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**CONC/11: A COMPUTER PROGRAM FOR CALCULATING  
THE PERFORMANCE OF DISH-TYPE SOLAR THERMAL  
COLLECTORS AND POWER SYSTEMS**

By  
L. D. Jaffe

February 15, 1984

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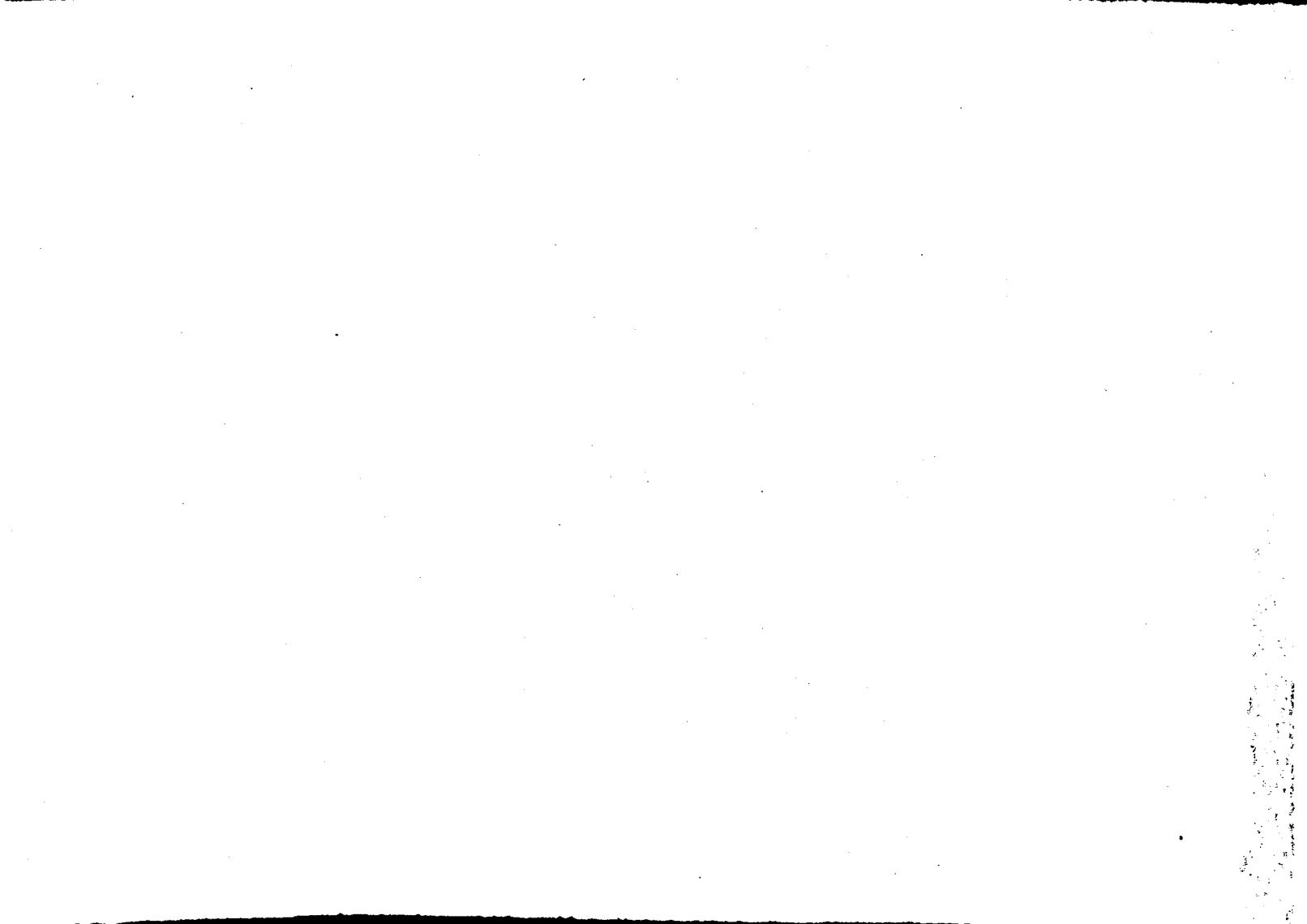
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ABS: The CONC/11 computer program designed for calculating the performance of dish-type solar thermal collectors and power systems is discussed. This program is intended to aid the system or collector designer in evaluating the performance to be expected with possible design alternatives. From design or test data on the characteristics of the various subsystems, CONC/11 calculates the efficiencies of the collector and the overall power system as functions of the receiver temperature for a specified insolation. If desired, CONC/11 will also determine the receiver aperture

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# CONC/11: A Computer Program for Calculating the Performance of Dish-Type Solar Thermal Collectors and Power Systems

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## ABSTRACT

CONC/11 is a computer program designed for calculating the performance of dish-type solar thermal collectors and power systems. It is intended to aid the system or collector designer in evaluating the performance to be expected with possible design alternatives. From design or test data on the characteristics of the various subsystems, CONC/11 calculates the efficiencies of the collector and the overall power system as functions of the receiver temperature for a specified insolation. If desired, CONC/11 will also determine the receiver aperture and the receiver temperature that will provide the highest efficiencies at a given insolation. The program handles both simple and compound concentrators. CONC/11 is written in Athena Extended Fortran (similar to Fortran 77) to operate primarily in an interactive mode on a Sperry 1100/81 computer. It could also be used on many small computers.

## ACKNOWLEDGMENT

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## SECTION I

### INTRODUCTION

CONC/11 is a computer program designed for calculation of the performance of dish-type solar thermal collectors and power systems. It is intended to aid the system or collector designer in evaluating the performance to be expected with possible design alternatives.

The solar thermal power system covered by CONC/11 consists conceptually of one or more dish-type solar collectors, power conversion subsystems, and power processing subsystems. Each collector is composed of a concentrator and a receiver (usually a cavity receiver), and serves to concentrate sunlight and convert its energy to heat in a working fluid. The power conversion subsystem (PCS) converts this heat to mechanical or electrical energy by means of a heat engine and (for electrical energy) an electrical generator. If the desired system output is heat, the power conversion subsystem is omitted. The power processing subsystem (PPS) transports the electrical or mechanical power from the PCS or the heat from the receiver to the system output and performs any associated power processing.

From design or test data on the characteristics of the various subsystems, CONC/11 calculates the collector efficiency and the overall power system efficiency as functions of the receiver temperature for a specified insolation. If desired, CONC/11 will also determine the receiver aperture and the receiver temperature that will provide the highest efficiencies at a given insolation.

CONC/11 does not calculate performance for conditions of varying insolation, such as those encountered over a year of service. However, it can be used as a tool for such calculations, as explained in Section IV.

CONC/11 handles designs in which the sunlight is reflected or refracted once (a simple concentrator) or twice (a compound concentrator, consisting of a primary and a secondary).



## SECTION II

### OPERATING ENVIRONMENT

CONC/11 was written to operate on a Sperry Univac 1100/81 computer, such as those used in the JPL Central Computing Facility. It could be run on any computer provided with the necessary software, an in-core memory of 16,000 words of at least 16 bits, and access to some form of mass storage. For input, either a card reader or an interactive terminal may be used. The input terminal needs a keyboard plus either a printer, a monitor, or a TV screen for prompting. CONC/11 was designed to send output to a printer with at least 126 characters per line. Printers with shorter line lengths could presumably handle the output by folding lines, which would result in some loss of readability.

CONC/11 is written in Athena Extended Fortran. This version of Fortran allows use of the IF....THEN....ELSEIF....ELSE.... structure. It is very similar to Fortran 77. CONC/11 also uses some routines from the libraries JPL\$ and CLIB\$, specifically the routines ASSIGN and CSF8 to assign a file from within a Fortran program, and the routine SLUP to perform a table lookup. Section VI of this report provides instructions for finding and using CONC/11.



## SECTION III

### PROGRAM STRUCTURE

#### A. INPUT

All inputs for CONC/11 are prompted. Inputs must be provided, and output is generated, for one set of input data at a time (a data set). Multiple data sets may be submitted sequentially during a single run of CONC/11.

CONC/11 utilizes two kinds of inputs, variables and arrays. Default values are provided for all variables at the beginning of a run. Values used for one data set are saved within the program and become the default values for the next data set. (One exception is noted below.) All variable values that differ from the default are entered by a single Fortran NAMELIST input statement, each in the form

VARIABLE = value

Input variables are themselves of two kinds: (1) real variables defining system characteristics numerically and (2) logical variables selecting certain system and program options. Some of these options pertain to the system design, some to the way array inputs will be provided, and some to the format of the program output as explained below. Input variables, their meaning and units, and their default values are tabulated in the CONC/11 dictionary (Appendix A) and also in Block 1 of the program listing (Appendix D).

Two arrays may be entered as part of each data set. One of these input arrays defines receiver temperatures for the data set; the other is optional and defines a set of efficiencies pertaining to the PCS, as is further explained below. There are initially no default values for these arrays. The first data set, therefore, must include a list of receiver temperatures. These temperatures must be entered, when prompted, in the form of 3 integers representing DO-loop parameters:

Temperature 1, Temperature 2, Temperature 3

where

Temperature 1 is the lowest receiver temperature (degrees Celsius) to be used,

Temperature 2 is a "not-to-be-exceeded" receiver temperature, and

Temperature 3 is the increment of receiver temperature to be used between successively higher temperatures.

The array of efficiencies pertaining to the PCS is prompted and accepted for the first data set if so indicated by the setting of appropriate logical variables. This array is entered, if needed, as a free-field list of real

variables,

Efficiency 1, Efficiency 2, Efficiency 3,....

where each efficiency in the sequence corresponds to a receiver temperature defined by the receiver temperature array.

CONC/11 saves internally the arrays of receiver temperatures and of efficiencies pertaining to the PCS and uses them as default values for all data sets after the first. To enter a new array for a new data set, the logical variable, NWTORF (NeW Temperature OR eFFiciency), must first be set .TRUE. for that data set. (The default value of NWTORF is set equal to .FALSE. for all data sets after the first.) When this is done, the program will prompt for an array of receiver temperatures, which must be entered. If the selected options require use of an array to define PCS efficiencies, that array will also be prompted for and must be entered.

#### Quantities to be Input

The CONC/11 dictionary (Appendix A) lists the quantities to be input, indicates whether they are required or optional, and gives the type of corresponding variable, the units, and the default value. Further information can be obtained from Block 1 of the program listing (Appendix D).

#### B. OPTIONS

CONC/11 will accept inputs in many alternative forms and provides a number of options concerning the system characteristics to be entered, the calculations to be done by the program, and the format of the output. Appendix B describes these options.

Depending upon the input options selected, some of the input variables are ignored by the program and need not be specified. To clarify the output, such variables are generally set equal to zero in the output (except that portion of the output which merely echoes the input). However, the default or input values of these variables are saved internally in the program and used as default values for the next data set.

#### C. OUTPUT

##### 1. Standard Output

If there are no input errors, the output for each data set takes one or two pages and consists of three parts: an echo of the input, a listing of the values used for the input variables, and an output table.



a. Echo of Input. This consists of:

- (1) The set number
- (2) An echo of the input NAMELIST, showing any new values for input variables
- (3) An echo of the list defining receiver temperatures if a new list has been input

If an array of efficiencies pertaining to the PCS is input, it is not echoed. The efficiencies used for the data set can be determined by examining the output table.

b. List of Values Used for Input Variables. This is a NAMELIST listing of the values used by the program for all input variables, whether provided by a new input, by default, or generated within the program. Values that are ignored by the program are generally set equal to zero. Values that vary with the receiver temperature are set equal to zero in this list; the values used are given in the output table.

c. Output Table. This table consists of one, or in some cases two, lines for each receiver temperature. The quantities listed depend upon the options chosen. (See Appendix B, Section D, "Options Pertaining to Output.") The following quantities are always given:

Receiver temperature, in °C and °F

Collector efficiency

Power conversion subsystem efficiency

System efficiency

The ratio, (system efficiency at this receiver temperature)/(highest system efficiency at any receiver temperature listed)

If the program optimizes the receiver aperture (option OPTMZE), the output table also gives

Geometric concentration ratio

Intercept factor

If calculations are made for a secondary concentrator (option SECONC), the collector and system efficiencies and the fraction of maximum system efficiency are given both with and without the secondary, as is the delta for each due to use of the secondary.

If the program optimizes the receiver aperture, and if a secondary concentrator is used (options OPTMZE and SECONC), the geometric concentration ratio and intercept factor of the primary are given both with and without use of the secondary. A second line for each receiver temperature gives the overall geometric concentration ratio and the overall intercept factor for the compound concentrator. In addition, if the program maximizes the secondary concentration ratio (option MAXSEC), this value is printed on the second line. Output of the second line may be suppressed if desired (option SUP2).

## 2. Extract of Output

If an extract of the output is requested (option XTRACT), a separate extract is provided, in addition to the standard output. For each data set, this extract consists of the echo of input and an abbreviated output table. This table includes only the lines for the lowest and highest receiver temperatures and for the receiver temperature at which system efficiencies are highest. Table headings are omitted.

## D. ERROR HANDLING

If an input format error is detected in a data set, an error message is placed in the output and the run is aborted after results for all preceding data sets are sent to output.

If the input values are found to be optically impossible or outside of the range of input that the program can handle, an error message is output and the program generally skips further processing of that data set. In a few cases, a warning is sent to output and processing of the data set continues.

If the efficiency or temperature given for power conditioning is thermodynamically impossible, the program provides an error message and skips further processing for the temperature concerned until acceptable values are input.

If the list of temperatures indicates that the accompanying array of efficiencies is too long for the allocated storage, a warning is generated and the array is truncated. If more efficiencies are input than correspond to the temperature list, the efficiency array is truncated. If too few efficiency values are provided, a read error will result.

If conflicting options are selected, the program chooses one and provides a message so stating.

If an extract is requested, but the Exec is unable to catalog or assign a file for this purpose, CONC/11 omits the extract and so states.

## SECTION IV

### EQUATIONS USED

The equations used are similar to those presented and discussed in Reference 1. The reader may find it useful to read Section II of that reference, where equations are given in algebraic form, before going through the rest of this section, in which Fortran notation is used.

The key output quantities are defined as:

$$\text{Collector efficiency} = \frac{\text{thermal power output of receiver}}{(\text{direct normal insolation}) \times (\text{concentrator aperture area})}$$

$$\text{System efficiency} = \frac{\text{net power output of system, deducting parasitics}}{(\text{direct normal insolation}) \times (\text{concentrator aperture area})}$$

Definitions of other solar engineering terms are given in Reference 1. All of the quantities used in the following equations are defined in Appendix A.

#### A. COLLECTOR

##### 1. Collector Efficiency

The equation used for collector efficiency is

$$A(1) = (\text{INS} \cdot \text{RH01} \cdot \text{BS1} \cdot \text{PHI} \cdot \text{ALPHA} - (1/\text{C1})(\text{EPS} \cdot \text{BOLTZ} \cdot (\text{TRK}^{**4} - \text{TAK}^{**4}) + \text{HC} \cdot (\text{TRK} - \text{TAK})) - \text{ARATIO} \cdot \text{HK} \cdot (\text{TRK} - \text{TAK})) / \text{INS} \quad (1)$$

Equation (1) assumes that the concentrator is pointed close to the sun line. It assumes that the only energy entering the receiver is sunlight from the concentrator and that receiver input may be expressed as this energy times an effective absorptance for the receiver aperture area. Equation (1) also assumes that the cavity temperature may be taken as uniform and that receiver losses may be expressed using an effective emittance for the aperture area, an effective convection coefficient for the aperture area, and an effective conductive coefficient for the wall area of the cavity -- all of these being independent of temperature, concentrator pointing, and wind velocity. These assumptions are usually adequate for preliminary system design.

Equation (1) is taken from Reference 1. It is a slightly modified form of a relation given earlier in Reference 2.

When a secondary concentrator is used, Equation (1) is modified by replacing RH01 by RH01 \* RH02, BS1 by BS1 \* BS2, PHI1 by PHI1S \* PHI2, and C1 by C1S \* C2 (Ref. 1). It may be necessary to adjust BS1 to take into account any shadowing of the primary by the secondary.

## 2. Intercept Factor and Concentration Ratio

The user of CONC/11 sometimes will have available all of the quantities on the right-hand side of Equation (1) and will be able to provide them as input. Often, however, the intercept factor or the geometric concentration ratio obtainable will not be known, and it will be necessary for the program to calculate them. CONC/11 obtains these quantities as follows:

For the variance of the angular distribution of sunlight leaving a local area of the (primary) mirror or lens (taken to be Gaussian), CONC/11 uses:

$$\text{DELTSQ} = (2.0 * \text{SLOPER} / 1000.0)^{**2} + (\text{SPECUL} / 1000.0)^{**2} + (\text{SOLSD} / 1000.0)^{**2} \quad (2)$$

For twice the square of the standard deviation of the flux distribution in the focal plane (taken to be Gaussian) in units of concentrator radius, the program uses:

$$\begin{aligned} \text{SIG2DF} = & 2.0 * \text{DELTSQ} * (1.0 / (\text{RMAR} * ((\text{TAN}(\text{RMAR} / 2.0))^{**2}))) * \\ & ((-1.0 / (3.0 * (\text{S}^{**3}) * \text{C})) + (2.0 / (3.0 * (\text{S}^{**3}))) + (2.0 / \text{S}) \\ & - (\text{C} / (3.0 * (\text{S}^{**3}))) - (2.0 * \text{C} / \text{S}) + ((4.0 * \text{S}) / (3.0 * \text{C})) \\ & - \text{ALOG}(\text{TAN}(\text{P4} + \text{RMAR} / 2.0)) + \text{ALOG}(\text{TAN}(\text{P4} - \text{RMAR} / 2.0))) \end{aligned} \quad (3a)$$

if the overall contour of the concentrator is a paraboloidal mirror, and

$$\text{SIG2DF} = 2.0 * \text{DELTSQ} * (1.0 + 2.0 * (\text{C}^{**2})) / (3.0 * \text{RMAR} * \text{C} * \text{S}) \quad (3b)$$

if the overall contour is planar. Here

$$\begin{aligned} \text{S} &= \text{SIN}(\text{RMAR}) \\ \text{C} &= \text{COS}(\text{RMAR}) \\ \text{T} &= \text{TAN}(\text{RMAR}) \end{aligned}$$

For the maximum intercept factor or geometric concentration ratio that is optically possible, CONC/11 uses:

$$\text{PHI1} = 1.0 - \text{EXP}(-1.0 / (\text{C1} * \text{SIG2DF})) \quad (4a)$$

or equivalently:

$$\text{C1} = 1.0 / (\text{SIG2DF} * (-\text{ALOG}(1.0 - \text{PHI1}))) \quad (4b)$$

Equation (4b) breaks down if  $\text{PHI1} = 1.0$ , which is not possible for a finite receiver aperture size because a Gaussian flux distribution extends to infinity. If given  $\text{PHI1} = 0$  as an input, the program uses:

$$\text{C1} = 1.0 / (\text{SIG2DF} * \text{VF}) \quad (4c)$$

as an approximation, where the parameter VF has been set = 6.

When a secondary concentrator is used, PH11 and C1 in Equations (4a) and (4c) are replaced by PH1S and C1S, and the maximum C2 that is optically possible is given by the smaller of the quantities:

$$1.0/(((\text{SIN}(\text{RMAR}+\text{DELT}))^{**2})*\text{PHI2}) \quad (5a)$$

and

$$(1.0/\text{C1S}*((\text{SIN}(\text{DELT}))^{**2})*\text{PHI2}))*\text{VF}/(-\text{ALOG}(1.0-\text{PHI1S})) \quad (5b)$$

if PH1S  $\neq$  1.0, or

$$1.0/(\text{C1S}*((\text{SIN}(\text{DELT}))^{**2})*\text{PHI2}) \quad (5c)$$

if PH1S = 1.0. Here, DELT = SQRT(DELT SQ).

Equations (3a) and (3b) require as input the rim angle of the concentrator. If the rim angle is not known to the user, CONC/11 will calculate it from the focal ratio, if given. The basic relationships are:

$$F = (1.0+\text{COS}(\text{RMAR}))/(\text{SIN}(\text{RMAR})) \quad (6a)$$

if the overall contour of the concentrator is that of a paraboloidal reflector, and

$$F = 1.0/(2.0*\text{TAN}(\text{RMAR})) \quad (6b)$$

if the overall contour is planar.

To solve Equation (6a) for RMAR, CONC/11 uses a table lookup; solution of Equation (6b) is done explicitly:

$$\text{RMAR} = \text{ATAN2}(1.0, (2.0*F)) \quad (6c)$$

Equations (4) and (5) are used to calculate intercept factors and geometric concentration ratios, as appropriate, when the options MAXPHI, MAXC, or MAXSEC are selected. In other cases they are used as a basis for warning messages stating that quantities input for these variables are greater than is optically possible.

If the option OPTMZE is selected, CONC/11 calculates the intercept factor and geometric concentration ratio that will provide maximum collector efficiency for a simple concentrator, using the equations:

$$\text{PHI1} = 1.0 - (\text{SIG2DF}*\text{EPS}*\text{BOLTZ}*(\text{TRK}^{**4} - \text{TAK}^{**4}) + \text{HC}(\text{TRK} - \text{TAK})) / (\text{INS}*\text{RH01}*\text{BS1}*\text{ALPHA}) \quad (7a)$$

$$\text{C1} = 1.0 / (\text{SIG2DF}*\text{ALOG}(\text{INS}*\text{RH01}*\text{BS1}*\text{ALPHA} / (\text{SIG2DF}*\text{EPS}*\text{BOLTZ}*(\text{TRK}^{**4} - \text{TAK}^{**4}) + \text{HC}(\text{TRK} - \text{TAK})))) \quad (7b)$$

If OPTMZE is selected with a secondary concentrator, the equations used are:

$$\text{PHI1S} = 1.0 - (\text{SIG2DF} * \text{EPS} * \text{BOLTZ} * (\text{TRK}^{**4} - \text{TAK}^{**4}) + \text{HC}(\text{TRK} - \text{TAK})) / (\text{INS} * \text{RHO1} * \text{RHO2} * \text{BS1} * \text{BS2} * \text{ALPHA} * \text{PHI2} * \text{C2}) \quad (7c)$$

$$\text{C1S} = 1.0 / \text{SIG2DF} * \text{ALOG}(\text{INS} * \text{RHO1} * \text{RHO2} * \text{BS1} * \text{BS2} * \text{ALPHA} * \text{PH2} * \text{C2} / (\text{SIG2DF} * \text{EPS} * \text{BOLTZ} * (\text{TRK}^{**4} - \text{TAK}^{**4}) + \text{HC}(\text{TRK} - \text{TAK}))) \quad (7d)$$

In Equations (7c) and (7d), C2 is calculated by expression (5a) if option MAXSEC has been selected; otherwise, CONC/11 uses the value of C2 provided by input or default.

Equation (2) assumes that the slope error and specularly spread of the mirror or lens and the angular spread of the incoming sunlight are all very small compared to the rim angle of the concentrator. This should be true for all practical concentrators. Equation (2) also assumes that the concentrator slope errors and specularly and the angular distribution of incoming sunlight are all normally distributed (Gaussian). This is a reasonable first approximation for slope errors, although circumferential slope errors may have a different standard deviation than tangential. The specularly spread of reflection from a glass mirror appears to be close to Gaussian, but if reflection is from a metal or polymeric mirror, the sum of two normal distributions may be needed for a good description (Ref. 3). For solar radiation, a Gaussian angular distribution is a rather crude approximation, although its accuracy depends on atmospheric conditions (Ref. 4). Unless the concentrator is unusually accurate, however, (SOLSD/1000.0)\*\*2 is considerably smaller than DELTSQ, and the inexactness of the solar representation has little effect upon the flux distribution in the focal plane (Ref. 4). Equation (2) neglects concentrator pointing errors and the spectral dispersion produced by a lens concentrator. If desired, either or both may be taken into account by providing as input for SPECUL the square root of the sum of the variances in angle due to specularly spread, pointing error, and dispersion.

Equation (3) is taken from Reference 5. As pointed out earlier (Ref. 6), the flux distribution in the focal plane may be taken as Gaussian. Reference 1 gives justification for the choice of Equation (3).

Equations (4a) and (4b) were derived in Reference 1. Equation (4c) is believed to be a reasonable approximation; the choice of VF = 6 was based on a cut-off reasonably far out on the tail of the Gaussian distribution (about 2.5 standard deviations).

Equation (5a) was derived from consideration of the theoretical performance of an ideal concentrator irradiated over an angle RMAR+DELTA (Refs. 7,8) and modified by the intercept factor PHI2. This modification is equivalent to assuming that the flux density is uniform, out to a finite radius, in the focal plane of the secondary. This is a good approximation for secondaries with good performance (Ref. 7). Equations (5b) and (5c) are derived in the same way from the theoretical performance of an ideal compound concentrator irradiated over an angle DELT and with primary characteristics given by Equation (4).

Equation (6) is straightforward geometry. Equation (7a) was derived by substituting Equation (4a) in Equation (1), differentiating, setting the differential  $d(A(1))/d(TRK) = 0$ , and solving for PH11. Equation (7b) was then derived by substituting this value of PH11 in Equation (4b). Equations (7c) and (7d) are derived in an analogous way, using factors appropriate to a compound concentrator.

## B. SYSTEM EFFICIENCY

The system efficiency is calculated as

$$A(5) = A(1)*PCSE*PPE \quad (8)$$

The power processing efficiency (PPE) is an input or default value. The power conversion subsystem efficiency (PCSE) is obtained in one of several ways, depending upon the options selected and the zero or nonzero values input for the pertinent variables. Thus, PCSE may be given as an array of input values, one for each receiver temperature, or may be calculated as

$$PCSE = PCEFCT*((TIK-TOK)/TIK) \quad (9a)$$

where PCEFCT, the PCS effectiveness as a fraction of Carnot efficiency, is an input or default value. Alternatively, PCSE may be taken as

$$PCSE = ENGE*GEARE*GENE \quad (9b)$$

Here GEARE and GENE are input values, and the engine efficiency, ENGE, is either given as an array of input values, one for each receiver temperature, or may be calculated as

$$ENGE = ENEFCT*((TIK-TOK)/TIK) \quad (10a)$$

where the engine effectiveness, ENGE, is an input value. Alternatively, ENGE may be taken as

$$ENGE = CYCE*MECHE*AUXE \quad (10b)$$

where MECHE and AUXE are input values, and the thermodynamic cycle efficiency, CYCE, is either given as an array of input values or calculated as

$$CYCE = CYCECT*((TIK-TOK)/TIK) \quad (11)$$

with the cycle effectiveness, CYCECT, being an input value.

The input temperature, TIK, is calculated as

$$TIK = TRK-DTRE \quad (12)$$

where the receiver temperature, TRK, is given by an input list and an internal conversion from Celsius to Kelvin, and DTRE and TOK are input or default values (with Celsius to Kelvin conversion).

Derivation of these equations is obvious.

CONC/11 determines the temperature at which system efficiency is greatest by calculating this efficiency at many receiver temperatures, which are defined by an input list, and noting at which temperature the system efficiency is highest. This is done for a fixed insolation. If it is desired to calculate yearly performance at a selected site (for which insolation data are available), or to optimize receiver temperature or aperture to provide maximum output over a year at such a site, the output for a given design may be calculated for each insolation level and the results weighted and summed to give total output for a year. By computing this total output for various receiver temperatures or apertures, the optimum based on yearly output may be determined.



## SECTION V

### FUNCTIONAL BLOCK DIAGRAMS

CONC/11 consists of a main program and two subroutines: NAMLRD, which carries out the NAMELIST read-in and echoing of the input variables, and OPT, which carries out the optical calculations and checks associated input values. OPT has three entries, CKNOPT, CKOPT, and OPTAP. CONC/11 also uses subroutines and functions from the MATH library and, as described in Section II, from the libraries JPL\$ and CLIB\$.

Figure 5-1 provides an overall block diagram of CONC/11. Figures 5-2, 5-3, and 5-4 give greater detail for Blocks 2.2, 2.3, and 2.4. Figures 5-5 and 5-6 are block diagrams for the subroutines NAMLRD and OPT.

