BIOLOGICAL CONVERSION OF ORGANIC REFUSE TO METHANE, VOLUME II

FINAL REPORT
Covering the period July 1, 1973 to November 30, 1976

by

Gerald E. Quindry
Jon C. Liebman
John T. Pfeffer

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Department of Civil Engineering
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

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APPENDIX C COMPUTER PROGRAMS AND DOCUMENTATION

This appendix contains detailed information on the simulation model. It is divided into five major sections; logic flow and notes, simulation results, definition of major program variables, program listing, and sample output. The section on simulation results includes an analysis of the system under various operating conditions. The program has been implemented on the University of Illinois D&C-10 system.

1. Logic Flow and Notes

1.1 Main Program Logic Flow

The overall structure of the program is shown in Figure C-1. The main program is divided into two parts in order to facilitate separate analyses of the "front-end" and "back-end" sub-systems and to help insure accommodation to time-sharing systems.

The first section of the main program is called ENERGY and the second section is named REFUSE. ENERGY includes the subprograms SOURCE, STORE, SIZE, SCRBBN, SEPARA, CAUST and SEWAGE (see Figure C-2). The output from SEWAGE as well as other information to be used in REFUSE is written in a disc file named TEMP and read from the same file at the beginning of the second section. Six unit processes are included in REFUSE. They are DIGEST, GCLEAN, dewatering (VACFIL or CENTR), INCIN, HAUL and LANDFIL (see Figure C-3). The summary for the "front-end" subsystem is given at the beginning of REFUSE and the one for the entire system is given in the subprogram SUMMARY at the end of REFUSE.

1.2 Notes on Main Program

ENERGY

The first program (ENERGY) is constructed for a refuse flow rate of 1000 tons/day, and will not provide correct costs for other flow rates. However, a rather crude scaling routine at the beginning of the second program (REFUSE) provides information on various front-end parameters and costs for any desired flow rate other than 1000 tons/day. The option statements provided in ENERGY include:

- (1) Input options
- (2) Output options, and
- (3) Subprogram inclusion and exclusion options.

The input options provide the ability either to use data stored within the program, or to use data input from the terminal. The output options permit printing out, either on the time-sharing terminal or on a line printer, all output information, or selective data and summary. The subprogram options allow inclusion or omission of some optional processes within the treatment chain. Those constants or variables which are used in each of the subprograms are placed in a common block and are initialized if necessary in ENERGY by assignment statements. For the purpose of consistency in mass balance some of the variables are redefined in the main program between subprogram call statements.

Figure C-1. Overall Structure of Computer Program

MAIN 1 (ENERGY)

Figure C-2. Overall Structure of Main 1 (ENERGY)

MAIN II (REFUSE)

Figure C-3. Overall Structure of Main II (REFUSE)

REFUSE

All the option statements except those not applicable are valid in REFUSE as in ENERGY. They can, however, be changed within REFUSE if desired. For a refuse flow rate other than 1000 tons/day, an approximation scheme is provided at the beginning of REFUSE for all of the major "front-end" parameters stored in file TEMP. A linear scaling is performed on mass and energy balance parameters and an exponential rule with an exponent of 0.6 is applied for cost parameters (Perry, 1973). There are two interim files called DFILE and IFILE besides the previously mentioned file, TEMP. DFILE accepts output information from the subprogram DIGEST and stores it to allow multiple analyses in processes following it. Output information from either of the dewatering subprograms is stored in IFILE, and multiple analyses can be performed on processes following it also.

The subroutine for incineration of residue (INCIN) is one of the routines which can be omitted from a run. If INCIN is not used, the filter cake solids are landfilled along with residues from screening and separation. If INCIN is used, the ash from the incinerator is hauled with the other residues instead of the dewatered cake.

1.3 Subprograms

SOURCE: Determines initial mass flow values

A. Logic Flow

The basic structure of SOURCE is shown in Figure C-4. The characteristics and quantity of refuse and sewage are contained in the program, but may be changed by selecting the input option.

Population (571,400) is given so as to provide the refuse flow rate of 1000 tons/day, based on a given per capita refuse generation rate (3.5 lbs/cap/day), and the sewage sludge quantity is calculated based on per capita BOD and SS contribution as well as primary and secondary treatment efficiencies. The fixed solids portion of the refuse stream is further classed into metal, glass, plastics, ash and fixed solids moisture. The energy content of both refuse and sewage sludge is also calculated here.

B. Notes

(1) Moisture content

$$CFMOIS = CRFSMO / (CRPLAS + CRASH) \quad (C-1)$$

$$CVMOIS = CRVSMO / CRVS \quad (C-2)$$

Fixed solids moisture content (CRFSMO) is defined as the weight of moisture in the fixed solid portion of the unit refuse weight. Volatile solids moisture content (CRVSMO) is defined as the weight of moisture in the volatile solid portion of the unit refuse weight.

Fixed solids moisture ratio (CFMOIS) is defined as the ratio of fixed solids moisture content to the combined weight of plastics and ash in the refuse weight (CRPLAS + CRASH), and volatile solids

Figure C-4. Flow Sheet of Subprogram SOURCE

moisture ratio (CVMOIS) is defined as the ratio of volatile solids moisture content to the volatile solids portion of the unit refuse weight (CRVS). See also (4) of this section.

(2) Refuse quantity

$$TWREF = POP * PCDREF * (1./24.) \quad (C-3)$$

Equation (C-3) calculates the quantity of refuse generated by the given population (POP) at the per capita daily refuse generation rate (PCDREF).

(3) Sewage sludge quantity

$$PSEDTS = PCDSS * POP * PEPSS * (1./24.) \quad (C-4)$$

$$SSEDTS = PCDBOD * POP * (1.-PEPBOD) * SSBODR/24. \quad (C-5)$$

$$TWDSS = PSEDTS + SSEDTS \quad (C-6)$$

Sewage sludge quantity is estimated by adding primary treatment solids generated (PSEDTS) and secondary treatment solids generated (SSEDTS) as shown in Equation (C-6). PSEDTS is calculated by Equation (C-4) which multiplies per capita SS (PCDSS), POP and treatment efficiency in respect to SS in the primary tank (PEPSS). SSEDTS, on the other hand, is calculated based on the SS-BOD ratio in secondary treatment. It can be obtained by multiplying POP, per capita BOD (PCDBOD), residual efficiency in the primary tank (1.-PEPBOD) and SSBODR as shown in Equation (C-5).

(4) Fixed solids moisture content

Of the four major fixed solids components (metals, glass, plastics and ash) the latter two are assumed to contain moisture within themselves. Therefore, FMOIS (fixed solids moisture in lbs/hr) is calculated as shown in Equation (C-7).

$$FMOIS = CFMOIS * (RPLAS + RASH) \quad (C-7)$$

where CFMOIS is the fixed solids moisture ratio (lbs/lb). FMOIS is not included in the moisture separable from volatile solids.

(5) Sewage sludge energy

Sewage sludge energy content is calculated based on the following equation as shown by Metcalf and Eddy, Inc. (1972).

$$SHV = A * (CSVS * 100. - B) \quad (C-8)$$

where

SHV = sludge heat value - BTU/lb total solids

CSVS = sludge volatile solids concentration - lbs/lb

A, B = constants

The total energy in the sewage sludge (TBTUS) is

$$TBTUS = SHV * TWDSS \quad (C-9)$$

where

$7WDSS$ = quantity of dry solids in sewage sludge - lbs/lb.

STORE: Calculates required refuse storage and energy and the cost of the storage facility.

A. Logic Flow

The program basically consists of cost calculations and energy calculations.

(1) Capital Cost

Capital costs of facilities and equipment for most of the "front-end" subprograms are based on National Center for Resource Recovery, Inc. (NCRR, 1974).

An appropriate cost index ratio (STCI) based on EPA's Treatment Plant and Sewer Construction Cost Index is applied to bring the costs to July 1975.

(2) Amortization

All costs are amortized to an hourly cost by multiplying the capital costs by the capital recovery rate (CRR) and dividing by (360. * 24.). One year is taken to be 360 working days of 24 hour duration.

$$CRR = XINT / (1. + XINT) ** (-DLIFE) \quad (C-10)$$

where

$XINT$ = interest rate

$DLIFE$ = design life - years

(3) Operation and Maintenance costs (OMC)

Rather than calculating OMC by means of individual itemization, a uniform OMC/capital amortized ratio of 0.2 is assumed (NCRR, 1974)

(4) Energy calculations

Energy calculations are based on the major power requirements on the given system. For example, the energy consumed by the front-end loader is calculated as follows:

$$FENDE = PFEND * C10 \quad (C-11)$$

where

$FENDE$ = front-end loader energy consumption - BTU/hr

$PFEND$ = front-end loader power requirement - HP

$C10$ = conversion factor from horsepower to BTU/hr

(5) Cumulative energy and costs (common to all other subprograms)

Cumulative energy and cost computations are based on the following categorization:

TSTUA = Total theoretical energy available in the form of refuse, sewage sludges or slurry mixture present in the process - BTU/hr

TBTUC = Total cumulative energy consumed - BTU/hr

THCCA = Total cumulative capital cost amortized - \$/hr

THOMC = Total cumulative operating and maintenance cost - \$/hr

TCC = Total capital investment - \$

SIZE, SCREEN, SEPARA, CAUST, AND SEWAGE

SIZE: Calculations for size reduction

SCREEN: Calculations for screening

SEPARA: Calculations for material separation

CAUST: Calculations for caustic treatment

SEWAGE: Calculations for mixing sewage sludge

A. Logic Flow

The basic flow of each of these programs is the same, and it is shown in Figure C-5.

B. Notes

(1) Removal Efficiencies

Removal efficiencies of refuse components in screening, magnetic separation and air classification are taken from Dynatech (1973).

(2) Mass Balance

Reduction in quantity of refuse occurs in subprograms SCREEN and SEPARA. Proper mass balance is performed in each of the subprograms and in part of the main program. Addition of caustic solution in subprogram CAUST and addition of sewage sludge in subprogram SEWAGE also require mass balance to compute the amount of slurry mixture to be fed in DIGEST.

(3) Energy Balance

The caustic treatment energy requirement is calculated from the heat necessary to increase the temperature of the slurry from ambient temperature to 266 degrees F. An additional fraction of this

Figure C-5. Basic Flow Sheet of Front-end Subprograms

amount is added to allow for heat loss during the process. A specific heat constant of 0.25 is assumed for the slurry solids.

$$THCAUS = (1. + HMAIN) * 198. * (SLMOIS + .25 * DRY) \quad (C-12)$$

where

THCAUS = Heat required for caustic treatment - BTU/hr

HMAIN = Allowance for heat loss

SLMOIS = Slurry moisture - lbs/hr

DRY = Slurry solids - lbs/hr

(4) Caustic treatment capital cost

The capital cost of the caustic treatment tanks (THKCC) is based on a tankage unit cost of \$150,000. per 15,000 gallon stainless steel tank (installed cost). The number of tanks required (NTNK) is based on an experimentally determined volume requirement for one pound of mixture (PB) and an estimate of the time required for a tank to be filled, heated, cooled sufficiently for opening, and emptied (TOVER).

DIGEST: Calculations for anaerobic digester

A. Logic Flow

The digester subroutine begins by accepting input values of the following design parameters:

- (1) Temperature in digester, degrees C (T)
- (2) Nominal detention time, days (DT)
- (3) Solids concentration in feed, % by weight (SCIN), and
- (4) Recycle fraction, % (RECYCL).

Calculations of specific weights (SWDS = specific weight of dry solids, SWSL = specific weight of slurry) are followed by calculation of total digester volume required on the basis of feed rate and detention time (line 117000). An empirical procedure is used to determine the number of digesters (NV) and the volume of each digester (VD) in such a way that a minimum detention time is always maintained. (lines 117100-119100; See Note 1).

These preliminary and design calculations are followed by interpolation of the fraction of volatile solids destroyed (PVSD) using empirical data. If caustic treatment is included, this fraction is increased in subroutine DESROI (called in line 121675). Because of the limited amount of data available, the volatile solids destruction with caustic treatment is only applicable at a digester temperature of 50 degrees C. Interpolation of Henry's constant (HK), the bicarbonate equilibrium constant (K1), the partial pressure of water vapor (VP) and the recycled alkalinity (ALKREC) follow in lines 121700-122910.

Calculations based on the carbon dioxide-bicarbonate-pH equilibrium system are performed in lines 123000 through 129400. These calculations determine total carbon dioxide produced (CO2T),

bicarbonate alkalinity (BICO), gaseous carbon dioxide (CO₂G), and aqueous carbon dioxide (CO₂S), all in moles/liter; carbon dioxide and methane gas production in cubic feet per hour (CO₂GCH and CH₄CH); lime requirement and cost (CAOH₂ and CAOH₂C); and equilibrium pH (H). See note 2 for the derivation of these equations.

Capital cost of the digester (TCCD) is determined in lines 125400 through 126300 and this cost is reduced to an hourly cost (TCCDA) in line 126400 (see note 3). The heat value and income from the methane (CH₄BTU and CH₄BEN) are calculated in lines 126600 and 126700. Mass balance information is calculated in lines 126800 through 127600. Required mixing energy is calculated in lines 127700 through 127900 followed by calculation of heat requirements in the reactor (see notes 4 and 5). Finally, summary energy and economic data are calculated and output is provided.

B. Notes on Digester Program

(1) Number of Digester Units

The number of digesters is chosen in such a way that even with one of the units being out of service the detention time will never be less than the set minimum. This will prevent poor performance in digestion when one of the units fails.

Table C-1

Total Number of Digesters Required	
Total Volume Required (cf)	Total Number of Digesters
0 to 130,000	2
130,000 to 500,000	3
500,000 to 1,250,000	4
1,250,000 to 1,700,000	5
1,700,000 to 2,000,000	6
Above 2,000,000	7

(2) Formulae for carbon dioxide-bicarbonate-pH equilibrium system.

The fermentation of refuse produces gaseous end products in the form of methane and carbon dioxide. If the chemical composition of the refuse is known, the composition of these end products can be calculated. Detailed characterization of urban refuse has shown that the majority of the material which can be digested is cellulose. With this assumption, the following equation shows that equal moles of methane and carbon dioxide are produced from cellulose fermentation.

This equation also shows that 162 grams of cellulose will yield 3 moles of carbon dioxide plus 3 moles of methane. Therefore, the total gas produced can be calculated from volatile solids destroyed in the reactor.

The volatile solids destruction per liter of digester volume can be computed with the following equation:

$$VSD = SCIN * CVS * (PVSD/100) * 1000 / DT \quad (C-14)$$

where

SCIN = digester feed slurry solid concentration - lbs/lb

CVS = volatile solids in feed - lbs/lb

PVSD = volatile solids destroyed - (%)

DT = detention time - days

VSD = grams of volatile solids destroyed per liter of digester per day

The values of PVSD were obtained experimentally, and are shown in Table C-2. Based on the assumption that the destruction of volatile

Table C-2

Fraction of Volatile Solids Destroyed (%)

without caustic pretreatment								
Temp / Days: degrees \								
C /	4	6	8	10	15	20	30	
35 /	16.5	26.4	28.6	29.8	32.0	32.7	34.0	
40 /	31.0	33.6	35.7	36.8	39.0	39.9	40.7	
45 /	26.7	29.0	31.2	32.3	34.1	35.4	36.4	
50 /	34.9	38.6	41.0	42.2	44.2	45.4	46.1	
55 /	40.4	42.6	44.5	45.2	47.2	48.2	49.1	
60 /	41.9	46.6	48.3	49.6	50.8	51.8	52.4	
with caustic pretreatment								
Temp / Days: degrees \								
C /	3	5	7.5	10				
60 /	47.1	51.6	56.3	57.4				

solids results from cellulose digestion, a volatile solids destruction of 162 grams will produce 3 moles of carbon dioxide and 3 moles of methane. The total carbon dioxide and methane production per liter of digester per day is given by Equation (C-15).

$$[\text{CO}_2]_T = [\text{CH}_4]_T = 3 * \text{VSD} / 162 \quad (\text{C-15})$$

Combining Equations (C-14) and (C-15) yields Equation (C-16).

$$[\text{CO}_2]_T = [\text{CH}_4]_T = 3000 * \text{SCIN} * \text{CVS} * \text{PVSD} / (162 * \text{DT}) \quad (\text{C-16})$$

Not all of the carbon dioxide produced is discharged as a gas. Carbon dioxide is relatively soluble and also reacts with the water to produce carbonic acid as shown in Equation (C-17).

Carbonic acid dissociates readily to form a hydrogen ion and bicarbonate.

The degree of dissociation is pH dependent and is controlled by the equilibrium constant shown in Equation (C-19).

$$K_1 = [\text{H}^+] * [\text{HCO}_3^-] / [\text{H}_2\text{CO}_3] \quad (\text{C-19})$$

The reaction between carbon dioxide and water is essentially complete and the concentration of carbon dioxide in solution is assumed equal to the concentration of bicarbonate. The dissociation constant for bicarbonate at various temperatures is given in Table C-3.

Table C-3

Effect of Temperature on K_1 of Carbonic Acid

Temp. degrees C	30	40	50	60
$K_1 \times 10^7$	4.9	5.04	5.13	5.19

Source: Handbook of Chemistry and Physics, 48th ed., CRC Publishing Co.

Other sources of alkalinity that must be included are the raw sewage sludge, the dilution water added to the digester, the recycled centrate (if recycle is used) and the alkalinity of the refuse stream itself. If caustic pretreatment of the refuse is employed, the alkalinity input with the refuse stream will be much higher than if the refuse is input without pretreatment.

The amount of sewage sludge alkalinity added is a function of (1) the ratio of dry sludge solids to dry refuse solids (2) the percent solids in the sewage sludge added to the digester feed and (3) the sludge alkalinity. This alkalinity divided by the detention time will yield the alkalinity per liter of digester contributed by the sewage sludge. This relationship is shown in Equation (C-20).

$$[\text{HCO}_3]_S = \text{ALKS} * \text{SCIN} * R / (100 * P * \text{DT}) \quad (\text{C-20})$$

where

$[\text{HCO}_3]_S$ = alkalinity - moles per liter of digester per day

ALKS = sewage sludge alkalinity - g/l as CaCO_3

P = sewage sludge solids concentration - lbs/lb

R = ratio of dry sludge solids to dry refuse solids

The alkalinity contributed by the dilution of the refuse stream down to the desired feed slurry concentration depends both on the amount of dilution required and the alkalinity of the liquid stream used for this purpose. Since the alkalinity of raw sewage (used for dilution because of the beneficial trace nutrients) and of the recycled centrate can differ by more than an order of magnitude, a weighted average is used for determining the alkalinity of the dilution water.

$$\text{ALKD} = \text{ALKW} * (1 - \text{RECYCL}) + \text{ALKREC} * \text{RECYCL} \quad (\text{C-21})$$

where

ALKD = alkalinity of dilution stream - g/l as CaCO_3

ALKW = alkalinity of sewage water - g/l as CaCO_3

ALKREC = alkalinity of recycled water - g/l as CaCO_3

Given the alkalinity of the dilution stream, the following equation calculates the alkalinity added from the dilution water per liter of digester per day.

$$[\text{HCO}_3]_D = \text{ALKD} / (100 * \text{DT}) \quad (\text{C-22})$$

where

$[\text{HCO}_3]_D$ = alkalinity - moles per liter of digester per day

Alkalinity is also contributed by the refuse. Experimental results show the refuse alkalinity to be equivalent to 1.5 g/l as calcium carbonate without caustic treatment and 4.0 g/l as calcium carbonate with caustic treatment. The amount of alkalinity added from the refuse is given by equation (C-23).

$$[\text{HCO}_3]_r = \text{ALKREF} / (100 * \text{DT}) \quad (\text{C-23})$$

The sum of equations (C-20), (C-22) and (C-23) yields the alkalinity added to the digester from external sources. The total alkalinity in the digester consists of this amount plus the carbon dioxide that is converted to bicarbonate as shown by Equations (C-17) and (C-18). The total carbon dioxide input into the system (both from external bicarbonate input and from the internal carbon dioxide production by the bacteria) is discharged as gaseous carbon dioxide and, in the liquid effluent, soluble carbon dioxide and alkalinity.

This relationship is shown in Equation (C-24).

$$[\text{CO}_2]_T = [\text{CO}_2]_g + ([\text{CO}_2]_s + [\text{HCO}_3] - \text{BICO}) / \text{DT} \quad (\text{C-24})$$

where

$[\text{CO}_2]_g$ = carbon dioxide in the gas phase - moles per liter of digester per day

$[\text{CO}_2]_s$ = soluble carbon dioxide - moles per liter of digester

BICO = external alkalinity introduced - moles per liter of digester per day

An equilibrium is established between the soluble carbon dioxide and bicarbonate alkalinity as shown in Equation (C-19). The equilibrium between the carbon dioxide in solution and that in the gas phase is controlled by Henry's Law, Equation (C-25).

$$P_{\text{CO}_2} = K_H X_{\text{CO}_2} \quad (\text{C-25})$$

where

P_{CO_2} = partial pressure of CO_2 - mm Hg

K_H = Henry's constant

X_{CO_2} = mole fraction of gas in solution

Values for Henry's constant are given in Table C-4.

Table C-4

Henry's Constant for Various Temperatures

Temp. degrees C	30	40	50	60
$K_H \times 10^7$	0.139	0.173	0.217	0.258

Source: Handbook of Chemistry and Physics, 48th ed., CRC Publishing Co.

The partial pressure of carbon dioxide can be closely approximated by assuming that the solvent contains only carbon dioxide and that the moles of carbon dioxide in solution are insignificant in calculating the moles of solution. Equation (C-26) shows the relationship between the partial pressure of carbon dioxide in atmospheres and soluble carbon dioxide in moles per liter.

$$P_{\text{CO}_2} = \frac{18 K_H * [\text{CO}_2]}{7.6 \times 10^5} = \frac{18 K_H * [\text{H}_2\text{CO}_3]}{7.6 \times 10^5} \quad (\text{C-26})$$

Combining Equations (C-19), (C-24) and (C-26) yields Equation (C-27) which has been solved for P_{CO_2} .

$$P_{CO_2} = \frac{18 K [H^+] (DT)}{7.6 \times 10^5 ([H^+] + K_H)} \left([CO_2]_T - [CO_2]_g + \frac{(BICO)}{DT} \right) \quad (C-27)$$

$$\text{Let } A = \frac{18 K_H [H^+] (DT)}{7.6 \times 10^5 ([H^+] + K_H)} \quad (C-28)$$

Since the digester is operated at atmospheric pressure, the sum of the partial pressures of the individual gases will equal one atmosphere. The gases that contribute to this pressure are methane, carbon dioxide and water vapor. Equation (C-29) presents this relationship where the partial pressures are in atmospheres.

$$1 = P_{CO_2} + P_{CH_4} + P_{H_2O} \quad (C-29)$$

The partial pressure of water vapor is a function of temperature as shown in Table C-5. The partial pressure of methane

Table C-5

Vapor Pressure of Water at Various Temperatures

Temp degrees C	30	35	40	45	50	55	60
Vapor Pressure mm HG	31.8	42.2	55.3	71.9	92.5	118.0	149.4

Source: Handbook of Chemistry and Physics, 48th ed., CRC Publishing Co.

is given by Equation (C-30) where n_{TG} (the moles of total gas per liter of digester) is simply the sum of the individual gases.

$$P_{CH_4} = \frac{[CH_4]_g}{n_{TG}} = \frac{[CH_4]_g}{[CO_2]_g + [CH_4]_g + [H_2O]_g} \quad (C-30)$$

Since methane is insoluble in water, $[CH_4]_T = [CH_4]_g$.

Also,

$$[H_2O]_g = P_{H_2O} (n_{TG}) \quad (C-31)$$

Therefore,

$$n_{TG} = (CO_2)_g + (CH_4)_g + P_{H_2O} (n_{TG}) \quad (C-32)$$

Combining Equations (C-27), (C-29), (C-30) and (C-32) and simplifying yields the following quadratic equation:

$$0 = A[CO_2]_g^2 + (1 - P_{H_2O} - \frac{A(BICO)}{DT}) [CO_2]_g - A([CO_2]_T^2 + \frac{(BICO)}{DT} [CO_2]_T) \quad (C-33)$$

Solving this equation for $[CO_2]$ will provide the quantity of CO_2 produced in the gas phase per liter of digester per day.

The mass balance of CO_2 as shown in Equation (C-21) indicates that the differences in $[CO_2]_T$ and $[CO_2]_S$ result from the washout of soluble carbon dioxide and bicarbonate that is the product of carbon dioxide reacting with hydroxide. Solving Equation (C-26) for soluble carbon dioxide yields Equation (C-34)

$$[CO_2]_S = \frac{7.6 \times 10^5}{18 K_H} P_{CO_2} \quad (C-34)$$

but

$$P_{CO_2} = \frac{[CO_2]_g}{n_{TG}} \quad (C-35)$$

Substituting Equation (C-34) for n_{TG} yields Equation (C-36)

$$[CO_2]_g = \frac{7.6 \times 10^5 (1 - P_{H_2O}) [CO_2]_g}{18 K_H ([CO_2]_T + [CO_2]_g)} \quad (C-36)$$

The hydroxide ion that must be added to the digester to maintain the specified pH depends upon the amount of CO_2 that reacts to form bicarbonate. This can be calculated from the mass balance of carbon dioxide.

$$[OH] = [CO_2]_T - [CO_2]_g - [CO_2]_S/DT + \frac{VACID}{(60 * DT)} - BICO \quad (C-37)$$

where

$[OH]$ = hydroxide required - moles per liter of digester per day

$VACID$ = volatile acid concentration - g/l

The total hydroxide required is calculated from Equation (C-38)

$$OH = \frac{(28.3) (17) [OH] (TVD)}{(453)} \quad (C-38)$$

where

OH = hydroxide required - lbs per day

TVD = digester volume - cu ft

If the calculated hydroxide requirement is negative, the specified pH of the digester is increased and the hydroxide requirement is recomputed. This is repeated until the hydroxide requirement becomes positive.

Gas production in terms of scf of dry gas per hour can be calculated from Equation (C-39)

$$G = ([CO_2]_g + [CO_2]_T) \left(\frac{22.4}{24} \right) (TVD) \quad (C-39)$$

The dry gas composition is given by Equation (C-40)

$$\% CH_4 = \frac{100 [CO_2]_T}{[CO_2]_g + [CO_2]_T} \quad (C-40)$$

(3). Capital cost of digester

Digester capital cost is calculated from data presented by Patterson and Banker (1971). The relationship shown in the graph on page 47 of that publication has been fitted with equations as follows:

- (a) For volumes (TVD) less than 50,000 cu ft:

Capital cost = \$165,000.

- (b) For volumes between 50,000 cu ft and 100,000 cu ft:

$$\text{Capital Cost} = (1.3) (TVD) + 100,000 \quad (C-41)$$

- (c) For volumes between 100,000 cu ft and 300,000 cu ft:

$$\text{Capital Cost} = (1.45) (TVD) + 85,000 \quad (C-42)$$

- (d) For volumes greater than 300,000 cu ft:

Let $V = TVD/100,000$

$$\text{Capital Cost} = (1000) (10^{0.987 \log v + 0.271}) \quad (C-43)$$

(4) Mixing energy required

Required mixing energy is assumed to be linear with volume and with digester solids concentration. Thus, the required horsepower is calculated by multiplying an empirical horsepower per cu ft by solids concentration and volume.

(5) Heating requirements

Heating requirements are made up of several components:

(a) Heatloss through digester walls is calculated by means of the following formula (Eckenfelder and O'Connor, 1961):

$$HL = \frac{(1.8) (A) (T - T_o)}{(1/PI + B/K + 1/PO)} \quad (C-44)$$

where

HL = heatloss - BTU/hr

A = area - sf

T = digester temperature - degrees C

T_o = ambient temperature - degrees C

PI = inside transmittance coefficient

PO = outside transmittance coefficient

B = length of heat flow path - inches

K = conductance coefficient for wall

Three separate equations of this type are used: one for walls, one for the roof, and one for the floor of the digester.

(b) Heat required to raise the temperature of the incoming slurry is calculated on the basis of an assumed incoming temperature and an assumed specific heat constant for solids in the slurry.

(c) Heatloss in water vapor is calculated by using the vapor pressure of water to determine the BTU loss per cubic foot of dry gas produced. This information is given in Table C-6. A regression fit of BTU/cf of dry gas has been made to obtain the following equation which is used in the program:

$$WHL = (0.0036634 G) \exp (0.105305 T) \quad (C-45)$$

where

WHL = heat loss in water vapor - BTU/hr

G = dry gas production - cf/hr

T = temperature - degrees C

(d) The total heat requirement is the sum of heatloss from the digester (HL), the heat required for the slurry (HR), and the water vapor heatloss (WHL). The actual heat requirement is calculated by subtracting the recycled heat (in the recycled centrate or filtrate) and the recovered caustic treatment heat from the total heat requirement.

Table C-6

Calculation of Water Vapor Heatloss

Temp. deg. C	Vapor Press. mm Hg	Heat of Vaporiz. BTU/lb	Specific Volume cf/lb	Volume Fraction %	Dry Gas Produced BTU/scf
35	42.175	1038.5	22.49	5.55	3.0615
36	44.563	1037.5	22.56	5.86	3.2402
38	49.692	1035.5	22.71	6.54	3.6348
40	55.325	1033.5	22.85	7.28	4.0716
42	61.50	1031.5	23.00	8.09	4.5549
44	68.26	1029.4	23.15	8.98	5.0941
46	75.65	1027.4	23.29	9.95	5.6956
48	83.71	1025.3	23.44	11.01	6.3633
50	92.51	1023.2	23.64	12.17	7.0958
52	102.09	1021.1	23.73	13.43	7.0477
54	112.51	1019.1	23.88	14.80	8.8795
56	123.80	1017.1	24.02	16.29	9.9304
58	136.08	1015.1	24.17	17.91	11.1097
60	149.38	1013.1	24.32	19.66	12.4343

(6) Maintenance Cost for Digestion

Digester maintenance cost is assumed to be 1 percent of the total installed costs per year. Power costs are not included (line 126500).

