HP(5) - Paper machine area
HP (6) - Additives area
HP(7) - Finishing and shipping
HP(8) - Water supply and treatment
HP (9) - Waste disposal
HP (10) - Power boiler, feedwater, and condensate areas
HP (11) - Coal handling
HP (12) - Recovery boiler area
HP (13) - Evaporators area
HP (14) - Lime kiln and recausticizing
HP (15) - Air supply system
HP (16) - Odor collection system

AEFU -Average efficiency of electrical energy use in mill equipment (decimal ratio of electric energy demand).
ALFC -Average power load factor for mill equipment (decimal ratio of total connected horsepower).
ANML -Average nonmotor load for mill and related facilities, for lighting and miscellaneous (kilowatts).

Calculations for Subroutine ELEC are:

Calculate total connected horsepower of mill machines and equipment:

TCHP = 0.0

TCHP = TCHP + HP (I), for I = 1 to 16

Calculate power load of mill machines and equipment (total horsepower):

TPLD = TCHP x ALFC

Calculate total electrical power demand of mill machines and equipment (kilowatts):

TEED = (TPLD/AEFU) x 0.746

Calculate total electrical power demand of mill, including nonmotor load:

TEED = TEED + ANML

Note that the electric power factors are used in each of the process subroutines (see flow diagrams).

Subroutine STEAM: Steam system, electric power, and cogeneration area

The purpose of this subroutine is to calculate the total process steam demands, to balance steam demands with steam output from the recovery and power boilers, to determine the quantity of cogenerated electric power, and to estimate the quantities of other related inputs and outputs for the steam system, electric power, and cogeneration areas of the process.

The model assumes three levels of process steam: high, medium, and low pressure. The model also assumes all process steam is obtained via a cogenerating turbine, which in turn obtains higher-pressure superheated steam from the power and recovery boilers. The assumptions built into this subroutine reflect typical conventional process design.

A total of 46 items of data is required for this subroutine. They include steam loss ratios, heat exchange efficiency, enthalpies of steam, feedwater, and make-up water, ratios of steam recovered, turbine generator efficiency, and various specific rates of process steam demand throughout the entire process:

BFFC -Blowdown ratio for power and recovery boilers (pounds blown/total pounds of steam produced in boilers). (Blow to flash tanks assumed to have low enthalpy and may be used to heat feedwater, but heat content is not accounted for here.)
CNSL -Losses from steam system in condensate receiver and deaerator (pounds of steam or condensate lost (e.g., in vents, etc.)/pound of total feedwater to power and recovery boilers).
FWHE - Feedwater heater heat exchange efficiency (ratio of heat input that exits in feedwater, average).
HCCN -Enthalpy of combined condensate from steam system to deaerator (Btu/pound of condensate).
HCMW -Enthalpy of make-up water to deaerator (Btu/pound of make-up water).
HHPP -Enthalpy of high-pressure process steam (Btu/pound of steam).
HLPP -Enthalpy of low-pressure process steam (Btu/pound of steam).
HMPP -Enthalpy of medium-pressure process steam (Btu/pound of steam).
HSHP -Enthalpy of superheated steam from boilers (Btu/pound of steam).
HTMS -Ratio of total high-pressure process steam recovered as medium-pressure process steam, excluding steam from turbines (ratio of total high-pressure steam).

PKWH -Price of purchased electrical energy ($/kilowatt-hour).

SMLS -Ratio of total medium-pressure process steam recovered as low pressure process steam, excluding steam from turbines (ratio of total medium-pressure steam).

SSSB -Superheated steam required for sootblowers in power and recovery boiler areas (pounds/total pounds of steam produced).

SVSE -Sales value of surplus electrical energy cogenerated in mill ($/kilowatt-hour).

TGEF -Turbine generator efficiency for conversion of steam energy to electrical energy (ratio of steam energy consumed to electric energy produced).

Average high-pressure process steam demands are:

HPAH -High-pressure steam for air heater in recovery boiler area (pounds/ton of black liquor solids to recovery boiler).

HPFW -High-pressure steam demand for power boiler feedwater heaters (pounds/pound of feedwater to power boiler).

HPMD -High-pressure steam miscellaneous demand volume (pounds/ton of product).

HPPB -High-pressure steam demand for power boiler area, air heaters, and miscellaneous (pounds/pound of steam produced in power boiler).

HPPM -High-pressure steam demand of paper machine and vacuum pump turbines (pounds/dry ton of paper or paperboard product). (This steam discharges to medium-pressure process steam header.)

HPSL -Losses from high-pressure process steam system (ratio of total high-pressure process steam not returned in condensate).

HPTC -High-pressure steam demand of paper machine thermocompressors for dryer drainage (pounds/dry ton of paper or paperboard product).

Average medium-pressure process steam demands are:

SMAH -Medium-pressure steam demand for air heater in recovery boiler area (pounds/ton of black liquor solids to recovery boiler).

SMAS -Medium-pressure steam demand for air supply area (pounds/dry ton of pulp produced).

SMBL -Medium-pressure steam demand for black liquor guns in recovery boiler furnace (pounds/ton of black liquor solids to recovery furnace).

SMDH -Medium-pressure steam demand for digester liquor heater (pounds/thousand gallons of white liquor to digester).

SMFW - Medium-pressure steam demand for power boiler feedwater heaters (pounds/pound of feedwater to power boiler).

SMEC - Medium-pressure steam demand for emissions control (electrostatic precipitators) in recovery boiler area (pounds/ton of black liquor solids to recovery furnace).

SMJE -Medium-pressure steam for steam jets in evaporators (pounds/ton of black liquor solids into evaporators).

SMLH - Medium-pressure steam demand for secondary black liquor heater in recovery boiler area (pounds/ton of black liquor solids to recovery boiler).

SMMD - Medium-pressure process steam miscellaneous demand volume (pounds/ton of product).

SMPB - Medium-pressure steam demand for power boiler area, air heaters, emissions control, and miscellaneous (pounds/pound of steam produced in power boiler).

SMPD - Medium-pressure steam demand for paper machine dryers (pounds/pound of water removed in heated dryer section of paper machine).

SMSL -Losses from medium-pressure process steam system (ratio of total medium-pressure steam not returned in condensate).

SMST - Medium-pressure steam demand for smelt dissolving tank in recovery area (pounds/ton of black liquor solids to recovery boiler).

Average low-pressure process steam demands are:

SLAH -Low-pressure steam demand for air heater in recovery boiler area (pounds/ton of black liquor solids to recovery).

SLCN - Low-pressure steam demand for black liquor concentrators (pounds/pound of water removed in black liquor concentrators).

SLDA - Low-pressure steam demand for deaerator (pounds/pound of total feedwater).

SLDG -Low-pressure steam demand for digester steaming vessel (pounds/dry ton of chips to digester).

SLEV - Low-pressure steam demand for black liquor evaporators (pounds/pound of water removed from black liquor in evaporators).

SLMD - Low-pressure miscellaneous steam demand (pounds/dry ton of paper or paperboard product).

SLPB - Low-pressure steam demand for power boiler area, air heaters, emissions control, etc. (pounds/pound of steam produced in power boiler).

SLPM -Low-pressure steam demand for paper machine auxiliary equipment and miscellaneous purposes (pounds/dry ton of product).

SLRS - Low-pressure steam demand for heating green liquor to slaker in recausticizing area (pounds/ton of black liquor solids to recovery area).

SLSE - Low-pressure steam demand for sulfur emissions odor control, collection system (pounds/dry ton of pulp produced).

SLSL -Losses from low-pressure process steam system (ratio of total low-pressure steam volume not returned in condensate to deaerator).

Calculations for Subroutine STEAM are:

Set initial feedwater enthalpy to zero:

HFWR = 0.0

Calculate initial estimate of recovery boiler steam output (pounds of superheated steam/day):

SORB = (HSRB x 1000000.0)/(HSHP - HFWR)

Calculate initial estimates of net boiler steam demands (pounds of superheated steam/day):

--(High-pressure process steam demands, approx.)

HPSD = ((HPPM x PPRD) + (HPTC x PPRD) + (HPAH x TBLS) + (HPMD x PPRD))

--(Medium-pressure process steam demands, approx.)

SMSD = ((SMPD x TWRD x 2000.0) + (SMJE x (TBLS + SOPR)) + (SMDH + TWLV) + (TBLS x (SMEC + SMAH + SMST + SMLH + SMBL)) + (SMAS x PROD) + (SMMD x PPRD) - (HPPM x PPRD) - ((HPSD - (HPPM x PPRD)) x HTMS))

--(Low-pressure process steam demands, approx.)

SLSD = ((PPRD x (SLPM + SLMD)) + (TBLS x (SLRS + SLAH)) + (((SLEV x WREV) + (SLCN x WRCN)) x 2000.0) + (SLDG x PPWD) + (SLSE x PROD) - (SMLS x GMSD) - SMLP)

Calculate initial estimate of power boiler steam output (pounds of superheated steam/day):

SOPB = (HPSD + SMSD + SLSD - SORB + (SSSB x SORB) + (SLDA x SORB x (1.0 + BFFC)))/(1.0 - SSSB - ((HPFW + SMFW + SLDA) x (1.0 + BFFC)) - (HPPB + SMPB + SLPB))

Follow iterative procedure to determine the steam energy balance (algorithm iterates until equilibrium enthalpy of feedwater to recovery boiler is obtained):

Calculate total steam and condensate losses from steam system, equivalent to make-up water requirements (pounds/day):

TSLS = (SSSB x (SOPB + SORB)) + (0.7 x BFFC x (SOPB + SORB)) + (HPSL x HPSD) + (SMSL x GMSD) + (SLSL x (SLSD + (SMLS x GMSD))) + (CNSL x ((SOPB + SORB) x (1.0 + BFFC)))

Calculate quantity of condensate to deaerator (pounds/day) (PBFW is feedwater to power boiler):

PBFW =(SOPB x (1.0 + BFFC))

CNDA = ((SOPB + SORB) x (1.0 + BFFC)) - TSLS -((SMFW + HPFW) x PBFW) -(SLDA x (SOPB + SORB) x (1.0 + BFFC))

Calculate enthalpy of feedwater to recovery boiler and power boiler feedwater heaters (Btu/pound of feedwater):

HFWT =((TSLS x HCMW) + (CNDA x HCCN) + (SLDA x HLPP x (SOPB + SORB) x (1.0 + BFFC)) + ((HPFW + SMFW) x HCCN x PBFW) - (CNSL x HCCN x ((SOPB + SORB) x (1.0 + BFFC))))/ ((SOPB +SORB) x (1.0 + BFFC))

HFWR= (HFWR + HFWT)/2.0

Recalculate steam output of recovery boiler (pounds/day):

SORB = (HSRB x 1000000.0)/(HSHP - HFWR)

Recalculate net high-pressure process steam demands (pounds/day):

HPSD = ((HPPM x PPRD) + (HPTC x PPRD) + (HPAH x TBLS) + (HPMD x PPRD) + (HPPB x SOPB) + (HPFW x PBFW))

Recalculate net medium-pressure process steam demands (pounds/day):

SMSD = ((SMPD x TWRD x 2000.0) + (SMDH x TWLV) + (SMJE x (TBLS + SOPR)) + (SMAS x PROD) + (TBLS x (SMEC + SMAH + SMLH + SMST + SMBL)) + (SMPB x SOPB) + (SMFW x PBFW) + (SMMD x PPRD) - (HPPM x PPRD) - ((HPSD - (HPPM x PPRD)) x HTMS))

Recalculate net low-pressure process steam demands (pounds/day):

SLSD = ((SLPM + SLMD) x PPRD) + ((SLRS + SLAH) x TBLS) + (SLEV x WREV x 2000.0) + (SLCN x WRCN x 2000.0) + (SLDG x PPWD) + (SLSE x PROD) + (SLPB x SOPB) + (SLDA x (SOPB + SORB) x (1.0 + BFFC)) - (SMLS x GMSD) - SMLP

Recalculate steam output of power boiler (pounds/day):

SOPB = (HPSD + SMSD + SLSD - (SORB x (1.0 - SSSB)))/(1.0 - SSSB)

PPFW = (SOPB x (1.0 + BFFC))

Check feedwater enthalpy.

Reiterate to equilibrium.

Calculate the enthalpy of feedwater to power boiler, out of feedwater heaters (Btu/pound of feedwater):

HBFW =((PBFW x HFWR) + (FWHE x (((HHPP - HCCN) x HPFW x PBFW) + ((HMPP - HCCN) x SMFW x PBFW))))/PBFW

Calculate the steam heat energy demand on power boiler (million Btu/day) (input to power boiler subroutine):

SHDM = ((SOPB x HSHP) - (SOPB x HPFW))/1000000.0

Calculate the amount of electrical energy cogenerated (kilowatt-hours/day) (1 kilowatt-hour = 3413.0 Btu of energy equivalent):

COGN =TGEF x (((HSHP - HHPP) x HPSD) + ((HSHP - HMPP) x SMSD) + ((HSHP - HLPP) x SLSD))/3413.0

Calculate purchased electrical energy requirements (kilowatt-hours/day):

PERQ =(TEED x 24.0) - COGN

SREE = 0.0

Calculate surplus electrical energy, if any, produced and sold (kilowatt-hours/day):

If PERQ < 0.0, SREE = -(PERQ)
If PERQ < 0.0, PERQ = 0.0

A flow diagram (fig. 6) shows the process area modeled in this subroutine. Note that process steam demands are shown on this diagram and also on the other process flow diagrams. Parameters calculated in this subroutine are shown in parentheses. Note that the results of this subroutine depend on previously calculated values of a variety of process parameters from other subroutines, which determine the high-, medium-, and low-pressure process steam demands.

Subroutine PWRBLR: Power boiler area

This subroutine calculates the quantities of fuels required for the power boiler furnace, the amount of sulfur dioxide in flue gases, the quantity of reclaimed salt cake, and the quantities of other process inputs in the power boiler, odor collection, and emission control area. A total of 24 data items is required for this subroutine:

CLMC -Moisture content of coal (ratio of total weight, including moisture, average).
COLA -Ash content of coal (ratio of dry weight).
COLC -Carbon content of coal (ratio of dry weight, ultimate analysis).
COLH -Hydrogen content of coal (ratio of dry weight).
COLO -Oxygen content of coal (ratio of dry weight).
COLN -Nitrogen content of coal (ratio of dry weight).
COLS -Sulfur content of coal (ratio of dry weight).
CPRC -Price of coal, f.o.b. mill, for power boiler ($/ton as-purchased) (supply unlimited at given price).
EXAR -Excess air admitted to power boiler furnace (decimal ratio of the theoretical minimum amount of air required for complete combustion, average).
HVWD -Combustion heat energy of wood and bark fuels, higher heating value (Btu/pound dry weight, average).
PCAS -Purchase price, f.o.b. mill, of caustic soda, 50% sodium hydroxide (NaOH), ($/ton).
PPSC -Purchase price of sodium sulfate (Na_2SO_4) salt cake for salt cake make-up ($/ton of salt cake).
RUHL -Radiation heat losses, unaccounted for, and miscellaneous heat losses, (decimal ratio of total heat energy input to power boiler).
SDOR -Sulfur dioxide (SO_2) removal from stack gases in flue gas desulfurizing area (decimal ratio of total sulfur dioxide in stack gases).
SGTP -Stack gas temperature of flue gases beyond effective heat recovery devices of power boiler (°F, average).
STRS -Sulfur dioxide generated from incineration of “TRS gases” in power boiler (pound/ton of pulp production).
WDMC -Moisture content of wood and bark fuels used in power boiler (decimal ratio of wet weight, average).
WMAX -Maximum quantity of wood and bark fuel that can be used for fuel in power boiler (dry tons/day). (Coal is used for remainder of heat energy.)
WODA -Ash content of wood and bark fuel (ratio of dry wood weight).
WODC -Average ultimate analysis carbon content of wood and bark fuel used in power boiler (decimal ratio of wood weight).
WODH -Hydrogen content of wood and bark fuel (ratio of dry wood weight).
WODN -Nitrogen content of wood and bark fuel (ratio of dry wood weight).
WODO -Oxygen content of wood and bark fuel (ratio of dry wood weight).
WPRC -Purchase price, f.o.b. mill, of wood fuel ($/dry ton) (or 2x selling price of surplus fuel).

Calculations for Subroutine PWRBLR are:

Calculate quantity of wood and bark residues produced and available for fuel (dry tons/day):

QRES = SRFR + HRFR + SBRK + HBRK

Calculate higher heating value of coal via Dulong formula (Btu/dry pound):

HVCO = (145.44 x COLC + 620.0 x (COLH + COLO/8.0) + 41.0 x COLS) x 100.0

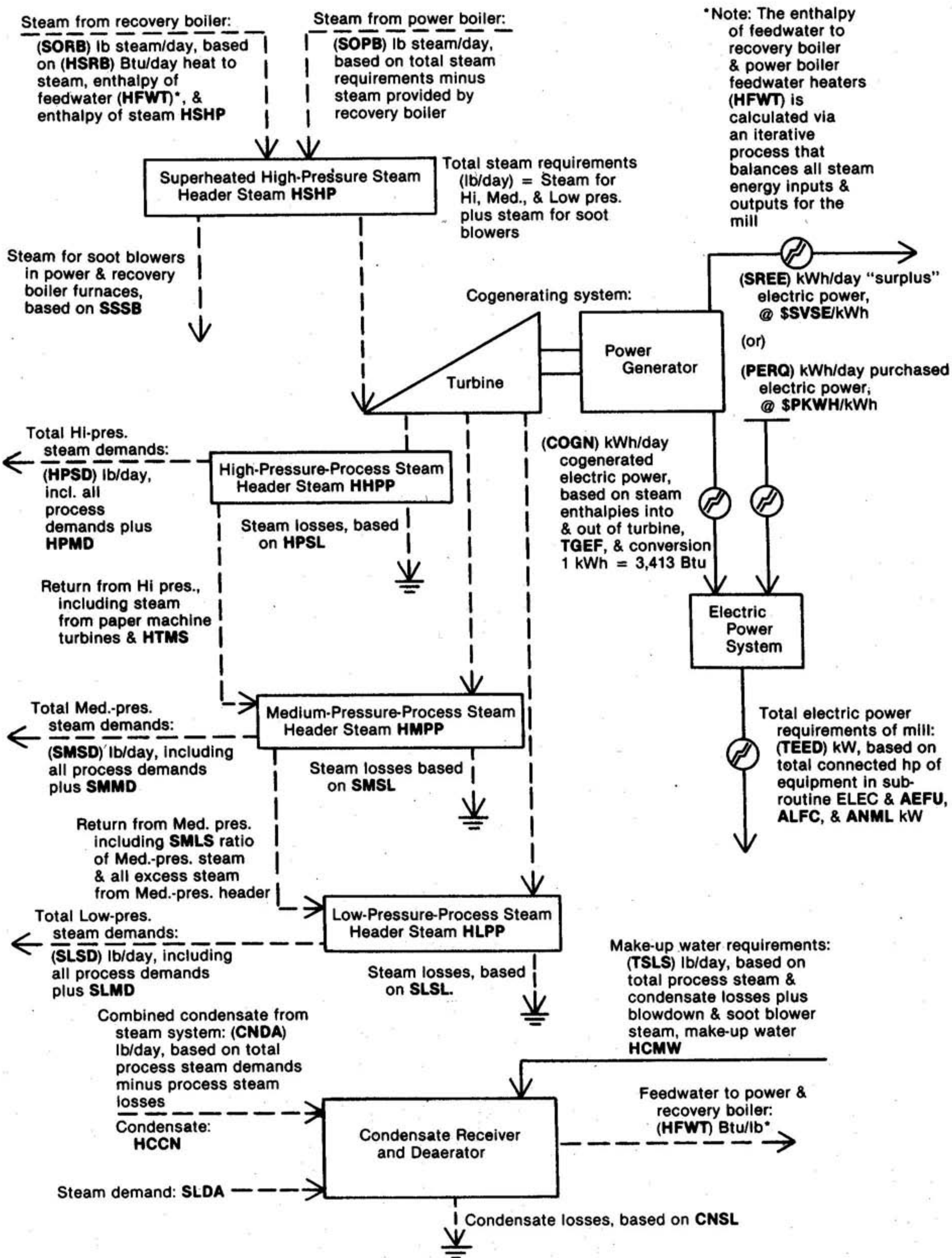

Figure 6.–Steam system, electric power and cogeneration area: Subroutine STEAM.

Calculate heat energy recovery from coal (Btu/dry ton):

Call SUB1 (HVCO, COLC, COLH, COLO, COLN, CLMC, SGTP, EXAR, RUHL, RCCO)

Calculate heat energy recovery from wood and bark fuel (Btu/dry ton):

Call SUB1 (HVWD, WODC, WODH, WODO, WODN, WDMC, SGTP, EXAR, RUHL, RCWD)

Determine total quantity of wood and bark residues and purchased wood fuel used in power boiler (dry tons):

WM = SHDM/RCWD
If WM<WMAX, WMAX = WM
If QRES>WMAX, SURE = QRES - WMAX
If QRES>WMAX, QWOD = 0.0
If QRES>WMAX, QRES = WMAX
QWOD = WMAX - QRES
If QWOD<0.0, QWOD = 0.0

Calculate heat energy recovered from wood and bark residues, and purchased wood fuels (million Btu/day).

HTRB = QRES x RCWD
HTRW = QWOD x RCWD

Calculate quantity of coal required (dry tons/day):

QCOL = (SHDM - (HTRB + HTRW))/RCCO
If QCOL<0.0, QCOL = 0.0

Calculate heat recovered from coal (million Btu/day):

HTRC = QCOL x RCCO

Calculate quantity of sulfur dioxide in stack gases (tons/day):

SDSG = (COLS x QCOL x 2.0) + (STRS x PROD/2000.0)

Calculate quantity of salt cake reclaimed as sodium sulfate (tons chemical/day; the factor of 2.21875 is the stoichiometric weight ratio of sodium sulfate to sulfur dioxide):

SSDS = SDSG x SDOR x 2.21875

Calculate quantity of caustic soda (50% sodium hydroxide) required for desulfurization process (tons chemical/day; the factor of 2.5 is the stoichiometric weight ratio of 2x sodium hydroxide to sulfur dioxide):

CSDS = SDSG x SDOR x 2.5

Calculate purchased salt cake requirements (tons/day of salt cake, as sodium sulfate):

PSCR = (SCLS x PROD/2000.0) - SSDS
SSCK = 0.0

Calculate surplus salt cake produced, if any (tons/day):

If PSCR<0.0, SSCK = -(PSCR)
If PSCR<0.0, PSCR = 0.0

Calculate weight of surplus wood fuel (wet tons/day) (including moisture in fuel):

SURB = SURB/(1.0 - WDMC)

Calculate weight of purchased wood fuel (wet tons/day) (including moisture In fuel):

QWOD = QWOD/(1.0 - WDMC)

Calculate weight of purchased coal fuel (wet tons/day) (including moisture in fuel):

QCOL = QCOU(1.0 - CLMC)

A further subroutine, SUB1 (HV, C, H, X, XN, PM, T2, EX, HL, RC), calculates heat energy recovery from combustion of wood, bark, or coal (million Btu/ton of dry fuel):

HV = higher heating value of fuel (Btu/pound)
C =carbon content of fuel (ratio of dry weight)
H =hydrogen content of fuel (ratio of dry weight)
X =oxygen content of fuel (ratio of dry weight)
XN =nitrogen content of fuel (ratio of dry weight)
PM = moisture content of fuel (ratio of wet weight of fuel)
T2 =stack gas temperature of combustion system beyond effective heat recovery devices
EX =excess air as a ratio of theoretical air required for combustion in furnace
HL = miscellaneous radiation and unaccounted-for heat losses, ratio of heat energy input
RC =heat recovery (million Btu/dry ton of fuel)
T1 =ambient temperature of air and fuel (= 60.0)

Calculate heat loss caused by fuel moisture and hydrogen in fuel (Btu/dry pound of fuel):

HLMH = (970.0 + (212.0 - T1) + (0.46 x (T2 - 212.0))) x (H x 9.0 + PM/(1.0 - PM))

Calculate heat loss caused by dry gas and excess air based on specific heats of dry gases:

HLDG = (T2 - T1) x (0.24 x (((H x 8.0) + (C x 2.667) -X/0.232) x EX + ((((H x 8.0) +(C x 2.66667) -810.232) x 0.768 + XN) x 0.25 + (C x 3.66667 x 0.22))

Calculate “conventional” heat losses due to radiation, miscellaneous and unaccounted-for losses:

HLMS = HV x HL

Calculate heat recovery (Btu/pound of dry fuel):

RCLB = HV - (HLMH + HLDG + HLMS)

Calculate heat recovery (million Btu/dry ton of fuel):

RC = RCLB x 0.002

A flow diagram (fig. 7) shows the process area modeled in this subroutine. Parameters calculated in this subroutine are in parentheses. Note that bark and fines removed from pulpwood in wood preparation are used as fuel in the power boiler furnace, subject to the maximum quantity of wood fuel that can be used. Note also that results of this subroutine depend on the steam energy balance calculated in the previous subroutine, which determines the quantity of steam output required from the power boiler.

Subroutine WATER: Water supply and wastewater treatment

This subroutine models the water supply system and wastewater treatment, including calculating the quantity of mill water required, the quantity of water treatment chemicals, the quantity of wastewater effluent, and the quantity of effluent treatment chemicals required. Seven items of data are required:

EFLF -Effluent flow to wastewater treatment facilities of mill (gallons/dry ton of paper or paperboard product).
ETCH -Effluent treatment chemicals (nutrients such as nitrogen and phosphoric compounds) (units (gallons, pounds, etc.)/thousand gallons of untreated effluent).
PETC -Average price of effluent treatment chemicals ($/unit (gallons, pounds, etc.)).
PWCH -Average price of feedwater treatment chemicals ($/unit of chemical (pounds, gallons, etc.)).
PWTR -Price of mill water ($/thousand gallons of water input requirements).
WATR -Mill water requirements (gallons/dry ton of paper or paperboard product output).
WTCH -Water treatment chemicals required (average units (pounds, gallons, etc.)/thousand gallons of water into mill).

Calculations for Subroutine WATER:

Calculate total mill water input requirements (million gallons/day):

TMWR = WATR x PPRD/1000000.0

Calculate mill water treatment chemical requirements (units of chemicals (gallons, pounds, etc.)/day):

TWTC = WTCH x TMWR x 1000.0

Calculate total effluent flow to wastewater treatment (millions of gallons/day):

TEFL = EFLF x PPRD/1000000.0

Calculate effluent treatment chemical requirements (units of chemicals (gallons, pounds, etc.)/day):

TETC = TEFL x ETCH x 1000.0

A flow diagram (fig. 8) shows the process area modeled in this subroutine.

Subroutine SALES: Sales revenues, material, energy, and labor costs

This subroutine calculates total process revenues, and material, energy, and labor costs (revenues and costs are calculated per year, per day, and per ton of product) based primarily on all of the process input and output calculations of the previous subroutihes. A total of 13 items of data is required:

AMLB -Average maintenance labor requirements (number of hourly wage maintenance workers needed/day (8-hr shifts each)).
AMWG -Average maintenance labor wage rate, including all fringe benefits and related expenses($/hr).
CCTC -Cost of cooling tower chemicals (cooling system for process water) ($/ton of paper (board) product).
CFWC -Cost of feedwater chemicals for treatment of boiler feedwater ($/ton of paper (board) products).
DFCS -Cost of dryer felts for paper machine dryers ($/dry ton of product).
DPYR -Effective number of days per year that the mill is in operation (days/year).
EXLB -Average nonprocess labor requirements (number of hourly wage non-process workers needed/day (8-hr shifts each)).
EXWG -Average nonprocess labor wage rate, including all fringe benefits and related expenses ($/hr).
PLWG -Average process labor wage rate, including all fringe benefits and related expenses ($/hr).
PSLB -Average process labor requirements (number of hourly wage process personnel needed/day (8-hr shifts each)).
RCST -Cost of roll covers for finished rolls of paper or paperboard product($/dry ton of product).
WCST -Cost of wires for paper machine ($/dry ton of product).
WFCS -Cost of wet felts for paper machine ($/dry ton of product).