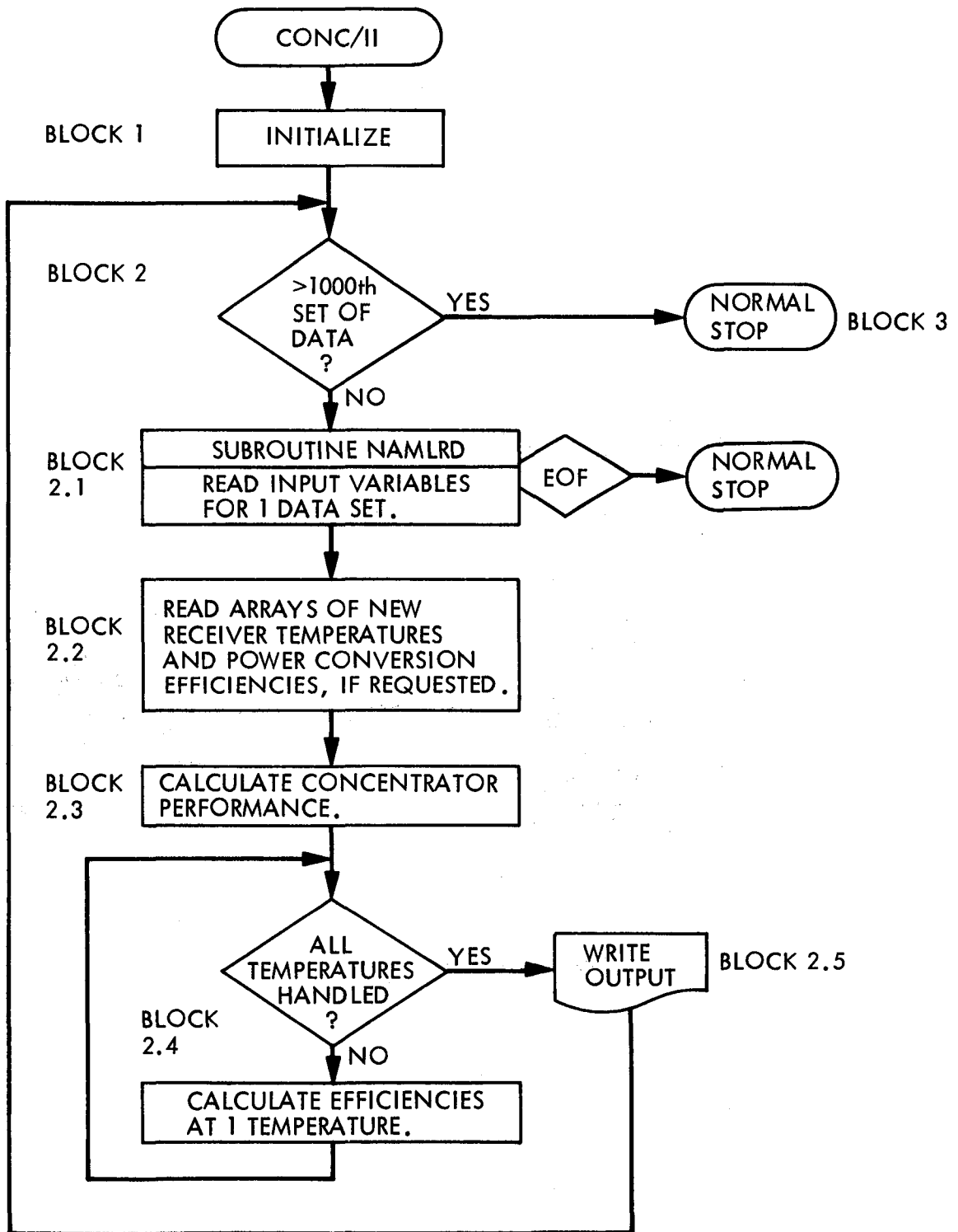


Figure 5-1. Overall Block Diagram of CONC/11

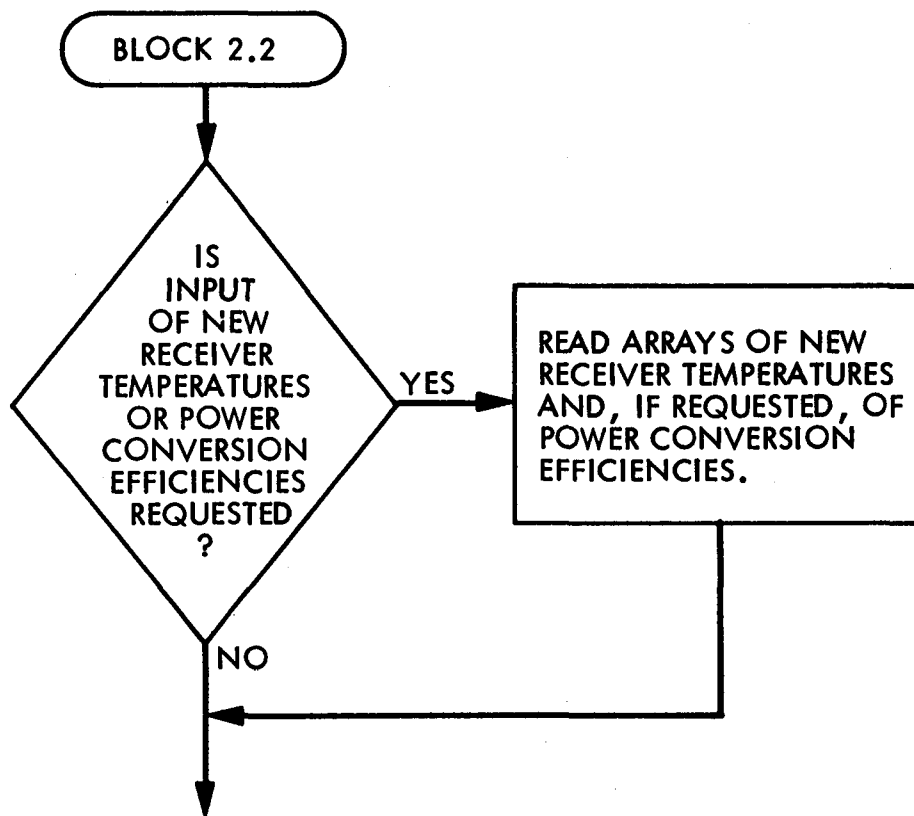


Figure 5-2. Diagram of Block 2.2

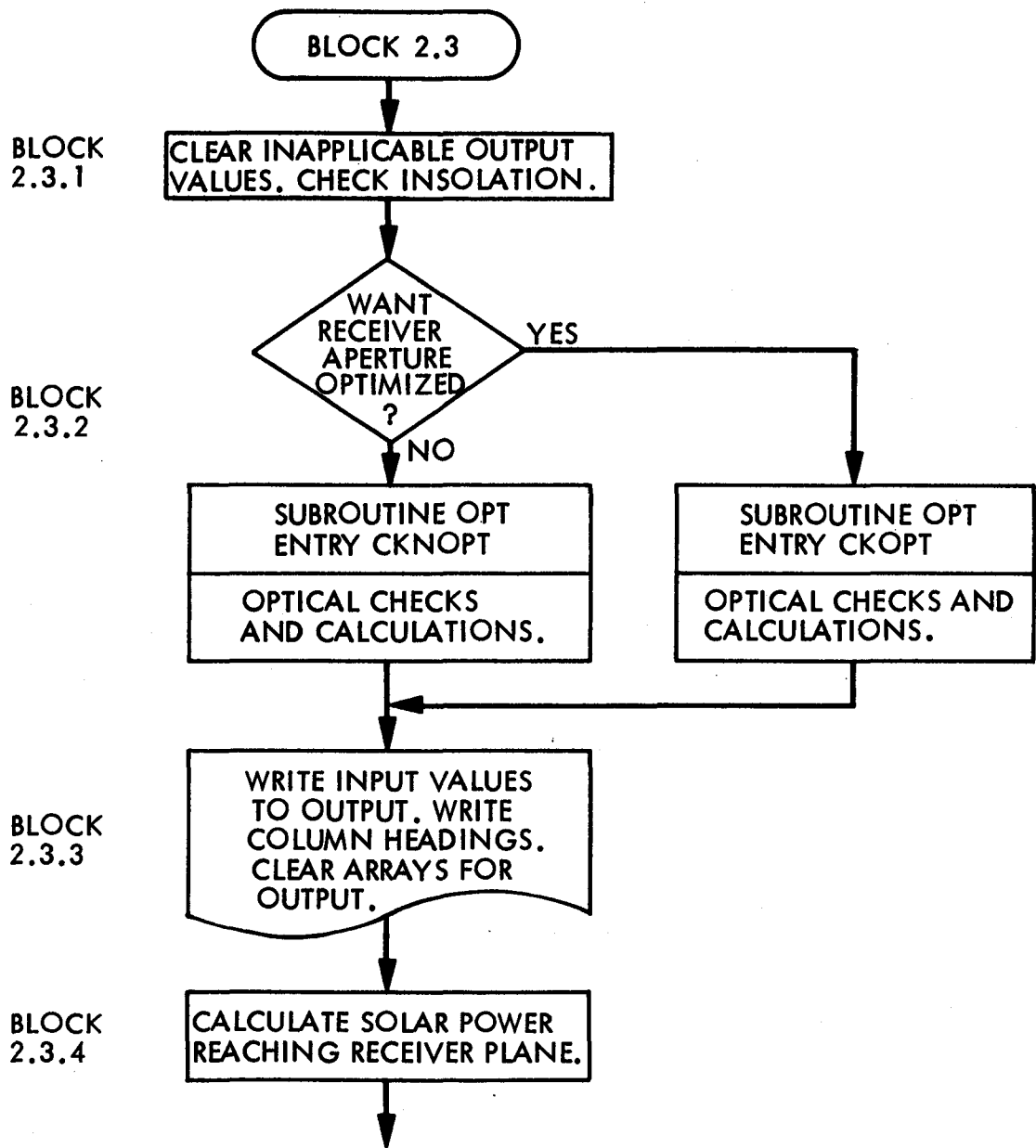


Figure 5-3. Diagram of Block 2.3

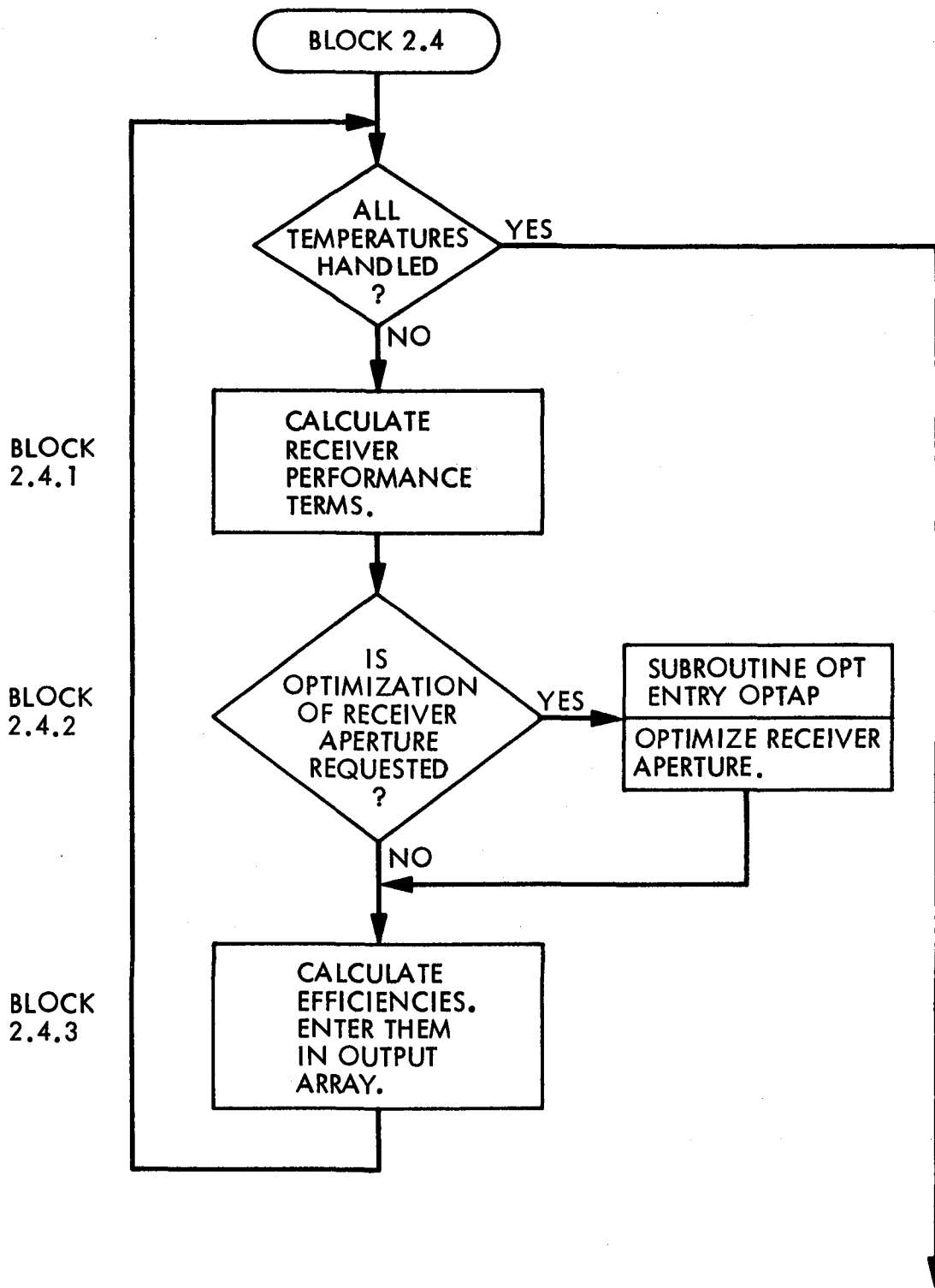


Figure 5-4. Diagram of Block 2.4

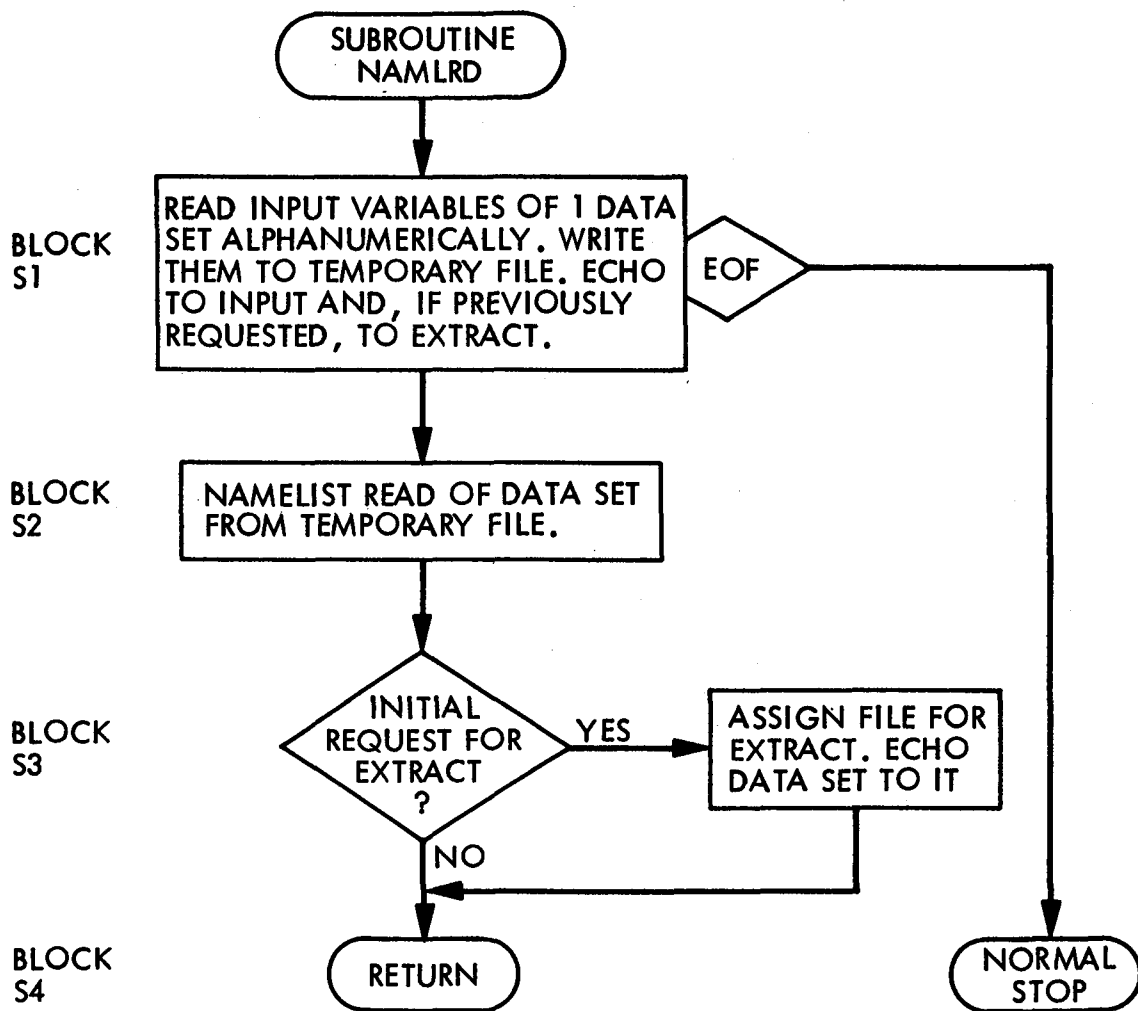


Figure 5-5. Block Diagram of Subroutine NAMLRD

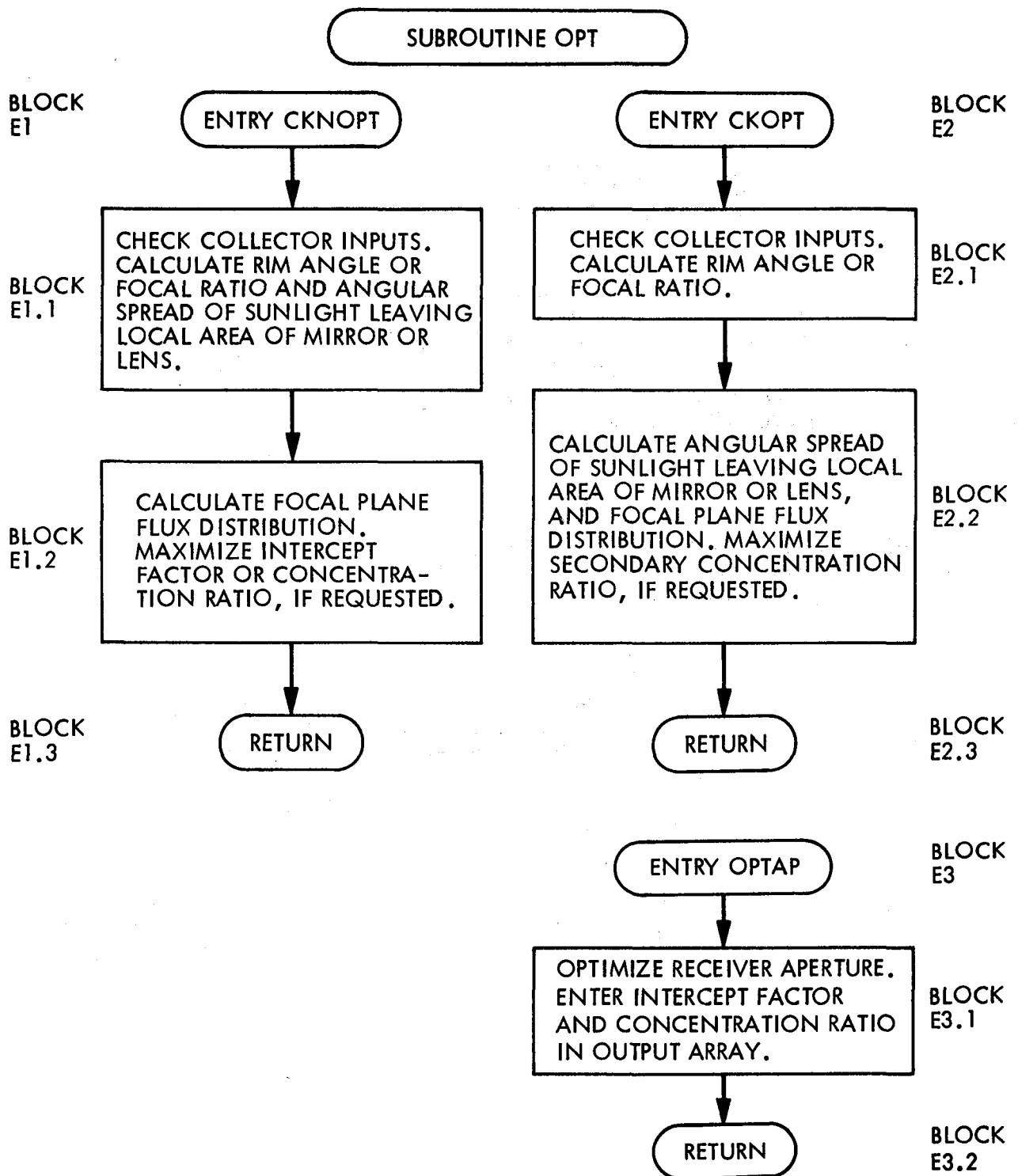


Figure 5-6. Block Diagram of Subroutine OPT





## SECTION VI

### USER INSTRUCTIONS

Source and absolute CONC/11 programs are stored in JPL MASSTOR as elements of the file JAFFE\*SOLAR1. To use these programs, arrange access to the MASSTOR file and transfer it to a JPL Sperry Univac 1100 file by initiating a run on the 1100 and then commanding

```
@SRD
RESTORE programfile FROM JAFFE*SOLAR1
STOP
```

(If MASSTOR is discontinued, files stored on it are to be saved. A backup tape identified as JAFFE1 is held by the author.)

The rest of these instructions pertain to execution on the Sperry Univac 1100. Similar methods can be used on other computers. The program is run on the Sperry 1100 by the command

```
@XQT programfile.CONC/11
```

To become familiar with the program, it is best to run it first in demand mode, from an interactive terminal set up to display and print transmissions from the 1100. This will permit display of prompts for all input, which should be entered with the keyboard. The input needed is described in Section III.A. above. Input and output will be displayed and printed. Multiple sets of input data are expected; after output is provided for one set, input is solicited for the next set. To end CONC/11 execution, enter

```
@EOF
```

when prompted for input values (NAMELIST). CONC/11 may be reinvoked as often as desired, and new sets of values entered.

When the user becomes familiar with CONC/11 and perhaps wishes to avoid inclusion of prompt and input messages in the output printout or to reduce time at the terminal, he may catalog and assign a file for output, then breakpoint to this file immediately before executing CONC/11:

```
@BK1 outputfile
@XQT programfile.CONC/11
```

After completing a CONC/11 execution, the data file should be sent to a printer by

```
@BK2 siteid, bldg/box
```

Care should be taken not to overwrite the output file by breakpointing successive CONC/11 executions. Either use the form

@BK1

without a file name, which creates a unique file each time it is invoked, or specify a different output file (or file cycle) for each execution.

A disadvantage of this method of execution is that the prompts displayed are limited to a carat. Therefore, it is necessary to keep track of the inputs that will be required. Accordingly, this mode is not recommended unless only very few sets are input per CONC/11 execution.

If the output is to be breakpointed, it is better to create a file containing the input for a CONC/11 execution and check this file. After output is breakpointed, CONC/11 is executed by

```
@XQT programfile.CONC/11
@ADD inputfile
```

Alternatively, once the user is familiar with the program, he may choose to execute it in batch mode, either from cards or from 1100 files, using the

```
@ADD inputfile
```

as mentioned above.

With any of these methods of execution, if option XTRACT is selected, an extract of the output (described in Section III.C.2. above) is placed in a file named XTRACT, which is cataloged and assigned by CONC/11. A new file cycle is cataloged at each CONC/11 execution to prevent overwriting. The XTRACT file should be printed out by commanding

```
@BLK,S XTRACT, bldg/box, printer
```

This command should be repeated once for each execution of CONC/11. Multiple executions may precede any printout of XTRACT. If this is done, printouts will be in the reverse order of the executions (e.g., latest XTRACT output printed first).

## REFERENCES

1. Jaffe, L. D., "Optimization of Dish Solar Collectors With and Without Secondary Concentrators," DOE/JPL-1060-57, May 15, 1982. Also accepted for publication, Journal of Energy.
2. Wen, L., "Effect of Optical Surface Properties on High-Temperature Solar Thermal Energy Conversion," Journal of Energy, Vol. 3, pp. 82-89, 1979.
3. Pettit, R. B., "Characterization of the Reflected Beam Profile of Solar Mirror Materials," Solar Energy, Vol. 19, pp. 733-741, 1977.
4. Wen, L., Huang, L., Poon, P., and Carley, W., "Comparative Study of Solar Optics for Parabolic Concentrators," Journal of Solar Energy Engineering, Vol. 102, pp. 305-315, November 1980.
5. Duff, W. S., and Lameiro, G. F., "A Performance Comparison Method for Solar Concentrators," Paper 74-WA/Sol-4, ASME Winter Annual Meeting, New York, New York, 1974.
6. Lof, G. O. G., and Duffie, J. A., "Optimization of Focusing Solar Collector Design," Journal of Engineering for Power, Vol. 85, pp. 221-228, 1963.
7. Welford, W. T., and Winston, R., The Optics of Nonimaging Concentrators, Academic Press, New York, New York, 1978.
8. Jaffe, L. D., and Poon, P. T., "Secondary and Compound Concentrators for Parabolic Dish Solar Thermal Power Systems," DOE/JPL-1060-43, April 15, 1981. Also, Proc. 16th Intersociety Energy Conversion Engineering Conference, Vol. 2, pp. 1752-1758, ASME, New York, New York, 1981.



APPENDIX A  
CONC/11 DICTIONARY



<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for</u>	
						<u>Input</u>	<u>Output</u>
A	Array	7	Real	-	-		
	A(1): Collector efficiency, without secondary A(2): Collector efficiency, with secondary A(3): Collector efficiency increase due to secondary A(4): Power conversion subsystem efficiency A(5): System efficiency, without secondary A(6): System efficiency, with secondary A(7): System efficiency increase due to secondary						
AA	Array	9,NT	Real	-	-		X
	Output array of efficiencies						
ALOG	Function	-	Real	-	-		
	Natural logarithm. (In Math Library.)						
ALPHA	Variable	-	Real	1.0	-		X
	Receiver effective absorptance						
AMAX1	Function	-	Real	-	-		
	Largest of 2 arguments. (Intrinsic function.)						
AMIN1	Function	-	Real	-	-		
	Smallest of 2 arguments. (Intrinsic function.)						
ARATIO	Variable	-	Real	0.025	-		X
	Ratio, (Receiver cavity wall area)/(Concentrator area)						
ASG100	Variable	-	Logical	-	-		
	Flag to indicate assignment of extract file XTRACT. (File 100 internally in Fortran.)						
ASSIGN	Subroutine	-	-	-	-		
	Sends @CAT and @ASG commands to Exec. (In library LIB*CLIB\$.)						
ATAN2	Function	-	Real	-	-		
	Arctangent of ratio of 2 arguments. (In Math Library.)						

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for</u>	
						<u>Input</u>	<u>Output</u>
AUXE	Variable	-	Real	0.0	-	X	
	Efficiency factor to account for power used by auxiliaries						
A5MAX	Variable	-	Real	-	-		
	Highest system efficiency, without secondary						
A6MAX	Variable	-	Real	-	-		
	Highest system efficiency, with secondary						
BOLTZ	Variable	-	Real	5.67032E-8	W/m <sup>2</sup> K <sup>4</sup>		
	Boltzman constant						
BOUND	Variable	-	Real	1.0E-7	-		
	Bound for equality comparisons of real numbers and to prevent division by zero						
BS1	Variable	-	Real	1.0	-	X	
	Blocking and shadowing factor of primary concentrator						
BS2	Variable	-	Real	1.0	-	X	
	Blocking and shadowing factor of secondary concentrator						
C	Procedure	-		-	-		
	Cosine of rim angle of (primary) concentrator						
CARNOT	Variable	-	Real	-	-		
	Carnot efficiency						
CINV	Variable	-	Real	-	-		
	Inverse of C1						
CINVS	Variable	-	Real	-	-		
	Inverse of C1S						
CKNOPT	Entry	-	-	-	-		
	Checks input of collector characteristics. Calculates angular distribution of sunlight leaving local area of mirror or lens. Used when receiver aperture optimization is not selected. (In subroutine OPT.)						



<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for</u>	
						<u>Input</u>	<u>Output</u>
CKOPT	Entry	-	-	-	-		
	Corresponds to preceding item. Used when receiver aperture optimization is selected. (In subroutine OPT.)						
COS	Function	-	Real	-	-		
	Cosine. (In Math Library.)						
CSF8	Function	-	Integer	-	-		
	Sends @USE command to Exec. (In library LIB*CLIB\$.)						
CYCE	Variable	-	Real	-	-		
	Thermodynamic cycle efficiency of engine						
CYCECT	Variable	-	Real	0.0	-		X
	Cycle effectiveness (fraction of Carnot efficiency)						
C1	Variable	-	Real	1000.0	-		X
	Geometric concentration ratio, without secondary						
C1MAX	Variable	-	Real	-	-		
	Maximum C1 that is optically possible						
C1S	Variable	-	Real	1000.0	-		X
	Primary geometric concentration ratio, with secondary						
C1SMAX	Variable	-	Real	-	-		
	Maximum C1S that is optically possible						
C2	Variable	-	Real	1.0	-		X
	Secondary geometric concentration ratio						
C2HOLD	Variable	-	Real	-	-		
	Temporary store of C2						
C2MAX	Variable	-	Real	-	-		
	Maximum C2 that is optically possible						

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for</u>	
						<u>Input</u>	<u>Output</u>
DELTA	Variable	-	Real	-	radian		
	Variance of Gaussian angular distribution of sunlight leaving a local area of (primary) mirror or lens						
DELTSQ	Variable	-	Real	-	(radian) <sup>2</sup>		
	Standard deviation of Gaussian angular distribution of sunlight leaving a local area of (primary) mirror or lens						
DTRF	Variable	-	Real	25.0	°C		X
	Temperature drop from receiver to engine						
DUMMY	Variable	-	Real	-	-		
	Dummy argument in call of subroutine SLUP						
EFF	Array	NT	Real	-	-		X
	Power conversion, engine, or cycle efficiencies corresponding to receiver temperatures designated by ITRC list						
ENEFACT	Variable	-	Real	0.0	-		X
	Power conversion effectiveness (fraction of Carnot efficiency)						
ENGE	Variable	-	Real	-	-		
	Engine efficiency						
EPS	Variable	-	Real	1.0	-		X
	Receiver effective emittance (for aperture area)						
EXP	Function	-	Real	-	-		
	Exponential. (In Math Library.)						
F	Variable	-	Real	0.6	-		X
	Focal ratio of (primary) concentrator						
FRAY	Array	90	Real	(DATA)	-		
	Focal ratios corresponding to RMARAY						
GEARE	Variable	-	Real	0.0	-		X
	Gear efficiency						

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for</u>	
						<u>Input</u>	<u>Output</u>
GENE	Variable	-	Real	0.0	-	X	
	Generator efficiency						
HC	Variable	-	Real	0.0	W/m <sup>2</sup> °C	X	
	Effective convection coefficient (for receiver aperture)						
HK	Variable	-	Real	0.0	W/m <sup>2</sup> °C	X	
	Effective conduction coefficient (for receiver cavity wall)						
I	Variable	-	Integer	-	degree		
	Index of DO loop to generate RMARAY						
ICYCEF	Variable	-	Logical	.FALSE.	-	X	
	.TRUE. to input engine cycle efficiency vs. temperature						
IDUMM	Variable	-	Integer	-	-		
	Dummy argument in call of subroutine ASSIGN						
IENGEF	Variable	-	Logical	.FALSE.	-	X	
	.TRUE. to input engine efficiency vs. temperature						
INREAD	Array	14	Integer	-	-		
	Read/Write buffer						
INS	Variable	-	Real	800.0	W/m <sup>2</sup>	X	
	Insolation						
IPCSEF	Variable	-	Logical	.FALSE.	-	X	
	.TRUE. to input PCS efficiency vs. temperature						
IRFLG	Variable	-	Logical	-	-		
	Flag to indicate if RMARAY has been generated						
ISTAT	Variable	-	Integer	-	-		
	Indicates status of execution of function CSF8						
ITRC	Variable	-	Integer	-	°C		
	Receiver temperature. (Index of DO loop.)						

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for</u>	
						<u>Input</u>	<u>Output</u>
ITRC1	Variable	-	Integer	-	°C		X
	Initial parameter of DO loop for receiver temperatures						
ITRC2	Variable	-	Integer	-	°C		X
	Terminal parameter of DO loop for receiver temperatures						
ITRC3	Variable	-	Integer	-	°C		X
	Incrementation parameter of DO loop for receiver temperatures						
J	Variable	-	Integer	-	-		
	Index of DO loop						
JJ	Variable	-	Integer	-	-		
	Number of records in input NAMELIST						
K	Variable	-	Integer	-	-		
	Index of DO loop						
L	Variable	-	Integer	-	-		
	Position of character in word of input NAMELIST. (Index of DO loop.)						
M	Variable	-	Integer				
	Data set number. (Index of DO loop.)						
MAXC	Variable	-	Logical	.FALSE.	-		X
	.TRUE. to maximize (primary) geometric concentration ratio						
MAXPHI	Variable	-	Logical	.FALSE.	-		X
	.TRUE. to maximize (primary) intercept factor						
MAXSEC	Variable	-	Logical	.FALSE.	-		X
	.TRUE. to use maximum possible secondary concentration						
MECHE	Variable	-	Real	0.0	-		X
	Mechanical efficiency of engine						
MIN	Function	-	Integer	-	-		
	Smaller of 2 arguments. (Intrinsic function.)						