(7) Nutrient Requirements

The amount of nitrogen required as a nutrient for digestion was determined experimentally as follows. The ammonia in the effluent from the reactor contains 0.3 to 0.4 g/l ammonia nitrogen. Therefore, the nitrogen lost in the effluent per day is:

$$0.35 \text{ g/l} \times 10 \text{ gal/day} \times 3.78 \text{ l/gal} \times 1 \text{ lb/453 g} = 0.03 \text{ lbs/day} \quad (\text{C-46})$$

If 107.5 g of ammonium chloride are added per day, the nitrogen added is:

$$107.5 \text{ g/day} \times (14 \text{ g N}) / (53 \text{ g NH}_4\text{Cl}) \times 1 \text{ lb/453 g} = 0.0627 \text{ lbs/day} \quad (\text{C-47})$$

Also, 2.5 liters of raw sewage sludge at about 3 percent solids were added daily to the reactor. The weight of the dry sludge solids is 75 g/l. These solids are about 5 percent nitrogen, so an additional 3.75 g (0.008 lbs) of nitrogen is obtained from the sludge. Therefore, the nitrogen required is:

$$0.0627 + 0.008 - 0.03 = 0.04 \text{ lbs/day} \quad (\text{C-48})$$

Since this is for a feed of 5 lbs dry solids feed to the digester, the nitrogen required would be 0.008 lbs per lb of dry solids feed to the digester, or 16 lbs per ton. This does not take into account the nitrogen that is in the refuse or that might be recycled in the centrate or filtrate. Based on this information the following calculations are performed:

$$\begin{aligned} \text{NIT} &= \text{UNIT} \times \text{SLTS} - \text{CSLNIT} \times (\text{SVS} + \text{SFIK}) - \\ &\quad \text{H2OREC} \times \text{HBCNIT} - \text{REFTS} \times \text{REFNIT} \end{aligned} \quad (\text{C-49})$$

where

NIT = nitrogen to be supplemented - lbs/hr

UNIT = lbs of nitrogen required per lb of slurry
solids (0.008) - lbs/lb total solids

SLTS = total slurry solids - lbs/hr

CSLNIT = concentration of sewage sludge nitrogen (0.005) -
lbs/lb

SVS = sewage sludge volatile solids - lbs/hr

SFIK = sewage sludge fixed solids - lbs/hr

H2OREC = quantity of water recycled - lbs/hr

REC NIT = concentration of nitrogen in recycle stream - lbs/lb

REF T S = weight of refuse - lbs/hr

REF NIT = nitrogen concentration in refuse - lbs/lb

The phosphorus requirement is assumed to be one-fifth of the nitrogen requirement. Both nitrogen and phosphorus are assumed to cost \$300 per ton as nitrogen and phosphorus, respectively (lines 125000 - 125300).

GCLEAN: Calculations for Gas Cleanup

This section is based on Dynatech (1973)

A. Logic Flow

Since the gas generated in digesters contains both carbon dioxide and methane, a separation step for obtaining pure methane is required. The process essentially consists of an absorber containing lean monoethanolamine (MEA), which, after contact, absorbs practically all the carbon dioxide (as well as hydrogen sulfide) from the gas stream. The spent MEA must be regenerated with sufficient heat to strip off acid gases for continual use. A portion of the MEA circulated must be replaced to maintain the purity of the solution.

B. Notes on Gas Cleanup Program

(1) Amount of MEA Solution Circulated

Since 1.5 moles of MEA are required to remove a mole of carbon dioxide, the weight of MEA circulated per hour (WMEAC) is

$$WMEAC = (CO2GCH/359.) * 1.5 * MWMEA \quad (C-50)$$

where

CO2GCH = carbon dioxide generated by digester - cf

MWMEA = molecular weight of MEA (61.08)

MEA is circulated as a 20 percent solution in water, so the amount of MEA solution is determined as follows:

$$SMEAC = (WMEAC/0.2) * (1./8.34) \quad (C-51)$$

where

SMEAC = Amount of MEA solution circulated - gallons/hr

(2) Steam requirement and its heat value

It is estimated that 1.1 pounds of steam (300 degrees F) are required for the heat treatment of a gallon of MEA circulated. The existing acid gas temperature is assumed to be 120 degrees F.

Therefore the heat required for spent MEA is

$$HVGC = 1.1 * SMEAC * (SPHWV * (300 - 212) + LATWT * 212 - 120) \quad (C-52)$$

where

HVGC = Heat required for gas clean-up - BTU/hr

SPHWV = Specific heat of water vapor (0.5)

LATWT = Heat of vaporization of water (1050) - BTU/lb

(3) Capital cost of MEA system

The capital cost of the MEA plant including the dehydration system is given as

$$MEACC = 1132000. * ((GASCH/359. * 2000.)/350.))^{0.5} \quad (C-53)$$

where

MEACC = Capital cost in 1973 dollars

(4) Maintenance costs for Gas Cleanup

It is assumed that an annual maintenance cost equivalent to 10 percent of the total installed cost will be incurred.

VACFIL: Calculations For Vacuum Filtration

The vacuum filter subroutine begins by accepting input values for the following variables which have been calculated in the digester routine:

- (1) Digester effluent solids concentration - lbs/lb (SCOUT)
- (2) Digester effluent solids flow rate - lbs/hr (PPS)
- (3) Digester effluent volatile solids concentration - lbs/lb dry solids (CVSOUT)
- (4) Digester effluent water flow rate - lbs/hr (PWLR)

In addition, the routine requires three design parameters:

- (5) Filtrate solids concentration - lbs/lb (Q)
- (6) Filter cake solids concentration - lbs/lb (FCSC)
- (7) Filter operating time - hours/day (OPT)

The filter loading rate (VPLR) is calculated by linear interpolation of experimental curves relating loading rate to filter cake solids concentration and influent solids concentration (lines 143700 - 145200). Required filter area for filters operation 24 hours/day (VFA) is then calculated, and modified to obtain required filter area for filters operating OPT hours/day (RVFA), number of filters (NVP), and individual filter area (VPIA) (lines 145300 - 146100, see note 1). Capital cost of the filters (VFCC) is then determined from empirical data (lines 146200 - 147300, see note 2). Mass balance

calculations are then performed (lines 147500 - 148100). Power requirements are determined in lines 148200 - 148800 from data detailed in the literature (see note 3). Operating costs and other cost calculations are performed in lines 148900 - 149200, and further mass balance information is determined in lines 149300 - 149700. The remainder of the program is devoted to printing the results.

B. Notes on Vacuum Filter Program

(1) Calculations of filter area and number of filters

The required filter area for filters operating OPT hours/day is determined from VFA by Equation (C-54):

$$RVFA = VFA * (24/OPT) \quad (C-54)$$

A tentative number of filters is calculated by assuming two filters when RVFA is less than 1800 sf, with one additional filter for every 900 sf (or fraction) above 1800 sf. Tentative area of individual filters is calculated by dividing RVFA by the tentative number of filters. If OPT is 24 hours, or if the tentative filter area and number of filters is such that the disablement of one filter would prevent performing the required filtration in 24 hours, the number of filters is increased by 1, and individual filter area recalculated.

(2) Filter capital cost

Filter capital cost is estimated from data given by Patterson and Banker (1971). The cost curve for vacuum filtration shown in that document has been piecewise linearized to give equations of the form:

$$VCC = a + b (RVFA) \quad (C-55)$$

where VCC is capital cost. Table C-7 shows values of a and b.

Table C-7

Capital Costs of Vacuum Filter
(Coefficients of Equation C-55)

Required Filter Area (RVFA, sf)	Constant Coefficient (a)	Multiplier (b)
less than 185	50,000	810.8
185 - 525	91,176	588.2
525 - 940	146,988	481.9
940 - 1950	227,722	396.0
Above 1950	220,000	400.0

(3) Filter power requirements

Two pumps require power in the vacuum filter: the filtrate pump and the vacuum pump. Data for power requirements for these pumps was obtained from commercial manufacturers' information (Rex Chainbelt, Inc. 1969). Least squares fits of the data provided equations (C-56) and (C-57).

$$VPHP = 0.87 + 0.0356 (PGPM) \quad (C-56)$$

$$VOHP = 3.27 + 0.1144 (VFA) \quad (C-57)$$

where

VPHP = horsepower required for filtrate pump

PGPM = filtrate flow rate - gallons/minute

VOHP = horsepower required for vacuum pump

VFA = filter area - square feet

(4) Maintenance cost For Vacuum Filters

Vacuum filter maintenance cost is assumed to be 5 percent of the total installed costs per year (line 147400).

CENTR: Calculations for Centrifugation

A. Logic Flow

Two limiting conditions exist for the performance of centrifugation. One is the slurry flow rate and the other is the solids loading. The number of centrifuges depends on which of the two limiting conditions dominates for a given operating scheme.

B. Notes

(1) Limiting Conditions

Given the desired cake solids concentration it is possible to estimate the design solids flow rate from experimental data. The linear approximation between the two for cake solids concentration up to 35 percent is given as:

$$SRATE = A + B * CCAKE \quad (C-58)$$

where

SRATE = design solids flow rate

A, B = experimental linear regression constants

CCAKE = desired cake solids concentration

The number of centrifuges required based on the solids flow rate can be determined by the following calculations. (Note that NCRUN is an integer variable.)

$$NCRUN = (EPS/SRATE) + 0.5 \quad (C-59)$$

$$NCACT = NCRUN + 1 \quad (C-60)$$

where

NCRUN = number of centrifuges required

NCACT = number of centrifuges required plus one extra centrifuge for backup

EFS = solids flow rate out of digester system

The true solids flow rate is then

$$SR = EFS/NCRUN \quad (C-61)$$

where

SR = design solids flow rate based on the integer number of centrifuges required

The liquid flow rate is similarly determined.

$$LR = DIGWTR/NCRUN \quad (C-62)$$

where

LR = design liquid flow rate based on the number of centrifuges required

However, since the limiting condition for liquid flow rate is predetermined to be 225 gpm, if the calculated number of centrifuges required to attain this limiting condition, N, exceeds that determined based on the solid flow rate as above, NCRUN, N must replace NCRUN (lines 159500 - 160400)

(2) Capital Cost of Centrifugation

Capital cost includes machine cost, installation and building. Based on current information installation cost is assumed to be 50 percent of the total machine cost. Machine and building costs are based on the number of centrifuges installed (lines 161400 - 161600).

INCIN: Calculations for Incineration of Residue

A. Logic Flow

Given the volatile solids composition of raw refuse in terms of carbon, hydrogen, nitrogen and oxygen and the estimated loss of carbon, hydrogen and oxygen due to the production of methane and carbon dioxide in the digester, the resulting residue composition of volatile solids subject to incineration is obtained as the difference between them. The amounts of carbon dioxide and water generated as combustion products are computed based on the assumption of complete combustion. The excess air required to insure complete combustion in practice increases the amount of nitrogen and oxygen in the combustion products.

Heat balance calculations proceed with the determination of heat loss, auxiliary fuel requirements and heat recovery. A portion of excess heat is supplied back to the caustic treatment, digestion and gas clean-up units to supply the heat requirements for those processes, but credit is given for the total excess heat since a charge was made for the heat in the subroutines requiring heat.

Capital cost calculations are based on the piecewise linearization of a logarithmic function, and a proportional approximation of capital cost is made for maintenance cost computations.

B. Notes

(1) Refuse Composition

Based on the experimental data the raw refuse composition is as shown in Table C-8.

Table C-8

Raw Refuse Composition

Components	lbs/lb Volatile Solids
C	0.539
H	0.070
N	0.008
O	0.383 (by difference)

(2) Digester Residue Composition of Volatile Solids

Based on the assumptions that 6.5 SCF of gas are generated per pound of volatile solids added in the digester and that the methane and carbon dioxide in the gas mixture are equi-molar in amount, the moles of methane or carbon dioxide are calculated as follows:

moles of methane (or carbon dioxide)

$$= \frac{6.5 \text{ SCF}}{1 \text{ lb}} \times \frac{1}{2} \times \frac{28.3 \text{ l}}{\text{SCF}} \times \frac{1 \text{ mole}}{22.4 \text{ l}} = 4.1 \text{ moles} \quad (\text{C-63})$$

The loss of carbon, hydrogen and oxygen in the form of gas is calculated in the following manner:

$$\text{C lost} = 2(4.1 \times 12/454) = 0.217 \text{ lbs/lb VS} \quad (\text{C-64})$$

$$\text{H lost} = 4(4.1 \times 1/454) = 0.036 \text{ lbs/lb VS} \quad (\text{C-65})$$

$$\text{O lost} = 4.1 \times 32/454 = 0.289 \text{ lbs/lb VS} \quad (\text{C-66})$$

The residual composition of volatile solids is obtained as the difference between the original amount and the loss due to gasification. Table C-9 summarizes the computations of the composition of volatile solids entering the incineration process.

Table C-9

Composition of Digester Residue Solids*				
Components	Original Composition	Loss	Residue	New Composition
C	0.539	0.217	0.322	0.703
H	0.070	0.036	0.034	0.074
N	0.008	0	0.008	0.0175
O	0.383	0.289	0.094	0.205
Total	1.000	0.542	0.458	0.9995

*All in lbs/lb volatile solids

(3) Combustion Air Required

The reactions between hydrogen and oxygen and between carbon and oxygen proceed as follows:

The amount of oxygen required for the first reaction is computed as:

$$\begin{aligned} \text{moles } O_2 \text{ required for } H_2 &= (0.074)/(2 \times 2) \\ &= 0.0185 \end{aligned} \quad (C-69)$$

and for the second reaction:

$$\text{moles } O_2 \text{ required for } C = 0.703/12 = 0.0585 \quad (C-70)$$

The total oxygen required is 0.077 moles, a part of which can be supplied from the oxygen in the refuse.

$$\text{moles } O_2 \text{ in refuse} = 0.205/32 = 0.0064 \quad (C-71)$$

The difference between the total required and the available oxygen ($0.077 - 0.0064 = 0.0706$ lbs/lb VS) is the actual requirement for complete combustion. Therefore the amount of air to be supplied is:

$$\begin{aligned} 0.0706 \text{ (moles/lb VS)} \times 32 \text{ (lbs } O_2/\text{moles } O_2) \times 4.32 \text{ (lbs air/lb } O_2) \\ = 9.76 \text{ (lbs air/lb VS)} \end{aligned} \quad (C-72)$$

The amount of each of the combustion products without excess air is computed as shown below.

$$\begin{aligned} N &= 9.76 \times (3.32/4.32) + 0.0175 = 7.52 \\ O_2 &= 0.0 \end{aligned}$$

$$\text{CO}_2 \quad 0.703 \times (44/12) = 2.58$$

$$\text{H}_2\text{O} \quad 0.074 \times (18/2) = 0.666$$

The total combustion products amount to 10.764 lbs/lb VS. When an excess air requirement is given, the amount of nitrogen and oxygen in the combustion products increases proportionately but that of carbon dioxide and water remains the same.

(4) Heatlosses

Heatlosses are due to the escape of dry products of combustion, latent heat of moisture, generation of water vapor and disposal of ash (lines 173600 - 174000).

$$\text{HLDPR} = \text{DPCT} * \text{CAKEVS} * \text{SPHDPC} * (\text{TINC} - \text{TSTD}) \quad (\text{C-73})$$

$$\text{HLMOIS} = (\text{CPH2O} * \text{CAKEVS} + \text{CAKEMO}) * \text{LATHT} \quad (\text{C-74})$$

$$\text{HLMV} = (\text{CPH2O} * \text{CAKEVS} + \text{CAKEMO}) * \text{SPHWV} * \text{TINC} - 212) \quad (\text{C-75})$$

$$\text{HLASH} = \text{CAKERS} * \text{SPHASH} * (\text{TRECOV} - \text{TSTD}) \quad (\text{C-76})$$

$$\text{BTUINC} = \text{HLDPC} + \text{HLMOIS} + \text{HLMV} + \text{HLASH} \quad (\text{C-77})$$

where

HLDPC = heatloss due to dry products of combustion - BTU/hr

DPCT = total weight of dry products of combustion generated per pound of volatile solids - lbs/lb VS

CAKEVS = weight of volatile solids in feed cake - lbs/hr

SPHDPC = specific heat of dry products of combustion - BTU/hr

TINC = incinerator temperature - degrees F

TSTD = standard temperature - degrees F

HLMOIS = heatloss due to moisture - BTU/hr

CPH2O = weight of moisture as combustion product generated per pound of volatile solids - lbs/lb VS

CAKEMO = weight of moisture in cake - lbs/hr

LATHT = latent heat of water - BTU/lb

HLMV = heatloss due to water vapor generation - BTU/hr

SPHWV = specific heat of water vapor - BTU/lb

CAKERS = total weight of fixed solids in feed cake - lbs/hr

SPHASH = specific heat of ash - BTU/lb

TRECOV = heat recovery temperature - degrees F

BTUINC = summation of heatlosses - BTU/hr

(5) Auxiliary Fuel

The positive difference between the total heatloss (BTUINC) and the available heat value of the cake (TBTUA) must be supplied from an external source to sustain the incineration process. However, since about one-half of the input fuel heating value is available for heating the refuse cake combustion products due to heatlosses from its own combustion products, the necessary heat value in the form of auxiliary fuel is calculated as follows (line 174100):

$$\text{FUELBT} = (\text{BTUINC} - \text{TBTUA}) * 2. \quad (\text{C-78})$$

where

FUELBT = heat required in the form of auxiliary fuel - BTU/hr

BTUINC = heatloss due to combustion of feed cake - BTU/hr

TBTUA = available heat value in feed cake - BTU/hr

The system is self-sustaining without auxiliary fuel if BTUINC - TBTUA is non-positive.

The air requirement for auxiliary fuel (assumed methane) is calculated based on the following reaction:

Assuming that 1 SCF of methane weighs 0.0445 lbs and possesses 1000 BTU, it follows that about 9.77 lbs of air is required for obtaining 1000 BTU. The heatloss calculations for auxiliary fuel proceed in a manner similar to that presented in the previous section.

(6) Heat Recovery

A portion of the heatloss can be recovered through a heat recovery system. The following relationships hold for heat balance in a self-sustaining system:

$$\text{HDDPC} = \text{DPCT} * \text{CAKEVS} * \text{SPHDPC} * (\text{TRECOV} - \text{TSTD}) \quad (\text{C-80})$$

$$\text{HDWV} = (\text{CPH2O} * \text{CAKEVS} + \text{CAKENO}) * \text{SPHWV} * \text{TRECOV} - 212 \quad (\text{C-81})$$

$$\text{HRCT} = \text{TBTUA} - \text{HDDPC} - \text{HLNOIS} - \text{HDWV} - \text{HLASH} \quad (\text{C-82})$$

where

HDDPC = heat dissipated out of the system with dry products of combustion - BTU/hr

HDWV = heat dissipated out of the system with water vapor - BTU/hr

HRCT = total heat recovered - BTU/hr

Basically, the same procedure of calculations is applied for the auxiliary fuel (lines 174500 - 175400).

If the total heat recovered is more than that required for heating the digesters, gas clean-up and caustic treatment, the remaining heat may be converted to other forms of energy or sold as steam.

(7) Capital cost of Incinerators

Incinerator capital cost is calculated from data presented by Patterson and Banker (1971). The relationship shown on page 52 of that publication has been fitted with the following set of equations (lines 176200 - 177100):

(a) For total input feed less than or equal to 100 lbs/hr:

$$\text{Capital cost} = 15.1 * 100 ** 0.55 * 1000 \quad (\text{C-83})$$

(b) For total input feed less than or equal to 2000 lbs/hr, but greater than 100 lbs/hr:

$$\text{Capital cost} = 15.1 * \text{CAKETS} ** 0.55 * 1000 \quad (\text{C-84})$$

(c) For total input feed less than or equal to 10,000 lbs/hr, but greater than 2000 lbs/hr:

$$\text{Capital cost} = 12.9 * \text{CAKETS} ** 0.57 * 1000 \quad (\text{C-85})$$

where

CAKETS = total solids in dewatered cake - lbs/hr

(8) Maintenance cost of incineration

Based on the current information a fixed portion (1.4 percent) of the installed cost is required for maintenance of incineration systems. This does not include auxiliary fuel cost (line 177300).

HAUL: Calculations for haul of residue

A. Logic Flow

HAUL is a user oriented program, since the haul distance (DIST) and a unit haul cost (RHAUL) depend much on the particular location of the system and other factors related to spatial and temporal restrictions.

B. Notes

The tonnage of haul material (TONHL), the distance to be hauled (DIST) and the rate (RHAUL) are multiplied to obtain the hourly cost (HCOST).

$$\text{HCOST} = \text{TONHL} * \text{DIST} * \text{RHAUL} \quad (\text{C-86})$$

LANFIL: Calculations for landfill disposal of residue**A. Logic Flow**

LANFIL is also user oriented. No provision is given to design the landfill operation.

B. Notes

The filling cost is given as RPILL (\$/ton) and is multiplied by the tonnage of fill (TONFIL).

SUMMARY: Final program output**A. Logic Flow**

Self explanatory

B. Notes

Since the front end routines, as well as INCIN, HAUL and LANFIL lack the extensive background information of the other subroutines, a separate accounting tabulation is provided to differentiate them from DIGEST, GCLEAN and dewatering. For the convenience of coarse analysis, however, the summary of the total process is also included.

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2. Simulation Results

The computer programs described in the previous section have been used to simulate the system under varying combinations of input conditions. The purpose of simulating the system is threefold. First, it is necessary in conducting the laboratory investigations to have some idea of which variables have the most significant impact on the performance of the system. This can be accomplished more simply by alteration of the mathematical model rather than by manipulation of the physical system. Second, by systematically changing the input parameters of the simulation model, it is possible to arrive at a set of control variable values that results in a rough approximation of the optimum operating conditions. Finally, using the income and cost information in the simulation program, it is possible to at least form an opinion on the economic feasibility of actually constructing and operating a full-scale plant.

The information supplied by the simulation program must be regarded as approximate because of the simplifications that are used in order to make the program short enough for inexpensive use and the approximations used in scaling up the process from the laboratory scale model to the full scale system. These approximations include both the physical system parameters and the cost parameters.

Several revisions have been made to the program since the last annual project report (Pfeffer and Liebman, 1975). Included in these revisions are the following:

1. Update cost calculations to the third quarter of 1975.
2. Add the provision for centrate recycle
3. Add the provision for caustic pretreatment of the refuse
4. Add the cost calculations for wastewater disposal
5. Allow pH in the digester to vary with the increasing alkalinity of the input stream due to recycle and caustic treatment
6. Correction of three programming errors
 - A. The weight of the ferrous metal removed by magnetic separation was not subtracted from the weight of the inert fraction going to the digester
 - B. An error in the calculation of digester pH caused the caustic requirement to be miscalculated
 - C. The cost approximation for the gas clean-up operation was low due to an error in a conversion factor.

The revised results from some simulation runs are shown in Table C-10. These simulation results are based on the assumption that 15 persons (at \$10/hr) are needed on a 24 hour basis to operate the system without caustic pretreatment and an additional two laborers are needed if the pretreatment step is included. Also, land costs and design costs are not included since they are site-specific and would be difficult to estimate. It should be noted, however that

TABLE C-10
SIMULATION RESULTS 1000 TONS/DAY SYSTEM

Run Number	1	2	3	4	5	6	7	8*
Caustic Treatment	No	No	No	No	No	No	Yes	Yes
Percent Recycle	80	80	80	80	80	80	0	45
Days Detention	6	8	10	6	6	6	6	5
Temperature °C	60	60	60	50	40	60	60	60
Feed Solids Concentration (Percent)	13.5	13.9	14.1	12.1	11.3	10.0	16.0	14.6
Digester Solids Concentration (Percent)	8.1	8.1	8.1	8.1	8.0	5.9	8.7	8.1
Methane Income (\$/hour)	258	267	274	214	187	259	295	285
Excess Steam Income (\$/hour)	86	84	82	98	105	82	49	57
Capital Cost (Million dollars)	14.33	14.88	15.50	15.29	16.02	15.08	14.20	14.14
Amortized Capital (\$/hour)	195	200	205	209	219	202	196	196
Operation & Maintenance Cost (\$/hour)**	115	118	121	121	127	118	174	154
Total Hourly Cost (\$/hour)***	460	468	476	480	496	470	540	483
Total Hourly Income (\$/hour)	720	727	732	688	688	717	720	718
Net Income (\$/hour)	260	259	256	208	192	247	180	235
Energy Out as CH ₄ (10 ⁷ BTU/hour)	12.9	13.4	13.7	10.7	9.3	13.0	14.8	14.3
Energy Out as Steam (10 ⁷ BTU/hour)	8.6	8.4	8.2	9.8	10.5	8.2	4.9	5.7
Percent Energy Recovery	57	58	58	55	53	56	52	53

* Complete output for this run is shown in Section 5.

** Does not include labor costs.

*** Including labor costs.

these costs, when amortized over the 20-25 year life of the facility, will not add a large amount to the hourly cost. If \$3 million is included for these purposes, total hourly costs will increase about \$30/hr. The assumed benefits in the simulated system are \$2.00/1000 SCF for methane, \$5.00/ton for refuse disposal, \$50.00/dry ton for sewage sludge disposal, \$17.00/ton for recovered ferrous scrap, and \$1.00/million BTU for excess steam. As can be shown by other simulations, the profitability of the overall system can be greatly increased by even a small increase in the price of methane or in the refuse disposal charge. The prices of recovered metal, sludge disposal, and excess steam are less significant in the determination of overall system economics.

The simulation results show that caustic pretreatment of the refuse is not beneficial under the assumed operating conditions. The additional cost (approximately \$110/hr) in chemicals, amortized capital, and heat is not recovered by reduction of digester detention time (run number 8) and reduction in the size of the dewatering and incineration subsystems that result from the higher percent reduction of volatile solids. The "break-even" point for inclusion of caustic pretreatment depends to a high degree on the cost of the caustic chemical used and the price at which the additional gas could be sold. The assumed price of caustic is \$120/ton for 76 percent NaOH. If gas price is increased, a price of approximately \$4.00/1000 SCF is required before caustic pretreatment would be considered.

The simulation results also show the desirability of recycling the water centrifuged from the digester effluent. This centrate contains nutrients, alkalinity and heat that would have to be supplied from some other source if recycle were not employed. Additionally, a saving results from the elimination of the requirement to treat the wastewater before discharge to a sewage system. The inclusion of a caustic pretreatment step in the process reduces the quantity of recycle that is possible due to the additional water that is added to the refuse in the caustic treatment process. Use of recycled water in the caustic treatment step is not feasible due to the high alkalinity of this water.

The effects of different detention times can be seen in simulation runs 1, 2, and 3. Although the reduction in net income is small for longer detention times, the increase in capital costs is evident. The increase in methane production indicates that if the price of gas is increased beyond the \$2.00/1000 SCF that has been used, the longer detention times would become more desirable. It is worth noting that as detention time increases, less excess steam is available for sale. This is due to the higher heating requirement for the larger volume digesters and less residual solids due to the higher efficiency of gas production. If a dependable market for the steam is not available, the longer detention times would be more desirable because more of the energy is recovered as methane.

The effects of digester temperature on the system economics can be seen in runs number 1, 4, and 5. The higher energy recovery and increased rate of methane production make operation at a high temperature desirable. The increase in capital costs of \$1.7 million associated with the lower temperatures is due to the increased size of the dewatering and incineration systems. Also, the lower digester temperatures mean a reduction in the proportion of the recovered energy that is in the more desirable form of methane and an increase in less desirable steam production.

The effects of increased feed solids concentration are indicated in runs 1 and 6. Although the increase in concentration requires more energy for mixing and pumping, the size of the digesters is reduced a great deal, and the corresponding reduction in capital costs increases the system profitability. However, additional research is needed to better determine the relationship between solids concentration and the mixing and pumping costs.

From other runs of the simulator, not shown here, several other qualitative conclusions about system behavior can be reached. Those variables which seem to be most important in determining final design parameters and system economics include:

1. Front-End removal efficiencies
The size of all subsequent units depends on the quantity of material passing through the separation processes.
2. Sewage sludge concentration
A low sewage sludge concentration greatly decreases the allowable centrate recycle rate
3. Interest rate
Increasing the interest rate to 10% adds about \$55/hr to the costs.
4. Caustic cost
The large amount of caustic required for pretreatment of refuse makes this variable very important in the consideration of this option.
5. Equipment design life
Equipment cost is amortized over its entire design life. If the estimated design life is shortened, the cost per hour for the equipment will increase significantly.
6. Heat recovery temperature
Decreasing the incinerator stack gas temperature from the assumed 600 deg. F will greatly increase the amount of steam available for use in the system and for sale.

It is also possible to conclude from the various simulation runs that some variables do not have a significant impact on the system.

1. Digester pH
Over the entire range of pH that would normally be found, the system economics are not affected to any great extent by the pH in the reactor.
2. Equipment capital costs
Within reasonable limits, an increase in estimated capital cost for any specific piece of equipment will not affect the system economics. Addition of an extra million dollars in capital costs will result in an increase in amortized capital costs of only \$10/hr if amortized over a 20 year period.

Finally, using both the numerical results found in Table C-10 and the "intuitive" results formed through actual use of the model, it is fairly clear that the system, as proposed could operate profitably and could significantly reduce the cost of refuse disposal and increase the supply of methane. Even though the assumptions used in the analysis are highly conservative, the process has been shown to be economically feasible.