Calculations for Subroutine SALES are:

Calculate mill revenues for paper (board), turpentine, “soap,” surplus electrical energy, excess reclaimed salt cake, surplus bark ($/day):

R(1,1) = SVAL x PPRD

R(2,1) = TPSV x TRPD

R(3,1) = SOPP x SOPR

R(4,1) = SVSE x SREE

R(5,1) = SVSC x SSCK

R(6,1) = (WPRC x 0.5) x SURB

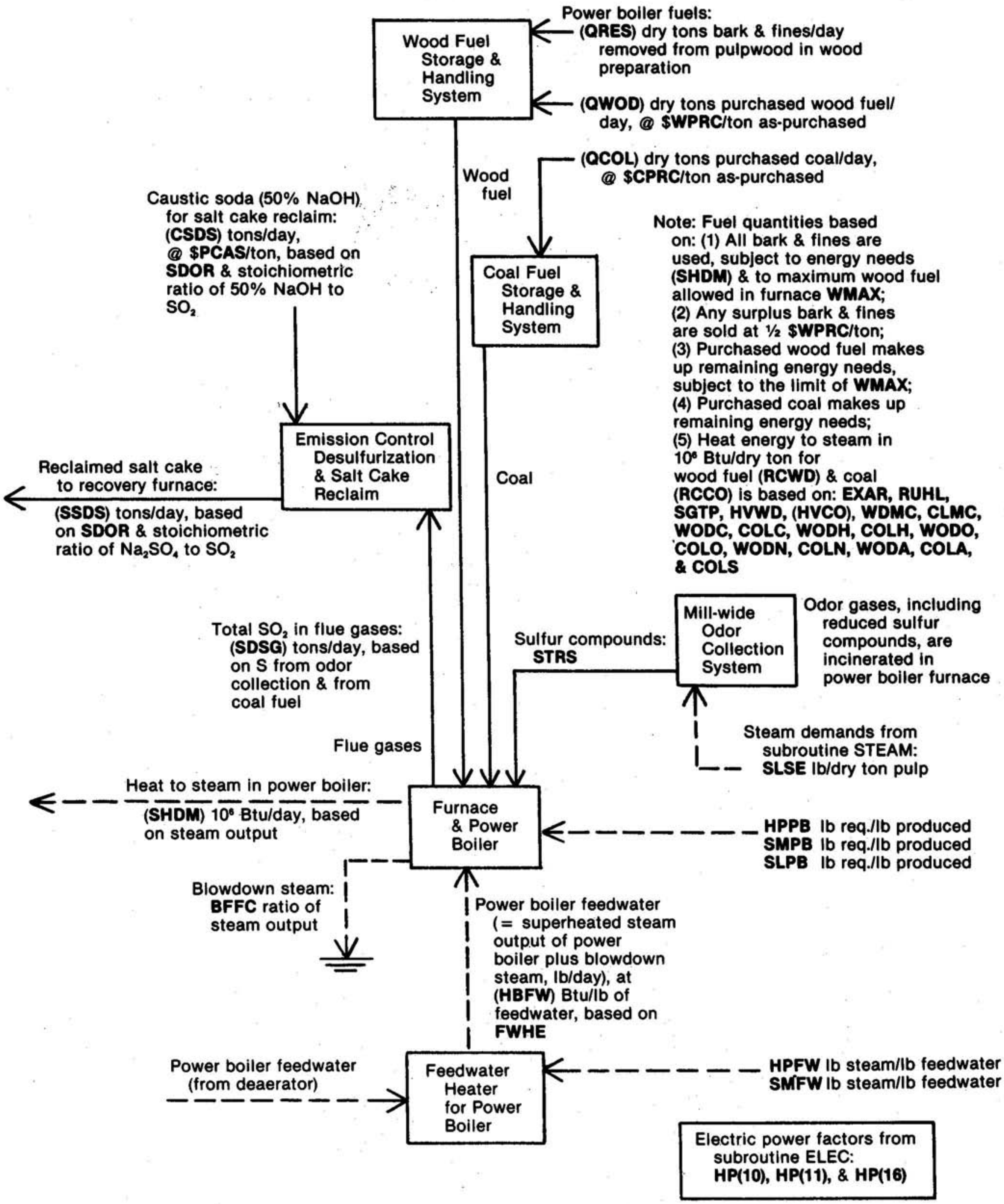

Figure 7.–Power boiler area: Subroutine PWRBLR.

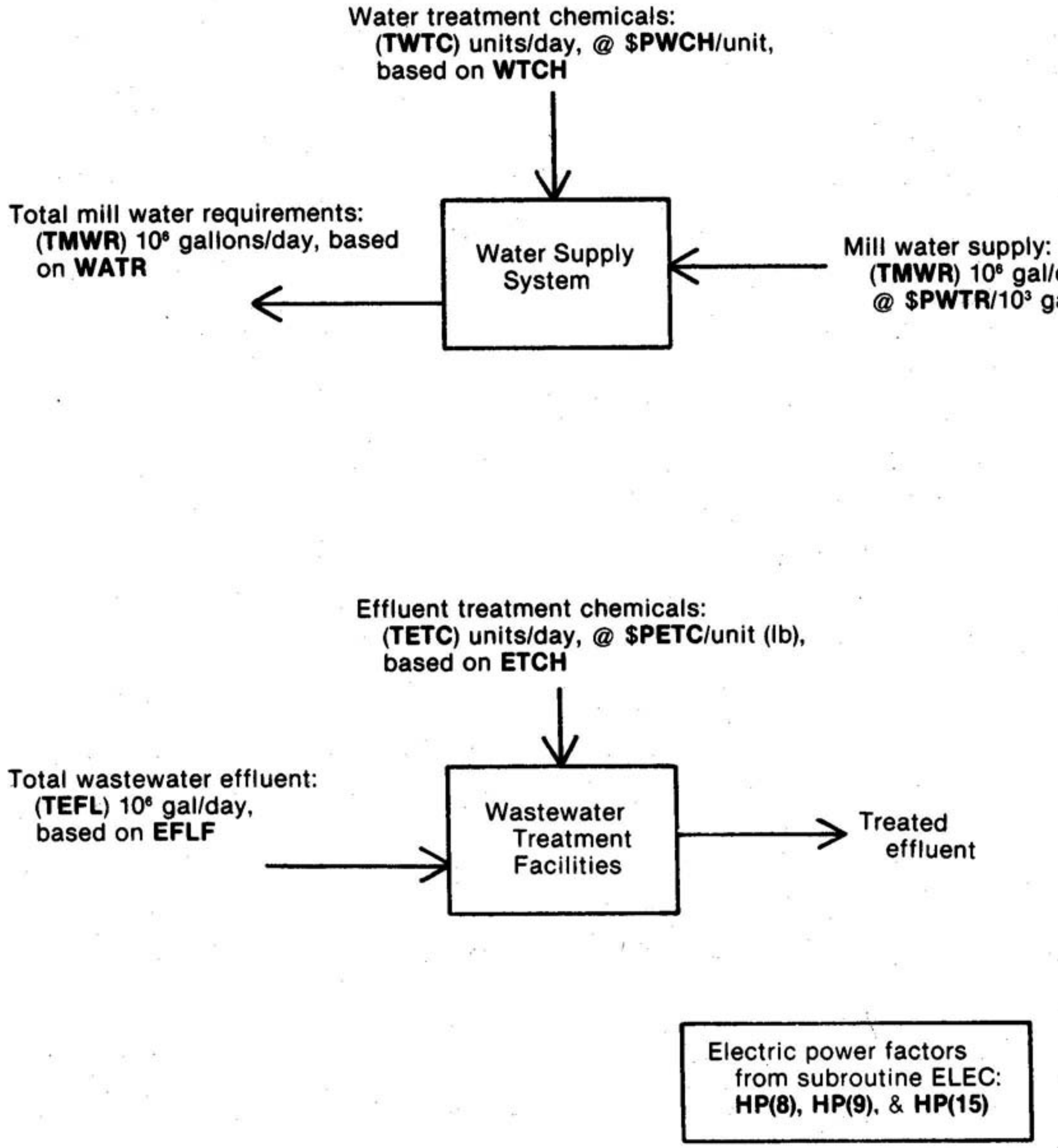

Figure 8.–Water supply, wastewater treatment and air supply area: Subroutine WATER.

Calculate fuel and energy costs for coal, wood fuel, natural gas, electrical energy ($/day):

VC(1,1) = CPRC x QCOL

VC(2,1) = WPRC x QWOD

VC(3,1) = PPKF x TKFR

VC(4,1) = PKWH x PERQ

Calculate pulpwood and recycled fiber raw material costs for softwood roundwood, hardwood roundwood, softwood "clean" chips, hardwood "clean" chips, softwood whole-tree chips, hardwood whole-tree chips, recycled old corrugated, and recycled paper ($/day):

VC(5,1) = PSRW x CDSW

VC(6,1) = PHRW x CDHW

VC(7,1) = PSPC x SCCW

VC(8,1) = PHPC x HCCW

VC(30,1) = PSWC x SWCW

VC(31,1) = PHWC x HWCW

VC(32,1) = PCOR x RCRT

VC(33,1) = PPAP x RPPT

Calculate costs of additives in stock preparation for alum, sulfuric acid, starch, defoamer, rosin, slimicide ($/day):

VC(9,1) = PALM x TALM

VC(10,1) = PACD x TACD

VC(11,1) = PSTC x TSTC

VC(12,1) = PDFM x TDFM

VC(13,1) = PRSN x TRSN

VC(14,1) = PSLM x TSLM

Calculate costs of make-up and reclaim chemicals for kraft process for salt cake, lime, caustic soda for salt cake reclaim ($/day):

VC(15,1) = PPSC x PSCR

VC(16,1) = PPLM x PLRQ

VC(17,1) = PCAS x CSDS

Calculate costs of other miscellaneous chemicals for cooling tower, boiler feedwater, mill water treatment, effluent treatment ($/day):

VC(18,1) = CCTC x PPRD

VC(19,1) = CFWC x PPRD

VC(20,1) = PWCH x TWTC

VC(21,1) = PETC x TETC

Calculate other variable costs, for roll covers, wires, wet felts, dryer felts, mill water supply ($/day):

VC(22,1) = RCST x PPRD

VC(23,1) = WCST x PPRD

VC(24,1) = WFCS x PPRD

VC(25,1) = DFCS x PPRD

VC(26,1) = PWTR x (TMWR/1000.0)

Calculate labor costs, for process labor, nonprocess labor, and maintenance ($/day):

VC(27,1) = PSLB x PLWG x 8.0

VC(28,1) = EXLB x EXWG x 8.0

VC(29,1) = AMLB x AMWG x 8.0

Sample Program Output

Figure 9 shows a sample of the program output. The output includes material balances, steam and energy balance, electric power, fuel and chemicals summary, and a revenue and cost summary for the overall process.

The output is largely self-explanatory. The material balances show the inputs and outputs in various parts of the overall process. The steam and energy balance shows the quantities of steam and energy produced in the recovery and power boilers, and the various steam and energy demands. Note that the steam demands and losses balance with steam output of the boilers. The revenue and cost summary provides an economic interpretation of the overall process. “Contribution margin” is total revenues minus total variable costs. Contribution margin is the net amount of revenues that can be regarded as available to cover fixed costs and capital costs, with the remaining amount available for earnings or profit. Taxes are not considered here. Note also that the variable costs include some items, particularly labor, that are probably “semivariable” in a strict sense. That is, as level of production increases or decreases, labor cost and other “semivariable” costs will not change in direct proportion.

The sample data values presented in the appendix were used to obtain the output in figure 9.

User Notes, Guidelines, and Summary

A complete listing of the sample data and the program are provided in the appendix. Data are read sequentially by each subroutine. The program uses the input format corresponding to the data list in the appendix, and includes complete output format corresponding to the output shown in figure 9.

The mathematical procedures used in the model were designed to be simple and straightforward, although the overall process is complex. The model and sample data were verified by comparison with physical parameters and estimated cost data provided by a consulting engineering firm that has been involved recently in design and installation of unbleached kraft paperboard mills. The model and sample data correspond to modern mill and process design criteria as verified in informal contacts with numerous industry personnel and reviews of numerous trade journal articles describing features of specific modern mills. The model has also been tested at a variety of extreme parameter values and appears to provide reasonable and satisfactory results.

The computer model permits a user to make quick, precise estimates of the effects of major economic, technological, or physical changes in an overall conventional unbleached kraft paperboard production process. With the model, users can develop their own basic set of data that reflects their concept of conventional process design and conventional process parameters. Then the user may adjust the basic set of data to reflect a specific process or economic change, and can obtain precise estimates of the effect of that change in a matter of minutes, using the computer model. The model is also inexpensive to run. Thus it is useful in evaluating research opportunities, process alternatives, and the results of applied technical research on the unbleached kraft paperboard process.

One final word of caution is necessary. The user must keep in mind that changes in one or several of the data parameters might necessitate changes in other data parameters. For example, if pulp yield is changed, it is probably true that the amount of black liquor recovered per ton of pulp will need to be changed also. Other data parameters can also be affected. Therefore, the user needs to have some familiarity with the overall process and with the way in which various data parameters are likely to be related to each other. A general rule to follow in using the model is the following: Whenever changes are made in any of the data, review all of the data to see if corresponding changes must be made in other values too. After a user develops familiarity with the model, that procedure will likely become second nature.

M A T E R I A L S   B A L A N C E

I. STOCK PREPARATION, ADDITIVES PAPER MACHINE, FINISHING AND SHIPPING AREAS

A. FINISHED PRODUCT OUTPUT:

1411.0 DRY TONS/DAY
MOISTURE CONTENT 6.0% TOTAL WT. BSIS)
(1489.4 TONS/DAY, GROSS PRODUCT OUTPUT AIR DRY WT.)
(89.4 TONS/DAY, WATER IN PRODUCT)

B. RECYCLED DRY BROKE (TO STOCK PREP.):

35.0 DRY TONS/DAY

C. TOTAL PAPER MACHINE AND DRYER THOUGHPUT (A + B):

0435.0 DRY TONS/DAY
(TRIMMED REEL WIDTH 32.4 INCHES)
(AVERAGE SPEED: 1437. LIN. FT./MIN)
(MAXIMUM SPEED: 1714. LIN. FT./MIIN.)

D. ADDITIVES AND RECYCLED MATERIALS IN STOCK PREPARATION

14.0 TONS/DAY ALUM
14.6 TONS/DAY ACID
.0 TONS/DAY STARCH
1.2 TONS/DAY DEFOAMER
1.0 TONS/DAY ROSIN
.6 TONS/DAY SLIMICIDE
.0 DRY TONS/DAY RECYCLED CORRUGATED
.0 DRY TONS/DAY RECYCLED PAPER

E. TOTAL WEIGHT ADDITIVES AND RECYCLED MATERIALS IN PRODUCT (INCLUDE ALL RECYCLED AT RECOVERY RATE. ALL ALUM, STARCH, ROSIN, PLUS HALF OF ACID, DEFOAMER, & SLIMICIDE)

23.3 DRY TONS/DAY

F. WEIGHT OF PULP INTO STOCK PREPARATION FROM DIGESTER (A - E):

1376.7 DRY TONS/DAY

G. WATER REMOVAL IN DRYER SECTION:

2060.9 TONS/DAY
(AVG. MOIST. CONT. INTO DRYER 60.0 % TOTAL WT.)
(AVG. MOIST. CONT. OUT OF DRYER 6.0 % TOTAL WT.)

II. DIGESTER, PULP WASHING AND EVAPORATORS

A. WEIGHT OF PULP OUT OF WASHERS (I.F):

1376.7 DRY TONS/DAY

B. PULPWOOD CHIPS INTO DIGESTERS

2573.3 DRY TONS/DAY

C. TURPENTINE RECOVERY FROM CHIPS:

3.5 TONS/DAY

D. BLACK LIQUOR SOLIDS IN WEAK BLACK LIQUOR FROM WAHSERS TO EVAPORATORS

1803.5 TONS DRY SOLIDS/DAY
(SOLIDS CONTENT: 15.0 %)

E. SOAP RECOVERY FROM BLACK LIQUOR

106.1 DRY TONS/DAY

F. WATER REMOVALS IN EVAPORATORS & CONCENTRATORS:

8522.5 TONS/DAY WATER REM. IN EVAPORATORS
(SOLIDS CONTENT TO CONCENTRATORS: 50.0 %)

783.4 TONS/DAY WATER REM. IN CONCENTRATORS:
(SOLIDS CONTENT TO RECOVERY BOILER: 65.0 %)

G. BLACK LIQUOR CONCENTRATE TO RECOVERY BOILER:

1697.4 TONS DRY SOLIDS/DAY

H. WHITE LIQUOR TO DIGESTER:

900.4 THOUSAND GALLONS/DAY
373.1 TONS/DAY ACTIVE ALKALI
(SODIUM OXIDE EQUILVALENT)
(14.5 % OF WOOD HEIGHT)

III. WOOD PREPERATION AREAS

A. VOLUME OF PULPWOOD INTO DIGESTER (II.B):

2573.3 DRY TONS/DAY

B. VOLUME OF BARK AND FINES REMOVED AND ROUTED TO POWER BOILER

330.6 DRY TONS/DAY

C. TOTAL VOLUME PULPWOOD REQUIRED INCLUDING BARK AND FINES (SEE BELOW *):

2904.0 DRY TONS/DAY

* AVG. QUANTITY OF SOFTWOOD ROUNDWOOD PULPWOOD REQURED PER DAY:

1154.5 DRY TONS/DAY, OR
871.3 CORDS/DAY

(MOISTURE CONTENT: 50.0%)

984.3 DRY TONS/DAY TO DIGESTER
150.1 DRY TONS/DAY BARK
20.1 DRY TONS/DAY FINES

* AVG. QUANTITY OF HARDWOOOD ROUNDWOOD PULPWOOD REQUIRED PER DAY:

337.6 DRY TONS/DAY, OR
230.4 CORDS/DAY

(MOISTURE CONTENTS 50.0%)

289.5 DRY TONS/DAY TO DIGESTER
42.2 DRY TONS/DAY BARK
5.9 DRY TONS/DAY FINES

* AVG. QUANTITY OF "CLEAN" SOFTWOOD CHIPS REQUIRED PER DAY

372.1 DRY TONS/DAY, OR
744.1 TONS/DAY, AS RECEIVED

(MOISTURE CONTENT: 50.0%)

360.9 DRY TONS/DAY TO DIGESTER
11.2 DRY TONS/DAY FINES

* AVG. QUANTITY OF "CLEAN" HARDWOOD CHIPS REQUIRED PER DAY:

39.8 DRY TONS/DAY, OR
79.6 TONS/DAY AS RECEIVED

(MOISTURE CONTENT: 50.0%)

38.6 DRY TONS/DAY TO DIGESTER
1.2 DRY TONS/DAY FINES

* AVG. QUANTITY OF SOFTWOOD WHOLE-TREE CHIPS REQUIRED PER DAY:

935.7 DRY TONS/DAY, OR
1871.4 TONS/DAY, AS RECEIVED

(MOISTURE CONTENT 50.0%)

842.1 DRY TONS/DAY TO DIGESTER
93.6 DRY TONS/DAY FINES

* AVG. QUANTITY OF HARDWOOD WHOLE-TREE CHIPS REQUIRED PER DAY

64.3 DRY TONS/DAY OR
128.7 TONS/DAY, AS RECEIVED

(MOISTURE CONTENT 50.0%)

57.9 DRY TONS/DAY TO DIGESTER
6.4 DRY TONS/DAY FINES

Figure 9.–Sample program output 1,400 T.P.D. Conventional process; 1982 Price data.

STEAM AND GROSS ENERGY BALANCE

	MILLION POUNDS Of STEAM		HEAT ENERGY ------MILLION B.T.U. -------		
	PER DAY	PER HR.	PER DAY	PER HR.	PER TON
STEAM OUTPUT:					
POWER BOILER	10.923	.455	15543.9	647.7	11.103
RECOVERY BOILER	12.561	.523	17875.0	744.8	12.768
TOTAL STEAM OUTPUT	23.485	.979	33418.9	1392.5	23.871
STEAM DEMANDS:					
SUPERHEATED STEAM (1413.0 B.T.U./LB.)					
SOOTBLOWERS	.737	.031	1048.7	43.7	.749
TURBINE GENERATORS (NET ENERGY)	--	--	3199.5	133.3	2.205
HIGH PRESSURE PROCESS (1381.6 B.T.U./LB.)					
PAPER MACH. & VAC. TURBINES	4.438	.185	6131.5	255.5	4.380
PAPER MACH. THERMOCOMPRESS.	1.302	.054	1798.8	75.0	1.285
REC. BOILER AIR HEATERS	.514	.021	710.6	29.6	.508
POWER BOILER FEEDWATER HTR.	1.253	.052	1731.0	12.1	1.236
POWER BOILER MISCELLANEOUS	.000	.000	.0	.0	.000
MISC. HIGH PRESSURE STEAM	.000	.000	.0	.0	.000
MEDIUM PRESSURE PROCESS (1279.2 B.T.U./LB.)					
PAPER MACHINE DRYERS	6059	.252	7750.7	322.9	5.536
DIGESTER LIQUOR HEATER	1.270	.053	1624.0	67.7	1.160
EVAPORATOR STEAM JETS	.074	.003	94.8	4.0	.068
AIR SPPLY AREA	.006	.000	1.9	.3	.006
EMISSIONS CONTROL, REC.BLR.	.106	.004	135.7	5.7	.097
AIR HEATERS, REC.BLR.	1.044	.043	1335.3	55.6	.954
DISSOLVING TANK	.080	.003	101.8	4.2	.073
SEC. BLACK LIQ. MTR.	.123	.005	157.6	6.6	.113
BLACK LIQ. GUNS, REC.BLR.	.066	.003	84.7	3.5	.060
POWER BOILER FEEDWATER HTR.	.543	.023	695.0	29.0	.496
POWER BOILER AREA MISC.	.000	.000	.0	.0	.000
MISC. MED, PRESSURE STEAM	.000	.000	.0	.0	.000
(STEAM FROM HIGH PRESSURE PROCESS)	(5.788)(	.241)(	7404.6)(	308.5)(	5.209)
LOW PRESSURE PROCESS (1219.4 B.T.U./LB.)					
PAPER MACHINE AUX. EQUIP.	2.000	.117	3414.3	142.3	2.439
GREEN LIQUOR HEATER	.353	.015	430.5	17.9	.308
AIR HEATERS, RE.BLR.	.429	.018	523.6	21.8	.374
EVAPORATORS (BLACK LIQUOR)	3.307	.138	4012.2	168.0	2.880
CONCENTRATORS (BLACK LIQUOR)	1.042	.043	1270.5	52.9	.908
DIGESTER STEAMING BESSEL	.715	.030	872.3	36.3	.623
ODOR CONTROL SYSTEM	1.155	.048	1408.5	58.7	1.006
POWER BOILER AREA MISC.	.066	.001	79.9	3.3	.057
DEAERATOR (FEEDWATER)	2.231	.093	2720.7	113.4	1.943
MISC. LOW PRESSURE STEAM	.000	.000	.0	.0	.000
(STEAM FROM MED. PRESSURE PROCESS)	(.440)(	.018)(	537.1)(	22.4)(	.304)
TOTAL STEAM DEMANDS	23.435	.979	33418.9	1392.5	23.871
HAM–UP WATER REQUIRED	4.417	.184	--	--	--

FEEDWATER ENTHALPY 269.0 B.T.U./LB.

NET STEAM ENERGY BALANCE

	HEAT ENERGY - - - - - - MILION B.T.U. - - - - - -		
	PER DAY	PER HR.	PER TON
NET ENERGY ADDED TO STEAM SYSTEM, IN:			
DEAERATOR & MAKE-UP WATER	2204.	92.	1.57
POWER BOILER FEEDWATER HEATER	2018.	84.	1.44
POWER BOILER	10574.	141.	7.55
RECOVERY BOILER	14466.	603.	10.33
TOTAL NET ENERGY	29262.	1219.	20.90
NET ENERGY SUBTRACTED FROM STEAM STYSTEM, IN:			
SUPERHEATED STEAM			
SOOTBLOWERS	1049.	44.	.75
TURBINE GENERATORS	3200.	133.	2.29
HIGH PRESSURE PROCESS			
PAPER MACHINE TURBINES	454.	19.	.32
STEAM TO MEDIUM PRESSURE PROCESS	138.	6.	.10
STEAM TO CONDENSATE	2014.	84.	1.44
STEAM LOSSES	0.	0.	.00
MEDIUM PRESSURE PROCESS			
STEAM TO LOW PRESSURE PROCESS	26.	1.	.02
STEAM TO CONDENSATE	8732.	364.	6.24
STEAM LOSSES	978.	11.	.70
LOW PRESSURE PROCESS			
STEAM TO CONDENSATE	9965.	415.	7.12
STEAM LOSSES	2715.	113.	1.94
TOTAL NET ENERGY	29270.	1220.	20.91

(NOTE: TOTALS MAY NOT AGREE PRECISELY)

ENTHALPY OF VARIOUS FLOWS

IN THE STEAM SYSTEM

	ENTHALPY (B.T.U./LB.)
COMBINED CONDENSATE (INTO CONSENSATE RECEIVER FROM PROCESS)	210.0
MAKE-UP WATER (INTO DEAERATOR)	40.0
PRIMARY FEEDWATER (TO REC. BOILER AND P.B. FEED WATER HEATERS)	269.0
FEEDWATER TO POWER BOILER (FROM P.S. FEEDWATER HEATERS)	451.0
SUPERHEATED STEAM (FROM BOILERS, TO TURBINE)	1423.0
HIGH PRESSURE PROCESS STEAM (FROM TURBINE)	1381.6
MED. PRESSURE PROCESS STEAM (FROM TURBINE)	1279.2
LOW PRESSURE PROCESS STEAM (FROM TURBINE)	1219.4

Figure 9.–Sample program output 1,400 T.P.D. Conventional process; 1982 Price data (continued).

REVENUES, COSTS, PROFIT CONTRIBUTION

	$/DAY	$/DRY TON	$-ANNUAL
REVENUES			
PAPERBOARD PRODUCT (* $290.00/DRY TON)	406000.	290.00	144130000.
TURPENTINE (* $ .60/GALLON)	849.	.61	301464.
TALL OIL SOAP (* $ 68.00/TON)	7218.	5.16	2562445.
TOTAL REVENUES	414067.	295.76	146993908.
PULPWOOD COSTS			
SOFTWOOD ROUNDWOOD (* $ 55.00/CORD)	47921.	34.23	17011973.
HARDWOODROUNDWOOD (* $ 36.00/CORD)	8296.	5.93	1945134.
"CLEAN" SOFTWOOD CHIPS (* $ 28.00/TON)	20836.	14.88	7396750.
"CLEAN" HARDWOOD CHIPS (* $ 21.00/TON)	1671.	1.19	593322.
SOFTWOOD WHOLE-TREE CHIPS (* $ 18.00/TON)	33685.	14.01	11958675.
HARWOOD WHOLE-TREE CHIPS (* $ 16.00/TON)	2059.	1.47	730822.
LABOR COSTS			
PROCESS LABOR (* $ 13.45/HR.)	25824.	18.45	9167520.
MPM-PROCESS LABOR (* $ 11.44/HR.)	4484	3.20	1591110.
MAINTENANCE LABOR (* $ 12.27/HR.)	9227.	6.59	3275599.
FUEL AND ENERGY COSTS			
COAL (* $ 69.00/TON)	11556.	8.25	4102550.
WOOD FUEL (* $ 12.00/TON)	14241.	10.17	5055473.
NAT. GAS (* $ 4.00/NFC)	8738.	6.24	3102034.
PURCHASED ELECTRIC (* $ .03t/KWH)	12126.	8.66	4304856.
MAKE-UP AND SALTCAKE RECLAIM CHEMICAL COSTS			
SALTCAKE MAKE-UP (* $ 80.00/TON)	273.	.20	91022.
LIME MAKE-UP (* $ 60.00/TON)	707.	.50	250948.
CASTIC SODA FOR RECLAIM (* $360.00/TON-50%)	7379.	5.27	2919658.
STOCK PREP. AND PAPER MACHINE ADDITIVES COSTS			
ALUM (* $ 130.00/TON)	1820.	1.30	646100.
SULFURIC ACID (* $ 74.00/TON)	1083.	.77	384330.
STARCH (* $ 240.00/TON)	0.	.00	0.
DEFOAMER (* $ 860.00/TON)	1023.	.73	363307.
ROSIN (* $ 580.00/TON)	609.	.43	216195.
SLIMICIDE (* $ 860.00/TON)	542.	.39	192339.
OTHER MISCELLANEOUS CHEMICALS COSTS			
COOLING TOWER CHEMICALS	56.	.04	19880.
BOILER FEEDWATER CHEMICALS	154.	.11	54670.
WATER TREATMENT CHEMICALS	40.	.03	14351.
EFFLUENT TREATMENT CHEMICALS	579.	.41	205499.
OTHER VAIABLE COSTS			
FINISHED ROLL COVERS	168.	.12	59640.
PAPER MACHINE WIRES	1064.	.76	377720.
WET FELTS	1568.	1.12	556640.
DRYER FELTS	1148.	.82	407540.
TOTAL VARIABLE COSTS	218879.	156.34	77701932.
CONTRIBUTION MARGIN	195189.	139.42	69291976.

ELECTRIC POWER, FUELS, CHEMICALS

ELECTRIC POWER BALANCE

TOTAL ELECTRIC POWER CONSUMED	1094267.	KWH/DAY
ELECTRIC POWER COGENERATED	703095.	KWH/DAY
PURCHASED ELECTRIC POWER	391173.	KWH/DAY
SURPLUS ELECTRIC POWER	0.	KWH/DAY

FUEL REQUIREMENTS

FOR POWER BOILER FURNACE

COAL	159.1	DRY TONS/DAY
PURCHASED WOOD FUEL	593.4	DRY TONS/DAY
WOOD RESIDUE	330.6	DRY TONS/DAY

FOR LIME KILN

NAT. GAS 2184.5 MCF/DAY

LIME BALANCE

LIME CONSUMED IN SLAKING & CAUSTIZING	294.54	TONS/DAY
LIME PRODUCED IN LIME LILN	282.76	TONS/DAY
PURCHASED MAKE-UP LIME	11.78	TONS/DAY

SALTCAKE BALANCE

NET SALTCAKE LOSSES 20.651 TONS/DAY
(EXCLUDING RECOVERY FROM POWER BOILER DESULFURIZING)

SALTCAKE RECOVERED IN POWER BOILER DESULFURIZING
17.235 TONS/DAY

BASED ON:

10.357 TONS/DAY SULUR DIOXIDE IN FLUE GASES
.750 REMOVAL RATIO

PURCHASED SALTCAKE REQUIRED 3.416 TONS/DAY

CAUSTIC SODA (30 PCT. SODIUM HYDROXIDE)
REQUIRED FOR DESULFURIZING 19.419 TONS CHEMICAL/DAY

Figure 9.–Sample program output 1,400 T. P. D. Conventional process; 1982 Price data (continued).