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for Input Output</u>
MNT	Variable	-	Integer	-	-	X
	Number of efficiencies, pertaining to PCS, to be read and number of receiver temperatures to be written					
MORDEC	Variable	-	Logical	.FALSE.	-	X
	.TRUE. to print more decimal places for efficiencies. (5 instead of 3.)					
NAMLRD	Subroutine	-		-	-	
	Reads in values of input variables					
NLIST	Namelist name	-		-	-	
	List of variables for NAMLIST					
NSET	Variable	-	Integer	-	-	
	Number of data sets entered					
NT	Parameter	-	-	50	-	
	Maximum number of receiver temperatures per data set					
NTCNT	Variable	-	Integer	-	-	
	Count of receiver temperatures					
NTRC	Variable	-	Integer	-	-	
	Number of receiver temperatures					
NWTORF	Variable	-	Logical	-	-	X
	.TRUE. to read new receiver temperatures or new efficiencies pertaining to PCS. (Default value: .TRUE. for first data set; .FALSE. for all others.)					
OPT	Subroutine	-	-	-	-	
	Calculates or checks optical characteristics					
OPTAA	Array	5,NT	Real	-	-	X
	Intercept factors for specified receiver temperatures and concentration ratios.					
	OPTAA (1,NTCNT): C1 for various receiver temperatures					
	OPTAA (2,NTCNT): CIS if SECONC =, TRUE, else PH1					
	OPTAA (3,NTCNT): PH1					
	OPTAA (4,NTCNT): PH1S					
	OPTAA (5,NTCNT): C2					

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for Input Output</u>
OPTAP	Entry	-		-	-	
	Optimizes receiver aperture. (In subroutine OPT.)					
OPTMZE	Variable	-	Logical	.FALSE.	-	X
	.TRUE. to optimize receiver aperture					
PARAB	Variable	-	Logical	.TRUE.	-	X
	.TRUE. : overall contour of (primary) mirror approximately paraboloidal .FALSE.: overall contour of (primary) mirror or lens approximately planar.					
PCEFCT	Variable	-	Real	0.5	-	X
	Power conversion effectiveness (fraction of Carnot efficiency)					
PHI1	Variable	-	Real	0.95	-	X
	Intercept factor (with no secondary concentrator)					
PHI1FC	Variable	-	Real	-	-	
	Function of PHI1 used to determine maximum possible geometric concentration ratio (no secondary)					
PHI1S	Variable	-	Real	(0.0)	-	X
	Intercept factor for primary concentrator (used with secondary)					
PHI1SF	Variable	-	Real	-	-	
	Function of PHI1S used to determine maximum possible primary geometric concentration ratio, with secondary					
PHI2	Variable	-	Real	1.0	-	X
	Intercept factor for secondary concentrator					
PI	Variable	-	Real	3.141592	-	
	$\pi$					
PPE	Variable	-	Real	0.95	-	X
	Power processing efficiency					
P4	Variable	-	Real	PI/4.0	-	
	$\pi/4$					

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for Input Output</u>
RH01	Variable	-	Real	0.9	-	X
	Effective reflectance or transmittance of (primary) concentrator					
RH02	Variable	-	Real	0.9	-	X
	Effective reflectance or transmittance of secondary concentrator					
RMA	Variable	-	Real	(0.0)	degree	X
	Rim angle of (primary) concentrator					
RMAR	Variable	-	Real	-	radian	
	Rim angle of (primary) concentrator					
RMARAY	Array	90	Real	-	degree	
	Rim angles corresponding to FRAY					
S	Procedure	-	-	-	-	
	Sine of rim angle of (primary) concentrator					
SECONC	Variable	-	Logical	.FALSE.		
	.TRUE. to calculate performance with secondary concentrator, as well as without					
SIG2DF	Variable	-	Real	-	-	
	Variance of flux distribution in focal plane, in units of (concentrator radius) <sup>2</sup>					
SIN	Function	-	Real	-	-	
	Sine. (In Math Library.)					
SLOPER	Variable	-	Real	2.0	mrاد	X
	Slope error of (primary) reflector					
SLUP	Subroutine	-		-	-	
	Table lookup and interpolation. (In Library LIB*JPL\$.)					
SOLSD	Variable	-	Real	2.3	mrاد	X
	Standard deviation of angular spread of incoming sunlight					

<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for Input Output</u>
SPECUL	Variable	-	Real	0.5	mrad	X
	Specularity spread of (primary) concentrator					
SQRT	Function	-	Real	-	-	X
	Square root. (In Math library.)					
SUP2	Variable	-	Logical	.FALSE.	-	
	.TRUE. to suppress 2nd line of output for each receiver temperature					
T	Procedure	-		-	-	
	Tangent of rim angle of (primary) concentrator					
TAC	Variable	-	Real	20.0	°C	X
	Ambient temperature					
TAK	Variable	-	Real	-	K	
	Ambient temperature					
TAN	Function	-	Real	-	-	
	Tangent. (In Math library.)					
TIK	Variable	-	Real	-	K	
	Engine inlet temperature					
TOC	Variable	-	Real	50.0	°C	X
	Outlet temperature of engine thermodynamic cycle					
TOK	Variable	-	Real	-	K	
	Outlet temperature of engine thermodynamic cycle					
TRK	Variable	-	Real	-	K	
	Receiver (cavity) temperature					
TRMA	Variable	-	Real	-	W/m <sup>2</sup>	
	Term pertaining to power into receiver (no secondary concentrator)					
TRMAS	Variable	-	Real	-	W/m <sup>2</sup>	
	Term pertaining to power into receiver with secondary concentrator					



<u>Name</u>	<u>Usage</u>	<u>Dimen- sions</u>	<u>Type</u>	<u>Default Value</u>	<u>Units</u>	<u>Used for</u>	
						<u>Input</u>	<u>Output</u>
TRMB	Variable	-	Real	-	W/m <sup>2</sup>		
	Term pertaining to radiation and convection loss from receiver						
TRMC	Variable	-	Real	-	W/m <sup>2</sup>		
	Term pertaining to conduction loss from receiver						
TT	Array	2, NT	Real	-	-		X
	Receiver temperatures						
		TT (1, NT)			°C		
		TT (2, NT)			°F		
VF	Variable	-	Real	6.0	-		
	Variance ratio limiting maximum concentration when PHI = 1.0						
XFLAG	Variable	-	Logical	-	-		
	.TRUE. to identify line of output tables to be included in extract						
XTRACT	Variable	-	Logical	.FALSE.	-		X
	.TRUE. to provide extract of output in file XTRACT						
XTRON	Variable	-	Logical	-	-		
	Flag to indicate if XTRACT has just been .TRUE.						
Y	Array	32	Real	-	-		
	Input values of real variables, held for next data set						
Z	Array	32	Real	-	-		
	Real variables used for input						
98	File	-	Temporary	-	-	X	-
	Holds input temporarily for NAMELIST read						
100	File	-	Cataloged	-	-	-	X
	Extract of output. (Named 'XTRACT' by Exec.)						



**APPENDIX B**

**OPTIONS**



## OPTIONS

### A. OPTIONS PERTAINING TO COLLECTOR CHARACTERISTICS

#### 1. Secondary Concentrator

If SECONC (SEcondary CONCentrator) is set `.TRUE.`, the output will show performance with a secondary concentrator, as well as without. If SECONC is `.FALSE.`, the output will be for a simple concentrator only (no secondary). The initial default value is `.FALSE.`

#### 2. Receiver Aperture Optimization

If OPTMZE is set `.TRUE.`, CONC/11 will calculate the receiver aperture size that provides maximum collector efficiency. It will calculate and output the corresponding geometric concentration ratio, intercept factor, and efficiencies. If SECONC is also `.TRUE.`, the program will optimize the receiver aperture and output the quantities named, both with and without a secondary concentrator. The initial default value of OPTMZE is `.FALSE.`

Optimization of receiver temperature to provide maximum system efficiency is always done by CONC/11 when data pertaining to PCS and PPS efficiencies are input, and need not be explicitly requested.

#### 3. Maximization of Geometric Concentration Ratio

Maximization of geometric concentration ratio at a given intercept factor is requested by setting MAXC (MAXimum Concentration) equal to `.TRUE.`. This should not be done if OPTMZE is true (in which case MAXC will be ignored). If SECONC and MAXC are both true (and OPTMZE is not), the program maximizes the geometric concentration ratio of the primary both with and without the secondary. The initial default value of MAXC is `.FALSE.`

#### 4. Maximization of Intercept Factor

Maximization of intercept factor at a given concentration ratio is requested by setting MAXPHI (MAXimum intercept factor) equal to `.TRUE.`. This should not be done if OPTMZE or MAXC is `.TRUE.` (in which case MAXPHI will be ignored). If SECONC and MAXPHI are both `.TRUE.`, the program maximizes the intercept factor of the primary both with and without the secondary. The initial default value of MAXPHI is `.FALSE.`

Note: If OPTMZE, MAXC, and MAXPHI are all `.FALSE.` (the initial default value), the program will use the input or default values of the geometric concentration ratio and the intercept factor (with and without a secondary concentrator if SECONC is `.TRUE.`)

## 5. Maximization of Geometric Concentration Ratio of Secondary

If both MAXSEC and SECONC are .TRUE., the program will calculate and use the maximum secondary concentration ratio compatible with the characteristics of the primary and with the secondary intercept factor. The initial default value of MAXSEC is .FALSE.

## 6. Shape of Concentrator

If PARAB is .TRUE., the overall contour of the (primary) concentrator is taken to be paraboloidal. If PARAB is .FALSE., the overall contour is taken to be flat. The initial default value is .TRUE.

## B. OPTIONS PERTAINING TO POWER CONVERSION CHARACTERISTICS

Power conversion characteristics may be input either as an effectiveness (that is, a constant fraction of Carnot efficiency) or as an array of efficiency values, corresponding to the receiver temperatures. Also, the effectiveness or the array of efficiencies can be given either for the power conversion subsystem as a whole, for the engine only, or for the thermodynamic cycle only.

If IPCSEF (Input PCS Efficiencies), IENGEF (Input ENGINE Efficiencies), or ICYCEF (Input CYCLE Efficiencies) is set .TRUE., the program expects input of a corresponding array of efficiencies. Not more than one of these variables should be set .TRUE. If two or three are set .TRUE., the program will interpret the efficiency array as pertaining to IPCSEF or IENGEF, in that order of preference.

If IPCSEF, IENGEF, and ICYCEF are all .FALSE. (the initial default value), the program will use the input or default value of PCEFCT (PCs EFFeCTiveness) if it is greater than zero. If PCEFCT is zero (or less), the program will use ENEFCT (ENGINE EFFeCTiveness) if it is greater than zero. Otherwise, the program will use CYCECT (CYCLE EFFeCTiveness).

Notes: If only the collector is of interest, this may be designated by IPCSEF, IENGEF, and ICYCEF all .FALSE. (their initial default value) and PCEFCT, ENEFCT, and CYCECT all zero. The initial default values of ENEFCT and CYCECT are zero, but that of PCEFCT is not. Thus, if the initial default values are still in use for a data set, it is only necessary to input PCEFCT = 0.0.

## C. OPTION PERTAINING TO INPUT

To enter either new receiver temperatures or a new table of efficiencies for power conversion, NWTORF (NeW Temperature OR efficiencies) must be set .TRUE. To enter a new table of efficiencies for power conversion, IPCSEF, IENGEF, or ICYCEF must also be set .TRUE.

The last sentence does not apply to entering a new effectiveness for power conversion, which is done by entering the desired value of PCEFCT, ENEFCT, or CYCECT, with IPCSEF, IENGEF, and ICYCEF all set .FALSE. and with NWTORF either .TRUE. or .FALSE.

The default value of NWTORF is .TRUE. for the first data set and .FALSE. for all subsequent data sets. The default value of NWTORF is not determined by its value in the preceding data set.

#### D. OPTIONS PERTAINING TO OUTPUT

##### 1. Extract of Output

Output of CONC/11 is one or two pages per data set; if many data sets are input, the output will be many pages. If .XTRACT. is set .TRUE., the program will also provide an extract of the output. This consists, for each data set, of an echo of the NAMELIST and receiver temperature inputs, plus outputs for the lowest and highest receiver temperatures and for the temperature that gives the highest system efficiency.

If .XTRACT. is .TRUE., CONC/11 catalogs and assigns a file named XTRACT and places the extract in this file. Each run of CONC/11 catalogs and assigns a new cycle of XTRACT.

The initial default value of XTRACT is .FALSE.

##### 2. Partial Suppression of Output

When both SECONC and OPTMZE are .TRUE., the standard output for each receiver temperature is too long to fit on one line of output, and therefore is folded over to a second line. Appropriate headings are printed for this line; nevertheless, the folding makes the main output table harder to read and doubles its length. If SUP2 (SUPpress 2nd line) is set .TRUE., output of the second line is suppressed. The quantities otherwise printed on this line are the geometric concentration ratio and intercept factor of the compound concentrator and, if MAXSEC is .TRUE., the geometric concentration ratio of the secondary concentrator.

The initial default value of SUP2 is .FALSE.

##### 3. More Decimal Places

In the standard output, efficiencies are given to three decimal places. If MORDEC (MORe DECimal places) is set .TRUE., efficiencies will be given to five decimal places.

The initial default value of MORDEC is .FALSE.





**APPENDIX C**

**SAMPLE CASES**

<b>Case A . . . . .</b>	<b>C-3</b>
<b>Case B . . . . .</b>	<b>C-9</b>
<b>Case C . . . . .</b>	<b>C-17</b>
<b>Case D . . . . .</b>	<b>C-33</b>



CASE A

Only collector of interest. (Not power conversion.)

Two data sets.

CONC/11 assumed to be in file SOLAR.

Control, input, and output by interactive terminal.

→Indicates input.

Notes on results:

For the selected input values, including an insolation of  $800 \text{ W/m}^2$ , increasing the receiver temperature from 700 to  $800^\circ\text{C}$  lowers collector efficiency from 0.79 to 0.76. If the insolation is increased to  $1000 \text{ W/m}^2$ , the corresponding efficiencies rise. The efficiency increase is greater at the higher receiver temperatures.

➔@RUN ABC,12345.DEF

➔@ASG,A SOLAR  
READY

➔@XQT SOLAR.CONC/11

```
SET      1
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
➔ $NLIST      PCEFCT=0.0,          $END
  $NLIST      PCEFCT=0.0,          $END
ENTER RECEIVER TEMPERATURES (M1,M2,M3  INTEGER)
➔700,800,25
ITRC1, ITRC2, ITRC3 =          700,      800,      25
$NLIST
INS      =      .80000000E+03
RH01     =      .90000000E+00
RH02     =      .00000000E+00
BS1      =      .10000000E+01
BS2      =      .00000000E+00
PHI1     =      .95000000E+00
PHI1S    =      .00000000E+00
PHI2     =      .00000000E+00
C1       =      .10000000E+04
C1S      =      .10000000E+04
C2       =      .00000000E+00
F        =      .60000000E+00
RMA      =      .45239635E+02
SLOPER   =      .20000000E+01
SPECUL   =      .50000000E+00
SOLSD    =      .23000000E+01
ALPHA    =      .10000000E+01
EPS      =      .10000000E+01
TAC      =      .20000000E+02
HC       =      .00000000E+00
ARATIO   =      .00000000E+00
HK       =      .00000000E+00
DTRE     =      .25000000E+02
TOC      =      .50000000E+02
PCEFCT   =      .00000000E+00
ENEFCT   =      .00000000E+00
CYCECT   =      .00000000E+00
MECHE    =      .00000000E+00
AUXE     =      .00000000E+00
GEARE    =      .00000000E+00
GENE     =      .00000000E+00
PPE      =      .95000000E+00
OPTMZE   =      F
PARAB    =      T
MAXC     =      F
MAXPHI   =      F
SECONC   =      F
MAXSEC   =      F
IPCSEF   =      F
IENGEF   =      F
ICYCEF   =      F
NWTORF   =      T
XTRACT   =      F
SUP2     =      F
MORDEC   =      F
$END
```

<u>RECEIVER TEMP.</u>		COLLECTOR	PCS	SYSTEM	FRAC.MAX.
<u>C</u>	<u>F</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>SYS.EFFIC.</u>
700.0	1292.0	.792	.000	.000	.000
725.0	1337.0	.785	.000	.000	.000
750.0	1382.0	.778	.000	.000	.000
775.0	1427.0	.770	.000	.000	.000
800.0	1472.0	.762	.000	.000	.000

```

SET      2
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
➔ $NLIST      INS=1000.0,                                $END

```

```

      $NLIST      INS=1000.0,                                $END
$NLIST
INS      =      .10000000E+04
RHQ1     =      .90000000E+00
RHQ2     =      .00000000E+00
BS1      =      .10000000E+01
BS2      =      .00000000E+00
PHI1     =      .95000000E+00
PHI1S    =      .00000000E+00
PHI2     =      .00000000E+00
C1       =      .10000000E+04
C1S      =      .10000000E+04
C2       =      .00000000E+00
F        =      .60000000E+00
RMA      =      .45239635E+02
SLOPER   =      .20000000E+01
SPECUL   =      .50000000E+00
SOLSD    =      .23000000E+01
ALPHA    =      .10000000E+01
EPS      =      .10000000E+01
TAC      =      .20000000E+02
HC       =      .00000000E+00
ARATIO   =      .00000000E+00
HK       =      .00000000E+00
DTRE     =      .25000000E+02
TOC      =      .50000000E+02
PCEFCT   =      .00000000E+00
ENEFCT   =      .00000000E+00
CYCECT   =      .00000000E+00
MECHE    =      .00000000E+00
AUXE     =      .00000000E+00
GEARE    =      .00000000E+00
GENE     =      .00000000E+00
PPE      =      .95000000E+00
OPTMZE   =      F
PARAB    =      T
MAXC     =      F
MAXPHI   =      F
SECONC   =      F
MAXSEC   =      F
IPCSEF   =      F
IENGEF   =      F
ICYCEF   =      F
NWTORF   =      F
XTRACT   =      F
SUP2     =      F
MORDEC   =      F
$END

```

<u>RECEIVER TEMP.</u>	<u>COLLECTOR</u>	<u>PCS</u>	<u>SYSTEM</u>	<u>FRAC.MAX.</u>	
<u>C</u>	<u>F</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>SYS.EFFIC.</u>
700.0	1292.0	.805	.000	.000	.000
725.0	1337.0	.799	.000	.000	.000
750.0	1382.0	.793	.000	.000	.000
775.0	1427.0	.787	.000	.000	.000
800.0	1472.0	.780	.000	.000	.000

```

SET      3
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
➔@EOF

STOP  NORMAL
➔FIN

```





## CASE B

Power conversion effectiveness entered as fraction of Carnot.

Two data sets.

CONC/11 restored from MASSTOR.

Control and input by interactive terminal. Output breakpointed to file for printer.

### Notes on results:

For the selected input values, including a reflectance of 0.90, the system efficiency is highest (0.30) at a receiver temperature of 775-800°C. However, the system efficiency at 650°C is 0.29, or 98% of the peak efficiency. If the reflectance is reduced to 0.80, the peak system efficiency falls to 0.26, and occurs at a slightly lower receiver temperature (750-775°C).

→@RUN ABC,12345,DEF  
→@SRD  
SRD 1R1 SL74R1 12/14/83 12:50:16 1100/80A 37R2C JPL  
@XQT SYS\*\*TEST1.S-R-D

S U I F (C) COPYRIGHT 1982 MASSTOR SYSTEMS

→RESTORE MYFILE FROM JAFFE\*SOLAR1

RESTORE: COMMAND ACCEPTED

CONNECT REQUEST TO ASSIGN SVSS FILE JAFFE\*SOLAR1

SVSS FILE READY

0 TRACKS TRANSFERRED

32 TRACKS TRANSFERRED

DATA RESTORED

RESTORE: COMMAND COMPLETED

→STOP

END OF S/R/D

→@BK1

BREAKPOINTED

→@XQT MYFILE.CONC/11

→\$NLIST PCEFCT=0.60,

\$END

→650,850,25

→\$NLIST RH01=0.80,

\$END

→@BK2 LSPH,506/13

@SYM DEF \*BKFIL\$ABC(1)..506/13,LSPH

SYMMED BY ABC

→@FIN

@XQT MYFILE.CONC/11

```

SET          1
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST      PCEFCT=0.60,
ENTER RECEIVER TEMPERATURES (M1,M2,M3    INTEGER)
ITRC1, ITRC2, ITRC3 =          650,      850,      25
  $NLIST
INS          =          .80000000E+03
RH01        =          .90000000E+00
RH02        =          .00000000E+00
BS1         =          .10000000E+01
BS2         =          .00000000E+00
PHI1        =          .95000000E+00
PHI1S       =          .00000000E+00
PHI2        =          .00000000E+00
C1          =          .10000000E+04
C1S         =          .10000000E+04
C2          =          .00000000E+00
F           =          .60000000E+00
RMA         =          .45239635E+02
SLOPER      =          .20000000E+01
SPECUL      =          .50000000E+00
SOLSD       =          .23000000E+01
ALPHA       =          .10000000E+01
EPS         =          .10000000E+01
TAC         =          .20000000E+02
HC          =          .00000000E+00
ARATIO      =          .00000000E+00
HK          =          .00000000E+00
DTRE        =          .25000000E+02
TOC         =          .50000000E+02
PCEFCT      =          .60000000E+00
ENEFCT      =          .00000000E+00
CYCECT      =          .00000000E+00
MECHE       =          .00000000E+00
AUXE        =          .00000000E+00
GEARE       =          .00000000E+00
GENE        =          .00000000E+00
PPE         =          .95000000E+00
OPTMZE      =          F
PARAB       =          T
MAXC        =          F
MAXPHI      =          F
SECONC      =          F
MAXSEC      =          F
IPCSEF      =          F
IENGEF      =          F
ICYCEF      =          F
NWTORF     =          T
XTRACT      =          F
SUP2        =          F
MORDEC      =          F
$END

```

<u>RECEIVER_TEMP.</u>	<u>COLLECTOR</u>	<u>PCS</u>	<u>SYSTEM</u>	<u>FRAC.MAX.</u>	
<u>_C_</u>	<u>_E_</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>SYS.EFFIC.</u>	
650.0	1202.0	.804	.384	.293	.977
675.0	1247.0	.798	.390	.296	.985
700.0	1292.0	.792	.396	.298	.991
725.0	1337.0	.785	.401	.299	.996
750.0	1382.0	.778	.406	.300	.999
775.0	1427.0	.770	.410	.300	1.000
800.0	1472.0	.762	.415	.300	1.000
825.0	1517.0	.752	.419	.300	.998
850.0	1562.0	.743	.423	.299	.995

SET 2  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")

\$NLIST RH01=0.80,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .80000000E+00  
RH02 = .00000000E+00  
BS1 = .10000000E+01  
BS2 = .00000000E+00  
PHI1 = .95000000E+00  
PHI1S = .00000000E+00  
PHI2 = .00000000E+00  
C1 = .10000000E+04  
C1S = .10000000E+04  
C2 = .00000000E+00  
F = .60000000E+00  
RMA = .45239635E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .60000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .00000000E+00  
GENE = .00000000E+00  
PPE = .95000000E+00  
OPTMZE = F  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = F  
MAXSEC = F  
IPCSEF = F  
IENGEF = F  
ICYCEF = F  
NWTORF = F  
XTRACT = F  
SUP2 = F  
MORDEC = F  
\$END

<u>RECEIVER</u>	<u>TEMP.</u>	<u>COLLECTOR</u>	<u>PCS</u>	<u>SYSTEM</u>	<u>FRAC.MAX.</u>
<u>  C  </u>	<u>  E  </u>	<u>  EFFIC.</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>SYS.EFFIC.</u>
650.0	1202.0	.709	.384	.259	.983
675.0	1247.0	.703	.390	.261	.990
700.0	1292.0	.697	.396	.262	.995
725.0	1337.0	.690	.401	.263	.998
750.0	1382.0	.683	.406	.263	1.000
775.0	1427.0	.675	.410	.263	1.000
800.0	1472.0	.667	.415	.263	.998
825.0	1517.0	.657	.419	.262	.995
850.0	1562.0	.648	.423	.261	.990

SET 3  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
STOP NORMAL  
@BK2 LSPH,506/13



## CASE C

Receiver aperture optimized.

Thermodynamic cycle effectiveness input as fraction of Carnot.

Five data sets.

New receiver temperatures input for last data set.

Extract of output prepared.

CONC/11 assumed to be in file SOLAR.

Control by interactive terminal. Data input from file. Output break-pointed to file for printer.

### Notes on results:

For the selected input values, the system efficiency at 700°C falls from 0.28 to 0.24 as the slope error increases from 0.5 to 5.0 mrad. At 800°C, the system efficiency falls from 0.29 to 0.24 over this range of slope errors. The receiver temperature at which system efficiency peaks is 860°C or higher for slope errors of 0.5 to 3.0 mrad. For a slope error of 5.0 mrad, the temperature for peak system efficiency is 710°C or slightly lower. The optimum geometric concentration ratio is about 6500 at a slope error of 0.5 mrad, about 650 at 5.0 mrad. The corresponding optimum intercept factors are 0.996 and 0.97.

```

->@RUN ABC,12345,DEF
->@ASG,A SOLAR
  READY
->@CAT,P DATAFILE
  READY
->@ASG,A DATAFILE
  READY
->@EDM DATAFILE.C
  ED-A 29B 12/14/83 13:41 C(0):F
  INPUT
-> $NLIST SLOPER=0.5, OPTMZE=T, CYCECT=0.65,
-> MECHE=0.9, AUXE=0.95, GEARE=0.9, GENE=0.98, XTRACT=T, $END
->700,860,20 $END
-> $NLIST SLOPER=1.0, $END
-> $NLIST SLOPER=2.0, $END
-> $NLIST SLOPER=3.0, $END
-> $NLIST NWTORF=T, SLOPER=5.0, $END
->700,860,10
->@EOF
  END EDIT 8 LINES OUTPUT
->@CAT,P OUTFILE(+1)
  READY
->@ASG,A OUTFILE
  READY
->@BK1 OUTFILE
  BREAKPOINTED
->@XQT SOLAR.CONC/11
->@ADD,L DATAFILE.C
->@BK2 LSPH,506/13
  @SYM DEF *OUTFILE(1)..,506/13,LSPH
  SYMMED BY ABC
->@BLK,S XTRACT,506/13,LSPH
  BLOCK 5.13 SL74R1 12/14/83 13:41:32
  10 PAGES SENT TO: 506/13,LSPH
->@FIN

```

@XQT SOLAR.CONC/11

```

SET      1
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST  SLOPER=0.5,    OPTMZE=T,    CYCECT=0.65,
          MECHE=0.9,    AUXE=0.95,    GEARE=0.9,    GENE=0.98,    XTRACT=T, $END
ENTER RECEIVER TEMPERATURES (M1,M2,M3  INTEGER)
ITRC1, ITRC2, ITRC3 =      700,      860,      20
$NLIST
INS      =      .80000000E+03
RH01    =      .90000000E+00
RH02    =      .00000000E+00
BS1     =      .10000000E+01
BS2     =      .00000000E+00
PHI1    =      .00000000E+00
PHI1S   =      .00000000E+00
PHI2    =      .00000000E+00
C1      =      .00000000E+00
C1S     =      .00000000E+00
C2      =      .00000000E+00
F       =      .60000000E+00
RMA     =      .45239635E+02
SLOPER  =      .50000000E+00
SPECUL  =      .50000000E+00
SOLSD   =      .23000000E+01
ALPHA   =      .10000000E+01
EPS     =      .10000000E+01
TAC     =      .20000000E+02
HC      =      .00000000E+00
ARATIO  =      .00000000E+00
HK      =      .00000000E+00
DTRE    =      .25000000E+02
TOC     =      .50000000E+02
PCEFCT  =      .50000000E+00
ENEFCT  =      .00000000E+00
CYCECT  =      .65000000E+00
MECHE   =      .90000000E+00
AUXE    =      .95000000E+00
GEARE   =      .90000000E+00
GENE    =      .98000000E+00
PPE     =      .95000000E+00
OPTMZE  =      T
PARAB   =      T
MAXC    =      F
MAXPHI  =      F
SECONC  =      F
MAXSEC  =      F
IPCSEF  =      F
IENGEF  =      F
ICYCEF  =      F
NWTORF  =      T
XTRACT  =      T
SUP2    =      F
MORDEC  =      F
$END

```

RECEIVER	TEMP.	GEOM.	INTERCEPT	COLLECTOR	PCS	SYSTEM	FRAC.MAX.
_C_	_E_	CONC.	RAIIQ	EACIQ	EFFIC.	EFFIC.	SYS.EFFIC.
700.0	1292.0	5827.8	.998	.887	.330	.278	.940
720.0	1328.0	5905.3	.998	.887	.333	.281	.949
740.0	1364.0	5983.2	.998	.886	.336	.283	.957
760.0	1400.0	6061.5	.998	.885	.340	.285	.965
780.0	1436.0	6140.3	.997	.884	.343	.288	.973
800.0	1472.0	6219.6	.997	.882	.346	.290	.980
820.0	1508.0	6299.4	.997	.881	.349	.292	.987
840.0	1544.0	6379.8	.997	.880	.352	.294	.994
860.0	1580.0	6460.7	.996	.879	.354	.296	1.000

SET 2  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
\$NLIST SLOPER=1.0,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .00000000E+00  
BS1 = .10000000E+01  
BS2 = .00000000E+00  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .00000000E+00  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .60000000E+00  
RMA = .45239635E+02  
SLOPER = .10000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .50000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .65000000E+00  
MECHE = .90000000E+00  
AUXE = .95000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = F  
MAXSEC = F  
IPCSEF = F  
IENGEF = F  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

RECEIVER_TEMP. _C_	GEOM. _E_	INTERCEPT CONC.RATIO	COLLECTOR EACIOR	PCS EFFIC.	SYSTEM EFFIC.	FRAC.MAX. SYS.EFFIC.	
700.0	1292.0	4251.9	.997	.883	.330	.276	.943
720.0	1328.0	4312.0	.997	.881	.333	.279	.952
740.0	1364.0	4372.7	.997	.880	.336	.281	.960
760.0	1400.0	4433.7	.996	.879	.340	.284	.968
780.0	1436.0	4495.3	.996	.877	.343	.286	.975
800.0	1472.0	4557.3	.996	.876	.346	.288	.982
820.0	1508.0	4619.9	.996	.874	.349	.290	.988
840.0	1544.0	4683.0	.995	.873	.352	.291	.994
860.0	1580.0	4746.7	.995	.871	.354	.293	1.000

SET 3  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
\$NLIST SLOPER=2.0,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .00000000E+00  
BS1 = .10000000E+01  
BS2 = .00000000E+00  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .00000000E+00  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .60000000E+00  
RMA = .45239635E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .50000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .65000000E+00  
MECHE = .90000000E+00  
AUXE = .95000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = F  
MAXSEC = F  
IPCSEF = F  
IENGEF = F  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END



<u>RECEIVER_TEMP.</u>	<u>GEOM.</u>	<u>INTERCEPT</u>	<u>COLLECTOR</u>	<u>PCS</u>	<u>SYSTEM</u>	<u>FRAC.MAX.</u>	
<u>_C_</u>	<u>_E_</u>	<u>CONC.RATIO</u>	<u>EACIOR</u>	<u>EEFIC.</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>SYS.EEFIC.</u>
700.0	1292.0	2186.1	.994	.865	.330	.271	.956
720.0	1328.0	2222.1	.993	.863	.333	.273	.963
740.0	1364.0	2258.5	.993	.860	.336	.275	.970
760.0	1400.0	2295.4	.992	.858	.340	.277	.976
780.0	1436.0	2332.7	.991	.855	.343	.278	.982
800.0	1472.0	2370.5	.991	.852	.346	.280	.987
820.0	1508.0	2408.9	.990	.849	.349	.281	.992
840.0	1544.0	2447.7	.989	.846	.352	.282	.996
860.0	1580.0	2487.1	.988	.843	.354	.284	1.000

SET 4  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
\$NLIST SLOPER=3.0,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .00000000E+00  
BS1 = .10000000E+01  
BS2 = .00000000E+00  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .00000000E+00  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .60000000E+00  
RMA = .45239635E+02  
SLOPER = .30000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .50000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .65000000E+00  
MECHE = .90000000E+00  
AUXE = .95000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = F  
MAXSEC = F  
IPCSEF = F  
IENGEF = F  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

<u>RECEIVER</u>	<u>IEMP.</u>	<u>GEOM.</u>	<u>INTERCEPT</u>	<u>COLLECTOR</u>	<u>PCS</u>	<u>SYSTEM</u>	<u>FRAC.MAX.</u>
<u>_C_</u>	<u>_E_</u>	<u>CONC.RATIO</u>	<u>EACIOR</u>	<u>EEEIC.</u>	<u>EFFIC.</u>	<u>EFFIC.</u>	<u>SYS.EFFIC.</u>
700.0	1292.0	1302.5	.988	.841	.330	.263	.974
720.0	1328.0	1327.2	.987	.837	.333	.265	.980
740.0	1364.0	1352.4	.986	.832	.336	.266	.985
760.0	1400.0	1377.9	.984	.828	.340	.267	.989
780.0	1436.0	1404.0	.983	.823	.343	.268	.992
800.0	1472.0	1430.4	.982	.818	.346	.269	.995
820.0	1508.0	1457.4	.981	.813	.349	.269	.998
840.0	1544.0	1484.9	.979	.808	.352	.270	.999
860.0	1580.0	1512.9	.977	.803	.354	.270	1.000

```

SET      5
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
$NLIST   NWTORF=T,      SLOPER=5.0,          $END
ENTER RECEIVER TEMPERATURES (M1,M2,M3  INTEGER)
ITRC1, ITRC2, ITRC3 =      700,          860,          10
$NLIST
INS      =      .80000000E+03
RH01    =      .90000000E+00
RH02    =      .00000000E+00
BS1     =      .10000000E+01
BS2     =      .00000000E+00
PHI1    =      .00000000E+00
PHI1S   =      .00000000E+00
PHI2    =      .00000000E+00
C1      =      .00000000E+00
C1S     =      .00000000E+00
C2      =      .00000000E+00
F       =      .60000000E+00
RMA     =      .45239635E+02
SLOPER  =      .50000000E+01
SPECUL  =      .50000000E+00
SOLSD   =      .23000000E+01
ALPHA   =      .10000000E+01
EPS     =      .10000000E+01
TAC     =      .20000000E+02
HC      =      .00000000E+00
ARATIO  =      .00000000E+00
HK      =      .00000000E+00
DTRE    =      .25000000E+02
TOC     =      .50000000E+02
PCEFCT  =      .50000000E+00
ENEFCT  =      .00000000E+00
CYCECT  =      .65000000E+00
MECHE   =      .90000000E+00
AUXE    =      .95000000E+00
GEARE   =      .90000000E+00
GENE    =      .98000000E+00
PPE     =      .95000000E+00
OPTMZE  =      T
PARAB   =      T
MAXC    =      F
MAXPHI  =      F
SECONC  =      F
MAXSEC  =      F
IPCSEF  =      F
IENGEF  =      F
ICYCEF  =      F
NWTORF  =      T
XTRACT  =      T
SUP2    =      F
MORDEC  =      F
$END

```

<u>RECEIVER</u>	<u>TEMP.</u>	<u>GEOM.</u>	<u>INTERCEPT</u>	<u>COLLECTOR</u>	<u>PCS</u>	<u>SYSTEM</u>	<u>FRAC.MAX.</u>
<u>_C_</u>	<u>_E_</u>	<u>CONC.</u>	<u>RAIIQ</u>	<u>EACIQB</u>	<u>EEEIC.</u>	<u>EEFIC.</u>	<u>EEFIC.</u>
		<u>SYS.</u>					<u>EEFIC.</u>
700.0	1292.0	650.3	.969	.775	.330	.243	1.000
710.0	1310.0	658.1	.968	.771	.331	.243	1.000
720.0	1328.0	666.0	.966	.767	.333	.243	1.000
730.0	1346.0	674.1	.965	.763	.335	.243	.999
740.0	1364.0	682.2	.964	.758	.336	.242	.999
750.0	1382.0	690.4	.962	.754	.338	.242	.998
760.0	1400.0	698.8	.961	.750	.340	.242	.997
770.0	1418.0	707.3	.959	.745	.341	.242	.995
780.0	1436.0	715.9	.957	.741	.343	.241	.994
790.0	1454.0	724.6	.956	.736	.344	.241	.992
800.0	1472.0	733.5	.954	.731	.346	.240	.990
810.0	1490.0	742.5	.952	.726	.347	.240	.987
820.0	1508.0	751.6	.950	.721	.349	.239	.985
830.0	1526.0	760.9	.949	.716	.350	.238	.982
840.0	1544.0	770.3	.947	.711	.352	.238	.979
850.0	1562.0	779.9	.945	.706	.353	.237	.975
860.0	1580.0	789.6	.943	.701	.354	.236	.972

SET 6  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")

STOP NORMAL

@BK2 LSPH,506/13

```

SET      1
$NLIST  SLOPER=0.5,  OPTMZE=T,  CYCECT=0.65,
        MECHE=0.9,  AUXE=0.95,  GEARE=0.9,  GENE=0.98,  XTRACT=T,  $END
ITRC1, ITRC2, ITRC3 = 700, 860, 20
700.0 1292.0 5827.8 .998 .887 .330 .278 .940
860.0 1580.0 6460.7 .996 .879 .354 .296 1.000

```

```

SET      2
$NLIST  SLOPER=1.0,  $END
700.0 1292.0 4251.9 .997 .883 .330 .276 .943
860.0 1580.0 4746.7 .995 .871 .354 .293 1.000

```

```

SET      3
$NLIST  SLOPER=2.0,  $END
700.0 1292.0 2186.1 .994 .865 .330 .271 .956
860.0 1580.0 2487.1 .988 .843 .354 .284 1.000

```

```

SET      4
$NLIST  SLOPER=3.0,  $END
700.0 1292.0 1302.5 .988 .841 .330 .263 .974
860.0 1580.0 1512.9 .977 .803 .354 .270 1.000

```

```

SET      5
$NLIST  NWTORF=T,  SLOPER=5.0,  $END
ITRC1, ITRC2, ITRC3 = 700, 860, 10
700.0 1292.0 650.3 .969 .775 .330 .243 1.000
710.0 1310.0 658.1 .968 .771 .331 .243 1.000
860.0 1580.0 789.6 .943 .701 .354 .236 .972

```

```

SET      6

```





## CASE D

Output with and without secondary concentrator. Secondary concentration maximized. Receiver aperture optimized.