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3. Definition of Major Program Variables

A	Dummy variable; also sewage sludge heat value constant.....	131.
A(1)	Roof surface area of digester (sf)	
A(2)	Wall surface area of digester (sf)	
A(3)	Bottom surface area of digester (sf)	
AA	Dummy variable	
ACASH	Ash separated from refuse stream by air classification (lbs/hr)	
ACCC	Air classifier capital cost (\$)	313150.
ACCCA	Air classifier capital cost amortized (\$/hr)	
ACDEN	Density of air classified residue (lbs/cf)	1000.
AC ²	Air classifier energy consumption (BTU/hr)	
ACFIX	Fixed solids separated from refuse stream by air classifica- tion (lbs/hr)	
ACFMOI	Fixed solids moisture separated from refuse stream by air classification (lbs/hr)	
ACGLAS	Glass separated from refuse stream by air classification (lbs/hr)	
ACLIPE	Air classifier design life (years)	15.
ACMETL	Metals separated from refuse stream by air classification (lbs/hr)	
ACMOIS	Total moisture removed in air classifier (lbs/hr)	
ACOMC	Air classifier operation and maintenance cost (\$/hr)	
ACPIAS	Plastic separated from refuse stream by air classification (lbs/hr)	
ACRES	Air classified residue (lbs/hr)	
ACVMOI	Moisture removed with volatile solids in air classifier (lbs/hr)	
ACVRES	Volume of air classified residue (lbs/hr)	
ACVS	Volatile solids separated from refuse stream by air class- ification (lbs/hr)	
ADWTR	Moisture added for digestion process (lbs/hr)	
AIR	Air required for incineration (lbs/lb VS)	9.76
ALKREC	Alkalinity of recycle stream (g/l as CaCO ₃)	
ALKREF	Alkalinity of refuse stream (g/l as CaCO ₃)	1.5
ALKS	Sewage sludge alkalinity (g/l as CaCO ₃)	2.0
ALKW	Carriage water alkalinity (g/l as CaCO ₃)	0.1
ASR	Ash remaining in refuse stream (lbs/hr)	
AUXCC	Auxiliary facility capital costs (\$)	101385.
AUXCCA	Auxiliary facility capital costs amortized (\$/hr)	
AUXLIF	Auxiliary facility design life (years)	15.
B	Dummy variable; also sewage sludge heat value constant.....	10.
B(1)	Roof heat flow path of digester (concrete) (inches)	8.0
B(2)	Wall heat flow path of digester (concrete) (inches)	18.0
B(3)	Floor heat flow path of digester (concrete) (inches)	12.0
BB	Dummy variable	
BDETM	Basic detention time data for volatile solids destruction table (days)	(See Table C-2)
BOLIFE	Shredder building design life (years)	20.
BICO	Concentration of bicarbonate alkalinity (moles/l)	
BLDCC	Shredder building capital costs (\$)	121255.
BLDCCA	Shredder building capital costs amortized (\$/hr)	
BTEMP	Basic temperature data for volatile solids destruction table (degrees C)	(See Table C-2)

BTUC	Energy consumed in each unit operation (BTU/hr)	
BTUS	Heat input to digesters from caustic treatment (BTU/hr)	
BTUINC	Incineration total heat expended (BTU/hr)	
BVSDS	Basic data for volatile solids destruction at a given temperature and detention time (lbs/lb VS).... (See Table C-2)	
C	Dummy variable	
CAKE	Cake production (lbs/hr)	
CAKEPS	Fixed solid portion of cake (lbs/hr)	
CAKEMO	Moisture in cake (lbs/hr)	
CAKETS	Total solids in cake (lbs/hr)	
CAKEVO	Volume of cake produced (cf/hr)	
CAKEVS	Volatile solid portion of cake (lbs/hr)	
CAOH2	Lime required in digester (lbs/hr)	
CAOH2C	Lime cost (\$/hr)	
CAUADD	Caustic feed rate (lbs/lb refuse).....	0.03
CAGOMC	Caustic treatment operation and maintenance cost (\$/hr)	
CAUS	Cost of caustic (\$/hr)	
CC	Dummy variable	
CCAKE	Solids concentration of cake (%).....	35.
CCSLD	Capital cost for centrifuge housing structures (\$)	
CCEN	Solids concentration of centrate (%).....	0.1
CCENT	Capital cost of centrifuge (\$)	
CCINST	Capital cost for centrifuge installation (\$)	
CEN	Centrate production (lbs/hr)	
CENCCA	Capital cost amortized for centrifugation (\$/hr)	
CENMC	Maintenance cost for centrifugation (\$/hr)	
CENMO	Moisture in centrate (lbs/hr)	
CENTS	Total solids in centrate (lbs/hr)	
CFNOIS	Refuse fixed solids moisture ratio (lbs/lb ash and plastic)	
CFUEL	Auxiliary fuel cost (\$/hr)	
CHEMP	Caustic feed rate (lbs/hr)	
CHABEN	Benefit from CH ₄ (\$/hr)	
CH4BTU	Total heat value of CH ₄ produced (BTU/hr)	
CH4CH	Methane produced (cf/hr)	
CH4DEN	Density of methane (lbs/cf).....	0.0445
CMO	Slurry moisture content in digester (lbs/lb)	
CKBTU	Heat value left in cake (BTU/hr)	
CNIT	Cost of nitrogen addition (\$/hr)	
COCHR	Pounds of carbon dioxide produced by a pound of methane....	2.75
CONVE	Conveyor energy consumed (BTU/hr)	
CO2G	Concentration of carbon dioxide gas (moles/l)	
CO2GCH	Carbon dioxide gas produced (cf/hr)	
CO2S	Concentration of aqueous carbon dioxide in slurry (moles/l)	
CO2T	Total concentration of carbon dioxide (moles/l)	
CPCO2	Combustion product carbon dioxide (lbs/lb VS).....	2.58
CPHOS	Cost of phosphate addition (\$/hr)	
CPH2O	Combustion product water (lbs/lb VS).....	0.666
CPN	Combustion product nitrogen (lbs/lb VS)	
CPO2	Combustion product oxygen (lbs/lb VS)	
CRASH	Refuse ash content (lb/lb refuse).....	0.04
CRDISR	Refuse disposal credit (\$/hr)	
CRDISS	Sewage sludge disposal credit (\$/hr)	
CRPIX	Refuse fixed solids content (lbs/lb).....	0.2
CRFSMO	Refuse fixed solid moisture content (lbs/lb).....	0.02
CPGLAS	Refuse glass content (lbs/lb).....	0.06
CRMETL	Refuse metal content (lbs/lb).....	0.08
CRPLAS	Refuse plastics content (lbs/lb).....	0.02

CRF	Capital recovery factor	
CRVS	Refuse volatile solids content (lbs/lb).....	0.52
CRVSMO	Refuse volatile solids moisture content (lbs/lb).....	0.26
CSFIX	Fixed solid content of sewage sludge total solids (lbs/lb)...	0.3
CSLFIX	Fixed solids in slurry (lbs/lb total solids)	
CSLMOI	Slurry moisture content (lbs/lb)	
CSLNIT	Concentration of nitrogen in slurry mixture (lbs/lb).....	0.05
CSLTS	Slurry total solids content (lbs/lb)	
CSLVS	Slurry volatile solid content in total solids (lbs/lb)	
CSTS	Sewage sludge total solid content (lbs/lb).....	0.05
CSVS	Sewage sludge volatile solid content (lbs/lb)	
CVCC	Conveyor capital costs (\$)	
	Storage.....	215975.
	Shredding.....	128727.
	Screening.....	41925.
	Air Classifier.....	36255.
CVCCA	Conveyor capital costs amortized (\$/hr)	
CVLIFE	Conveyor design life (years).....	15.
CVMOIS	Refuse volatile solids moisture ratio (lbs/lb VS)	
CVSOUT	Volatile solids concentration in digester or in effluent (lbs/lb)	
C4	Mixing HP required/1000 cf at 0.04 digester slurry concentration (HP).....	0.475
C5	Conversion factor from HP to KW.....	0.741
C6	Cost of electricity (\$/KWH).....	0.015
C9	Methane gas value (\$/mil BTU).....	2.0
C10	Conversion factor from HP to BTU/hr.....	2542.5
C11	Constant for water vapor heatloss calculation.....	0.433872
C12	Constant for water vapor heatloss calculation.....	1.05752
C15	Methane energy content (BTU/cf).....	1000.
C16	Constant for solid flow rate calculation.....	10722.727
C17	Constant for solid flow rate calculation.....	-214.545
C90	Price for steam (\$/mil BTU).....	1.0
D	Dummy variable	
DAYS	Basic data for volatile solids destruction (days)	
DD	Dummy variable	
DDBTUC	Digester-dewatering units total energy consumed (BTU/hr)	
DDCC	Digester-dewatering units capital investment (\$)	
DDHCCA	Digester-dewatering units total capital amortized (\$/hr)	
DDRCRD	Digester-dewatering units total credit (\$/hr)	
DDROMC	Digester-dewatering units total operational and maintenance cost (\$/hr)	
DENW	Density of water (lbs/cf).....	62.4
DH	Height of digester (ft).....	40.
DIFF	Basic data for volatile solids destruction	
DIGMC	Maintenance cost for digesters (\$/hr)	
DIGWTF	Water flow rate in digester (lbs/hr)	
DISCHG	Quantity of wastewater discharged (lbs/hr)	
DISPOS	Cost of wastewater treatment (\$/hr)	
DIST	Haul distance to landfill (miles).....	10.
DLIFE	Process design life (years)	
	Digester.....	25.
	Centrifuge.....	10.
	Incinerator.....	20.
	Vacuum filter.....	20.
DPCT	Dry products of combustion total (lbs/lb VS)	
DRY	Weight of dry refuse (lbs/hr)	
DESCRIB	Run description array	
DTA	Actual detention time in digesters (days).....	10.

DTP	Detention time in digesters in case one of the units fails (days)	
EPASH	Ash removal efficiency (lbs/lb)	
	Air classifier.....	0.8
	Screen.....	0.5
EPGLAS	Glass removal efficiency (lbs/lb)	
	Air classifier.....	0.85
	Screen.....	0.85
EPMETL	Metal removal efficiency (lbs/lb)	
	Air classifier	0.9
	Screen.....	0.0
EPMG	Magnetic separator efficiency (lbs/lb).....	0.85
EPPLAS	Plastic removal efficiency (lbs/lb)	
	Air classifier.....	0.5
	Screen.....	0.0
EFS	Effluent solids flow rate from digester (lbs/hr)	
EFSL	Effluent slurry flow rate from digester (lbs/hr)	
EFVS	Effluent volatile solids flow rate from digester (lbs/hr); also volatile solids removal efficiency (lbs/lb).....	0.1
EXCESS	Excess recycle requested (lbs/hr)	
EXHT	Excess heat (BTU/hr)	
FAIR	Auxiliary fuel air requirement	
FCC	Front-end total energy consumed (BTU/hr)	
FCMO	Filter cake moisture content (lbs/lb)	
FCMR	Filter cake moisture flow rate (lbs/hr)	
FCPCO2	Auxiliary fuel combustion product carbon dioxide (lbs/hr)	
FCPH2O	Auxiliary fuel combustion product water (lbs/hr)	
FCPN	Auxiliary fuel combustion product nitrogen (lbs/hr)	
FCPO2	Auxiliary fuel combustion product oxygen (lbs/hr)	
FCSC	Filter cake solids concentration (lbs/lb).....	0.2
FDPCT	Auxiliary fuel dry products of combustion total (lbs/hr)	
PELIFE	Front-end loader design life (years).....	10.
PENCC	Front-end loader capital cost (\$).....	58300.
PENCCA	Front-end loader capital cost amortized (\$/hr)	
PENDE	Front-end loader energy consumption (BTU/hr)	
FGPM	Filtrate flow rate (gallons/minute)	
PHCCA	Front-end total capital amortized (\$/hr)	
FHCRD	Front-end total credit (\$/hr)	
PHOMC	Front-end total operation and maintenance cost (\$/hr)	
FI(1)	Digester roof transmittance coefficient, inside.....	2.0
FI(2)	Digester wall transmittance coefficient, inside.....	2.0
FI(3)	Digester floor transmittance coefficient, inside.....	2.0
FIXR	Fixed solids remaining after separation (lbs/hr)	
FLTR	Filtrate flow rate (lbs/hr)	
PMOIS	Moisture in fixed solid portion of refuse (lbs/hr)	
FO(1)	Digester roof transmittance coefficient, outside.....	1.3
FO(2)	Digester wall transmittance coefficient, outside.....	1.3
FO(3)	Digester floor transmittance coefficient, outside.....	2.0
FRATE	Dry solids flow rate entering digester (lbs/day)	
PSI	Fixed solids flow rate in digester (lbs/hr)	
FTSL	Filtrate solids flow rate (lbs/hr)	
FUELBT	Auxiliary fuel heat value required (BTU/hr)	
FWLR	Digester effluent water flow rate (lbs/hr)	
GASCH	Total gas produced (cf/hr)	
GCLIFE	Gas clean-up design life (years).....	15.
GLASR	Glass remaining in refuse stream after separation (lbs/hr)	
H	pH in digester	
HAULV	Volume of residue to be hauled (cy/hr)	
HAULWT	Weight of residue to be hauled (lbs/hr)	

HCDIG	Heating cost for digestion (\$/hr)	
HCGC	Heating cost for gas clean-up (\$/hr)	
HCOST	Hourly cost total in each process (\$/hr)	
HDDPC	Heat dissipated with dry products of combustion (BTU/hr)	
HDMV	Heat dissipated with water vapor (BTU/hr)	
HEATC	Cost of caustic treatment heat (\$/hr)	
HK	Henry's constant.....	(See Table C-4)
HL(1)	Heatloss from roof of digester (BTU/hr)	
HL(2)	Heatloss from wall of digester (BTU/hr)	
HL(3)	Heatloss from floor of digester (BTU/hr)	
HLASH	Heatloss due to ash (BTU/hr)	
HLDPC	Heatloss due to dry products of combustion (BTU/hr)	
HLHOIS	Heatloss due to latent heat of water (BTU/hr)	
HLT	Total heatloss from digester surfaces (BTU/hr)	
HLWV	Heatloss due to water vapor (BTU/hr)	
HMAIN	Ratio of caustic treatment heatloss to initial heat requirement.....	0.1
HR	Heat required for slurry in digester (BTU/hr)	
HRCT	Heat recovered total (BTU/hr)	
HTCRD	Heat value credit for incineration (\$/hr)	
HTPDPC	Heatloss due to dry products of combustion in auxiliary fuel (BTU/hr)	
HTPH2O	Heatloss due to moisture in auxiliary fuel (BTU/hr)	
HVGC	Heat required for gas clean-up (BTU/hr)	
H2OCHR	Pounds of water produced by a pound of methane.....	2.25
H2OREC	Centrate or filtrate recycled to digesters (lbs/hr)	
I	Dummy variable	
ICENT	Dummy variable	
ICH	Dummy variable	
ICT	Dummy variable	
IDBW	Dummy variable	
IDIG	Dummy variable	
IEACH	Dummy variable	
IFE	Dummy variable	
IGC	Dummy variable	
IHAU	Dummy variable	
IINC	Dummy variable	
ILAN	Dummy variable	
IN	Dummy variable	
INC	Dummy variable	
INCCA	Incinerator capital amortized (\$/hr)	
INCCC	Incinerator capital cost (\$)	
INCDEN	Incinerator residue density (lbs/cf)	
INCMC	Maintenance cost for incineration (\$/hr)	
INCRS	Incineration residue weight (lbs/hr)	
INCREV	Incineration residue volume (cf/hr)	
INOP	Dummy variable	
IOOP	Dummy variable	
IOUT	Dummy variable	
IREP	Dummy variable	
ISC	Dummy variable	
ISUM	Dummy variable	
ITEST	Dummy variable	
I1	Dummy variable	
I2	Dummy variable	
J	Dummy variable	
K	Dummy variable	
KFLAG	Dummy variable	
K(1)	Conductance coefficient for digester roof.....	8.3
K(2)	Conductance coefficient for digester wall.....	8.3

K(3)	Conductance coefficient for digester floor.....	8.3
K1	Equilibrium constant for bicarbonate system.....	(See Table C-3)
LATHT	Latent heat of water (BTU/lb).....	1050.
LR	Liquid flow rate based on number of centrifuges in operation (lbs/hr)	
LRATE	Liquid limiting flow rate (gpm).....	225.
M	Dummy variable	
MCR	Annual maintenance cost/installed capital cost ratio	
	Digestion.....	0.01
	Vacuum filtration.....	0.05
	Centrifugation.....	0.05
	Incineration.....	0.014
MEACC	MEA system capital cost (\$)	
MEACCA	MEA system capital cost amortized (\$/hr)	
MEAOMC	MEA system operation and maintenance costs (\$/hr)	
METLCR	Metal sale credit (\$/hr)	
METLR	Metal remaining in refuse stream after separation (lbs/hr)	
MGCC	Magnetic separator capital cost (\$).....	52800.
MGCCA	Magnetic separator capital cost amortized (\$/hr)	
MGE	Magnetic separator energy consumption (BTU/hr)	
MGLIFE	Magnetic separator design life (years).....	15.
MGMETL	Metals separated by magnetic separation (lbs/hr)	
MGOMC	Magnetic separator operation and maintenance cost (\$/hr)	
MISCC	Miscellaneous facilities capital costs (\$).....	33745.
MISCCA	Miscellaneous facilities capital costs amortized (\$/hr)	
MISLIP	Miscellaneous facilities design life (years)	
MIXCC	Mixing tank capital costs (\$).....	10000.
MIXCCA	Mixing tank capital costs amortized (\$/hr)	
MIXE	Mixing energy consumption (BTU/hr)	
MIXOMC	Mixing tank operation and maintenance costs (\$/hr)	
MOISP	Moisture remaining in fixed solid portion of refuse stream (lbs/hr)	
MOISR	Moisture remaining in refuse stream after separation (lbs/hr)	
MP	Mixing power required for digester (HP)	
MPC	Cost of mixing power in digester (\$/hr)	
MPP	Mixing energy in digester (BTU/hr)	
NUMEA	Make-up MEA (lbs/hr)	
MWMEA	Molecular weight of MEA.....	61.08
MXLIFE	Mixing tank design life (years).....	20.
N	Number of centrifuge units required based on liquid flow rate limiting condition	
NCACT	Number of centrifuge units actually required	
NCRUN	Number of centrifuge units in operation	
NIT	Nitrogen requirement for digestion (lbs/hr)	
NTMP	Dummy variable	
NTIME	Dummy variable	
NTNK	Number of caustic treatment tanks required	
NV	Number of digester units	
NVDATA	Dummy variable	
NVP	Number of filter units	
OB	Caustic required for pH control in digesters (moles/l)	
OMCCR	Operation and maintenance cost/capital amortized ratio	
	Air classification.....	0.2
	Buildings.....	0.2
	Caustic treatment.....	0.2
	Conveyors.....	0.2

	magnetic separation.....	0.2
	Mixing.....	0.2
	Screening.....	0.2
	Shredder.....	1.0
	Storage.....	0.2
OPT	Filter operating time (hrs/day).....	16.
P	Power required for centrifugation (BTU/hr); also sewage sludge solids concentration (lbs/lb).....	0.05
PAC	Power required for air classifier unit (HP/hr).....	540.
PC	Power cost for centrifugation (\$/hr)	
PCDBOD	Per capita BOD generation (lbs/day).....	0.2
PCDREF	Per capita refuse generation (lbs/day).....	7.0
PCDSS	Per capita SS generation (lbs/day).....	0.22
PCONV	Power required for conveyor unit (hp/hr).....	50.
PEPBOD	Primary sedimentation BOD removal efficiency (lbs/lb BOD).....	0.3
PEPSS	Primary sedimentation SS removal efficiency (lbs/lb TS).....	0.6
PEXAIR	Percentage excess air required for incineration.....	50.
PFEND	Front-end loader power requirement (HP).....	132.
PH	Hydrogen ion concentration (moles/l)	
PHOS	Phosphate requirement for digestion (lbs/hr)	
PLASR	Plastics remaining in refuse stream after separation (lbs/hr)	
PLIFE	Pump design life (years).....	20.
PMG	Magnetic separator power required (HP).....	25.
PMIX	Mixing power required (HP).....	100.
PMPC	Pump capital costs (\$)	7500.
PMPCCA	Pump capital costs amortized (\$/hr)	
PMPOMC	Pump operation and maintenance costs (\$/hr)	
POP	Population.....	205700.
PPUMP	Pumping power required (HP).....	100.
PR	Volume required for caustic treatment (cf/lb).....	0.064
PRI	Dummy variable	
PRJ	Dummy variable	
PSC	Screening power required (HP).....	40.
PSEDT	Primary sedimentation total solids (lbs/hr)	
PSH	Shredder power requirement (HP).....	1500.
PUMPF	Pumping energy consumed (BTU/hr)	
PVLIPE	Design life of caustic treatment tanks (years).....	10.
PVSD	Fraction of volatile solids destroyed (lbs/lb TS)	
PVUCC	Unit cost of caustic treatment tanks (\$/gal).....	5.0
Q	Filtration solids concentration (lbs/lb).....	0.001
R	Ratio of sewage sludge solids to dry refuse solids (lbs/lb).....	0.0476
RASH	Ash remaining in refuse stream after separation (lbs/hr)	
RBTUC	Rear-end total energy consumed (BTU/hr)	
RCC	Rear-end total capital investment (\$)	
RD	Radius of digester (ft)	
RECNI	Concentration of nitrogen in centrate or filtrate (lbs/lb).....	0.00035
RECYCL	Amount of centrate or filtrate recycled to digesters (%)	
REFNIT	Concentration of nitrogen in refuse (lbs/lb).....	0.0068
REFRT	Total refuse flow rate (lbs/hr)	
REFTON	Refuse flow rate (tons/hr)	
RESASH	Residual ash to be hauled (lbs/hr)	
RESGLA	Residual glass to be hauled (lbs/hr)	
RESMET	Residual metals to be hauled (lbs/hr)	
RESMOI	Residual moisture to be hauled (lbs/hr)	

RESPLA	Residual plastics to be hauled (lbs/hr)	
RESTOT	Residual total to be hauled (lbs/hr)	
RPILL	landfill cost (\$/ton).....	2.0
RPIX	Fired solids remaining in refuse stream after separation (lbs/hr)	
RGLAS	Glass remaining in refuse stream after separation (lbs/hr)	
RHAUL	Haul cost (\$/ton-mile).....	0.2
RHCCA	Rear-end total capital amortized (\$/hr)	
RHCRD	Rear-end total credit (\$/hr)	
RHOMC	Rear-end total operation and maintenance cost (\$/hr)	
RHV	Refuse heat value (BTU/lb).....	7800.
RINST	Installation cost/machine cost ratio for centrifugation.....	0.5
RMETL	Metal remaining in refuse stream after separation (lbs/hr)	
RMOIS	Moisture remaining in refuse stream after separation (lbs/hr)	
RPLAS	Plastic remaining in refuse stream after separation (lbs/hr)	
RVFA	Required filter area (sf)	
RVS	Volatile solids remaining in refuse stream after separation (lbs/hr)	
SCALE	Scaling factor	
SCASH	Screened ash (lbs/hr)	
SCCC	Screen capital cost (\$)	154305.
SCCA	Screen capital cost amortized (\$/hr)	
SCDEN	Screen residue density (lbs/cf).....	800.
SCE	Screen energy consumption (BTU/hr)	
SCFIY	Screened total fixed solids (lbs/hr)	
SCFMOI	Screened moisture in fixed solid portion (lbs/hr)	
SCGLAS	Screened glass (lbs/hr)	
SCIN	Solids concentration entering digester (lbs/lb).....	0.1
SCLIFE	Screen design life (years).....	15.
SCMETL	Screened metals (lbs/hr)	
SCMOIS	Screened moisture (lbs/hr)	
SCOMC	Screen operation and maintenance cost (\$/hr)	
SCOUT	Solids concentration in digester or in effluent (lbs/lb)	
SCPLAS	Screened plastics (lbs/hr)	
SCRES	Screened residue total weight (lbs/hr)	
SCVPES	Screened residue total volume (cf/hr)	
SCVS	Screened volatile solids (lbs/hr)	
SPIX	Sludge fixed solids (lbs/hr)	
SHCC	Shredder capital cost (\$)	588405.
SHCCA	Shredder capital cost amortized (\$/hr)	
SHZ	Shredder energy consumption (BTU/hr)	
SHLIFB	Shredder design life (years).....	10.
SHOMC	Shredder operation and maintenance cost (\$/hr)	
SHDPHR	Shredder operation time (hrs/day)	
SHV	Sludge heat value (BTU/lb dry solids)	
SL	Slurry flow rate (lbs/hr)	
SLPIX	Slurry fixed solids (lbs/hr)	
SLIN	Slurry flow rate entering digester (lbs/hr)	
SLMOIS	Slurry moisture (lbs/hr)	
SLTS	Slurry total solids (lbs/hr)	
SLVS	Slurry volatile solids (lbs/hr)	
SMEAC	MEA solution circulated (lbs/hr)	
SMOIS	Sludge moisture (lbs/hr)	
SPHASH	Specific heat of ash (BTU/lb).....	0.2

SPHDPC	Specific heat of dry products of combustion (BTU/lb).....	0.25
SPHWV	Specific heat of water vapor (BTU/lb).....	0.5
SP	Solid flow rate based on number of centrifuges in operation (lbs/hr)	
SRATE	Limiting solid flow rate (lbs/lb)	
SSBODR	Suspended solids produced per lb BOD in activated sludge system (lbs/lb).....	0.5
SSPTS	Secondary sedimentation total solids (lbs/hr)	
STCC	Storage bin capital cost (\$)	197470.
STCCA	Storage bin capital cost amortized (\$/hr)	
STCI	Sewage treatment cost index ratio	
STC172	Sewage treatment cost index (1/72).....	167.7
STC174	Sewage treatment cost index (1/74).....	188.1
STC175	Sewage treatment cost index (1/75).....	225.7
STC771	Sewage treatment cost index (7/71).....	150.6
STC772	Sewage treatment cost index (7/72).....	170.0
STC773	Sewage treatment cost index (7/73).....	183.7
STC775	Sewage treatment cost index (7/75).....	255.4
STEAM	Steam required for gas clean-up (lbs/hr)	
STLIFE	Storage bin design life (years).....	15.
STOMC	Storage operation and maintenance cost (\$/hr)	
STS	Sewage sludge total solids (lbs/hr)	
SURCHG	Cost of wastewater treatment (\$/1000 gal).....	1.0
SVS	Sewage sludge volatile solids (lbs/hr)	
SWDS	Specific weight of dry solids	
SWF	Specific weight of fixed solids.....	2.5
SWSL	Specific weight of wet slurry	
SWV	Specific weight of volatile solids.....	1.1
SWW	Specific weight of water.....	1.0
T	Digester temperature (degrees C).....	60.
TBTOR	Total BTU value available (BTU/hr)	
TBTUC	Total (cumulative) BTU value consumed (BTU/hr)	
TBTUL	Total BTU value left (BTU/hr)	
TBTUR	Total BTU value of refuse (BTU/hr)	
TBTUS	Total BTU value of sewage sludge (BTU/hr)	
TCAC	Total cost of air classification (\$/hr)	
TCAPT	Total capital cost for incineration (\$)	
TCC	Total (cumulative) capital investment (\$)	
TCCD	Total capital cost of digester (\$)	
TCCDA	Total capital cost of digester amortized (\$/hr)	
TCMG	Total cost of magnetic separation (\$/hr)	
TCMIX	Total cost of mixing (\$/hr)	
TCPUMP	Total cost of pumping (\$/hr)	
TDF	Digester temperature (degrees F)	
TFMP	Temperature of caustic treatment (degrees F).....	266.
THCAUS	Heat required for caustic treatment (BTU/hr)	
THCCA	Total hourly cumulative capital cost amortized (\$/hr)	
THCRD	Total hourly credit including CH ₄ benefit (\$/hr)	
THLD	Total heatloss from digester (BTU/hr)	
THOMC	Total hourly (cumulative) operation and maintenance cost (\$/hr)	
THR	Total heat required in digester (BTU/hr)	
TIME	Time difference for volatile solids destruction data (days)	
TINC	Incinerator temperature (degrees C).....	1400.
TNPC	Total cost of mixing power in digester (\$/hr)	
TMPE	Total mixing energy consumed in digester (BTU/hr)	
TNKCC	Caustic treatment capital cost (\$)	
TNKCCA	Caustic treatment capital cost amortized (\$/hr)	

TO(1)	Digester roof temperature, outside (degrees C).....	12.5
TO(2)	Digester wall temperature, outside (degrees C).....	12.5
TO(3)	Digester floor temperature, outside (degrees C).....	15.0
TOMFIL	Tonnage of fill material (tons/hr)	
TONHL	Tonnage of haul material (tons/hr)	
TOVER	Time required for caustic treatment process (hours).....	4.0
TRECOV	Heat recovery temperature (degrees F).....	600.
TSO	Slurry temperature entering digester (degrees C).....	15.
TSTD	Standard temperature (degrees F).....	77.
TVD	Total volume of digesters including redundancy (cf)	
TVOL	Total volume of caustic treatment tanks (cf)	
TWDSS	Total weight of dry solids (lbs/hr)	
TWREF	Total weight of refuse generated (lbs/hr)	
TWWS	Total weight of wet sludge (lbs/hr)	
UAREA	Area required for a unit centrifuge (sf).....	1000.
UCBLD	Unit cost of housing for centrifuge (\$/sf).....	40.
UCCAUS	Unit cost of caustic (\$/ton).....	158.
UCCENT	Unit machine cost of centrifuge (\$/unit).....	125000.
UCFUEL	Unit cost of auxiliary fuel (\$/mil BTU).....	2.0
UCLIME	Unit cost of lime (\$/ton).....	25.
UCNIT	Unit cost of nitrogen (\$/lb).....	0.15
UCPHOS	Unit cost of phosphate (\$/lb).....	0.15
UCREDR	Credit for refuse disposal (\$/ton).....	5.00
UCREDS	Credit for sewage sludge disposal (\$/dry ton).....	50.
UCRMET	Credit for ferrous metal sale (\$/ton).....	17.
UPAIR	Air required for auxiliary fuel per 1000 BTU (lbs/1000 BTU).....	0.77
UNIT	Nitrogen content in slurry solids (lbs/lb TS).....	0.008
UP	Power requirement for unit centrifuge (HP).....	200.
US	Specific heat constant for solids (BTU/degree F).....	0.54
UN	Specific heat constant for water (BTU/degree F).....	1.0
VACID	Volatile acid content in digester (g/l).....	0.2
VBTU	Energy use for vacuum filtration (BTU/hr)	
VCC	Capital cost of vacuum filtration unit in 1971 (\$)	
VD	Volume of each digester (cf)	
VFPFS	Vacuum filter cake fixed solids (lbs/hr)	
VFPS	Filter cake solids flow rate (lbs/hr)	
VEFVS	Vacuum filter cake volatile solids (lbs/hr)	
VFA	Calculated filter area (sf)	
VFCC	Capital cost of vacuum filtration unit in 1973 (\$)	
VFCCAN	Amortized capital cost for vacuum filtration (\$/hr)	
VFCCAY	Amortized capital cost for vacuum filtration (\$/yr)	
VFCR	Cake production (lbs/hr)	
VPCSC	Filter cake solids concentration basic data (lbs/lb)	
VFIA	Area of single filter (sf)	
VFLR	Filter loading rate (lbs/sf-hr)	
VFLR1	Dummy variable	
VFLR2	Dummy variable	
VFMC	Vacuum filter maintenance cost (\$/hr)	
VPOC	Vacuum filter operating cost (\$/hr)	
VOBTU	24-hour average operating energy consumption for filtration (BTU/hr)	
VOHP	24-hour average operating horsepower for filtration (HP)	
VOLCR	Cake production (cf/hr)	

VP	Vapor pressure of water (mm Hg).....	(See Table C-5)
VPBTU	Filtrate pump energy consumption (HP/hr)	
VPHP	Filtrate pump power (HP)	
VR	Dummy variable	
VRES	Residue volume (cf)	
VSCOUT	Vacuum filter loading rate basic data	
VSD	Volatile solids destroyed (lbs/hr)	
VSI	Volatile solids flow rate entering digester (lbs/hr)	
VSR	Volatile solids remaining in refuse stream (lbs/hr)	
VSWC	Specific weight of wet cake	
VSWDS	Specific weight of cake dry solids	
VTHP	Total power for vacuum filtration (HP)	
VVFLR	Vacuum filter loading rate basic data	
V1	Constant for filter loading rate equation.....	554.434
V2	Constant for filter loading rate equation.....	4.98
V5	Constant for filtrate pump power equation.....	0.0356
V6	Constant for filtrate pump power equation.....	0.87
V7	Constant for vacuum pump power equation.....	0.1144
V8	Constant for vacuum pump power equation.....	3.27
WHL	Water vapor heatloss (BTU/hr)	
WMEAC	Weight of MEA circulated (lbs/hr)	
WSLIFE	Weigh station design life (years).....	15.
WSTCC	Weigh station capital cost (\$).....	64090.
WSTCCA	Weigh station capital amortized (\$/hr)	
X	Dummy variable	
XBTU1	Dummy variable	
XBTU2	Dummy variable	
XOMC1	Dummy variable	
XOMC2	Dummy variable	
XINT	Interest rate.....	0.06
X1	Dummy variable	
X2	Dummy variable	
Y	Dummy variable	
Y1	Dummy variable	
Z	Dummy variable	