Appendix
Program Data and Program Listing

Note in the data listing that each numerical item of data is described by the line directly above it. For example, the numerical value of 20.9 corresponds to the data parameter ACID. Each numerical value can be entered in the first 20 columns of the line following its description in the data listing. Note also at the top of the data listing the parameter “NX” which controls the amount and type of program output.

```
        =====    DATA    =====

 1400     T.P.D.
LINERBOARD     MILL
CONVENTIONAL     PROCESS
 1982    PRICE    DATA
NX-OUTPUT   SPEC  (I-II,III,STEAM,SALES),(2-I,III,STEAM,SALES),(3-I,II,STEAM,SALES)
13                   (4-I,II,III,SALES),(5-SALES),(6-STEAM,SALES),(7-II,III,
                     STEAM,SALES,POWER),(8-I,III,STEAM,SALES,POWER),(9-I,II,
                     STEAM,SALES,POWER),(10-I,III,SALES,POWER),(11-SALES,
                     POWER),(12,STEAM,SALES,POWER),(13-ALL)
******************************************************************************
*           DATA   FOR   STPREP   SUBROUTINE            *
******************************************************************************
ACID  –QUAN CONCEN  SULFURIC  ACID  ADDED--LBS  ACID/DRY  TON  PAPER  OR  PAPERBOARD
20.9
ALUM-QUAN  ALUM  ADDED  IN  STK  PREP-LBS  ALUM  SOLID/DRY  TON  PAP  OR  BOARD  PRODUCT
20.0
DBKT-DRY  BROKE  RECYCLED  TO  STOCK  PREP--RATIO  10  TOTAL  PAPER  OR  BOARD  PRODUCT
0.025
DFOM-QUAN  DEFOAMER  ADDTVS  IN  STK  PREP--LBS/DRY  TON  PAPER  OR  PAPBD  PRODUCED
 1.7
DSMC-M.C.  SHEET  ENTERING  THERMAL  DRYER  SECTION--RATIO  TO  TOTAL  WEIGHT  OF  SHEET
0.60
PACD-PURCHASE   PRICE   OF   SULFURIC   ACID--$/TON   F.O.B.   MILL
74.0
PALM-PURCHASE   PRICE   OF   ALUM--SITON   F.O.B.   MILL
 130.0
PCOR  -  PRICE  OF  RECYCLED  OLD  CORRUGATED  AS  RAW  MAT  FURN  IN  STPREP,  $/DRY  TON
55.0
PDFM-PURCHASE   PRICE   OF   DEFOAMER--$/TON   F.O.B.   MILL
860.0
PMND-MINIMUM   DENSITY   OF   PAPER   OR   PAPERBD   PROD--DRY   LBS/1000   SQUARE   FEET
 42.0
PPAP  -  PRICE  OF  OTHER  RECYCLED  PAPER  RAY  MATERIAL  IN  STPREP,  $/DRY  TON
 12.0
PPDN-AVG   DENSITY   PAPER   OR   PAPERBD   PROD--DRY   LBS/1000  SQUARE  FEET  PAPER  OR  BOARD
50.1
PPMC-AVG  MOISTURE  CONTENT  OF  SHEET  OUT  OF  DRYERS--TOTAL  WEIGHT  BASIS
0.06
PPRD-PAPER  OR  PAPERBOARD  PRODUCTION  VOLUME-DRY  TONS  OF  PAP  OR  PAPBD/DAY
 1000.0
PRSN-PURCHASE   PRICE   OF   ROSIN,   $/TON   F.O.B.   MILL
580.0
PSLM-PURCHASE   PRICE   OF   SLIMICIDE,   $/TON   F.O.B.   MILL
660.0
PSTC-PURCHASE   PRICE   OF   STARCH,   $/TON   F.O.B.   MILL
200.0
RCOR-RECY   OLD   CORRUGATED   FIBER--WEIGHT   RATIO   CORR.   FIBER/TOTAL   PULP
0.00
RECYD-RECOVERY  RATE  OLD  CORR,  RATIO  RAN  MATERIAL  WEIGHT  RECOVERED  IN  PRODUCT
0.92
ROSN-QUAN  ROSIN  ADDED  IN  STK  PREP--LBS  ROSIN  SOLIDS/DRY  TON  PAP  OR  PAPBD  PROD
 1.5
RPAP-OTHER   RECY   PAPER   FIBER--WEIGHT   RATIO   OF   OTHER   RECY   FIBER/TOTAL   PULP
0.00
RPVD-RECOVERY   RATE   OTHER   RECYC   PAP,  RATIO  RAW  MATERIAL  WEIGHT  RECOVERED  IN  PROD
 0.70
SLIM-QUAN   SLIMICIDE   ADDED   IN   STK   PREP--LBS   ADDED/DRY   TON   PRODUCT
 0.9
STRC-QUAN   STARCH   ADD   IN   STK   PREP--LBS   DRY   STARCH   SOLID/DRY   TON   PAP  OR   PAPBD
 0.0
SVAL-AVG   SALES   VALUE   OF   PAPER   OR   PAPBD   PROD-$/DRY   TON,   F.O.B.   MILL
290.0
TRWD-TRIMNED   REEL   WIDTH   ON   SHEET   ROLL   WINDER
324.0
******************************************************************************
*          DATA   FOR   DIG   SUBROUTINE                  *
******************************************************************************
AACN-ACTIVE   ALKALI   CONCENT   IN   WHITE   LIQ--LBS   ACT   ALKALI/CU   FT   WHITE   LIQUOR
6.2
AALK-ACT   ALKALI,SOD   HYDROX+SOD   SULFIDE   IN   WHITE  LIQ,DE   RATIO   OF   DRY   WOOD  WEIGHT
0.145
BSDS-BLK   LIQ   SOLIDS   FROM   DIGEST,WASHERS   TO   EVAP--TONS   DRY   SOLIDS/DRY   TON   PULP
 1.31
CCBL-SOLIDS   CONT   CONCENT   BLK   LIQ   EXITING   CONCENTRS--LIQ   SOLIDS   WT   RATIO   TOT   LIQ
 0.65
CEBL-SOLIDS   CONT   OF   EVAPORATED   BLK   LIQ--LIQ   SOLIDS   WEIGHT   RATIO   OF   TOTAL   LIQUOR
0.50
CNBL-SOLIDS   CONT   WEAK   BLK   LIQ   EXIT   WASH   TO   EVAP--LIQ   SOLIDS   WT   RATIO   TOT   BLK   LIQ
0.15
CNWP-CONSIST   WASHED   PULP   EXITING   WASH(0.D.   PULP   WT   RATIO   TOT   PULP   SLURRY   WEIGHT)
0.10
PWMC-PULPWOOD   M.C.,   DECIMAL   RATIO   OF   NET   WEIGHT,   ENTERING   CHIP   FEED
0.50
PYLD-PULP   YIELD--RATIO   OF   0.D.   WT   PULP/DRY   WEIGHT   CHIP   RAY   MAT   INTO   DIGESTER
0.535
SCLS-TOTAL   SALTCAKE   LOSSES--LBS   SODIUM   SULFATE/DRY   TON   PULP
30.0
SCPL-SALTCAKE   LOSS   IN   PULP--RATIO   OF   TOTAL   SALTCAKE   LOSSES
0.50
SOAP-QUAN   SAPONIFIED   FATTY   ACIDS--DRY   LBS   SOAP   RECOV/DRY   TON   PULPWOOD   INPUT
82.5
SOPP-SALES   VALUE   OF   SOAP   SKIMMINGS,$/TON,   F.O.B.   WILL   (SALES   PRICE)
68.0
TPSV-TURPENTINE   SALES   VALUE,   $/GALLON,   F.0.B.   MILL
0.60
TURP-TURPENTINE   RECOVERY,   GALLONS   TURP   RECOVERED/DRY   TON   WOOD   INTO   DIGESTER
0.55
**********************************************************************
*          DATA   FOR   WDPREP   SUBROUTINE             *
**********************************************************************
HBPC-WT   RATIO   REMOVED   AS   BARK   FROM   HARDWOOD   ROUNDWOOD--RATIO   TO   TOT   WT   INCL   BARK
0.125
HCHM0M.C.   OF   HARDWOOD   CLEAN   CHIP   PULPWD--DECIMAL   RATIO   OF   WET   WEIGHT,   AVG
0.50
HTCF-BARK   &   FINES   REMOVED   SCREENING   HDWD   CLEAN   CHIPS--RATIO   TOT   DRY   NT   OF   CHIPS
0.03
HWCD-TOT   WT/CORD   HDWD   ROUNDWOOD,WET   NT   BASIS--LBS/CORD,   INCLUDING   BARK
5860.0                    SOUTHERN   RED   OAK   (.52/.47   FOR   LOBLOLLY   PINE)
HWFR-FINES   REMOVED   SCREEN   HDWD   RNDWD   CHIPS--RATIO   TOT   DRY   WT   CHIPS,BEFORE   SCREEN
0.02
HWMC-AVG   M.C.   HDWD   RNDWD   PLPWD,   RATIO   TOTAL   WIEGHT,   INCLUDING   BARK
0.50
HWPC-HDWD   PURCH   CHIPS   AS   RATIO   OF   TOT   CHIPS   IN   DIG--FRACT   TOT   DRY   WT   HDWD   CHIPS
 .25
HWTC-HDWD   WHLE-TREE-CHPS   RATIO   TOT   HDWD   CUR   CHPS,RATIO   TOT DRY   WT   HDWD   PUR   CHIPS
0.60
HWTF-BARK/FINES   REM   IN   SCRNING   HDWD   WHLE-TREE-CHPS-DEC   RATIO   TOT   DRY   WT   HD   W-T-C
0.10
HWTM-M.C.  HDWD   PURCH   WHLE-TREE-CHIPS,   DEC   RATIO   YET   WEIGHT,AVERAGE
0.50
PHPC-PRICE   OR   VALUE   HDWD   CLEAN   CHIPS--$/TON   AS   PURCHASED,   AVG
21.0
PHRM-PURCHASE   PRICE   F.0.B.   MILL   HARDWOOD   ROUNDWOOD--$/CORD,   AVG
36.0
PHWC-PUR   PRICE   FOB   MILL   HDWD   WHLE-TREE-CHPS-$/TON   AS   PURCHASED,   AVERAGE
16.0
PSPC-PRICE   OR   VALUE   SOFTWOOD   CLEAN   CHIPS--$/TON   AS   PURCHASED,   AVG
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28.00
PSRW-PURCHASE   PRICE   F.O.B.   MILL,   SOFTWOOD   ROUNDWOOD--$/CORD,   AVG
55.0
PSWC-PUR   PRICE   FOB   MILL   SFTWD   WHLE-TREE-CHPS,$/TON   AS   PURCHASED,   AVERAGE
18.0
SBPC-WEIGHT   RATIO   REM   AS   BARK   DEBARK   SFTWD   RNDWD--FRACT   TOT   DRY   IT   PURCH   RNDWD
0.13
SCHM-M.C.   SOFTWOOD   CLEAN   CHIPS,   DEC   RATIO   WET   WEIGHT,   AVG.
0.50
SFWD~SOFTWOOD   RATIO   Of   PULPWOOD   INTO   DIG--RATIO   OF   TOTAL   DRY   WEIGHT   CHIPS
0.85
STCF-BARK   AND   FINES   REMOVED   SCREENING   SOFTWOOD   CLEAN   CHIPS--RATIO   TOTAL   DRY   WGHT
0.03
SWCD-TOT   WT/CORD   SOFTWOOO   RNDWD   PULPWD,   MET   WT   BASIS--LBS/CORD,   INCLUDING   BARK
5300.0
SWFR-FINES   REM   SCREEN   SFTWD   ROUNDWOOD   CHIPS--RATIO   TOT   DRY   WT   BEFORE   SCREENING
0.02
SWMC-AVG   M.C.   SOFTWD   RNDWD   PLPWD--RATIO   TOT   WET   UT   PLPWD   AS   PURCH,   INCLUDING   BAR
0.50
SWPC-SFTWD   PURCH CHIPS RATIO   TOT   SFWD   CHIPS INTO   DIG--RATIO   TOT   DRY   WT   SFTWD   CHI
0.55
SWTC-SFTWD   W-TREE-CHPS   RATIO   TOT   SFTWO   PUR   CHPS,RATIO   TOT   DRY   WT   SFTWD   PUR   CHIPS
0.70
SWTF-BARK/FINES   REM   SCRNING   SFTWD   W-TREE-CHPS--DEC   RATIO   TOT   DRY   WT   SFTWO   W-T-C
0.10
SWTM-M.C.   SFTWD   PUR   WRLE-TREE-CHPS,DEC   RATIO   WET   WEIGHT,   AVERAGE
0.50
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*          DATA   FOR   RECBLR   SUBROUTINE          *
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ACTV-ACTIVITY   WHITE   LIQ.   RATIO   ACT   ALKALI/TOTAL   ALKALI,SODIUM   OXIDE   WT   EQUIV
0.80
AVLM-LIME   AVAIL,   AVG   WEIGHT   RATIO   OF   TOTAL   LIME   TO   SLAKER
0.85
CAUS-CAUST   EFFIC   CAUS   REACT--WT   RATIO   SODIUM   HVD   TO   SODIUM   HYD   +   SODIUM   CARBONAT
0.80
CNMD-CONSISIENCY   FILT   LIMEMUD   ENTRNG   KILN--DRY   WT   MUD   SOLIDS   RATIO   FILTIRED   MUD
0.70
EFKF-AVG   COMB   HEATING   EFFIC   KILN   FUEL,   RATIO   HEATING   VALUE   CONTENT
.82
FLMR-LIME   MUD   RECYCL   RATIO, WEIGHT   RATIO   TOTAL   LIME   MUD
0.17
HHKF-AVG   HIGHER   HEATIN   VALUE   KILN   FUEL-MILLION   BTU/UNIT   OF   FUEL
1.0
HRRB-EFFECTIVE   HEAT   RECOVERY   RATIO--DEC   RATIO   CROSS   HEAT   ENGY   VAL   BLK   LIQ   SOLIDS
0.70
HVBL-GROSS   HEAT   ENERGY   VALUE   OF   SLACK   LIQUOR   SOLIDS--BTU/DR   LB.
6100.0
PLMU-PURCHASED   LIME   MAKE-UP,   AVG   WEIGHT   RATIO   OF   TOTAL   LIME   TO   SLAKER
0.04
PPKF-AVG   PURCHASE   PRICE   OF   KILN   FUEL   IN   $/UNIT   OF   FUEL
4.0
PPLM-PURCHASE   PRICE   OF   PURCHASED   LIME,   $/TON   F.O.B.   MILL
60.0
SVSC-SALES   VALUE   OF   SURPLUS   OR   EXCESS   SALTCAME,SIDRV   TON   F.O.B.   MILL
00.0
SSWL-SODIUM   SULFIDE   RATIO   OF   TOTAL   ALKALI   IN   WHITE   LIQ,   1/2   WEIGHT   RATIO
0.000
TKEG-TEMPERATURE   OF   KILN   EXIT   GAS,   DEGREES   F,   AVERAGE
800.0
TKPD-AVERAGE   TEMPERATURE   OF   KILN   PRODUCT   SOLIDS   EXITING   KILN,   DEGREES   F.
1900.0
******************************************************************************
*          DATA   FOR   WATER   SUBROUTINE          *
******************************************************************************
EFLF-EFFLUENT   FLOW   TO   WASTEWATER   TRTMNT   FAC--GAL/DRY   TON   OF   PAP   OR   PAPBD   PROD
2790.0
ETCH-EFFLUENT   TREATMENT   CHEM--UNITS   OF   CHEMICALS/1000   GAL   UNTREATED   EFFLUENT
0.57
PETC-AVERAGE   PRICE   EFFLUENT   TREATMENT   CHEM--DOLLARS/UNIT   (GALLONS'S   ETC.)
0.26
PWCH-AVERAGE   PRICE   WATER   TRTMT   CHEM/UNIT   OF   CHEM   ($/LB,   GAL,   ETC.)
0.22
PWTR-PRICE   MILL   WATER-$/1000   GALLONS   OF   WATER   INPUT   REQUIREMENTS
0.0
WATR-MILL   WATER   REQUIREMENTS--GAL/DRY   TON   PAPER   OR   PAPERBD   PRODUCT   OUTPUT
3750.0
WTCH-WATER   TRTMENT   CHEM   REQUIRED,AVG   UNITS/1000   GALLONS   WATER   INTO   MILL
0.035
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*          DATA   COR   ELEC   SUBROUTINE          *
******************************************************************************
HP(1)-WOOD   PREPARATION   AREA
8130.0
HP(2)-DIGESTER   AND   TURPENTINE   AREA
10050.0
HP(3)-WASHING   AND   REFINING   AREA
17187.0
HP(4)-STOCK   PREPARATION   AREA
18265.0
HP(S)-PAPER   MACHINE   AREA
16697.0
HP(6)-ADDITIVES   ARIA
128.0
HP(7)-FINISHING   AND   SHIPPING   AREA
32.0
HP(8)-WATER   SUPPLY   AND   TREATMENT   AREA
1276.0
HP(9)-WASTE   DISPOSAL   AREA
1889.0
HP(10)-POWER   BOILER   AREA
8937.0
HP(11)-COAL   HANDLING   AREA
438.0
HP(12)-RECOVERY   BOILER   AREA
4786.0
HP(13)-EVAPORATORS   AREA
1870.0
HP(14)-LIME   KILN   AND   RECAUSTIZING   AREA
3005.0
HP(15)-AIR   SUPPLY   SYSTEM
3000.0
HP(16)-ODOR   COLLECTION   SYSTEM
4672.0
ALFC-AVERAGE   POWER   LOAD   FAC/MILL   EQUIP--DEC   RATIO   OF   CONNECTED   HORSEPOWER
0.50
AEFU-AVG   EFFICIENCY   Of   ELECTRICITY   USE   IN   MILL   EQUIP--DEC   RATIO   OF   ELEC   ENGY   DEM
0.90
ANML-AVG   NON-MOTOR   LOAD,   LIGHTING   AND   MISCELLANEOUS--KILOWATTS
0000.0
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*          DATA   FOR   STEAW   SUBROUTINE          *
******************************************************************************
BFFC-BLOWDOWN   RATIO   FOR   PWR   AND   RECBLRS--LBS   BLOWN/TOT   LBS   STEAM   PRODUCED
0.015
CNSL-LOSSES   FROM   STEAM   SYSTEM   IN   CONDENSATE   RECEIVER   AND   DEAERATOR
0.0186
FWHE-FDWTR   HTR   HEAT   EXCHANGE   EFFIC--RATIO   MEAT   INPUT   EXITING   FEEDWATER,AVERAGE
0.985
HCCN-ENTHALPY   OF   COMBINED   CONDENSATE   STEAM   SYS   TO   DEAERATOR--BTU/LB   CONDENSATE
210.0
HCMW-ENTHALPY   OF   MAKE-UP   WATER   TO   DEAERATOR--BTUILB   MAKE-UP   WATER
40.0
HHPP-ENTHALPY   OF   HIGH   PRESSURE   PROCESS   STEAM--BTU/LB   STEAM
1381.6
HLPP-ENTHALPY   OF   LOW   PRESSURE   PROCESS   STEAM--BTU/LB   STEAM
1219.4
HMPP-ENTHALPY   OF   MEDIUM   PRESSURE   PROCESS   STEAM--BTU/LB   STEAM
1279.2
HSHP-ENTHALPY   OF   SUPERHEATED   STEAM   FROM   BOILERS,   BTU/LB   STEAM
1023.0
HTMS-RATIO   TOT   HIGH   PRES   PROC   STEAM   REC   AS   MED   PROC   STEAM,EXC   STEAM   FROM   TURBINE
0.44
PKWH-PRICE   OF   PURCHASED   ELECTRIC   ENERGY,   $/KILOWATT   HOUR
0.031
SMLS-RATIO   TOT   MED   PRES   PROC   STEAM   REC   AS   LOW   PROC   STEAM,EXC   STEAM   FROM   TURBINE
0.017
SSSB-SUPERHTD   STEAM   REQ   SOOTBLWRS   IN   PWR   RECBLRS--LBS   STEAM/TOT   LBS   STEAM   PROD
0.03138
SVSE-SALES   VAL   SURPLUS   ELEC   ENGY   COGENERATED   IN   MILL--$/KILOWATT   HOUR
0.015
TGEF-TURBINE   GENERATOR   EFFICIENCY   FOR   CONVERT   TURBINE   ENERGY   TO   ELECT   ENERGY
0.75
HPAH-HIGH   PRES   STEAM   AIR   WTR   IN   RECBLR--LBS   STEAM/TON   BLK   LIQ   SOLIDS   TO   RECBLR
303.0
HPFW-HIGH   PRES   STEAM   DEMAND   PWRBLR   FDWTR   HTRS-LBS   STEAM/LB   FDWTR   TO   PWRBLR
0.113
HPMD-HIGH   PRES   STEAM   MISC   DEMAND   VOLUME--LBS   STEAM/TON   PROD
0.00
HPPB-HIGH   PRES   STEAM   DEMAND   PWRBLR,AIR   HTRS+MISC--LBS   STEAM/LB   STEAM   PROD   PWRB
0.0
HPPM-HIGH   PRES   STEAM   DEMAND   PAP   MACH+TURBINES--LBS   STEAM/DRY   TON   PAP   OR   PAPBD
3170.0
HPSL-LOSSES   FROM   HIGH   PRES   STEAM   SYS--RATIO   TOT   NIGH   PRES   NOT   RET   IN   CONDENSATE
0.00
HPTC-HIGH   PRES   STEAM   DEMAND   PAP   MACH   THERMOCOMPRESSORS--LBS   STEAM/DRY   TON   PAPER
930.0
SMAH-MED   PRES   STEAM   OEM   AIR   HTR   RECBLR-LBS   STEAMITON   BLK   LIQ   SOLIDS   TO   RECBLR
615.0
SMAS-MED   PRES   STEAM   OEM   AIR   SPLY   AREA--LBS   STEAM/DRY   TON   PULP   PRODUCED
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1.5
SMBL-MED   PRES   STEAM   DEMAND BLK LIQ   GUNS   RECBLR   FURN--LBS   STEAM/TON BLK LIQ   SOLID
39.0
SHDH-MED   PRES   STEAM   DEMAND   DIG   LIQ   HTR--LBS   STEAM/1000   GAL   WHITE   LIQ   TO   DIGESTER
1410.0
SMEC-MED   PRES   STEAM   DEMAND   EMISSION   CONTROL   RECBLR--LBS  STEAM/TON  BLK  LIQ   SOLIDS
62.5
SMFW-MED  PRES  STEAM  DEMAND  PWRBLR  FDWRT  HTRS--LBS  STEAM/LB  FDWTR  TO  PWRBLR
0.049
SMJE-MED   PRES   STEAM   JETS   IN   EVAP--LBS   STEAM/TON   BLK   LIQ   SOLIDS   INTO   EVAPORATOR
41.1
SMLH-MED   PRES   STEAM   DEMAND   SEC   BLK   LIQ   HTR   RECBLR--LBS   STEAMITON   BLK   LIQ   SOLIDS
72.6
SMMD-MED   PRES   PROCESS   STEAM   MISC   DEMAND   VOLUME--LBS   STEAM/TON   PRODUCT
0.0
SMPB-MED   PRES   STEAM   DEMAND   PWRBLR,AIR   HTRS,EMISS--LBS   STEAM/LBS   STEAM   PROD   PWRBL
0.00
SMPD-MED  PRES  STEAM  DEMAND  PAP  MACH  DRYRS--LBS  STEAM/LB  WTR  REM  HTD  DRYER  PAPMCH
1.47
SMSL-LOSSES  MED  PRES  PROC  STEAM  SYS--RATIO  TOT  MED  PRES  STEAM  NOT  RET  CONDENSATE
0.08156
SMST-MED   PRES   STEAM   DEMAND   SMELT   DISSLVNG   TANK--LS   STEAM/TON   BLK   LIQ   SOLIDS
46.9
SLAH-LOW   PRES   STEAM   DEMAND   AIR   HTR   RECBLR--LBS   STEAM/TON   BLK LIQ   SOLIDS   TO   RECOV
253.0
SLCH-LOW   PRES   STEAM   DEMAND   BLK   LIQ   CONCEN--LBS   STEAM/LB   WTR   REM   BLK   LIQ   CONCENT
0.665
SLDA-LOW   PRES   STEAM   DEMAND   DEAERATOR,   LBS   STEAM/LB   TOTAL   FEEDWATER
0.0936
SLDG-LOW   PRES   STEAM   DEMAND DIG   STEAM   VESSEL--LBS   STEAM/DRY   TON   CHIPS   TO   DIGESTER
278.0
SLEV-LOW   PRES   STEAM   DEMAND   BLK   LIQ   EVAP--LBS   STEAM/LB   WTR   REM   BLK   LIQ   EVAPORATOR
0.194
SLMD-LOW   PRES   MISC   STEAM   DEMAND--LBS   STEAM/DRY   TON   PAP   OR   PAPBD   PRODUCED
0.0
SLPB-LOW   PRES   STEAM   DEMAND   PWRBLR,AIR   HTRS,EMISS,MISC--LBS/LB   STEAM   PROD   PWRBLR
0.006
SLPM-LOW   PRES   STEAM   DEMAND   PAP   MACH   AUX   EQUIP+MISC--LBS   STEAM/DRY   TON   PROD
2000.0
SLRS-LOW   PRES   STEAM   DEMAND   HTNG   GREEN   LIQ   TO   SLAKER--LBS   STEAMITON   BLK   LIQ   SOLID
208.0
SLSE-LOW   PRES   STEAM   DEMAND   SULFUR   EMISS   ODOR   CONTROL--LBS/DRY   TON   PULP   PRODUCED
839.0
SLSL-LOSSES   LOW   PRES   PROC   STEAM   SYS--RATIO   TOT   LOW   PRES   STEAM   VOL   NOT   RET   CONDEN
0.184
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*            DATA   FOR   PWRBLR   SUBROUTINE                    *
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CLMC-M.C.    COAL,    RATIO    TOTAL    WEIGHT,    INCLUDING    MOISTURE,    AVERAGE
0.05
COLA-ASH  CONTENT   OF   COAL,   RATIO   OF   DRY   WEIGHT
0.10
COLC-CARBON    CONTENT    OF    COAL,    RATIO    OF    DRY    WEIGHT,    ULTIMATE    ANALYSIS
0  76
COLH-HYDROGEN   CONTENT   OF   COAL,   RATIO   OF   DRY   WEIGHT
0.04
COLO-OXYGEN   CONTENT   OF   COAL,   RATIO   Of   DRY   WEIGHT
0.065
COLN-NITROEEN    CONTENT    OF    COAL,   RATIO   OF   DRY   WEIGHT
0.015
COLS-SULFUR   CONTENT   OF   COAL,   RATIO   OF   DRY   WEIGHT
0.02
CPRC-PRICE    COAL    FOR    POWER    BOILER--$/TON    AS-PURCHASED,    F.O.B.    MILL
69.0
EXAR-EXCESS   AIR   TO   PWR   FURN--DEC   RATIO   OF   THEORETICAL   MIN   FOR   COMPLTE   COMB,   AVG
0.40
HVWD-COMBUSTION   HEAT   ENERGY   WOOD   AND   BARK   FUELS,   HIGH   MEAT   VAL--BTU/LB,DRY/AVG
9000.0
PCAS-PURCH    PRICE,F.O.B.    MILL,    OF    51%    CAUSTIC    SODA,    $/TON
580.0
PPSC-PURCHASE    PRICE    SODIUM    SULFATE    SALTCAKE    FOR    MAKE-UP,$/TON    OF    SALTCAKE
80.0
RUHL-RAD   HEAT   LOSS,UNACC   FOR   +   MISC   HEAT   LOSS--DEC   RATIO   OF   TOT   HEAT   ENGY   PWRBLR
0.02
SDOR-SULFUR   DIOX   REM   STACK   GAS   FLUE   GAS   DESULF--DEC   RATIO   TOT   SULF   DIOX   STK   GAS
0.75
SGTP-STACK   GAS   TEMP   BEYOND   EFFECTIVE   MEAT   RECV   DEVICES,OF   PWRBLR--DEG   F,   AVG
575.0
STRS-SULFUR   DIOX   GENER   INCINER   TRS   EASES   IN   PNRBLR--LB   SO2/TON   PULP   PRODUCED
5.8
WDMC-M.C.    WOOD   AND   BARK   FUELS   IN   POWERBOILER--DEC   RATIO   WET   WEIGHT,   AVG
0.50
WMAX-MAX  QUANTITY  WOOD  AND  BARK  USED  FOR  FUEL  IN    POWERBOILER--DRY     TONS/DAY
924.0
WODA-ASH   CONTENT   WOOD   AND   BARK   FUEL--RATIO   DRY   WOOD   WEIGHT
0.02
WODC-AVG   ULT   ANALYSIS   CARBON   CONT   WOOD   +   BARK   FUEL   IN   PWRBLR--DEC   RATIO  WOOD  WT
0.50
WODH-HYDROGEN  CONTENT   WOOD   AND   BARK   FUEL--RATIO   DRY   WOOD   WEIGHT
0.06
MOON-NITROGEN    CONTENT   WOOD   AN0   BARK   FUEL--RATIO   DRY   WOOD   WEIGHT
0.01
WOOD-OXYEEM  CONTENT   WOOD   AN0   BARK   FUEL--RATIO   DRY   WOOD   WEIGHT
0.41
WPRC-PURCHASE    PRICE    WOOD    FUEL,$/TON    AS-PURCHASED,    FOB    MILL    (*    2X    SALES    VALUE)
12.0
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*            DATA   FOR   SALES   SUBROUTINE                    *
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AMLB-AVG   MAINT   LABOR   REQ.   NO.   HOURLY   WAGE   WORKERS/DAY   (8-HR   SHIFTS)
94.0
AMWG-AVG    MAINT    LABOR    WAGE    RATE,    INC    FRINGE    BENEFITS    AN0    RELATED    EXPENSES--$/HR.
12.27
CCTC-COST    COOLING    TOWER    CHEMICALS--$/TON    PAP(BD)   PRODUCED
0.04
CFWC-COST    FEEDWATER    CHEMICAL    TRTMT    BOILER    FEEDWATER-$/TON    PAP(BD)OF    PRODUCT
0.11
DFCS-COST DRYER    FELTS    PAPER    MACHINE    DRYERS,$/DRY    TON    OF    PRODUCT
0.82
DPYR-DAYS/YEAR     MILL     IS     IN     OPERATION
355.0
EXLB-AVG    NON-PROCESS    LABOR    REQ--NO,    HRLY    WAGE    WORKERS    NEEDED/DAY    (8-HRS    EA. )
49.0
EXWE-AVG    NON-PROCESS   LABOR   MACE   RATE   INC    FRINGE    BENEF    AND    RELTED    EXP.--$/HR.
11.44
PLWG-AVG   PROCESS   LABOR   WAGE   RATE,   INCL    FRINGE    BENEF    AND    RELATED    EXP--$/HR
13.45
PSLB-AVG    PROC    LBR    REQ-NO.   HRLY   WAGE   PROCESS   PERS   NEEDED/DAY   (8-HR         SHIFTS/EA)
240.0
RCST-COST    ROLL    COVERS   FINISHED   ROLLS   PAP    OR    PAPBD    PRODUCT--$/DRY    TON    OF    PRODUCT
0.12
WCST-COST    WIRES    FOR    PAPER    MACHINE--/DRY    TON    OF    PRODUCT
0.76
WFCS-COST    WET    FELTS    FOR    PAPER    MACHINE--$/DRY    TON    OF    PRODUCT
1.12
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=====      STPREP      =====

C   ***   THIS   IS   THE   SUBROUTINE   FOR   THE   STOCK   PREPARATION,   ADDITIVES.
C   ***   PAPER   MACHINE,   FINISHING,   AND   SHIPPING   AREAS.
C
      SUBROUTINE     STPREP
C
      COMMON/ALL/CAOX,CDHW,CDSW,COGN,CPRC,CSDS,HBRK,HCCW,HWCW,HRFR,
     * HSRB,NX,PACD,PALM,
     * PCAS,PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PHRW,PLRQ~PPAP,
     * PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
     * PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
     * SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
     * SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
     * TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
      DIMENSION     SO(22)
C
C   ***   THIS   IS   THE   LIST   Of   INPUTS:
C
C   ***   ACID  -  QUANTITY   OF   CONCENTRATED   SULFURIC   ACID   ADDED   TO   SYSTEM   IN
C   ***            STOCK   PREPARATION.   IN   POUNDS   OF   CONCENTRATED   ACID   PER   DRY
C   ***            TON   OF   PAPER   OR   PAPERBOARD   PRODUCED.
C   ***   ALUM  -  QUANTITY   OF   ALUM   ADDED   IN   STOCK   PREPARATION   IN   POUNDS   OF
C   ***            DRY   ALUM   SOLIDS   (IN   LIQUID   SLURRY),   POUNDS   PER   DRY   TON   OF
C   ***            PAPER   OR   PAPERBOARD   PRODUCED
C   ***   DBKT  -  PAPER   OR   PAPERBOARD   RECYCLED   AS   DRY   "BROKE"   AND   TRIM   TO
C   ***            STOCK   PREPARATION   AS   A   RATIO   OF   TOTAL   PAPER   OR
C   ***            PAPERBOARD       PRODUCTION.
C   ***   DFOM  -  QUANTITY   OF   DEFOAMER   ADDITIVES   IN   STOCK   PREPARATION   AND
C   ***            MACHINE   AREAS   IN   POUNDS   OF   ADDITIVES   PER   DRY   TON   OF   PAPER
C   ***            OR   PAPERBOARD   PRODUCED.
C   ***   DSMC  -  MOISTURE   CONTENT   OF   SWEET   ENTERING   HEATED   DRYER   SECTION.
C   ***            RATIO   OF   TOTAL   WEIGHT   OF   SHEET.
C   ***   PACD  -  PURCHASE   PRICE   OF   SULFURIC   ACID   ($/TON   FOB   MILL)
C   ***   PALM  -  PURCHASE   PRICE   OF   ALUM   ($/TON   FOB   MILL)
C   ***   PCOR  -  PRICE   OF   RECYCLED   OLD   CORRUGATED,  USED   AS   RAW   MATERIAL
C   ***            FURNISH   IN   STOCK   PREPARATION,   DOLLARS   PER   DRY   TON.
C   ***   PDFM  -  PURCHASE   PRICE   OF   DEFOAMER   ($/TON   FOB   MILL)
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C *** PMND - MINIMUM DENSITY OF PAPER OR PAPERBOARD PRODUCT IN DRY
C ***        POUNDS PER THOUSAND SQUARE FEET.
C *** PPAP - PRICE OF RECYCLED PAPER, USED AS RAW MATERIAL IN STOCK
C ***        PREPARATION, DOLLARS PER DRY TON.
C *** PPON - AVERAGE DENSITY OF PAPER OR PAPERBOARD PRODUCT IN DRY
C ***        POUNDS PER THOUSAND SQUARE FEET OF PAPER OR BOARD.
C *** PPHC - AVERAGE REEL MOISTURE CONTENT OF PAPER OR PAPERBOARD
C ***        PRODUCT, TOTAL WEIGHT BASIS.
C *** PPRD - PAPER OR PAPERBOARD PRODUCTION VOLUME OF THE MILL, IN DRY
C ***        TONS OF PIPER OR PAPERBOARD PER DAY.
C *** PRSN - PURCHASE PRICE OF ROSIN ($/TON FOB MILL).
C *** PSLM - PURCHASE PRICE OF SLIMICIDE ($/TON FOB MILL).
C *** PSTC - PURCHASE PRICE OF STARCH ($/TON FOB MILL).
C *** RCOR - RECYCLED OLD CORRUGATED RAW MATERIAL AS A RATIO OF
C ***        TOTAL WEIGHT OF PAPER(BOARD) PRODUCT, DECIMAL RATIO OF
C ***        DRY PRODUCT WEIGHT. RECYCLED FURNISH ENTERS IN STOCKPREP.
C *** RCYD - YIELD OR RECOVERY WEIGHT FOR RECYCLED OLD CORRUGATED.
C ***        RATIO OF RAW MATERIAL DRY WEIGHT RECOVERED IN PRODUCT.
C *** ROSN - QUANTITY OF ROSIN ADDED IN STOCK PREPARATION, IN POUNDS OF
C ***        ROSIN SOLIDS PER DRY TON OF PAPER OR PAPERBOARD PRODUCED.
C *** RPAP - RECYCLED PAPER RAW MATERIAL AS A RATIO OF TOTAL WEIGHT
C ***        OF PAPER(BOARD) PRODUCT, DECIMAL RATIO OF DRY PRODUCT
C ***        WEIGHT.
C *** RPVO - YIELD OR RECOVERY RATE FOR RECYCLED PAPER RAW MATERIAL,
C ***        RATIO OF RAW MATERIAL DRY WEIGHT RECOVERED IN PROOUCT.
C *** SLIM - QUANTITY OF SLIMICIDE ADDITIVES PER DRY TON OF PAPER OR
C ***        PAPERBOARD PRODUCED, POUNDS OF ADDITIVES PER DRY TON OF
C ***        PRODUCT.
C *** STRC - QUANTITY OF STARCH ADDITIVES IN STOCK PREPARATION, IN
C ***        POUNDS OF DRY STARCH SOLIDS PER DRY TON OF PAPEP (BOARD)
C ***        PRODUCT.
C *** SVAL - AVERAGE SALES VALUE OF PAPER OR PAPERBOARD PRODUCT, IN
C ***        DOLLARS PER DRY TON, F.O.B. MILL.
C *** TRWD - TRIMMED REEL WIDTH ON SHEET ROLL WINDER.
C
C *** READ STATEMENTS:
C
      READ (5,10)ACID,ALUM,DBKT,DFOM,DSMC,PACD,PALM,PCOR,PDFM,
     *           PMND,PPAP,PPDN,PPMC,PRRD,PSRN,PSLM,PSTC,RCOR,RCYD,ROSN,
     *           RPAP,RPYD,SLIM,STRC,SVAL,TRWD
   10 FORMAT (////26(F20.0//))
C
C *** CALCULATIONS:
C
C *** CALCULATE TOTAL DRY WEIGHT OF CHEMICAL AND SIZING ADDITIVES IN
C *** POUNDS PER DRY TON IN PROOUCT, ASSUMING ALL OF ALUM. STARCH, AND
C *** ROSIN ADDITIVES ARE IN FINAL PRODUCT, PLUS ONE-HALF OF ACID.
C *** DEFOAMER AND SLIMICIDE ADDITIVES, BY WEIGHT.
      ADTV = ALUM + STRC + ROSN + 0.5 * (ACID + DFOM+ SLIM)
C *** CALCULATE QUANTITY OF RECYCLED OLD CORRUGATE0 USED, DRY TONS PER
C *** DAY:
      IF (RCYD.LE.O.0) GO TO 20
      IF (RPYD.LE.0.0) GO TO 20
      RCPT = RCOR * ((PPRD-(PPRO*ADTV/2000.0))/RCYD)
C *** CALCULATE QUANTITY OF RECYCLED PAPER USED, DRY TONS PER DAY:
      RPPT = RPAP * ((PPRD-(PPRD*ADTV/2000.0))/RPYD)
   20 CONTINUE
C *** CALCULATE PULP PRODUCTION QUANTITY REQUIRED, IN DRY TONS OF PULP
C *** PER DAY:
      PROD = PPRD - (PPRO * ADTV/2000.0) - (RCRT*RCYD) - (RPPT*RPYD)
      IF (PROD.LE.0.01) PROD = 0.0
C *** CALCULATE TOTAL DRY PAPER THROUGHPUT OF PAPER MACHINE IN DRY TONS
C *** PER DAY, INCLUDING PRODUCT PLUS DRY BROKE AND DRY TRIMS VOLUME
C *** THAT ARE RECYCLED:
      TDPT = PPRD + (PPRD * DBKT)
C *** CALCULATE AVERAGE OPERATIONAL PAPER MACHINE SPEED IN LINEAL FEET
C *** PER MINUTE OF FINISHED PAPER SHEET:
      ASPD = ((PPRD/1440.0) * (2000.0)/(PPDN/1000.0))/
     +     (TRWD/12.0)
C *** CALCULATE MAXIMUM OPERATIONAL PAPER MACHINE SPEED IN LINEAL FEET
C *** PER MINUTE OF FINISHED PRODUCT:
      MSPD = ((PPRD/1440.0) * (2000.0)/(PMND/1000.0))/
     +     (TRWD/12.0)
C *** CALCULATE TOTAL WATER REMOVAL IN HEATED DRYER SECTION OF PAPER
C *** MACHINE, TONS OF WATER PER DAY:
      TWRD = (TDPT/(1.0 - DSMC)) - (TDPT/(1.0 - PPMC))
C *** CALCULATE TONS OF EACH ADDITIVE REQUIRED PER DAY:
      TALM = PPRD * ALUM/2000.0
      TACD = PPRD * ACID/2000.0
      TSTC = PPRD * STRC/2000.0
      TDFM = PPRD * DFOM/2000.0
      TRSN = PPRD * ROSN/2000.0
      TSLM = PPRD * SLIM/2000.0
C
C THESE ARE THE OUTPUT STATEMENTS:
C
      IF (NX.EQ.1.OR.NX.EQ.5.OR.NX.EQ.6) GO TO 500
      IF (NX.EQ.7.OR.NX.EQ.11.OR.NX.EQ.12) GO TO 500
      SO(1) = PPRD
      SO(2) = PPMC * 100.0
      SO(3) = PPRD/(1.0 - PPMC)
      SO(4) = PPMC * PPRD/(1.0 - PPMC)
      SO(5) = PPRD * DBKT
      SO(6) = TDPT
      SO(7) = TRWD
      SO(8) = ASPD
      SO(9) = MSPD
      SO(10) = TWRD
      SO(11) = DSMC * 100.0
      SO(12) = PPMC * 100.0
      SO(13) = PPRD * ALUM/2000.0
      SO(14) = PPRD * ACID/2000.0
      SO(15) = PPRD * STRC/2000.0
      SO(16) = PPRD * DFOM/2000.0
      SO(17) = PPRD * ROSN/2000.0
      SO(18) = PPRD * SLIM/2000.0
      SO(19) = PPRD * ADVTV/2000.0 + (RCRT+RCYD) + (RPPT*RPYD)
      SO(20) = PROD
      SO(21) = RCRT
      SO(22) = RPPT
      WRITE (6,100)
  100 FORMAT ('1',10X,'M A T E R I A L S   B A L A N C E'///
     +2X,'I.      STOCK PREPARATION, ADDITIVES, PAPER MACHINE,'/
     +2X,'        FINISHING AND SHIPPING AREAS'/)
      WRITE (6,110) (SO(I),I=1,9)
  110 FORMAT (4X,'A.  FINISHED PRODUCT OUTPUT:'//
     +9X,F7.1,' DRY TONS/DAY
     +9X,F7.1,''(MOISTURE CONTENT',F6.1,' % TOTAL WT. BASIS)'/
     +20X,'(',F7.I,' TONS/DAY, GROSS PRODUCT OUTPUT AIR DRY WT.)'/
     +20X.'(', F7.1,' TONS/DAY, WATER IN PRODUCT)'//
     +4X,'8.  RECYCLED DRY BROKE (TO STOCK PREP.):'//
     +9X,F7.1,' DRY TONS/DAY'//
     +4X,'C.  TOTAL PAPER MACHINE AND DRYER THROUGHPUT (A + 8):'//
     +9X,F7.1,' DRY TONS/DAY'/
     +20X,'(TRIMMED REEL WIDTH:',F5.0,' INCHES)'/
     +20X,'(AVERAGE SPEED:',F0.0,' LIN. FT./MIN.),/
     +20X,'(MAXIMUM SPEED:',F6.0.' LIN. FT./MIN.)'//)
      WRITE (6,120) (SO(I), I=13,18),SO(21),SO(22)
  120 FORMAT (4X,'D.  ADDITIVES AND RECYCLED MATERIALS IN STOCK'/
     +9X,'PREPARATION:'//
     +9X,F7.1,' TONS/DAY ALUM'/
     +9X,F7.1,' TONS/DAY ACID'/
     +9X,F7.1,' TONS/DAY STARCH'/
     +9X,F7.1,' TONS/DAY DEFOAMER'/
     +9X,F7.1,' TONS/DAY ROSIN'/
     +9X,FT.7,1' TONS/DAY SLIMICIDE'/
     +9X,F7.1,' DRY TONS/DAY RECYCLED CORRUGATED'/
     +9X,F7.1,' DRY TONS/DRY RECYCLED PAPER'//)
      WRITE (6.130) (SO(I), I=19,20)
  130 FORMAT (4X,'E.  TOTAL WEIGHT ADDITIVES AND RECYCLED MATERIALS IN'/
     +9X,'PRODUCT (INCLUDES ALL RECYCLED AT RECOVERY RATE,'/
     +9X,'ALL ALUM. STARCH, ROSIN, PLUS HALF Of ACID,'/
     +9X,'DEFOAMER, & SLIMICIDE)'/I
     +9X,F7.1,' DRY TONS/DAY'//
     +4X,'F.  WEIGHT OF PULP INTO STOCK PREPARATION FROM'/
     +9X,'DIGESTER (A - E):'//
     +9X,F7.1,' DRY TONS/DAY'/)
      WRITE (6,140) (SO(I),I=10,12)
  140 FORMAT (4X,'G.  WATER REMOVAL IN DRYER SECTION:'//
     +9X1F7.1,' TONS/DAY'/
     +20X,'(AVG. MOIST. CONT. INTO DRYER ',F5.1,' % TOTAL WT.)'/
     +20X,'(AVG. MOIST. CONT. OUT OF DRYER ',F5.1,' % TOTAL WT.)'///)
  500 CONTINUE
      END
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      ===== DIG =====
C *** THIS IS THE SUBROUTINE FOR THE DIGESTER, PULP WASHING AND
C ***    EVAPORATOR AREAS.
C
      SUBROUTINE DIG
C
      COMMON/ALL/CAOX,CDHW,CDSW,COGN,CPRC,CSOD,HBRK,HCCW,HWCW~HRFR,
     * HSRB,NX,PACD,PALM,
     * PCAS,PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
     * PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
     * PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
     * SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW.SREE,SRFR,SSCK,SURB,SVAL,SVSC,
     * SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
     * TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
      DIMENSION DO(15)
C
C *** THIS IS THE LIST OF INPUTS:
C
C *** AACN - ACTIVE ALKALI CONCENTRATION IN WHITE LIQUOR, POUNDS OF
C ***        ACTIVE ALKALI PER CUBIC FOOT OF WHITE LIQUOR.
C *** AALK - ACTIVE ALKALI (IN WHITE LIQUOR ENTERING DIGESTER),
C ***        SODIUM HYDROXIDE AND SODIUM SULFIDE IN WHITE LIQUOR,
C ***        IN SODIUM OXIDE WEIGHT EQUIVALENT, EXPRESSED AS A DECIMAL
C ***        RATIO OF DRY WOOD WEIGHT.
C *** BSDS - BLACK LIQUOR SOLIOS IN WEAK BLACK LIQUOR FROM DIGESTER AND
C ***        WASHERS TO EVAPORATORS, EXPRESSED AS TONS OF DRY SOLIOS
C ***        PER DRY TON OF PULP.
C *** CCBL - SOLIDS CONTENT OF CONCENTRATED BLACK LIQUOR, EXITING
C ***        CONCENTRATORS (TO SALT CAKE MIX TANK IN RECOVERY BOILER
C ***        AREA). LIQUOR SOLIOS WEIGHT RATIO OF TOTAL LIQUOR.
C *** CEBL - SOLIOS CONTENT OF EVAPORATED BLACK LIQUOR, EXITING
C ***        EVAPORATORS AND ENTERING CONCENTRATORS (LIQUOR SOLIOS
C ***        WEIGHT RATIO OF TOTAL-LIQUOR).
C *** CNBL - SOLIDS CONTENT OF WEAK BLACK LIQUOR EXITING WASHERS TO
C ***        EVAPORATORS (BLACK LIQUOR SOLIDS WEIGHT RATIO OF TOTAL
C ***        BLACK LIQUOR WEIGHT).
C *** PROD - PULPMILL PRODUCTION VOLUME, IN TONS OF OVENDRY PULP
C ***        PRODUCED PER DAY, AVERAGE.
C *** PWMC - PULPWOOD MOISTURE CONTENT, DECIMAL RATIO OF WET WEIGHT,
C ***        ENTERING CHIP FEED.
C *** PYLD - PULP YIELD, OVENDRY WEIGHT OF PULP TO DRY WEIGHT OF PULP
C ***        CHIP RAW MATERIAL ENTERING DIGESTER, EXPRESSED AS A
C ***        DECIMAL RATIO.
C *** SCLS - TOTAL SALTCAKE (SODIUM SULFATE) LOSSES, OR 'MAKE-UP
C ***        CHEMICAL" REQUIREMENTS, IN POUNDS OF SODIUM SULFATE/DRY
C ***        TON OF PULP (SALTCAKE ADDED IN RECOVERY).
C *** SCPL - SALTCAKE LOSS IN PULP (BOUND IN PULP OUT OF WASHERS) AS A
C ***        RATIO OF TOTAL SALTCAKE LOSSES (REMAINING SALTCAKE
C ***        LOSSES ASSUMED TO OCCUR IN EVAPORATORS, RECOVERY FURNACE
C ***        AND RECAUSTICIZING AREAS).
C *** SOAP - QUANTITY OF SAPONIFIED FATTY ACIDS (SOAP) RECOVERED IN
C ***        SOAP SKIMMER IN EVAPORATOR AREA, DRY POUNDS OF SOAP
C ***        RECOVERED PER TON OF WOOD CHIPS INTO DIGESTER (SOAP WILL
C ***        GO TO EXTERNAL TALL OIL PLANT).
C *** SOPP - PRICE OF SOAP SKIMMINGS IN $ PER TON, F.O.B. MILL (SALES
C ***        PRICE).
C *** TPSV - TURPENTINE SALES VALUE, $ PER GALLON, F.O.B. MILL.
C *** TURP - TURPENTINE RECOVERY. IN GALLONS OF TURPENTINE RECOVERED
C ***        PER TON OF WOOD CHIPS INTO DIGESTER.
C
C *** READ STATEMENTS:
C
      READ (5,10)AACN,AALK,BSDS,CCBL,CEBL,CNBL,CNWP,PWMC,PYLD,SCLS,
     +           SCPL,SOLP,SOPP,TPSV,TURP
   10 FORMAT (//15(F20.0//))
C
C *** CALCULATIONS:
C
C *** CALCULATE QUANTITY OF PULPWOOD CHIPS REQUIRED AS INPUT TO
C *** DIGESTER, IN DRY TONS PER DAY:
      PPWD = PROD/PYLD
C *** CALCULATE TURPENTINE RECOVERY FROM TURPENTINE SEPARATOR AND
C *** DECANTER:
C *** (A.) CALCULATE RECOVERY IN GALLONS PER DAY:
      TRPD = TURP * PPWD
C *** (B.) TURPENTINE SPECIFIC GRAVITY:
      TSPG = 0.6
C *** (C.) TURPENTINE RECOVERY IN TONS PER DAY:
      TRTD = TRPD * (0.13368) * (62.4) * TSPG/~2000.0
C *** CALCULATE TONS PER DAY OF SLACK LIQUOR SOLIOS TO EVAPORATORS,
C *** IN WEAK BLACK LIQUOR:
      TBLS = PROD * BSDS
C *** CALCULATE TONS PER DAY OF WATER TO EVAPORATORS IN WEAK SLACK
C *** LIQUOR:
      WBLW = (TBLS/CNBL) - TBLS
C *** CALCULATE SOAP RECOVERY, TONS PER DAY, AND BLACK LIQUOR SOLIOS
C *** REMAINING AFTER SOAP RECOVERY:
      SOPR = SOAP * PPWD2000.0
      TBLS = TBLS - SOPR
C *** CALCULATE TONS OF ACTIVE ALKALI REQUIRED PER DAY, IN SODIUM OXIDE
C *** WEIGHT EQUIVALENT (IN WHITE LIQUOR TO DIGESTER):
      TDAA = AALK * PPWD
C *** CALCULATE WET WEIGHT OF PULPWOOD CHIPS INTO DIGESTER-TONS PER DAY:
      PWIN = PPWD/(1.0 - PWMC)
C *** CALCULATE TONS PER DAY OF WATER IN EVAPORATED LIQUOR TO BLACK
C *** LIQUOR CONCENTRATORS:
      EBLW = (TBLS/CEBL) - TBLS
C *** CALCULATE WATER REMOVAL IN EVAPORATORS (TONS PER DAY):
      WREV = WBLW - EBLW
C *** CALCULATE TONS PEP DAY OF WATER IN CONCENTRATE0 BLACK LIQUOR TO
C *** RECOVERY AREA:
      CBLW = (TBLS/CCBL) - TBLS
C *** CALCULATE WATER REMOVAL IN BLACK LIQUOR CONCENTRATORS, TONS PER
C *** DAY:
      WRCN : EBLW - CBLW
C *** CALCULATE WHITE LIQUOR VOLUME TO DIGESTER IN THOUSANDS OF GALLONS

      TWLV = ((TDAA * 2000.0)/AACN)/133.68056
C
C THIS IS THE LISTING OF OUTPUT STATEMENTS:
C
      IF (NX.EQ.2.OR.NX.EQ.5) GO TO 500
      IF (NX.EQ.2.OR.NX.EQ.5.OR.NX.EQ.6) GO TO 500
      IF (NX.EQ.8.OR.NX.EQ.11.OR.NX.EQ.12) GO TO 500
      DO(1) = PROD
      DO(3) = PPWD
      DO(4) = TRTD
      DO(5) = TBLS + SOPR
      DO(6) = CNBL * 100.0
      DO(7) = SOPR
      DO(8) = WREV
      DO(9) = CEBL * 100.0
      DO(10) = WRCN
      DO(11) = CCBL * 100.0
      DO(12) = TBLS
      DO(13) = TWLV
      DO(14) = TDAA
      DO(15) = AALK * 100.0
      WRITE (6,100)
  100 FORMAT ('1',1X,'II. DIGESTER, PULP WASHING AND EVAPORATORS'/)
      WRITE (6,110) DO(1), DO(3), DO(4)
   10 FORMAT (4X,'A. WEIGHT OF PULP OUT OF WASHERS (I.F):'///
     +9X,F7.1,' DRY TONS/DAY'///
     +4X,'8. PULPWOOD CHIPS INTO DIGESTER:'//
     +9X,F7.1,' DRY TONS/DAY'///
     +4X,'C, TURPENTINE RECOVERY FROM CHIPS:'//
     +9X,F7.1,' TONS/DAY'///)
      WRITE (6,120) (DO(I),I=5,7)
   20 FORMA7 4X,'D. BLACK LIQUOR SOLIDS IN WEAK BLACK'/
     +       4X,' LIQUOR FROM WASHERS TO EVAPORATORS'//
     +9X,F7.1,' TONS DRY SOLIDS/DAY'/
     +20X,'(SOLIDS CONTENT:,F6.1.' %)'///
     +4X,'E. SOAP RECOVERY FROM SLACK LIQUOR:'//
     +9X,F7.1,' DRY TONS/DAY'///)
      WRITE (6,130) (DO(I),I=8,11)
  130 FORMAT (4X,'F. WATER REMOVALS IN EVAPORATORS C CONCENTRATORS:'//
     +9X,F7.1,' TONS/DAY WATER REM. IN EVAPOPATORS'/
     +20X,'(SOLIDS CONTENT TO CONCENTRATORS:',F6.1,' %)'//
     +9X,F7.1,' TONS/DAY WATER REM. IN CONCENTRATORS:'/
     +20X,'(SOLIDS CONTENT TO RECOVERY BOILER:',F6.1,' %)'///)
      WRITE (6,140) (DO(I),I=12,15)
  140 FORMAT (4X,'G. BLACK LIQUOR CONCENTRATE TO RECOVERY BOILER:'//
     +9X,F7.1,' TONS DRY SOLIDS/DAY'///
     +4X,'H. WHITE LIQUOR TO DIGESTER:'//
     +9X,F7.1,' THOUSAND GALLONS/DAY'/
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      +9X,F7.1,'   TONS/DAY   ACTIVE   ALKALI'/
      +2OX,'(SODIUM   OXIDE   EQUIVALENT)'/
      +20X,'(',F7.1,'   %   OF   WOOD   WEIGHT)'/)
  500 CONTINUE
      END
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===== WDPREP =====