Engine efficiencies input as table.

Ten data sets.

New engine efficiencies input at sixth data set.

Extract of output prepared. (The extract is printed before the standard output. For table headings, see the standard output.)

CONC/11 assumed to be in file SOLAR.

Batch run.

### Notes on results:

For the selected input values, and without a secondary concentrator, system efficiency is highest at low focal ratio (0.4). With the engine efficiencies used in data sets 1-5, system efficiency at this focal ratio peaks at 0.32 and a receiver temperature of 1450°C; the optimum geometric concentration ratio for these conditions is 4700. With the engine efficiencies used in data sets 6-10, system efficiency at focal ratio 0.4 peaks at 0.38 and a receiver temperature of 1325°C; the optimum geometric concentration ratio for these conditions is 4200.

If the receiver temperature is limited to 500°C, the system efficiencies attainable are 0.11 for the first set of engine efficiencies, and 0.19 for the engine efficiencies of data sets 6-10. If the receiver efficiency is limited to 900°C, a system efficiency of 0.27 (84% of the peak efficiency) can be obtained with the first set of engine efficiencies, and the optimum geometric concentration ratio is 3100. For the engine efficiencies of sets 6-10, a system efficiency of 0.34 (89% of peak) can be obtained; the optimum geometric concentration ratio is again 3100.

Use of a secondary concentrator improves system efficiency at the longer focal ratios and higher receiver temperatures. Highest system efficiency (0.33 for data sets 1-5, 0.39 for sets 6-10) is obtained at focal ratios of 0.8 or longer and receiver temperatures of 1500°C or higher. The optimum geometric concentration ratio of the primary is 2200 and 1500 for focal lengths of 0.8 and 1.0, respectively; with the corresponding secondary geometric concentration ratios of 3.0 and 4.4, the overall geometric concentration ratio is 6800. The efficiencies attainable with a secondary concentrator are slightly higher than those attainable without a secondary. If, however, receiver temperature is limited to 900°C, system efficiencies attainable with a secondary are not as high as those attainable without one.



```

▶@RUN ABC,12345,DEF
▶@BLK,F ,506/13,LSPH
▶@ASG,A SOLAR
▶@XQT SOLAR.CONC/11
▶$NLIST F=0.4, SECONC=T, RHQ2=0.96, MAXSEC=T, OPTMZE=T,
IENGEF=T, GENE=0.98, GEARE=0.9, XTRACT=T, $END
▶500,1500,25
▶.154, .175, .195, .214, .232
▶.249, .265, .280, .293, .307, .318, .329, .339, .349, .359
▶.367, .376, .385, .393, .401, .409, .416, .424, .430, .437
▶.443, .450, .457, .463, .470, .476, .483, .489, .495, .500
▶.505, .511, .516, .522, .527, .533
▶$NLIST F=0.5, $END
▶$NLIST F=0.6, $END
▶$NLIST F=0.8, $END
▶$NLIST F=1.0, $END
▶$NLIST F=0.4, NWTORF=T, $END
▶500,1500,25
▶.254, .275, .295, .314, .332
▶.349, .365, .380, .393, .407, .418, .429, .439, .449, .459
▶.467, .476, .485, .493, .501, .509, .516, .524, .530, .537
▶.543, .550, .557, .563, .570, .576, .583, .589, .595, .600
▶.605, .611, .616, .622, .627, .633
▶$NLIST F=0.5, $END
▶$NLIST F=0.6, $END
▶$NLIST F=0.8, $END
▶$NLIST F=1.0, $END
▶@BLK,S XTRACT,506/13,LSPH
▶@FIN

```

```

SET 1
$NLIST F=0.4, SECONC=T, RHO2=0.96, MAXSEC=T, OPTMZE=T,
IENGEF=T, GENE=0.98, GEARE=0.9, XTRACT=T, $END
ITRC1, ITRC2, ITRC3 = 500, 1500, 25
500.0 932.0 2251.7 2192.6 .998 .998 .887 .853 -.034 .136 .114 .110 -.004 .363 .352
1.23 2701.5 .998
1450.0 2642.0 4667.1 4420.3 .951 .958 .722 .713 -.008 .460 .316 .312 -.004 1.000 .998
1.23 5446.2 .958
1500.0 2732.0 4851.8 4585.7 .945 .953 .706 .700 -.006 .470 .315 .312 -.003 .999 1.000
1.23 5650.0 .953

SET 2
$NLIST F=0.5, $END
500.0 932.0 2142.0 2012.1 .998 .999 .887 .855 -.032 .136 .114 .110 -.004 .366 .343
1.55 3122.3 .999
1400.0 2552.0 4313.7 3817.4 .953 .969 .729 .743 .014 .451 .312 .318 .006 1.000 .990
1.55 5923.5 .969
1500.0 2732.0 4667.5 4091.9 .941 .961 .697 .720 .023 .470 .311 .321 .010 .997 1.000
1.55 6349.4 .961

SET 3
$NLIST F=0.6, $END
500.0 932.0 1845.9 1669.2 .998 .999 .884 .855 -.029 .136 .114 .110 -.004 .377 .340
1.97 3280.5 .999
1325.0 2417.0 3603.6 2986.3 .954 .975 .730 .764 .034 .437 .303 .317 .014 1.000 .978
1.97 5869.0 .975
1500.0 2732.0 4168.2 3363.9 .930 .963 .669 .726 .057 .470 .299 .324 .026 .986 1.000
1.97 6611.2 .963

SET 4
$NLIST F=0.8, $END
500.0 932.0 1322.2 1109.5 .996 .999 .878 .856 -.022 .136 .113 .110 -.003 .405 .339
3.04 3376.7 .999
1225.0 2237.0 2526.4 1849.0 .946 .982 .711 .785 .074 .415 .280 .309 .029 1.000 .949
3.04 5627.6 .982
1500.0 2732.0 3283.6 2224.4 .895 .964 .592 .729 .137 .470 .264 .326 .061 .945 1.000
3.04 6770.1 .964

SET 5
$NLIST F=1.0, $END
500.0 932.0 977.4 765.0 .995 .999 .870 .856 -.014 .136 .112 .110 -.002 .433 .339
4.44 3395.4 .999
1100.0 2012.0 1756.8 1172.0 .945 .987 .708 .805 .097 .385 .259 .295 .036 1.000 .903
4.44 5201.5 .987
1500.0 2732.0 2713.1 1532.3 .848 .964 .505 .730 .225 .470 .225 .326 .101 .870 1.000
4.44 6800.7 .964

SET 6
$NLIST F=0.4, NWTORF=T, $END
ITRC1, ITRC2, ITRC3 = 500, 1500, 25
500.0 932.0 2251.7 2192.6 .998 .998 .887 .853 -.034 .224 .189 .182 -.007 .500 .489
1.23 2701.5 .998
1325.0 2417.0 4241.8 4036.9 .963 .969 .758 .744 -.014 .525 .378 .371 -.007 1.000 .998
1.23 4973.9 .969
1400.0 2552.0 4491.0 4262.0 .956 .963 .737 .726 -.011 .539 .377 .372 -.005 .998 1.000
1.23 5251.3 .963
1500.0 2732.0 4851.8 4585.7 .945 .953 .706 .700 -.006 .558 .374 .371 -.003 .990 .998

```

1.23 5650.0 .953

SET 7

\$NLIST	F=0.5,						\$END								
500.0	932.0	2142.0	2012.1	.998	.999	.887	.855	-.032	.224	.189	.182	-.007	.504	.477	
			1.55	3122.3		.999									
1325.0	2417.0	4069.9	3625.2	.961	.974	.752	.759	.008	.525	.375	.379	.004	1.000	.992	
			1.55	5625.3		.974									
1500.0	2732.0	4667.5	4091.9	.941	.961	.697	.720	.023	.558	.370	.382	.012	.987	1.000	
			1.55	6349.4		.961									

SET 8

\$NLIST	F=0.6,						\$END								
500.0	932.0	1845.9	1669.2	.998	.999	.884	.855	-.029	.224	.188	.182	-.006	.517	.473	
			1.97	3280.5		.999									
1275.0	2327.0	3460.2	2887.1	.959	.978	.746	.774	.028	.514	.364	.378	.014	1.000	.982	
			1.97	5674.1		.978									
1500.0	2732.0	4168.2	3363.9	.930	.963	.669	.726	.057	.558	.355	.385	.030	.974	1.000	
			1.97	6611.2		.963									

SET 9

\$NLIST	F=0.8,						\$END								
500.0	932.0	1322.2	1109.5	.996	.999	.878	.856	-.022	.224	.187	.182	-.005	.549	.471	
			3.04	3376.7		.999									
1175.0	2147.0	2414.2	1788.2	.953	.984	.729	.793	.064	.491	.340	.370	.030	1.000	.957	
			3.04	5442.5		.984									
1500.0	2732.0	3283.6	2224.4	.895	.964	.592	.729	.137	.558	.314	.387	.073	.923	1.000	
			3.04	6770.1		.964									

SET 10

\$NLIST	F=1.0,						\$END								
500.0	932.0	977.4	765.0	.995	.999	.870	.856	-.014	.224	.185	.182	-.003	.579	.470	
			4.44	3395.4		.999									
1050.0	1922.0	1671.2	1133.3	.953	.989	.728	.811	.083	.462	.320	.356	.037	1.000	.920	
			4.44	5029.8		.989									
1500.0	2732.0	2713.1	1532.3	.848	.964	.505	.730	.225	.558	.268	.387	.120	.838	1.000	
			4.44	6800.7		.964									

SET 11

C-37

@RUN ABC,12345,DEF

@BLK,F ,506/13,LSPH  
BLOCK 5.13 SL74R1 12/16/83 14:58:27  
NEW DEFAULT ROUTING: 506/13,LSPH

@ASG,A SOLAR

@XQT SOLAR.CONC/11

```

SET 1
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
$NLIST F=0.4, SECONC=T, RHO2=0.96, MAXSEC=T, OPTMZE=T,
IENGEF=T, GENE=0.98, GEARE=0.9, XTRACT=T, $END
ENTER RECEIVER TEMPERATURES (M1,M2,M3 INTEGER)
ITRC1, ITRC2, ITRC3 = 500, 1500, 25
ENTER ENGINE EFFICIENCIES (FREE-FIELD, REAL)
EFFICIENCIES ENTERED
$NLIST
INS = .80000000E+03
RHO1 = .90000000E+00
RHO2 = .96000000E+00
BS1 = .10000000E+01
BS2 = .10000000E+01
PHI1 = .00000000E+00
PHI1S = .00000000E+00
PHI2 = .10000000E+01
C1 = .00000000E+00
C1S = .00000000E+00
C2 = .00000000E+00
F = .40000000E+00
RMA = .64010816E+02
SLOPER = .20000000E+01
SPECUL = .50000000E+00
SOLSD = .23000000E+01
ALPHA = .10000000E+01
EPS = .10000000E+01
TAC = .20000000E+02
HC = .00000000E+00
ARATIO = .00000000E+00
HK = .00000000E+00
DTRE = .25000000E+02
TOC = .50000000E+02
PCEFCT = .00000000E+00
ENEFCT = .00000000E+00
CYCECT = .00000000E+00
MECHE = .00000000E+00
AUXE = .00000000E+00
GEARE = .90000000E+00
GENE = .98000000E+00
PPE = .95000000E+00
OPTMZE = T
PARAB = T
MAXC = F
MAXPHI = F
SECONC = T
MAXSEC = T
IPCSEF = F
IENGEF = T
ICYCEF = F
NWTORF = T
XTRACT = T
SUP2 = F
MORDEC = F
$END

```

RECEIVER TEMP.	PRIM.GEOM.CONC.	PRIM.INTERCEPT FACI.	COLLECTOR EFFICIENCY	PCS	SYSTEM EFFICIENCY	FRAC.MAX.SYS.EFFIC.								
<u>C</u>	<u>F</u>	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	DELTA	EFFIC.	W/O SEC.	W/SEC.	DELTA	W/O SEC.	W/SEC.
		SECONDARY	OVERALL		OVERALL									
		GEOM.CONC.	GEOM.CONC.		ICPI.FACI.									
500.0	932.0	2251.7	2192.6	.998	.998	.887	.853	-.034	.136	.114	.110	-.004	.363	.352
			1.23 2701.5			.998								
525.0	977.0	2299.6	2238.0	.998	.998	.886	.852	-.034	.154	.130	.125	-.005	.411	.400
			1.23 2757.5			.998								
550.0	1022.0	2347.9	2283.7	.997	.998	.884	.851	-.033	.172	.144	.139	-.005	.458	.445
			1.23 2813.8			.998								
575.0	1067.0	2396.6	2329.8	.997	.998	.882	.849	-.033	.189	.158	.152	-.006	.501	.487
			1.23 2870.5			.998								
600.0	1112.0	2445.8	2376.3	.997	.997	.880	.848	-.033	.205	.171	.165	-.006	.542	.527
			1.23 2927.8			.997								
625.0	1157.0	2495.5	2423.1	.996	.997	.878	.846	-.032	.220	.183	.177	-.007	.581	.565
			1.23 2985.6			.997								
650.0	1202.0	2545.7	2470.5	.996	.997	.876	.844	-.032	.234	.195	.187	-.007	.616	.600
			1.23 3043.9			.997								
675.0	1247.0	2596.6	2518.3	.996	.996	.874	.842	-.032	.247	.205	.198	-.007	.650	.633
			1.23 3102.8			.996								
700.0	1292.0	2648.0	2566.7	.995	.996	.872	.840	-.031	.258	.214	.206	-.008	.678	.660
			1.23 3162.4			.996								
725.0	1337.0	2700.1	2615.6	.994	.995	.869	.838	-.031	.271	.224	.216	-.008	.708	.690
			1.23 3222.7			.995								
750.0	1382.0	2752.9	2665.1	.994	.995	.866	.836	-.030	.280	.231	.223	-.008	.731	.713
			1.23 3283.7			.995								
775.0	1427.0	2806.4	2715.2	.993	.994	.864	.834	-.030	.290	.238	.230	-.008	.754	.736
			1.23 3345.4			.994								
800.0	1472.0	2860.6	2766.0	.993	.994	.861	.831	-.029	.299	.244	.236	-.008	.774	.756
			1.23 3408.0			.994								
825.0	1517.0	2915.7	2817.4	.992	.993	.858	.829	-.029	.308	.251	.242	-.008	.794	.775
			1.23 3471.3			.993								
850.0	1562.0	2971.5	2869.5	.991	.992	.854	.826	-.028	.317	.257	.248	-.009	.814	.795
			1.23 3535.5			.992								
875.0	1607.0	3028.2	2922.4	.990	.992	.851	.823	-.028	.324	.262	.253	-.009	.829	.810
			1.23 3600.7			.992								
900.0	1652.0	3085.8	2976.0	.989	.991	.847	.820	-.027	.332	.267	.258	-.009	.845	.827
			1.23 3666.7			.991								
925.0	1697.0	3144.4	3030.4	.988	.990	.843	.817	-.027	.340	.272	.263	-.009	.862	.843
			1.23 3733.7			.990								
950.0	1742.0	3203.9	3085.6	.987	.989	.839	.813	-.026	.347	.276	.268	-.009	.876	.857
			1.23 3801.8			.989								
975.0	1787.0	3264.4	3141.7	.986	.989	.835	.810	-.025	.354	.281	.272	-.009	.889	.871
			1.23 3870.9			.989								
1000.0	1832.0	3325.9	3198.7	.985	.988	.831	.806	-.025	.361	.285	.276	-.008	.902	.884
			1.23 3941.1			.988								
1025.0	1877.0	3388.6	3256.5	.984	.987	.826	.802	-.024	.367	.288	.280	-.008	.913	.895
			1.23 4012.4			.987								
1050.0	1922.0	3452.3	3315.4	.983	.985	.822	.798	-.023	.374	.292	.284	-.008	.925	.908
			1.23 4084.9			.985								
1075.0	1967.0	3517.2	3375.2	.982	.984	.817	.794	-.023	.379	.294	.286	-.008	.932	.916
			1.23 4158.6			.984								
1100.0	2012.0	3583.4	3436.1	.980	.983	.812	.790	-.022	.385	.297	.289	-.008	.942	.926
			1.23 4233.6			.983								
1125.0	2057.0	3650.8	3498.0	.979	.982	.807	.786	-.021	.391	.299	.292	-.008	.949	.933

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1150.0	2102.0	3719.5	1.23 4309.9	.977	.981	.982	.801	.761	-.020	.397	.302	.295	-.008	.957	.943
			1.23 4387.6			.981									
1175.0	2147.0	3789.6	1.23 3625.2	.975	.979	.796	.776	-.019	.403	.305	.297	-.007	.965	.951	
			1.23 4466.7			.979									
1200.0	2192.0	3861.1	1.23 3690.6	.974	.978	.790	.771	-.019	.408	.306	.299	-.007	.971	.958	
			1.23 4547.2			.978									
1225.0	2237.0	3934.0	1.23 3757.2	.972	.976	.784	.766	-.018	.415	.309	.302	-.007	.978	.966	
			1.23 4629.3			.976									
1250.0	2282.0	4008.5	1.23 3825.1	.970	.974	.778	.761	-.017	.420	.310	.304	-.007	.983	.972	
			1.23 4712.9			.974									
1275.0	2327.0	4084.6	1.23 3894.3	.968	.973	.771	.756	-.016	.426	.312	.306	-.006	.989	.979	
			1.23 4798.2			.973									
1300.0	2372.0	4162.3	1.23 3964.9	.966	.971	.765	.750	-.015	.431	.313	.307	-.006	.993	.984	
			1.23 4885.2			.971									
1325.0	2417.0	4241.8	1.23 4036.9	.963	.969	.758	.744	-.014	.437	.314	.309	-.006	.996	.988	
			1.23 4973.9			.969									
1350.0	2462.0	4323.0	1.23 4110.4	.961	.967	.751	.739	-.013	.441	.315	.309	-.005	.997	.990	
			1.23 5064.4			.967									
1375.0	2507.0	4406.0	1.23 4185.4	.959	.965	.744	.732	-.012	.445	.315	.310	-.005	.998	.992	
			1.23 5156.9			.965									
1400.0	2552.0	4491.0	1.23 4262.0	.956	.963	.737	.726	-.011	.451	.316	.311	-.005	.999	.995	
			1.23 5251.3			.963									
1425.0	2597.0	4578.0	1.23 4340.3	.953	.961	.729	.720	-.010	.455	.315	.311	-.004	.999	.996	
			1.23 5347.7			.961									
1450.0	2642.0	4667.1	1.23 4420.3	.951	.958	.722	.713	-.008	.460	.316	.312	-.004	1.000	.998	
			1.23 5446.2			.958									
1475.0	2687.0	4758.3	1.23 4502.0	.948	.956	.714	.707	-.007	.465	.315	.312	-.003	.999	.999	
			1.23 5547.0			.956									
1500.0	2732.0	4851.8	1.23 4585.7	.945	.953	.706	.700	-.006	.470	.315	.312	-.003	.999	1.000	
			1.23 5650.0			.953									



SET 2  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
\$NLIST F=0.5,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .96000000E+00  
BS1 = .10000000E+01  
BS2 = .10000000E+01  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .10000000E+01  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .50000000E+00  
RMA = .53130088E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .00000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = T  
MAXSEC = T  
IPCSEF = F  
IENGEF = T  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

RECEIVER_TEMP.		PRIM.GEOM.CONC.		PRIM.INTERCEPT_FACI.		COLLECTOR EFFICIENCY			PCS	SYSTEM EFFICIENCY			FRAC.MAX.SYS.EFFIC.	
C	F	W/O_SEC.	W/SEC.	W/O_SEC.	W/SEC.	W/O_SEC.	W/SEC.	DELTA	EFFIC.	W/O_SEC.	W/SEC.	DELTA	W/O_SEC.	W/SEC.
		SECONDARY		OVERALL		OVERALL								
		GEOM.CONC.		GEOM.CONC.		ICPI.FACI.								
500.0	932.0	2142.0	2012.1	.998	.999	.887	.855	-.032	.136	.114	.110	-.004	.366	.343
		1.55	3122.3			.999								
525.0	977.0	2188.0	2052.7	.998	.998	.885	.854	-.031	.154	.130	.125	-.005	.416	.390
		1.55	3185.2			.998								
550.0	1022.0	2234.4	2093.5	.997	.998	.883	.853	-.031	.172	.144	.139	-.005	.462	.433
		1.55	3248.5			.998								
575.0	1067.0	2281.3	2134.5	.997	.998	.881	.851	-.030	.189	.158	.153	-.005	.506	.475
		1.55	3312.2			.998								
600.0	1112.0	2328.6	2175.9	.997	.998	.879	.850	-.029	.205	.171	.165	-.006	.547	.514
		1.55	3376.4			.998								
625.0	1157.0	2376.4	2217.6	.996	.997	.877	.849	-.029	.220	.183	.177	-.006	.586	.551
		1.55	3441.1			.997								
650.0	1202.0	2424.8	2259.7	.996	.997	.875	.847	-.028	.234	.194	.188	-.006	.622	.585
		1.55	3506.4			.997								
675.0	1247.0	2473.8	2302.1	.995	.997	.873	.845	-.027	.247	.205	.198	-.006	.656	.617
		1.55	3572.2			.997								
700.0	1292.0	2523.3	2345.0	.995	.996	.870	.844	-.027	.258	.214	.207	-.007	.684	.644
		1.55	3638.8			.996								
725.0	1337.0	2573.6	2388.3	.994	.996	.868	.842	-.026	.271	.223	.217	-.007	.715	.674
		1.55	3706.0			.996								
750.0	1382.0	2624.5	2432.1	.994	.996	.865	.840	-.025	.280	.230	.224	-.007	.738	.696
		1.55	3773.9			.996								
775.0	1427.0	2676.1	2476.4	.993	.995	.862	.838	-.024	.290	.238	.231	-.007	.761	.719
		1.55	3842.6			.995								
800.0	1472.0	2728.4	2521.1	.992	.995	.859	.836	-.023	.299	.244	.237	-.007	.781	.738
		1.55	3912.1			.995								
825.0	1517.0	2781.6	2566.4	.991	.994	.855	.833	-.022	.308	.250	.244	-.006	.801	.758
		1.55	3982.4			.994								
850.0	1562.0	2835.6	2612.3	.991	.994	.852	.831	-.021	.317	.256	.250	-.006	.821	.778
		1.55	4053.6			.994								
875.0	1607.0	2890.4	2658.8	.990	.993	.848	.828	-.020	.324	.261	.255	-.006	.835	.793
		1.55	4125.6			.993								
900.0	1652.0	2946.1	2705.8	.989	.992	.844	.826	-.019	.332	.266	.260	-.006	.852	.809
		1.55	4198.7			.992								
925.0	1697.0	3002.7	2753.5	.988	.992	.841	.823	-.018	.340	.271	.265	-.006	.868	.826
		1.55	4272.7			.992								
950.0	1742.0	3060.3	2801.9	.987	.991	.836	.820	-.016	.347	.275	.270	-.005	.882	.840
		1.55	4347.7			.991								
975.0	1787.0	3118.9	2850.9	.986	.990	.832	.817	-.015	.354	.280	.274	-.005	.895	.854
		1.55	4423.8			.990								
1000.0	1832.0	3178.6	2900.7	.984	.990	.828	.814	-.014	.361	.284	.279	-.005	.908	.868
		1.55	4501.0			.990								
1025.0	1877.0	3239.3	2951.2	.983	.989	.823	.810	-.012	.367	.287	.282	-.004	.918	.879
		1.55	4579.4			.989								
1050.0	1922.0	3301.2	3002.4	.982	.988	.818	.807	-.011	.374	.291	.287	-.004	.931	.892
		1.55	4658.9			.988								
1075.0	1967.0	3364.2	3054.5	.980	.987	.813	.803	-.010	.379	.293	.289	-.003	.938	.901
		1.55	4739.7			.987								
1100.0	2012.0	3428.4	3107.4	.979	.986	.808	.800	-.008	.385	.296	.293	-.003	.947	.911
		1.55	4821.7			.986								
1125.0	2057.0	3493.9	3161.1	.977	.985	.802	.796	-.006	.391	.298	.295	-.002	.953	.919

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			1.55	4905.1		.985													
1150.0	2102.0	3560.8	3215.7	.976	.984	.797	.792	-.005	.397	.300	.299	-.002	.962	.929					
			1.55	4989.8		.984													
1175.0	2147.0	3628.9	3271.2	.974	.982	.791	.788	-.003	.403	.303	.302	-.001	.970	.938					
			1.55	5075.9		.982													
1200.0	2192.0	3698.5	3327.6	.972	.981	.785	.783	-.001	.408	.304	.304	-.001	.975	.945					
			1.55	5163.5		.981													
1225.0	2237.0	3769.6	3385.0	.970	.980	.778	.779	.000	.415	.307	.307	.000	.982	.954					
			1.55	5252.6		.980													
1250.0	2282.0	3842.2	3443.5	.968	.979	.772	.774	.002	.420	.308	.309	.001	.986	.961					
			1.55	5343.3		.979													
1275.0	2327.0	3916.4	3503.0	.966	.977	.765	.769	.004	.426	.310	.311	.002	.992	.969					
			1.55	5435.6		.977													
1300.0	2372.0	3992.3	3563.5	.964	.976	.759	.764	.006	.431	.311	.313	.002	.995	.975					
			1.55	5529.6		.976													
1325.0	2417.0	4069.9	3625.2	.961	.974	.752	.759	.008	.437	.312	.315	.003	.998	.980					
			1.55	5625.3		.974													
1350.0	2462.0	4149.2	3688.0	.959	.972	.744	.754	.010	.441	.312	.316	.004	.999	.983					
			1.55	5722.8		.972													
1375.0	2507.0	4230.5	3752.1	.956	.971	.737	.749	.012	.445	.312	.317	.005	.999	.986					
			1.55	5822.2		.971													
1400.0	2552.0	4313.7	3817.4	.953	.969	.729	.743	.014	.451	.312	.318	.006	1.000	.990					
			1.55	5923.5		.969													
1425.0	2597.0	4398.9	3884.0	.951	.967	.722	.738	.016	.455	.312	.319	.007	.999	.992					
			1.55	6026.8		.967													
1450.0	2642.0	4486.2	3951.9	.948	.965	.714	.732	.018	.460	.312	.320	.008	.999	.996					
			1.55	6132.2		.965													
1475.0	2687.0	4575.7	4021.2	.944	.963	.705	.726	.020	.465	.311	.320	.009	.997	.997					
			1.55	6239.7		.963													
1500.0	2732.0	4667.5	4091.9	.941	.961	.697	.720	.023	.470	.311	.321	.010	.997	1.000					
			1.55	6349.4		.961													



SET 3  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")

SEND

\$NLIST F=0.6,  
\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .96000000E+00  
BS1 = .10000000E+01  
BS2 = .10000000E+01  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .10000000E+01  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .60000000E+00  
RMA = .45239635E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .00000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = T  
MAXSEC = T  
IPCSEF = F  
IENGEF = T  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
HORDEC = F  
SEND

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RECEIVER\_TEMP. PRIM.GEOM.CONC. PRIM.INTERCEPT\_FACT. COLLECTOR EFFICIENCY PCS SYSTEM EFFICIENCY FRAC.MAX.SYS.EFFIC.  
 \_C\_ \_E\_ W/O\_SEC. W/SEC. W/O\_SEC. W/SEC. W/O\_SEC. W/SEC. DELTA EFFIC. W/O\_SEC. W/SEC. DELTA W/O\_SEC. W/SEC.

SECONDARY OVERALL OVERALL  
 GEOM.CONC. GEOM.CONC. ICPI.FACT.