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4.	Program Listing	00100020
		00100030
C		00100040
C	MAIN PROGRAM ENERGY	00100060
C		00100080
	COMMON IN, IOUT, INOP, IOOP, C5, C6, C10, XINT, ICT,	00100100
1	STC771, STC172, STC772, STC773, STC174, STC175, STC775,	00100110
1	THREF, RNOIS, RVS, RPIX, RMETL, RGLAS, BPLAS, RASH, PNOIS,	00100200
1	TBTUR, TBTUS, TBTUC, TBTUA, TCC, THCCA, THOMC, THCRD	00100300
	REAL*4 NOISR, NOISF, NETLR	00100400
	IN=5	00100500
	C5=0.741	00100700
	C6=0.015	00100800
	C10=2542.4	00100900
	STC771=150.6	00101000
	STC172=167.7	00101020
	STC772=170.0	00101040
	STC773=183.7	00101050
	STC174=188.1	00101060
	STC175=225.7	00101080
	STC775=255.4	00101085
	XINT=0.06	00101100
	TBTUC=0.	00101200
	TCC=0.	00101300
	THCCA=0.	00101400
	THOMC=0.	00101500
	THCRD=0.	00101600
	WRITE(5,196)	00101700
196	FORMAT(' THIS PROGRAM PROVIDES INFORMATION ON',//	00101800
1	' FRONT-END ROUTINES FOR THE REFUSE FLOW RATE',//	00101810
1	' OF 1000 TONS/DAY'//	00101820
1	' YES - 1, NO - 0'//)	00101830
	WRITE(5,201)	00101900
201	FORMAT(' TEST RUN?')	00102000
	READ(IN,301) ITEST	00102100
301	FORMAT(I)	00102200
	IF(ITEST.EQ.0) GO TO 170	00102300
	WRITE(5,204)	00102400
204	FORMAT(' OPTIONS AUTOMATICALLY SET')	00102500
	INOP=1	00102600
	IOOP=1	00102700
	ISC=1	00102800
	GO TO 360	00102900
170	WRITE(5,175)	00103000
175	FORMAT(' INPUT OPTIONS: (1) OR (2) '//	00103100
1	' (1) USE MODEL DATA FOR ALL SUBROUTINES'//	00103200
1	' (2) INPUT DATA FROM TERMINAL')	00103300
	READ(IN,301) INOP	00103400
	WRITE(5,270)	00103500
270	FORMAT(' OUTPUT OPTIONS: (1) OR (2) '//	00103600
1	' (1) PRINT ALL THE OUTPUTS'//	00103700
1	' (2) PRINT DESIGN AND SUMMARY OUTPUTS')	00103800
	READ(IN,301) IOOP	00103900
	WRITE(5,356)	00104000
356	FORMAT(' INCLUDE SCREEN')	00104100
	READ(IN,301) ISC	00104110
360	WRITE(5,275)	00104120

275	FORMAT(' INCLUDE CAUSTIC TREATMENT')	00104130
	READ(5,301) ICT	00104140
	WRITE(5,202)	00104210
202	FORMAT(' OUTPUT MODE, LP=3 OR TTY=5 ?')	00104220
	READ(IN,203) IOUT	00104230
203	FORMAT(I)	00104240
	IF(IOUT.EQ.5) GO TO 365	00104250
	WRITE(IOUT,196)	00104260
	WRITE(IOUT,204)	00104270
	IF(ICT.EQ.1) WRITE(IOUT,275)	00104280
365	CALL SOURCE(TWWS,SMOIS,STS,SVS,SPIX,SHV,CVMOIS,CPMOIS,CSTS,	00104300
1	TWSS,RHV)	00104350
	CALL STORE	00104400
	CALL SIZE	00104500
	IF(ISC.EQ.0) GO TO 385	00104600
	CALL SCREEN(CPMOIS,CVMOIS,MOISR,NETLR,GLASR,PLASR,ASHR,MOISP,	00104700
1	FIXR,VSR,REFRT,SCNETL,SCGLAS,SCPLAS,SCASH,	00104800
1	SCPMOI,SCRES,SCVRES)	00104900
	RMETL=NETLR	00105000
	RGLAS=GLASR	00105100
	RPLAS=PLASR	00105200
	RASH=ASHR	00105300
	PMOIS=MOISP	00105400
	PMOIS=MOISR	00105500
	RPIX=FIXR	00105600
	RVS=VSR	00105650
	TWREF=REFRT	00105700
	RESMET=SCNETL	00105800
	RESGLA=SCGLAS	00105900
	RESPLA=SCPLAS	00106000
	RESASH=SCASH	00106100
	RESMOI=SCPMOI	00106200
	RESTOT=SCRES	00106300
	VRES=SCVRES	00106400
	GO TO 386	00106500
385	RESNET=0.	00106600
	RESGLA=0.	00106700
	RESPLA=0.	00106800
	RESASH=0.	00106900
	RESMOI=0.	00107000
	RESTOT=0.	00107100
	VRES=0.	00107200
386	CALL SEPARA(CVMOIS,CPMOIS,MOISR,NETLR,GLASR,PLASR,ASHR,MOISP,	00107300
1	FIXR,VSR,REFRT,ACMETL,ACGLAS,ACPLAS,ACASH,	00107400
1	ACRES,ACVRES,RHV)	00107500
	RMETL=NETLR	00107600
	RGLAS=GLASR	00107700
	RPLAS=PLASR	00107800
	RASH=ASHR	00107900
	PMOIS=MOISP	00108000
	PMOIS=MOISR	00108100
	RPIX=FIXR	00108200
	RVS=VSR	00108250
	TWREF=REFRT	00108300
	RESNET=RESNET+ACMETL	00108400
	RESGLA=RESGLA+ACGLAS	00108500
	RESPLA=RESPLA+ACPLAS	00108600
	RESASH=RESASH+ACASH	00108700

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RESNOI=RESNOI+ACHOIS                                00108800
RESTOT=RESTOT+ACRES                                  00108900
VRES=VRES+ACVRES                                      00109000
IF(ICT.NE.1) GO TO 387                                00109010
CALL CAUST(REFTW,SLMOIS,CAUS,THCAUS)                  00109020
TWREF=REFTW                                           00109030
RMOIS=SLMOIS                                           00109040
387 CALL SEWAGE(TWWS,SMOIS,STS,SVS,SPIX,SHV,           00109100
1      SL,CSLTS,CSLVS,TWDSS)                          00109200
      IF(ICT.EQ.0) CAUS=0.                            00109250
      CALL OFILE(1,'TEMP')                             00109300
      WRITE(1,302) IN, IOUT, INOP, IOOP, ICT, C5, C6, C10, XINT, THCAUS,
1      STC771, STC172, STC772, STC773, STC174, STC175, STC775,
1      TBTUR, TBTUS, TBTUC, TBTUA, TCC, THCCA, THOMC, THCRD,
1      SL, CSLTS, CSLVS, CSTS, RVS, RPIX, SVS, SPIX, CAUS,
1      SCHETL, SCGLAS, SCPLAS, SCASH, SCFMOI, SCRES, SCVRES,
1      ACMETL, ACGLAS, ACPLAS, ACASH, ACHOIF, ACRES, ACVRES 00109800
302  FORMAT(5I,4F,2.7F,4E,2X,/,27P)                  00109900
      END FILE 1                                         00110000
388  STOP                                                00110100
      EBD                                                00110200
      SUBROUTINE SOURCE(TWWS,SMOIS,STS,SVS,SPIX,SHV,CVMOIS,CFMOIS,
1      CSTS,TWDSS,RHV)                                00110300
      COMMON IN, IOUT, INOP, IOOP, C5, C6, C10, XINT, ICT,
1      STC771, STC172, STC772, STC773, STC174, STC175, STC775,
1      TWREF, RMOIS, RVS, RPIX, RMETL, RGLAS, RPLAS, RASH, PMOIS,
1      TBTUR, TBTUS, TBTUC, TBTUA, TCC, THCCA, THOMC, THCRD
1      DATA POP,PCDREP,PEPSS,PCDSS,PEPBOB,PCBOD,SSBODR/
1      571400.,3.5,0.6,0.22,0.3,0.2,0.5/             00110800
      DATA CRVSMO,CRVS,CRFSMO,CRPIX,A,B/              00110900
1      0.26,0.52,0.02,0.20,131.,10./                  00111000
      DATA CRMETL,CRGLAS,CRPLAS,CRAH/                 00111100
1      0.08,0.06,0.02,0.04/                            00111200
      DATA CSPIX/0.3/                                  00111300
      CSTS=0.5                                           00111400
      RHV=7800.                                          00111450
      CFMOIS=CRFSMO/(CRPLAS+CRAH)                      00111500
      CVMOIS=CRVSMO/CRVS                                00111550
      IF(INOP.EQ.1) GO TO 270                          00111600
      WRITE(5,451)                                       00111700
451  FORMAT(' CHANGE BASIC DATA FOR REPOSE AND SEWAGE '
1      ' CHARACTERISTICS')                             00111800
      WRITE(5,452)                                       00111900
452  FORMAT(' INPUT CRVSMO,CRVS,CRFSMO,CRPIX')          00112000
      READ(IN,102) CRVSMO,CRVS,CRFSMO,CRPIX            00112500
102  FORMAT(4F)                                           00112600
      WRITE(5,453)                                       00112700
453  FORMAT(' INPUT CRMETL,CRGLAS,CRPLAS,CRAH,RHV')     00112800
      READ(IN,103) CRMETL,CRGLAS,CRPLAS,CRAH,RHV       00112900
103  FORMAT(5F)                                           00113000
      WRITE(IOUT,454)                                    00113100
454  FORMAT(' INPUT TS. CONC. AND FS. CONC.')          00113200
      READ(IN,104) CSTS,CSPIX                           00113300
104  FORMAT(2F)                                           00113400
      CFMOIS=CRFSMO/(CRPLAS+CRAH)                      00113420
      CVMOIS=CRVSMO/CRVS                                00113520
270  CSVS=1.-CSPIX                                       00115800
      TWREF=POP*PCDREP*(1./24.)                        00115900

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PSEDTS=PCDSS*POP*PEPSS*(1./24.)
SSBDTS=PCDBOD*POP*(1.-PEPBOD)*SSBODR*(1./24.)
TWDSS=PSEDTS+SSBDTS
300 RMOIS=(CRVSMO+CRFSMO)*TWREF
RVS=CRVS*TWREF
RPIX=CRPIX*TWREF
RNETL=CRNETL*TWREF
RGLAS=CRGLAS*TWREF
RPLAS=CRPLAS*TWREF
RASH=CRASH*TWREF
PHOIS=CPHOIS*(RPLAS+RASH)
TBTUR=RVS*RHV
TWWS=TWDSS/CSTS
SMOIS=TWWS*(1.-CSTS)
SVS=TWDSS*CSVS
SPIX=TWDSS*CSPIX
SHV=1*(CSTS*100.-B)
TBTUS=SHV*TWDSS
WRITE(IOUT,875) POP,TWREF,TWWS,TBTUR,TBTUS
875 FORMAT(///' ***** DESIGN INPUT AND OUTPUT DATA FOR SOURCE'//
1 ' POPULATION(EQUIV.).....',P10.0,/,
1 ' REFUSE GENERATED.....',2X,P10.2,' LBS/HR'/,
1 ' SEWAGE GENERATED.....',2X,P10.2,' LBS/HR'/,
1 ' REFUSE ENERGY CONTENT.',2X,E10.3,' BTU/HR'/,
1 ' SEWAGE ENERGY CONTENT.',2X,E10.3,' BTU/HR')
IF(IOOP.EQ.2) GO TO 900
WRITE(IOUT,882)
882 FORMAT(///' REFUSE CONSTITUENTS'//)
CALL OUT1(IOUT,TWREF,RMOIS,RVS,RPIX,RNETL,RGLAS,
1 RPLAS,RASH,PHOIS)
WRITE(IOUT,885) TBTUR
885 FORMAT(' ENERGY CONTENT.....',2X,E10.3,' BTU/HR')
WRITE(IOUT,886) TWWS,SMOIS,TWDSS,SVS,SPIX,TBTUS
886 FORMAT(///' SEWAGE CONSTITUENTS'//
1 ' SEWAGE GENERATED.....',2X,P10.2,' LBS/HR'/,
1 ' MOISTURE.....',2X,P10.2,' LBS/HR'/,
1 ' TOTAL SOLIDS.....',2X,P10.2,' LBS/HR'/,
1 ' VOLATILE SOLIDS.....',2X,P10.2,' LBS/HR'/,
1 ' FIXED SOLIDS.....',2X,P10.2,' LBS/HR'/,
1 ' ENERGY CONTENT.....',2X,E10.3,' BTU/HR')
900 RETURN
END
SUBROUTINE STORE
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,
1 STC771,STC172,STC772,STC773,STC174,STC175,STC775,
1 TWREF,RMOIS,RVS,RPIX,RNETL,RGLAS,RPLAS,RASH,PHOIS,
1 TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD
REAL*4 MISLIP,MISCC,MISCCA
DATA UCREDR,OMCCR/5.00,0.2/
DATA STCC,WSTCC,FENCC/197470.,64090.,58300./
DATA STLIFE,WSLIFE,FELIFE/15.,15.,10./
DATA CVCC,MISCC,CVLIFE,MISLIP/215975.,33745.,15.,10./
DATA PFEND,PCONV/132.,50./
CRR(XINT,DLIFE)=XINT/(1.-(1.+XINT)**(-DLIFE))
STCI=(STC775/STC174)
STCC=STCC*STCI
WSTCC=WSTCC*STCI
FENCC=FENCC*STCI

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CVCC=CVCC*STCI                                00121040
NISCC=NISCC*STCI                              00121050
STCCA=STCC*CRR(XINT,STLIFE)/(360.*24.)        00121300
WSTCCA=WSTCC*CRR(XINT,WSLIFE)/(360.*24.)      00121400
PENCCA=PENCC*CRR(XINT,PRLIFE)/(360.*24.)      00121500
CVCCA=CVCC*CRR(XINT,CVLIFE)/(360.*24.)        00121520
NISCCA=NISCC*CRR(XINT,NISLIFE)/(360.*24.)     00121540
STONC=(STCCA+WSTCCA+PENCCA+CVCCA+NISCCA)*ONCCR 00121600
HCOST=STCCA+WSTCCA+PENCCA+CVCCA+NISCCA+STONC  00121900
PENDE=PENDE*C10                               00122000
CONVE=PCONV*C10                               00122020
TBTUA=TBTUR                                    00122100
BTUC=PENDE+CONVE                              00122120
TBTUC=TBTUR+BTUC                             00122200
CRDISR=UCREDR*THREF/2000.                     00122300
THCPD=THCPD+CRDISR                           00122400
THCCA=THCCA+STCCA+WSTCCA+PENCCA+CVCCA+NISCCA  00122500
THONC=THONC+STONC                             00122600
TCC=TCC+STCC+PENCC+WSTCC+CVCC+NISCC          00122700
WRITE(IOUT,1045)THREF,TBTUA,BTUC,HCOST        00122800
1045  FORMAT(///' ***** DESIGN INPUT AND OUTPUT DATA FOR STORE'// 00122900
1      ' REFUSE FLOW RATE.....',2X,F10.2,' LBS/HR'// 00123300
1      ' ENERGY AVAILABLE.....',2X,E10.3,' BTU/HR'// 00123400
1      ' ENERGY CONSUMED.....',2X,E10.3,' BTU/HR'// 00123500
1      ' HOURLY COST TOTAL.....',2X,F10.2,' $/HR'// 00123600
      IF(IOP.EQ.2) GO TO 1090                  00123700
      WRITE(IOUT,1065)                        00123800
1065  FORMAT(///' MASS FLOW'//)                00123900
      CALL OUT1(IOUT,THREF,THOIS,RVS,RPIX,RHETL,RGLAS, 00124000
1      RPLAS,RASH,PNOIS)                      00124100
      WRITE(IOUT,1076)TBTUA,BTUC,PENDE,CONVE    00124200
1076  FORMAT(///' ENERGY BALANCE'//          00124300
1      ' AVAILABLE.....',2X,E10.3,' BTU/HR'// 00124400
1      ' CONSUMED.....',2X,E10.3,' BTU/HR'// 00124500
1      ' FRONTEND LOADER.....',2X,E10.3,' BTU/HR'// 00124510
1      ' CONVEYOR.....',2X,E10.3,' BTU/HR'// 00124520
      WRITE(IOUT,1081)STCC,PENCC,WSTCC,CVCC,NISCC,HCOST, 00124600
1      STCCA,PENCCA,WSTCCA,CVCCA,NISCCA,STONC,CRDISR 00124700
1081  FORMAT(///' COST BALANCE'//            00124800
1      ' CAPITAL INVESTMENTS'//              00124900
1      ' STORAGE BIN.....',2X,F10.2,' $'// 00125000
1      ' FRONTEND LOADER.....',2X,F10.2,' $'// 00125100
1      ' WEIGH STATION.....',2X,F10.2,' $'// 00125200
1      ' CONVEYOR.....',2X,F10.2,' $'// 00125220
1      ' MISCELLANEOUS.....',2X,F10.2,' $'// 00125240
1      ' HOURLY TOTAL.....',2X,F10.2,' $/HR'// 00125300
1      ' CAPITAL AMORTIZED'//                00125400
1      ' STORAGE BIN.....',2X,F10.2,' $/HR'// 00125500
1      ' FRONTEND LOADER.....',2X,F10.2,' $/HR'// 00125600
1      ' WEIGH STATION.....',2X,F10.2,' $/HR'// 00125700
1      ' CONVEYOR.....',2X,F10.2,' $/HR'// 00125720
1      ' MISCELLANEOUS.....',2X,F10.2,' $/HR'// 00125740
1      ' OPERATION AND MAINTENANCE'//        00125800
1      ' STORAGE TOTAL.....',2X,F10.2,' $/HR'// 00125900
1      ' REFUSE DISP. CREDIT....',2X,F10.2,' $/HR'// 00126200
1090  RETURN                                  00126300
      END                                      00126400
      SUBROUTINE SIZE                          00126500

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COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,
1      STC771,STC172,STC772,STC773,STC174,STC175,STC775,
1      TWREF,RNOIS,RVS,RPIX,RMETL,RGLAS,RPLAS,RASH,RNOIS,
1      TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD
DATA OMCCR/0.2/
DATA SHCC,CVCC,BLDCC/588495.,128727.,121255./
DATA SHLIFE,CVLIFE,BDLIFE/10.,15.,20./
DATA PSK,PCONV/1500.,50./
CRR(XINT,BLIFE)=XINT/(1.-(1.+XINT)**(-BLIFE))
STCI=(STC775/STC174)
SHCC=SHCC*STCI
CVCC=CVCC*STCI
BLDCC=BLDCC*STCI
SHCCA=SHCC*CRR(XINT,SHLIFE)/(360.*24.)
CVCCA=CVCC*CRR(XINT,CVLIFE)/(360.*24.)
BLDCCA=BLDCC*CRR(XINT,BDLIFE)/(360.*24.)
SHE=PSK*C10
CONVE=PCONV*C10
BTUC=SHE+CONVE
SHOMC=(SHCCA*5.+CVCCA+BLDCCA)*OMCCR
HCCOST=SHCCA+CVCCA+BLDCCA+SHOMC
TBTUA=TBTUR
TBTUC=TBTUC+BTUC
THCCA=THCCA+SHCCA+CVCCA+BLDCCA
THOMC=THOMC+SHOMC
TCC=TCC+SHCC+CVCC+BLDCC
WRITE(IOUT,2202)TWREF,TBTUA,BTUC,HCCOST
2202  FORMAT(///' ***** DESIGN INPUT AND OUTPUT DATA FOR SIZE'//
1      ' REFUSE FLOW RATE.....',2X,F10.2,' LBS/HR',//
1      ' ENERGY AVAILABLE.....',2X,E10.3,' BTU/HR',//
1      ' ENERGY CONSUMED.....',2X,E10.3,' BTU/HR',//
1      ' HOURLY COST TOTAL.....',2X,F10.2,' $/HR')
1      IP(IOOP,EQ.2) GO TO 2250
WRITE(IOUT,2216)
2216  FORMAT(///' MASS FLOW'//)
CALL OUT1(IOUT,TWREF,RNOIS,RVS,RPIX,RMETL,RGLAS,
1      RPLAS,RASH,RNOIS)
WRITE(IOUT,2226)TBTUA,BTUC,SHE,CONVE
2226  FORMAT(///' ENERGY BALANCE'//
1      ' AVAILABLE.....',2X,E10.3,' BTU/HR',//
1      ' CONSUMED.....',2X,E10.3,' BTU/HR',//
1      ' SHREDDER.....',2X,E10.3,' BTU/HR',//
1      ' CONVEYOR.....',2X,E10.3,' BTU/HR')
WRITE(IOUT,2231)SHCC,CVCC,BLDCC,HCCOST,SHCCA,CVCCA,BLDCCA,SHOMC
2231  FORMAT(///' COST BALANCE'//
1      ' CAPITAL INVESTMENTS'//
1      ' SHREDDER.....',2X,F10.2,' $',//
1      ' CONVEYOR.....',2X,F10.2,' $',//
1      ' BUILDING.....',2X,F10.2,' $',//
1      ' HOURLY TOTAL.....',2X,F10.2,' $/HR',//
1      ' CAPITAL AMORTIZED'//
1      ' SHREDDER.....',2X,F10.2,' $/HR',//
1      ' CONVEYOR.....',2X,F10.2,' $/HR',//
1      ' BUILDING.....',2X,F10.2,' $/HR',//
1      ' OPERATION AND MAINTENANCE'//
1      ' SHREDDING TOTAL.....',2X,F10.2,' $/HR')
2250  RETURN
END

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SUBROUTINE SCREEN (CPHOIS,CVMOIS,MOISR,METLR,GLASR,PLASR,ASHR,
1      MOISF,FIKR,VSR,REFRT,SCNETL,SCGLAS,SCPLAS,SCASH,
1      SCFMOI,SCRES,SCVRES)
1      COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,
1      STC771,STC172,STC772,STC773,STC174,STC175,STC775,
1      TWREF,RMOIS,RVS,RPIX,RMETL,RGLAS,RPLAS,RASH,PHOIS,
1      TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THONC,THCRD
REAL*4 METLR,MOISF,MOISR
DATA SCDEN,OHCCR/800.,0.2/
DATA EPMETL,EPGLAS,EPPLAS,EPASH/0.0,0.85,0.0,0.5/
DATA SCCC,CVCC,SCLIFE,CVLIFE/15*305.,41925.,15.,15./
DATA PSC,PCONV/40.,50./
CRR=(XINT,DLIFE)/XINT/(1.-(1.+XINT)**(-DLIFE))
STCI=(STC775/STC174)
SCCC=SCCC*STCI
CVCC=CVCC*STCI
SCCCA=SCCC*CRR(XINT,SCLIFE)/(360.*24.)
CVCCA=CVCC*CRR(XINT,CVLIFE)/(360.*24.)
SCE=PSC*C10
CONVE=PCONV*C10
BTUC=SCE+CONVE
SCONC=OHCCR*(SCCCA+CVCCA)
HCOST=SCCCA+CVCCA+SCONC
SCVS=0.
SCNETL=RMETL*EPMETL
SCGLAS=RGLAS*EPGLAS
SCPLAS=RPLAS*EPPLAS
SCASH=RASH*EPASH
SCVMOI=SCVS*CVMOIS
SCFMOI=(SCPLAS+SCASH)*CPHOIS
SCMOIS=SCVMOI+SCFMOI
SCPIX=SCNETL+SCGLAS+SCPLAS+SCASH
SCRES=SCPIX+SCFMOI
SCVRES=SCRES/SCDEN
METLR=RMETL-SCNETL
GLASR=RGLAS-SCGLAS
PLASR=RPLAS-SCPLAS
ASHR=RASH-SCASH
VSR=RVS-SCVS
MOISF=PHOIS-SCFMOI
MOISR=RMOIS-SCMOIS
FIKR=METLR+GLASR+PLASR+ASHR
REFRT=MOISR+VSR+PIR
TBTUA=TBTUR
TBTUC=TBTUC+BTUC
THCCA=THCCA+SCCCA+CVCCA
THONC=THONC+SCONC
TCC=TCC+SCCC+CVCC
WRITE(IOUT,2411)TWREF,TBTUA,BTUC,HCOST
2411  FORMAT(///' ***** DESIGN INPUT AND OUTPUT DATA FOR SCREEN'//
1      ' REFUSE FLOW RATE.....',2X,F10.2,' LBS/HR',//
1      ' ENERGY AVAILABLE.....',2X,F10.3,' BTU/HR',//
1      ' ENERGY CONSUMED.....',2X,F10.3,' BTU/HR',//
1      ' HOURLY COST TOTAL.....',2X,F10.2,' $/HR')
IF(IOOP.EQ.2)GO TO 2420
WRITE(IOUT,2426)
2426  FORMAT(///' MASS FLOW'//
1      ' IN'/)

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1 CALL OUT1(IOUT,TWREF,RMOIS,RVS,RPIX,RMETL,RGLAS,      00135800
  RPIAS,RASH,PNOIS)                                     00135900
WRITE(IOUT,2436)                                         00136000
2436 FORMAT(/' OUT'/)                                     00136100
CALL OUT1(IOUT,REPRT,MOISR,RVS,PIXR,NETLR,GLASR,        00136200
  PLASR,ASHR,MOISP)                                     00136300
WRITE(IOUT,2427)                                         00136400
2427 FORMAT(/' RESIDUE'/)                                00136500
CALL OUT1(IOUT,SCRES,SCMCIS,SCVVS,SCFIX,SCMETL,SCGLAS,  00136600
  SCPLAS,SCASH,SCFMOI)                                  00136700
WRITE(IOUT,2439)TBTNA,BTUC,SCE,CONVE                    00136800
2439 FORMAT(/' ENERGY BALANCE'//)                      00136900
1 ' AVAILABLE.....',2X,E10.3,' BTU/HR',/             00137000
1 ' CONSUMED.....',2X,E10.3,' BTU/HR',/               00137100
1 ' SCREEN.....',2X,E10.3,' BTU/HR',/                 00137110
1 ' CONVEYOR.....',2X,E10.3,' BTU/HR',/                00137120
WRITE(IOUT,2441)SCCC,CVCC,HCOST,SCCCA,CVCCA,SCONC       00137200
2441 FORMAT(/' COST BALANCE'//)                          00137300
1 ' CAPITAL INVESTMENTS'//                              00137400
1 ' SCREEN.....',2X,F10.2,' $',/                      00137420
1 ' CONVEYOR.....',2X,F10.2,' $',/                     00137440
1 ' HOURLY TOTAL.....',2X,F10.2,' $/HR',/              00137500
1 ' CAPITAL AMORTIZED',/                                00137510
1 ' SCREEN.....',2X,F10.2,' $/HR',/                   00137600
1 ' CONVEYOR.....',2X,F10.2,' $/HR',/                   00137620
1 ' OPERATION AND MAINTENANCE',/                       00137700
1 ' SCREEN TOTAL.....',2X,F10.2,' $/HR'               00137720
2450 RETURN                                              00137800
END                                                       00137900
SUBROUTINE SEPARA(CVMOIS,CPMOIS,MOISR,METLR,GLASR,PLASR,ASHR,
  MOISP,PIXR,VSR,REPRT,ACMETL,ACGLAS,ACPLAS,ACASH,
  ACRES,ACVRES,RHV)                                     00138000
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,           00138100
  STC771,STC172,STC772,STC773,STC174,STC175,STC775,    00138200
  TWREF,RMOIS,RVS,RPIX,RMETL,RGLAS,RPLAS,RASH,PNOIS,  00138300
  TBTNR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THONC,THCRD       00138400
  PFAL*4 NGCC,NGCCA,NGOMC,NGE,METLCR,MOISR,           00138500
  METLR,MOISP,NGMETL,MGLIFE                             00138600
DATA UCRMET,OMCCR/17.,0.2/                             00138700
DATA NGCC,MGLIFE,EPMG/52800.,15.,0.85/                 00138750
DATA ACCC,ACLIFE,ACDEN/313150.,15.,1000./              00138800
DATA EPMETL,EFGLAS,EPPLAS,EPASH,EPVS/0.9,0.85,0.5,0.8,0.1/ 00138900
DATA CVCC,AUXCC,CVLIFE,AUXLIF/36255.,101385.,15.,15./  00139000
DATA PAC,PHG,PCONV/540.,25.,50./                       00139100
CPR(XINT,DLIFE)=XINT/(1.-(1.+XINT)**(-DLIFE))          00139200
STCI=(STC775/STC174)                                    00139300
NGCC=NGCC*STCI                                           00139400
NGCCA=NGCC*CRP(XINT,MGLIFE)/(360.*24.)                 00139500
NGE=PHG*C10                                              00139600
NGOMC=NGCCA*OMCCR                                        00139700
TCMG=NGCCA+NGOMC                                         00139800
NGMETL=RMETL*EPMG                                        00139900
METLCR=NGMETL*UCRMET/2000.                              00140000
ACCCA=ACCC*CRP(XINT,ACLIFE)/(360.*24.)                 00140100
CVCCA=CVCC*CRP(XINT,CVLIFE)/(360.*24.)                 00140200
AUXCCA=AUXCC*CRP(XINT,AUXLIF)/(360.*24.)               00140300
ACE=PAC*C10                                              00140400
CONVE=PCONV*C10                                          00140500