```
      SUBROUTINE WDPREP
C
C *** THIS IS THE SUBROUTINE FOR THE WOOD PREPARATION AREA.
C
      COMMON/ALL/CAOX,CDHW,CDSW,COGN,CPRC,CSDS,HBRK,HCCW,HWCW,HRFR,
     * HSRB,NX,PACD,PALM,
     * PCAS,PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
     * PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
     * PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
     * SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
     * SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
     * TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
      DIMENSION WO(35)
C
C *** THIS IS THE LIST OF INPUTS:
C
C *** HBPC - WEIGHT RATIO REMOVED AS BARK IN DEBARKING HARDWOOD
C ***        ROUNDWOOD PULPWOOD, RATIO OF TOTAL DRY WEIGHT OF
C ***        PURCHASED ROUNDWOOD, INCLUDING BARK.
C *** HCHM - MOISTURE CONTENT OF HAROWOOD PURCHASED "CLEAN' CHIP
C ***        PULPWOOD, DECIMAL RATIO OF WET WEIGHT. AVERAGE.
C *** HTCF - FINES REMOVED IN SCREENING HARDWOOD PURCHASED "CLEAN"
C ***        CHIPS AS A RATIO OF TOTAL DRY WEIGHT
C ***        OF HARDWOOD PURCHASED "CLEAN" CHIPS.
C *** HWCD - TOTAL WEIGHT PER CORD OF HARDWOOD ROUNDWOOD PULPWOOD, WET
C ***        WEIGHT BASIS, POUNDS PER CORD INCLUDING BARK, AS PURCHASED
C *** HWFR - FINES REMOVED IN SCREENING HARDWOOD ROUNDWOOD CHIPS
C ***        AS A RATIO OF TOTAL DRY WEIGHT OF HARDWOOD
C ***        ROUNDWOOD CHIPS BEFORE SCREENING.
C *** HWHC - AVERAGE MOISTURE CONTENT IN HARDWOOD ROUNDWOOD PULPWOOD,
C ***        RATIO OF TOTAL WET WEIGHT OF PULPWOOD AS PURCHASED,
C ***        INCLUDING BARK.
C *** HWPC - HARDWOOD PURCHASED CHIPS (WHOLE-TREE AND "CLEAN") AS A
C ***        RATIO OF TOTAL HARDWOOD CHIPS INTO DIGESTER, FRACTION
C ***        OF TOTAL DRY WEIGHT OF HARDWOOD PURCHASED AND ROUNDWOOD
C ***        CHIPS.
C *** HWTC - HARDWOOD WHOLE-TREE CHIPS AS A RATIO OF TOTAL HARDWOOD
C ***        PURCHASED CHIPS. RATIO OF TOTAL DRY WEIGHT OF HARDWOOD
C ***        PURCHASED CHIPS.
C *** HWTF - BARK AND FINES REMOVED IN SCREENING HARDWOOD WHOLE-TREE
C ***        CHIPS AS A DECIMAL RATIO OF TOTAL DRY WEIGHT OF
C ***        HARDWOOD WHOLE-TREE CHIPS.
C *** HWTM - MOISTURE CONTENT OF HARDWOOD PURCHASE0 WHOLE-TREE CHIPS,
C ***        DECIMAL RATIO OF WET WEIGHT, AVERAGE.
C *** PHPC - PRICE OR VALUE OF HARDWOOD PURCHASED "CLEAN" CHIPS, $ PER
C ***        TON AS PURCHASED, AVERAGE.
C *** PHRW - PURCHASE PRICE F.O.B. MILL FOR HARDWOOD ROUNDWOOD, $ PER
C ***        CORD, AVERAGE.
C *** PHWC - PURCHASE PRICE, FOB MILL, FOR HARDWOOD WHOLE-TREE CHIPS,
C ***        $ PER TON AS PURCHASED, AVERAGE.
C *** PPWD - QUANTITY OF SCREENED PULPWOOD CHIPS REQUIRED, CRY TONS PER
C ***        DAY INTO DIGESTER. AVERAGE TOTAL QUANTITY.
C *** PSPC - PRICE OR VALUE OF SOFTWOOD PURCHASED "CLEAN. CHIPS, $ PER
C ***        TON AS PURCHASED, AVERAGE.
C *** PSRW - PURCHASE PRICE F.O.B. MILL FOR SOFTWOOD ROUNDWOOD, $ PER
C ***        CORD, AVERAGE.
C *** PSWC - PURCHASE PRICE F.O.B. HILL FOR SOFTWOOD WHOLE-TREE CHIPS,
C ***        $ PER TON AS PURCHASED, AVERAGE.
C *** SBPC - WEIGHT RATIO REMOVED AS BARK IN DEBARKING SOFTWOOD
C ***        ROUNDWOOD PULPWOOD. RATIO OF TOTAL DRY WEIGHT OF
C ***        PURCHASED ROUNDWOOD, INCLUDING BARK.
C *** SCHM - MOISTURE CONTENT OF SOFTWOOD PURCHASED "CLEAN" CHIP
C ***        PULPWOOD, DECIMAL RATIO OF WET WEIGHT, AVERAGE.
C *** SFWD - SOFTWOOD RATIO OF TOTAL PULPWOOD CHIPS INTO DIGESTER,
C ***        DECIMAL RATIO OF TOTAL DRY WEIGHT OF CHIPS.
C *** STCF - FINES REMOVED IN SCREENING SOFTWOOD PURCHASED "CLEAN"
C ***        CHIPS AS A RATIO OF TOTAL DRY WEIGHT OF SOFTWOOD
C ***        PURCHASED "CLEAN" CHIPS.
C *** SWCD - TOTAL WEIGHT PER CORD OF SOFTWOOD ROUNDWOOD PULPWOOD, WET
C ***        WEIGHT BASIS, POUNDS PER CORD INCLUDING BARK,AS PURCHASED
C *** SWFR - FINES REMOVED IN SCREENING SOFTWOOD ROUNDWOOD CHIPS (TO
C ***        WOOD FUEL) AS A RATIO OF TOTAL DRY WEIGHT OF SOFTWOOD
C ***        ROUNDWOOD CHIPS BEFORE SCREENING.
C *** SWMC - AVERAGE MOISTURE CONTENT IN SOFTWOOD ROUNDWOOD PULPWOOD,
C ***        RATIO OF TOTAL WET WEIGHT OF PULPWOOD AS PURCHASED,
C ***        INCLUDING BARK.
C *** SWPC - SOFTWOOD PURCHASED CHIPS (WHOLE-TREE AND "CLEAN") AS A
C ***        RATIO OF TOTAL SOFTWOOD INTO DIGESTER, FRACTION OF
C ***        TOTAL DRY WEIGHT OF SOFTWOOD PURCHASED AND ROUNDWOOD
C ***        CHIPS.
C *** SWTC - SOFTWOOD WHOLE-TREE CHIPS AS A RATIO OF TOTAL SOFTWOOD
C ***        PURCHASED CHIPS. RATIO OF TOTAL DRY WEIGHT OF SOFTWOOD
C ***        PURCHASED CHIPS;
C *** SWTF - BARK AND FINES REMOVED IN SCREENING SOFTWOOD WHOLE-TREE
C ***        CHIPS AS A DECIMAL RATIO OF TOTAL DRY WEIGHT OF
C ***        SOFTWOOD WHOLE-TREE CHIPS.
C *** SWTM - MOISTURE CONTENT OF SOFTWOOD PURCHASED WHOLE-TREE CHIPS,
C ***        DECIMAL RATIO OF WET WEIGHT, AVERAGE.
C
C *** READ STATEMENTS:
C
      READ (5,10),HBPC,HCHM,HTCF,HWCD,HWFR,HWMC,HWPC,HWTC,HWTF,HWTH,
     +            PHPC,PHRW,PHWC,PSPC,PSRW,PSWC,SBPC,SCHM,SFWD,STCF,
     +            SWCD,SUFR,SWMC,SWPC.SWTC,SWTF,SWTM
   10 FORMAT (//27(F20.0//))
C
C ***   CALCULATIONS:
C
C *** CALCULATE DRY TONS PER DAY OF SOFTWOOD CHIPS INTO DIGESTER:
      SPUD = PPWD * SFWD
C *** CALCULATE DRY TONS PER DAY OF HARDWOOD CHIPS INTO DIGESTER:
      HPWD = PPWD * (1.0 - SFWD)
C *** CALCULATE DRY TONS PER DAY OF SOFTWOOD ROUNDWOOD CHIPS INTO
C *** DIGESTER:
      SRPW = SPWD * (1.0 - SWPC)
C *** CALCULATE DRY TONS PER DAY OF HARDWOOD ROUNDWOOD CHIPS INTO
C *** DIGESTER:
      HRPW = HPWD * (1.0 - HWPC)
C *** CALCULATE DRY TONS PER DAY OF SOFTWOOD FINES REMOVED IN SCREENING
C *** SOFTWOOD ROUNDWOOD PULPWOOD CHIPS (FINES GO TO POWER BOILER FUEL
C *** STORAGE AREA):
      SRFR = (SRPW/(1.0 - SWFR)) * SWFR
C *** CALCULATE DRY TONS PER DAY OF HARDWOOD FINES REMOVED IN SCREENING
C *** HARDWOOD ROUNDWOOD PULPWOOD CHIPS (FINES GO TO POWER BOILER FUEL
C *** STORAGE AREA):
      HRFR = (HRPW/(1.0 - HWFR)) * HWFR
C *** CALCULATE DRY TONS PER DAY OF SOFTWOOD BARK REMOVED FROM SOFTWOOD
C *** ROUNDWOOD (TO POWER BOILER FUEL STORAGE AREA):
      SBRK = ((SRPW + SRFR)/(1.0 - SBPC)) * SBPC
C *** CALCULATE DRY TONS PER DAY OF HARDYWOOD BARK REMOVED FROM HARDWOOD
C *** ROUNDWOOD (TO POWER BOILER FUEL STORAGE AREA):
      HBRK = ((HRPW + HRFR)/(1.0 - HBPC)) * HBPC
C *** CALCULATE REQUIRED COROS PER DAY OF SOFTWOOD ROUNDWOOD PULPWOOD:
      CDSW = ((SRPW + SRFR + SBRK)/(1.0 - SWMC))/(SWCD/2000.0)
C *** CALCULATE REQUIRED COROS PER DAY OF HARDWOOD ROUNDWOOD PULPWOOD
      CDHW = ((HRPW + HRFR + HBRK)/(1.0 - HWMC))/(HWCD/2000.0)
C *** CALCULATE DRY TONS PER DAY OF SCREENED SOFTWOOD PURCHASED CHIPS
C *** INTO DIGESTER:
      SPCH = SPWD * SWPC
C *** CALCULATE DRY TONS PER DAY OF SCREENED HARDWOOD PURCHASED CHIPS
C *** INTO DIGESTER:
      HPCH = HPWD * HWPC
C *** CALCULATE DRY TONS PER DAY OF SOFTWOOD FINES, INCLUDING FINES
C *** FROM WHOLE-TREE CHIPS AND "CLEAN" CHIPS SCREENING (FINES TO
C *** POWER BOILER FUEL STORAGE AREA):
      SWCF = ((SPCH * SWTC)/(1.0 - SWTF)) * SWTF
      SPCF = ((SPCH * (1.0 - SWTC))/(1.0 - STCF)) * STCF
C *** CALCULATE DRY TONS PER DAY OF HARDWOOD FINES, INCLUDING FINES
C *** FROM WHOLE-TREE CHIP AND "CLEAN" CHIP SCREENING (FINES TO POWER
C *** BOILER FUEL STORAGE AREA):
      HWCF = ((HPCH * HWTC)/(1.0 - HWTF)) * HWTF
      HPCF = ((HPCH * (1.0 - HWTC))/(1.0 - HTCF)) * HTCF
C *** CALCULATE DRY TONS PURCHASED PER DAY OF "CLEAN" SOFTWOOD CHIPS,
C *** INCLUDING FINES:
      SPCC = (SPCH * (1.0 - SWTC)) + SPCF
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      C *** CALCULATE DRY TONS PURCHASED PER DAY OF SOFTWOOD WHOLE-TREE
      C  ***  CHIPS,  INCLUDING  FINES:
            SPWC = (SPCH * SWTC) + SWCF
      C *** CALCULATE DRY TONS PURCHASED PER DAY OF "CLEAN" HARDWOOD CHIPS,
      C  ***  INCLUDING  FINES:
            HPCC = (HPCH * (1.0 - HWTC)) + HPCF
      C *** CALCULATE DRY TONS PURCHASED PER DAY OF HARDWOOD WHOLE-TREE
      C  ***  CHIPS,  INCLUDING  FINES:
            HPWC = (HPCH * HWTC) + HWCF
      C *** CALCULATE TONS OF "CLEAN" SOFTWOOD CHIPS PURCHASED PER DAY, TONS
      c *** AS RECEIVED (WET WEIGHT BASIS):
            SCCW = SPCC/(1.0 - SCHM)
      C *** CALCULATE TONS OF SOFTWOOD WHOLE-TREE CHIPS PURCHASED PER DAY,
      C *** TONS AS RECEIVED (WET WEIGHT BASIS):
            SWCW = SPWC/(1.0 - SWTM)
      C *** CALCULATE TONS OF "CLEAN" HARDWOOD CHIPS PURCHASED PER DAY, TONS
      C *** AS RECEIVED (WET WEIGHT BASIS):
            HCCW = HPCC/(1.0 - HCHM)
      C *** CALCULATE TONS OF HARDWOOD WHOLE-TREE CHIPS PURCHASED PER DAY,
      C *** TONS AS RECEIVED (WET WEIGHT BASIS):
            HWCW = HPWC/(1.0 - HWTM)
      C
      C     THESE ARE THE OUTPUT STATEMENTS:
      C
            WO(1) = PPWD
            WO(2) = SRFR + HRFR + SBRK + HBRK + SWCF + SPCF + HWCF + HPCF
            WO(3) = WO(1) + WO(2)
            WO(4) = SRPW + SRFR + SBRK
            WO(5) = CDSW
            WO(6) = SWMC * 100.0
            WO(7) = SRPW
            WO(8) = SBRK
            WO(9) = SRFR
            WO(10) = HRPW + HRFR + HBRK
            WO(11) = CDHW
            WO(12) = HWMC * 100.0
            WO(13) = HRPW
            WO(14) = HBRK
            WO(15) = HRFR
            WO(16) = SPCC
            WO(17) = SCCW
            WO(18) = SCHM * 100.0
            WO(19) = SPCC - SPCF
            WO(20) = SPCF
            WO(21) = HPCC
            WO(22) = HCCW
            WO(23) = HCHM * 100.0
            WO(24) = HPCC - HPCF
            WO(25) = HPCF
            WO(26) = SPWC
            WO(27) = SWCW
            WO(28) = SWTM * 100.0
            WO(29) = SPWC - SWCF
            WO(30) = SWCF
            WO(31) = HPWC
            WO(32) = HWCW
            WO(33) = HWTM * 100.0
            WO(34) = HPWC - HWCF
            WO(35) = HWCF
      C *** CALCULATE TOTAL SOFTWOOD AND TOTAL HARDWOOD FINES
            SRFR = SRFR + SWCF + SPCF
            HRFR = HRFR + HWCF + HPCF
            IF (NX.EQ.3.OR.NX.EQ.5.OR.NX.EQ.6) GO TO 500
            IF (NX.EQ.9.OR.NX.EQ.11.OR.NX.EQ.12) GO TO 500
            WRITE (6,100) (WO(I),I=1,3)
        100   FORMAT ('1',1X,'III.  WOOD  PREPARATION  AREA:'///
           +4X,'A.  VOLUME  OF  PULPWOOD  INTO  DIGESTER  (II.B):'//
           +9X,F7.1,'  DRY  TONS/DAY'///
           +4X,'B.  VOLUME  OF  BARK  AND  FINES  REMOVED'/
           +4X,'  AND  ROUTED  TO  POWER  BOILER'//
           +9X,F7.1,'  DRY  TONS/DAY'///
           +4X,'C.  TOTAL  VOLUME  OF  PULPWOOD  REQUIRED'/
           +4X,'  INCLUDING  BARK  AND  FINES  (SEE  BELOW  *):'//
           +9X,F7.1,'  DRY  TONS/DAY'//)
            IF(CDSW.GT.0.01)  WRITE  (6,110)  (WO(I),I=4,9)
        110  FORMAT  ('  ',8X,'*  AVG.  QUANTITY  OF  SOFTWOOD  ROUNDWOOD'/
           +10X,'PULPWOOD  REQUIRED  PER  DAY:'//
           +9X,F7.1,'  DRY  TONS/DAY,  OR'/
           +9X,F7.1,'  CORDS/DAY'//
           +25X,'(MOISTURE  CONTENT:',F6.1,'%)'//
           +20X,F7.1,'  DRY  TONS/DAY  TO  DIGESTER'/
           +20X,F7.1,'  DRY  TONS/DAY  BARK'/
           +20x,F7.1,'  DRY  TONS/DAY  FINES'//)
            IF(CDHW.GT.0.01)  WRITE  (6,120)  (WO(I),  I=10,15)
        120  FORMAT  ('  ',8X,'*  AVG.  QUANTITY  OF  HARDWOOD  ROUNDWOOD'/
           +10X,'PULPWOOD REQUIRED PER DAY:'//
           +9X,F7.1,'  DRY  TONS/DAY,  OR'/
           +9X,F7.1,'  CORDS/DAY'//
           +25X,'(MOISTURE  CONTENT:',F6.1,'%)'//
           +20X,F7.1,'  DRY  TONS/DAY  TO  DIGESTER'/
           +20X,F7.1,'  DRY  TONS/DAY  BARK'/
           +20X,F7.1,'  DRY  TONS/DAY  FINES'//)
            IF  (SCCM.GT.0.01)  WRITE  (6,130)  (WO(I),I=16,20)
        130  FORMAT  (8X,'*  AVG.  QUANTITY  OF  "CLEAN"  SOFTWOOD'/
           +10X,'CHIPS  REQUIRED  PER  DAY:'//
           +9X,F7.1,'  DRY  TONS/DAY,  OR'/
           +9X,F7.1,'  TONS/DAY,  AS  RECEIVED'//
           +25X,'(MOISTURE  CONTENT:',F6.1,'%)'//
           +20X,F7.1,'  DRY  TONS/DAY  TO  DIGESTER'/
           +20X,F7.1,'  DRY  TONS/DAY  FINES'///)
            IF  (HCCW.GT.0.01)  WRITE(6,140)  (WO(I),I=21,25)
        140  FORMAT  ('  ',8X,'*  AVG.  QUANTITY  OF  "CLEAN.  HARDWOD'/
           +10X,'CHIPS  REQUIRED  PER  DAY:'//
           +9X,F7.1,'  DRY  TONS/DAY,  OR'/
           +9X,F7.1,'  TONS/DAY,  AS  RECEIVED'//
           +25X,'(MOISTURE  CONTENT:',F6.1,'%)'//
           +20X,F7.1,'  DRY  TONS/DAY  TO  DIGESTER'/
           +20X,F7.1,'  DRY  TONS/DAY  FINES'///)
            IF  (SWCW.GT.0.01)  WRITE  (6,150)  (WO(I),I=26,30)
        150  FORMAT  ('  ',8X,'*  AVG.  QUANTITY  OF  SOFTWOOD  WHOLE-TREE  CHIPS'/
           +10X,'REQUIRED  PER  DAY:'//
           +9X,F7.1,'  DRY  TONS/DAY,  OR'/
           +9X,F7.1,'  TONS/DAY,  AS  RECEIVED'//
           +25X,'(MOISTURE  CONTENT',F6.1,'%)'//
           +20X,F7.1,'  DRY  TONS/DAY  TO  DIGESTER'/
           +20X,F7.1,'  DRY  TONS/DAY  FINES'///)
            IF  (HWCW.GT.0.01)  WRITE  (6,160)  (WO(I),I=31,35)
        160  FORMAT  ('  ',8X,'*  AVG.  QUANTITY  OF  HARDWOOD  WHOLE-TREE  CHIPS'/
           +10X,'REQUIRED  PER  DAY:'//
           +9X,F7.1,'  DRY  TONS/DAY,  OR'/
           +9X,F7.1,'  TONS/DAY,  AS  RECEIVED'//
           +25X,'(MOISTURE  CONTENT,'F6.1,'%)'//
           +20X,F7.1,'  DRY  TONS/DAY  TO  DIGESTER'/
           +20X,F7.1,'  DRY  TONS/DAY  FINES'///)
        500  CONTINUE
            END
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===== RECBLR =====