500.0	932.0	1845.9	1669.2	.998	.999	.884	.855	-.029	.136	.114	.110	-.004	.377	.340
			1.97 3280.5			.999								
525.0	977.0	1886.8	1702.5	.997	.998	.882	.854	-.028	.154	.129	.125	-.004	.427	.386
			1.97 3346.0			.998								
550.0	1022.0	1928.0	1736.0	.997	.998	.880	.853	-.027	.172	.144	.139	-.004	.475	.430
			1.97 3411.9			.998								
575.0	1067.0	1969.7	1769.8	.996	.998	.878	.852	-.026	.189	.158	.153	-.005	.520	.471
			1.97 3478.2			.998								
600.0	1112.0	2011.9	1803.7	.996	.998	.876	.851	-.025	.205	.170	.165	-.005	.562	.510
			1.97 3544.9			.998								
625.0	1157.0	2054.6	1838.0	.995	.998	.874	.849	-.024	.220	.182	.177	-.005	.602	.547
			1.97 3612.2			.998								
650.0	1202.0	2097.8	1872.5	.995	.997	.871	.848	-.023	.234	.193	.188	-.005	.639	.581
			1.97 3680.1			.997								
675.0	1247.0	2141.7	1907.3	.994	.997	.868	.846	-.022	.247	.204	.199	-.005	.673	.612
			1.97 3748.5			.997								
700.0	1292.0	2186.1	1942.5	.994	.997	.865	.845	-.021	.258	.212	.207	-.005	.702	.640
			1.97 3817.6			.997								
725.0	1337.0	2231.1	1978.0	.993	.996	.862	.843	-.020	.271	.222	.217	-.005	.733	.669
			1.97 3887.4			.996								
750.0	1382.0	2276.9	2013.9	.992	.996	.859	.841	-.018	.280	.229	.224	-.005	.756	.691
			1.97 3957.9			.996								
775.0	1427.0	2323.3	2050.1	.991	.995	.856	.839	-.017	.290	.236	.231	-.005	.779	.713
			1.97 4029.1			.995								
800.0	1472.0	2370.5	2086.8	.991	.995	.852	.837	-.015	.299	.242	.238	-.004	.799	.733
			1.97 4101.2			.995								
825.0	1517.0	2418.5	2123.9	.990	.995	.848	.835	-.014	.308	.248	.244	-.004	.819	.753
			1.97 4174.1			.995								
850.0	1562.0	2467.3	2161.4	.989	.994	.844	.832	-.012	.317	.254	.250	-.004	.839	.772
			1.97 4247.8			.994								
875.0	1607.0	2516.9	2199.4	.988	.993	.840	.830	-.010	.324	.258	.255	-.003	.853	.787
			1.97 4322.5			.993								
900.0	1652.0	2567.5	2237.9	.987	.993	.836	.827	-.008	.332	.263	.261	-.003	.870	.804
			1.97 4398.1			.993								
925.0	1697.0	2618.9	2276.8	.985	.992	.831	.825	-.006	.340	.268	.266	-.002	.886	.821
			1.97 4474.7			.992								
950.0	1742.0	2671.3	2316.3	.984	.992	.827	.822	-.005	.347	.272	.271	-.001	.899	.835
			1.97 4552.4			.992								
975.0	1787.0	2724.7	2356.4	.983	.991	.822	.819	-.002	.354	.276	.275	-.001	.912	.849
			1.97 4631.1			.991								
1000.0	1832.0	2779.1	2397.0	.981	.990	.816	.816	-.000	.361	.280	.280	-.000	.924	.863
			1.97 4710.9			.990								
1025.0	1877.0	2834.6	2438.2	.980	.989	.811	.813	.002	.367	.283	.283	.001	.934	.874
			1.97 4791.8			.989								
1050.0	1922.0	2891.3	2480.0	.978	.988	.805	.810	.004	.374	.286	.288	.001	.945	.887
			1.97 4873.9			.988								
1075.0	1967.0	2949.1	2522.4	.977	.988	.800	.806	.006	.379	.288	.290	.002	.951	.896
			1.97 4957.3			.988								
1100.0	2012.0	3008.1	2565.5	.975	.987	.794	.803	.009	.385	.291	.294	.003	.960	.906
			1.97 5042.0			.987								
1125.0	2057.0	3068.5	2609.2	.973	.986	.787	.799	.011	.391	.292	.297	.004	.965	.915

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			1.97	5127.9		.986											
1150.0	2102.0	3130.1	2653.6	.971	.985	.781	.795	.014	.397	.294	.300	.005	.973	.925			
			1.97	5215.2		.985											
1175.0	2147.0	3193.1	2698.8	.969	.983	.774	.791	.017	.403	.297	.303	.006	.979	.934			
			1.97	5304.0		.983											
1200.0	2192.0	3257.6	2744.7	.967	.982	.768	.787	.019	.408	.298	.305	.007	.983	.942			
			1.97	5394.2		.982											
1225.0	2237.0	3323.5	2791.4	.964	.981	.761	.783	.022	.415	.299	.308	.009	.989	.951			
			1.97	5485.9		.981											
1250.0	2282.0	3391.0	2838.8	.962	.980	.753	.778	.025	.420	.300	.310	.010	.992	.957			
			1.97	5579.2		.980											
1275.0	2327.0	3460.2	2887.1	.959	.978	.746	.774	.028	.426	.302	.313	.011	.997	.966			
			1.97	5674.1		.978											
1300.0	2372.0	3531.0	2936.3	.956	.977	.738	.769	.031	.431	.302	.315	.013	.999	.972			
			1.97	5770.7		.977											
1325.0	2417.0	3603.6	2986.3	.954	.975	.730	.764	.034	.437	.303	.317	.014	1.000	.978			
			1.97	5869.0		.975											
1350.0	2462.0	3678.0	3037.2	.951	.974	.722	.759	.037	.441	.302	.318	.016	.999	.981			
			1.97	5969.1		.974											
1375.0	2507.0	3754.4	3089.1	.948	.972	.714	.754	.040	.445	.302	.319	.017	.997	.984			
			1.97	6071.1		.972											
1400.0	2552.0	3832.8	3142.0	.944	.970	.705	.749	.044	.451	.302	.321	.019	.997	.989			
			1.97	6175.0		.970											
1425.0	2597.0	3913.2	3195.8	.941	.969	.696	.743	.047	.455	.301	.321	.020	.994	.991			
			1.97	6280.9		.969											
1450.0	2642.0	3995.9	3250.8	.937	.967	.687	.738	.050	.460	.301	.323	.022	.993	.995			
			1.97	6388.8		.967											
1475.0	2687.0	4080.9	3306.8	.934	.965	.678	.732	.054	.465	.299	.323	.024	.989	.997			
			1.97	6498.9		.965											
1500.0	2732.0	4168.2	3363.9	.930	.963	.669	.726	.057	.470	.299	.324	.026	.986	1.000			
			1.97	6611.2		.963											



SET 4  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
\$NLIST F=0.8,

\$END

\$NLIST  
INS = .80000000E+03  
RHO1 = .90000000E+00  
RHO2 = .96000000E+00  
BS1 = .10000000E+01  
BS2 = .10000000E+01  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .10000000E+01  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .80000000E+00  
RMA = .34707878E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .00000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = T  
MAXSEC = T  
IPCSEF = F  
IENGEF = T  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

RECEIVER	TEMP.	PRIM.GEOM.CONC.		PRIM.INTERCEPT FACI.		COLLECTOR EFFICIENCY		PCS EFFIC.	SYSTEM EFFICIENCY			FRAC.MAX.SYS.EFFIC.		
		W/O_SEC.	W/SEC.	W/O_SEC.	W/SEC.	W/O_SEC.	W/SEC.		DELTA	W/O_SEC.	W/SEC.	DELTA	W/O_SEC.	W/SEC.
			SECONDARY GEOM.CONC.	OVERALL GEOM.CONC.	OVERALL ICPI.FACI.									
500.0	932.0	1322.2	1109.5	.996	.999	.878	.856	-.022	.136	.113	.110	-.003	.405	.339
			3.04	3376.7		.999								
525.0	977.0	1353.6	1131.5	.996	.999	.875	.855	-.021	.154	.128	.125	-.003	.459	.385
			3.04	3443.8		.999								
550.0	1022.0	1385.5	1153.7	.995	.998	.873	.853	-.019	.172	.143	.139	-.003	.509	.428
			3.04	3511.3		.998								
575.0	1067.0	1417.7	1176.0	.995	.998	.870	.852	-.017	.189	.156	.153	-.003	.557	.469
			3.04	3579.1		.998								
600.0	1112.0	1450.5	1198.4	.994	.998	.866	.851	-.015	.205	.168	.165	-.003	.602	.508
			3.04	3647.5		.998								
625.0	1157.0	1483.8	1221.0	.993	.998	.863	.850	-.013	.220	.180	.177	-.003	.643	.544
			3.04	3716.3		.998								
650.0	1202.0	1517.6	1243.8	.992	.997	.860	.848	-.011	.234	.191	.188	-.002	.682	.578
			3.04	3785.7		.997								
675.0	1247.0	1551.9	1266.8	.991	.997	.856	.847	-.009	.247	.201	.199	-.002	.717	.610
			3.04	3855.7		.997								
700.0	1292.0	1586.9	1290.0	.991	.997	.852	.845	-.007	.258	.209	.207	-.002	.747	.637
			3.04	3926.4		.997								
725.0	1337.0	1622.5	1313.5	.990	.996	.848	.843	-.004	.271	.218	.217	-.001	.779	.666
			3.04	3997.7		.996								
750.0	1382.0	1658.8	1337.2	.988	.996	.843	.842	-.001	.280	.225	.224	-.000	.803	.688
			3.04	4069.7		.996								
775.0	1427.0	1695.8	1361.1	.987	.996	.838	.840	.001	.290	.231	.231	.000	.826	.711
			3.04	4142.6		.996								
800.0	1472.0	1733.5	1385.3	.986	.995	.833	.838	.004	.299	.237	.238	.001	.846	.730
			3.04	4216.2		.995								
825.0	1517.0	1772.0	1409.7	.985	.995	.828	.836	.007	.308	.242	.244	.002	.865	.750
			3.04	4290.6		.995								
850.0	1562.0	1811.2	1434.5	.983	.994	.823	.833	.010	.317	.248	.251	.003	.884	.769
			3.04	4365.9		.994								
875.0	1607.0	1851.4	1459.5	.982	.994	.817	.831	.014	.324	.251	.256	.004	.898	.784
			3.04	4442.2		.994								
900.0	1652.0	1892.4	1484.9	.980	.993	.811	.828	.017	.332	.256	.261	.005	.913	.801
			3.04	4519.3		.993								
925.0	1697.0	1934.3	1510.6	.978	.993	.805	.826	.021	.340	.260	.266	.007	.928	.818
			3.04	4597.5		.993								
950.0	1742.0	1977.1	1536.6	.976	.992	.799	.823	.025	.347	.263	.271	.008	.940	.832
			3.04	4676.7		.992								
975.0	1787.0	2021.0	1562.9	.974	.991	.792	.820	.028	.354	.266	.276	.010	.951	.846
			3.04	4757.0		.991								
1000.0	1832.0	2065.9	1589.7	.972	.990	.785	.817	.032	.361	.269	.280	.011	.961	.860
			3.04	4838.3		.990								
1025.0	1877.0	2112.0	1616.8	.970	.990	.778	.814	.036	.367	.271	.284	.013	.969	.871
			3.04	4920.8		.990								
1050.0	1922.0	2159.1	1644.3	.967	.989	.770	.811	.041	.374	.274	.288	.014	.978	.884
			3.04	5004.6		.989								
1075.0	1967.0	2207.5	1672.2	.965	.988	.763	.808	.045	.379	.275	.291	.016	.982	.893
			3.04	5089.5		.988								
1100.0	2012.0	2257.2	1700.5	.962	.987	.755	.804	.050	.385	.276	.294	.018	.987	.904
			3.04	5175.7		.987								
1125.0	2057.0	2308.1	1729.3	.959	.986	.746	.801	.054	.391	.277	.297	.020	.990	.912

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SET 5  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")

\$NLIST F=1.0,  
\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .96000000E+00  
BS1 = .10000000E+01  
BS2 = .10000000E+01  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .10000000E+01  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .10000000E+01  
RMA = .28072355E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .00000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = T  
MAXSEC = T  
IPCSEF = F  
IENGEF = T  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

\$END

RECEIVER	TEMP.	PRIM.GEOM.CONC.	PRIM.INTERCEPT	FACI.	COLLECTOR EFFICIENCY	PCS	SYSTEM EFFICIENCY			FRAC.MAX.SYS.EFFIC.				
C	F	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	DELTA	EFFIC.	W/O SEC.	W/SEC.	DELTA	W/O SEC.	W/SEC.
		SECONDARY	OVERALL		OVERALL									
		GEOM.CONC.	GEOM.CONC.	ICPT.	FACI.									
500.0	932.0	977.4	765.0	.995	.999	.870	.856	-.014	.136	.112	.110	-.002	.433	.339
		4.44	3395.4	.994	.999	.866	.855	-.012	.154	.127	.125	-.002	.490	.384
525.0	977.0	1002.3	780.2	.994	.999	.866	.855	-.012	.154	.127	.125	-.002	.490	.384
		4.44	3462.7	.993	.998	.863	.854	-.009	.172	.141	.139	-.001	.544	.428
550.0	1022.0	1027.7	795.5	.993	.998	.863	.854	-.009	.172	.141	.139	-.001	.544	.428
		4.44	3530.5	.992	.998	.859	.852	-.006	.189	.154	.153	-.001	.594	.469
575.0	1067.0	1053.4	810.8	.992	.998	.859	.852	-.006	.189	.154	.153	-.001	.594	.469
		4.44	3598.6	.991	.998	.854	.851	-.003	.205	.166	.165	-.001	.641	.507
600.0	1112.0	1079.7	826.3	.991	.998	.854	.851	-.003	.205	.166	.165	-.001	.641	.507
		4.44	3667.3	.990	.998	.850	.850	-.000	.220	.177	.177	-.000	.684	.544
625.0	1157.0	1106.4	841.9	.990	.998	.850	.850	-.000	.220	.177	.177	-.000	.684	.544
		4.44	3736.4	.989	.997	.845	.848	.003	.234	.188	.188	.001	.724	.578
650.0	1202.0	1133.7	857.6	.989	.997	.845	.848	.003	.234	.188	.188	.001	.724	.578
		4.44	3806.1	.988	.997	.840	.847	.007	.247	.197	.199	.002	.761	.609
675.0	1247.0	1161.6	873.4	.988	.997	.840	.847	.007	.247	.197	.199	.002	.761	.609
		4.44	3876.4	.986	.997	.835	.845	.011	.258	.205	.208	.003	.791	.636
700.0	1292.0	1190.0	889.4	.986	.997	.835	.845	.011	.258	.205	.208	.003	.791	.636
		4.44	3947.4	.985	.996	.829	.844	.015	.271	.213	.217	.004	.823	.665
725.0	1337.0	1219.1	905.6	.985	.996	.829	.844	.015	.271	.213	.217	.004	.823	.665
		4.44	4019.0	.983	.996	.823	.842	.019	.280	.219	.224	.005	.846	.688
750.0	1382.0	1248.8	921.9	.983	.996	.823	.842	.019	.280	.219	.224	.005	.846	.688
		4.44	4091.4	.981	.996	.817	.840	.023	.290	.225	.232	.006	.869	.710
775.0	1427.0	1279.2	938.3	.981	.996	.817	.840	.023	.290	.225	.232	.006	.869	.710
		4.44	4164.5	.980	.995	.810	.838	.027	.299	.230	.238	.008	.888	.730
800.0	1472.0	1310.4	955.0	.980	.995	.810	.838	.027	.299	.230	.238	.008	.888	.730
		4.44	4238.4	.978	.995	.803	.836	.032	.308	.235	.244	.009	.907	.749
825.0	1517.0	1342.3	971.8	.978	.995	.803	.836	.032	.308	.235	.244	.009	.907	.749
		4.44	4313.1	.976	.994	.796	.833	.037	.317	.240	.251	.011	.925	.769
850.0	1562.0	1375.0	988.9	.976	.994	.796	.833	.037	.317	.240	.251	.011	.925	.769
		4.44	4388.7	.973	.994	.789	.831	.042	.324	.243	.256	.013	.936	.784
875.0	1607.0	1408.6	1006.1	.973	.994	.789	.831	.042	.324	.243	.256	.013	.936	.784
		4.44	4465.3	.971	.993	.781	.829	.048	.332	.246	.261	.015	.950	.801
900.0	1652.0	1443.1	1023.6	.971	.993	.781	.829	.048	.332	.246	.261	.015	.950	.801
		4.44	4542.7	.968	.993	.773	.826	.053	.340	.249	.266	.017	.963	.817
925.0	1697.0	1478.5	1041.2	.968	.993	.773	.826	.053	.340	.249	.266	.017	.963	.817
		4.44	4621.2	.966	.992	.765	.823	.059	.347	.252	.271	.019	.972	.831
950.0	1742.0	1514.8	1059.2	.966	.992	.765	.823	.059	.347	.252	.271	.019	.972	.831
		4.44	4700.7	.963	.991	.756	.821	.065	.354	.254	.276	.022	.980	.846
975.0	1787.0	1552.3	1077.3	.963	.991	.756	.821	.065	.354	.254	.276	.022	.980	.846
		4.44	4781.3	.960	.991	.747	.818	.071	.361	.256	.280	.024	.988	.859
1000.0	1832.0	1590.7	1095.7	.960	.991	.747	.818	.071	.361	.256	.280	.024	.988	.859
		4.44	4862.9	.956	.990	.738	.815	.077	.367	.257	.284	.027	.992	.871
1025.0	1877.0	1630.4	1114.4	.956	.990	.738	.815	.077	.367	.257	.284	.027	.992	.871
		4.44	4945.8	.953	.989	.728	.811	.083	.374	.259	.288	.030	.998	.884
1050.0	1922.0	1671.2	1133.3	.953	.989	.728	.811	.083	.374	.259	.288	.030	.998	.884
		4.44	5029.8	.949	.988	.718	.808	.090	.379	.259	.291	.032	.998	.893
1075.0	1967.0	1713.3	1152.5	.949	.988	.718	.808	.090	.379	.259	.291	.032	.998	.893
		4.44	5115.0	.945	.987	.708	.805	.097	.385	.259	.295	.036	1.000	.903
1100.0	2012.0	1756.8	1172.0	.945	.987	.708	.805	.097	.385	.259	.295	.036	1.000	.903
		4.44	5201.5	.941	.986	.697	.801	.104	.391	.259	.297	.039	.999	.912
1125.0	2057.0	1801.6	1191.8	.941	.986	.697	.801	.104	.391	.259	.297	.039	.999	.912

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1150.0	2102.0	1848.0	4.44	5289.4		.985	.986	.797	.111	.397	.259	.301	.042	.998	.922
				1211.9	.937		.686								
1175.0	2147.0	1895.9	4.44	5378.6		.984	.985	.793	.118	.403	.258	.304	.045	.997	.932
				1232.3	.932		.675								
1200.0	2192.0	1945.4	4.44	5469.2		.983	.984	.789	.126	.406	.257	.306	.049	.993	.939
				1253.1	.927		.663								
1225.0	2237.0	1996.7	4.44	5561.3		.982	.983	.785	.134	.415	.257	.309	.053	.990	.948
				1274.2	.922		.652								
1250.0	2282.0	2049.9	4.44	5654.9		.981	.982	.781	.141	.420	.255	.311	.056	.984	.955
				1295.6	.917		.639								
1275.0	2327.0	2105.0	4.44	5750.1		.979	.981	.776	.149	.426	.254	.314	.060	.980	.964
				1317.4	.911		.627								
1300.0	2372.0	2162.3	4.44	5846.9		.978	.979	.772	.157	.431	.252	.316	.064	.972	.970
				1339.6	.906		.615								
1325.0	2417.0	2221.7	4.44	5945.3		.976	.978	.767	.166	.437	.250	.318	.069	.963	.976
				1362.2	.899		.602								
1350.0	2462.0	2283.5	4.44	6045.5		.975	.976	.762	.174	.441	.247	.319	.073	.952	.979
				1385.1	.893		.588								
1375.0	2507.0	2347.8	4.44	6147.5		.973	.975	.757	.182	.445	.243	.320	.077	.939	.983
				1408.5	.886		.575								
1400.0	2552.0	2414.7	4.44	6251.4		.972	.973	.752	.191	.451	.240	.322	.082	.928	.988
				1432.4	.879		.561								
1425.0	2597.0	2484.5	4.44	6357.1		.970	.972	.747	.199	.455	.237	.323	.086	.914	.990
				1456.7	.872		.548								
1450.0	2642.0	2557.4	4.44	6464.9		.968	.970	.741	.208	.460	.233	.324	.091	.901	.995
				1481.4	.864		.533								
1475.0	2687.0	2633.5	4.44	6574.7		.966	.968	.736	.217	.465	.229	.325	.096	.885	.997
				1506.6	.856		.519								
1500.0	2732.0	2713.1	4.44	6686.6		.964	.966	.730	.225	.470	.225	.326	.101	.870	1.000
				1532.3	.848		.505								
			4.44	6800.7			.964								



```
SET 6
ENTER INPUT VALUES (NAMELIST, WITH NAME *NLIST*)
$NLIST F=0.4, NWTORF=T,
ENTER RECEIVER TEMPERATURES (M1,M2,M3 INTEGER)
ITRC1, ITRC2, ITRC3 = 500, 1500,
ENTER ENGINE EFFICIENCIES (FREE-FIELD, REAL)
EFFICIENCIES ENTERED
$NLIST
```

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\$END

```
INS = .80000000E+03
RH01 = .90000000E+00
RH02 = .96000000E+00
BS1 = .10000000E+01
BS2 = .10000000E+01
PHI1 = .00000000E+00
PHI1S = .00000000E+00
PHI2 = .10000000E+01
C1 = .00000000E+00
C1S = .00000000E+00
C2 = .00000000E+00
F = .40000000E+00
RMA = .64010816E+02
SLOPER = .20000000E+01
SPECUL = .50000000E+00
SOLSD = .23000000E+01
ALPHA = .10000000E+01
EPS = .10000000E+01
TAC = .20000000E+02
HC = .00000000E+00
ARATIO = .00000000E+00
HK = .00000000E+00
DTRE = .25000000E+02
TOC = .50000000E+02
PCEFCT = .00000000E+00
ENEFCT = .00000000E+00
CYCECT = .00000000E+00
MECHE = .00000000E+00
AUXE = .00000000E+00
GEARE = .90000000E+00
GENE = .98000000E+00
PPE = .95000000E+00
OPTMZE = T
PARAB = T
MAXC = F
MAXPHI = F
SECONC = T
MAXSEC = T
IPCSEF = F
IENGEF = T
ICYCEF = F
NWTORF = T
XTRACT = T
SUP2 = F
MORDEC = F
$END
```

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RECEIVER TEMP.		PRIM.GEOM.CONC.		PRIM.INTERCEPT FACI.		COLLECTOR EFFICIENCY			PCS	SYSTEM EFFICIENCY			FRAC.MAX.SYS.EFFIC.	
C	F	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	DELTA	EFFIC.	W/O SEC.	W/SEC.	DELTA	W/O SEC.	W/SEC.
		SECONDARY GEOM.CONC.		OVERALL GEOM.CONC.		OVERALL ICPI.FACI.								
500.0	932.0	2251.7	2192.6	.998	.998	.887	.853	-.034	.224	.189	.182	-.007	.500	.489
		1.23	2701.5	.998	.998	.886	.852	-.034	.243	.204	.196	-.008	.540	.528
525.0	977.0	2299.6	2238.0	.998	.998	.884	.851	-.033	.260	.219	.210	-.008	.578	.566
		1.23	2757.5	.997	.998	.882	.849	-.033	.277	.232	.223	-.009	.614	.601
550.0	1022.0	2347.9	2283.7	.997	.998	.880	.848	-.033	.293	.245	.236	-.009	.648	.634
		1.23	2813.8	.997	.998	.878	.846	-.032	.308	.257	.247	-.009	.680	.665
575.0	1067.0	2396.6	2329.8	.997	.998	.876	.844	-.032	.322	.268	.258	-.010	.709	.695
		1.23	2870.5	.997	.997	.874	.842	-.032	.335	.278	.268	-.010	.736	.721
600.0	1112.0	2445.8	2376.3	.997	.997	.872	.840	-.031	.347	.287	.277	-.010	.759	.744
		1.23	2927.8	.996	.997	.869	.838	-.031	.359	.296	.286	-.011	.784	.769
625.0	1157.0	2495.5	2423.1	.996	.997	.866	.836	-.030	.369	.303	.293	-.011	.803	.788
		1.23	2985.6	.996	.996	.864	.834	-.030	.378	.310	.300	-.011	.821	.806
650.0	1202.0	2545.7	2470.5	.996	.996	.861	.831	-.029	.387	.317	.306	-.011	.838	.822
		1.23	3043.9	.996	.994	.858	.829	-.029	.396	.323	.312	-.011	.853	.838
675.0	1247.0	2596.6	2518.3	.996	.996	.854	.826	-.028	.405	.329	.318	-.011	.869	.854
		1.23	3102.8	.994	.992	.851	.823	-.028	.412	.333	.322	-.011	.881	.866
700.0	1292.0	2648.0	2566.7	.995	.996	.847	.820	-.027	.420	.338	.327	-.011	.894	.879
		1.23	3162.4	.994	.995	.843	.817	-.027	.428	.343	.332	-.011	.907	.893
725.0	1337.0	2700.1	2615.6	.994	.995	.839	.813	-.026	.435	.347	.336	-.011	.917	.904
		1.23	3222.7	.994	.995	.835	.810	-.025	.442	.351	.340	-.011	.928	.914
750.0	1382.0	2752.9	2665.1	.994	.995	.831	.806	-.025	.449	.354	.344	-.011	.938	.925
		1.23	3283.7	.993	.994	.826	.802	-.024	.455	.357	.347	-.010	.945	.933
775.0	1427.0	2806.4	2715.2	.993	.994	.822	.798	-.023	.462	.361	.351	-.010	.955	.943
		1.23	3345.4	.993	.994	.817	.794	-.023	.467	.363	.353	-.010	.960	.949
800.0	1472.0	2860.6	2766.0	.993	.994	.812	.790	-.022	.474	.365	.355	-.010	.966	.956
		1.23	3408.0	.992	.993	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
825.0	1517.0	2915.7	2817.4	.992	.993	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3471.3	.991	.992	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
850.0	1562.0	2971.5	2869.5	.991	.992	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3535.5	.990	.992	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
875.0	1607.0	3028.2	2922.4	.990	.992	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3600.7	.989	.991	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
900.0	1652.0	3085.8	2976.0	.989	.991	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3666.7	.988	.990	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
925.0	1697.0	3144.4	3030.4	.988	.990	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3733.7	.987	.989	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
950.0	1742.0	3203.9	3085.6	.987	.989	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3801.8	.986	.989	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
975.0	1787.0	3264.4	3141.7	.986	.989	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3870.9	.985	.988	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
1000.0	1832.0	3325.9	3198.7	.985	.988	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	3941.1	.984	.987	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
1025.0	1877.0	3388.6	3256.5	.984	.987	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	4012.4	.983	.985	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
1050.0	1922.0	3452.3	3315.4	.983	.985	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	4084.9	.982	.984	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
1075.0	1967.0	3517.2	3375.2	.982	.984	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	4158.6	.980	.983	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
1100.0	2012.0	3583.4	3436.1	.980	.983	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
		1.23	4233.6	.979	.982	.807	.786	-.021	.479	.367	.357	-.010	.971	.961
1125.0	2057.0	3650.8	3498.0	.979	.982	.807	.786	-.021	.479	.367	.357	-.010	.971	.961

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			1.23	4309.9		.982											
1150.0	2102.0	3719.5		3561.1	.977	.981	.801	.781	-.020	.485	.369	.360	-.009	.977	.968		
			1.23	4387.6		.981											
1175.0	2147.0	3789.6		3625.2	.975	.979	.796	.776	-.019	.491	.371	.362	-.009	.982	.975		
			1.23	4466.7		.979											
1200.0	2192.0	3861.1		3690.6	.974	.978	.790	.771	-.019	.497	.373	.364	-.009	.986	.979		
			1.23	4547.2		.978											
1225.0	2237.0	3934.0		3757.2	.972	.976	.784	.766	-.018	.503	.374	.366	-.008	.991	.984		
			1.23	4629.3		.976											
1250.0	2282.0	4008.5		3825.1	.970	.974	.778	.761	-.017	.508	.375	.367	-.008	.993	.988		
			1.23	4712.9		.974											
1275.0	2327.0	4084.6		3894.3	.968	.973	.771	.756	-.016	.514	.377	.369	-.008	.997	.993		
			1.23	4798.2		.973											
1300.0	2372.0	4162.3		3964.9	.966	.971	.765	.750	-.015	.519	.378	.370	-.007	.999	.996		
			1.23	4885.2		.971											
1325.0	2417.0	4241.8		4036.9	.963	.969	.758	.744	-.014	.525	.378	.371	-.007	1.000	.998		
			1.23	4973.9		.969											
1350.0	2462.0	4323.0		4110.4	.961	.967	.751	.739	-.013	.529	.378	.371	-.006	.999	.999		
			1.23	5064.4		.967											
1375.0	2507.0	4406.0		4185.4	.959	.965	.744	.732	-.012	.534	.377	.371	-.006	.998	.999		
			1.23	5156.9		.965											
1400.0	2552.0	4491.0		4262.0	.956	.963	.737	.726	-.011	.539	.377	.372	-.005	.998	1.000		
			1.23	5251.3		.963											
1425.0	2597.0	4578.0		4340.3	.953	.961	.729	.720	-.010	.543	.376	.372	-.005	.996	.999		
			1.23	5347.7		.961											
1450.0	2642.0	4667.1		4420.3	.951	.958	.722	.713	-.008	.549	.376	.372	-.004	.995	1.000		
			1.23	5446.2		.958											
1475.0	2687.0	4758.3		4502.0	.948	.956	.714	.707	-.007	.553	.375	.371	-.004	.992	.998		
			1.23	5547.0		.956											
1500.0	2732.0	4851.8		4585.7	.945	.953	.706	.700	-.006	.558	.374	.371	-.003	.990	.998		
			1.23	5650.0		.953											



SET 7  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
\$NLIST F=0.5,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .96000000E+00  
BS1 = .10000000E+01  
BS2 = .10000000E+01  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .10000000E+01  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .50000000E+00  
RMA = .53130088E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .00000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = T  
MAXSEC = T  
IPCSEF = F  
IENGEF = T  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

RECEIVER TEMP. PRIM.GEOM.CONC. PRIM.INTERCEPT FACI. COLLECTOR EFFICIENCY PCS SYSTEM EFFICIENCY FRAC.MAX.SYS.EFFIC.  
 C F W/O SEC. W/SEC. W/O SEC. W/SEC. W/O SEC. W/SEC. DELTA EFFIC. W/O SEC. W/SEC. DELTA W/O SEC. W/SEC.

		SECONDARY GEOM.CONC.		OVERALL GEOM.CONC.		OVERALL ICPI.FACI.				SYSTEM EFFICIENCY			FRAC.MAX.SYS.EFFIC.	
C	F	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	DELTA	EFFIC.	W/O SEC.	W/SEC.	DELTA	W/O SEC.	W/SEC.
500.0	932.0	2142.0	2012.1	.998	.999	.887	.855	-.032	.224	.189	.182	-.007	.504	.477
			1.55	3122.3		.999								
525.0	977.0	2188.0	2052.7	.998	.998	.885	.854	-.031	.243	.204	.197	-.007	.544	.515
			1.55	3185.2		.998								
550.0	1022.0	2234.4	2093.5	.997	.998	.883	.853	-.031	.260	.218	.211	-.008	.583	.552
			1.55	3248.5		.998								
575.0	1067.0	2281.3	2134.5	.997	.998	.881	.851	-.030	.277	.232	.224	-.008	.619	.587
			1.55	3312.2		.998								
600.0	1112.0	2328.6	2175.9	.997	.998	.879	.850	-.029	.293	.245	.236	-.008	.653	.619
			1.55	3376.4		.998								
625.0	1157.0	2376.4	2217.6	.996	.997	.877	.849	-.029	.308	.257	.248	-.008	.685	.650
			1.55	3441.1		.997								
650.0	1202.0	2424.8	2259.7	.996	.997	.875	.847	-.028	.322	.268	.259	-.009	.714	.679
			1.55	3506.4		.997								
675.0	1247.0	2473.8	2302.1	.995	.997	.873	.845	-.027	.335	.278	.269	-.009	.742	.705
			1.55	3572.2		.997								
700.0	1292.0	2523.3	2345.0	.995	.996	.870	.844	-.027	.347	.287	.278	-.009	.765	.728
			1.55	3638.8		.996								
725.0	1337.0	2573.6	2388.3	.994	.996	.868	.842	-.026	.359	.296	.287	-.009	.790	.752
			1.55	3706.0		.996								
750.0	1382.0	2624.5	2432.1	.994	.996	.865	.840	-.025	.369	.303	.294	-.009	.808	.771
			1.55	3773.9		.996								
775.0	1427.0	2676.1	2476.4	.993	.995	.862	.838	-.024	.378	.310	.301	-.009	.827	.789
			1.55	3842.6		.995								
800.0	1472.0	2728.4	2521.1	.992	.995	.859	.836	-.023	.387	.316	.307	-.009	.843	.805
			1.55	3912.1		.995								
825.0	1517.0	2781.6	2566.4	.991	.994	.855	.833	-.022	.396	.322	.313	-.008	.859	.821
			1.55	3982.4		.994								
850.0	1562.0	2835.6	2612.3	.991	.994	.852	.831	-.021	.405	.328	.320	-.008	.874	.837
			1.55	4053.6		.994								
875.0	1607.0	2890.4	2658.8	.990	.993	.848	.828	-.020	.412	.332	.324	-.008	.886	.849
			1.55	4125.6		.993								
900.0	1652.0	2946.1	2705.8	.989	.992	.844	.826	-.019	.420	.337	.329	-.008	.899	.863
			1.55	4198.7		.992								
925.0	1697.0	3002.7	2753.5	.988	.992	.841	.823	-.018	.428	.342	.334	-.007	.912	.876
			1.55	4272.7		.992								
950.0	1742.0	3060.3	2801.9	.987	.991	.836	.820	-.016	.435	.345	.339	-.007	.922	.887
			1.55	4347.7		.991								
975.0	1787.0	3118.9	2850.9	.986	.990	.832	.817	-.015	.442	.349	.343	-.006	.932	.898
			1.55	4423.8		.990								
1000.0	1832.0	3178.6	2900.7	.984	.990	.828	.814	-.014	.449	.353	.347	-.006	.942	.909
			1.55	4501.0		.990								
1025.0	1877.0	3239.3	2951.2	.983	.989	.823	.810	-.012	.455	.356	.350	-.005	.949	.918
			1.55	4579.4		.989								
1050.0	1922.0	3301.2	3002.4	.982	.988	.818	.807	-.011	.462	.359	.354	-.005	.958	.928
			1.55	4658.9		.988								
1075.0	1967.0	3364.2	3054.5	.980	.987	.813	.803	-.010	.467	.361	.357	-.004	.963	.935
			1.55	4739.7		.987								
1100.0	2012.0	3428.4	3107.4	.979	.986	.808	.800	-.008	.474	.363	.360	-.004	.970	.943
			1.55	4821.7		.986								
1125.0	2057.0	3493.9	3161.1	.977	.985	.802	.796	-.006	.479	.365	.362	-.003	.974	.949

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SET 8  
ENTER INPUT VALUES (NAMelist, WITH NAME "NLIST")

\$NLIST F=0.6,

\$END

\$NLIST  
INS " .80000000E+03  
RH01 " .90000000E+00  
RH02 " .96000000E+00  
BS1 " .10000000E+01  
BS2 " .10000000E+01  
PHI1 " .00000000E+00  
PHI1S " .00000000E+00  
PHI2 " .10000000E+01  
C1 " .00000000E+00  
C1S " .00000000E+00  
C2 " .00000000E+00  
F " .60000000E+00  
RMA " .45239635E+02  
SLOPER " .20000000E+01  
SPECUL " .50000000E+00  
SOLSD " .23000000E+01  
ALPHA " .10000000E+01  
EPS " .10000000E+01  
TAC " .20000000E+02  
HC " .00000000E+00  
ARATIO " .00000000E+00  
HK " .00000000E+00  
DTRE " .25000000E+02  
TOC " .50000000E+02  
PCEFCT " .00000000E+00  
ENEFCT " .00000000E+00  
CYCECT " .00000000E+00  
MECHE " .00000000E+00  
AUXE " .00000000E+00  
GEARE " .90000000E+00  
GENE " .98000000E+00  
PPE " .95000000E+00  
OPTMZE " T  
PARAB " T  
MAXC " F  
MAXPHI " F  
SECONC " T  
MAXSEC " T  
IPCSEF " F  
IENGEF " T  
ICYCEF " F  
NWTORF " F  
XTRACT " T  
SUP2 " F  
MORDEC " F  
\$END

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RECEIVER\_TEMP. PRIM.GEOM.CONC. PRIM.INTERCEPT\_FACI. COLLECTOR EFFICIENCY PCS SYSTEM EFFICIENCY FRAC.MAX.SYS.EFFIC.  
 \_C\_ \_F\_ W/O\_SEC. W/SEC. W/O\_SEC. W/SEC. W/O\_SEC. W/SEC. DELTA EFFIC. W/O\_SEC. W/SEC. DELTA W/O\_SEC. W/SEC.