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	BTUC=MGE+ACR+CONVE	00141000
	ACOMC=(ACCCA+CVCCA+AUXCCA)*OMCCR	00141020
	TCAC=ACCCA+ACOMC	00141040
	HCOST=TCNG+TCAC	00141060
	ACHETL=(RMETL-MGMETL)*EFMETL	00141100
	ACGLAS=RGLAS*EPGLAS	00141200
	ACPLAS=RPLAS*EPPLAS	00141300
	ACASH=RASH*EPASH	00141400
	ACVS=RVS*EFVS	00141500
	ACPIX=ACHETL+ACGLAS+ACPLAS+ACASH	00141600
	ACVMOI=ACVS*CVMOIS	00141700
	ACFMOI=(ACPLAS+ACASH)*CFMOIS	00141800
	ACHOIS=ACVMOI+ACFMOI	00141900
	ACRES=ACVS+ACPIX+ACHOIS	00142000
	ACVRES=ACRES/ACDEN	00142500
	METLR=RMETL-MGMETL-ACHETL	00142600
	GLASR=RGLAS-ACGLAS	00142700
	PLASR=RPLAS-ACPLAS	00142800
	ASHR=RASH-ACASH	00142900
	VSR=RVS-ACVS	00143000
	FIXR=RFIX-ACPIX-MGMETL	00143100
	MOISF=PMOIS-ACFMOI	00143120
	NOISR=PMOIS-ACHOIS	00143200
	REFRT=VSR+FIXR+NOISR	00143300
	TBTUA=TBTUA-ACVS*RHV	00143400
	TBTUC=TBTUC+BTUC	00144500
	THCRD=THCRD+METLCR	00144600
	THCCA=THCCA+MGCCA+ACCCA+CVCCA+AUXCCA	00144700
	THOMC=THOMC+MGOMC+ACOMC	00144800
	TCC=TCC+MGCC+ACCC+CVCC+AUXCC	00144900
	WRITE(IOUT,2881)TWREP,TBTUA,BTUC,HCOST	00145000
2881	FORMAT(// ' ***** DESIGN INPUT AND OUTPUT DATA FOR SEPARA' //	00145100
1	1 ' REFUSE FLOW RATE.....',2X,F10.2,' LBS/HR',//	00145400
1	1 ' ENERGY AVAILABLE.....',2X,E10.3,' BTU/HR',//	00145500
1	1 ' ENERGY CONSUMED.....',2X,E10.3,' BTU/HR',//	00145600
1	1 ' HOURLY COST TOTAL.....',2X,F10.2,' \$/HR',//	00145900
	IF(.NOT.(EQ.2)) GO TO 2920	00146200
	WRITE(IOUT,2901)	00146300
2901	FORMAT(// ' MASS FLOW' //	00146400
1	1 ' IN' //	00146500
	CALL OUT1(IOUT,TWREP,PMOIS,RVS,RFIX,RMETL,RGLAS,	00146600
1	1 RPLAS,RASH,PMOIS)	00146700
	WRITE(IOUT,2906)	00147100
2906	FORMAT(// ' OUT' //	00147200
	CALL OUT1(IOUT,REFRT,NOISR,VSR,FIXR,METLR,GLASR,	00147300
1	1 PLASR,ASHR,MOISF)	00147400
	WRITE(IOUT,2907)	00147500
2907	FORMAT(// ' RESIDUE' //	00147600
	CALL OUT1(IOUT,ACRES,ACHOIS,ACVS,ACPIX,ACHETL,ACGLAS,	00147700
1	1 ACPLAS,ACASH,ACFMOI)	00147800
	WRITE(IOUT,2909)MGMETL	00147900
2909	FORMAT(// ' RECOVERY' //	00148000
1	1 ' METAL.....',2X,F10.2,' LBS/HR',//	00148100
	WRITE(IOUT,2908)TBTUA,BTUC,MGE,ACE,CONVE	00148200
2908	FORMAT(// ' ENERGY BALANCE' //	00148300
1	1 ' AVAILABLE.....',2X,E10.3,' BTU/HR',//	00148400
1	1 ' CONSUMED.....',2X,E10.3,' BTU/HR',//	00148500
1	1 ' MAG. SEP.....',2X,E10.3,' BTU/HR',//	00148600

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1      ' A.C. SPP.....',2X,F10.3,' BTU/HR',/      00148700
1      ' CONVEYOR.....',2X,F10.3,' BTU/HR')      00148720
WRITE(IOUT,2910)HGCC,ACCC,CVCC,AUXCC,      00148800
2910  HCCST, HGCCA,ACCCA,CVCCA,AUXCCA,HGOMC,ACOMC,NETLCR      00148820
      FORMAT('/' COST BALANCE'//      00148900
1      ' CAPITAL INVESTMENTS'//      00149000
1      ' MAG. ....',2X,F10.2,' $',/      00149100
1      ' A.C. ....',2X,F10.2,' $',/      00149120
1      ' CONVEYOR.....',2X,F10.2,' $',/      00149140
1      ' AUX. PAC. ....',2X,F10.2,' $',/      00149160
1      ' HOURLY TOTAL.....',2X,F10.2,' $/HR',/      00149200
1      ' CAPITAL AMORTIZED',/      00149220
1      ' MAG. ....',2X,F10.2,' $/HR',/      00149240
1      ' A.C. ....',2X,F10.2,' $/HR',/      00149260
1      ' CONVEYOR.....',2X,F10.2,' $/HR',/      00149270
1      ' AUX.PAC. ....',2X,F10.2,' $/HR',/      00149280
1      ' OPERATION AND MAINTENANCE',/      00149300
1      ' MAG. ....',2X,F10.2,' $/HR',/      00149400
1      ' A.C. TOTAL.....',2X,F10.2,' $/HR',/      00149500
1      ' METAL SAL* CREDIT*.....',2X,F10.2,' $/HR')      00149700
2920  RETURN      00149800
      END      00149900
SUBROUTINE SEWAGE(TWWS,SMOIS,STS,SVS,SPIX,SHV,
1      SL,CSLTS,CSLVS,TWDSS)      00150000
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,      00150100
1      STC771,STC172,STC772,STC773,STC174,STC175,STC775,      00150200
1      TWREF,RMOIS,RVS,RPIX,RNETL,RGLAS,RPLAS,RASH,PNOIS,      00150250
1      TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD      00150300
      RYAL*U MIXCC,MIXCCA,MIXOMC,MIXE,MXLIFE      00150400
      DATA UCRED,OMCCR/50.,0.2/      00150500
      DATA MIXCC,PNPCC,MXLIFE/10000.,7500.,20.,20./      00150600
      DATA PMIX,PPUMP/100.,100./      00150700
      CPR(XINT,DLIFE)=XINT/(1.-(1.+XINT)**(-DLIFE))      00150710
      STCI=(STC775/STC773)      00150720
      SLMOIS=RMOIS+SMOIS      00150730
      SLTS=RVS+RPIX+SVS+SPIX      00150800
      SL=SLMOIS/SLTS      00150900
      SLVS=RVS+SVS      00151000
      SPIX=RPIX+SPIX      00151100
      CSLMOI=SLMOIS/SL      00151200
      CSLTS=1.-CSLMOI      00151300
      CSLVS=SLVS/SLTS      00151400
      CSLPIX=1.-CSLVS      00151500
      MIXCC=MIXCC*STCI      00151600
      MIXCCA=MIXCC*CRR(XINT,MXLIFE)/(360.*24.)      00151700
      MIXOMC=MIXCCA*OMCCR      00151710
      PNPCC=PNPCC*STCI      00151800
      PNPCCA=PNPCC*CRR(XINT,PLIFE)/(360.*24.)      00151900
      PNPOMC=PNPCCA*OMCCR      00151910
      MIXE=PMIX*C10      00152000
      PUMP=PPUMP*C10      00152100
      BTUC=MIXE+PUMP      00152200
      TCMIX=MIXCCA+MIXOMC      00152210
      TCPUMP=PNPCCA+PNPOMC      00152300
      HCCST=TCMIX+TCPUMP      00152400
      TBTUA=TBTUR+TBTUS      00152500
      TBTUC=TBTUC+MIXE+PUMP      00152600
      THCCA=THCCA+MIXCCA+PNPCCA      00152700

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THOMC=THOMC+MIXOMC+PNPOMC
CRDISS=UCHEDS*TWDSS/2000.
THCRD=THCRD+CRDISS
TCC=TCC+MIXCC+PNPCC
WRITE(IOUT,3241)TWREF,TWWS,SL,TBTUA,BTUC,HCCST
3241  FORMAT(///' ***** DESIGN INPUT AND OUTPUT DATA FOR SEWAGE'//
      ' REPOSE FLOW RATE.....',2X,F10.2,' LBS/HR',/
      ' SEWAGE FLOW RATE.....',2X,F10.2,' LBS/HR',/
      ' SLURRY FLOW RATE.....',2X,F10.2,' LBS/HR',/
      ' ENERGY AVAILABLE.....',2X,F10.3,' BTU/HR',/
      ' ENERGY CONSUMED.....',2X,F10.3,' BTU/HR',/
      ' HOURLY COST TOTAL.....',2X,F10.2,' $/HR')
      IF(IOP.EQ.2) GO TO 3290
      WRITE(IOUT,3256)
3256  FORMAT(///' MASS FLOW'//
      ' IN'///,' REPOSE')
      CALL OUT(IOUT,TWREF,RMOIS,RVS,RPIX,RMETL,RGLAS,
      RPLAS,RASH,RMOIS)
      WRITE(IOUT,3261)TWWS,SMOIS,SVS,SPIX
3261  FORMAT(///' SEWAGE'//
      ' SEWAGE SLUDGE TOTAL....',2X,F10.2,' LBS/HR',/
      ' MOISTURE.....',2X,F10.2,' LBS/HR',/
      ' VOLATILE SOLIDS.....',2X,F10.2,' LBS/HR',/
      ' FIXED SOLIDS.....',2X,F10.2,' LBS/HR')
      WRITE(IOUT,3268) SL,SLMOIS,SLTS,SLVS,SLFIX,
      CSLMOI,CSLTS,CSLVS,CSLPIX
3268  FORMAT(///' OUT'//
      ' SLURRY TOTAL.....',2X,F10.2,' LBS/HR',/
      ' MOISTURE.....',2X,F10.2,' LBS/HR',/
      ' TOTAL SOLIDS.....',2X,F10.2,' LBS/HR',/
      ' VOLATILE SOLIDS.....',2X,F10.2,' LBS/HR',/
      ' FIXED SOLIDS.....',2X,F10.2,' LBS/HR',/
      ' CONCENTRATION'//
      ' MOISTURE.....',2X,F10.2,' LBS/LB',/
      ' TOTAL SOLIDS.....',2X,F10.2,' LBS/LB',/
      ' VOLATILE SOLIDS.....',2X,F10.2,' LBS/LB(TS)',/
      ' FIXED SOLIDS.....',2X,F10.2,' LBS/LB(TS)')
      WRITE(IOUT,3274)TBTUA,MIXE,PUMPE
3274  FORMAT(///' ENERGY BALANCE'//
      ' AVAILABLE.....',2X,F10.3,' BTU/HR',/
      ' CONSUMED'//
      ' MIXING.....',2X,F10.3,' BTU/HR',/
      ' PUMPING.....',2X,F10.3,' BTU/HR')
      WRITE(IOUT,3276)MIXCC,PNPCC,HCCST,MIXCCA,PNPCCA,
      MIXOMC,PNPOMC,CRDISS
3276  FORMAT(///' COST BALANCE'//
      ' CAPITAL INVESTMENTS',/
      ' MIXING TANK.....',2X,F10.2,' $',/
      ' PUMPING.....',2X,F10.2,' $',/
      ' HOURLY TOTAL.....',2X,F10.2,' $/HR',/
      ' CAPITAL AMORTIZED',/
      ' MIXING TANK.....',2X,F10.2,' $/HR',/
      ' PUMPING.....',2X,F10.2,' $/HR',/
      ' OPERATION AND MAINTENANCE',/
      ' MIXING TANK.....',2X,F10.2,' $/HR',/
      ' PUMPING.....',2X,F10.2,' $/HR',/
      ' SLUDGE DISP. CREDIT....',2X,F10.2,' $/HR')
3290  RETURN

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	1	REPLAS, RASH, PMOIS)	00164500
		WRITE(IOUT, 203) TNKCC, NCOST, TNKCCA, CAUCMC, CAUS, HEATC	00164600
203		FORMAT(// ' COST BALANCE' //	00164700
	1	' CAPITAL INVESTMENT... '2X, F10.2, ' \$' /	00164800
	1	' HOURLY TOTAL..... '2X, F10.2, ' \$/HR' /	00164900
	1	' CAPITAL AMORTIZED... '2X, F10.2, ' \$/HR' /	00165000
	1	' OP. AND MAINT..... '2X, F10.2, ' \$/HR' /	00165050
	1	' CHEMICAL ADDITION... '2X, F10.2, ' \$/HR' , /	00165100
	1	' HEATING COST..... '2X, F10.2, ' \$/HR')	00165150
		WRITE(IOUT, 204) NTNK	00165200
204		FORMAT(// ' NO. OF TRTMT. TANKS. '2X, I10, //)	00165300
		RETURN	00165400
		END	00165500

C		00100020
C		00100040
C		00100060
C		00100080
	COMMON IN, IOUT, INOP, ICOP, C5, C6, C10, XINT, ICT,	00100100
1	STC771, STC172, STC772, STC773, STC174, STC175, STC775,	00100150
1	TBTUR, TBTUS, TBTUC, TBTUA, TCC, THCCA, THOMC, THCRD,	00100200
1	TBTUC, PHCRD, PHCCA, PHOMC, FCC, RECYCL,	00100300
1	DDBTUC, DDHCRD, DDHCCA, DDHOMC, DDCC,	00100400
1	IDIG, IGC, IDEW, IINC, INAG, ILAN, ISUM	00100500
	REAL*4 INCRS, INCRV, INCDRN, INCCC, INCCA	00100600
	DATA SURCHG/1./	00100625
	DIMENSION DSCRIB(20)	00100650
310	CALL IFILE(1, 'TEMP')	00100700
	READ(1, 101) IN, IOUT, INOP, ICOP, ICT, C5, C6, C10, XINT, THCAUS,	00100900
1	STC771, STC172, STC772, STC773, STC174, STC175, STC775,	00100850
1	TBTUR, TBTUS, TBTUC, TBTUA, TCC, THCCA, THOMC, THCRD,	00100900
1	SL, CSLTS, CSLVS, CSTS, RVS, RPIX, SVS, SPIX, CAUS,	00101000
1	SCMETL, SCGLAS, SCPLAS, SCASH, SCFMOI, SCRES, SCVRES,	00101100
1	ACMETL, ACGLAS, ACPLAS, ACASH, ACMOIP, ACRES, ACVRPS	00101200
101	FORMAT(51, 4F, E, 7F, 4E, 2X, /, 27P)	00101250
	END FILE 1	00101255
	WRITE(5, 70)	00101256
70	FORMAT(' DESCRIBE THIS RUN')	00101257
	READ(5, 71) DSCRIB	00101258
71	FORMAT(20A4)	00101259
	WRITE(5, 104)	00101260
104	FORMAT(' NEED FRONT-END SUMMARY?')	00101270
	READ(IN, 102) IFE	00101280
	WRITE(5, 106)	00101300
106	FORMAT(' OUTPUT MODE, LP=3 OR TTY=5?')	00101302
	READ(IN, 102) IOUT	00101303
	WRITE(5, 90)	00101305
90	FORMAT(' INPUT REFUSE FLOW RATE(TONS/DAY)')	00101310
	READ(IN, 91) REPTON	00101315
91	FORMAT(F)	00101320
	IF(IOUT.EQ.5) GO TO 95	00101321
	WRITE(IOUT, 96) DSCRIB, REPTON	00101322
96	FORMAT(' ', 20A4, /, ' REFUSE FLOW RATE',	00101323
1	' (TONS/DAY)=' , P10, 2)	00101324
95	IF(REPTON.EQ.1000.) GO TO 92	00101325
	SCALE=REPTON/1000.	00101327
	TBTUR=TBTUR*SCALE	00101330
	TBTUS=TBTUS*SCALE	00101335
	TBTUA=TBTUR+TBTUS	00101340
	TBTUC=TBTUC*SCALE	00101345
	THCAUS=THCAUS*SCALE	00101346
	CAUS=CAUS*SCALE**0.6	00101347
	TCC=TCC*SCALE**0.6	00101350
	THCCA=THCCA*SCALE**0.6	00101355
	THOMC=THOMC*SCALE**0.6	00101360
	THCRD=THCRD*SCALE	00101365
	SL=SL*SCALE	00101370
	RVS=RVS*SCALE	00101375
	RPIX=RPIX*SCALE	00101380
	SVS=SVS*SCALE	00101385
	SPIX=SPIX*SCALE	00101390

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SCMETL=SCMETL*SCALE
SCGLAS=SCGLAS*SCALE
SCPLAS=SCPLAS*SCALE
SCASH=SCASH*SCALE
SCPMOI=SCPMOI*SCALE
SCRFS=SCRFS*SCALE
SCVRES=SCVRES*SCALE
ACHETL=ACHETL*SCALE
ACGLAS=ACGLAS*SCALE
ACPLAS=ACPLAS*SCALE
ACASH=ACASH*SCALE
ACMOIP=ACMOIP*SCALE
ACRFS=ACRFS*SCALE
ACVRES=ACVRES*SCALE
92 HCCOST=THCCA+THOMC+CAUS
   IF (IFE.EQ.0) GO TO 105
   WRITE (IOUT,93) TBTUR,TBTUS,TBTUA,TBTUC,
93 TCC,HCCOST,THCCA,THOMC,CAUS,THCRD
   FORMAT (///' *****FRONT-END SUMMARY'//
1 ' ENERGY BALANCE',/
1 ' REFUSE ENERGY CONTENT.',2X,E10.3,' BTU/HR',/
1 ' SEWAGE ENERGY CONTENT.',2X,E10.3,' BTU/HR',/
1 ' TOTAL ENERGY AVAILABLE',2X,E10.3,' BTU/HR',/
1 ' TOTAL ENERGY CONSUMED.',2X,E10.3,' BTU/HR',/
1 ' COST BALANCE',/
1 ' CAPITAL INVESTMENTS...',2X,F10.2,' $',/
1 ' HOURLY COSTS.....',2X,F10.2,' $/HR',/
1 ' CAPITAL AMORTIZED....',2X,F10.2,' $/HR',/
1 ' OP. AND MAINT.....',2X,F10.2,' $/HR',/
1 ' CAUSTIC FEED.....',2X,F10.2,' $/HR',/
1 ' CREDITS.....',2X,F10.2,' $/HR')
105 TBTUC=TBTUC
   FCC=TCC
   FHCCA=THCCA
   FHOMC=THOMC
   FHCRD=THCRD
   IDIG=1
   IGC=1
   IDEW=1
   IINC=1
   IHAV=1
   ILAN=1
   ISUM=1
220 WRITE (5,153)
153 FORMAT (' NEED OUTPUTS FROM EACH SUBROUTINE?')
   READ (IN,102) IEACH
102 FORMAT (I)
   IF (IEACH.EQ.1) GO TO 155
   WRITE (5,154)
154 FORMAT (' 1 FOR YES, 0 FOR NO; DIG,IGC,DEW,INC,HAV,LAN,SUM')
   READ (IN,103) IDIG,IGC,IDEW,IINC,IHAV,ILAN,ISUM
103 FORMAT (7I)
155 WRITE (5,156)
156 FORMAT (' (1) MODEL DATA OR (2) INPUT YOURSELF?')
   READ (IN,102) INOP
   WRITE (5,157)
157 FORMAT (' (1) LONG OR (2) SHORT OUTPUT?')
   READ (IN,102) IOOP

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00102000
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00102100
00102150
00102200
00102250
00103200
00103300
00103400
00103500
00103600
00103700
00103800
00103900
00104000
00104100
00104200
00104300
00104400
00104500
00104600

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79	WRITE(5,90)	00104625
90	FORMAT(' RECYCLE PERCENT? LIMITS ARE 0 AND 80')	00104651
	READ (5,81) RECYCL	00104671
81	FORMAT(7)	00104701
	IF (ICT.EQ.1) WRITE(IOUT,82)	00104800
82	FORMAT(' CAUSTIC TREATMENT INCLUDED',//)	00104850
	CALL DIGEST(CSTS,SL,CSLTS,CSLVS,SCOUT,EFS,EPVS,PSI,	00104900
1	DIGWTR,CVSOUT,CH4BTU,CH4BEN,THR,HCDIG,H2OREC,	00105000
1	RVS,RPIX,SVS,SPIX,GASCH,CH4CH,CO2GCH,	00105100
1	KFLAG)	00105101
	IF (KFLAG.EQ.1) GO TO 79	00105105
	CALL GCLEAN(GASCH,CH4CH,CO2GCH,HVGC,HCGC)	00105110
	CALL OFILE(20,'OFILE')	00105200
	WRITE(20,201) TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD,	00105300
1	SCOUT,EFS,EPVS,PSI,DIGWTR,CVSOUT,THR,HCDIG,CH4BTU,CH4BEN	00105400
201	FORMAT(168)	00105500
	END FILE 20	00105550
168	CALL IFILE(21,'IFILE')	00105600
	READ(21,201) TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD,SCOUT	00105700
1	,EFS,EPVS,PSI,DIGWTR,CVSOUT,THR,HCDIG,CH4BTU,CH4BEN	00105800
	END FILE 21	00105850
	WRITE(5,120)	00105900
120	FORMAT(//' CENTRIFUGE?')	00106000
	READ(IN,102) ICENT	00106100
	IF (ICENT.EQ.0) GO TO 165	00106200
	CALL CENTR(SCOUT,EFS,EPVS,PSI,DIGWTR,CVSOUT,	00106300
1	CAKE,CAKEVS,CAKEFS,CAKEMO,CAKEVO,H2OREC,SURCHG)	00106400
	GO TO 130	00106500
165	CALL VACFIL(SCOUT,EFS,EPVS,PSI,DIGWTR,CVSOUT,	00106600
1	VICR,VEPVS,VEPFS,PCMR,VOLCR,H2OREC,SURCHG)	00106700
	CAKE=VPCR	00106800
	CAKEVO=VOLCR	00106900
	CAKEVS=VEPVS	00107000
	CAKEFS=VEPFS	00107100
	CAKEMO=PCMR	00107200
130	CALL OFILE(22,'IFILE')	00107300
	WRITE(22,202) CAKE,CAKEVO,CAKEVS,CAKEFS,CAKEMO,	00107400
1	TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD,THR,HCDIG,	00107500
1	CH4BTU,CH4BEN,DBBTUC,DBHCRD,DBHCCA,DBHOMC,DBCC	00107600
202	FORMAT(202)	00107700
	END FILE 22	00107750
300	CALL IFILE(23,'IFILE')	00107800
	READ(23,202) CAKE,CAKEVO,CAKEVS,CAKEFS,CAKEMO,	00107900
1	TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD,THR,HCDIG,	00108000
1	CH4BTU,CH4BEN,DBBTUC,DBHCRD,DBHCCA,DBHOMC,DBCC	00108100
	END FILE 23	00108150
	WRITE(5,151)	00108200
151	FORMAT(//' INCINERATION?')	00108300
	READ(IN,102) INC	00108400
	IF (INC.EQ.0) GO TO 190	00108500
	CALL INCIN(CAKEVS,CAKEFS,CAKEMO,INCRFS,INCRFV,THR,HCDIG,	00108600
1	TBTUL,HVGC,THCAUS)	00108650
	HAULWT=SCRES+ACRES+INCRFS	00108700
	HAULV=SCYRES+ACYRES+INCRFV	00108800
	WRITE(IOUT,160)	00108900
160	FORMAT(//' HAUL RESIDUE FROM SCREEN,SEPARA AND INCIN')	00109000
175	CALL HAUL(HAULWT,HAULV)	00109100
	CALL LANFIL(HAULWT,HAULV)	00109200

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GC TO 180                                00109300
190  HAULMT=SCRES+ACRES+CAKE              00109400
    HAULV=SCVRES+ACVRES+CAKEVO          00109500
    WRITE(IOUT,197)                      00109600
197  FORMAT(/' HAUL RESIDUE FROM SCREEN,SEPARA AND DEWATERING UNIT'/) 00109700
    GO TO 175                             00109800
180  CALL SUMMARY(CH4BTU,CH4BPN,THR,HCDIG,HVGC,HCGC,INC,TBTUL,CAUS) 00109900
    IF(IOUT.EQ.5) GO TO 205              00109950
    WRITE(IOUT,210)                      00109960
205  WRITE(5,210)                        00110050
210  FORMAT(/' WANT TO REPEAT ANALYSIS FROM',/
1    ' (1) F-END, (2) DEWATER, (3) INCIN, OR (4) STOP?') 00110100
    READ(IN,102) IREP                    00110200
    IF(IOUT.EQ.5) GO TO 206              00110300
    WRITE(IOUT,215) IREP                 00110310
215  FORMAT(I)                           00110320
206  IF(IREP.EQ.1) GO TO 310              00110330
    IF(IREP.EQ.4) GO TO 250              00110350
    WRITE(5,230)                         00110360
230  FORMAT(' CHANGE INOP AND IOOP?')   00110400
    READ (5,235) ICH                     00110500
235  FORMAT(I)                           00110501
    IF(ICH.EQ.0) GO TO 245               00110502
    WRITE(5,255)                         00110503
255  FORMAT(' INOP(1 OR 2) AND IOOP(1 OR 2)') 00110504
    READ(5,240) INCP,IOOP                00110505
240  FORMAT(2I)                          00110510
245  IF(IREP.EQ.2) GO TO 164              00110520
    IF(IREP.EQ.3) GO TO 300              00110700
250  STOP                                00110800
    END                                  00111400
    SUBROUTINE DIGEST(CSTS,SL,CSLTS,CSLVS,SCOUT,EPS,EPVS,FSI,
1      DIGWTR,CVSOUT,CH4BTU,CH4BPN,THR,HCDIG,HZOR2C,
1      RVS,RPIX,SVS,SPIX,GASCH,CH4CH,CO2GCH,
1      KFLAG)                            00111600
    COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,
1      STC771,STC172,STC772,STC773,STC174,STC175,STC775,
1      TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCND,
1      PBTUC,PHCRD,PHCCA,PHOMC,FCC,RECYCL,
1      DDBTUC,DDHCRD,DDHCCA,DDHOMC,DDCC,
1      IDIG,IGC,IDEW,IINC,IHAN,ILAN,ISUM 00111700
    DIMENSION BTEMP(6),BDETH(7),BVSDS(6,7) 00111801
    DIMENSION FI(3),B(3),FO(3),TO(3),K(3),A(3),HL(3),VR(5) 00111810
    DIMENSION X(22),Y(22)                 00111900
    REAL*4 K,MP,MPE,MPC,K1,MCR,NIT        00111950
    DATA ALKS,ALKW,R,P,VACID/2.0,0.1,0.0476,0.05,0.2/ 00112000
    DATA NIEMP,NTIME/6,7/                 00112100
    DATA BTEMP/35.,40.,45.,50.,55.,60./ 00112200
    DATA BDETH/4.,6.,8.,10.,15.,20.,30./ 00112300
    DATA X,Y/20.,30.,40.,50.,60.,70.,
1      18.,30.,40.,50.,60.,70.,
1      25.,30.,35.,40.,45.,50.,55.,60.,65.,0.,
1      .108,.139,.173,.217,.258,.3,
1      3.5,4.9,5.0,5.13,5.19,5.24,
1      23.756,31.824,42.175,55.324,71.98,92.51,118.04,
1      149.38,187.54,0./
    DATA BVSDS/.165,.310,.267,.349,.404,.419,
1      .264,.336,.290,.386,.426,.466,

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1	.286,.357,.312,.410,.445,.483,	00114100
1	.298,.368,.323,.422,.452,.496,	00114200
1	.320,.390,.341,.442,.472,.508,	00114300
1	.327,.399,.354,.454,.482,.518,	00114400
1	.340,.407,.364,.461,.491,.524/	00114500
	DATA SWV,SWP,SWW,DENR,DR,C4,C9/1.1,2.5,1.0,62.4,40.,0.075,2./	00114600
	DATA C11,C12,C15,C90/0.433872,1.05752,1000.,1./	00114700
	DATA FI,5/2.0,2.0,2.0,8.,18.,12./	00114800
	DATA PC,TO/1.3,1.3,2.0,12.5,12.5,15.0/	00114900
	DATA K/8.3,8.3,8.3/	00115000
	DATA BW,US/1.0,0.25/	00115100
	DATA NVDATA,VR/5,130000.,500000.,1250000.,1700000.,2000000./	00115200
	DATA T,DTA,SCIN,DLIFE,MCR/60.,10.,0.1,25.,1.0/	00115300
	DATA BNIT,CSLNT,UCNIT,UCPHOS,UCLINE/0.008,0.005,0.15,0.15,25./	00115400
	DATA RECNIT,REFNIT,ALKREF/0.00035,.0068,1.5/	00115450
	CRR=XINT/(1.-(1.+XINT)**(-DLIFE))	00115500
	IF(ICT.EQ.1) ALKREF=4.0	00115550
	TSO=15.	00115575
	IF(INOP.EQ.1) GO TO 885	00115600
400	WRITE(5,410)	00115700
410	FORMAT(/' PROVIDE T(C),DT(D),SCIN(X)')	00115800
	READ(IN,101)T,DTA,SCIN	00115900
101	FORMAT(3F)	00116000
	IF(IOUT.EQ.5) GO TO 886	00116010
	WRITE(IOUT,410)	00116020
	WRITE(IOUT,420)T,DTA,SCIN	00116030
420	FORMAT(3(2X,F5.2))	00116040
886	SCIN=SCIN/100.	00116100
885	CNO=1.-SCIN	00116200
	SLTS=SL*CSLTS	00116300
	SLMOIS=(1.-CSLTS)*SL	00116400
	ADWTR=SLTS/SCIN-SLTS-SLMOIS	00116500
	H2OREC=RECYCL*0.01*(SLMOIS+ADWTR)	00116510
	IF(H2OREC.GE.ADWTR) GO TO 300	00116520
	KFLAG=0	00116530
	ADWTR=ADWTR-H2OREC	00116540
	GO TO 310	00116550
300	EXCESS=H2OREC-ADWTR	00116560
	WRITE(5,305)H2OREC,EXCESS	00116570
305	FORMAT('0000 MUCH RECYCLE CALLED FOR',//	00116580
1	'0AVAILABLE FOR RECYCLE ',F10.2,'LBS/HR',//	00116590
1	'0EXCESS OF ',F10.2,'LBS/HR')	00116591
	KFLAG=1	00116592
	RETURN	00116593
310	SLIN=SL+ADWTR+H2OREC	00116600
	FRATE=SLTS*24.	00116700
	SWDS=(SWV*SWP)/(SWV+CSLTS*(SWP-SWV))	00116800
	SWSL=(SWW*SWDS)/(CNO*SWDS+SCIN*SWW)	00116900
1050	TVD=FRATE*DTA/(SCIN*SWSL*DENV)	00117000
	IF(TVD.LT.VR(1))GO TO 1015	00117100
	IF(TVD.GE.VR(NVDATA)) GO TO 1017	00117200
	GO TO 1020	00117300
1015	NV=2	00117400
	GO TO 1026	00117500
1017	NV=7	00117600
	GO TO 1026	00117700
1020	DC 1025 N=2,NVDATA	00117800
	IF(TVD.LT.VR(N))GO TO 1023	00117900