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      C *** THIS IS THE SUBROUTINE FOR THE RECOVERY BOILER, LIME KILN,
      C ***   AND RECAUSTICIZING AREAS:
      C
            SUBROUTINE RECBLR
      C
            COMMON/ALL/CAOX/CDHW,CDSW,COGN,CPRC,CSDS,HBRK,HCCW,HWCW,HRFR,
           *  HSRB,NX,PACD,PALM,
           *  PCAS,PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
           *  PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
           *  PWCH,PWTR,QCOL,QWOD,PCRT,RPPT,
           *  SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
           *  SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
           *  TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
      C
      C *** THIS IS THE LIST OF INPUTS:
      C
      C *** ACTV - ACTIVITY OF WHITE LIQUOR, RATIO OF ACTIVE ALKALI TO TOTAL
      C ***         ALKALI, IN SODIUM OXIDE WEIGHT EQUIVALENTS.
      C *** AVLM - LIME AVAILABILITY, AVERAGE WEIGHT RATIO OF TOTAL LIME
      C ***        TO SLAKER WHICH IS ACTIVE CALCIUM OXIDE, REMAINDER
      C ***        ASSUMED TO BE INERT MATERIAL IN CAUSTICIZING REACTION.
      C *** CAUS - CAUSTICIZING EFFICIENCY OF CAUSTICIZING REACTION,
      C ***        MEASURED AS THE WEIGHT RATIO OF SODIUM HYDROXIDE TO
      C ***        SODIUM HYDROXIDE PLUS SODIUM CARBONATE IN WHITE LIQUOR,
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C ***           EXPRESSED IN SODIUM OXIDE WEIGHT EQUIVALENTS, AND IN
C ***           WHICH THE SODIUM HYDROXIDE CONTENT OF GREEN LIQUOR HAS
C ***           BEEN SUBTRACTED FROM THE WHITE LIQUOR CONTENT (STANDARD
C ***             TAPPI DEFINITION).
C *** CNMD - CONSISTENCY OF THE FILTERED LIME MUD ENTERING THE LIME
C ***           KILN, DRY WEIGHT OF LIME MUD SOLIDS RATIO OF TOTAL
C ***            WEIGHT OF FILTERED LIME MUD.
C *** EFKF - AVERAGE COMBUSTION HEATING EFFICIENCY OF KILN FUEL,
C ***           RATIO OF HIGHER HEATING VALUE OF FUEL WHICH IS NOT
C ***            LOST IN COMBUSTION GASES AND EXCESS AIR EXITING
C ***            THE KILN.
C *** FLMR - LIME MUD RECYCLING RATIO, WEIGHT RATIO OF TOTAL LIME
C ***           MUD ENTERING LIME KILN WHICH IS RECYCLED TO THE
C ***           MUD WASHER, REPRESENTING UNCALCINED MATERIAL WHICH
C ***            IS CAPTUPED IN THE LIME KILN FLUE GAS SCRUBBER AND
C ***            EMISSIONS SEPARATOR.
C *** HHKF - AVERAGE HIGHER HEATING VALUE OF KILN FUEL IN MILLIONS OF
C ***            B.T.U. PER UNIT OF FUEL (E.G., PER MCF OF GAS, FOR
C ***            EXAMPLE).
C *** HRRB - EFFECTIVE HEAT RECOVERY RATIO OF RECOVERY BOILER, DECIMAL
C ***            RATIO OF GROSS HEAT ENERGY VALUE OF BLACK LIQUOR
C ***            SOLIDS THAT ARE RECOVERED AS STEAM HEAT ENERGY (ADJUSTED
C ***            FOR TOTAL HEAT INPUTS TO FURNACE AND HEAT OF REACTION
C ***            CORRECTION, AS WELL AS FOR COMBUSTION HEAT LOSSES: NOT TO
C ***            BE CONFUSED WITH "COMBUSTION HEAT RECOVERY EFFICIENCY
C ***            OF RECOVERY BOILER).
C *** HVBL - GROSS HEAT ENERGY VALUE (HEATING VALUE) OF BLACK LIQUOR
C ***            SOLIDS, B.T.U. PER DRY POUND.
C *** PLMU - PURCHASED LIME MAKE-UP, AVERAGE WEIGHT RATIO OF TOTAL
C ***            LIME TO SLAKER WHICH IS PURCHASED OR 'MAKE-UP" LIME.
C *** PPKF - AVERAGE PURCHASE PRICE OF KILN FUEL IN DOLLARS PER UNIT OF
C ***             FUEL.
C *** PPLM - PURCHASE PRICE OF PURCHASED LIME IN DOLLARS PER TON,
C ***            F.O.B.    MILL.
C *** SVSC - SALES VALUE OF SURPLUS SALTCAKE GENERATED IN CHEMICAL
C ***            RECOVERY AND DESULFURIZATION AREAS, $/DRY TON OF SURPLUS
C ***            SALTCAKE,    F.O.B.   MILL.
C *** SSWL - SODIUM SULFATE RATIO OF TOTAL ALKALI IN WHITE LIQUOR,
C ***            (ONE-HALF) WEIGHT RATIO IN SODIUM OXIDE EQUIVALENTS.
C *** TBLS - TOTAL BLACK LIQUOR SOLIDS TO SALT CAKE MIX TANKS AND
C ***            RECOVERY BOILER AREA, DRY TONS PER DAY OF BLACK LIQUOR
C ***            SOLIDS.
C *** TDAA - TONS PER DAY OF ACTIVE ALKALI IN SODIUM OXIDE WEIGHT
C ***            EQUIVALENT, IN WHITE LIQUOR TO DIGESTER, FROM WHITE
C ***            LIQUOR    CLARIFIER.
C *** TKEG - TEMPERATURE OF KILN EXIT GASES IN DEGREES FARENHEIT. AVE.
C *** TKPD - AVERAGE TEMPERATURE OF KILN PRODUCT SOLIDS EXITING KILN,
C ***            IN DEGREES FARENHEIT.
C
C ***  READ STATEMENTS:
C
      READ (5,10)ACTV,AVLM,CAUSMCNMD,EFKF,FLMR,HHKF,HRRB,HVBL,PLMU,PPKF,
     +           PPLM,SVSC,SSWL,TKEG,TKPD
   10 FORMAT  (//16(F20.0//))
C
C  ***  CALCULATIONS:
C
C *** CALCULATE HEAT ENERGY TO STEAM IN RECOVERY BOILER, MILLIONS OF
C  ***  B.T.U.  PER  DAY:
      HSRB = TBLS * (0.002) * HVBL * HRRB
C *** CALCULATE THE WEIGHT EQUIVALENT OF THE TOTAL ALKALI (TOTAL SODIUM
C *** COMPOUNDS) IN WHITE LIQUOR, IN SODIUM OXIDE WEIGHT EQUIVALENT,
C *** TONS PEP DAY:
      TALK = TDAA/ACTV
C *** CALCULATE THE WEIGHT EQUIVALENT OF SODIUM SULFATE IN WHITE
C *** LIQUOR, IN SODIUM OXIDE WEIGHT EQUIVALENT, TONS PER DAY:
      SDSL = TALK * SSWL
C *** CALCULATE THE WEIGHT EQUIVALENT OF SODIUM CARBONATE IN WHITE
C *** LIQUOR, IN SODIUM OXIDE WEIGHT EQUIVALENT, TONS PER DAY:
      SDCA = TALK - (TDAA + SDSL)
C *** CALCULATE THE WEIGHT EQUIVALENT OF SODIUM HYDROXIDE PRODUCED IN
C *** CAUSTICIZING REACTION, IN SODIUM OXIDE WEIGHT EQUIVALENT,
C *** CORRECTED FOR SODIUM HYDROXIDE PRESENT IN GREEN LIQUOR, BASED ON
C  ***  TAPPI DEFINITION OF CAUSTICIZING EFFICIENCY, TONS PER DAY:
      soon = (CAUS * SDCA)/(1.0 - CAUS)
C *** CALCULATE THEORETICAL WEIGHT OF CALCIUM OXIDE FOR CAUSTICIZING
C *** REACTION, TONS PER DAY:
      CAOX = SODH * (56.0/62.0)
C *** CALCULATE QUANTITY OF PURCHASE0 LIME REQUIRED, TONS PER DAY:
      PLRQ = (CAOX * PLMU)/(AVLM)
C *** CALCULATE TOTAL WEIGHT OF LIME PRODUCED IN LIME KILN TO SLAKER,
C *** IN TONS PER DAY:
      TMLP = (CAOX/AVLM) - PLRQ
C *** CALCULATE ACTUAL WEIGHT OF LIME CONSUMED IN SLAKING & CAUSTIC.
      CAOX = CAOX/AVLM
C *** CALCULATE WEIGHT OF INERT MATERIAL IN LIME FROM LINE KILN TO
C *** SLAKER, TONS PER DAY:
      WINR = TWLP * (1.0 - AVLM)
C *** CALCULATE THEORETICAL DRY WEIGHT OF LINE MUD TO LIME KILN, TONS
C *** PER DAY:
      WTLM = ((TWLP - WINR) * (100.0/56.0)) + WINR
C *** CALCULATE ACTUAL DRY WEIGHT OF LIME MUD TO LIME KILN AFTER
C *** CORRECTING FOR PARTICULATE EMISSIONS AND RECYCLE0 FRACTION (TO
C *** MUD WASHER), TONS PER DAY OF LIME MUD:
      WTLM = WTLM/(1.0 - FLMR)
C *** CALCULATE WEIGHT OF WATER ENTERING LIME KILN WITH FILTERED LIME
C *** MUD TONS PER DAY:
      WIMK = (WTLM/CNMD) * (1.0 - CNMD)
C *** CALCULATE HEAT ENERGY REQUIREMENTS FOR LIME KILN IN MILLIONS OF
C *** B.T.U. PER DAY (ASSUMING AMBIENT TEMP. OF 70 DEG. F.):
C ***  (A.) ENERGY REQUIRED TO EVAPORATE WATER IN LIME MUD ENTERING
C ***  KILN:
      WTEN = WIMK * (0.002) * (970.0 * (212.0 - 70.0) +
     +   (0.46    *    (TKEG    -    212.0)))
C ***  (B.1 ENERGY INTO KILN PRODUCT, ASSUMING A SPECIFIC HEAT OF
C ***  0.25 B.T.U. PER POUND OF KILN PRODUCT PER DEGREE F. ABOVE
C ***  AMBIENT TEMPERATURE:
      PLEN = TWLP (0.002) * (TKPD - 70.0) * 0.25
C ***  (C.) ENERGY REQUIRED FOR DISSOCIATION OF CALCIUM CARBONATE IN
C ***  LIME KILN, ASSUMING A HEAT OF DISSOCIATION OF 1,390 B.T.U. PER
C ***  POUND OF ACTIVE CALCIUM OXIDE IN LIME KILN PRODUCT:
      HDEN = (TWLP * AVLM) * (0.002) * (1390.0)
C ***  (D.) ENERGY INTO CARBON DIOXIDE PRODUCED IN DISSOCIATION
C ***  REACTION, ASSUMING A SPECIFIC HEAT OF 0.25 B.T.U PER
C ***  POUND OF CARBON DIOXIDE GAS PER DEGREE F. ABOVE AMBIENT
C ***  TEMPERATURE:
      CDEN = (TWLP * AVLM) * (44.0/56.0) * (0.002) * (0.25) *
     +(TKEG - 70.0)
C ***  (E.) CALCULATE ENERGY INTO RECYCLED LIME MUD, "DUST" CAPTURED
C ***  IN SCRUBBER AND SEPARATORS, ASSUMING A SPECIFIC MEAT OF 0.25
C ***  B.T.U. PER POUND OF DUST, PER DEGREE F. ABOVE AMBIENT:
      EMEN = (WTLM * FLMR) * (0.002) * (TKEG - 70.0) * 0.25
C ***  (F.) CALCULATE TOTAL HEAT ENERGY REQUIREMENTS INCLUDING A
C ***  15.0 PERCENT FACTOR FOR THERMAL RADIATION HEAT LOSSES:
      THEN = (WTEN + PLEN + HDEN + CDEN + EMEN) * 1.15
C *** CALCULATE GROSS ENERGY INPUT REQUIREMENTS IN KILN FUEL,
C *** MILLION B.T.U. PER DAY:
      GHEN = THEN/EFKF
C *** CALCULATE UNITS OF KILN FUEL REQUIRE0 PER DAY:
      TKFR = GHEN/HHKF
      END
```

===== ELEC =====

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C *** THIS IS THE SUBROUTINE THAT CALCULATES ELECTRIC POWER
C ***   REQUIREMENTS
C
      SUBROUTINE ELEC
C
      COMMON/ALL/CAOX,CDHW,CDSW.COGN,CPRC,CSDS,HBRK,HCCW,HCCW,HRFR,
     +   HSRB,NX,PACD,PALM,
     +   PCAS.PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
     +   PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
     +   PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
     +   SBRK,SCLS,SWDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
     +   SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
     +   TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
      DIMENSION   HP(16)
C
C *** THIS IS THE LIST OF INPUTS:
C
C *** (TOTAL CONNECTED HORSEPOWER OF MACHINES AND EQUIPMENT BY MILL
C ***   AREA)-
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C   *** HP(1)   - WOOD PREPARATION AREA
C   *** HP(2)   - DIGESTER AND TURPENTINE AREA
C   *** HP(3)   - MASHING AND REFINING AREA
C   *** HP(4)   - STOCK PREPARATION AREA
C   *** HP(5)   - PAPER MACHINE AREA
C   *** HP(6)   - ADDITIVES AREA
C   *** HP(7)   - FINISHING AND SHIPPING AREA
C   *** HP(8)   - WATER SUPPLY AND TREATMENT AREA
C   *** HP(9)   - WASTE DISPOSAL AREA
C   *** HP(10)  - POWER BOILER, FEEDWATER & CONDENSATE AREAS
C   *** HP(11)  - COAL HANDLING AREA
C   *** HP(12)  - RECOVERY BOILER AREA
C   *** HP(13)  - EVAPORATORS AREA
C   *** HP(14)  - LIME KILN AND RECAUSTICIZING AREA
C   *** HP(15)  - AIR SUPPLY SYSTEM
C   *** HP(16)  - ODOR COLLECTION SYSTEM
C
C   *** AEFU - AVERAGE EFFICIENCY OF ELECTRICAL ENERGY USE IN MILL
C   ***          EQUIPMENT, DECIMAL RATIO OF ELECTRIC ENERGY DEMAND
C   *** ALFC - AVERAGE POWER LOAD FACTOR FOR MILL EQUIPMENT, DECIMAL
C   ***          RATIO OF TOTAL CONNECTED HORSEPOWER.
C   *** ANML - AVERAGE NON-MOTOR LOAD FOR MILL AND RELATED FACILITIES,
C   ***          FOR LIGHTING AND MISCELLANEOUS, IN KILOWATTS
C
C   *** READ STATEMENTS:
C
          READ (5,10) HP(1),HP(2),HP(3)HP(4),HP(5),HP(6),HP(7),HP(8),HP(9),
         +            HP(10),HP(11),HP(12),HP(13),HP(14),HP(15),HP(16)ALFC,
         +            AEFU,ANML
    10    FORMAT      (//19(F20.0//))
C
C   *** CALCULATIONS:
C
C   *** CALCULATE TOTAL CONNECTED HORSEPOWER OF MILL MACHINES AND
C   *** EQUIPMENT:
          TCHP = 0.0
          DO 1 I = 1,16
          TCHP = TCHP + HP(I)
1         CONTINUE
C   *** CALCULATE POWER LOAD IN TOTAL HORSEPOWER OF MILL MACHINES AND
C   *** EQUIPMENT:
          TPLD = TCHP * ALFC
C   *** CALCULATE TOTAL ELECTRICAL POWER DEMAND OF MILL MACHINES AND
C   *** EQUIPMENT IN KILOWATTS:
          TEED = (TPLD/AEFU) * 0.746
C   *** CALCULATE TOTAL ELECTRICAL POWER DEMAND OF MILL, INCLUDING
C   *** NON MOTOR LOAD:
          TEED = TEED + ANML
          END
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          =====   STEAM   =====

          SUBROUTINE STEAM
C
C   *** THIS IS THE SUBROUTINE FOP THE STEAM ENERGY BALANCE AND
C   ***   COGENERATION AREA.
C
          COMMON/ALL/CAOX,CDHW,CDSW,COGN,CPRC,CSDS,HBRK,HCCW,HWCW,HRFR,
         *  HSRB,NX,PACD,PALM,
         *  PCAS,PCOR,POFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
         *  PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
         *  PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
         *  SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
         *  SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
         *  TRSN,TSLM,TSTC,WLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
C
C   *** THIS SUBROUTINE CALCULATES TOTAL STEAM ENERGY REQUIREMENTS FOR
C   ***  THE MILL, AND DETERMINES COGENERATION CAPACITY.  THE SUBROUTINE
C   ***  IS BASED ON A REALISTIC ASSUMPTION THAT THERE ARE THREE WINOS OF
C   ***  PROCESS STEAM USED IN THE MILL, WHICH HERE ARE CALLED:
C   ***  (1) HIGH PRESSURE PROCESS STEAM, (2) MEDIUM PRESSURE PROCESS
C   ***  STEAM, AND (3) LOW PRESSURE PROCESS STEAM.  ALSO, PROCESS STEAM
C   ***  IS OBTAINED FROM HIGH ENTHALPY SUPERHEATED STEAM (4) FROM POWER
C   ***  AND RECOVERY BOILERS AFTER PASSING THROUGH POWER AND PROCESS
C   ***  TURBINES.  TYPICAL STEAM PRESSURES AND TEMPERATURES ARE, FOR
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C   ***   EXAMPLE, (1) 550 PSIG/750 F., (2) 150 PSIG/520 F.,
C   ***   (3) 50 PSIG/355 F. FOR PROCESS STEAM, AND (4) 900 PSIG/850 F.
C   ***  FOR SUPERHEATED STEAM FROM BOILERS.
C
C   *** THIS IS THE LIST OF INPUTS:
C
C   *** BFFC - BLOWDOWN RATIO FOR POWER AND RECOVERY BOILERS, POUNDS
C   ***          BLOW PER TOTAL POUNDS OF STEAM PRODUCED IN BOILERS.
C   ***          (BLOW TO FLASH TANKS ASSUMED TO HAVE LOW ENTHALPY AND MAY
C   ***          BE USED TO HEAT FEEDWATER, BUT HEAT CONTENT IS NOT
C   ***          ACCOUNTED FOR HERE.)
C   *** CNSL - LOSSES FROM STEAM SYSTEM IN CONDENSATE RECEIVER AND
C   ***          DEAERATOR, POUNDS OF STEAM OR CONDENSATE LOST (E.G., IN
C   ***          VENTS, ETC.) PER POUND OF TOTAL FEEDWATER TO POWER AND
C   ***          RECOVERY BOILERS.
C   *** FWHE - FEEDWATER HEATER HEAT EXCHANGE EFFICIENCY
C   ***          (RATIO OF HEAT INPUT WHICH EXITS IN FEEDWATER, AVE.).
C   *** HCCN - ENTHALPY OF COMBINE0 CONDENSATE FROM STEAM SYSTEM TO
C   ***          DEAERATOR (B.T.U. PER POUND OF CONDENSATE).
C   *** HCHW - ENTHALPY OF MAKE-UP WATER TO DEAERATOR, B.T.U. PER POUND
C   ***          OF MAKE-UP WATER.
C   *** HHPP - ENTHALPY OF HIGH PRESSURE PROCESS STEAM. B.T.U. PER POUND
C   ***          OF STEAM.
C   *** HLPP - ENTHALPY OF LOW PRESSURE PROCESS STEAM, B.T.U. PER POUND
C   ***          OF STEAM.
C   *** HMPP  -  ENTHALPY OF MEDIUM PRESSURE PROCESS STEAM, B.T.U. PER
C   ***          POUND OF STEAM.
C   *** HSHP - ENTHALPY OF SUPERHEATED STEAM FROM BOILERS, B.T.U. PER
C   ***          POUND OF STEAM.
C   *** HSRB - HEAT ENERGY TO STEAM IN RECOVERY BOILER, MILLIONS OF
C   ***          B.T.U. PER DAY.
C   *** HTMS - RATIO OF TOTAL HIGH PRESSURE PROCESS STEAM THAT IS
C   ***          RECOVERED AS MEDIUM PESSURE PROCESS STEAM, EXCLUDING
C   ***          STEAM FROM TURBINES (RATIO OF TOTAL HIGH PRESSURE
C   ***          STEAM).
C   *** PKWH - PRICE OF PURCHASED ELECTRICAL ENERGY, DOLLARS PER KILOWATT
C   ***          HOUR.
C   *** PPRD - PAPER OR PAPERBOARD PRODUCTION IN DRY TONS PER DAY.
C   *** PPWD - TOTAL PULPWOOD INTO DIGESTER, DRY TONS OF WOOD PER DAY.
C   *** PROD - TOTAL PULP PRODUCTION, DRY TONS OF PULP PER DAY.
C   *** SMLS - RATIO OF TOTAL MEDIUM PRESSURE PROCESS STEAM THAT IS
C   ***          RECOVERED AS LOW PRESSURE PROCESS STEAM, EXCLUDING STEAM
C   ***          FROM TURBINES, (RATIO OF TOTAL MEDIUM PRESSURE STEAM).
C   *** SOPR - TOTAL SOAP RECOVERY, DRY TONS OF SOAP PER DAY.
C   *** SSSB - SUPERHEATED STEAM REQUIRED FOR SOOTBLOWERS IN POWER AND
C   ***          RECOVERY BOILER AREAS (POUNDS OF STEAM PER TOTAL POUNDS
C   ***          OF STEAM PRODUCED).
C   *** SVSE - SALES VALUE OF SURPLUS ELECTRICAL ENERGY COGENERATED IN
C   ***          MILL, DOLLARS PER KILLOWATT HOUR.
C   *** TBLS - TOTAL BLACK LIQUOR SOLIOS TO RECOVERY FURNACE, TONS OF DRY
C   ***          SOLIDS PER DAY.
C   *** TEED - TOTAL ELECTRICAL POWER DEMAND OF MILL. KILLOWATTS.
C   *** TGEF - TURBINE GENERATOR EFFICIENCY FOR CONVERSION OF TURBINE
C   ***          ENERGY TO ELECTRICAL ENERGY.
C   *** TWRD - TOTAL WATER REMOVAL IN HEATED DRYER SECTION OF PAPER
C   ***          MACHINE, TONS OF WATER PER DAY.
C   *** WRCN - TOTAL WATER REMOVAL IN CONCENTRATORS, TONS OF WATER/DAY.
C   *** WREV - TOTAL WATER REMOVAL IN EVAPORATORS, TONS OF WATER PER DAY.
C
C          AVERAGE HIGH PRESSURE PROCESS STEAM DEMANDS:
.
C   *** HPAH - HIGH PRESSURE STEAM FOR AIR HEATER IN RECOVERY BOILER
C   ***          AREA, POUNDS OF STEAM PER TON OF BLACK LIQUOR SOLIDS TO
C   ***          RECOVERY BOILER.
C   *** HPFW - HIGH PRESSURE STEAM DEMAND FOR POWER BOILER FEEDWATER
C   ***          HEATERS, POUNDS OF STEAM PER POUND OF FEEDWATER TO POWER
C   ***          BOILER.
C   *** HPMD - HIGH PRESSURE STEAM MISCELLANEOUS DEMAND VOLUME, POUNDS OF
C   ***          STEAM PER TON OF PRODUCT.
C   *** HPPB - HIGH PRESSURE STEAM DEMAND FOR POWER BOILER AREA, AIR
C   ***          HEATERS, AND MISCELLANEOUS, POUNDS OF STEAM PER POUND OF
C   ***          STEAM PRODUCED IN POWER BOILER.
C   *** HPPM - HIGH PRESSURE STEAM DEMAND OF PAPER MACHINE AND VACUUM
C   ***          PUMP TURBINES, THIS STEAM DISCHARGES TO MEDIUM PRESSURE
C   ***          PROCESS STEAM HEADER, POUNDS OF STEAM PER DRY TON OF
C   ***          PAPER OR PAPERBOARD PRODUCT.
C   *** HPSL - LOSSES FROM HIGH PRESSURE PROCESS STEAM SYSTEM (RATIO
C   ***          OF TOTAL HIGH PRESSURE PROCESS STEAM NOT RETURNED IN
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      C ***              CONDENSATE).
      C *** HPTC - HIGH PRESSURE STEAM DEMAND OF PAPER MACHINE THERMO-
      C ***            COMPRESSORS FOR DRYER DRAINAGE, POUNDS OF STEAM PER DRY
      C ***            TUN OF PAPER OR PAPERBOARD PRODUCT.
      C
      C          AVERAGE MEDIUM PRESSURE PROCESS STEAM DEMANDS:
      C
      C *** SHAH - MEDIUM PRESSURE STEAM DEMAND FOR AIR HEATER IN RECOVERY
      C ***            BOILER AREA, POUNDS OF STEAM PER TON OF BLACK LIQUOR
      C ***            SOLIDS TO RECOVERY BOILER.
      C *** SMAS - MEDIUM PRESSURE STEAM DEMAND FOR AIR SUPPLY AREA, POUNDS
      C ***            OF STEAM PER DRY TON OF PULP PRODUCED.
      C *** SMBL - MEDIUM PRESSURE STEAM DEMAND FOR BLACK LIQUOR GUNS IN
      C ***            RECOVERY BOILER FURNACE, POUNDS OF STEAM PER TON OF BLACK
      C ***            LIQUOR SOLIDS TO RECOVERY FURNACE.
      C *** SMDH - MEDIUM PRESSURE STEAM DEMAND FOR DIGESTER LIQUOR HEATER.
      C ***            POUNDS OF STEAM PER THOUSAND GALLONS OF WHILE LIQUOR TO
      C ***            DIGESTER.
      C *** SMFW - MEDIUM PRESSURE STEAM DEMAND FOR POWER BOILER FEEDWATER
      C ***            HEATERS, ROUNDS OF STEAM PER POUND OF FEEDWATER TO POWER
      C ***            BOILER.
      C *** SMEC - MEDIUM PRESSURE STEAM DEMAND FOR EMISSIONS CONTROL
      C ***            (ELECTROSTATIC PRECIPITATORS) IN RECOVERY BOILER AREA,
      C ***            POUNDS OF STEAM PER TON OF BLACK LIQUOR SOLIOS TO
      C ***            RECOVERY FURNACE.
      C *** SMJE - MEDIUM PRESSURE STEAM FOR STEAM JETS IN EVAPORATORS,
      C ***            POUNDS OF STEAM PER TON OF BLACK LIQUOR SOLIDS INTO
      C ***            EVAPORATORS.
      C *** SMLH - MEDIUM PRESSURE STEAM DEMAND FOR SECONDARY BLACK LIQUOR
      C ***            HEATER IN RECOVERY BOILER AREA, POUNDS OF STEAM PER TON
      C ***            OF BLACK LIQUOR SOLIOS TO RECOVERY BOILER.
      C *** SMMD - MEDIUM PRESSURE PROCESS STEAM MISCELLANEOUS DEMAND VOLUME,
      C ***            POUNDS OF STEAM PER TON OF PRODUCT.
      C *** SMPB - MEDIUM PRESSURE STEAM DEMAND FOR POWER BOILER AREA, AIR
      C ***            HEATERS, EMISSIONS CONTROL, AND MISCELLANEOUS, POUNDS OF
      C ***            STEAM PER POUND OF STEAM PRODUCED IN POWER BOILER.
      C *** SMPD - MEDIUM PRESSURE STEAM DEMAND FOR PAPER MACHINE DRYERS.
      C ***            POUNDS OF STEAM PER POUND OF WATER REMOVED IN HEATED
      C ***            DRYER SECTION OF PAPER MACHINE.
      C *** SMSL - LOSSES FROM MEDIUM PRESSURE PROCESS STEAM SYSTEM (RATIO
      C ***            OF TOTAL MEDIUM PRESSURE STEAM NO7 RETURNED IN
      C ***            CONDENSATE).
      C *** SMST - MEDIUM PRESSURE STEAM DEMAND FOR SMELT DISSOLVING TANK IN
      C ***            RECOVERY AREA, POUNDS OF STEAM PER-TON OF BLACK LIQUOR
      C ***            SOLIOS TO RECOVERY BOILER.
      C
      C          AVERAGE LOW PRESSURE PROCESS STEAM DEMANDS:
      C
      C *** SLAH - LOW PRESSURE STEAM DEMAND FOR AIR HEATER IN RECOVERY
      C ***            BOILER AREA, POUNDS OF STEAM PER TON OF BLACK LIQUOR
      C ***            SOLIOS TO RECOVERY.
      C *** SLCN - LOW PRESSURE STEAM DEMAND FOR BLACK LIQUOR CONCENTRATORS,
      C ***            POUNDS OF STEAM PER POUND OF WATER REMOVED IN BLACK
      C ***            LIQUOR CONCENTRATORS.
      C *** SLDA - LOW PRESSURE STEAM DEMAND FOR DEAERATOR, POUNDS OF STEAM
      C ***            PER POUND OF TOTAL FEEDWATER.
      C *** SLDG - LOW PRESSURE STEAM DEMAND FOR DIGESTER STEAMING VESSEL,
      C ***            POUNDS OF STEAM PER DRY TON OF CHIPS TO DIGESTER.
      C *** SLEV - LOW PRESSURE STEAM DEMAND FOR BLACK LIQUOR EVAPORATORS.
      C ***            POUNDS OF STEAM PER POUND OF WATER REMOVED FROM BLACK
      C ***            LIQUOR IN EVAPORATORS.
      C *** SLMD - LOW PRESSURE MISCELLANEOUS STEAM DEMAND, POUNDS OF STEAM
      C ***            PER DRY TON OF PAPER OR PAPERBOARD PRODUCT.
      C *** SLPB - LOW PRESSURE STEAM DEMAND FOP POWER BOILER AREA, AIR
      C ***            HEATERS, EMISSIONS CONTROL, MISCELLANEOUS, POUNDS PER
      C ***            POUND OF STEAM PRODUCED IN POWER BOILER.
      C *** SLPM - LOW PRESSURE STEAM DEMAND FOR PAPER MACHINE AUXILIARY
      C ***            EQUIPMENT AND MISCELLANEOUS PURPOSES, POUNDS OF STEAM PER
      C ***            DRY TON OF PRODUCT.
      C *** SLPS - LOW PRESSURE STEAM DEMAND FOR HEATING GREEN LIQUOR TO
      C ***            SLAKER IN RECUASTICIZING AREA, POUNDS OF STEAM PER TON OF
      C ***            BLACK LIQUOR SOLIOS TO RECOVERY AREA.
      C *** SLSE - LOW PRESSURE STEAM DEMAND FOR SULFUR EMISSIONS ODOR
      C ***            CONTROL, COLLECTION SYSTEM, POUNDS PER DRY TON OF PULP
      C ***            PRODUCED.
      C *** SLSL - LOSSES FROM LOW PRESSURE PROCESS STEAM SYSTEM (RATIO OF
      C ***            TOTAL LOW PRESSURE STEAM VOLUME THAT IS NOT RETURNED IN
      C ***            CONDENSATE TO DEAERATOR).
      C
      C *** READ STATEMENTS:
      C
            DIMENSION      0(40,5).OP(20,3)
            READ(5,11)     BFFC,CNSL,FWHE,HCCN,HCMW,HHPP,HLPP,HMPP,HSHP,HTMS,PKWH,
           *               SMLS,SSSB,SVSE,TGEF,HPAH,HPFW,HPMD,HPPB.HPPM,HPSL,HPTC,
           *               SMAH,SMAS,SMBL,SMDH,SMEC,SMFW,SMJE,SMLH,SMMD,SMPB,SMPD,
           *               SMSL,SMST,SLAM,SLCN,SLDA,SLDG,SLEV,SLMD.SLPB,SLPM,SLRS,
           *               SLSE,SLSL
         11   FORMAT      (//46(F20.0//))
      C *** CALCULATIONS:
      C
      C *** SET INITIAL FEEDWATER ENTHALPY TO ZERO:
            HFWR = 0.0
      C *** CALCULATE INITIAL ESTIMATE OF RECOVERY BOILER STEAM OUTPUT,
      C *** POUNDS OF SUPERHEATED STEAM/DAY:
            SORB =    (HSRB * 1000000.0)/(HSHP - HFWR)
      C *** CALCULATE INITIAL ESTIMATE OF NET BOILER STEAM DEMANDS, POUNDS OF
      C *** SUPERHEATED STEAM/DAY:
      C ***  -- (HIGH PRESSURE PROCESS STEAM DEMANDS)
            HPSD = ((HPPM *   PPROD + (HPTC * PPRD) + (HPAH * TBLS) +
           I          (HPMD * PPRD))
      C ***  -- (MEDIUM PRESSURE PROCESS STEAM DEMANDS, APPROX.)
            SMSD = ((SMPD * TWRD * 2000.0) + (SMJE * (TBLS + SOPR)) +
           *          (SMDH + TWLV) +
           *          (TBLS * (SMEC + SMAH + SMST + SMLH + SMBL)) +
           *          (SMAS * PROD) +
           *          (SMMD * PPRD) -
           *          (HPPM * PPRD) -
           *          ((HPSD - (HPPM * PPRD)) * HTMS))
            GMSD = SMSD + (HPPM * PPRD) + ((HPSD - (HPPM * PPRD)) * HTMS)
            SMLP = 0.0
            IF (SMSD .LT. 0.0) SMLP = -SMSD
            IF (SMSD .LT. 0.0) SMSD = 0.0
            GMSD = GMSD - SMLP
      C ***  -- (LOU PRESSURE STEAM DEMANDS, APPROX.)
            SLSD = ((PPRD * (SLPM + SLMD)) +
           *          (TBLS * (SLRS + SLAH)) +
           *           (((SLEV * WREV) + (SLCN * WRCN)) * 2000.01 I
           *          (SLOG * PPWD) +
           *          (SLSE * PROD) -
           *          (SMLS * GMSD) - SMLP)
      C *** CALCULATE INITIAL ESTIMATE OF POWER BOILER STEAM OUTPUT, POUNDS
      C *** OF SUPERHEATED STEAM/DAY:
            SOPB = (HPSD + SMSD + SLSD - SORB + (SSSB * SORB) +
           *          (SLDA * SORB * (1.0 + BFFC)))/(1.0 - SSSB - ((HPFW +
           *          SMFW + SLDA) * (1.0 + BFFC)) - (HPPB + SMPB + SLPB))
      C *** FOLLOW ITERATIVE PROCEDURE TO DETERMINE THE STEAM ENERGY BALANCE
      C *** (ALGORITHM ITERATES UNTIL EQUILIBRIUM ENTHALPY OF FEEDWATER TO
      C *** RECOVERY BOILER IS OBTAINED):
          1 CONTINUE
      C *** CALCULATE TOTAL STEAM AND CONDENSATE LOSSES FROM STEAM SYSTEM,
      C *** EQUIVALENT TO MAKE-UP WATER REQUIREMENTS, POUNDS LOST/DAY:
            TSLS = (SSSB * (SOPB + SORB)) +
           *          (0.7 * BFFC * (SOPB + SORB)) +
           *          (HPSL * HPSD) +
           *          (SMSL * GMSD) +
           *          (SLSL * (SLSD + (SMLS * GMSD))) +
           *          (CNSL * ((SOPB + SORB) * (1.0 + BFFC)))
      C *** CALCULATE QUANTITY OF CONDENSATE TO DEAERATOR, POUNDS/DAY (PBFW
      C *** IS FEEDWATER TO POWER BOILER):
            PBFW = (SOPB * (1.0 + BFFC))
            CNDA = ((SOPB + SORB) * (1.0 + BFFC)) - TSLS -
           *          ((SMFW + HPFW * PBFW) -
           *          (SLDA * (SOPB + SORB) * (1.0 + BFFC))
      C *** CALCULATE ENTHALPY OF FEEDWATER TO RECOVERY BOILER AND POWER
      C *** BOILER FEEDWATER HEATERS, B.T.U. PER POUND OF FEEDWATER:
            HFWT = ((TSLS * HCMW) +
           *          (CNDA * HCCN) +
           *          (SLDA * HLPP * (SOPB + SORB) * (1.0 + BFFC)) +
           *          ((HPFW + SMFW) * HCCN * PBFW) -
           *          (CNSL * HCCN * ((SOPB + SORB) I (1.0 + BFFC))))/
           *           ((SOPB + SORB) * (1.0 + BFFC))
            HFWR = (HFWR + HFWT)/2.0
      C *** RECALCULATE STEAM OUTPUT OF RECOVERY BOILER, POUNDS OF STEAM/DAY:
            SORB = (HSRB * 1000000.0)/(HSHP - HFWR)
      C *** RECALCULATE NET HIGH PRESSURE PROCESS STEAM DEMANDS, POUNDS/DAY:
            HPSD = ((HPPM * PPRD) + (HPTC * PPRD) +
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      *          (HPAH  *  TBLS)  +  (HPMD  *  PRRD)  +
      .          (HPPB  *  SOPB)  +  (HPFW  *  PBFW))
C  ***  RECALCULATE  NET  MEDIUM  PRESSURE  PROCESS  STEAM  DEMANDS,  POUNDS/DAY:
       SMSD  *  ((SMPD  *  TWRD  *  2000.0)  +  (SMDH  *  TWLV)  +
      *          (SMJE  *  (TBLS  +  SOPR))  +  (SMAS  *  PPOD)  +
      *          (TBLS  *  (SMEC  +  SMAH   +  SMLH  +  SMST  +  SMBL))  +
      *          (SMPB  *  SOPB)  +  (SMFW  *  PBFW)  +
      *          (SMMD  *  PPRD)  -  (HPPM  *  PPRD)  -
      *          ((HPSD  -  (HPPM  *  PPRD))  *  HTMS))
       GMSD  =  SMSD  +  (HPPM  *  PPRD)  +  ((HPSD  -  (HPPM  *  PPRD))  *  HTMS)
       SMLP  =  0.0
       IF  (SMSD  .LT.  0.0)  SMLP  =  -SMSD
       IF  (SMSD  .LT.  0.0)  SMSD  =  0.0
C  ***  RECALCULATE  NET  LOW  PRESSURE  PROCESS  STEAM  DEMANDS,  POUNDS/DAY:
       SLSD  =  ((SLPW  +  SLMD)  *  PPRD)  +
      *          ((SLRS  +  SLAH)  *  TBLS)  +
      *          (SLEV  *  WREV  *  2000.0)  +
      *          (SLCN  *  WRCN  *  2000.0)  +
      *          (SLDG  *  PPWD)  +
      *          (SLSE  *  PROD)  +