SECONDARY OVERALL OVERALL  
 GEOM.CONC. GEOM.CONC. ICPI.FACI.

500.0	932.0	1845.9	1669.2	.998	.999	.884	.855	-.029	.224	.188	.182	-.006	.517	.473
		1.97	3280.5		.999									
525.0	977.0	1886.8	1702.5	.997	.998	.882	.854	-.028	.243	.203	.197	-.007	.558	.511
		1.97	3346.0		.998									
550.0	1022.0	1928.0	1736.0	.997	.998	.880	.853	-.027	.260	.218	.211	-.007	.597	.548
		1.97	3411.9		.998									
575.0	1067.0	1969.7	1769.8	.996	.998	.878	.852	-.026	.277	.231	.224	-.007	.634	.582
		1.97	3478.2		.998									
600.0	1112.0	2011.9	1803.7	.996	.998	.876	.851	-.025	.293	.244	.237	-.007	.669	.615
		1.97	3544.9		.998									
625.0	1157.0	2054.6	1838.0	.995	.998	.874	.849	-.024	.308	.255	.248	-.007	.701	.645
		1.97	3612.2		.998									
650.0	1202.0	2097.8	1872.5	.995	.997	.871	.848	-.023	.322	.266	.259	-.007	.731	.673
		1.97	3680.1		.997									
675.0	1247.0	2141.7	1907.3	.994	.997	.868	.846	-.022	.335	.276	.269	-.007	.759	.700
		1.97	3748.5		.997									
700.0	1292.0	2186.1	1942.5	.994	.997	.865	.845	-.021	.347	.285	.278	-.007	.782	.722
		1.97	3817.6		.997									
725.0	1337.0	2231.1	1978.0	.993	.996	.862	.843	-.020	.359	.294	.287	-.007	.807	.747
		1.97	3887.4		.996									
750.0	1382.0	2276.9	2013.9	.992	.996	.859	.841	-.018	.369	.301	.295	-.006	.826	.765
		1.97	3957.9		.996									
775.0	1427.0	2323.3	2050.1	.991	.995	.856	.839	-.017	.378	.308	.302	-.006	.844	.783
		1.97	4029.1		.995									
800.0	1472.0	2370.5	2086.8	.991	.995	.852	.837	-.015	.387	.313	.308	-.006	.860	.800
		1.97	4101.2		.995									
825.0	1517.0	2418.5	2123.9	.990	.995	.848	.835	-.014	.396	.319	.314	-.005	.876	.816
		1.97	4174.1		.995									
850.0	1562.0	2467.3	2161.4	.989	.994	.844	.832	-.012	.405	.325	.320	-.005	.891	.832
		1.97	4247.8		.994									
875.0	1607.0	2516.9	2199.4	.988	.993	.840	.830	-.010	.412	.329	.325	-.004	.902	.844
		1.97	4322.5		.993									
900.0	1652.0	2567.5	2237.9	.987	.993	.836	.827	-.008	.420	.333	.330	-.003	.915	.857
		1.97	4398.1		.993									
925.0	1697.0	2618.9	2276.8	.985	.992	.831	.825	-.006	.428	.338	.335	-.003	.927	.871
		1.97	4474.7		.992									
950.0	1742.0	2671.3	2316.3	.984	.992	.827	.822	-.005	.435	.341	.340	-.002	.937	.882
		1.97	4552.4		.992									
975.0	1787.0	2724.7	2356.4	.983	.991	.822	.819	-.002	.442	.345	.344	-.001	.947	.893
		1.97	4631.1		.991									
1000.0	1832.0	2779.1	2397.0	.981	.990	.816	.816	-.000	.449	.348	.348	-.000	.956	.904
		1.97	4710.9		.990									
1025.0	1877.0	2834.6	2438.2	.980	.989	.811	.813	.002	.455	.351	.351	.001	.963	.913
		1.97	4791.8		.989									
1050.0	1922.0	2891.3	2480.0	.978	.988	.805	.810	.004	.462	.354	.355	.002	.971	.923
		1.97	4873.9		.988									
1075.0	1967.0	2949.1	2522.4	.977	.988	.800	.806	.006	.467	.355	.358	.003	.975	.930
		1.97	4957.3		.988									
1100.0	2012.0	3008.1	2565.5	.975	.987	.794	.803	.009	.474	.357	.361	.004	.980	.938
		1.97	5042.0		.987									
1125.0	2057.0	3068.5	2609.2	.973	.986	.787	.799	.011	.479	.358	.363	.005	.984	.944

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SET 9  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")

\$NLIST F=0.8,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .96000000E+00  
BS1 = .10000000E+01  
BS2 = .10000000E+01  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .10000000E+01  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .80000000E+00  
RMA = .34707878E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .00000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = T  
MAXSEC = T  
IPCSEF = F  
IENGEF = T  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

RECEIVER TEMP.		PRIM.GEOM.CONC.		PRIM.INTERCEPT FACI.		COLLECTOR EFFICIENCY			PCS	SYSTEM EFFICIENCY			FRAC.MAX.SYS.EFFIC.	
C	F	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	W/O SEC.	W/SEC.	DELTA	EFFIC.	W/O SEC.	W/SEC.	DELTA	W/O SEC.	W/ SEC.
			SECONDARY GEOM.CONC.	OVERALL GEOM.CONC.		OVERALL ICPI.FACI.								
500.0	932.0	1322.2	1109.5	.996	.999	.878	.856	-.022	.224	.187	.182	-.005	.549	.471
			3.04	3376.7		.999								
525.0	977.0	1353.6	1131.5	.996	.999	.875	.855	-.021	.243	.202	.197	-.005	.593	.509
			3.04	3443.8		.999								
550.0	1022.0	1385.5	1153.7	.995	.998	.873	.853	-.019	.260	.216	.211	-.005	.634	.545
			3.04	3511.3		.998								
575.0	1067.0	1417.7	1176.0	.995	.998	.870	.852	-.017	.277	.229	.224	-.005	.672	.580
			3.04	3579.1		.998								
600.0	1112.0	1450.5	1198.4	.994	.998	.866	.851	-.015	.293	.241	.237	-.004	.708	.612
			3.04	3647.5		.998								
625.0	1157.0	1483.8	1221.0	.993	.998	.863	.850	-.013	.308	.252	.248	-.004	.742	.642
			3.04	3716.3		.998								
650.0	1202.0	1517.6	1243.8	.992	.997	.860	.848	-.011	.322	.263	.259	-.003	.773	.671
			3.04	3785.7		.997								
675.0	1247.0	1551.9	1266.8	.991	.997	.856	.847	-.009	.335	.272	.270	-.003	.801	.697
			3.04	3855.7		.997								
700.0	1292.0	1586.9	1290.0	.991	.997	.852	.845	-.007	.347	.280	.278	-.002	.824	.719
			3.04	3926.4		.997								
725.0	1337.0	1622.5	1313.5	.990	.996	.848	.843	-.004	.359	.289	.288	-.001	.849	.743
			3.04	3997.7		.996								
750.0	1382.0	1658.8	1337.2	.988	.996	.843	.842	-.001	.369	.295	.295	-.001	.868	.762
			3.04	4069.7		.996								
775.0	1427.0	1695.8	1361.1	.987	.996	.838	.840	.001	.378	.301	.302	.000	.886	.780
			3.04	4142.6		.996								
800.0	1472.0	1733.5	1385.3	.986	.995	.833	.838	.004	.387	.307	.308	.002	.901	.796
			3.04	4216.2		.995								
825.0	1517.0	1772.0	1409.7	.985	.995	.828	.836	.007	.396	.312	.314	.003	.916	.812
			3.04	4290.6		.995								
850.0	1562.0	1811.2	1434.5	.983	.994	.823	.833	.010	.405	.316	.320	.004	.930	.828
			3.04	4365.9		.994								
875.0	1607.0	1851.4	1459.5	.982	.994	.817	.831	.014	.412	.320	.325	.005	.940	.840
			3.04	4442.2		.994								
900.0	1652.0	1892.4	1484.9	.980	.993	.811	.828	.017	.420	.324	.330	.007	.951	.854
			3.04	4519.3		.993								
925.0	1697.0	1934.3	1510.6	.978	.993	.805	.826	.021	.428	.327	.336	.008	.962	.867
			3.04	4597.5		.993								
950.0	1742.0	1977.1	1536.6	.976	.992	.799	.823	.025	.435	.330	.340	.010	.970	.879
			3.04	4676.7		.992								
975.0	1787.0	2021.0	1562.9	.974	.991	.792	.820	.028	.442	.332	.344	.012	.977	.890
			3.04	4757.0		.991								
1000.0	1832.0	2065.9	1589.7	.972	.990	.785	.817	.032	.449	.335	.349	.014	.984	.901
			3.04	4838.3		.990								
1025.0	1877.0	2112.0	1616.8	.970	.990	.778	.814	.036	.455	.336	.352	.016	.988	.910
			3.04	4920.8		.990								
1050.0	1922.0	2159.1	1644.3	.967	.989	.770	.811	.041	.462	.338	.356	.018	.994	.920
			3.04	5004.6		.989								
1075.0	1967.0	2207.5	1672.2	.965	.988	.763	.808	.045	.467	.339	.359	.020	.995	.927
			3.04	5089.5		.988								
1100.0	2012.0	2257.2	1700.5	.962	.987	.755	.804	.050	.474	.340	.362	.022	.998	.935
			3.04	5175.7		.987								
1125.0	2057.0	2308.1	1729.3	.959	.986	.746	.801	.054	.479	.340	.364	.025	.998	.941

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SET 10  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")  
\$NLIST F=1.0,

\$END

\$NLIST  
INS = .80000000E+03  
RH01 = .90000000E+00  
RH02 = .96000000E+00  
BS1 = .10000000E+01  
BS2 = .10000000E+01  
PHI1 = .00000000E+00  
PHI1S = .00000000E+00  
PHI2 = .10000000E+01  
C1 = .00000000E+00  
C1S = .00000000E+00  
C2 = .00000000E+00  
F = .10000000E+01  
RMA = .28072355E+02  
SLOPER = .20000000E+01  
SPECUL = .50000000E+00  
SOLSD = .23000000E+01  
ALPHA = .10000000E+01  
EPS = .10000000E+01  
TAC = .20000000E+02  
HC = .00000000E+00  
ARATIO = .00000000E+00  
HK = .00000000E+00  
DTRE = .25000000E+02  
TOC = .50000000E+02  
PCEFCT = .00000000E+00  
ENEFCT = .00000000E+00  
CYCECT = .00000000E+00  
MECHE = .00000000E+00  
AUXE = .00000000E+00  
GEARE = .90000000E+00  
GENE = .98000000E+00  
PPE = .95000000E+00  
OPTMZE = T  
PARAB = T  
MAXC = F  
MAXPHI = F  
SECONC = T  
MAXSEC = T  
IPCSEF = F  
IENGEF = T  
ICYCEF = F  
NWTORF = F  
XTRACT = T  
SUP2 = F  
MORDEC = F  
\$END

RECEIVER_TEMP	PRIM.GEOM.CONC.	PRIM.INTERCEPI.FACI.	COLLECTOR EFFICIENCY	PCS EFFIC.	SYSTEM EFFICIENCY			FRAC.MAX.SYS.EFFIC.						
C	F	W/O_SEC.	W/SEC.	W/O_SEC.	W/SEC.	W/O_SEC.	W/SEC.	DELTA	W/O_SEC.	W/SEC.				
		SECONDARY GEOM.CONC.	OVERALL GEOM.CONC.	OVERALL ICPI.FACI.										
500.0	932.0	977.4	765.0	.995	.999	.870	.856	-.014	.224	.185	.182	-.003	.579	.470
		4.44	3395.4	.999	.999									
525.0	977.0	1002.3	780.2	.994	.999	.866	.855	-.012	.243	.200	.197	-.003	.625	.508
		4.44	3462.7	.999	.999									
550.0	1022.0	1027.7	795.5	.993	.998	.863	.854	-.009	.260	.213	.211	-.002	.667	.545
		4.44	3530.5	.998	.998									
575.0	1067.0	1053.4	810.8	.992	.998	.859	.852	-.006	.277	.226	.224	-.002	.707	.579
		4.44	3598.6	.998	.998									
600.0	1112.0	1079.7	826.3	.991	.998	.854	.851	-.003	.293	.238	.237	-.001	.744	.611
		4.44	3667.3	.998	.998									
625.0	1157.0	1106.4	841.9	.990	.998	.850	.850	-.000	.308	.249	.248	-.000	.778	.642
		4.44	3736.4	.998	.998									
650.0	1202.0	1133.7	857.6	.989	.997	.845	.848	.003	.322	.258	.259	.001	.809	.670
		4.44	3806.1	.997	.997									
675.0	1247.0	1161.6	873.4	.988	.997	.840	.847	.007	.335	.267	.270	.002	.837	.696
		4.44	3876.4	.997	.997									
700.0	1292.0	1190.0	889.4	.986	.997	.835	.845	.011	.347	.275	.278	.003	.860	.719
		4.44	3947.4	.997	.997									
725.0	1337.0	1219.1	905.6	.985	.996	.829	.844	.015	.359	.283	.288	.005	.885	.743
		4.44	4019.0	.996	.996									
750.0	1382.0	1248.8	921.9	.983	.996	.823	.842	.019	.369	.288	.295	.007	.902	.761
		4.44	4091.4	.996	.996									
775.0	1427.0	1279.2	938.3	.981	.996	.817	.840	.023	.378	.294	.302	.008	.919	.780
		4.44	4164.5	.996	.996									
800.0	1472.0	1310.4	955.0	.980	.995	.810	.838	.027	.387	.298	.308	.010	.933	.796
		4.44	4238.4	.995	.995									
825.0	1517.0	1342.3	971.8	.978	.995	.803	.836	.032	.396	.302	.314	.012	.946	.812
		4.44	4313.1	.995	.995									
850.0	1562.0	1375.0	988.9	.976	.994	.796	.833	.037	.405	.306	.321	.014	.958	.828
		4.44	4388.7	.994	.994									
875.0	1607.0	1408.6	1006.1	.973	.994	.789	.831	.042	.412	.309	.325	.017	.966	.840
		4.44	4465.3	.994	.994									
900.0	1652.0	1443.1	1023.6	.971	.993	.781	.829	.048	.420	.312	.331	.019	.975	.853
		4.44	4542.7	.993	.993									
925.0	1697.0	1478.5	1041.2	.968	.993	.773	.826	.053	.428	.314	.336	.022	.983	.867
		4.44	4621.2	.993	.993									
950.0	1742.0	1514.8	1059.2	.966	.992	.765	.823	.059	.435	.316	.340	.024	.988	.878
		4.44	4700.7	.992	.992									
975.0	1787.0	1552.3	1077.3	.963	.991	.756	.821	.065	.442	.317	.344	.027	.993	.889
		4.44	4781.3	.991	.991									
1000.0	1832.0	1590.7	1095.7	.960	.991	.747	.818	.071	.449	.319	.349	.030	.997	.900
		4.44	4862.9	.991	.991									
1025.0	1877.0	1630.4	1114.4	.956	.990	.738	.815	.077	.455	.319	.352	.033	.998	.909
		4.44	4945.8	.990	.990									
1050.0	1922.0	1671.2	1133.3	.953	.989	.728	.811	.083	.462	.320	.356	.037	1.000	.920
		4.44	5029.8	.989	.989									
1075.0	1967.0	1713.3	1152.5	.949	.988	.718	.808	.090	.467	.319	.359	.040	.998	.927
		4.44	5115.0	.988	.988									
1100.0	2012.0	1756.8	1172.0	.945	.987	.708	.805	.097	.474	.318	.362	.044	.996	.935
		4.44	5201.5	.987	.987									
1125.0	2057.0	1801.6	1191.8	.941	.986	.697	.801	.104	.479	.317	.364	.047	.992	.941

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1150.0	2102.0	1848.0	4.44	5289.4		.985	.986	.797	.111	.485	.316	.367	.051	.989	.949
			4.44	1211.9	.937		.686								
1175.0	2147.0	1895.9	4.44	5378.6		.984	.985	.793	.118	.491	.315	.370	.055	.986	.956
			4.44	1232.3	.932		.675								
1200.0	2192.0	1945.4	4.44	5469.2		.983	.984	.789	.126	.497	.313	.372	.059	.979	.962
			4.44	1253.1	.927		.663								
1225.0	2237.0	1996.7	4.44	5561.3		.982	.983	.785	.134	.503	.311	.375	.064	.974	.968
			4.44	1274.2	.922		.652								
1250.0	2282.0	2049.9	4.44	5654.9		.981	.982	.781	.141	.508	.309	.377	.068	.966	.973
			4.44	1295.6	.917		.639								
1275.0	2327.0	2105.0	4.44	5750.1		.979	.981	.776	.149	.514	.306	.379	.073	.959	.979
			4.44	1317.4	.911		.627								
1300.0	2372.0	2162.3	4.44	5846.9		.978	.979	.772	.157	.519	.303	.381	.078	.949	.984
			4.44	1339.6	.906		.615								
1325.0	2417.0	2221.7	4.44	5945.3		.976	.978	.767	.166	.525	.300	.382	.083	.939	.988
			4.44	1362.2	.899		.602								
1350.0	2462.0	2283.5	4.44	6045.5		.975	.976	.762	.174	.529	.296	.383	.087	.926	.990
			4.44	1385.1	.893		.588								
1375.0	2507.0	2347.8	4.44	6147.5		.973	.975	.757	.182	.534	.292	.384	.092	.912	.991
			4.44	1408.5	.886		.575								
1400.0	2552.0	2414.7	4.44	6251.4		.972	.973	.752	.191	.539	.287	.385	.098	.899	.994
			4.44	1432.4	.879		.561								
1425.0	2597.0	2484.5	4.44	6357.1		.970	.972	.747	.199	.543	.283	.386	.103	.884	.995
			4.44	1456.7	.872		.548								
1450.0	2642.0	2557.4	4.44	6464.9		.968	.970	.741	.208	.549	.278	.386	.108	.870	.998
			4.44	1481.4	.864		.533								
1475.0	2687.0	2633.5	4.44	6574.7		.966	.968	.736	.217	.553	.273	.387	.114	.854	.998
			4.44	1506.6	.856		.519								
1500.0	2732.0	2713.1	4.44	6686.6		.964	.966	.730	.225	.558	.268	.387	.120	.838	1.000
			4.44	1532.3	.848		.505								
			4.44	6800.7			.964								

SET 11  
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")

STOP NORMAL

@BLK,S XTRACT,506/13,LSPH  
BLOCK 5.13 SL74R1 12/16/83 14:58:34  
30 PAGES SENT TO: 506/13,LSPH

@FIN

APPENDIX D  
LISTING, WITH SYMBOL TABLE AND INDEX





ELEMENT: JAFFE\*SOLARI.CONC/11      OPTIONS: BFQS  
ATHENA EXTENDED FORTRAN 25J-28 (14 SEP 82)  
COMPILATION DONE ON 13 DEC 83 AT 11:18:52

MAIN PROGRAM

SUBROUTINE	NAMLRD	ENTRY POINT	03727	SEQ	001474
SUBROUTINE	OPT	ENTRY POINT	06153	SEQ	001674
ENTRY	CKNOPT	ENTRY POINT	06156	SEQ	001712
ENTRY	CKOPT	ENTRY POINT	06161	SEQ	002241
ENTRY	OPTAP	ENTRY POINT	06164	SEQ	002432

STORAGE USED (BLOCK, NAME, LENGTH)

0001	*CODE	006167
0006	*CODE	000000
0000	*TEMP	000066
0004	*CONSTANTS	001665
0002	*SIMPLE VAR	000113
0010	*ARRAYS	002133
0011	N\$BLNK	000000

EXTERNAL REFERENCES

0012	CSF8
0013	PRINT\$
0014	ASSIGN
0015	SLUP
0016	NINTR\$
0017	NER18\$
0020	NRDU\$
0021	NI02\$
0022	NWDU\$
0023	NWNL\$
0024	NSTOP\$
0025	NI01\$
0026	ATH4\$
0027	NI03\$
0030	NREW\$
0031	NRNL\$
0032	NER10\$
0033	NER19\$
0034	ALOG
0035	ATAN2
0036	SIN
0037	COS
0040	TAN
0041	EXP
0042	SQRT
0043	NER21\$
0044	NERR4\$

STORAGE ASSIGNMENT FOR VARIABLES (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0010 R 000000 A	0010 R 000153 AA	0010 R 002113 ALPHA	0010 R 002117 ARATIO	0002 L 000016 ASG100
0010 R 002127 AUXE	0002 R 000047 ASMAX	0002 R 000050 A6MAX	0002 R 000032 BOLTZ	0002 R 000034 BOUND
0010 R 002076 BS1	0010 R 002077 BS2	0002 R 000060 CARNOT	0002 R 000111 CINV	0002 R 000112 CINV5
0001 003737 CKNOPT	0001 005123 CKOPT	0012 I 000000 CSF8	0002 R 000064 CYCE	0010 R 002125 CYCECT
0010 R 002103 C1	0002 R 000103 C1MAX	0010 R 002104 C1S	0002 R 000105 C1SMAX	0010 R 002105 C2
0002 R 000110 C2HOLD	0002 R 000107 C2MAX	0002 R 000106 DELT	0002 R 000077 DELTSG	0010 R 002121 DTRE
0002 R 000100 DUMMY	0010 R 001447 EFF	0010 R 002124 ENEFCT	0002 R 000063 ENGE	0010 R 002114 EPS
0010 R 002106 F	0010 R 001607 FRAY	0002 I 000020 F\$ 1	0002 I 000021 F\$ 2	0002 I 000022 F\$ 3
0002 I 000023 F\$ 4	0002 I 000024 F\$ 5	0002 I 000025 F\$ 6	0002 I 000026 F\$ 7	0002 I 000027 F\$ 8
0002 I 000072 F\$ 12	0002 I 000073 F\$ 13	0010 R 002130 GEARE	0010 R 002131 GENE	0010 R 002116 HC
0010 R 002120 HK	0002 I 000075 I	0002 L 000003 ICYCEF	0002 I 000067 IDUMM	0002 L 000002 IENGEF
0010 I 001531 INREAD	0010 R 002073 INS	0002 L 000001 IPCSEF	0002 L 000071 IRFLG	0002 I 000070 ISTAT
0002 I 000054 ITRC	0002 I 000037 ITRC1	0002 I 000040 ITRC2	0002 I 000041 ITRC3	0002 I 000065 I\$
0002 I 000036 J	0002 I 000045 JJ	0002 I 000044 K	0002 I 000066 L	0002 I 000035 M
0002 L 000007 MAXC	0002 L 000010 MAXPHI	0002 L 000011 MAXSEC	0010 R 002126 MECHE	0002 I 000043 MNT
0002 L 000014 MORDEC	0002 I 000033 NSET	0002 I 000053 NTCNT	0002 I 000042 NTRC	0002 L 000004 NWTORF
0010 R 001055 OPTAA	0001 005661 OPTAP	0002 L 000005 OPTMZE	0002 L 000006 PARAB	0010 R 002123 PCEFCCT
0010 R 002100 PHI1	0002 R 000102 PHI1FC	0010 R 002101 PHI1S	0002 R 000104 PHI1SF	0010 R 002102 PHI2
0002 R 000030 PI	0010 R 002132 PPE	0002 R 000031 P4	0010 R 002074 RH01	0010 R 002075 RHC2
0010 R 002107 RMA	0002 R 000076 RMAR	0010 R 001741 RMARAY	0002 L 000000 SECONC	0002 R 000101 SIG2DF
0010 R 002110 SLOPER	0010 R 002112 SOLSD	0010 R 002111 SPECUL	0002 L 000013 SUP2	0010 R 002115 TAC
0002 R 000046 TAK	0002 R 000056 TIK	0010 R 002122 TOC	0002 R 000057 TOK	0002 R 000055 TRK
0002 R 000051 TRMA	0002 R 000052 TRMAS	0002 R 000061 TRMB	0002 R 000062 TRMC	0010 R 000007 TT
0002 R 000074 VF	0002 L 000015 XFLAG	0002 L 000012 XTRACT	0002 L 000017 XTRON	0010 R 001547 Y
0010 R 002073 Z	0001 001553 10011	0001 003346 100202	0001 001553 100640	0001 001576 1012G
0001 001651 1022I	0001 001703 1024I	0001 001703 1024I	0001 001726 1035G	0001 001744 1041G
0001 001762 1045G	0001 002000 1046I	0004 001161 105F	0001 002017 1055G	0001 002035 1061G
0001 002053 1065G	0001 002070 1066I	0001 002111 1076G	0004 000222 110F	0001 002127 1102G
0001 002145 1106G	0001 002162 1107I	0001 002303 1131I	0001 002302 1131I	0001 002367 1145I
0001 002367 1145I	0001 002370 1145I	0001 002367 1145I	0001 002406 1157G	0001 002424 1163G
0001 002442 1164I	0001 002456 1173G	0001 002474 1177G	0001 002511 1200I	0001 002527 1210G
0001 002545 1214G	0001 002562 1215I	0001 002562 1215I	0001 002567 1215I	0001 002577 1225G
0001 002635 1234I	0001 002651 1236I	0001 002651 1236I	0001 002674 1247G	0001 002712 1253G
0001 002730 1257G	0001 002746 1260I	0001 002765 1267G	0001 003003 1273G	0001 003021 1277G
0001 003036 1300I	0001 003057 1310G	0001 003075 1314G	0001 003113 1320G	0001 003131 1321I
0001 003130 1321I	0001 003147 1332G	0001 003165 1336G	0001 003203 1337I	0001 003217 1346G
0001 003235 1352G	0001 003252 1353I	0001 003270 1363G	0001 003306 1367G	0001 003326 1370I
0001 003323 1370I	0001 003323 1370I	0001 003331 1402G	0001 003410 1504I	0001 003417 1514G
0001 003466 1536I	0001 003470 1541G	0001 003510 1544G	0001 003601 1575I	0001 003616 1606G
0001 003646 1623I	0001 003653 1627I	0001 003654 1631I	0001 003762 1722I	0001 004012 1733I
0001 004027 1747I	0001 004037 1755I	0001 004045 1757I	0001 004045 1757I	0001 004077 1771I
0001 004133 2006I	0001 001555 200640	0001 004205 2014I	0001 003533 201514	0001 000200 202G
0001 004262 2024I	0001 004271 2033I	0001 004274 2035I	0001 004273 2035I	0001 004306 2044G
0004 001163 205F	0001 004323 2051I	0001 004341 2054I	0001 004355 2057I	0001 004356 2057I
0001 004355 2057I	0001 004400 2065I	0001 004407 2067I	0001 004407 2067I	0001 000210 207G
0001 004442 2101I	0001 004562 2105I	0001 004606 2107I	0004 001142 211F	0001 004624 2113I
0001 004640 2117I	0004 001145 212F	0001 004642 2121I	0001 004654 2126I	0001 004672 2134I
0001 004672 2134I	0001 004672 2134I	0001 004712 2143I	0001 004726 2147I	0004 000223 215F
0001 004730 2151I	0001 004742 2156I	0001 004760 2164I	0001 004760 2164I	0001 004760 2164I
0001 005001 2177I	0004 000652 220F	0004 000676 221F	0001 005030 2215I	0004 000707 222F
0001 005063 2222I	0001 005107 2226I	0004 000736 223F	0001 005121 2234I	0001 005121 2234I
0001 005121 2234I	0004 000755 225F	0004 000772 226F	0001 005144 2260I	0004 000775 227F
0001 005201 2274I	0004 001012 228F	0004 001112 230F	0001 005213 2302G	0001 005230 2307I
0001 005246 2312I	0001 005262 2315I	0001 005263 2315I	0001 005262 2315I	0001 005300 2326I
0001 005322 2333I	0001 005331 2335I	0001 005331 2335I	0001 005331 2335I	0004 001127 235F