	GO TO 1025	00118000
1023	NV=N+1	00118100
	GO TO 1025	00118200
1025	CONTINUE	00118300
1026	VD=TV0/NV	00118400
	DTF=VD*(NV-1)*(SCIN*SWSL*DENW)/PRATE	00118500
	IF(DTF.LT.3.) GO TO 1030	00118600
	GO TO 1080	00118700
1030	DTA=DTA+1.	00118800
	IF(IOUT.EQ.5) GO TO 1035	00118850
	WRITE(IOUT,1060)DTA	00118900
1035	WRITE(5,1060)DTA	00118950
1060	FORMAT(' DT ADJUSTED TO',1X,F2.0)	00119000
	GO TO 1050	00119100
1080	IF(T.LT.BTEMP(1)) GO TO 500	00119200
	IF(T.GT.BTEMP(NTEMP)) GO TO 500	00119300
	IF(DTA.LT.BDETH(1)) GO TO 500	00119400
	IF(DTA.GT.BDETH(NTIME)) GO TO 500	00119500
	GO TO 500	00119600
500	IF(IOUT.EQ.5) GO TO 505	00119650
	WRITE(IOUT,510)BTEMP(1),BTEMP(NTEMP),BDETH(1),BDETH(NTIME)	00119700
505	WRITE(5,510)BTEMP(1),BTEMP(NTEMP),BDETH(1),BDETH(NTIME)	00119750
510	FORMAT(' VALUES OUT OF RANGE.',/	00119800
1	' TEMP MUST BE BETWEEN',F6.2,' AND ',F6.2,/'	00119900
1	' DTA MUST BE BETWEEN',F6.2,' AND ',F6.2,/'	00120000
550	DO 570 I=2,NTEMP	00120200
	IF(T.LT.BTEMP(I)) GO TO 600	00120300
570	CONTINUE	00120400
	I=NTEMP	00120500
500	I=I-1	00120600
	DO 630 J=2,NTIME	00120700
	IF(DTA.LT.BDETH(J)) GO TO 650	00120800
630	CONTINUE	00120900
	J=NTIME	00121000
650	J=J-1	00121100
	PRI=(T-BTEMP(I))/(BTEMP(I+1)-BTEMP(I))	00121200
	PRJ=(DTA-BDETH(J))/(BDETH(J+1)-BDETH(J))	00121300
	PVSD=BVSDES(I,J)*(1.+PRI*PRJ-PRI-PRJ)	00121400
1	+BVSDES(I,J+1)*(PRJ-PRI*PRJ)+BVSDES(I+1,J)*(PRI-PRI*PRJ)	00121500
1	+BVSDES(I+1,J+1)*PRI*PRJ	00121600
	H=6.8	00121650
	IF(ICT.EQ.1) CALL DESROY(DTA,PVSD)	00121675
660	PH=10.**(-H)	00121700
	IF(H.GE.8.) STOP	00121750
	I1=1	00121800
	I2=6	00121900
	CALL INTPOR(T,I1,I2,X,Y,Z)	00122000
	HK=Z*10.**7	00122100
	I1=7	00122200
	I2=12	00122300
	CALL INTPOR(T,I1,I2,X,Y,Z)	00122400
	K1=Z*10.**(-7)	00122500
	I1=13	00122600
	I2=21	00122700
	CALL INTPOR(T,I1,I2,X,Y,Z)	00122800
	VP=Z/760.	00122900
	M=1	00122905
	CALL INTERP(RECTCL,ALKREC,M)	00122910

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D      WFIT2(5,9998) RECYCL,ALKREC,HK,PH,DTA,K1,VP,VACID,TVD      00122911
9998   FCNMT('O',9(E14,7))      0012291:
      CC2T=1000.*3.*SCIN*CSLVS*PVSD/(162.*DTA)      0012300:
      BICO=SCIN*ALKS=P/(CSTS*DTA*100.)+(1-RECYCL/100.)*      00123100
1      ALKW/(100.*DTA)*(RECYCL/100.)*ALKREC/(100.*DTA)+      00123101
1      ALKREF/(DTA*100.)      00123102
      AA=18.*HK*PH*DTA/(7.6*10.**5*(PH+K1))      00123200
      BP=1.-VP-AA*BICO/DTA      00123300
      CC=-AA*(CO2T**2+CO2T*BICO/DTA)      00123400
      DD=SQRT(88**2-4.*AA*CC)      00123500
      X1=(-88+DD)/(2.*AA)      00123600
      X2=(-88-DD)/(2.*AA)      00123700
850    IF(X1.GT.X2) GO TO 865      00123800
      CO2G=X2      00123900
      GO TO 870      00124000
865    CO2G=X1      00124100
870    CO2S=(7.6*10.**5*CO2G*(1.-VP))/(18.*HK*(CO2T+CO2G))      00124200
      OH=CO2T-CO2G+VACID/(60.*DTA)-CO2S/DTA-BICO      00124300
      IF(OH.GE.0.) GO TO 871      00124400
      H=9+0.05      00124401
      WRITE(5,872)H      00124402
872    FORMAT(' PH INCREASED TO ',P4.2)      00124403
      IF(IOUT.EQ.5) GO TO 873      00124404
      WRITE(IOUT,872)H      00124405
873    GO TO 660      00124406
871    CONTINUE      00124407
      CO2GCH=CO2G*22.4*TVD/24.      00124500
      CH4CH=CO2T*22.4*TVD/24.      00124600
      GASCH=CO2GCH+CH4CH      00124700
      CAOH2=OH*TVD*28.3*37./(453.*24.)      00124800
      IF(H.GT.6.8)CAOH2=0.      00124850
      CAOH2C=OCLINE*CAOH2/2000.      00124900
D      WRITE(5,9997)CAOH2C,CO2G,CO2S,BICO,OH      00124901
9997   FCNMT('O',5E14,7)      00124902
      NIT=UNIT*SLTS-CSLNIT*(SVS+SPIX)-(H2OREC*RECINIT)-      00125000
1      REPNIT*(RVS+RPIX)      00125025
D      WRITE(5,9966)UNIT,SLTS,CSLNIT,SVS,SPIX,H2OREC,      00125030
D      1 RPNIT,REPINIT,RVS,SPIX      00125035
9966   FCNMT(1X,5E14,6,/,1X,5E14,6)      00125040
      IF(NIT.LE.0.)NIT=0.      00125050
      CNIT=UCNIT*NIT      00125100
      PHOS=(1./5.)*NIT      00125200
      CPHOS=UCPHOS*PHOS      00125300
      IF(TVD.GT.50000.)GO TO 910      00125400
      TCCD=165.*1000.*(STC775/STC771)      00125500
      GO TO 917      00125600
910    IF(TVD.LT.100000.)GO TO 914      00125700
      IF(TVD.LT.300000.)GO TO 916      00125800
      TCCD=10.**{0.987*ALOG10(TVD/1000.)+0.271}*1000.*(STC775/STC771) 00125900
      GO TO 917      00126000
914    TCCD=(1.3*(TVE/1000.)+100.)*1000.*(STC775/STC771)      00126100
      GO TO 917      00126200
916    TCCD=(1.45*(TVD/1000.)+85.)*1000.*(STC775/STC771)      00126300
917    TCCDA=TCCD*CCR/(360.*24.)      00126400
      DIGRC=(CCR/100.)*TCCD/(360.*24.)      00126500
      CH4BTU=CH4CH*C15      00126600
      CH4BEN=(CH4BTU/10.**6)*C9      00126700
      VSI=SLTS*CSLVS      00126800

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PSI=SLTS*(1.-CSLVS)
VSD=VSI*PVSD
DIGWTR=SLMOIS*ADWTR+H2OREC
EPVS=VSI-VSD
EFS=EPVS+PSI
EPSL=DIGWTR+EFS
SCOUT=EFS/EPSL
CVSOUT=EPVS/EFS
NP=CA*(SCOUT/0.04)*(VD/1000.)
MPE=NP*C10
TMPF=NV*MPE
NPC=NP*C5*C6
TMPC=NV*NPC
A(1)=VD/DH
A(3)=A(1)
RD=(A(1)/3.14)**(1./2.)
A(2)=2.*3.14*RD*DH
HLT=0.
DO 1220 I=1,3
HL(I)=A(I)*1.8*(T-TO(I))/((1./PI(I))+(B(I)/K(I))+(1./PO(I)))
HLT=HLT+HL(I)
1220 CONTINUE
D WRITE(IOUT,742) PRATE,SCIN,CMO,UM,US,TSO
742 FORMAT(' ORIGINAL DATA'/' PRATE= ',F10.2/
1 ' SCIN= ',F10.2,5X,' CMO= ',F10.2/
1 ' UM= ',F8.2,5X,' US= ',F8.2,' TSO= ',F5.1)
THLD=NV*HLT
TSO=(1-(RECYCL/100.))*TSO+(RECYCL/100.)*(T-10.)
D WRITE(IOUT,6720)TSO
6720 FORMAT(' AFTER LINE 29150 TSO=',F6.2)
HR=(T-TSO)*1.8*(PRATE/SCIN)*(CMO*UM+SCIN*US)/24.
D WRITE(IOUT,618)HR
618 FORMAT(' HEAT REQUIRED= ',F10.2)
IF(ICT.NE.1) GO TO 920
TDF=T*9./5.+32.
BTUS=(212.-TDF)*(SLMOIS+.25*SLTS)
HR=HR-BTUS
IF(HR.LT.0.)HR=0.
920 WHL=C11*C12**T*(CO2GCH+CH4CH)
THR=THLD+HR+WHL
HCDIG=(THR/10.**6)*C90
HCCOST=TCCDA+TMPC+HCDIG+CAOH2C+CNIT+CPHOS+DIGHC
TBTUL=TBTUA-CH4BTU
TBTUC=TBTUC+THR+TMPF
THCRD=THCRD+CH4BEM
THCCA=THCCA+TCCDA
THONC=THONC+TMPC+HCDIG+CAOH2C+CNIT+CPHOS+DIGHC
TCC=TCC+TCCD
WRITE (IOUT,1299)RECYCL
1299 FORMAT(' RECYCLE IS',F6.2,' PERCENT')
IF(IDIG.EQ.0)GO TO 2780
IF(IOOP.EQ.2)GO TO 2775
WRITE(IOUT,1300)T,DTA,DTP,SCIN,CSLVS,PRATE,
1 TVD,VD,NV,
1 SLMOIS,ADWTR,DIGWTR,SLIS,VSI
WRITE(IOUT,1301)PSI,EFS,EPVS,PSI,VSD,
1 SLIN,EPSL,GASCH,CH4CH,CO2GCH,
1 SCIN,SCOUT,CSLVS,CVSOUT

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00126900
00127000
00127100
00127200
00127300
00127400
00127500
00127600
00127700
00127800
00127900
00128000
00128100
00128200
00128300
00128400
00128500
00128600
00128700
00128800
00128900
00129000
00129010
00129020
00129030
00129040
00129100
00129150
00129160
00129170
00129200
00129205
00129206
00129210
00129220
00129230
00129240
00129250
00129300
00129400
00129600
00129700
00129800
00129900
00130000
00130100
00130200
00130400
00130450
00130475
00130500
00130600
00130700
00130800
00130900
00131000
00131100
00131200

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WRITE(IOUT, 1302) TBTUA, THR, THPE, HR, THLD, WHL, CH4BTU, TBTUL,
1      TCCD, HCCST, TCCDA, TMPC, HCDIG, CAOH2C,
1      DIGMC, CNIT
WRITE(IOUT, 1303) CPHOS, CH4BEN
7300  FORMAT(///' *****DIGESTER SYSTEM OUTPUTS'///
1      ' INPUT DATA'//
1      ' REACTOR TEMPERATURE... ', 2X, F10.2, ' DEG.C'//
1      ' DETENTION TIME(NEW)... ', 2X, F10.2, ' DAYS'//
1      ' DETENTION TIME(PAIL)... ', 2X, F10.2, ' DAYS'//
1      ' TS. CONC. COMING IN... ', 2X, F10.2, ' LBS/LB'//
1      ' VS. CONC. COMING IN... ', 2X, F10.2, ' LBS/LB(TS)'//
1      ' SOLIDS FLOW RATE..... ', 2X, F10.2, ' LBS/DAY'//
1      ' DESIGN OUTPUT DATA'//
1      ' TOT. DIG. VOL..... ', 2X, F10.2, ' CF'//
1      ' EACH DIG. VOL..... ', 2X, F10.2, ' CF'//
1      ' NO. OF DIGESTERS..... ', 5X, I3, ' UNITS'//
1      ' MASS BALANCE'//
1      ' WATER'//
1      ' IN..... ', 2X, F10.2, ' LBS/HR'//
1      ' ADDED..... ', 2X, F10.2, ' LBS/HR'//
1      ' OUT..... ', 2X, F10.2, ' LBS/HR'//
1      ' SOLIDS'//
1      ' TOTAL SOLIDS IN..... ', 2X, F10.2, ' LBS/HR'//
1      ' VOLATILE SOLIDS..... ', 2X, F10.2, ' LBS/HR'//
1301  FORMAT(' FIXED SOLIDS..... ', 2X, F10.2, ' LBS/HR'//
1      ' TOTAL SOLIDS OUT..... ', 2X, F10.2, ' LBS/HR'//
1      ' VOLATILE SOLIDS..... ', 2X, F10.2, ' LBS/HR'//
1      ' FIXED SOLIDS..... ', 2X, F10.2, ' LBS/HR'//
1      ' VS. DESTROYED..... ', 2X, F10.2, ' LBS/HR'//
1      ' SLURRY'//
1      ' IN..... ', 2X, F10.2, ' LBS/HR'//
1      ' OUT..... ', 2X, F10.2, ' LBS/HR'//
1      ' GAS PRODUCTION'//
1      ' TOTAL GAS PRODUCED... ', 2X, F10.2, ' CF/HR'//
1      ' CH4..... ', 2X, F10.2, ' CF/HR'//
1      ' CO2..... ', 2X, F10.2, ' CF/HR'//
1      ' CONCENTRATION'//
1      ' SLURRY CONC.'//
1      ' IN..... ', 2X, F10.3, ' LBS/LB'//
1      ' OUT..... ', 2X, F10.3, ' LBS/LB'//
1      ' VOLATILE SOLIDS CONC.'//
1      ' IN..... ', 2X, F10.2, ' LBS/LB(TS)'//
1      ' OUT..... ', 2X, F10.2, ' LBS/LB(TS)'//
1      ' ENERGY BALANCE'//
1302  FORMAT(' ENERGY AVAILABLE..... ', 2X, E10.3, ' BTU/HR'//
1      ' ENERGY CONSUMED'//
1      ' TOTAL HEAT..... ', 2X, E10.3, ' BTU/HR'//
1      ' MIXING ENERGY..... ', 2X, E10.3, ' BTU/HR'//
1      ' HEAT FOR DIGESTION... ', 2X, E10.3, ' BTU/HR'//
1      ' DIGESTER HEATLOSS... ', 2X, E10.3, ' BTU/HR'//
1      ' WAT. VAP. HEATLOSS... ', 2X, E10.3, ' BTU/HR'//
1      ' ENERGY PRODUCED'//
1      ' HEAT VALUE OF CH4... ', 2X, E10.3, ' BTU/HR'//
1      ' ENERGY LEFT..... ', 2X, E10.3, ' BTU/HR'//
1      ' COST BALANCE'//
1      ' CAPITAL INVESTMENT.... ', 2X, F10.2, ' $'//
1      ' TOTAL COST..... ', 2X, F10.2, ' $/HR'//
1      ' AMORTIZED CAP. COST. ', 2X, F10.2, ' $/HR'//

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1      MIXING COST.....',2X,F10.2,' $/HR'/          00137200
1      HEATING COST.....',2X,F10.2,' $/HR'/          00137300
1      LINE COST.....',2X,F10.2,' $/HR'/            00137400
1      MATERIAL SUPPLY.....',2X,F10.2,' $/HR'/        00137500
1      NITROGEN.....',2X,F10.2,' $/HR'/              00137600
1303   FORMAT(' PHOSPHATE.....',2X,F10.2,' $/HR'/      00137700
1      ' CH4 BENEFIT.....',2X,F10.2,' $/HR'/          00137800
      GO TO 2780                                       00137900
2775   WRITE(IOUT,2776) T,ETA,VD,NV,CH4CH,CH4BTU,HCOST,CH4BEN 00138000
2776   FORMAT(///' DESIGN INPUT AND OUTPUT DATA FOR DIGEST'// 00138100
1      ' TEMPERATURE.....',2X,F10.2,' DEG'/          00138200
1      ' DETENTION TIME.....',2X,F10.2,' DAYS'/        00138300
1      ' EACH DIG. VOL.....',2X,F10.2,' CP'/           00138400
1      ' NO. OF DIGESTERS.....',6X,I3,' UNITS'/         00138500
1      ' CH4 GAS PRODUCED.....',2X,F10.2,' CF/HR'/      00138600
1      ' CH4 ENERGY GAIN.....',2X,E10.3,' BTU/HR'/     00138700
1      ' TOTAL HOURLY COST.....',2X,F10.2,' $/HR'/      00138800
1      ' CH4 BENEFIT.....',2X,F10.2,' $/HR'/          00138900
2780   TBTUA=TBTUL                                     00139000
      RETURN                                           00139100
      END                                              00139200
      SUBROUTINE INTERP(C,D,K)                         00139201
      DIMENSION X(3),Y(3),A(6)                       00139203
      DATA X,A/0.,50.,80.,1.1,1.5,2.,9.3,7.5,5.6/    00139205
      IF (K.EQ.2) GO TO 10                            00139207
      DO 5 I=1,3                                       00139209
5      Y(I)=A(I)                                       00139211
      GO TO 20                                         00139213
10     DO 15 I=1,3                                    00139215
15     Y(I)=A(I+3)                                     00139217
20     DO 30 I=1,3                                    00139219
30     IF(C.LE.X(I)) GO TO 35                         00139221
      WRITE(5,39)                                     00139223
39     FORMAT('ORECYCLE PERCPNT IS BEYOND RANGE OF DATA FOR ',/ 00139225
1      'CALKALINITY OR VACUUM FILTER DATA')          00139227
      STOP                                           00139229
35     IF(K.EQ.2) GO TO 50                            00139230
      IF (C.NE.X(I)) GO TO 40                        00139231
      D=Y(I)                                           00139233
      RETURN                                           00139235
40     J=I-1                                           00139237
      D=Y(J)+((Y(I)-Y(J))/(X(I)-X(J)))*(C-X(J))      00139239
      RETURN                                           00139241
50     IF(C.NE.X(I)) GO TO 60                        00139243
      D=D*Y(I)/Y(1)                                    00139245
      RETURN                                           00139247
60     I1=I-1                                          00139249
      YI=Y(I1)+((Y(I)-Y(I1))/(X(I)-X(I1)))*(C-X(I1)) 00139251
      D=D*YI/Y(1)                                      00139253
      RETURN                                           00139255
      END                                              00139257
      SUBROUTINE DESROY(DTA,PVSD)                     00139259
      DIMENSION DAYS(4),VSD(4)                       00139261
      DATA DAYS/3.,5.,7.5,10./                      00139263
      DATA VSD/.471,.516,.563,.574/                00139265
      IF(DTA.LT.DAYS(1).OR.DTA.GT.DAYS(4)) GO TO 20   00139267
      DO 10 I=2,4                                     00139269
10     IF(DTA.GT.DAYS(I)) GO TO 10                   00139271

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DIFF=VSD(I)-VSD(I-1)
TIME=DAYS(I)-DAYS(I-1)
FRAC=DTA-DAYS(I-1)
PVSD=VSD(I-1)+(FRAC/TIME)*DIFF
RETURN
10 CONTINUE
20 WRITE(5,100)DTA
100 FORMAT(' ',P6.2,' DAY RETENTION TIME IS OUT OF BOUNDS'/
1 ' ' FOR CAUSTIC TREATMENT DATA')
STOP
END
SUBROUTINE INTPCR(D,I1,I2,A,B,C)
DIMENSION A(22),B(22)
DO 30 I=I1,I2
IF(A(I+1).GT.D)GO TO 50
30 CONTINUE
WRITE(5,2846)
2846 FORMAT(' SCOUT OUT OF RANGE')
STOP
50 C=B(I)+(D-A(I))*(B(I+1)-B(I))/(A(I+1)-A(I))
RETURN
END
SUBROUTINE GCLEAN(GASCH,CH4CH,CO2GCH,HVGC,HCGC)
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,
1 STC771,STC172,STC772,STC773,STC174,STC175,STC775,
1 TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD,
1 FBTUC,FHCRD,FHCCA,FHOMC,FCC,RECYCL,
1 DDBTUC,DDHCRD,DDHCCA,DDHOMC,DDCC,
1 IDIG,IGC,IDEW,IINC,INAH,ILAN,ISUM
PFAL*4 NMEA,NMEA,NEACC,NEACCA,NEAOMC,LATHT
DATA NMEA,SPHNV,LATHT/61.08,0.5,1050./
DATA GCLIFE,C90/15.,1.0/
STCI=STC775/STC773
WHEAC=(CO2GCH/359.)*1.5*NMEA
SHEAC=(WHEAC/0.2)*(1./8.34)
NMEA=0.02*WHEAC
STEAM=1.1*SHEAC
HVGC=STEAM*(SPHNV*(300.-212.)+(212.-120.)*LATHT)
HCGC=(HVGC/10.**6)*C90
MFACC=1132000.*((GASCH*24.*30.)/(359.*2000.))/350.)*0.5
1 *STCI
NEACCA=NEACC*XINT/(1.-(1.+XINT)**(-GCLIFE))/(360.*24.)
NEAOMC=0.1*NEACCA
HCOST=NEACCA+NEAOMC+HCGC
TBTUC=TBTUC+HVGC
THCCA=THCCA+NEACCA
THOMC=THOMC+NEAOMC+HCGC
TCC=TCC+NEACC
IF(IGC.EQ.0)GO TO 2900
WRITE(IOUT,2920)GASCH,CH4CH,CO2GCH,WHEAC,NMEA,
2920 HVGC,NEACC,HCOST,NEACCA,NEAOMC,HCGC
FORMAT(' ' *****GAS CLEAN-UP SYSTEM OUTPUTS'///,
1 ' INPUT DATA',//,
1 ' TOTAL GAS IN.....',2X,P10.2,' CF/HR',/
1 ' CH4.....',2X,P10.2,' CF/HR',/
1 ' CO2.....',2X,P10.2,' CF/HR',//
1 ' DESIGN OUTPUT DATA',//
1 ' NEA REQUIRED.....',2X,P10.2,' LBS/HR',/

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1 * MAKE-UP MEA.....',2X,F10.2,' LBS/HR',/ 00140366
1 * HEAT REQUIRED.....',2X,F10.3,' BTU/HR',/ 00140368
1 * CAPITAL INVESTMENTS.....',2X,F10.2,' $',/ 00140370
1 * HOURLY COST TOTAL.....',2X,F10.2,' $/HR',/ 00140372
1 * CAPITAL AMORTIZED.....',2X,F10.2,' $/HR',/ 00140374
1 * OP. AND MAINT.....',2X,F10.2,' $/HR',/ 00140376
1 * HEATING.....',2X,F10.2,' $/HR') 00140377
2900 RETURN 00140378
END 00140380
SUBROUTINE VACFIL(SCOUT,BFS,BFVS,PSI,DIGWTR,CVSOUT,
1 VPCR,VFVS,VFVS,PCNR,VOLCR,H2OREC,SURCHG) 00140400
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT, 00140500
1 STC771,STC772,STC773,STC774,STC175,STC775, 00140650
1 TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD, 00140700
1 FBTUC,FHCRD,FHCCA,PHOMC,PCC,RECTCL, 00140800
1 DDBTUC,DDHCRD,DDHCCA,DDHOMC,DDCC, 00140900
1 IDIG,IGC,IDEU,IINC,IMAU,ILAN,ISUM 00141000
DIMENSION VPCSC(6),VSCOUT(7),VVPLR(6,7),X(6),Y(6) 00141100
REAL*4 MCR 00141200
DATA X/0.,185.,525.,940.,1950.,4450./ 00141300
DATA Y/50000.,200000.,400000.,600000.,1000000.,2000000./ 00141400
DATA VPCSC/0.16,0.18,0.20,0.22,0.24,0.26/ 00141500
DATA VSCOUT/.0199,.03,.04,.05,.06,.07,.09/ 00141600
DATA VVPLR/28.5,22.,18.,11.,7.,5.5, 00141700
1 33.,25.,20.,13.,9.5,7., 00141800
1 41.,32.,24.5,16.5,13.5,9.5, 00141900
1 51.,40.,30.5,22.,18.,12., 00142000
1 63.,50.,37.,29.,23.,15., 00142100
1 76.,61.,45.5,36.5,28.5,18., 00142200
1 103.,84.5,67.,53.,39.,25./ 00142300
DATA V1,V2/554.434,4.98/ 00142400
DATA V5,V6,V7,V8/0.0356,0.87,0.1144,3.27/ 00142500
DATA OPT,Q,PCSC/16.,0.001,0.2/ 00142600
DATA SWV,SWW,SWF,DENW,DLIFE,MCR/1.1,1.,2.5,62.4,20.,5./ 00142700
CHR=XINT/(1.-(1.+XINT)**(-DLIFE)) 00142800
IF(INOP.EQ.1) GO TO 3170 00142900
WRITE(5,370) 00143000
370 FORMAT('/ OP.HR.(HR/D), % S IN FILTRATE, % S IN CAKE') 00143100
READ(IN,101)OPT,Q,PCSC 00143200
101 FORMAT(3F) 00143300
IF(IOUT.EQ.5) GO TO 102 00143310
WRITE(IOUT,370) 00143320
WRITE(IOUT,103) 00143330
103 FORMAT(3(2X,F5.2)) 00143340
102 Q=Q/100. 00143400
PCSC=PCSC/100. 00143500
3170 PWLR=DIGWTR 00143600
DO 22 J=2,6 00143700
IF(PCSC.LE.VPCSC(J)) GO TO 33 00143800
22 CONTINUE 00143900
J=6 00144000
IF(IOUT.EQ.5) GO TO 3710 00144050
WRITE(IOUT,3711) 00144100
3710 WRITE(5,3711) 00144150
3711 FORMAT(1X,' WARNING---CAKE SOLIDS CONCENTRATION EXTRAPOLATED.') 00144200
33 DO 44 K=1,7 00144300
IF(SCOUT.LE.VSCOUT(K)) GO TO 55 00144400
44 CONTINUE 00144500

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55	VPLR1=({SCOUT-VSCOUT(K-1)}*(VFLR(J,K)-VFLR(J,K-1)))/	00144600
1	{VSCOUT(K)-VSCOUT(K-1)}+VFLR(J,K-1)	00144700
	VPLR2=({SCOUT-VSCOUT(K-1)}*(VFLR(J-1,K)-VFLR(J-1,K-1)))/	00144800
1	{VSCOUT(K)-VSCOUT(K-1)}+VFLR(J-1,K-1)	00144900
	VPLR=({VPCSC(J)-PCSC}* (VPLR2-VPLR1))/ (VPCSC(J)-VPCSC(J-1))	00145000
1	+VPLR1	00145100
	M=2	00145150
	CALL INTERP(RECYCL,VPLR,M)	00145175
	IF(VPLR.LT.3.) VPLR=3.	00145200
	VFA=EFS/VPLR	00145300
	FVFA=VFA*24./OPT	00145400
	NVP=({RVFA-901)/900)+2	00145500
	VPIA=FVFA/NVP	00145600
	IF(OPT.EQ.24.0) GO TO 305	00145700
	IF(NVP.GE.24./(24.-OPT)) GO TO 330	00145800
305	NVP=NVP+1	00145900
	VPIA=VFA/(NVP-1)	00146000
330	RVFA=VPIA*NVP	00146100
	Z=RVFA	00146200
	IF(Z.EQ.0.0) GO TO 410	00146300
	GO TO 415	00146400
410	VCC=0.	00146500
	VPC=0.	00146600
	GO TO 430	00146700
415	DO 419 I=2,6	00146800
	IF(X(I).GT.Z) GO TO 418	00146900
419	CONTINUE	00147000
	I=6	00147100
418	VCC=Y(I-1)+(Z-X(I-1))/(X(I)-X(I-1))*(Y(I)-Y(I-1))	00147200
420	VPC=VCC*(STC775/STC771)	00147300
430	VPC=({MCR/100.)*VPC/(360.*24.)	00147400
	PCNO=1.-PCSC	00147500
	PTSL=(Q*(FPLR)-Q*EFS*PCNO/PCSC)/(1.-Q-Q*PCNO/PCSC)	00147600
	VEFS=EFS-PTSL	00147700
	VEFS=VEFS*(EFS/EFS)	00147800
	VEFS=VEFS*(PSI/EFS)	00147900
	PCNR=VEFS*PCNO/PCSC	00148000
	FGPM=(FPLR-PCNR)*7.48/(62.4*60.)	00148100
	VPHP=V5*FGPM+V6	00148200
	VPTU=VPHP*C10	00148300
	VOHP=V7*VFA+V8	00148400
	VTHP=VPHP+VOHP	00148500
	VOBTU=VOHP*C10	00148600
	VBTU=VTHP*C10	00148700
	VFOC=VTHP*C5*C6	00148900
	VPCAY=VPC*CRR	00149000
	VPCAH=VPCAY/(360.*24.)	00149100
	HCOST=VPCAH+VFOC+VPC	00149200
	VPCR=VEFS/PCSC	00149300
	VSWDS=(SWV*SWF)/(SWV+CVSOUT*(SWF-SWV))	00149400
	VSWC=(SWV*VSWDS)/((1.-PCSC)*VSWDS+(PCSC*SWV))	00149500
	VOLCR=VPCR/(DENW*VSWC)	00149600
	PLTR=(FPLR-PCNR)	00149700
	DISCHG=PLTR-H2OREC	00149710
	IF(DISCHG.LE.0.) DISCHG=0.	00149720
	DISPOS=DISCHG*SURCHG*7.48/(62.4*1000.)	00149730
	HCOST=HCOST+DISPOS	00149740
	TBTUL=TBTUA	00149800