      *          (SLPB  *  SOPB  +
      *          (SLDA  *  (SOPB  +  SORB)  *  (1.0  +  BFFC))  -
      *          (SMLS  *  GMSD)  -  SMLP
C  ***  RECALCULATE  STEAM  OUTPUT  OF  POWER  BOILER,  POUNDS/DAY:
       SOPR = (HPSP  +  SMSD  +  SLSD  -  (SORB  *  (1.0  -  SSSB)))/(1.0  -  SSSB)
       PPFW  =  (SOPB  *  (1.0  +  BFFC))
C  ***  CHECK  FEEDWATER  ENTHALPY
       HC  =  HFWT  -  HFWR
       IF  (HC.LE.0.05)  GO  TO  2
C  ***  REITERATE  TO  EQUILIBRIUM
       GO  TO  1
    2   CONTINUE
C  ***  CALCULATE  THE  ENTHALPY  OF  FEEDWATER  TO  POWER  BOILER,  OUT  OF
C  ***  FEEDWATER  HEATERS,  B.T.U.  PER  POUND  OF  FEEDWATER:
       HBFW  =  ((PBFW  *  HFWR)  +  (FWHE  *  (((HHPP  -  HCCN)  *  HPFW  *  PBFW)  +
      *          ((HMPP  -  HCCN)  *  SMFW  *  PBFW))))/PBFW
C  ***  CALCULATE  THE  STEAM  HEAT  ENERGY  DEMAND  ON  POWER  BOILER,  MILLIONS
C  ***  OF  B.T.U.  PER  DAY  (INPUT  TO  POWER  BOILER  SUBROUTINE):
       SHDM  =  ((SOPS  *  HSHP)  -  (SOPB  *  HPFW))/1000000.0
C  ***  CALCULATE  THE  AMOUNT  OF  ELECTRICAL  ENERGY  COGENERATED,  IN
C  ***  KILOWATT  HOURS  PER  DAY  (ONE  KILOWATT  HOUR  EQUALS  3413.0  B.T.U.
C  ***  OF  ENERGY  EQUIVALENT):
       COGN  =  TGEF  *  (((HSHP  -  HMPP)  *  HPSD)  +
      +                    ((HSHP  -  HMPP)  *  SMSD)  +
      +                      ((HSHP  -  HLPP)  *  SLSD))/3413.0
C  ***  CALCULATE  PURCHASED  ELECTRICAL  ENERGY  REQUIREMENTS,  KILOWATT-
C  ***  HOURS  PER  DAY:
       PERQ  =  (TEED  *  24.0)  -  COGN
       SREE  =  0.0
C  ***  CALCULATE  SURPLUS  ELECTRICAL  ENERGY,  IF  ANY,  PRODUCED  AND  SOLD,
C  ***  KILOWATT-HOURS  PER  DAY:
       IF  (PERQ.LT.0.0)  SREE  =  -(PERQ)
       IF  (PERQ.LT.0.0)  PERQ  =  0.0
       0(1.1)  =  SOPB
       0(2,1)  =  SORB
       0(3,1)  =  SOPB  +  SORB
       DO  10  I  =  1,3
       0(I,4)  =  0(I,1)  *  HSHP
   10  CONTINUE
       0(4,1)  =  SSSB  *  (SOPB  +  SORB)
       0(4,4)  =  0(4,1)  *  HSHP
       0(5,4)  =  COGN  *  3413.0/TGEF
       0(6,1)  =  HPPM  *  PPRD
       0(7,1)  =  HPTC  *  PPRD
       0(8,1)  =  HPAH  *  TBLS
       0(9,1)  =  HPFW  *  PBFW
       0(10,1)  =  HPPB  *  SOPB
       0(11,1)  =  HPMD  *  PPRD
       DO 20 I  =  6,11
       0(I.4)  =  0(I,1)  *  HMPP
   20  CONTINUE
       0(12,1)  =  SMPD  *  TWRD  *  2000.0
       0(13,1)  =  SMDH  *  TWLV
       0(14,1)  =  SMJE  *  (TBLS  +  SOPR)
       0(15,1)  =  SMAS  *  PROD
       0(16,1)  =  SMEC  *  TBLS
       0(17,1)  =  SMAH  *  TBLS
       0(18,1)  =  SMST  *  TBBS
       0(19,1)  =  SMLH  *  TBLS
       0(20.1)  =  SMBL  *  TBLS
       0(21,1)  =  SMFW  *  PBFW
       0(22,1)  =  SMPB  *  SOPB
       0(23,1)  =  SMMD  *  PPRD
       0(24,1)  =  (HPPM  *  PPRD)  +  ((MPSD  -  (HPPM  *  PPRD))  *  HTMS)  -  SMLP
       DO 30 I =  12,24
       0(I.4)  =  0(I.1)  *  HMPP
   30  CONTINUE
       0(25,1)  = SLPM  *  PPRD
       0(26,1)  = SLRS  *  TBLS
       0(27.1)  = SLAH  *  TBLS
       0(28,1)  = SLEV  *  WREV  *  2000.0
       0(29,1)  = SLCN  *  WRCN  *  2000.0
       0(30,1)  = SLDG  * PPWD
       0(31,1)  = SLSE  * PROD
       0(32,1)  = SLPB  *  SOP8
       0(33,1)  = SLDA  *  (SOPB  +  SORB)  *  (1.0  +  BFFC)
       0(34,1)  = SLMD  * PPRD
       0(35,1)  = GMSD  * SMLS  + SMLP
       DO  40  I  =  25,35
       0(I,4)  =  0(I,1)  *  HLPP
   40  CONTINUE
       0(36,1)  =  0.0
       0(36,4)  =  0.0
       0(5,1)  =  0.0
       DO  50  I  =  4,35
       0(36,1)  =  0(36.1)  +  0(I,1)
       0(36,4)  =  0(36,4)  +  0(I.4)
   50  CONTINUE
       0(36.1)  =  0(36,1)  -  2  *  0(24,1)  -  2  *  0(35,1)
       0(36,4)  =  0(36,4)  -  2  *  0(24,4)  -  2  *  0(35,4)
       0(37,1)  =  TSLS
       DO  60  I  =  1,37
       0(I,1)  =  0(I,1)/1000000.0
       0(I,2)  =  0(I,1)/24.0
       0(I,3)  =  0(I,4)/1000000.
       0(I,4)  =  0(I,3)/24.0
       0(I,5)  =  0(I,3)/PPRD
   60  CONTINUE
C  ***  CALCULATE  NET  STEAM  ENERGY  VALUES  ADDED  TO  SYSTEM
       OP(1,1)  =  (O(33,1)  *  (HLPP  -  HFWR))  +  (((TSLS  *  HCMW)
      +  -  (CNSL  *  HCCN  *  ((SOPR  +  SORB)  *  (1.0  +  BFFC))))/1000000.)
       OP(2,I)  =  (FWHE  *  (((HHPP  -  HCCV)  *  HPFW  *  PBFW)
      +            +  ((HMPP  -  HCCN)  *  SMFW  *  PBFW)))/1000000.
       OP(3,1)  =  (SOPR  *  (HSHP  -  HBFW)  -  (SOPB  *  0.584  *  BFFC  *  HBFW))/
      +              1000000.
       OP(4,1)  =  (SORB  *  (HSHP  -  HFWR)  -  (SORB  *  0.584  *  BFFC  *  HFWR))/
      +              1000000.
       OP(5,1)  =  OP(1,1)  +  OP(2,1)  +  OP(3,1)  +  OP(4,1)
C  ***  CALCULATE  NET  STEAM  ENERGY  VALUES  SUBTRACTED  FROM  SYSTEM
       OP(6,1)  =  0(4,3)
       OP(7,1)  =  0(5,3)
       OP(8,1)  =  0(6,3)  *  ((HHPP  -  HMPP)/HHPP)
       OP(9,1)  =  (HTMS  *  (HPSD  -  PPRD)))  *  (HHPP  -  HMPP)/1000000.
       OP(9,1)  =  (HPSD  -  HPPM  *  PPRD)  -  (HTMS  *  (HPSD  -
      +            (HPPM  *  PPRD)))  -  (HPSD  *  HPSL))  *  (HHPP  -  HCCN)
      +            /1000000.
       OP(11,1)  =  HPSD  *  HPSL  *  HHPP/1000000.
       OP(12,1)  =  ((GMSD  *  SMLS)  +  SMLP)  *  (HMPP  -  HLPP)/1000000.
       OP(13,1)  =  (GMSD  -  GMSD  *  SMLS)  -  (SMLS  *  GMSD))  *
      +            (HHPP-      HCCN)/1000000.
       OP(14,1)  =  SMSL  *  GMSD  *  HMPP/1000000.
       OP(16,1)  =  SLSL  *  (SLSD  +  (SMLS  *  GMSD)  +  SMLP)  *  HLPP/1000000.
       OP(15.1)  =  ((OP(16,1)/SLSL)  -  OP(16,1))  *  ((HLPP-HCCN)/HLPP)
       OP(17.1)  =  0.0
       DO  70  K  =  6,16
       OP(17,1)  5  OP(17,1)  +  OP(K,I)
   70  CONTINUE
       DO  80  J=1,17
       0P(J,2)  =  OP(J,1)/24.0
       OP(J,3)  =  OP(J,I)/PPRO
   80  CONTINUE
C
C  -  OUTPUT
       IF  (NX.EQ.4.OR.NX.EQ.5)  GO  TO  500
       IF  (NX.EQ.10.OR.NX.EQ.11)  GO  TO  500
       WRITE  (6.200)
  200  FORMAT  ('1',6X,'S  T  E  A  M    A  N  D    G  R  O  S  S    E  N  E  R  G  Y    B  A
      +L  A  N  C  E'/
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      +//32X,'MILLION    POUNDS    OF    '11X,'HEAT    ENERGY'/38,'STEAM',9X,
      +'------MILLION    B.T.U.------'/
      +32X,'PER   DAY   PER   HR.   PER   DAY   PER   HR.   PER   TON'/)
       WRITE   (6,210)  O(1,1),O(1,2),O(1,3),O(1,4),O(1,5),O(2,1),O(2,2),
      +                 O(2,3),P(2,4),P(2,5),O(3,1),O(3,2),O(3,3),O(3,4),
      +                 O(3,5)
  210  FORMAT   ('0','STEAM    OUTPUT:'//1X,'POWER    BOILER'18X,2F9.3,F10.1,
      +  F10.1,F9.3/1X,'RECOVERY          BOILER',15X,2F9.3,2F10.1,F9.3//
      +4X,'TOTAL    STEAM    OUTPUT',9X,2F9.3,2F10.1,F9.3//)
       WRITE (6220)   HSHP,O(4,1),O(4,2),O(4,3),O(4,4),O(4,5),
      +                 O(5,3),O(5,4),O(5,5)
  220  FORMAT   ('0','STEAM   DEMANDS:'//
      +1X,'SUPERHEATED    STEAM    (',F8.1,'    B.T.U./LB.)'//
      +2X,'SOOTBLOWERS',18X,2F9.3,2F10.1,F9.3/
      +2X,'TURBINE     GENERATORS     (NET     ENERGY)',3X,'--',7X--',F12.1,F10.1,
      +F9.3//)
       WRITE  (6,230)   HHPP, O(6,),O(6,2),O(6,3),O(6,4),O(6,5),
      +                          O(7,1),O(7,2),O(7,3),O(7,4),O(7,5),
      +                          O(8,1),O(8,2),O(8,3),O(8,4),O(8,5),
      +                          O(9,1),O(9,2),O(9,3),O(9,4),O(9,5),
      +                          O(10,1),O(10,2),O(10,3),O(10,4),O(10,5),
      +                          O(11,1),O(11,2),O(11,3),O(11,4),O(11,5),
  230  FORMAT   ('0','HIGH   PRESSURE   PROCESS   (',F8.1,'   B.T.U./LB.)'//
      +2X,'PAPER   MACH.   &   VAC.   TURBINES',2X,2F9.3,2F10.1,F9.3/
      +2X,'PAPER   MACH.     THEROCOMPRESS.',2X,2F9.3,2F10.1,F9.3/
      +2X,'REC.    BOILER    AIR    HEATERS',6X,2F9.3,2F10.1,F9.3/
      +2X,'POWER   BOILER    FEEDWATER    HTR.',2X,1F9.3,2F10.1,F9.3/
      +2X,'POWER   BOILER     MISCELLANEOUS',3X,2F9.3,2F10.1,F9.3/
      +2X,'MISC.    HIGH    PRESSURE    STEAM',4X2F9.3,2F10.1,F9.3//)
       WRITE  (6,240)  HMPP,  O(12,1),O(12,2),O(12,3),O(12,4),O(12,5),
      +                       O(13,1),O(13,2),O(13,3),O(13,4),O(13,5),
      +                       O(14,1),O(14,2),O(14,3),O(14,4),O(14,5),
      +                       O(15,1),O(15,2),O(15,3),O(15,4),O(15,5),
      +                       O(16,1),O(16,2),O(16,3),O(16,4),O(16,5),
      +                       O(17,1),O(17,2),O(17,3),O(17,4),O(17,5),
      +                       O(18,1),O(18,2),O(18,3),O(18,4),O(18,5)
  240  FORMAT   ('0','MEDIUM    PRESSURE    PROCESS    (',F9.1,'    B.T.U./LB)'//
      +2X,'PAPER    MACHINE    DRYERS',9X,F29.3,2F10.1,F9.3/
      +2X,'DIGERSTER   LIQUOR    HEATER',7X,2F9.3,2F10.1,F9.3/
      +2X,'EVAPORATOR   STEAM      JETS',8X,2F9.3,2F10.1,F9.3/
      +2X,'AIR  SUPPLY  AREA',14X,2F9.3,2F10.1,F9.3/
      +2X,'EMMISSIONS      CONTROL,REC.BLR.',3X,2F9.3,2F10.1,F9.3/.
      +2X,'AIR      HEATERS,       REC.BLR.',8X,2F9.3,2F10.1,F9.3/
      +2X,'DISSOLVING      TANK',14X,2F9.3,2F10.1,F9.3/
       WRITE        (6,250)       O(19,1),O(19,2),O(19,3),O(19,4),O(19,5),
      +                   O(20,1),O(20,2),O(20,3),O(20,4),O(20,5),
      +                   O(21,1),O(21,2),O(21,3),O(21,4),O(21,5),
      +                   O(22,1),O(22,2),O(22,3),O(22,4),O(22,5),
      +                   O(23,1),O(23,2),O(23,3),O(23,4),O(23,5),
      +                   O(24,1),O(24,2),O(24,3),O(24,4),O(24,5),
  250  FORMAT  (2X,'SEC.BLACK         LIQ.        HTR.'9X,2F9.3,2F10.1,F9.3/
      +           2X,'BLACK    LIQ.    GUNS,     REC.BLR,',4X,2F9.3,2F10.1,F9.3/
      +           2X,'POWER   BOILER   FEEDWATER   HTR.',2X,2F9.3,2F10.1,F9.3/
      +           2X,'POWER    BOILER    AREA    MISC.',6X,2F9.3,2F10.1,F9.3/
      +           2X,'MISC.    MED.    PRESSURE    STEAM',4X,2F9.3,2F10.1,F9.3/
      +           2X,"(STEAM   FROM   FROM   HIGH   PRESSURE'/4X,'PROCESS)',20X,
      +              2('(',F7.3,')'),2('(',F8.1,')'),'(',F7.3,')'//)
       WRITE  (6,260)  HLPP,O(25,1),O(25,2),O(25,3),O(25,4),O(25,5),
      +                         O(26,1),O(26,2),O(26,3),O(26,4),O(26,5),
      +                         O(27,1),O(27,2),O(27,3),O(27,4),O(27,5),
      +                         O(28,1),O(28,2),O(28,3),O(28,4),O(28,5),
      +                         O(29,1),O(29,2),O(29,3),O(29,4),O(29,5),
      +                         O(30,1),O(30,2),O(30,3),O(30,4),O(30,5),
  260  FORMAT   ('1',LOW    PRESSURE    PROCESS    (',F8.1'   B.T.U./LB.)'//
      +2X,'PAPER     MACHINE     AUX.     EQUIP.',4X,2F9.3,2F10.1,F9.3/
      +2X,GREEN      LIQUOR       HEATER',10X,2F9.3,2F10.1,F9.3
      +2X,'AIR       HEATERS,       REC.BLR.',8X,2F9.3,2F10.1,F9.3
      +2X,'EVAPORATORS      (BLACK      LIQUOR)',3X,2F9.3,2F10.1,F9.3
      +2X,'CONCENTRATORS      (BLACK      LIQUOR)',1X,2F9.3,2F10.1,F9.3
      +2X,'DIGESTER       STAMING        VESSEL',5X2F9.3,2F10.1,F9.3
       WTIRE   (6,270)  O(31,1),O(31,2),O(31,3),O(31,4),O(31,5),
      +                 O(32,1),O(32,2),O(32,3),O(32,4),O(32,5),
      +                 O(33,1),O(33,2),O(33,3),O(33,4),O(33,5),
      +                 O(34,1),O(34,2),O(34,3),O(34,4),O(34,5),
      +                 O(35,1),O(35,2),O(35,3),O(35,4),O(35,5),
  270  FORMAT   (2X,'ODOR    CONTORL    SYSTEM',10X,2F9.3,2F10.1,F9.3
      +             2X,'POWER    BOILER    AREA    MISC.',6X,2F9.3,2F10.1,F9.3
      +             2X,'DEAERATOR        (FEEDWATER)',8X,2F9.3,2F10.1,F9.3
      +             2X,'MISC.    LOW    PRESSURE    STEAM',5X,2F9.3,2F10.1,F9.3/
      +             2X,'(STEAM    FROM    MED.    PRESSURE'/4X,'PROCESS)'.20X,
      +             2('(',F7.3,')'),2('(',F.8.1,')').'('.F7.3,')'//)
       WRITE   (6,280)          O(36,1),O(36,2),O(36.3),O(36,4),O(36,5)
  280  FORMAT    ('0',5X,'TOTAL     STEAM     DEMANDS,6X,2F9.3,2F10.1,F9.3//)
       WRITE   (6,290)   O(37,1),O(37,2),HFWR
  290  FORMAT    ('0','MAKE-UP     WATER     REQUIRED',8X,F9.3,F9.3,7X,'--',8X,
      +          '--',6X,'-',////1X,'FEEDWATER             ENTHALPY',5X,F9.1.'          B.T.U./LB.'//)
       WRITE     (6,300)
  300 FORMAT  ('1'/6X,'N  E  T     S  T  E  A  M     E  N  E  R  G  Y     B  A  L  A  N  C  E'//
      +49X,    'HEAT      ENERGY'/42X,'------MILLION        B.T.U.-------'/42X,'PER        DAY',
      +3X,'PER       HR.',3X,'PER       TON'/)
       WRITE      (6,310)      ((OP(J,K),K=1,3),J=1,5)
  310  FORMAT   ('0',1X, 'NET   ENERGY   ADDED   TO   STEAM   SYSTEM,   IN:'//4X,
      +'DEAERATOR     &     MAKE-UP     WATER',11X,2F10.0.F9.2/
      +4X,'POWER  BOILER  FEEDWATER  HEATER',7X,2F10.0,F9.2/
      +4X,'POWER      BOILER',24X,2F10.0,F9.2/
      +4X,'RECOVERY       BOILER',21X,2F10.0,F9.2//
      +7X,'TOTAL    NET    ENERGY',17X,2F10.0,F9.2/)
       WRITE      (6,320)      ((OP(J,K),K=1,3),J=6,17)
  320 FORMAT  ('0',1X,'NET ENERGY SUBTRACTED FROM STEAM SYSTEM,  IN:'//
      +3X,'SUPERHEATED STEAM'/
      +5X,'SOOTBLOWERS',24X.2F10.0,F9.2/
      +5X,'TURBINE      GENERATORS',17X,2F10.0,F9.2//
      +3X,'HIGH PRESSURE PROCESS'/
      +5X,'PAPER    MACHINE    TURBINES',13X,2F10.0.F9.2/
      +5X,'STEAM  TO  MEDIUM  PRESSURE  PROCESS',3X,2F10.0,F9.2/
      +5X,'STEAM     TO     CONDESATE',16X,2F10.0,F9.2/
      +5X,'STEAM       LOSSES',23X,2F10.0,F9.2//
      +3X,'MEDIUM PRESSURE PROCESS'/
      +5X, 'STEAM  TO  LOW  PRESSURE PROCESS',6X,2F10.0,F9.2/
      +5X,'STEAM  TO    CONDENSATE',16X,2F10.0,F9.2/
      +5X,'STEAM       LOSSES',23X,2F10.0,F9.2//
      +3X,'LOW PRESSURE PROCESS'/
      +5X,'STEAM    TO    CONDENSATE',16X,2F10.0,F9.2/
      +5X,'STEAM       LOSSES',23X,2F10.0,F9.2//
      +8X,'TOTAL      NET      ENERGY',16X,2F10.0,F9.2////
      +8X,'(NOTE:    TOTALS    MAY  NOT  AGREE    PRECISELY)')
       WRITE      (6,330)
  330   FORMAT     (1I'/2X,'ENTHALPY     OF     VARIOUS     FLOWS'//2X,
      +'IN   THE   STEAM SYSTEM'/35X,'ENTHALPY'/33X,'(B.T.U./LB.)'/)
       WRITE      (6,340)  HCCN,HCMW,HFMR,HBFW,HSWP,HWPP,HPP,HLPP
  340   FORMAT    ('    '/4X,   'COMBINED    CONDENSATE',  12X,F8.1/
      +6X,'(INTO CONDENSATE RECEIVER FROM PROCESS)'//
      +4X,'MAKE-UP     WATER',18X,F8.1/
      +6X,'(INTO     DEAERATOR)'//
      +4X,'PRIMARY     FEEDWATER',14X,F8.1/
      +6X,'(TO  REC.  BOILER  AND  P.B.  FEEDWATER  HEATERS)'//
      +4X,'FEEDWATER  TO  POWER  BOILER'6X,F8.1/
      +6X,'(FROM  P.B.  FEEDWATER  HEATERS)'//
      +4X,'SUPERHEATED     STEAM',14X,F8.1/
      +6X,'(FROM   BOILERS,   TO   TURBINE)'//
      +4X,'HIGH  PRESSURE  PROCESS  STEAM',4X,F8.1/
      +6X,'(FROM      TURBINE)'//
      +4X,'MED.  PRESSURE  PROCESS  STEAM',4X,F8.1/
      +6X,'(FROM      TURBINE)'//
      +4X,'LOW  PRESSURE  PROCESS  STEAM',5X,F8.1/
      +6X,'(FROM         TURBINE)')
  500    CONTINUE
         END
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===== PWRBLR =====

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       SUBROUTINE  PWRBLR
C
C  ***  THIS  IS  THE  SUBROUTINE  FOR  THE  POWER  BOILER,  COAL  HANDLING
C  ***    AND  FLUE  GAS  DESULFURIZING  AREAS
C
       COMMON/ALL/CAOX,CDMW,CDSW,COGN,CPRC,CSDS,HBRK,HCCW,HWCW,HRFR,
     *     HSRB,NX,PACQ,PALM,
     *     PCAS,PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
     *     PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
     *     PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
     *     SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
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          * SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
          * TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
      C
      C  ***  THIS IS THE LIST OF INPUTS:
      C
      C  ***  CAPB - BOILER DESIGN CAPACITY AS A FACTOR PROPORTIONAL TO
      C  ***          STEAM HEAT ENERGY DEMAND (FACTOR MUST BE GREATER THAN 1.0)
      C  ***  CLMC - MOISTURE CONTENT OF COAL, RATIO OF TOTAL WEIGHT,
      C  ***          INCLUDING MOISTURE, AVERAGE.
      C  ***  COLA - ASH CONTENT OF COAL, RATIO OF DRY WEIGHT.
      C  ***  COLC - CARBON CONTENT OF COAL, RATIO OF DRY WEIGHT, ULTIMATE
      C  ***          ANALYSIS.
      C  ***  COLH - HYDROGEN CONTENT OF COAL, RATIO OF DRY WEIGHT.
      C  ***  COLO - OXYGEN CONTENT OF COAL, RATIO OF DRY WEIGHT.
      C  ***  COLN - NITROGEN CONTENT OF COAL, RATIO OF DRY WEIGHT.
      C  ***  COLS - SULFUR CONTENT OF COAL, RATIO OF DRY WEIGHT.
      C  ***  CPPC - PRICE OF COAL FOR POWER BOILER, $/TON AS-PURCHASE0
      C  ***          (SUPPLY UNLIMITED AT GIVEN PRICE, F.O.B. MILL).
      C  ***  EXAR - EXCESS AIR ADMITTED TO POWER BOILER FURNACE, EXPRESSED
      C  ***          AS A DECIMAL RATIO OF THE THEORETICAL MINIMUM AMOUNT
      C  ***          OF AIR REQUIRED FOR COMPLETE COMBUSTION, AVERAGE.
      C  ***  HVWD - COMBUSTION HEAT ENERGY OF WOOD AND BARK FUELS, HIGHER
      C  ***          HEATING VALUE, BTU/LB. DRY, AVERAGE.
      C  ***  PCAS - PURCHASE PRICE, F.O.B. MILL, OF 50% CAUSTIC SODA
      C  ***          (50% SODIUM HYDROXIDE), DOLLARS PER TON.
      C  ***  PPSC - PURCHASE PRICE OF SODIUM SULFATE SALTCAKE FOR SALTCAKE
      C  ***          MAKE-UP, DOLLARS PER TON OF SALTCAKE.
      C  ***  PROD - PULPMILL PRODUCTION VOLUME, TONS OF OVENDRY PULP PRODUCED
      C  ***          PER DAY, AVERAGE.
      C  ***  QRES - QUANTITY OF BARK RESIDUES PRODUCED AND USED FOR FUEL IN
      C  ***          POWER BOILER, DRY TONS/DAY, AVERAGE USAGE.
      C  ***  QWOD - QUANTITY OF PURCHASED WOOD FUEL USED FOR FUEL IN POWER
      C  ***          BOILER, DRY TONS/DAY, AVERAGE OR MAXIMUM AVAILABLE.
      C  ***  RUHL - RADIATION HEAT LOSSES, UNACCOUNTED FOR, AND MISCELLANEOUS
      C  ***          HEAT LOSSES, AS A DECIMAL RATIO OF TOTAL HEAT ENERGY
      C  ***          INPUT TO POWER BOILER.
      C  ***  SCLS - SALTCAKE (SODIUM SULFATE) LOSSES OR MAKE-UP REQUIREMENTS,
      C  ***          POUNDS OF SALTCAKE PER DRY TON OF PULP, EXCLUDING
      C  ***          SALTCAKE FROM POWER BOILER ELECTROSTATIC PRECIPITATORS.
      C  ***  SOOR - SULFUR DIOXIDE REMOVAL FROM STACK GASES IN FLUE GAS
      C  ***          DESULFURIZING AREA, DECIMAL RATIO OF TOTAL SULFUR
      C  ***          DIOXIDE IN STACK GASES.
      C  ***  SGTP - STACK GAS TEMPERATURE OF FLUE GASES BEYOND EFFECTIVE HEAT
      C  ***          RECOVERY DEVICES OF POWER BOILER, DEGREES, F, AVERAGE.
      C  ***  SHDM - STEAM HEAT ENERGY DEMAND ON POWER BOILER, MMBTU/DAY, AVE.
      C  ***  STRS - SULFUR DIOXIDE (SO2) GENERATED FROM INCINERATION OF
      C  ***          "TRS GASES" IN POWER BOILER, LB. OF SO2/TON OF PULP
      C  ***          PRODUCTION.
      C  ***  SVSC - SALES VALUE, F.O.B. MILL, OF EXCESS SALTCAKE PRODUCT FROM
      C  ***          SALTCAKE RECLAIM, DOLLARS PER TON OF SALTCAKE.
      C  ***  HDMC - MOISTURE CONTENT OF WOOD AND BARK FUELS USED IN POWER
      C  ***          BOILER, DECIMAL RATIO OF WET WEIGHT, AVERAGE.
      C  ***  WMAX - MAXIMUM QUANTITY OF WOOD AND BARK FUEL THAT CAN BE USED
      C  ***          FOR FUEL IN POWER BOILER, DRY TONS/DAY, (COAL USED FOR
      C  ***          REMAINDER OF HEAT ENERGY).
      C  ***  WODA - ASH CONTENT OF WOOD AND BARK FUEL, RATIO OF DRY WOOD
      C  ***          WEIGHT.
      C  ***  WODC - AVERAGE ULTIMATE ANALYSIS CARBON CONTENT OF WOOD AND BARK
      C  ***          FUEL USED IN POWER BOILER, DECIMAL RATIO OF WOOD WT.
      C  ***  WODH - HYDROGEN CONTENT OF WOOD AND BARK FUEL, RATIO OF DRY
      C  ***          WOOD WEIGHT.
      C  ***  WODN - NITROGEN CONTENT OF WOOD AND BARK FUEL, RATIO OF DRY
      C  ***          WOOO WEIGHT.
      C  ***  WODO - OXYGEN CONTENT OF WOOD AND BARK FUEL, RATIO OF DRY
      C  ***          WOOD WEIGHT.
      C  ***  WPRC - PRICE OF PURCHASED WOOD FUEL, $/DRY TON, FOB-MILL (OR,
      C  ***          2X SELLING PRICE OF SURPLUS FUEL).
      C
      C  ***  READ STATEMENTS:
      C
            READ (5,10)CLMC,COLA,COLC,COLH,COLO,COLN,COLS,CPRC,EXAR,HVWD,
          +            PCAS,PPSC,RUHL,SDOR,SGTP,STRS,WDMC,WMAX,WODA,WODC,
          +            WODH,WODN,WODO,WPRC
        10  FORMAT  (//24(F20.0//))
      C
      C       CALCULATIONS:
      C
      C  ***  CALCULATE QUANTITY OF WOOD AND BARK RESIDUES PRODUCED AND
      C  ***  AVAILABLE FOR FUEL, DRY TONS PER DAY:
            ORES = SRFR + HRFR + SBRK + HBRK
      C  ***  CALCULATE HIGHER HEATING VALUE Of COAL PER DRY POUND VIA
      C  ***   DULONG FORMULA:
            HVCO = (145.44 * COLC + 620.0 * (COLH + COLO/8.0) + 41.0 *
          + COLS) * 100.0
      C  ***  CALCULATE HEAT ENERGY RECOVERY FROM COAL PER DRY TON:
            CALL   SUB1   (HVCO,COLC,COLH,COLO,COLN,CLMC,SGTP,EXAR,RUHL,RCCO)
      C  ***  CALCULATE HEAT ENERGY RECOVERY FROM WOOD AND BARK FUEL/DRY TON:
            CALL  SUB1(HVWD,WODH,WODO,WODN,WDMC,SGTP,EXAR,RUHL,RCWD)
      C  ***  DETERMINE TOTAL QUANTITY OF WOOD AND BARK RESIDUES AND
      C  ***  PURCHASED WOOD FUEL USED IN POWER BOILER:
            WM = SHDM/RCWD
            IF   (WM.LE.WMAX  WWAX = WM
            IF  (QRES.GT.WMAX)  SURB = QRES - WMAX
            IF  (QRES.GT.WMAX)  QWOD = 0.0
            If  (QRES.GT.WMAX)  QRES = WMAX
            QWOD = WMAX - QRES
            IF   (QWOD.LE.0.0)  QWOD = 0.0
      C  ***  CALCULATE HEAT ENERGY RECOVERED FROM WOOO AND BARK RESIDUES, AND
      C  ***  PURCHASE0 WOOO FUELS (MILLIONS OF B.T.U./DAY):
            HTRB = QRES + RCWD
            HTRW = QWOD * RCWD
      C  ***  CALCULATE QUANTITY OF COAL REQUIRED, DRY TONS PER DAY:
            QCOL = (SHDM - (HTRB + HTRW))/RCCO
            IF   (QCOL.LE.0.0)   QCOL = 0.0
      C  ***  CALCULATE HEAT RECOVERED FROM COAL, MILLIONS OF B.T.U. PER DAY:
            HTRC = QCOL * RCCO
      C  ***  CALCULATE QUANTITY OF SULFUR DIOXIDE IN STACK GASES(TONS/DAY)
            SDSG = (COLS * QCOL * 2.0) + (STRS * PROD/2000.0)
      C  ***  CALCULATE QUANTITY OF SALTCAKE RECLAIMED AS SODIUM SULFATE
      C  ***  IN 15% SOLIDS SOLUTION TO EVAPORATOR
      C  ***   (TONS CHEMICAL DAY:  THE FACTOR OF 2.21875 IS THE
      C  ***  STOICHIOMETRIC WEIGHT RATIO OF SODIUM SULFATE TO SULFUR DIOXIDE):
            SSDS = SDSG * SDOR * 2.21875
      C  ***  CALCULATE QUANTITY OF CAUSTIC SODA (50% SODIUM HYDROXIDE)
      C  ***  REQUIRED FOR DESULFURIZATION PROCESS (TONS CHEMICAL/DAY: THE
      C  ***  FACTOR OF 2.5 IS THE STOICHIOMETRIC WEIGHT RATIO OF 2X SODIUM
      C  ***  HYDROXIDE TO SULFUR DIOXIDE):
            CSDS = SDSG * SDOR * 2.5
      C  ***  CALCULATE PURCHASED SALTCAKE REQUIREMENTS, TONS PER DAY OF
      C  ***  SALTCAKE, AS SODIUM SULFATE:
            PSCR = (SCLS * PROD/2000.0) - SSDS
            SSCK = 0.0
      C  ***  CALCULATE SURPLUS SALTCAKE PRODUCED, IF ANY, TONS PER DAY:
            IF   (PSCR.LT. 0.0)   SSCK = -(PSCR)
            IF   (PSCR.LT.0.0)   PSCR = 0.0
            SLS = (SCLS  *  PROD/2000.0)
            SRB = SURB
            QWD = QWOD
            QCL = QCOL
      C  ***  CALCULATE WEIGHT OF SURPLUS WOOD FUEL IN WET TONS/DAY
      C  ***   (INCLUDING MOISTURE IN FUEL)
            SURB = SURB/(1.0 - WDMC)
      C  ***  CALCULATE WEIGHT OF PURCHASED WOOD FUEL IN WET TONS/DAY
      C  ***   (INCLUDING MOISTURE IN FUEL)
            QWOD = QWOD/(1.0 - WDMC)
      C  ***  CALCULATE WEIGHT OF PURCHASED COAL FUEL IN WET TONS/DAY
      C  ***   (INCLUDING MOISTURE IN FUEL)
            QCOL = QCOL/(1.0 - CLMC)
            TLEC = TEED * 24.0
            IF   (NX.EQ.1.OR.NX.EQ.2.OR.NX.EQ.3)   GO  TO  500
            IF   (NX.EQ.4.OR.NX.EQ.5.OR.NX.EQ.6)   GO  TO  500
            WRITE   (6,20)
        20  FORMAT  ('1'///6X,'E L E C T R I C   P o W E R,   F U E L S,   C H
          +E M I C A L S'///2X,'ELECTRIC POWER BALANCE')
            WRITE  (6,30)  TLEC, COGN, PERQ, SREE
        30  FORMAT  ('  ',3X,'TOTAL  ELECTRIC  POWER  CONSUMED',7X,F10.0,2X,
          *'KWH/DAY'//4X,'ELECTRIC  POWER  COGENEPATED',10X,F10.0,2X,
          +'KWH/DAY//4X,'PURCHASED  ELECTRIC  POWER',12X,F10.0,2X,'KWH/DAY'//
          +4X,'SURPLUS  ELECTRIC  POWER',14X,F10.0,2X,'KWH/DAY'///)
            WRITE   (6,40)   QCL,QWD,QRES,TKFR
        40  FORMAT ('  ',2X,'FUEL REQUIREMENTS'//4X,'FOR POWER BOILER FURNACE'/
          +/6X,'COAL',16X,F8.1,2X,'DRY     TONS/DAY'/
          + 6X,'PURCHASED  WOOD  FUEL',1X,F8.1,2X,'DRY  TONS/DAY'/
          + 6X,WOOD   RESIDUES',7X,F8.1,2X,'DRY   TONS/DAY'//
          + 4X,'FOR  LIVE  KILN'//
          + 6X,'NAT.  GAS',12X,F8.1,2X,'MCF/DAY'/)
            IF   (SRB.GT.0.0001)   WRITE   (6,50)   SRB
        50  FORMAT   ('   ',4X,'SURPLUS   WOOD   FUEL',2X,F8.1,2X,'DRY   TONS/DAY'*/)
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      WRITE (6,60) CAOX/TWLP/PLRQ
   60 FORMT ('0',2X,'LIME BALANCE*//4X,'LIME CONSUMED IN SLAKING & CAUS
     +TIZING',4X,F8.2,2X,'TONS/DAY,//4X''LIME PRODUCED IN LIME KILN',
     +15X,F8.2,2X,'TONS/DAY'//4X,'PURCHASED MAKE-UP LIME',19X,F8.2,
     +2X,'TONS/DAY'//)
      WRITE (6.70) SLS,SSDS,SDSG,SDOR
   70 FORMAT (' ,2X,'SALTCAKE BALANCE'//4X''NET SALTCAKE LOSSES',12X,
     +F7.3r2X,'TONS/DAY'/6X,'(EXCLUDING RECOVERY FROM POWER BOILER DESUL
     +FURIZING)'//4X,'SALTCAKE RECOVERED IN POWER BOILER DESULFURIZING'/
     +35X,F7.3,2X,'TONS/DAY'//10X,'BASED ON:'//
     +10X,F7.3,2X,'TONS/DAY SULFUR DIOXIDE IN FLUE GASES'/
     +10X,F7.3,2X,'REMOVAL RATIO'/)
      IF (PSCR.GT.0.001) WRITE (6,80) PSCR
   8O FORMAT (' ',4X,'PURCHASED SALTCAKE REQUIRED',4X,F7.3,2X,
     +'TONS/DAY'/)
      IF (SSCK.GT.0.0001) WRITE (6,90) SSCK
   90 FORMAT (' ',3X,'SURPLUS SALTCAKE PRODUCED',6X,F7.3,2X,'TONS/DAY'/)
      WRITE (6,100) CSDS
  100 FORMAT (' ',3X,'CAUSTIC SODA (50 PCT. SODIUM HYDROXIDE)'/4X,'REQUI
     +RED FOR DESULFURIZING',5X,F7.3,2X,'TONS CHEMICAL/DAY')
  500 CONTINUE
C
      SUBROUTINE SUB1(HV,C,H,X,XN,PM,T2,EX,HL,RC)
C
C *** THIS SUBROUTINE CALCULATES HEAT ENERGY RECOVERY FROM COMBUSTION
C *** OF WOOD, BARK, OR COAL, IN MILLIONS OF BTU'S PER TON OF DRY FUEL
C *** HV IS HIGHER HEATING VALUE OF FUEL BTU/LB
C *** C  IS CARBON CONTENT OF FUEL (RATIO OF DRY WEIGHT)
C *** H  IS HYDROGEN CONTENT OF FUEL
C *** X  IS OXYGEN CONTENT OF FUEL
C *** XN  IS NITROGEN CONTENT OF FUEL
C *** PM IS MOISTURE CONTENT OF FUEL (RATIO OF YET WEIGHT OF FUEL)
C *** T2 IS STACK GAS TEMP OF COMBUSTION SYSTEM BEYOND EFFECTIVE MEAT
C ***   RECOVERY DEVICES
C *** EX IS EXCESS AIR AS A RATIO OF THEORETICAL AIR REQUIRE0 FOR
C ***   COMBUSTION IN FURNACE
C *** HL IS MISCELLANEOUS RADIATION AND UNACCOUNTED FOR MEAT LOSSES,
C ***   RATIO OF HEAT ENERGY INPUT
C *** RC IS HEAT RECOVERY IN MILLIONS OF BTU PER DRY TON OF FUEL
C *** T1 IS AMBIENT TEMPERATURE OF AIR AND FUEL
      T1 = 60.0
C *** CALCULATE MEAT LOSS CAUSED BY FUEL MOISTURE AND HYDROGEN IN FUEL
C *** PER DRY POUND OF FUEL:
      HLMH = (970.0 + (212.0 - T1) + (0.46 * (T2 - 212.0)))
     + * (H * 9.0 + PM/(1.0-PM))
C *** CALCULATE HEAT LOSS USE0 BY DRY GAS AND EXCESS AIR BASED ON
C *** SPECIFIC HEATS DRY GASES:
      HLDG = (T2 - T1) * (0.24 * (((H * 8.0) + (C * 2.667) - X)/
     + 0.232) * EX + ((((H * 8.0) + (C * 2.66667) - X)/0.232) *
     + 0.768 + XN) * 0.25 + (C * 3.66667 * 0.22))
C *** CALCULATE 'CONVENTIONAL" MEAT LOSSES DUE TO RADIATION,
C *** MISCELLANEOUS AND UNACCOUNTED FOR LOSSES:
      HLMS = HY * HL
C *** CALCULATE HEAT RECOVERY PER POUND OF DRY FUELS
      RCLB = HV - (HLMH + HLDG + HLMS)
C *** CALCULATE HEAT RECOVERY PER DRY TON OF FUEL IN MILLIONS OF BTU'S:
      RC = RCLB * 0.002
      END
```