0001	005401	2350I	0001	005521	2354I	0001	005545	2356I	0001	005570	2371I	0001	005617	2407I
0001	005643	2416I	0001	005657	2426I	0001	005657	2426I	0001	005657	2426I	0001	005676	2442I
0001	006030	2457I	0001	000265	246I	0001	006051	2463I	0001	006063	2471I	0001	006063	2471I
0001	006113	2476I	0001	006124	2500I	0001	000301	263I	0004	000350	270F	0004	000403	271F
0004	000417	272F	0004	000457	273F	0004	000567	275F	0004	000610	276F	0004	000613	277F
0004	000634	278F	0004	001073	280F	0004	001121	285F	0004	000507	290F	0004	000517	291F
0004	000525	292F	0004	000534	293F	0004	001077	294F	0004	000542	295F	0004	000547	296F
0004	000554	297F	0004	000562	298F	0004	001104	299F	0001	000331	311I	0001	000336	321I
0001	000343	330I	0001	000345	336I	0001	000345	336I	0001	000357	344G	0001	000372	353I
0001	000372	353I	0001	000402	363I	0001	000407	366I	0001	000415	374I	0001	000424	405I
0001	000432	411I	0001	000435	413I	0001	000477	425I	0001	000504	432I	0001	000565	472I
0001	001553	50L	0001	000611	507I	0001	000611	507I	0001	000612	507I	0001	000637	526I
0001	000636	526I	0001	000666	545I	0001	000712	562I	0001	000712	562I	0001	000723	575G
0001	003326	60L	0001	000736	603G	0001	000737	606G	0001	000747	614G	0001	000757	622G
0001	001010	640G	0001	001035	656I	0001	001121	667I	0001	001204	674I	0001	003656	70L
0001	001241	710I	0001	001240	710I	0001	001256	714I	0004	001107	730F	0001	001300	730I
0001	001301	730I	0001	001311	734I	0004	001124	735F	0001	003660	75L	0001	001334	750I
0001	001333	750I	0001	001337	753I	0001	001343	755I	0001	001343	755I	0001	001354	757I
0001	001354	757I	0001	001467	771G	0001	001505	773I	0004	001066	780F	0004	001115	785F
0001	003350	80L	0001	003352	90L	0001	003361	92L	0001	003667	95L	0001	003676	96L
0001	003705	97L												

```

00101 1*
00101 2* C * * * * * * * * * * * * * *
00101 3* CONC/11
00101 4* C CALCULATES PERFORMANCE OF SOLAR THERMAL CONCENTRATOR, COLLECTOR, OR
00101 5* C POWER SYSTEM.
00101 6*
00101 7* C * * * * * * * * * * * * * *
00101 8* C
00101 9* C CALCULATES COLLECTOR EFFICIENCY AS
00101 10* C  $A(1) = (INS * RHO1 * BS1 * PHI * ALPHA - (1/C1) * (EPS * BOLTZ * (TRK ** 4 - TAK ** 4)$ 
00101 11* C  $+ HC * (TRK - TAK)) - ARATIO * HK * (TRK - TAK)) / INS$ 
00101 12* C WHERE QUANTITIES ARE DEFINED IN BLOCK 1..
00101 13* C
00101 14* C CALCULATES SYSTEM EFFICIENCY AS
00101 15* C  $A(5) = A(1) * PCSE * PPE$ 
00101 16* C WHERE POWER CONVERSION EFFICIENCY PCSE OR A(4) IS GIVEN BY
00101 17* C PCSE = PCSEFF(TEMPERATURE)
00101 18* C OR PCSE = PCEFFCT * (TIK - TOK) / TIK
00101 19* C OR PCSE = ENGE * GEARE * GENE
00101 20* C AND ENGE = ENGEFF(TEMPERATURE)
00101 21* C OR ENGE = ENEFCT * (TIK - TOK) / TIK
00101 22* C OR ENGE = CYCE * MECHE * AUXE
00101 23* C AND CYCE = CYCEFF(TEMPERATURE)
00101 24* C OR CYCE = CYCECT * (TIK - TOK) / TIK
00101 25* C PCSEFF(TEMPERATURE), ENGEFF(TEMPERATURE), CYCEFF(TEMPERATURE), ARE
00101 26* C RESPECTIVELY THE POWER CONVERSION, ENGINE, AND CYCLE EFFICIENCIES
00101 27* C AS FUNCTIONS OF TEMPERATURE, TIK AND TOK ARE THE INPUT AND OUTPUT
00101 28* C TEMPERATURES (KELVIN), AND THE OTHER QUANTITIES ARE DEFINED IN
00101 29* C BLOCK 1.
00101 30* C
00101 31* C CALCULATES PERFORMANCE FOR AS MANY RECEIVER TEMPERATURES AS DESIRED
00101 32* C AND INDICATES WHICH TEMPERATURE GIVES MAXIMUM SYSTEM EFFICIENCY.
00101 33* C
00101 34* C IF DESIRED WILL ALSO OPTIMIZE RECEIVER APERTURE AREA.
00101 35* C THIS OPTIMIZATION IS DESCRIBED IN SUBROUTINE OPT BELOW.
00101 36* C
00101 37* C CAN HANDLE COMPOUND CONCENTRATORS (PRIMARY PLUS SECONDARY).
00101 38* C
00101 39* C PROVIDES MANY OPTIONAL FORMS OF INPUT, WITH DEFAULT VALUES.
00101 40* C ALL INPUT IS PROMPTED AND IS ECHOED TO OUTPUT.

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00101 41* C
00101 42* C PROVIDES CERTAIN CHECKS OF THEORETICAL POSSIBILITY OF SPECIFIED
00101 43* C OPTICAL AND ENGINE PERFORMANCE.
00101 44* C
00101 45* C ASSUMES OVERALL CONTOUR OF PRIMARY CONCENTRATOR IS EITHER AN
00101 46* C APPROXIMATELY PARABOLOIDAL MIRROR OR AN APPROXIMATELY PLANAR MIRROR
00101 47* C OR LENS.
00101 48* C
00101 49* C *****
00101 50* C *****
00101 51* C ** WHEN PROMPTED FOR INPUT, ENTER VALUES OF INPUT VARIABLES AS **
00101 52* C ** NAMELIST (REAL) WITH NAME "NLIST". **
00101 53* C ** (IF NOT FAMILIAR WITH NAMELIST INPUT, SEE FORTRAN MANUAL.) **
00101 54* C ** FOR FIRST SET OF INPUTS, PROGRAM WILL USE VALUES GIVEN IN **
00101 55* C ** BLOCK 1 AS DEFAULTS. FOR SUBSEQUENT SETS OF INPUTS, IT WILL **
00101 56* C ** USE VALUES FROM PRECEDING SET AS DEFAULTS (EXCEPT NWTORF). **
00101 57* C **
00101 58* C ** THEN, WHEN PROMPTED, ENTER RECEIVER TEMPERATURES IN CELSIUS AS **
00101 59* C ** DO-LOOP PARAMETERS: MIN, MAX, AND INCREMENT (INTEGER). **
00101 60* C ** FOR FIRST DATA SET THESE MUST BE INPUT (NO DEFAULT). FOR **
00101 61* C ** SUBSEQUENT DATA SETS, TEMPERATURES FROM PRECEDING SET ARE **
00101 62* C ** DEFAULT. **
00101 63* C **
00101 64* C **
00101 65* C ** IF WANT TO ENTER A TABLE OF EFFICIENCIES PERTAINING TO POWER **
00101 66* C ** CONVERSION, SET IPCSEF, IENGEF, OR ICYCEF=T WHEN INPUTTING **
00101 67* C ** NAMELIST. THEN, WHEN PROMPTED, ENTER EFFICIENCIES AS FREE-FIELD **
00101 68* C ** LIST (REAL), ONE PER RECEIVER TEMPERATURE. **
00101 69* C ** IF WANT RECEIVER APERTURE OPTIMIZATION, SET OPTMZE=T WITH **
00101 70* C ** NAMELIST. **
00101 71* C ** FOR OTHER OPTIONS, SEE LIST OF LOGICAL VARIABLES IN BLOCK 1. **
00101 72* C **
00101 73* C ** RE-ENTER NEW SETS OF DATA FOR INPUT VARIABLES AS DESIRED. **
00101 74* C **
00101 75* C ** IF, AFTER FIRST DATA SET HAS BEEN PROCESSED, WANT TO ENTER NEW **
00101 76* C ** RECEIVER TEMPERATURES OR NEW EFFICIENCIES PERTAINING TO POWER **
00101 77* C ** CONVERSION, MUST RESET NWTORF=T WHEN ENTERING NAMELIST. **
00101 78* C **
00101 79* C ** USE ASCII PRINTER TO ASSURE PROPER TABLE HEADINGS. **
00101 80* C **
00101 81* C ** IF RECOMPILE: **
00101 82* C ** USE ATHENA FORTRAN COMPILER (@TFOR). **
00101 83* C ** WITH @MAP USE THE STATEMENTS: **
00101 84* C ** LIB LIB*JPL$ **
00101 85* C ** LIB LIB*CLIB$ **
00101 86* C ** TO INCLUDE PROPER ROUTINES. **
00101 87* C *****
00101 88* C *****
00101 89* C
00101 90* C
00101 91* C
00101 92* C * * * * *
00101 93* C * * * * *
00101 94* C BLOCK 0. DEFINE STORAGE.
00101 95* C COMPILER (DATA=IBM)
00103 96* C PARAMETER NT=50 @MAX NO. OF TEMPERATURES
00105 97* C MONITOR

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00107 98* REAL INS,MECHE
00110 99* INTEGER CSF8
00111 100* LOGICAL SECONC,IPCSEF,IENGEF,ICYCEF,NWTORF,OPTMZE,PARAB,
00111 101* & MAXC,MAXPHI,
00111 102* & MAXSEC,XTRACT,SUP2,MORDEC,XFLAG, ASG100,XTRON
00112 103* DIMENSION A(7),TT(2,NT),AA(9,NT),OPTAA(5,NT),EFF(NT),INREAD(14),
00112 104* & Y(32),Z(32)
00113 105* EQUIVALENCE (INS,Z(1)),(RH01,Z(2)),(RH02,Z(3)),(RS1,Z(4)),
00113 106* & (BS2,Z(5)),(PHI1,Z(6)),(PHI1S,Z(7)),(PHI2,Z(8)),(C1,Z(9)),
00113 107* & (C1S,Z(10)),(C2,Z(11)),
00113 108* & (F,Z(12)),(RMA,Z(13)),(SLOPER,Z(14)),(SPECUL,Z(15)),
00113 109* & (SOLSD,Z(16)),(ALPHA,Z(17)),(EPS,Z(18)),(TAC,Z(19)),(HC,Z(20)),
00113 110* & (ARATIO,Z(21)),(HK,Z(22)),(DTRE,Z(23)),
00113 111* & (TOC,Z(24)),(PCEFACT,Z(25)),
00113 112* & (ENEFACT,Z(26)),(CYCECT,Z(27)),(MECHE,Z(28)),(AUXE,Z(29)),
00113 113* & (GEARE,Z(30)),(GENE,Z(31)),(PPE,Z(32))
00114 114* NAMELIST/NLIST/INS,RH01,RH02,BS1,BS2,PHI1,PHI1S,PHI2,C1,C1S,C2,
00114 115* & F,RMA,SLOPER,SPECUL,SOLSD,ALPHA,EPS,
00114 116* & TAC,HC,ARATIO,HK,DTRE,TOC,PCEFACT,ENEFACT,CYCECT,MECHE,AUXE,
00114 117* & GEARE,GENE,PPE,OPTMZE,PARAB,MAXC,MAXPHI,SECONC,MAXSEC,IPCSEF,
00114 118* & IENGEF,ICYCEF,NWTORF,XTRACT,SUP2,MORDEC
00114 119* C
00114 120* C * * * * * * * * * * * * * *
00114 121* C * * * * * * * * * * * * * *
00114 122* C * * * * * * * * * * * * * *
00114 123* C
00114 124* C BLOCK 1. INITIALIZATION.
00114 125* C DEFAULT VALUES FOR INPUT OF SYSTEM CHARACTERISTICS.
00115 126* INS=800.0 @INSOLATION, W/M**2
00116 127* RH01=0.9 @REFLECTANCE OR TRANSMITTANCE
00117 128* @ OF (PRIMARY) CONCENTRATOR. 00021
00117 129* @EFFECTIVE REFLECTANCE OR 00023
00120 130* @ TRANSMITTANCE OF SECONDARY
00120 131* @ CONCENTRATOR, CONSIDERING 00025
00120 132* @ AVERAGE NUMBER OF REFLECTIONS
00120 133* @ AT SECONDARY. (IGNORED IF NO
00120 134* @ SECONDARY CONCENTRATOR.)
00120 135* RS1=1.0 @BLOCKING AND SHADOWING FACTOR
00121 136* @ (OF PRIMARY). 00027
00121 137* BS2=1.0 @BLOCKING AND SHADOWING FACTOR OF
00122 138* @ SECONDARY. (IGNORED IF NO 00031
00122 139* @ SECONDARY.)
00122 140* PHI1=0.95 @INTERCEPT FACTOR, WITHOUT
00123 141* @ SECONDARY. 00033
00123 142* @ (IGNORED IF OPTIMIZE RECEIVER
00123 143* @ APERTURE.)
00123 144* PHI1S=0.0 @PRIMARY INTERCEPT FACTOR WITH
00124 145* @ SECONDARY. (IGNORED IF NO 00034
00124 146* @ SECONDARY.)
00124 147* @ PROGRAM SETS PHI1S=PHI1 IF
00124 148* @ PHI1S.LE.0.0
00124 149* @ (IGNORED IF OPTIMIZE RECEIVER
00124 150* @ APERTURE.)
00124 151* PHI2=1.0 @SECONDARY INTERCEPT FACTOR
00125 152* C1=1000.0 @GEOMETRIC CONCENTRATION RATIO 00036
00126 153* @ WITHOUT SECONDARY. 00040
00126 154* @ (IGNORED IF OPTIMIZE RECEIVER

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00126	155*		@ APERTURE.)	
00126	156*	C1S=1000.0	@PRIMARY GEOMETRIC CONCENTRATION	
00127	157*		@ RATIO WITH SECONDARY.	00042
00127	158*		@ (IGNORED IF OPTIMIZE RECEIVER	
00127	159*		@ APERTURE.)	
00127	160*	C2=1.0	@SECONDARY GEOMETRIC	
00130	161*		@ CONCENTRATION RATIO.	00044
00130	162*		@ (IGNORED IF MAXIMIZE SECONDARY	
00130	163*		@ CONCENTRATION.)	
00130	164*	F=0.6	@FOCAL RATIO (OF PRIMARY).	
00131	165*		@ REQUIRED ONLY IF OPTIMIZE	00046
00131	166*		@ RECEIVER APERTURE OR IF	
00131	167*		@ MAXIMIZE INTERCEPT FACTOR OR	
00131	168*		@ CONCENTRATION RATIO, AND	
00131	169*		@ DO NOT SUPPLY RIM ANGLE.	
00131	170*	RMA=0.0	@RIM ANGLE OF (PRIMARY)	
00132	171*		@ CONCENTRATOR, IN DEGREES.	00047
00132	172*		@ REQUIRED ONLY IF OPTIMIZE	
00132	173*		@ RECEIVER APERTURE OR IF	
00132	174*		@ MAXIMIZE INTERCEPT FACTOR OR	
00132	175*		@ CONCENTRATION RATIO.	
00132	176*		@ (SUPPLY EITHER RMA OR F.)	
00132	177*	SLOPER=2.0	@SLOPE ERROR OF	
00133	178*		@ (PRIMARY) REFLECTOR, IN MRAD.	00051
00133	179*		@ FOR (PRIMARY) LENS SET	
00133	180*		@ SLOPER=0.5* STD. DEV. OF	
00133	181*		@ TRANSMITTED RAYS.	
00133	182*		@ (REQUIRED ONLY IF OPTIMIZE.)	
00133	183*	SPECUL=0.5	@SPECULARITY SPREAD OF (PRIMARY)	
00134	184*		@ CONCENTRATOR, IN MRAD.	00053
00134	185*		@ (REQUIRED ONLY IF OPTIMIZE.)	
00134	186*	SOLSD=2.3	@STD. DEV. OF ANGULAR SPREAD OF	
00135	187*		@ INCOMING SUNLIGHT, IN MRAD.	00055
00135	188*		@ (REQUIRED ONLY IF OPTIMIZE.)	
00135	189*	ALPHA=1.0	@RECEIVER EFFECTIVE ABSORPTIVITY	
00136	190*	EPS=1.0	@RECEIVER EFFECTIVE EMISSIVITY	00057
00137	191*	TAC=20.0	@AMBIENT TEMPERATURE, CELSIUS	00061
00140	192*	HC=0.0	@EFFECTIVE CONVECTION COEFFICIENT	00063
00141	193*		@ W/((M**2 OF RECEIVER APERTURE)	00064
00141	194*		@ * DEG C)	
00141	195*	ARATIO=0.025	@RATIO, (RECEIVER CAVITY WALL	
00142	196*		@ AREA) / (CONCENTRATOR AREA)	00066
00142	197*	HK=0.0	@EFFECTIVE CONDUCTION COEFFICIENT	
00143	198*		@ W/((M**2 OF RECEIVER WALL)	00067
00143	199*		@ * DEG C)	
00143	200*	DTRE=25.0	@TEMPERATURE DROP FROM RECEIVER	
00144	201*		@ TO ENGINE, CELSIUS	00071
00144	202*	TOC=50.0	@TEMPERATURE OF HEAT	
00145	203*		@ REJECTION, CELSIUS	00073
00145	204*	PCEFCT=0.5	@POWER CONVERSION EFFECTIVENESS	
00146	205*		@ AS FRACTION OF CARNOT	00075
00146	206*		@ EFFICIENCY.	
00146	207*		@ (SUPPLY EITHER PCEFCT, ENFCT,	
00146	208*		@ OR CYCECT, OR ELSE SET IPCSEF,	
00146	209*		@ IENGEF, OR ICYCEF=T AND SUPPLY	
00146	210*		@ LIST OF EFFICIENCIES).	
00146	211*	ENFCT=0.0	@ENGINE EFFECTIVENESS: FRACTION	

00147	212*		@ OF CARNOT EFFICIENCY	00076
00147	213*	CYCECT=0.0	@CYCLE EFFECTIVENESS: FRACTION OF	
00150	214*		@ CARNOT EFFICIENCY	00077
00150	215*	MECHE=0.0	@MECHANICAL EFFICIENCY OF ENGINE	
00151	216*	AUXE=0.0	@EFFICIENCY FACTOR TO ACCOUNT FOR	00100
00152	217*		@ POWER USED BY AUXILIARIES	00101
00152	218*	GEARE=0.0	@GEAR EFFICIENCY	
00153	219*	GENE=0.0	@GENERATOR EFFICIENCY	00102
00154	220*	PPE=0.95	@POWER PROCESSING EFFICIENCY	00103
00154	221*			
00154	222*	C		
00154	223*	C	DEFAULT VALUES FOR OPTIONS	
00154	224*	C		
00155	224*	OPTMZE=.FALSE.	@.TRUE. TO OPTIMIZE RECEIVER	00105
00156	225*		@ APERTURE.	00106
00156	226*	PARAB=.TRUE.	@ OVERALL CONTOUR OF PRIMARY	
00157	227*		@ APPROXIMATELY PARABOLOIDAL.	00110
00157	228*		@ .FALSE. IF OVERALL CONTOUR	
00157	229*		@ APPROXIMATELY PLANAR.	
00157	230*	MAXC=.FALSE.	@.TRUE. TO MAXIMIZE PRIMARY	
00160	231*		@ GEOMETRIC CONCENTRATION RATIO.	00111
00160	232*		@ (DO NOT USE WITH OPTMZE OR	
00160	233*		@ MAXPHI.)	
00160	234*	MAXPHI=.FALSE.	@.TRUE. TO MAXIMIZE PRIMARY	
00161	235*		@ INTERCEPT FACTOR.	00112
00161	236*		@ (DO NOT USE WITH OPTMZE OR	
00161	237*		@ MAXC.)	
00161	238*	SECONC=.FALSE.	@SECONDARY CONCENTRATOR: .TRUE. TO	
00162	239*		@ CALCULATE WITH SECONDARY	00113
00162	240*		@ CONCENTRATOR AS WELL AS WITHOUT	
00162	241*	MAXSEC=.FALSE.	@.TRUE. TO USE MAXIMUM POSSIBLE	
00163	242*		@ SECONDARY CONCENTRATION.	00114
00163	243*	IPCSEF=.FALSE.	@.TRUE. TO INPUT PCS EFFICIENCY	
00164	244*		@ VS. TEMPERATURE	00115
00164	245*	IENGEF=.FALSE.	@.TRUE. TO INPUT ENGINE	
00165	246*		@ EFFICIENCY VS. TEMPERATURE.	00116
00165	247*	ICYCEF=.FALSE.	@.TRUE. TO INPUT ENGINE CYCLE	
00166	248*		@ EFFICIENCY VS. TEMPERATURE	00117
00166	249*		@ (DO NOT SET MORE THAN ONE OF	
00166	250*		@ THESE 3 EQUAL TO .TRUE.	
00166	251*		@ IF NONE OF THESE ARE TRUE,	
00166	252*		@ WILL USE PCS EFFECTIVENESS IF	
00166	253*		@ IF NON-ZERO	
00166	254*		@ OTHERWISE WILL USE ENGINE	
00166	255*		@ EFFECTIVENESS IF NON-ZERO	
00166	256*		@ OTHERWISE WILL USE CYCLE	
00166	257*		@ EFFECTIVENESS.)	
00166	258*	NWTORF=.TRUE.	@READ IN NEW RECEIVER	
00167	259*		@ TEMPERATURES OR NEW POWER	00120
00167	260*		@ CONVERSION EFFICIENCIES.	
00167	261*		@ (NWTORF = NEW TEMPERATURE OR	
00167	262*		@ EFFICIENCIES).	
00167	263*		@ WARNING! NWTORF IS SET FALSE	
00167	264*		@ AFTER ANY OUTPUT. MUST BE RESET	
00167	265*		@ .TRUE. IF WISH TO INPUT NEW	
00167	266*		@ RECEIVER TEMPERATURES OR NEW	
00167	267*		@ LIST OF POWER CONVERSION,	
00167	268*		@ ENGINE, OR CYCLE EFFICIENCIES.	



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00167 269*      XTRACT=.FALSE.      @PROVIDES EXTRACT OF OUTPUT, IN
00170 270*      @ FILE XTRACT.
00170 271*      @ EXTRACT CONSISTS OF SET NO.,
00170 272*      @ ECHO OF NAMELIST AND RECEIVER
00170 273*      @ TEMPERATURE INPUT, PLUS OUTPUT
00170 274*      @ FOR LOWEST AND HIGHEST
00170 275*      @ TEMPERATURES AND FOR
00170 276*      @ TEMPERATURE AT WHICH SYSTEM
00170 277*      @ EFFICIENCY IS HIGHEST.
00170 278*      SUP2=.FALSE.      @.TRUE. TO SUPPRESS SECOND LINE
00171 279*      @ OF OUTPUT (C2, OVERALL
00171 280*      @ CONCENTRATION RATIO, OVERALL
00171 281*      @ INTERCEPT FACTOR), WHICH
00171 282*      @ OTHERWISE IS PRINTED WHEN
00171 283*      @ OPTIMIZE WITH SECONDARY
00171 284*      @ CONCENTRATOR.
00171 285*      MORDEC=.FALSE.      @.TRUE. TO PRINT MORE DECIMAL
00172 286*      @ PLACES ON EFFICIENCIES.
00172 287*      @ (5 PLACES INSTEAD OF 3)
00172 288*      C
00172 289*      C OTHER INITIALIZATION
00172 290*      C
00172 291*      PI=3.141592      @TRUNCATED TO AVOID ROUND-OFF
00173 292*      @ ABOVE EXACT VALUE AND
00173 293*      @ CONSEQUENT WRONG QUADRANT
00173 294*      @ IN RMA-RMAR CONVERSION.
00173 295*      P4=PI/4.0
00174 296*      BOLTZ=5.67032E-8      @BOLTZMANN CONSTANT, W/M2K4
00175 297*      NSET=0      @NO. OF DATA SETS ENTERED.
00176 298*      BOUND=1.0E-7      @BOUND FOR EQUALITY COMPARISONS
00177 299*      @ OF REAL NUMBERS AND TO PREVENT
00177 300*      @ DIVIDE BY ZERO.
00177 301*      ASG100=.FALSE.      @FLAG TO INDICATE ASSIGNMENT OF
00200 302*      @ EXTRACT FILE XTRACT, WHICH IS
00200 303*      @ NAMED FILE 100 INTERNALLY
00200 304*      @ IN FORTRAN. (NOT USED UNLESS
00200 305*      @ XTRACT=.TRUE.)
00200 306*      XTRON=.FALSE.      @FLAG TO INDICATE IF XTRACT HAS
00201 307*      @ JUST BEEN .TRUE.
00201 308*      C
00201 309*      C * * * * *
00201 310*      C * * * * *
00201 311*      C * * * * *
00201 312*      C
00201 313*      C BLOCK 2.
00201 314*      C LOOP TO INPUT 1 DATA SET, PROCESS DATA, AND OUTPUT RESULTS
00201 315*      C FOR THIS DATA SET.
00201 316*      C
00201 317*      DO M=1,1000      @REPEAT UNTIL READ @EOF
00204 318*      NSET=NSET+1      @SERIAL NO. OF SET OF INPUT
00205 319*      @ VALUES.
00205 320*      C
00205 321*      C * * * * *
00205 322*      C * * * * *
00205 323*      C BLOCK 2.1.
00205 324*      C READ 1 SET OF INPUT DATA

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00512 470*          ENDIF          @ENDIF SUP2
00513 471*          ELSE
00514 472*            WRITE (6,275)    @WRITE COLUMN HEADS IF NO
00517 473*            WRITE (6,276)    @ SECONDARY CONCENTRATOR
00522 474*            WRITE (6,277)
00525 475*            WRITE (6,278)
00530 476*          ENDIF          @ENDIF SECONC

00531 477*          ELSE          @NO OPTIMIZE
00532 478*            IF (SECONC)
00533 479*              WRITE (6,220)        @WRITE COLUMN HEADS IF
00536 480*              WRITE (6,221)        @ SECONDARY CONCENTRATOR
00541 481*              WRITE (6,222)
00544 482*              WRITE (6,223)
00547 483*            ELSE
00550 484*              WRITE (6,225)        @WRITE COLUMN HEADS IF NO
00553 485*              WRITE (6,226)        @ SECONDARY CONCENTRATOR
00556 486*              WRITE (6,227)
00561 487*              WRITE (6,228)
00564 488*            ENDIF          @ENDIF SECONC

00565 489*          ENDIF          @ENDIF OPTMZE

00566 490*          ERPRINT 1, ' '
00574 491*          DO J=1,7
00577 492*            A(J)=0.0
00600 493*          ENDLLOOP          @ENDLOOP J

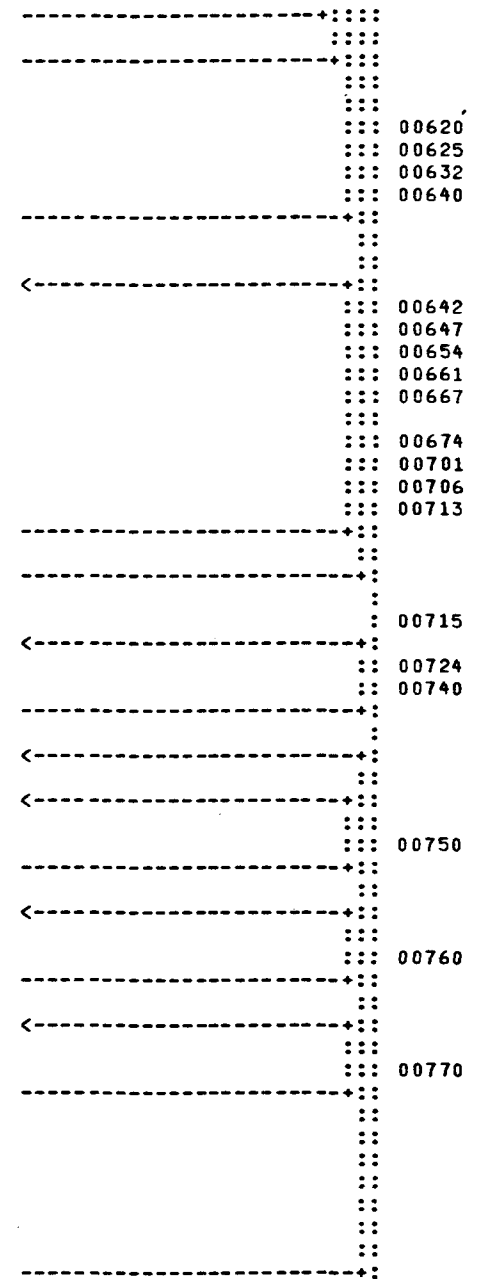
00602 494*          DO K=1,NT
00605 495*            DO J=1,2
00610 496*              TT(J,K)=0.0
00611 497*            ENDLLOOP          @ENDLOOP J

00613 498*            DO J=1,5
00616 499*              OPTAA(J,K)=0.0
00617 500*            ENDLLOOP          @ENDLOOP J

00621 501*            DO J=1,9
00624 502*              AA(J,K)=0.0
00625 503*            ENDLLOOP          @ENDLOOP J

00627 504*          ENDLLOOP          @ENDLOOP K
00627 505*          C
00627 506*          C * * * * *
00627 507*          C
00627 508*          C
00627 509*          C BLOCK 2.3.4.
00627 510*          C CALCULATE SOLAR POWER REACHING RECEIVER PLANE, PER UNIT
          C CONCENTRATOR AREA.

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00631 511*
00631 512*      TAK=TAC+273.16
00632 513*      A5MAX=1.0E-30      @INITIALIZATION. SET .GT. 0.0 TO
00633 514*      A6MAX=1.0E-30      @ PREVENT DIVISION BY ZERO
00634 515*      TRMA=INS*RHO1*BS1*ALPHA
00635 516*      TRMAS=TRMA*RHO2*BS2
00636 517*      NTCNT=0              @COUNT OF TEMPERATURES
00636 518*      C
00636 519*      C * * * * *
00636 520*      C * * * * *
00636 521*      C
00636 522*      C BLOCK 2.4.
00636 523*      C LOOP TO HANDLE EFFICIENCY CALCULATIONS FOR 1 RECEIVER TEMPERATURE
00636 524*      C
00637 525*      DO ITRC=ITRC1,ITRC2,ITRC3      @RECEIVER TEMPERATURE
00637 526*      C
00637 527*      C * * * * *
00637 528*      C
00637 529*      C BLOCK 2.4.1.
00637 530*      C CALCULATE RECEIVER PERFORMANCE TERMS
00637 531*      C

00642 532*      NTCNT=NTCNT+1
00643 533*      IF (NTCNT.GT.NT) EXITLOOP ITRC
00645 534*      TRK=ITRC+273.16
00646 535*      TIK=TRK-DTRE
00647 536*      IF (TIK.LE. 0.0) THEN

00651 537*      ERPRINT ,'ENGINE INLET TEMPERATURE BELOW ABSOLUTE ZERO.'
00656 538*      CYCLE ITRC
00657 539*      ENDIF      @ENDIF TRK

00660 540*      TOK=TOC+273.16
00661 541*      CARNOT=(TIK-TOK)/TIK
00662 542*      TT(1,NTCNT)=ITRC      @RECEIVER TEMPERATURE, CELSIUS
00663 543*      TT(2,NTCNT)=(ITRC+40.)*1.8-40.      @RECEIVER FAHRENHEIT
00664 544*      TRMB=EPS*BOLTZ*(TRK**4-TAK**4)+HC*(TRK-TAK)
00665 545*      TRMC= ARATIO*HK*(TRK-TAK)
00665 546*      C
00665 547*      C * * * * *
00665 548*      C
00665 549*      C BLOCK 2.4.2.
00665 550*      C IF OPTIMIZING RECEIVER APERTURE, CALL ENTRY OF SUBROUTINE OPT
00665 551*      C TO PERFORM THIS OPTIMIZATION.
00665 552*      C
00666 553*      IF (OPTMZE) CALL OPTAP ($50)
00666 554*      C
00666 555*      C * * * * *
00666 556*      C BLOCK 2.4.3.
00666 557*      C CALCULATE EFFICIENCIES. ENTER THEM IN OUTPUT ARRAY.
00666 558*      C
00670 559*      A(1)=AMAX1(0.0,(TRMA*PHI1-TRMB/C1-TRMC)/INS)
00670 560*      & @COLLECTOR EFFICIENCY,
00670 561*      & @ WITHOUT SECONDARY
00671 562*      IF (SECONC) THEN

00673 563*      A(2)=AMAX1(0.0,(TRMAS*PHI1S*PHI2-TRMB/(C1S*C2)-TRMC)/INS)

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: 00773
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: 00776
: 01003
: 01006

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: 01111

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: 01122

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00673 564*      &                                @COLLECTOR EFFICIENCY,
00674 565*                                @ WITH SECONDARY
00674 566*      A(3)= A(2)-A(1)                @COLLECTOR EFFICIENCY
00674 567*      &                                @ INCREASE DUE TO SECONDARY
00675 568*      ENDIF                            @ENDIF SECONC
----->
00676 569*      IF (IPCSEF) THEN
00700 570*      A(4)=EFF(NTCNT)                    @POWER CONVERSION SUBSYSTEM
00701 571*      @ EFFICIENCY USING PCSEFF.
00701 572*      IF (A(4).GT.CARNOT) THEN
00703 573*      ERPRINT , 'PCS EFFICIENCY GREATER THAN CARNOT.'
00710 574*      CYCLE ITRC
00711 575*      ENDIF                            @ENDIF A(4)
----->
00712 576*      ELSEIF (PCEFCT.GT.0.0)
00714 577*      A(4)=PCEFCT*CARNOT                    @PCS EFFICIENCY
00715 578*      @ USING PCEFCT OF CARNOT
00715 579*      ELSE                                @USING PCSE=ENGE*GEARE*GENE
00716 580*      IF (IENGEF) THEN                    @USING ENGEFF(T)
00720 581*      ENGE=EFF(NTCNT)
00721 582*      IF (ENGE.GT.CARNOT) THEN
00723 583*      ERPRINT , 'ENG EFFICIENCY GREATER THAN CARNOT.'
00730 584*      CYCLE ITRC
00731 585*      ENDIF                            @ENDIF ENGE
----->
00732 586*      ELSEIF (ENEFCT.GT.0.0)                @USING ENGINE EFFICIENCY
00734 587*      @ ENEFCT OF CARNOT
00734 588*      ENGE=ENEFCT*CARNOT
00735 589*      ELSE                                @USING ENGE=CYCE*MECHE*AUXE
00736 590*      IF (ICYCEF) THEN                    @USING CYCEFF(T)
00740 591*      CYCE=EFF(NTCNT)
00741 592*      IF (CYCE.GT.CARNOT) THEN
00743 593*      ERPRINT , 'CYCLE EFFICIENCY GREATER THAN CARNOT.'
00750 594*      CYCLE ITRC
00751 595*      ENDIF                            @ENDIF CYCE
----->
00752 596*      ELSE
00753 597*      CYCE=CYCECT*CARNOT
00754 598*      ENDIF                            @ENDIF ICYCEF
----->
00755 599*      ENGE=CYCE*MECHE*AUXE
00756 600*      ENDIF                            @ENDIF IENGEF