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TBTUC=TBTUC+VBTU
THCRD=THCRD
THCCA=THCCA+VFCCA
THOMC=THOMC+VPOC+VFMC+DISPOS
TCC=TCC+VFCC
DDBTUC=TBTUC-FBTUC
DDHCRD=THCRD-FHCRD
DDHCCA=THCCA-FHCCA
DDHOMC=THOMC-FHOMC
DDCC=TCC-FCC
IF (IDEM.EQ.0) GO TO 4020
IF (IOOP.EQ.2) GO TO 4015
WRITE(IOUT,800) OPT,PCSC,0,SCOUT,CVSOUT,EFS,
1 VFA,VPFA,VFP,VPIA,VFLR,FWR,FMR,PLTR
WRITE(IOUT,801) EFS,VDFS,PTSL,VPCR,FGPM,SCOUT,PCSC,0,
1 TBTUA,VBTU,VTHP,VPBTU,VPHF,VOSTU,VOHP
800 WRITE(IOUT,802) TBTUL,VFCC,HOCST,VFCCA,VPOC,VFMC,DISPOS
FORMAT(' *****VACUUM FILTER SYSTEM OUTPUTS'//)
1 ' INPUT DATA'//
1 ' OPERATING TIME.....',2X,F10.2,' HRS'//
1 ' CAKE SOLIDS CONC.....',2X,F10.2,' LBS/LB'//
1 ' FILTRATE SOLIDS CONC...',2X,F10.3,' LBS/LB'//
1 ' TS. CONC. COMING IN...',2X,F10.2,' LBS/LB'//
1 ' VS. CONC. COMING IN...',2X,F10.2,' LBS/LB(TS)'//
1 ' SOLIDS FLOW RATE IN...',2X,F10.2,' LBS/HR'//
1 ' DESIGN OUTPUT DATA'//
1 ' CALC. FILT. AREA.....',2X,F10.2,' SF'//
1 ' REQUIRED FILT. AREA...',2X,F10.2,' SF'//
1 ' NO. OF VAC. FILTERS...',6X,I3,' UNITS'//
1 ' EACH FILTER AREA.....',2X,F10.2,' SF'//
1 ' VAC. FILT. LOADING.....',2X,F10.2,' LBS/SP-HR'//
1 ' MASS BALANCE'//
1 ' WATER'//
1 ' IN.....',2X,F10.2,' LBS/HR'//
1 ' OUT'//
1 ' CAKE.....',2X,F10.2,' LBS/HR'//
1 ' FILTRATE.....',2X,F10.2,' LBS/HR'//
801 FORMAT(' SOLIDS'//)
1 ' IN.....',2X,F10.2,' LBS/HR'//
1 ' OUT'//
1 ' CAKE.....',2X,F10.2,' LBS/HR'//
1 ' FILTRATE.....',2X,F10.2,' LBS/HR'//
1 ' CAKE PRODUCTION.....',2X,F10.2,' LBS/HR'//
1 ' FILTRATE FLOW.....',2X,F10.2,' GPM'//
1 ' CONCENTRATION'//
1 ' SOLIDS IN.....',2X,F10.2,' LBS/LB'//
1 ' CAKE SOLIDS.....',2X,F10.2,' LBS/LB'//
1 ' FILTRATE SOLIDS.....',2X,F10.3,' LBS/LB'//
1 ' ENERGY BALANCE'//
1 ' ENERGY AVAILABLE.....',2X,F10.3,' BTU/HR'//
1 ' ENERGY CONSUMED'//
1 ' TOTAL ENERGY.....',2X,F10.3,' BTU/HR'//
1 ' IN H.P.....',2X,F10.2,' HP'//
1 ' FILTRATE PUMP.....',2X,F10.3,' BTU/HR'//
1 ' IN H.P.....',2X,F10.2,' HP'//
1 ' VAC. FILTER.....',2X,F10.3,' BTU/HR'//
1 ' IN H.P.....',2X,F10.2,' HP'//
802 FORMAT(' ENERGY LEFT.....',2X,F10.3,' BTU/HR'//)

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1 * COST BALANCE'//
1 * CAPITAL INVESTMENT.....',F10.0,' $'/
1 * TOTAL COST.....',2X,F10.2,' $/HR'/
1 * AMORTIZED CAP.....',2X,F10.2,' $/HR'/
1 * POWER.....',2X,F10.2,' $/HR'/
1 * MATERIALS SUPPLY.....',2X,F10.2,' $/HR'/
1 * WASTEWATER TRTMT.....',2X,F10.2,' $/HR')
GO TO 4020
4015 WRITE(IOUT,4016)SCOUT,EFS,EFVS,RVFA,OPT,NVF,HCOST
4016 FORMAT(///' DESIGN INPUT AND OUTPUT DATA FOR VACFIL'//
1 * SLURRY CONC.....',2X,F10.2,' LBS/LB'/
1 * TOTAL SOLIDS IN.....',2X,F10.2,' LBS/HR'/
1 * VOLATILE SOLIDS IN.....',2X,F10.2,' LBS/HR'/
1 * VAC. FIL. AREA.....',2X,F10.2,' SP'/
1 * OPERATION TIME.....',2X,F10.2,' HRS'/
1 * NO. OF FILTERS.....',6X,I3,' UNITS'/
1 * HOURLY COST TOTAL.....',2X,F10.2,' $/HR')
4020 TBTUA=TBTUL
RETURN
END
SUBROUTINE CENTR(SCOUT,EFS,EFVS,FSI,DIGWTR,CVSOUT,
1 CAKE,CAKEVS,CAKEFS,CAKEHO,CAKEVO,H2OREC,SURCHG)
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,
1 STC771,STC172,STC772,STC773,STC174,STC175,STC775,
1 TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD,
1 PBTUC,PHCRD,PHCCA,PHOMC,PCC,RECYCL,
1 DOBTUC,DOHCRD,DOHCCA,DOHOMC,DDCC,
1 IDIG,IGC,IDEW,IINC,INAD,ILAN,ISUM
REAL*4 LRATE,NCR,LR
DATA C16,C17,LRATE/10722.727,-210.545,225./
DATA UCCENT,UCBLD,UREA,RINST/125000.,40.,1000.,0.5/
DATA DLIPE,UP,NCR/10.,200.,5./
CCAKE=35.
CCEN=0.1
CRR=XINT/(1.-(1.+XINT)**(-DLIPE))
STCI=STC775/STC175
IF(INOP.EQ.1)GO TO 200
WRITE(5,100)
100 FORMAT(' PROVIDE %CAKE AND %CENTRATE SOLIDS')
READ(IN,101)CCAKE,CCEN
101 FORMAT(2F)
IF(IOUT.EQ.5)GO TO 102
WRITE(IOUT,100)
WRITE(IOUT,103)CCAKE,CCEN
103 FORMAT(2(2X,F6.3))
102 IF(CCAKE.LE.35.)GO TO 200
IF(IOUT.EQ.5)GO TO 250
WRITE(IOUT,300)
250 WRITE(5,300)
300 FORMAT(' DATA NOT COMPLETELY RELIABLE')
200 SRATE=C16+C17*CCAKE
NCRUN=(EFS/SRATE)*0.5
NCACT=NCRUN+1
SR=EFS/NCRUN
LR=DIGWTR/NCRUN
LRATE=LRATE*62.4*60./7.48
N=(DIGWTR/LRATE)*0.5
IF(N.LE.1)N=1
00155700
00155800
00155900
00156000
00156100
00156200
00156250
00156300
00156400
00156500
00156600
00156700
00156800
00156900
00157000
00157100
00157200
00157300
00157400
00157500
00157600
00157700
00157800
00157850
00157900
00158000
00158100
00158200
00158300
00158400
00158500
00158600
00158650
00158660
00158700
00158750
00158760
00158800
00158900
00159000
00159100
00159110
00159120
00159130
00159140
00159200
00159250
00159300
00159350
00159400
00159500
00159600
00159700
00159800
00159900
00160000
00160100
00160200

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IF (N.LE.NCRUN) GO TO 400
NCRUN=N
NCACT=N+1
SR=EPS/NCRUN
LR=DIGWTR/NCRUN
400 CCAKE=(SRATP-C15)/C17
CCENT=NCACT*UCCENT*STCI
CCINST=BINST*CCENT*STCI
CCBLD=UAREA*NCACT*UCBLD*STCI
TCAPT=CCENT*CCINST*CCBLD
CENCCA=TCAPT*CRR/(360.*24.)
P=UP*NCRUN*C10
PC=UP*NCRUN*C5*C6
CENMC=(MCP/100.)*TCAPT/(360.*24.)
HCCOST=CENCCA+PC+CENMC
CCAKE=CCAKE/100.
CCEN=CCEN/100.
CENTS=CCEN*(DIGWTR-EPS*(1.-CCAKE)/CCAKE)/(1.-CCFN-
1 CCEN*((1.-CCAKE)/CCAKE))
CENMO=CENTS*(1.-CCEN)/CCEN
DISCHG=CENMO-H2OPEC
IF (DISCHG.LE.0.) DISCHG=0.
DISPOS=DISCHG*SURCHG*7.48/(62.4*1000.)
HCCOST=HCCOST+DISPOS
CEN=CENTS+CENMO
CAKETS=EPS-CENTS
CAKEVS=CAKETS*(EPS/EPS)
CAKEPS=CAKETS*(PSI/EPS)
CAKEMO=CAKETS*(1.-CCAKE)/CCAKE
CAKE=CAKETS+CAKEMO
CAKEVO=CAKE/62.4
TBTUL=TBTUA
TBTUC=TBTUC+P
THCRD=THCRD
THCCA=THCCA+CENCCA
THOMC=THOMC+PC+CENMC+DISPOS
TCC=TCC+TCAPT
DDBTUC=TBTUC-PBTUC
DDHCRD=THCRD-PHCRD
DDHCCA=THCCA-PHCCA
DDHOMC=THOMC-PHOMC
DDCC=TCC-PCC
IF (IDEN.EQ.0) GO TO 600
IF (IDOP.EQ.2) GO TO 550
WRITE (IOUT,500) CCAKE,CCEN,SCOUT,CVSOUT,EPS,DIGWTR,
1 SR,LR,NCRUN,NCACT,
1 DIGWTR,CAKEMO
WRITE (IOUT,501) CENMO,EPS,CAKETS,CENTS,CAKE,CEN,SCOUT,CCAKE,CCEN,
1 TBTUA,P,TBTUL
WRITE (IOUT,502) TCAPT,CCENT,CCINST,CCBLD,HCCOST,CENCCA,PC,CENMC,
1 DISPOS
500 FORMAT(//' *****CENTRIFUGE DESIGN OUTPUTS'//
1 ' INPUT DATA'//
1 ' OPERATING TIME IS ASSUMED TO BE 24 HOURS/DAY'/
1 ' CAKE SOLIDS CONC.....',2X,F10.2,' LBS/LB'/
1 ' CENTRATE SOLIDS CONC...',2X,F10.3,' LBS/LB',/
1 ' TS. CONC. COMING IN...',2X,F10.2,' LBS/LB'/
1 ' VS. CONC. COMING IN...',2X,F10.2,' LBS/LB'/

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1 ' SOLIDS FLOW RATE IN...',2X,F10.2,' LBS/HR'// 00165600
1 ' LIQUID FLOW RATE IN...',2X,F10.2,' LBS/HR'// 00165700
1 ' DESIGN OUTPUT DATA'// 00165800
1 ' SOLIDS FLOW RATE EACH.',2X,F10.2,' LBS/HR'// 00165900
1 ' LIQUID FLOW RATE EACH.',2X,F10.2,' LBS/HR'// 00166000
1 ' NO. CENT. RUNNING.....',2X,I10,' UNITS'// 00166100
1 ' NO. CENT. ACTUAL.....',2X,I10,' UNITS'// 00166200
1 ' MASS BALANCE'// 00166300
1 ' WATER'// 00166400
1 ' IN.....',2X,F10.2,' LBS/HR'// 00166500
1 ' OUT'// 00166600
1 ' CAKE.....',2X,F10.2,' LBS/HR'// 00166700
501 FORMAT(' CENTRATE.....',2X,F10.2,' LBS/HR'// 00166800
1 ' SOLIDS'// 00166900
1 ' IN.....',2X,F10.2,' LBS/HR'// 00167000
1 ' OUT'// 00167100
1 ' CAKE.....',2X,F10.2,' LBS/HR'// 00167200
1 ' CENTRATE.....',2X,F10.2,' LBS/HR'// 00167300
1 ' CAKE PRODUCTION.....',2X,F10.2,' LBS/HR'// 00167400
1 ' CENTRATE FLOW.....',2X,F10.2,' LBS/HR'// 00167500
1 ' CONCENTRATION'// 00167600
1 ' SOLIDS IN.....',2X,F10.2,' LBS/HR'// 00167700
1 ' CAKE SOLIDS.....',2X,F10.2,' LBS/HR'// 00167800
1 ' CENTRATE SOLIDS.....',2X,F10.3,' LBS/HR'// 00167900
1 ' ENERGY BALANCE'// 00168000
1 ' ENERGY AVAILABLE.....',2X,E10.3,' BTU/HR'// 00168100
1 ' ENERGY CONSUMED.....',2X,E10.3,' BTU/HR'// 00168200
1 ' ENERGY LEFT.....',2X,E10.3,' BTU/HR'// 00168300
502 FORMAT(' COST BALANCE'// 00168400
1 ' CAPITAL INVESTMENT'// 00168500
1 ' TOTAL.....',2X,F10.2,' $'// 00168600
1 ' CENTRIFUGE.....',2X,F10.2,' $'// 00168700
1 ' INSTALLATION.....',2X,F10.2,' $'// 00168800
1 ' BUILDING.....',2X,F10.2,' $'// 00168900
1 ' HOURLY COST'// 00169000
1 ' TOTAL.....',2X,F10.2,' $/HR'// 00169100
1 ' AMORTIZED CAP.....',2X,F10.2,' $/HR'// 00169200
1 ' POWER.....',2X,F10.2,' $/HR'// 00169300
1 ' MATERIALS SUPPLY.....',2X,F10.2,' $/HR'// 00169400
1 ' WASTEWATER TRTMT.....',2X,F10.2,' $/HR'// 00169450
GO TO 600 00169500
550 WRITE(IOUT,560) SCOUT,EPS,EFS,NCRUN,NCACT,HOCST 00169600
560 FORMAT(///' DESIGN INPUT AND OUTPUT DATA FOR CENTRIFUGE'// 00169700
1 ' SLURRY CONC.....',2X,F10.2,' LBS/LB'// 00169800
1 ' TOTAL SOLIDS IN.....',2X,F10.2,' LBS/HR'// 00169900
1 ' VOLATILE SOLIDS IN.....',2X,F10.2,' LBS/HR'// 00170000
1 ' NO. CENT. RUNNING.....',2X,I10,' UNITS'// 00170100
1 ' NO. CENT. ACTUAL.....',2X,I10,' UNITS'// 00170200
1 ' HOURLY COST TOTAL.....',2X,F10.2,' $/HR'// 00170300
600 TBTUA=TBTUL 00170400
RETURN 00170500
END 00170600
SUBROUTINE INCIN(CAKEVS,CAKEFS,CAKENO,INCRES,INCRPF,THR,
1 HCDIG,TBTUL,HVGC,THCAUS) 00170700
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT, 00170750
STC771,STC172,STC772,STC773,STC174,STC175,STC775, 00170800
TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD, 00170900
TBTUC,PHCRD,PHCCA,PHOMC,FCC,RECYCL, 00171000

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1  DDHTUC,DDHCRD,DDHCCA,DDHOMC,DDCC,      00171100
1  IDIG,IGC,IDEN,IINC,INAH,ILAN,ISUM      00171200
    RFAL*4 INCDEN,INCRES,INCREV,INCCC,INCCA,LATHT,MCR, 00171300
1  INCMC                                    00171400
    DATA SPHDPC,SPHVV,SPHASH,LATHT,UCFUEL/      00171500
1  C.25, 0.5, 0.2, 1050.,2.0/              00171600
    DATA DLIPT,INCDEN,MCR/                    00171700
1  20., 1000., 1.4/                        00171800
    DATA AIR,PEXAIR,CPCO2,CPH2O/              00171900
1  9.76,50., 2.58,0.666/                   00172000
    DATA TINC,TSTD,TRECOV,C90/               00172100
1  140.,77.,600.,1.0/                      00172200
    DATA UFAIR,CH4DEN,COCHR,H2OCHR/           00172300
1  0.77, 0.0445, 2.75, 2.25/               00172400
9  WRITE (5,5005)AIR,PEXAIR,DLIPE           00172401
5005  FORMAT(3F)                             00172402
    CRR=XINT/(1.-(1.+XINT)**(-DLIPE))          00172500
    IF (INOP.30.1) GO TO 50                  00172600
    WRITE(5,10)                              00172700
10  FORMAT(/' PROVIDE % EXCESS AIR')         00172800
    READ(IN,101) PEXAIR                      00172900
101  FORMAT(F)                               00173000
    IF (IOUT.30.5) GO TO 50                  00173010
    WRITE(IOUT,10)                           00173020
    WRITE(IOUT,30) PEXAIR                    00173030
30  FORMAT(F6.2)                             00173040
50  CPN=(1.+PEXAIR/100.)*AIR*(3.32/4.32)     00173100
    CPO2=(PEXAIR/100.)*AIR*(1./4.32)         00173200
    DPCT=CPN+CPO2+CPCO2                     00173300
    INCRES=CAKEFS                             00173400
    INCREV=INCRES/INCDEN                     00173500
    HLDPC=DPCT*CAKEVS*SPHDPC*(TINC-TSTD)     00173600
    HLMOIS=(CPH2O*CAKEVS+CAKENO)*LATHT       00173700
    HLWV=(CPH2O*CAKEVS+CAKENO)*SPHVV*(TINC-212.) 00173800
    HFLASH=CAKEFS*SPHASH*(TRECOV-TSTD)       00173900
    BTUINC=HLDPC+HLMOIS+HLWV+HFLASH           00174000
    FUELBT=(BTUINC-TBTUA)*2.                 00174100
    IF (FUELBT.GE.0) GO TO 500               00174200
    FUELBT=0.                                00174300
    GO TO 600                                00174400
500  FAIR=(FUELBT/1000.)*UFAIR               00174500
    FCP02=(PEXAIR/100.)*FAIR*(1./4.32)       00174600
    FCPN=(1.+PEXAIR/100.)*FAIR*(3.32/4.32)   00174700
    FCPCO2=(FUELBT/1000.)*CH4DEN*COCHR       00174800
    FDPCT=FCP02+FCPN+FCPCO2                  00174900
    FCPH2O=(FUELBT/1000.)*CH4DEN*H2OCHR       00175000
    HTPDEC=(DPCT*CAKEVS+FDPCT)*SPHDPC*(TRECOV-TSTD) 00175100
    HTPH2O=(CPH2O*CAKEVS+CAKENO+FCPH2O)*LATHT 00175200
    HTPVV=(CPH2O*CAKEVS+CAKENO+FCPH2O)*SPHVV*(TRECOV-212.) 00175300
    HRCT=TBTUA+FUELBT-HTPDEC-HTPH2O-HFLASH-HTPV 00175400
    GO TO 700                                00175500
600  HDDPC=DPCT*CAKEVS*SPHDPC*(TRECOV-TSTD) 00175600
    HDWV=(CPH2O*CAKEVS+CAKENO)*SPHVV*(TRECOV-212.) 00175700
    HRCT=TBTUA-HDDPC-HLMOIS-HDWV-HFLASH      00175800
700  EXHT=HRCT-THR-HVGC-TBCAUS              00175900
    IF (EXHT.LE.0.) EXHT=0.                  00175950
    HTRD=(HRCT/10.**6)*C90                   00176000
    CAKETS=CAKEVS+CAKEFS                     00176100

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IF(CAKETS.LE.100.)GO TO 100
IF(CAKETS.LE.2000.)GO TO 120
IF(CAKETS.LE.10000.)GO TO 140
INCCC=2.5*CAKETS**0.75*1000.
GO TO 160
100 INCCC=15.1*100.**0.55*1000.
GO TO 160
120 INCCC=15.1*CAKETS**0.55*1000.
GO TO 160
140 INCCC=12.9*CAKETS**0.572*1000.
160 INCCA=INCCC*CR/(360.*24.)*(STC775/STC772)
INCMC=(MCR/100.)*INCCC/(360.*24.)
CFUEL=FUELBT*UCFUEL/10.**6
HCCOST=INCCA+INCMC+CFUEL
TBTUL=0.
TBTUC=TBTUC+FU3LBT
THCRD=THCRD+HTCRD
THCCA=THCCA+INCCA
THOMC=THOMC+INCMC+CFUEL
TCC=TCC+INCCC
IF(IINC.EQ.0)GO TO 4670
WRITE(IOUT,20)CAKETS,CAKEPS,CAKEMO,INCRPS,TBTUA,BTUINC,
1 FUELBT,HRCT,THCAUS,TNB,HVGC,EXHC,INCCC,HCCOST,
1 INCCA,INCMC
WRITE(IOUT,31)CFUEL,HTCRD
20 FORMAT(///' *****DESIGN INPUT AND OUTPUT DATA FOR INCIN'//
1 ' VOLATILE SOLIDS IN.....',2X,F10.2,' LBS/HR'//
1 ' FIXED SOLIDS IN.....',2X,F10.2,' LBS/HR'//
1 ' MOISTURE IN.....',2X,F10.2,' LBS/HR'//
1 ' RESIDUE OUT.....',2X,F10.2,' LBS/HR'//
1 ' AVAILABLE ENERGY.....',2X,E10.3,' BTU/HR'//
1 ' ENERGY REQUIRED.....',2X,E10.3,' BTU/HR'//
1 ' FUEL ENERGY ADDED.....',2X,E10.3,' BTU/HR'//
1 ' HEAT RECOVERED.....',2X,E10.3,' BTU/HR'//
1 ' (CAUSTIC TREATMENT)....',E10.3,' BTU/HR'//
1 ' (DIGESTER HEAT).....',2X,E10.3,' BTU/HR'//
1 ' (GAS CLEAN-UP HEAT)....',2X,E10.3,' BTU/HR'//
1 ' EXCESS HEAT.....',2X,E10.3,' BTU/HR'//
1 ' COST',/
1 ' CAPITAL INVESTMENT...',2X,F10.2,' $'//
1 ' TOTAL COST.....',2X,F10.2,' $/HR'//
1 ' CAPITAL AMORTIZED...',2X,F10.2,' $/HR'//
1 ' MATERIALS SUPPLY.....',2X,F10.2,' $/HR'//
31 FORMAT(' AUX. FUEL.....',F10.2,' $/HR'//
1 ' HEAT PCC. CREDIT.....',2X,F10.2,' $/HR'//
4670 TBTUA=TBTUL
RETURN
END
SUBROUTINE HAUL(HAULWT,HAULV)
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT,
1 STC771,STC772,STC773,STC774,STC775,STC776,
1 TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD,
1 PBTUC,PHCRD,PHCCA,PHOMC,PCC,RECYCL,
1 DBBTUC,DBHCRD,DBHCCA,DBHOMC,DBCC,
1 IDIG,IGC,IDEW,IINC,IMAD,ILAN,ISUM
DATA DIST,HAUL/10.,0.20/
IF(INOP.EQ.1)GO TO 100
WRITE(5,10)