===== WATER =====

```
C *** THIS IS THE SUBROUTINE FOR THE WATER SUPPLY AND WASTEWATER
C ***   DISPOSAL AREAS
C
      SUBROUTINE WATER
C
      COMMON/ALL/CAOX,COHW,CDSW,COGN,CPRC,CSDS,HBRK,HCCW,HWCW,HRFR,
     *  MSRB,NX,PACD,PALM,
     *  PCAS,PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
     *  PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
     *  PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
     *  SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
     *  SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
     *  TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
C
C *** THIS IS THE LIST OF INPUTS:
C
C *** EFLF - EFFLUENT FLOW TO WASTEWATER TREATMENT FACILITIES OF
C ***        MILL, GALLONS PER DRY TON OF PAPER OR PAPERBOARD PRODUCT.
C *** ETCH - EFFLUENT TREATMENT CHEMICALS (NUTRIENTS SUCH AS NITROGEN
C ***        AND PHOSPHORIC COMPOUNDS) IN UNITS OF CHEMICALS (GALLONS,
C ***        POUNDS, ETC.) PER THOUSAND GALLONS OF UNTREATED EFFLUENT.
C *** PETC - AVERAGE PRICE OF EFFLUENT TREATMENT CHEMICALS IN DOLLARS
C ***          PER UNIT (GALLONS, POUNDS,ETC.).
C *** PWCH - AVERAGE PRICE OF FEEDWATER TREATMENT CHEMICALS PER UNIT OF
C ***         CHEMICAL (DOLLARS PER POUND, GALLONS, ETC.).
C *** PWTR - PRICE OF MILL WATER, DOLLARS PER THOUSAND GALLONS OF WATER
C ***          INPUT REQUIREMENTS.
C *** WATER - MILL WATER REQUIREMENTS, GALLONS PER DRY TON OF PAPER OR
C ***        PAPERBOARD PRODUCT OUTPUT.
C *** WTCH - WATER TREATMENT CHEMICALS REQUIRED, AVERAGE UNITS (POUNDS,
C ***        GALLONS, ETC.) PER THOUSAND GALLONS OF WATER INTO MILL.
C
C *** READ STATEMENTS:
C
      READ (5,10) EFLF,ETCH,PETC,PWCH,PWTR,WATR,WTCH
   10 FORMAT (//7(F20.0//))
C
C ***  CALCULATIONS:
C
C *** CALCULATE TOTAL MILL WATER INPUT REQUIREMENTS, MILLIONS OF
C *** GALLONS PER DAY:
      TMWR = WATR * PPRD/1000000.0
C *** CALCULATE MILL WATER TREATPENT CHEMICAL REQUIREMENTS IN UNITS OF
C *** CHEMICALS (GALLONS, POUNDS, ETC.) PER DAY:
      TWTC = WTCH * TMWR * 1000.0
C *** CALCULATE TOTAL EFFLUENT FLOW TO WASTEWATER TREATMENT, MILLIONS
C *** OF GALLONS PER DAY:
      TEFL = EFLF I PPRD/1000000.0
C *** CALCULATE EFFLUENT TREATMENT CHEMICAL REQUIREMENTS IN UNITS OF
C *** CHEMICALS (GALLOWS, POUNDS, ETC.) PER DAY:
      TETC = TEFL * ETCH * 1000.0
      END
```