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10	FORMAT(/' PROVIDE DIST. (MI), COST (\$/TON-MILE)')	00181700
	READ (IN, 101) DIST, RHAUL	00181800
101	FORMAT (2F)	00181900
	IF (IOUT.EQ.5) GO TO 100	00181910
	WRITE (IOUT, 10)	00181920
	WRITE (IOUT, 102) DIST, RHAUL	00181930
102	FORMAT (2 (2X, F5. 2))	00181940
100	TONHL=HAULWT/2000.	00182000
	HCOST=TONHL*DIST*RHAUL	00182100
	TBTUA=TBTUA	00182200
	TBTUC=TBTUC	00182300
	THCRD=THCRD	00182400
	THCCA=THCCA	00182500
	THONC=THONC+HCOST	00182600
	TCC=TCC	00182700
	IF (IHAU.EQ.0) GO TO 4850	00182800
	WRITE (IOUT, 20) DIST, TONHL, HAULV, HCOST	00182900
20	FORMAT (///' *****DESIGN INPUT AND OUTPUT DATA FOR HAUL'//	00183000
1	1 ' HAUL DISTANCE.....', 2X, F10.2, ' MILES'//	00183100
1	1 ' HAUL WEIGHT.....', 2X, F10.2, ' TONS/HR'//	00183200
1	1 ' HAUL VOLUME.....', 2X, F10.2, ' CY/HR'//	00183300
1	1 ' HAUL COST.....', 2X, F10.2, ' \$/HR'//	00183400
4850	RETURN	00183500
	END	00183600
	SUBROUTINE LANFIL (HAULWT, HAULV)	00183700
	COMMON IN, IOUT, INOP, IOOP, C5, C6, C10, XINT, ICT,	00183800
1	1 STC771, STC172, STC772, STC773, STC174, STC175, STC775,	00183850
1	1 TBTUR, TBTUS, TBTUC, TBTUA, TCC, THCCA, THONC, THCRD,	00183900
1	1 PBTUC, PHCRD, PHCCA, PHONC, PCC, RECYCL,	00184000
1	1 DDBTUC, DDHCRD, DDHCCA, DDHONC, DDCC,	00184100
1	1 IDIG, IGC, IDEW, IINC, IHAU, ILAN, ISUM	00184200
	DATA RFILL/2./	00184300
	IF (INOP.EQ.1) GO TO 100	00184400
	WRITE (5, 10)	00184500
10	FORMAT(/' PROVIDE LANDFILL COST (\$/TON)')	00184600
	READ (IN, 101) RFILL	00184700
101	FORMAT (F)	00184800
	IF (IOUT.EQ.5) GO TO 100	00184810
	WRITE (IOUT, 10)	00184820
	WRITE (IOUT, 30) RFILL	00184830
30	FORMAT (F6. 2)	00184840
100	TONFIL=HAULWT/2000.	00184900
	HCOST=TONFIL*RFILL	00185000
	TBTUA=TBTUA	00185100
	TBTUC=TBTUC	00185200
	THCRD=THCRD	00185300
	THCCA=THCCA	00185400
	THONC=THONC+HCOST	00185500
	TCC=TCC	00185600
	IF (ILAN.EQ.0) GO TO 5020	00185700
	WRITE (IOUT, 20) TONFIL, HAULV, HCOST	00185800
20	FORMAT (///' *****DESIGN INPUT AND OUTPUT DATA FOR LANDFILL'//	00185900
1	1 ' AMT. OF FILL.....', 2X, F10.2, ' TONS/HR'//	00186000
1	1 ' VOL. OF FILL.....', 2X, F10.2, ' CY/HR'//	00186100
1	1 ' HOURLY COST.....', 2X, F10.2, ' \$/HR'//	00186200
5020	RETURN	00186300
	END	00186400
	SUBROUTINE SUMARY (CH4BTE, CH4BEN, THR, HCDIG, HVGCC, HCCC, INC, TBTUL,	00186500

```

1  CAUS)                                00186550
COMMON IN,IOUT,INOP,IOOP,C5,C6,C10,XINT,ICT, 00186600
1  STC771,STC172,STC772,STC773,STC174,STC175,STC775, 00186650
1  TBTUR,TBTUS,TBTUC,TBTUA,TCC,THCCA,THOMC,THCRD, 00186700
1  PBTUC,PHCRD,PHCCA,PHOMC,PCC,RECYCL, 00186800
1  DDBTUC,DDHCRD,DDHCCA,DDHOMC,DDCC, 00186900
1  IDIG,IGC,IGEN,IINC,IMAU,ILAN,ISUM 00187000
CKBTU=TBTUR+TBTUS-CH4BTU 00187100
RBTUC=TBTUC-DDBTUC-PBTUC 00187200
IF(RBTUC.LE.1000.)RBTUC=0. 00187250
RRCRD=THCRD-DDHCRD-PHCRD 00187300
RHCCA=THCCA-DDHCCA-PHCCA 00187400
RHOMC=THOMC-DDHOMC-PHOMC 00187500
RCOST=THCCA+THOMC+CAUS 00187550
RCC=PCC-DDCC-PCC 00187600
IF(INC.EQ.0)GO TO 5070 00187700
XBTU1=DDBTUC-THR-HVGC 00187800
XBTU2=TBTUC-THR-HVGC 00187900
XOMC1=DDHOMC-HCDIG-HCGC 00188000
XOMC2=THOMC-HCDIG-HCGC 00188100
GO TO 5077 00188200
5070 XBTU1=DDBTUC 00188300
XBTU2=TBTUC 00188400
XOMC1=DDHOMC 00188500
XOMC2=THOMC 00188600
5077 IF(ISUM.EQ.0)GO TO 5540 00188700
WRITE(IOUT,5090) 00188800
5090 FORMAT(///' ****SUMMARY OUTPUTS'// 00188900
1 ' FRONT-END SUMMARY'//) 00189000
WRITE(IOUT,5120)PBTUC,PHCCA,PHOMC,CAUS,PHCRD,PCC 00189100
5120 FORMAT(' ENERGY CONSUMED.....',2X,E10.3,' BTU/HR'// 00189200
1 ' CAP. AMORT.....',2X,F10.2,' $/HR'// 00189300
1 ' OP. AND MAINT.....',2X,F10.2,' $/HR'// 00189400
1 ' CAUSTIC ADDITION.....',2X,F10.2,' $/HR'// 00189450
1 ' CREDIT(METALS+DISP.)...',2X,F10.2,' $/HR'// 00189500
1 ' CAP. INVEST.....',2X,F10.2,' $') 00189600
WRITE(IOUT,5210) 00189700
5210 FORMAT(///' DIGESTER AND DEWATERING SUMMARY'//) 00189800
WRITE(IOUT,5230)DDBTUC,XBTU1,CH4BTU,CKBTU, 00189900
1 DDHCCA,DDHOMC,XOMC1,DDHCRD,DDCC 00190000
5230 FORMAT(' ENERGY CONSUMED'// 00190100
1 ' W/O SUPPLY FROM INCIN.',2X,E10.3,' BTU/HR'// 00190200
1 ' (W/ SUPPLY FROM INCIN).',2X,E10.3,' BTU/HR'// 00190300
1 ' ENERGY RECOVERED(CH4)...',2X,E10.3,' BTU/HR'// 00190400
1 ' ENERGY LEFT IN CAKE....',2X,E10.3,' BTU/HR'// 00190500
1 ' CAP AMORT.....',2X,F10.2,' $/HR'// 00190600
1 ' OP. AND MAINT.'// 00190700
1 ' W/O SUPPLY FROM INCIN.',2X,F10.2,' $/HR'// 00190800
1 ' (W/ SUPPLY FROM INCIN).',2X,F10.2,' $/HR'// 00190900
1 ' CREDIT(CH4).....',2X,F10.2,' $/HR'// 00191000
1 ' CAP. INVEST.....',1X,F11.2,' $') 00191100
WRITE(IOUT,5310) 00191200
5310 FORMAT(///' REAR-END SUMMARY'//) 00191300
WRITE(IOUT,5330)RBTUC,RHCCA,RHOMC,RRCRD,RCC 00191400
5330 FORMAT(' ENERGY CONSUMED.....',2X,E10.3,' BTU/HR'// 00191500
1 ' CAP. AMORT.....',2X,F10.2,' $/HR'// 00191600
1 ' OP. AND MAINT.....',2X,F10.2,' $/HR'// 00191700
1 ' CREDIT(HEAT).....',2X,F10.2,' $/HR'// 00191800

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1	' CAP. INVEST.....',2X,F10.2,' \$')	00191900
	WRITE(IOUT,5410)	00192000
5410	FORMAT(// ' ENTIRE PROCESS SUMMARY'//)	00192100
	WRITE(IOUT,5440) TBTUR,TBTUS,TBTUC,XBTU2,CH4BTU,CKBTU,	00192200
1	RCOST,THCCA,THOMC,XOMC2,CAUS,THCRD	00192300
5440	FORMAT(' REFUSE ENERGY.....',2X,E10.3,' BTU/HR'/	00192400
1	' SEWAGE SLUDGE ENERGY... ',2X,E10.3,' BTU/HR'/	00192500
1	' ENERGY CONSUMED'/	00192600
1	' W/O SUPPLY FROM INCIN.',2X,E10.3,' BTU/HR'/	00192700
1	' (W/ SUPPLY FROM INCIN). ',2X,E10.3,' BTU/HR'/	00192800
1	' ENERGY RECOVERED(CH4)... ',2X,E10.3,' BTU/HR'/	00192900
1	' ENERGY LEFT IN CAKE.... ',2X,E10.3,' BTU/HR'/	00193000
1	' TOTAL HOURLY COST.....',2X,F10.2,' \$/HR'/	00193050
1	' CAP. AMORT.....',2X,F10.2,' \$/HR'/	00193100
1	' OP. AND MAINT.'/	00193200
1	' W/O SUPPLY FROM INCIN.',2X,F10.2,' \$/HR'/	00193300
1	' (W/ SUPPLY FROM INCIN). ',2X,F10.2,' \$/HR'/	00193400
1	' CAUSTIC ADDED.....',2X,F10.2,' \$/HR'/	00193450
1	' CREDIT(TOTAL).....',2X,F10.2,' \$/HR')	00193500
	WRITE(IOUT,5450) CH4BPN,TCC	00193510
5450	FORMAT(	00193520
1	' (CH4 BENEFIT).....',2X,F10.2,' \$/HR'/	00193600
1	' CAP. INVEST.....',2X,F11.2,' \$')	00193700
5540	RTURN	00193800
	END	00193900

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5. Simple Output

5.1 Main Program ENERGY

THIS PROGRAM PROVIDES INFORMATION ON
FRONT-END ROUTINES FOR THE REFUSE FLOW RATE
OF 1000 TONS/DAY

YES - 1, NO - 0

OPTIONS AUTOMATICALLY SET
INCLUDE CAUSTIC TREATMENT

***** DESIGN INPUT AND OUTPUT DATA FOR SOURCE

POPULATION(EQUIV.).....	571400.	
REFUSE GENERATED.....	83329.17	LBS/HR
SEWAGE GENERATED.....	9618.57	LBS/HR
REFUSE ENERGY CONTENT.	0.338E+09	BTU/HR
SEWAGE ENERGY CONTENT.	0.378E+08	BTU/HR

REFUSE CONSTITUENTS

REFUSE TOTAL.....	83329.17	LBS/HR
MOISTURE.....	23332.17	LBS/HR
VOLATILE SOLIDS.....	43331.17	LBS/HR
FIXED SOLIDS.....	16665.83	LBS/HR
METAL.....	6666.33	LBS/HR
GLASS.....	4999.75	LBS/HR
PLASTICS.....	1666.58	LBS/HR
ASH.....	3333.17	LBS/HR
(MOISTURE).....	1666.58	LBS/HR
ENERGY CONTENT.....	0.338E+09	BTU/HR

SEWAGE CONSTITUENTS

SEWAGE GENERATED.....	9618.57	LBS/HR
MOISTURE.....	4809.28	LBS/HR
TOTAL SOLIDS.....	4809.28	LBS/HR
VOLATILE SOLIDS.....	3366.50	LBS/HR
FIXED SOLIDS.....	1442.78	LBS/HR
ENERGY CONTENT.....	0.378E+08	BTU/HR

***** DESIGN INPUT AND OUTPUT DATA FOR STORE

REFUSE FLOW RATE.....	83329.17	LBS/HR
ENERGY AVAILABLE.....	0.338E+09	BTU/HR
ENERGY CONSUMED.....	0.463E+06	BTU/HR

HOURLY COST TOTAL..... 11.63 \$/HR

MASS FLOW

REFUSE TOTAL.....	83329.17 LBS/HR
MOISTURE.....	23332.17 LBS/HR
VOLATILE SOLIDS.....	43331.17 LBS/HR
FIXED SOLIDS.....	16665.83 LBS/HR
METAL.....	6666.33 LBS/HR
GLASS.....	4999.75 LBS/HR
PLASTICS.....	1666.58 LBS/HR
ASH.....	3333.17 LBS/HR
(MOISTURE).....	1666.58 LBS/HR

ENERGY BALANCE

AVAILABLE.....	0.338E+09 BTU/HR
CONSUMED.....	0.463E+06 BTU/HR
FRONTEND LOADER.....	0.336E+06 BTU/HR
CONVEYOR.....	0.127E+06 BTU/HR

COST BALANCE

CAPITAL INVESTMENTS	
STORAGE BIN.....	269122.48 \$
FRONTEND LOADER.....	79159.36 \$
WEIGH STATION.....	87020.66 \$
CONVEYOR.....	293248.35 \$
MISCELLANEOUS.....	45818.57 \$
HOURLY TOTAL.....	11.63 \$/HR
CAPITAL AMORTIZED	
STORAGE BIN.....	3.20 \$/HR
FRONTEND LOADER.....	1.24 \$/HR
WEIGH STATION.....	1.04 \$/HR
CONVEYOR.....	3.49 \$/HR
MISCELLANEOUS.....	0.72 \$/HR
OPERATION AND MAINTENANCE	
STORAGE TOTAL.....	1.94 \$/HR
REFUSE DISP. CREDIT...	208.32 \$/HR

***** DESIGN INPUT AND OUTPUT DATA FOR SIZE

REFUSE FLOW RATE.....	83329.17 LBS/HR
ENERGY AVAILABLE.....	0.338E+09 BTU/HR
ENERGY CONSUMED.....	0.394E+07 BTU/HR
HOURLY COST TOTAL.....	29.62 \$/HR

MASS FLOW

REFUSE TOTAL.....	83329.17 LBS/HR
-------------------	-----------------

MOISTURE.....	23332.17	LBS/HR
VOLATILE SOLIDS.....	43331.17	LBS/HR
FIXED SOLIDS.....	16665.83	LBS/HR
METAL.....	6666.33	LBS/HR
GLASS.....	4999.75	LBS/HR
PLASTICS.....	1666.58	LBS/HR
ASH.....	3333.17	LBS/HR
(MOISTURE).....	1666.58	LBS/HR

ENERGY BALANCE

AVAILABLE.....	0.338E+09	BTU/HR
CONSUMED.....	0.394E+07	BTU/HR
SHREDDER.....	0.381E+07	BTU/HR
CONVEYOR.....	0.127E+06	BTU/HR

COST BALANCE

CAPITAL INVESTMENTS		
SHREDDER.....	738929.49	\$
CONVEYOR.....	174784.03	\$
BUILDING.....	164638.63	\$
HOURLY TOTAL.....	29.62	\$/HR
CAPITAL AMORTIZED		
SHREDDER.....	12.56	\$/HR
CONVEYOR.....	2.08	\$/HR
BUILDING.....	1.66	\$/HR
OPERATION AND MAINTENANCE		
SHREDDING TOTAL.....	12.31	\$/HR

***** DESIGN INPUT AND OUTPUT DATA FOR SCREEN

REFUSE FLOW RATE.....	83329.17	LBS/HR
ENERGY AVAILABLE.....	0.338E+09	BTU/HR
ENERGY CONSUMED.....	0.229E+06	BTU/HR
HOURLY COST TOTAL.....	3.81	\$/HR

MASS FLOW

IN

REFUSE TOTAL.....	83329.17	LBS/HR
MOISTURE.....	23332.17	LBS/HR
VOLATILE SOLIDS.....	43331.17	LBS/HR
FIXED SOLIDS.....	16665.83	LBS/HR
METAL.....	6666.33	LBS/HR
GLASS.....	4999.75	LBS/HR
PLASTICS.....	1666.58	LBS/HR
ASH.....	3333.17	LBS/HR
(MOISTURE).....	1666.58	LBS/HR

OUT

REFUSE TOTAL.....	76857.27	LBS/HR
MOISTURE.....	22776.64	LBS/HR
VOLATILE SOLIDS.....	43331.17	LBS/HR
FIXED SOLIDS.....	10749.46	LBS/HR
METAL.....	6666.33	LBS/HR
GLASS.....	749.96	LBS/HR
PLASTICS.....	1666.58	LBS/HR
ASH.....	1666.58	LBS/HR
(MOISTURE).....	1111.06	LBS/HR

RESIDUE

REFUSE TOTAL.....	6471.90	LBS/HR
MOISTURE.....	555.53	LBS/HR
VOLATILE SOLIDS.....	0.00	LBS/HR
FIXED SOLIDS.....	5916.37	LBS/HR
METAL.....	0.00	LBS/HR
GLASS.....	4249.79	LBS/HR
PLASTICS.....	0.00	LBS/HR
ASH.....	1666.58	LBS/HR
(MOISTURE).....	555.53	LBS/HR

ENERGY BALANCE

AVAILABLE.....	0.338E+09	BTU/HR
CONSUMED.....	0.229E+06	BTU/HR
SCREEN.....	0.102E+06	BTU/HR
CONVEYOR.....	0.127E+06	BTU/HR

COST BALANCE

CAPITAL INVESTMENTS		
SCREEN.....	209513.54	\$
CONVEYOR.....	56925.28	\$
HOURLY TOTAL.....	3.81	\$/HR
CAPITAL AMORTIZED		
SCREEN.....	2.50	\$/HR
CONVEYOR.....	0.68	\$/HR
OPERATION AND MAINTENANCE		
SCREEN TOTAL.....	0.64	\$/HR

***** DESIGN INPUT AND OUTPUT DATA FOR SEPAPA

REFUSE FLOW RATE.....	76857.27	LBS/HR
ENERGY AVAILABLE.....	0.304E+09	BTU/HR
ENERGY CONSUMED.....	0.156E+07	BTU/HR
HOURLY COST TOTAL.....	5.83	\$/HR

MASS FLOW

IN

REFUSE TOTAL.....	76857.27	LBS/HR
-------------------	----------	--------

MOISTURE.....	22776.64	LBS/HR
VOLATILE SOLIDS.....	43331.17	LBS/HR
FIXED SOLIDS.....	10749.46	LBS/HR
METAL.....	6666.33	LBS/HR
GLASS.....	749.96	LBS/HR
PLASTICS.....	1666.59	LBS/HR
ASH.....	1666.58	LBS/HR
(MOISTURE).....	1111.06	LBS/HR

OUT

REFUSE TOTAL.....	60265.04	LBS/HR
MOISTURE.....	19887.89	LBS/HR
VOLATILE SOLIDS.....	38998.05	LBS/HR
FIXED SOLIDS.....	1379.10	LBS/HR
METAL.....	100.00	LBS/HR
GLASS.....	112.49	LBS/HR
PLASTICS.....	833.29	LBS/HR
ASH.....	333.32	LBS/HR
(MOISTURE).....	389.87	LBS/HR

RESIDUE

REFUSE TOTAL.....	10925.84	LBS/HR
MOISTURE.....	2888.74	LBS/HR
VOLATILE SOLIDS.....	4333.12	LBS/HR
FIXED SOLIDS.....	3703.98	LBS/HR
METAL.....	899.96	LBS/HR
GLASS.....	637.47	LBS/HR
PLASTICS.....	833.29	LBS/HR
ASH.....	1333.27	LBS/HR
(MOISTURE).....	722.19	LBS/HR

RECOVERY

METAL.....	5666.38	LBS/HR
------------	---------	--------

ENERGY BALANCE

AVAILABLE.....	0.304E+09	BTU/HR
CONSUMED.....	0.156E+07	BTU/HR
MAG. SEP.....	0.636E+05	BTU/HR
A.C. SEP.....	0.137E+07	BTU/HR
CONVEYOR.....	0.127E+06	BTU/HR

COST BALANCE

CAPITAL INVESTMENTS	
MAG.	71691.23 \$
A.C.	313150.00 \$
CONVEYOR.....	36255.00 \$
AUX. PAC.	101385.00 \$
HOURLY TOTAL.....	5.83 \$/HR
CAPITAL AMORTIZED	
MAG.	0.85 \$/HR
A.C.	3.73 \$/HR

CONVEYOR.....	0.43 \$/HR
AUX.FAC.	1.21 \$/HR
OPERATION AND MAINTENANCE	
MAG.	0.1 \$/HR
A.C. TOTAL.....	1.07 \$/HR
METAL SALE CREDIT.....	48.16 \$/HR

***** DESIGN INPUT AND OUTPUT DATA FOR CAUST

REFUSE FLOW RATE.....	60265.04LBS/HR
CAUSTIC FEED RATE.....	1211.31LBS/HR
ENERGY AVAILABLE.....	0.304E+09BTU/HR
ENERGY CONSUMED.....	0.286E+08BTU/HR
HOURLY COST TOTAL.....	141.26\$/HR

MASS FLOW

IN

REFUSE TOTAL.....	60265.04 LBS/HR
MOISTURE.....	19887.89 LBS/HR
VOLATILE SOLIDS.....	38998.05 LBS/HR
FIXED SOLIDS.....	1379.10 LBS/HR
METAL.....	100.00 LBS/HR
GLASS.....	112.49 LBS/HR
PLASTICS.....	833.29 LBS/HR
ASH.....	333.32 LBS/HR
(MOISTURE).....	388.87 LBS/HR

OUT

REFUSE TOTAL.....	161508.59 LBS/HR
MOISTURE.....	121131.44 LBS/HR
VOLATILE SOLIDS.....	38998.05 LBS/HR
FIXED SOLIDS.....	1379.10 LBS/HR
METAL.....	100.00 LBS/HR
GLASS.....	112.49 LBS/HR
PLASTICS.....	833.29 LBS/HR
ASH.....	333.32 LBS/HR
(MOISTURE).....	388.87 LBS/HR

COST BALANCE

CAPITAL INVESTMENT...	900000.00 \$
HOURLY TOTAL.....	141.26 \$/HR
CAPITAL AMORTIZED...	14.15 \$/HR
OP. AND MAINT.....	2.83 \$/HR
CHEMICAL ADDITION...	95.69 \$/HR
HEATING COST.....	28.58 \$/HR

NO. OF TRTMT. TANKS.

6

***** DESIGN INPUT AND OUTPUT DATA FOR SEWAGE

REFUSE FLOW RATE.....	161508.59	LBS/HR
SEWAGE FLOW RATE.....	9618.57	LBS/HR
SLURRY FLOW RATE.....	171127.16	LBS/HR
ENERGY AVAILABLE.....	0.376E+09	BTU/HR
ENERGY CONSUMED.....	0.509E+06	BTU/HR
HOURLY COST TOTAL.....	0.29	\$/HR

MASS FLOW

IN

REFUSE

REFUSE TOTAL.....	161508.59	LBS/HR
MOISTURE.....	121131.44	LBS/HR
VOLATILE SOLIDS.....	38998.05	LBS/HR
FIXED SOLIDS.....	1379.10	LBS/HR
METAL.....	100.00	LBS/HR
GLASS.....	112.49	LBS/HR
PLASTICS.....	833.29	LBS/HR
ASH.....	333.32	LBS/HR
(MOISTURE).....	388.87	LBS/HR

SEWAGE

SEWAGE SLUDGE TOTAL...	9618.57	LBS/HR
MOISTURE.....	4809.28	LBS/HR
VOLATILE SOLIDS.....	3366.50	LBS/HR
FIXED SOLIDS.....	1442.78	LBS/HR

OUT

SLURRY TOTAL.....	171127.16	LBS/HR
MOISTURE.....	125940.72	LBS/HR
TOTAL SOLIDS.....	45186.43	LBS/HR
VOLATILE SOLIDS.....	42364.55	LBS/HR
FIXED SOLIDS.....	2821.88	LBS/HR
CONCENTRATION		
MOISTURE.....	0.74	LBS/LB
TOTAL SOLIDS.....	0.26	LBS/LB
VOLATILE SOLIDS.....	0.94	LBS/LB (TS)
FIXED SOLIDS.....	0.06	LBS/LB (TS)

ENERGY BALANCE

AVAILABLE.....	0.376E+09	BTU/HR
CONSUMED		
MIXING.....	0.254E+06	BTU/HR
PUMPING.....	0.254E+06	BTU/HR

COST BALANCE

CAPITAL INVESTMENTS

MIXING TANK..... 13903.10 \$

PUMPING..... 10427.33 \$

HOURLY TOTAL..... 0.29\$/HR

CAPITAL AMORTIZED

MIXING TANK..... 0.14 \$/HR

PUMPING..... 0.11 \$/HR

OPERATION AND MAINTENANCE

MIXING TANK..... 0.03 \$/HR

PUMPING..... 0.02 \$/HR

SLUDGE DISP. CREDIT... 120.23 \$/HR

5.2 Main Program REFUSE

Run Number 8 in Table C-10
 REFUSE FLOW RATE(TONS/DAY)= 1000.00

*****FRONT-END SUMMARY

ENERGY BALANCE
 REFUSE ENERGY CONTENT. 0.338E+09 BTU/HR
 SEWAGE ENERGY CONTENT. 0.378E+08 BTU/HR
 TOTAL ENERGY AVAILABLE 0.376E+09 BTU/HR
 TOTAL ENERGY CONSUMED. 0.353E+08 BTU/HR
 COST BALANCE
 CAPITAL INVESTMENTS... 3624971.81 \$
 HOURLY COSTS..... 194.09 \$/HR
 CAPITAL AMORTIZED.... 49.80 \$/HR
 OP. AND MAINT..... 48.59 \$/HR
 CAUSTIC FEED..... 95.69 \$/HR
 CREDITS..... 376.72 \$/HR
 CAUSTIC TREATMENT INCLUDED

PROVIDE T(C),DT(D),SCIN(%)
 60.00 5.00 14.60

PH INCREASED TO 6.85
 PH INCREASED TO 6.90
 PH INCREASED TO 6.95
 PH INCREASED TO 7.00
 PH INCREASED TO 7.05
 PH INCREASED TO 7.10
 PH INCREASED TO 7.15
 PH INCREASED TO 7.20
 PH INCREASED TO 7.25
 RECYCLE IS 45.00 PERCENT

*****DIGESTER SYSTEM OUTPUTS

INPUT DATA

REACTOR TEMPERATURE... 60.00 DEG.C
 DETENTION TIME(MEW)... 5.00 DAYS
 DETENTION TIME(PAII).. 3.75 DAYS
 TS. CONC. COMING IN... 0.15 LBS/LB
 VS. CONC. COMING IN... 0.94 LBS/LB(TS)
 SOLIDS FLOW RATE..... 1084474.44 LBS/DAY

DESIGN OUTPUT DATA

TOT. DIG. VOL..... 584522.46 CF
 EACH DIG. VOL..... 146130.62 CF
 NO. OF DIGESTERS..... 4 UNITS

MASS BALANCE

WATER		
IN.....	125940.73	LBS/HR
ADDED.....	19429.61	LBS/HR
OUT.....	264309.70	LBS/HR
SOLIDS		
TOTAL SOLIDS IN.....	45186.43	LBS/HR
VOLATILE SOLIDS...	42364.55	LBS/HR
FIXED SOLIDS.....	2821.88	LBS/HR
TOTAL SOLIDS OUT....	23326.33	LBS/HR
VOLATILE SOLIDS...	20504.44	LBS/HR
FIXED SOLIDS.....	2821.88	LBS/HR
VS. DESTROYED.....	21860.11	LBS/HR
SLURRY		
IN.....	309496.13	LBS/HR
OUT.....	287636.02	LBS/HR
GAS PRODUCED		
TOTAL GAS PRODUCED..	279289.07	CF/HR
CH ₄	142715.55	CF/HR
CO ₂	136573.52	CF/HR
CONCENTRATION		
SLURRY CONC.		
IN.....	0.146	LBS/LB
OUT.....	0.081	LBS/LB
VOLATILE SOLIDS CONC.		
IN.....	0.94	LBS/LB (TS)
OUT.....	0.88	LBS/LB (TS)

ENERGY BALANCE

ENERGY AVAILABLE.....	0.376E+09	BTU/HR
ENERGY CONSUMED		
TOTAL HEAT.....	0.100E+09	BTU/HR
MIXING ENERGY.....	0.143E+07	BTU/HR
HEAT FOR DIGESTION..	0.463E+07	BTU/HR
DIGESTER HEATLOSS...	0.190E+07	BTU/HR
WAT. VAP. HEATLOSS..	0.347E+07	BTU/HR
ENERGY PRODUCED		
HEAT VALUE OF CH ₄ ...	0.143E+09	BTU/HR
ENERGY LEFT.....	0.233E+09	BTU/HR

COST BALANCE

CAPITAL INVESTMENT....	1703054.93	\$
TOTAL COST.....		
AMORTIZED CAP. COST.	15.42	\$/HR
MIXING COST.....	6.26	\$/HR
HEATING COST.....	10.00	\$/HR
LINE COST.....	0.00	\$/HR
MATERIALS SUPPLY.....	1.97	\$/HR
NITROGEN.....	3.19	\$/HR
PHOSPHATE.....	0.64	\$/HR
CH ₄ BENEFIT.....	285.43	\$/HR

*****GAS CLEAN-UP SYSTEM OUTPUTS

INPUT DATA

TOTAL GAS IN.....	279289.07	CF/HR
CH ₄	142715.55	CF/HR
CO ₂	136573.52	CF/HR

DESIGN OUTPUT DATA

HEA REQUIRED.....	34854.78	LBS/HR
MAKE-UP HEA.....	697.10	LBS/HR
HEAT REQUIRED.....	0.273E+08	BTU/HR
CAPITAL INVESTMENTS....	1407845.97	\$
HOURLY COST TOTAL.....	45.72	\$/HR
CAPITAL AMORTIZED.....	16.78	\$/HR
OP. AND MAINT.....	1.68	\$/HR
HEATING.....	27.26	\$/HR

PROVIDE %CAKE AND %CENTRATE SOLIDS
35.000 0.100

*****CENTRIFUGE DESIGN OUTPUTS

INPUT DATA

OPERATING TIME IS ASSUMED TO BE 24 HOURS/DAY

CAKE SOLIDS CONC.....	0.35	LBS/LB
CENTRATE SOLIDS CONC..	0.001	LBS/LB
TS. CONC. COMING IN...	0.08	LBS/LB
VS. CONC. COMING IN...	0.88	LBS/LB
SOLIDS FLOW RATE IN...	23326.33	LBS/HR
LIQUID FLOW RATE IN...	264309.70	LBS/HR

DESIGN OUTPUT DATA

SOLIDS FLOW RATE EACH.	3332.33	LBS/HR
LIQUID FLOW RATE EACH.	37758.53	LBS/HR
NO. CENT. RUNNING.....	7	UNITS
NO. CENT. ACTUAL.....	8	UNITS

MASS BALANCE

WATER		
IN.....	264309.70	LBS/HR
OUT		
CAKE.....	42908.74	LBS/HR
CENTRATE.....	221400.96	LBS/HR
SOLIDS		
IN.....	23326.33	LBS/HR
OUT		
CAKE.....	23104.71	LBS/HR
CENTRATE.....	221.62	LBS/HR
CAKE PRODUCTION.....	66013.45	LBS/HR
CENTRATE FLOW.....	221622.58	LBS/HR

CONCENTRATION

SOLIDS IN.....	0.08 LBS/HR
CAKE SOLIDS.....	0.35 LBS/HR
CENTRATE SOLIDS.....	0.001 LBS/HR

ENERGY BALANCE

ENERGY AVAILABLE.....	0.233E+09 BTU/HR
ENERGY CONSUMED.....	0.356E+07 BTU/HR
ENERGY LEFT.....	0.233E+09 BTU/HR

COST BALANCE

CAPITAL INVESTMENT

TOTAL.....	2714075.38 \$
CENTRIFUGE.....	1357788.41 \$
INSTALLATION.....	921794.67 \$
BUILDING.....	434492.29 \$

HOURLY COST

TOTAL.....	86.23 \$/HR
AMORTIZED CAP.....	42.68 \$/HR
POWER.....	15.56 \$/HR
MATERIALS SUPPLY.....	15.71 \$/HR
WASTEWATER TRTMT.....	12.28 \$/HR

PROVIDE 5% EXCESS AIR

50.00

*****DESIGN INPUT AND OUTPUT DATA FOR INCIN

VOLATILE SOLIDS IN....	20309.63 LBS/HR
FIXED SOLIDS IN.....	2795.07 LBS/HR
MOISTURE IN.....	42908.74 LBS/HR
RESIDUE OUT.....	2795.07 LBS/HR
AVAILABLE ENERGY.....	0.233E+09 BTU/HR
ENERGY REQUIRED.....	0.194E+09 BTU/HR
FUEL ENERGY ADDED.....	0.000E+00 BTU/HR
HEAT RECOVERED.....	0.123E+09 BTU/HR
(CAUSTIC TREATMENT)....	0.286E+08 BTU/HR
(DIGESTER HEAT).....	0.100E+08 BTU/HR
(GAS CLEAN-UP HEAT)....	0.273E+08 BTU/HR
EXCESS HEAT.....	0.570E+08 BTU/HR

COST

CAPITAL INVESTMENT...	4685061.25 \$
TOTAL COST.....	78.62 \$/HR
CAPITAL AMORTIZED...	71.03 \$/HR
MATERIALS SUPPLY.....	7.59 \$/HR
AUX. FUEL.....	0.00 \$/HR
HEAT REC. CREDIT.....	122.84 \$/HR

HAUL RESIDUE FROM SCREEN, SEPARA AND INCIN

PROVIDE DIST. (MI) , COST (\$/TON-MILE)

10.00 0.20

*****DESIGN INPUT AND OUTPUT DATA FOR HAUL

HAUL DISTANCE.....	10.00 MILES
HAUL WEIGHT.....	10.10 TONS/HR
HAUL VOLUME.....	21.81 CY/HR
HAUL COST.....	20.19 \$/HR

PROVIDE LANDFILL COST(\$/TON)

2.00

*****DESIGN INPUT AND OUTPUT DATA FOR LANDFILL

AMT. OF FILL.....	10.10 TONS/HR
VOL. OF FILL.....	21.81 CY/HR
HOURLY COST.....	20.19 \$/HR

*****SUMMARY OUTPUTS

FRONT-END SUMMARY

ENERGY CONSUMED.....	0.353E+08 BTU/HR
CAP. AMORT.....	49.80 \$/HR
OP. AND MAINT.....	48.59 \$/HR
CAUSTIC ADDITION.....	95.69 \$/HR
CREDIT (METALS+DISP.) ...	376.72 \$/HR
CAP. INVEST.....	3624971.81 \$

DIGESTER AND DEWATERING SUMMARY

ENERGY CONSUMED	
W/O SUPPLY FROM INCIN.	0.423E+08 BTU/HR
(W/ SUPPLY FROM INCIN).	0.499E+07 BTU/HR
ENERGY RECOVERED (CH ₄)..	0.143E+09 BTU/HR
ENERGY LEFT IN CAKE....	0.233E+09 BTU/HR
CAP AMORT.....	74.88 \$/HR
OP. AND MAINT.	
W/O SUPPLY FROM INCIN.	94.54 \$/HR
(W/ SUPPLY FROM INCIN).	57.28 \$/HR
CREDIT (CH ₄)	285.43 \$/HR
CAP. INVEST.....	5824977.00 \$

REAR-END SUMMARY

ENERGY CONSUMED.....	0.000E+00 BTU/HR
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CAP. AMORT.....	71.03 \$/HR
OP. AND MAINT.....	47.98 \$/HR
CREDIT (HEAT).....	122.84 \$/HR
CAP. INVEST.....	4685060.44 \$

ENTIRE PROCESS SUMMARY

REFUSE ENERGY.....	0.338E+09 BTU/HR
SEWAGE SLUDGE ENERGY...	0.378E+08 BTU/HR
ENERGY CONSUMED	
W/O SUPPLY FROM INCIN.	0.7758+08 BTU/HR
(W/ SUPPLY FROM INCIN).	0.403E+08 BTU/HR
ENERGY RECOVERED (CH ₄)..	0.143E+09 BTU/HR
ENERGY LEFT IN CAKE....	0.233E+09 BTU/HR
TOTAL HOURLY COST.....	482.51 \$/HR
CAP. AMORT.....	195.70 \$/HR
OP. AND MAINT.	
W/O SUPPLY FROM INCIN.	191.11 \$/HR
(W/ SUPPLY FROM INCIN).	153.85 \$/HR
CAUSTIC ADDED.....	95.69 \$/HR
CREDIT (TOTAL).....	784.99 \$/HR
(CH ₄ BENEFIT).....	285.43 \$/HR
CAP. INVEST.....	14135009.30 \$

WANT TO REPEAT ANALYSIS FROM
 (1) P-END, (2) RAWWATER, (3) INCIN, OR (4) STOP?

REFERENCES

- Dynatech R/D Company (1973). Fuel Gas Production From Solid Waste, Progress Report NSF/RANN/SE/C-827/PR/73/3, Dynatech R/D Company, Cambridge, Massachusetts.
- Eckenfelder, W. W., Jr. and O'Connor, D. J. (1961). Biological Waste Treatment, Pergamon Press, New York.
- Handbook of Chemistry and Physics (1967). 48th ed., CRC Publishing Co., Cleveland, Ohio.
- Metcalf and Eddy, Inc. (1972). Wastewater Engineering, McGraw-Hill Book Co., New York.
- National Center for Resource Recovery, Inc. (1974). Cost Analysis for the New Orleans Resource Recovery and Disposal Program, Washington, D.C.
- Patterson, W. L. and Banker, R. F. (1971). Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities, Water Poll. Control Res. Series 170900AN 10/71, U.S. Environmental Protection Agency, Washington, D.C.
- Perry, F. H. (1973). Chemical Engineers Handbook, 5th ed., McGraw-Hill Book Co., New York.
- Pfeffer, J. T. and Liebman, J. C. (1975). Biological Conversion of Organic Refuse to Methane, Annual Report NSF/RANN/SE/GI-39191/PR/75/2, Dept. of Civil Engineering, University of Illinois - Urbana, Report UILU-ENG-2019.
- Rex Chainbelt, Inc. (Enviro Rex) (1969). Vacuum Filter Bulletin 315-141, Milwaukee, Wisconsin.