===== SALES =====

```
C *** THIS IS THE SALES REVENUES, MATERIALS ENERGY AND LABOR COSTS
C ***   SUBROUTINE.
C
      SUBROUTINE SALES
C
      COMMON/ALL/CAOX,CDHW,CDSW,COGN,CPRC,CSDS,H8RK,HCCW,HWCW,HRFR,
     *  HSRB,NX,PACD.PALM,
     *  PCAS,PCOR,PDFM,PERQ,PETC,PHPC,PHWC,PSWC,PHRW,PKWH,PLRQ,PPAP,
     *  PPKF,PPLM,PPRD,PPSC,PPWD,PRO,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
     *  PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
     *  SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
     *  SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
     *  TRSN,TSLC,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
      DIMENSION R(8,4), VC(34,4)
C
C *** THIS IS THE LIST OF INPUTS:
C
C *** AMLB - AVERAGE MAINTENANCE LABOR REQUIREMENTS, NUMBER OF HOURLY
C ***        WAGE MAINTENANCE WORKERS NEEOEO PER DAY (8-HOUR SHIFTS
C ***        EACH).
C *** AMWG - AVERAGE MAINTENANCE LABOR WAGE RATE, INCLUDING ALL FRINGE
C ***         BENEFITS AND RELATE0 EXPENSES, DOLLARS PER HOUR.
C *** CCTC - COST OF COOLING TOYER CHEMICALS (COOLING SYSTEM FOR
C ***        PROCESS WATER), DOLLARS PER TON OF PAPER (BOARD) PRODUCT.
C *** CFWC - COST OF FEEDWATER CHEMICALS FOR TREATMENT OF BOILER FEED-
C ***        WATER, DOLLARS PER TON OF PAPER (BOARD) PRODUCT.
C *** DFCS - COST OF DRYER FELTS FOR PAPER MACHINE DRYERS, DOLLARS PER
C ***        DRY TON OF PRODUCT.
C *** DPYR - DAYS PEP YEAR, EFFECTIVE NUMBER OF DAYS PER YEAR THAT THE
C ***          MILL IS IN OPERATION.
C *** EXLB - AVERAGE NON-PROCESS LABOR REQUIREMENTS, NUMBER OF HOURLY
C ***        WAGE NON-PROCESS WORKERS NEEOEO PER DAY (8-HOUR SHIFTS
C ***        EACH).
C *** EXWG - AVERAGE NON-PROCESS LABOR WAGE RATE, INCLUDING ALL FRINGE
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C ***              BENEFITS AND RELATED EXPENSES, DOLLARS PER HOUR.
C *** PLUG - AVERAGE PROCESS LABOR WAGE RATE, INCLUDING ALL FRINGE
C ***              BENEFITS AND RELATED EXPENSES, DOLLARS PER HOUR.
C *** PSLB - AVERAGE PROCESS LABOR REQUIREMENTS, NUMBER OF HOURLY WAGE
C ***             PROCESS PERSONNEL NEEDED PER DAY (8-HOUR SHIFTS EACH).
C ***  RCST - COST OF ROLL COVERS FOR FINISHED ROLLS OF PAPER OR PAPER-
C ***             BOARD PRODUCT, DOLLARS PER DRY TON OF PRODUCT.
C *** WCST - COST OF WIRES FOR PAPER MACHINE, DOLLARS PER. DRY TON OF
C ***              PRODUCT.
C *** WFCS - COST OF WET FELTS FOR PAPER MACHINE, DOLLARS PER DRY TON
C ***              OF PRODUCT.
C
C ***  READ STATEMENTS:
C
       READ (5,1)   AMLB,AMWG,CCTC,CFWC,DFCS,DPYR,EXLB,EXWG,PLWG,PSLB,RCST,
      *                 WCST,WFCS
   1        FORMAT       (//12(F20.0//),F20.0)
C
C  ***   CALCULATIONS:
C
C
C *** CALCULATE MILL REVENUES, DOLLARS PER DAY, FOR PAPER (BOARD),
C ***  TURPENTINE, "SOAP", SURPLUS ELECTRICAL ENERGY, EXCESS RECLAIMED
C ***  SALTCAKE, SURPLUS BARK:
       R(1,1)  =  SVAL  *  PPRD
       R(2,1)  =  TPSV  *  TRPD
       R(3,1)  =  SOPP  *  SOPR
       R(4,1)  =  SVSE  *  SREE
       R(5,1)  =  SVSC  *  SSCK
       R(6,1)  =  (WPRC  *  0.5)  *  SURB
C *** CALCULATE FUEL AND ENERGY COSTS, DOLLARS PER DAY, FOR COAL, WOOD
C ***  FUEL, NATURAL GAS, ELECTRICAL ENERGY:
       VC(1,1)  =  CPRC  *  QCOL
       VC(2,1)  =  WPRC  *  QWOD
       VC(3,1)  =  PPKF  *  TKFR
       VC(4,1)  =  PKWH  *  PERQ
C *** CALCULATE PULPWOOD AND RECYCLED FIBER RAN MATERIAL COSTS, DOLLARS
C *** SOFTWOOD ROUNDWOOD, HARDWOOD ROUNDWOOD, SOFTWOOD 'CLEAN' CHIPS,
C *** HARDWOOD "CLEAN" CHIPS, SOFTWOOD WHOLE-TREE CHIPS, HARDWOOD WHOLE
C *** TREE CHIPS, RECYCLED OLD CORRUGATED, AND RECYCLED PAPER:
       VC(5,1)  =  PSRW  *  CDSW
       VC(6,1)  =  PHRW  *  CDHW
       VC(7,1)  =  PSPC  *  SCCW
       VC(8,1)  =  PHPC  *  HCCW
       VC(30,1)  =  PSWC  *  SWCW
       VC(31,1)  =  PHWC  *  HWCW
       VC(32,1)  =  PCOR  *  RCRT
       VC(33,1)  =  PPAP  *  RPPT
C *** CALCULATE COSTS OF ADDITIVES IN STOCK PREPARATION, DOLLARS PER
C *** DAY, FOR ALUM, SULFURIC ACID STARCH, DEFOAMER, ROSIN, SLIMICIDE:
       VC(9,1)   =  PALM  *  TALM
       VC(10,1)  =  PACD  *  TACD
       VC(11,1)  =  PSTC  *  TSTC
       VC(12,1)  =  PDFM  *  TDFM
       VC(13,1)  =  PRSN  *  TRSN
       VC(14,1)  =  PSLM  *  TSLM
C *** CALCULATE COSTS OF MAKE-UP AND RECLAIM CHEMICALS FOR KRAFT
C *** PROCESS, DOLLARS PER DAY, FOR SALTCAKE, LIME, CAUSTIC SODA FOR
C ***  SALTCAKE RECLAIM:
       VC(15.1)     = PPSC * PSCR
       VC(16,1)     = PPLM * PLRQ
       VC(17,1)     = PCAS * CSDS
C *** CALCULATE COSTS OF OTHER MISCELLANEOUS CHEMICALS, DOLLARS PER
C *** DAY, FOR COOLING TOWER, BOILER FEEDWATER, MILL WATER TREATMENT,
C ***  EFFLUENT TREATMENT:
       VC(18,1)     = CCTC * PPRD
       VC(19.1)     = CFWC * PPRD
       VC(20,1)     = PWCH * TWTC
       VC(21.1)     = PETC * TETC
C *** CALCULATE OTHER VARIABLE COSTS, DOLLARS PER DAY, FOR ROLL COVERS,
C *** WIRES, WET FELTS, DRYER FELTS, MILL WATER SUPPLY:
       VC(22,1)     = RCST * PPRD
       VC(23,1)     = WCST * PPRD
       VC(24,1)     = WFCS * PPRD
       VC(25,1)     = DFCS * PPRD
       VC(26,1)     = PWTR *     (TMWR/1000.0)
C *** CALCULATE LAROR COSTS, DOLLARS PER DAY, FOR PROCESS LABOR, NON-
C *** PROCESS LABOR, AND MAINTENANCE:
       VC(27,1)     = PSLB * PLWG *  8.0
       VC(28,1)     = EXLR * EXWG *  8.0
       VC(29,1)     = AMLB * AMWG *  8.0
C *** CALCULATE REVENUES IN DOLLARS PER TON OF PRODUCT AND PER YEAR:
       DO 2 I =  1,6
       R(I,2)    =  R(I,1)/PPRD
       R(I.3)    =  R(I.1)   *   DPYR
   2   CONTINUE
C *** CALCULATE COSTS IN DOLLARS PER TON OF PRODUCT AND PER YEAR:
       DO  3  I=1,33
       VC(I.2)   =   VC(I.1)/PPRD
       VC(I,3)   =   BC(I,1)   *   DPYR
   3   CONTINUE
C  *** ASSIGN    PRICE-PER-UNIT-OF-BARIABLE    INPUT    DATA:
       R(1,4   =   SVAL
       R(2,4)  =   TPSB
       R(3,4)  =   SOPP
       R(4,4)  =   SVSE
       R(5,4)  =   SVSC
       R(6,4)  =   WPRC  *  0.5
       VC(1,4)  =  CPRC
       VC(2,4)  =  WPRC
       VC(3,4)  =  PPKF
       VC(4,4)  =  PKWH
       VC(5,4)  =  PSRW
       VC(6,4)  =  PHRW
       VC(7,4)  =  PSPC
       VC(8,4)  =  PHPC
       VC(9,4)  =  PALM
       VC(10,4)  =  PACD
       VC(11,4)  =  PSTC
       VC(12,4)  =  PDFM
       VC(13,4)  =  PRSN
       VC(14,4)  =  PSLM
       VC(15,4)  =  PPSC
       VC(16,4)  =  PPLM
       VC(17,4)  =  PCAS
       VC(20,4)  =  PWCH
       VC(21,4)  =  PETC
       VC(26,4)  =  PWTR
       VC(27,4)  =  PLWG
       VC(28,4)  =  EXWG
       VC(29,4)  =  AMWG
       VC(30,4)  =  PSWC
       VC(31,4)  =  PHWC
       VC(32,4)  =  PCOR
       VC(33,4)  =  PPAP
       WRITE   (6,10)
  10   FORMAT ('1',5C,'R E V E N U E S, C O S T S, P R O F I T C O
      * N T R I B U T I O N'///)
       WRITE (6,20)   (R(I,4),R(I,1),R(I,2)),R(I,3),I=1,3)
  20   FORMAT ('0',51X,'$/DAY'',3X,'$/DRY TON',3X,'$-ANNUAL'//1X,'REVENUES
      *'//1X,'PAPERBOARD      PRODUCT      (@       $',F6.2,'/DRY       TON)',9X,F10.0,F9.2,
      *F12.0/1X,
      *'TURPENTINE           (@          $',F6.2,'/GALLON)',10X,F10.0,1X,F8.2,
      *F12.0/
      *1X,'TALL OIL SOAP          (@          $',F6.2,'/TON)',3x,10x,F10.0,1x,F8.2,
      *F12.0)
       IF   (SREE.GT.0.1)    WRITE    (6,30)    R(4,4),R(4,1),R(4,2),R(4,3)
  30   FORMAT  ('  ','SURPLUS COGEN. ELECTRIC (@    $',F6.3,'/KWH)',9X,F10.0,
      *1X,F8.2,F12.0)
       IF   (SSCK.GT.0.1)    WRITE    (6,40)    R(5,4),R(5,1),R(5,2),R(5,3)
  40   FORMAT  ('  ','ECESS  RECLAIM  SALTCAKE  (@    $',F6.2,'/TON)',9X,F10.0,
      *1X,F8.2,F12.0)
       IF   (SURB.GT.0.1)    WRITE    (6,50)    R(6,4),R(6,1),R(6,2),R(6,3)
  50   FORMAT  ('  ','SURPLUS WOOD FUEL (@ 1/2 FUEL PRICE,$'F6.2,'/TON)',
      *1X,F10.0,1X,F8.2,F12.0)
       DO  55  I-1,3
       R(7,I)  =  R(1,I)  +  R(2,I)  +  R(3,I)  +  R(4,I)  +  R(5,I)  +  R(6,I)
  55   CONTINUE
       WRITE     (6,56)     R(7,1),R(7,2),R(7,3)
  56   FORMAT   ('0'/5X,'TOTAL  REVENUES',30X,F10.0,F9.2,F12.0)
       WRITE   (6,60)
  60   FORMAT   ('0',3(/),1X'PULPWOOD  COSTS'/)
       IF   (CDSW,GT.0.0001)   WRITE   (6,57)   VC(5,4),VC(5,1),VC(5,2),VC(5,3)
       IF   *CDGWM,GT,0,0001)   WRITE   (6,58)   VC(6,4),VC(6,1),VC(6,2),VC(6,3)
  57   FORMAT('  ','SOFTWOOD  ROUNDWOOD  (@  $',F6.2,'/CORD)',13X,F10.0,
      *F9.2,F12.0)
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   58  FORMAT('  ','HARDWOOD  ROUNDWOOD  (@  $',F6.2,'/CORD)',13X,F10.0,
      *F9.2,F12.0)
       IF    (SCCW.GT.0.01)    WRITE(6,61)    VC(7,4),VC(7,1),VC(7,2),VC(7,3)
       IF    (HCCW.GT.0.01)    WRITE(6,62)    VC(8,4),VC(8,1),VC(8,2),VC(8,3)
       IF    (SWCW.GT.0.01)    WRITE(6,63)    VC(30,4),VC(30,1),VC(30,2),VC(30,3)
       IF    (HWCW.GT.0.01)    WRITE(6,64)    VC(31,4),VC(31,1),VC(31,2),VC(31,3)
       IF    (RCRT.GT.0.01)    WRITE(6,65)    VC(32,4),VC(32,1),VC(32,2),VC(32,3)
       IF    (RPPT.GT.0.01)    WRITE(6,66)    VC(33,4),VC(33,1),VC(33,2),VC(33,3)
   61  FORMAT('  ','"CLEAN"  SOFTWOOD  CHIPS  (@  $',F6.2,'/TON)',10X,
      *  F10.0,F9.2,F12.0)
   62  FORMAT('  ',"CLEAN"  HARWOOD  CHIPS  (@  $',F6.2,'/TON)',10X,
      *  F10.0,F9.2,F12.0)
   63  FORMAT('  ','SOFTWOOD  WHOLE-TREE  CHIPS  (@  $',F6.2,'/TON)',7X,
      *  F10.0,F9.2,F12.0)
   64  FORMAT('  ','HARDWOOD  WHOLE-TREE  CHIPS  (@  $,F6.2,'/TON)',7X,
      *  F10.0,F9.2.F12.0)
   65  FORMAT('  ','RECYCLED  CORRUGATED  (@  $',F6.2,'/TON)',13X,
      *  F10.0,F9.2,F12.0)
   66  FORMAT('','RECYCLED  PAPER  (@  $',F6.2,'/TON)',18X,
      *  F10.0,F9.2,F12.0)
       WRITE  (6,70)      (VC(I,4),VC(I,1),VC(I,2),VC(I,3),I-27,29)
   70  FORMAT  ('0',3(/),1X,'LABOR  COSTS'//
      *1X,'PROCESS  LABOR          (@    $',F6.2,'/HR.)',15X,F10.0,1X,F8.2,F12.0/
      *1X,'NON-PROCESS  LABOR     (@    $',F6.2,'/HR.)',15X,F10.0,1X,F8.2,F12.0/
      *1X,'MAINTENANCE  LABOR     (@    $',F6.2,'/HR.)',15X,F10.0,1X,F8.2,F12.0/
       WRITE       (6,80)        (VC(I,4),VC(I,1),VCI,2),VC(I,3),I=1,3
   80  FORMAT  ('0',3(/),1X,'FUEL  AND  ENERGY  COSTS'//
      **1X,'COAL          (@       $',F7.2,'/TON)',22X,F10.0,1X,F8.2,F12.0/
      *1X,'WOOD FUEL    (@       $',F7.2,'/TON),12X,10X,F10.0,1X,F.2,F13.0/
      *1X,'NAT.GAS       (@       $',F7.2,'MCF)',12X,10X,F10.0,1X,F8.2,F12.0)
       IF   (PERQ.GT.0.1)   WRITE   (6,90)   VC(4,4),VC(4,1),VC(4,2),VC(4,3)
   90  FORMAT  ('  ','PURCHASED  ELECTRIC  (@  $',F6.3,'/KWH)',14X,F10.0,1X,
      *F8.2,F12.0)
       WRITE       (6,100)       (VC(I,4,VC(I,1),VC(I,2),VC(I,3),I=15,17)
  100  FORMAT  ('0',3(/),1X'MAKE-UP  AND  SALTCAKE  RECLAIM  CHEMICAL  COSTS'/
      */1X,'SALTCAKE  MAKE-UP           (@        $'F6.2,'/TON)',8X,F10.0,1X,
      *F8.2.F12.0/
      *1X,'LIME  MAKE-UP               (@    $',F6.2,'/TON)',8X,F10.0,1X,
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       =====  MAIN  =====

C *** THIS IS THE MAIN SUBROUTINE FOR THE LINERBOARD PROGRAM.
C
       COMMON/ALL/CAOX,CDHW,COSN,COGN,CPRC,CSDS,HBRK,HCCW,HWCW,HRFR,
      *  HSRB,NX,PACD,PALM,
      *PCAS,PCOR,PDFM,PERQ,PETC.PHPC,PHWC,PSWC,PHPW,PKWH,PLRQ,PPAP,
      *  PPKF,PPLM,PPRD,PPSC,PPWD,PROD,PRSN,PSCR,PSLM,PSPC,PSRW,PSTC,
      *PWCH,PWTR,QCOL,QWOD,RCRT,RPPT,
      * SBRK,SCLS,SHDM,SOPP,SOPR,SCCW,SWCW,SREE,SRFR,SSCK,SURB,SVAL,SVSC,
      *    SVSE,TACD,TALM,TBLS,TDAA,TDFM,TEED,TETC,TKFR,TMWR,TPSV,TRPD,
      *TRSN,TSLM,TSTC,TWLP,TWLV,TWRD,TWTC,WPRC,WRCN,WREV
C
       DIMENSION  TITL(80)
C *** READ IN TITLE SHEET OF OUTPUT
       READ    (5,10)    (TITL(I),I=1,80)
   10  FORMAT (20A4)
C *** WRITE TITLE AT TOP OF OUTPUT
       WRITE    (6,20)    (TITL(I),I=1,80)
   20  FORMAT       (1H1,20(/),4(25X,20A4//))
C *** READ IN SPECIFICATION FUR VARIOUS OUTPUTS
       READ  (5,30)  NX
   30  FORMAT  (/I2///)
C
C *** CALL OTHER SUBROUTINES
C
       CALL STPREP
       CALL  DIG
       CALL WDPREP
       CALL RECBLR
       CALL WATER
       CALL ELEC
       CALL STEAM
       CALL PWRBLR
       CALL SALES
       STOP
       END
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