----->
00757 601*      A(4)=ENGE*GEARE*GENE
00760 602*      ENDIF                            @ENDIF IPCSEF
----->
00761 603*      A(5)=A(1)*A(4)*PPE                    @SYSTEM EFFICIENCY
00762 604*      @ W/O SECONDARY
00762 605*      ASMAX=AMAX1(ASMAX,A(5))
00763 606*      IF (SECONC) THEN

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00765 607*          A(6)=A(2)*A(4)*PPE          @SYSTEM EFFICIENCY          : 01407
00766 608*          @WITH SECONDARY          : 01432
00766 609*          A6MAX=AMAX1(A6MAX,A(6))
00767 610*          A(7)= A(6)-A(5)          @SYSTEM EFFICIENCY INCREASE : 01437
00770 611*          @ DUE TO SECONDARY          : 01461
00770 612*          DO J=1,7
00773 613*          AA(J,NTCNT)=A(J)
00774 614*          ENDOLOOP          @ENDLOOP J          : 01470
                                : 01506
00776 615*          ELSE          @NO SECONDARY CONCENTRATOR
00777 616*          AA(1,NTCNT)=A(1)
01000 617*          AA(2,NTCNT)=A(4)
01001 618*          AA(3,NTCNT)=A(5)
01002 619*          ENDFIF          @ENDIF SECONC          : 01510
                                : 01524
                                : 01540
                                : 01556
01003 620*          50          CONTINUE          @ERROR RETURN FOR
01004 621*          @ SUBROUTINE OPTAP
01004 622*          ENDOLOOP          @ENDLOOP ITRC
01006 623*          NTCNT=MIN(NTCNT,NT)
01006 624*          C
01006 625*          C *          *          *          *          *          *          *          *          *          *          *          *          *
01006 626*          C *          *          *          *          *          *          *          *          *          *          *          *          *
01006 627*          C *
01006 628*          C *          BLOCK 2.5.
01006 629*          C *          WRITE OUTPUT FOR 1 SET OF DATA.
01006 630*          C *
01006 631*          C *          *          *          *          *          *          *          *          *          *          *          *          *
01006 632*          C
01007 633*          IF (SECONC) THEN
01011 634*          DO K=1,NTCNT
01014 635*          AA(8,K)=AA(5,K)/A5MAX
01015 636*          AA(9,K)=AA(6,K)/A6MAX
01016 637*          XFLAG=.FALSE.          @FLAG, SET TRUE TO IDENTIFY THOSE
01017 638*          @ LINES OF OUTPUT TABLE TO BE
01017 639*          @ INCLUDED IN EXTRACT, IF EXTRACT
01017 640*          @ HAS BEEN REQUESTED.
01017 641*          IF (XTRACT) THEN
01021 642*          IF ((K.EQ.1).OR.(K.EQ.NTCNT)) XFLAG=.TRUE.
01023 643*          IF ((AA(8,K).GT.(1.0-BOUND)).OR.(AA(9,K).GT.(1.0-BOUND)))
01023 644*          &          XFLAG=.TRUE.
01025 645*          ENDFIF          @ENDIF XTRACT          : 01564
                                : 01571
                                : 01600
                                : 01615
                                : 01632
                                : 01633
01026 646*          IF (OPTMZE) THEN
01030 647*          IF (MORDEC) THEN
01032 648*          WRITE (6,780) ((TT(J,K),J=1,2),(OPTAA(J,K),J=1,4),
01032 649*          &          (AA(J,K),J=1,9))
01051 650*          ELSE
01052 651*          WRITE (6,280) ((TT(J,K),J=1,2),(OPTAA(J,K),J=1,4),
01052 652*          &          (AA(J,K),J=1,9))
01071 653*          ENDFIF          @ENDIF MORDEC          : 01704
                                : 01706
                                : 01710
                                : 02001
                                : 02071

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01072 654*      IF (XFLAG)
01072 655*      &      WRITE (100,280) ((TT(J,K),J=1,2),(OPTAA(J,K),J=1,4),
01072 656*      &      (AA(J,K),J=1,9))
01112 657*      IF (.NOT.SUP2) THEN

01114 658*      IF (MAXSEC) THEN

01116 659*      WRITE (6,294) OPTAA(5,K), OPTAA(2,K)*OPTAA(5,K),
01116 660*      &      OPTAA(4,K)*PHI2
01124 661*      IF (XFLAG) WRITE (100,294) OPTAA(5,K),
01124 662*      &      OPTAA(2,K)*OPTAA(5,K), OPTAA(4,K)*PHI2
01133 663*      ELSE
01134 664*      WRITE (6,299) OPTAA(2,K)*C2, OPTAA(4,K)*PHI2
01141 665*      IF (XFLAG) WRITE (100,299) OPTAA(2,K)*C2,
01141 666*      &      OPTAA(4,K)*PHI2
01147 667*      ENDIF          @ENDIF MAXSEC

01150 668*      ENDIF          @ENDIF SUP2

01151 669*      ELSE
01152 670*      IF (MORDEC) THEN

01154 671*      WRITE (6,730) ((TT(J,K),J=1,2),(AA(J,K), J=1,9))
01167 672*      ELSE
01170 673*      WRITE (6,230) ((TT(J,K),J=1,2),(AA(J,K), J=1,9))
01203 674*      ENDIF          @ENDIF MORDEC

01204 675*      IF (XFLAG)
01204 676*      &      WRITE (100,230) ((TT(J,K),J=1,2),(AA(J,K), J=1,9))
01220 677*      ENDIF          @ENDIF OPTMZE

01221 678*      ENDOLOOP          @ENDLOOP K

01223 679*      ELSE          @SECONC=F
01224 680*      DO K=1,NTCNT

01227 681*      AA(4,K)=AA(3,K)/A5MAX
01230 682*      XFLAG=.FALSE.
01231 683*      IF (XTRACT) THEN

01233 684*      IF ((K.EQ.1).OR.(K.EQ.NTCNT)) XFLAG=.TRUE.
01235 685*      IF (AA(4,K).GT.(1.0-BOUND)) XFLAG=.TRUE.
01237 686*      ENDIF          @ENDIF XTRACT

01240 687*      IF (OPTMZE) THEN

01242 688*      IF (MORDEC) THEN

01244 689*      WRITE (6,785) ((TT(J,K),J=1,2),(OPTAA(J,K),J=1,2),
01244 690*      &      (AA(J,K),J=1,4))
01263 691*      ELSE
01264 692*      WRITE (6,285) ((TT(J,K),J=1,2),(OPTAA(J,K),J=1,2),
01264 693*      &      (AA(J,K),J=1,4))
01303 694*      ENDIF          @ENDIF MORDEC

01304 695*      IF (XFLAG)

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01304 696*      &          WRITE (100,285) ((TT(J,K),J=1,2),(OPTAA(J,K),J=1,2),
01304 697*      &          (AA(J,K),J=1,4))
01324 698*      ELSE
01325 699*      IF (MORDEC) THEN
                                <-----
01327 700*          WRITE (6,735) ((TT(J,K),J=1,2), (AA(J,K), J=1,4))
                                <-----
01342 701*      ELSE
                                <-----
01343 702*          WRITE (6,235) ((TT(J,K),J=1,2), (AA(J,K), J=1,4))
                                <-----
01356 703*      ENDIF
                                <-----
01357 704*          IF (XFLAG)
01357 705*      &          WRITE (100,235) ((TT(J,K),J=1,2), (AA(J,K), J=1,4))
01373 706*      ENDIF
                                <-----
01374 707*          ENDOLOOP
                                <-----
01376 708*          ENDIF
                                <-----
01377 709*      60  CONTINUE
                                <-----
01400 710*          NWTORF=.FALSE.
                                <-----
01401 711*          DO J=1,32
                                <-----
01401 712*          Z(J)=Y(J)
                                <-----
01401 713*          ENDLOOP
                                <-----
01401 714*          @ERROR RETURN FOR
01401 715*          @ SUBROUTINES CKNOPT AND CKOPT.
01401 716*          @ MUST INPUT NAMELIST NWTORF=T IN
01404 717*          @ NEXT SET OF DATA IF WANT NEW
01405 718*          @ RECEIVER TEMPERATURES OR
01407 719*          @ NEW EFFICIENCIES FOR POWER
01411 720*          @ CONVERSION..
01411 721*          @RESTORES INPUT VALUES THAT WERE
01411 722*          @ SAVED.
01411 723*          @ENDLOOP J
01411 724*          @ENDLOOP M
01411 725*          @GO BACK AND READ NEW INPUTS
01411 726*      C
01411 727*      C BLOCK 3.
01411 728*      C NORMAL STOP OF PROGRAM AFTER 1000 SETS OF DATA.
01411 729*      80  STOP NORMAL
01411 730*      C
01411 731*      C ABNORMAL STOPS OF PROGRAM.
01411 732*      C
01412 733*      90  ERPRINT , 'BAD ITRC READ'
01417 734*          STOP BDREAD
01420 735*      92  ERPRINT , 'BAD PCSEFF READ'
01425 736*          STOP BDREAD
01425 737*      C
01425 738*      C * * * * *
01425 739*      C * * * * *
01425 740*      C * * * * *
01425 741*      C
01425 742*      C BLOCK 4.
01425 743*      C INPUT AND OUTPUT FORMATS.
01425 744*      C

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: 03204
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: 03351
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: 03353
: 03360
: 03362
: 03367

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01426 745* 110 FORMAT ( )
01427 746* 215 FORMAT (' ITRC1, ITRC2, ITRC3 =',2(I10,','),I10)
01430 747* 220 FORMAT (1H+,3X,'RECEIVER TEMP.',1X,2X,'COLLECTOR EFFICIENCY',
01430 748* & 2X,2X,'PCS',3X,3X,'SYSTEM EFFICIENCY',3X,'FRAC.MAX.SYS.EFFIC.')
01431 749* 221 FORMAT (1H+,3X,13(' '),4X,20(' '),13X,17(' '),3X,18(' '))
01432 750* 222 FORMAT (1X,5X,'C',4X,3X,'F',4X,'W/O SEC.',1X,'W/SEC.',
01432 751* & 2X,'DELTA',3X,'EFFIC.',1X,1X,'W/O SEC.',1X,'W/SEC.',1X,'DELTA',
01432 752* & 1X,1X,'W/O SEC.',1X,'W/ SEC.')
01433 753* 223 FORMAT (1H+,2(4X,3(' '),1X),2X,7(' '),2X,3(5(' '),3X),7(' '),
01433 754* & 2(2X,5(' '),2X,7(' '),2X,6(' '))
01434 755* 225 FORMAT (1H+,2X,'RECEIVER TEMP.',1X,'COLLECTOR',3X,'PCS',2X,
01434 756* & 'SYSTEM',2X,'FRAC.MAX.')
01435 757* 226 FORMAT (1H+,2X,14(' '))
01436 758* 227 FORMAT (1X,5X,'C',4X,3X,'F',5X,'EFFIC.',2X,1X,'EFFIC.',1X,
01436 759* & 'EFFIC.',1X,'SYS.EFFIC.')
01437 760* 228 FORMAT (1H+,2(4X,3(' '),1X),2X,7(' '),3X,5(' '),2X,5(' '),2X,
01437 761* & 9(' '))
01440 762* 230 FORMAT (1X,2F8.1,9F8.3)
01441 763* 235 FORMAT (1X,2F8.1,4F8.3)
01442 764* 270 FORMAT (1H+,2X,'RECEIVER TEMP.',1X,'PRIM.GEOM.CONC.',1X,
01442 765* & 'PRIM.INTERCEPT FACT.',1X,'COLLECTOR EFFICIENCY',
01442 766* & 2X,2X,'PCS',3X,2X,'SYSTEM EFFICIENCY',3X,'FRAC.MAX.SYS.EFFIC.')
01443 767* 271 FORMAT (1H+,2X,13(' '),2X,14(' '),2X,19(' '),2X,20(' '),12X,
01443 768* & 17(' '),3X,18(' '))
01444 769* 272 FORMAT (1X,5X,'C',4X,3X,'F',3X,'W/O SEC.',2X,'W/SEC.',2X,
01444 770* & 'W/O SEC.',1X,'W/SEC.',3X,'W/O SEC.',1X,'W/SEC.',
01444 771* & 1X,'DELTA',2X,'EFFIC.',1X,'W/O SEC.',1X,'W/SEC.',2X,'DELTA',
01444 772* & 1X,1X,'W/O SEC.',1X,'W/ SEC.')
01445 773* 273 FORMAT (1H+,2(4X,3(' '),1X),1X,7(' '),3X,5(' '),3X,7(' '),2X,
01445 774* & 5(' '),4X,7(' '),2X,2(5(' '),2X),5(' '),2X,7(' '),
01445 775* & 2X,5(' '),3X,5(' '),2X,7(' '),2X,6(' '))
01446 776* 275 FORMAT (1H+,2X,'RECEIVER TEMP.',2X,'GEOM.',2X,'INTERCEPT',1X,
01446 777* & 'COLLECTOR',1X,'PCS',3X,'SYSTEM',2X,'FRAC.MAX.')
01447 778* 276 FORMAT (1H+,2X,13(' '))
01450 779* 277 FORMAT (1X,5X,'C',4X,3X,'F',2X,'CONC.RATIO',1X,'FACTOR',3X,
01450 780* & 'EFFIC.',2X,'EFFIC.',1X,
01450 781* & 'EFFIC.',1X,'SYS.EFFIC.')
01451 782* 278 FORMAT (1H+,2(4X,3(' '),1X),10(' '),1X,6(' '),3X,5(' '),3X,5(' '),
01451 783* & 2X,5(' '),2X,9(' '))
01452 784* 280 FORMAT (1X,4F8.1,1X,11F8.3,L5)
01453 785* 285 FORMAT (1X,3F8.1,5F8.3)
01454 786* 290 FORMAT (1H0,20X,'SECONDARY',3X,'OVERALL',9X,'OVERALL')
01455 787* 291 FORMAT (1H+,20X,9(' '),3X,7(' '),9X,7(' '))
01456 788* 292 FORMAT (21X,2('GEOM.CONC. '),5X,'ICPT.FACT.')
01457 789* 293 FORMAT (1H+,20X,9(' '),2X,9(' '),7X,9(' '))
01460 790* 294 FORMAT (22X,F8.2,1X,F8.1,8X,F8.3)
01461 791* 295 FORMAT (33X,'OVERALL',9X,'OVERALL')
01462 792* 296 FORMAT (1H+,32X,7(' '),9X,7(' '))
01463 793* 297 FORMAT (32X,'GEOM.CONC.',6X,'ICPT.FACT.')
01464 794* 298 FORMAT (1H+,31X,9(' '),7X,9(' '))
01465 795* 299 FORMAT (31X,F8.1,8X,F8.3)
01466 796* 730 FORMAT (1X,2F8.1,9F8.5)
01467 797* 735 FORMAT (1X,2F8.1,4F8.5)
01470 798* 780 FORMAT (1X,4F8.1,1X,2F8.3,9F8.5)
01471 799* 785 FORMAT (1X,3F8.1,F8.3,4F8.5)
01471 800* C
01471 801* C

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01471 802* C * * * * *
01471 803* C * * * * *
01471 804* C * * * * *
01471 805* C
01472 806* SUBROUTINE NAMLRD
01472 807* C READS INPUT DATA
01472 808* C (EXCEPT ARRAYS OF RECEIVER TEMPERATURES AND OF POWER CONVERSION
01472 809* C EFFICIENCIES).
01472 810* C FIRST READS SET OF DATA ALPHANUMERICALLY, ECHOES IT, AND WRITES DATA
01472 811* C SET TO A TEMPORARY FILE.
01472 812* C THEN READS DATA SET FROM TEMPORARY FILE USING NAMELIST.
01472 813* C
01472 814* C * * * * *
01472 815* C * * * * *
01472 816* C
01475 817* WRITE (6,211) NSET @WRITES SET NUMBER
01501 818* IF (XTRON) WRITE (100,212) NSET @BEGINS WRITE OF XTRACT, IF
01506 819* @ EXTRACT HAS BEEN REQUESTED.
01506 820* ERPRINT , 'ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")'
01506 821* C
01506 822* C *****
01506 823* C *****
01506 824* C **
01506 825* C ** INPUT 1 SET OF DATA (EXCEPT ARRAYS). **
01506 826* C ** SET IS LIMITED TO 20 LINES (NOT INCLUDING ARRAYS). **
01506 827* C **
01506 828* C *****
01506 829* C *****
01506 830* C
01506 831* C BLOCK S.1.
01506 832* C READ 1 SET OF DATA ALPHANUMERICALLY. ECHO IT. WRITE DATA SET
01506 833* C INTO TEMPORARY FILE.
01506 834* C
01513 835* DO J=1,20 @LOOP TO READ 1 LINE EACH TIME.
01516 836* @ (NOT OVER 20 LINES PER DATA
01516 837* @ SET)
01516 838* JJ=J
01517 839* READ (5,105,ERR=75,END=70) INREAD @FIRST READ (ALPHANUMERIC).
01523 840* WRITE (98,105) INREAD @ USES FILE 98 FOR TEMPORARY
01527 841* @ STORE AND RE-READ (NAMELIST).
01527 842* WRITE (6,205) INREAD @ECHO PRINT
01533 843* IF (XTRON) WRITE (100,205) INREAD @ECHO TO EXTRACT, IF.
01540 844* @ EXTRACT REQUESTED IN PRECEDING
01540 845* @ DATA SET.
01540 846* DO K=1,14 @LOOP TO READ 1 WORD EACH TIME.
01543 847* @ (14 WORDS PER LINE OF INREAD)
01543 848* DO L=((K.EQ.1)+(1+(J.EQ.1))),5 @LOOP TO READ 1 CHARACTER.
01546 849* @ (SCANS CHARACTERS 0-5 OF
01546 850* @ INREAD WORD, EXCEPT 0 OF FIRST
01546 851* @ WORD AND 1 OF FIRST CARD FIRST
01546 852* @ WORD, WHICH SERVE ONLY TO
01546 853* @ IDENTIFY INPUT AS NAMELIST)
01546 854* IF (FLD(L*6,6,INREAD(K)).EQ.(FLD(0,6,'$').OR.(FLD(0,6,'&'))))
01546 855* @ EXITLOOP J @FINDS TERMINATING '$' OR '&'

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01550 856*          ENDLLOOP          @ENDLOOP L          ::: 03534
-----+-----
01552 857*          ENDLLOOP          @ENDLOOP K          :::
-----+-----
01554 858*          ENDLLOOP          @ENDLOOP J.         :::
-----+-----
01556 859*          @ ENDS FIRST READ (ALPHANUMERIC).
01556 860*          REWIND 98          @RESETS FILE 98 FOR
01560 861*          @ NAMELIST READ          @ NAMELIST READ          03537
01560 862*          C
01560 863*          C * * * * * * * * * * * * * * * * * * * * * * * *
01560 864*          C * * * * * * * * * * * * * * * * * * * * * * * *
01560 865*          C
01560 866*          C BLOCK S.2
01560 867*          C NAMELIST READ OF DATA FROM TEMPORARY FILE.
01560 868*          C
01560 869*          READ (98, NLIST, ERR=95, END=96)
01564 870*          REWIND 98          @RESET          03545
01564 871*          C
01564 872*          C * * * * * * * * * * * * * * * * * * * * * * * *
01564 873*          C * * * * * * * * * * * * * * * * * * * * * * * *
01564 874*          C
01564 875*          C BLOCK S.3
01564 876*          C ON INITIAL REQUEST FOR EXTRACT, CATALOGS AND ASSIGNS FILE FOR THIS
01564 877*          C OUTPUT.
01564 878*          C
01566 879*          IF ((XTRACT).AND.(.NOT.ASG100)) THEN          03550
-----+-----
01570 880*          CALL ASSIGN('@CAT,P XTRACT(+1)',IDUMM,1,$97)          : 03553
01571 881*          CALL ASSIGN('@ASG,A XTRACT',IDUMM,1,$97)          : 03561
01572 882*          ISTAT=CSF8(3,'@USE 100,XTRACT')          : 03567
01573 883*          IF (ISTAT.LT.0) GO TO 97          : 03574
01575 884*          ASG100=.TRUE.          : 03600
01576 885*          ENDDIF          @ENDIF XTRACT/ASG100          : 03602
01576 886*          C          :
01576 887*          C * * * * * * * * * * * * * * * * * * * * * * * *          :
01576 888*          C          :
01576 889*          C IF EXTRACT IS REQUESTED NOW AND HAS NOT BEEN PREVIOUSLY REQUESTED,          :
01576 890*          C ECHOES INPUT TO EXTRACT FILE.          :
01576 891*          C          :
-----+-----
01577 892*          IF ((XTRACT).AND.(.NOT. XTRON)) THEN
-----+-----
01601 893*          WRITE (100,212) NSET          : 03605
01605 894*          DO J=1,JJ          : 03613
-----+-----
01610 895*          READ (98, 105, ERR=95, END=96) INREAD          : 03620
01614 896*          WRITE (100,205) INREAD          @TO EXTRACT FILE.          : 03632
01620 897*          ENDLLOOP          @ENDLOOP JJ          : 03644
-----+-----
01622 898*          REWIND 98          :
01624 899*          ENDDIF          @ENDIF XTRACT/XTRON          : 03647
-----+-----
01625 900*          IF (XTRACT) THEN
-----+-----
01627 901*          XTRON=.TRUE.          : 03651
01630 902*          ELSE          : 03654

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01671 938* C
01671 939* C * * * * * * * * * * * * * *
01671 940* C * * * * * * * * * * * * * *
01671 941* C * * * * * * * * * * * * * *
01671 942* C
01672 943* C SUBROUTINE OPT
01672 944* C
01672 945* C CALCULATES OR CHECKS OPTICAL CHARACTERISTICS.
01672 946* C
01672 947* C CHECKS WHETHER SPECIFIED COLLECTOR CHARACTERISTICS ARE CONSISTENT.
01672 948* C CALCULATES FOCAL PLANE DISTRIBUTION.
01672 949* C IF REQUESTED, OPTIMIZES RECEIVER APERTURE OR MAXIMIZES INTERCEPT
01672 950* C FACTOR OR CONCENTRATION RATIO.
01672 951* C FOR COMPOUND CONCENTRATOR, ASSUMES SECONDARY PROVIDES UNIFORM FLUX ON
01672 952* C ON FOCAL PLANE. IF REQUESTED, MAXIMIZES SECONDARY CONCENTRATION RATIO
01672 953* C
01672 954* C ENTRY CKNOPT IS CALLED IF RECEIVER APERTURE OPTIMIZATION IS
01672 955* C NOT REQUESTED.
01672 956* C ENTRIES CKOPT AND OPTAP ARE CALLED IF RECEIVER APERTURE OPTIMIZATION
01672 957* C IS REQUESTED. THESE OPTIMIZE RECEIVER APERTURE AREA FOR EACH
01672 958* C EACH TEMPERATURE.

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01672 959* C
01672 960* C * * * * * * * * * * * * * * *
01672 961* C * * * * * * * * * * * * * * *
C BLOCK E.0
01672 962* C
01672 963* C DEFINE STORAGE FOR SUBROUTINE.
01672 964* C
01675 965* LOGICAL IRFLG @FLAG INDICATING IF ARRAY OF RIM
01676 966* @ ANGLES HAS ALREADY BEEN
01676 967* @GENERATED.
01676 968* DIMENSION FRAY(90),RMARAY(90) @ARRAYS GIVING FOCAL RATIOS AND
01677 969* @ CORRESPONDING RIM ANGLES FOR
01677 970* @ PARABOLOID.
01677 971* DATA IRFLG/.FALSE./
01701 972* DATA VF/6.0/ @VARIANCE RATIO LIMITING
01703 973* @ MAXIMUM CONCENTRATION WHEN
01703 974* @ PHI .EQ. 1.0. USED TO CUT OFF
01703 975* @ GAUSSIAN FLUX DISTRIBUTION.
01703 976* DATA (FRAY(I), I=1,60)/
01703 977* & .28647187E02,.14322502E02,.95471230E01,.71590694E01,.57259462E01,
01703 978* & .47702882E01,.40874673E01,.35751696E01,.31765539E01,.28575155E01,
01703 979* & .25963515E01,.23785931E01,.21942237E01,.20360883E01,.18989402E01,
01703 980* & .17788440E01,.16727905E01,.15784392E01,.14939424E01,.14178217E01,
01703 981* & .13488805E01,.12861396E01,.12287903E01,.11761585E01,.11276781E01,
01703 982* & .10828699E01,.10413259E01,.10026961E01,.96667913E00,.93301354E00,
01703 983* & .90147168E00,.87185438E00,.84398661E00,.81771389E00,.79289942E00,
01703 984* & .76942158E00,.74717192E00,.72605339E00,.70597887E00,.68686999E00,
01703 985* & .66865599E00,.65127287E00,.63466256E00,.61877229E00,.60355396E00,
01703 986* & .58896364E00,.57496118E00,.56150973E00,.54857546E00,.53612724E00,
01703 987* & .52413641E00,.51257646E00,.50142292E00,.49065311E00,.48024601E00,
01703 988* & .47018209E00,.46044318E00,.45101240E00,.44187396E00,.43301315E00,
01703 989* & /
01705 990* DATA (FRAY(I), I=61,90)/
01705 991* & .42441622E00,.41607030E00,.40796335E00,.40008405E00,.39242181E00,
01705 992* & .38496665E00,.37770921E00,.37064065E00,.36375266E00,.35703740E00,
01705 993* & .35048746E00,.34409586E00,.33785599E00,.33176158E00,.32580671E00,
01705 994* & .31998578E00,.31429344E00,.30872466E00,.30327461E00,.29793876E00,
01705 995* & .29271274E00,.28759245E00,.28257395E00,.27765347E00,.27282747E00,
01705 996* & .26809252E00,.26344537E00,.25888291E00,.25440218E00,.25000000E00,
01705 997* & /
01707 998* @TABLE OF FOCAL RATIOS AT
01707 999* @ 1 DEGREE INCREMENTS OF RIM
01707 1000* @ ANGLE (1 TO 60 DEGREES,
01707 1001* @ 61 TO 90 DEGREES)
01707 1001* @ PARABOLOIDAL CONTOUR.
01707 1002* DEFINE S=SIN(RMAR)
01710 1003* DEFINE C=COS(RMAR)
01711 1004* DEFINE T=TAN(RMAR)
01711 1005* C
01711 1006* C * * * * * * * * * * * * * * *
01711 1007* C * * * * * * * * * * * * * * *
C
01711 1008* C
01711 1009* C BLOCK E.1
01711 1010* C OPTICAL CHECKS AND CALCULATIONS.
01711 1011* C
01711 1012* C CALLED IF RECEIVER APERTURE OPTIMIZATION IS NOT REQUESTED.
01711 1013* C CHECKS CONSISTENCY OF COLLECTOR INPUT VALUES.
01711 1014* C CALCULATES RIM ANGLE FROM GIVEN FOCAL RATIO OR VICE VERSA.
01711 1015* C CALCULATES FLUX DISTRIBUTION IN FOCAL PLANE AS A GAUSSIAN WITH

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01711 1016* C SIG2DF=TWICE THE VARIANCE OF FLUX DISTRIBUTION (IN UNITS OF
01711 1017* C PRIMARY CONCENTRATOR RADIUS):
01711 1018* C FOR OVERALL CONTOUR PARABOLOIDAL,
01711 1019* C SIG2DF=2.0*DELT SQ*(1.0/(RMA*((TAN(RMAR/2.0))**2)))*
01711 1020* C ((-1.0/(3.0*(S**3)*C))+2.0/(3.0*(S**3)))+(2.0/S)-
01711 1021* C (C/(3.0*(S**3)))-(2.0*C/S)+((4.0*S)/(3.0*C))-
01711 1022* C LN(TAN(PI/4+RMA/2.0))+LN(TAN(PI/4-RMAR/2.0))
01711 1023* C FOR OVERALL CONTOUR PLANAR,
01711 1024* C SIG2DF=2.0*DELT SQ*(1.0+2.0*(C**2))/(3.0*RMA*C*S)
01711 1025* C (THESE ARE DUFF-LAMIERO EXPRESSIONS FOR FLUX SPREAD IN FOCAL
01711 1026* C PLANE).
01711 1027* C HERE S=SIN(RMAR)
01711 1028* C C=COS(RMAR)
01711 1029* C RMAR=RIM ANGLE IN RADIANS (RELATED TO FOCAL RATIO F).
01711 1030* C DELT SQ=(2.0*SLOPER/1000.0)**2+(SPECUL/1000.0)**2+(SOLSD/1000.0)**2
01711 1031* C SLOPER=EQUIVALENT SLOPE ERROR.
01711 1032* C SPECUL=SPECULARITY SPREAD.
01711 1033* C SOLSD=STD. DEV. OF INCOMING SUNLIGHT.
01711 1034* C
01712 1035* C ENTRY CKNOPT ($)
01712 1036* C
01712 1037* C * * * * *
01712 1038* C BLOCK E.1.1
01712 1039* C CHECKS INPUT OF COLLECTOR CHARACTERISTICS.
01712 1040* C CALCULATES CONCENTRATOR RIM ANGLE OR FOCAL RATIO.
01712 1041* C CALCULATES VARIANCE OF GAUSSIAN ANGULAR DISTRIBUTION OF SUNLIGHT
01712 1042* C LEAVING A LOCAL AREA OF (PRIMARY) MIRROR OR LENS.
01712 1043* C
01713 1044* C IF ((C1 .LE. 0.0).AND.(MAXPHI.OR.(.NOT.MAXC))) THEN
01715 1045* ERPRINT , 'C1 MUST BE POSITIVE.' : 03752
01722 1046* RETURN 1 : 03757
01723 1047* @ENDIF @ENDIF C1 : 03763
----->
01724 1048* IF (((PHI1.LE. 0.0).OR.(PHI1.GT. 1.0)).AND.
01724 1049* & (MAXC.OR.(.NOT.MAXPHI))) THEN
01726 1050* ERPRINT , 'PHI1 MUST BE POSITIVE AND NOT OVER 1.0' : 04002
01733 1051* RETURN 1 : 04007
01734 1052* @ENDIF @ENDIF PHI1 : 04013
----->
01735 1053* IF (MAXC.AND.MAXPHI) THEN
01737 1054* ERPRINT , 'CANNOT MAXIMIZE C AND PHI SIMULTANEOUSLY.' : 04016
01744 1055* ERPRINTO, 'WILL MAXIMIZE C.' : 04023
01751 1056* @ENDIF @ENDIF MAXC/MAXPHI : 04030
----->
01752 1057* IF (SECONC) THEN
01754 1058* IF (C1S.LE. 0.0) C1S=C1 : 04032
01756 1059* IF (PHI1S.LE. 0.0) PHI1S=PHI1 : 04040
01760 1060* @ENDIF @ENDIF SECONC : 04046
----->
01761 1061* DELT SQ=(2.0*SLOPER/1000.0)**2+(SPECUL/1000.0)**2+(SOLSD/1000.0)**2
01762 1062* @VARIANCE OF GAUSSIAN ANGULAR : 04063
01762 1063* @ DISTRIBUTION OF SUNLIGHT
01762 1064* @ LEAVING A LOCAL AREA OF MIRROR

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01762 1065*          @ OR LENS.
01762 1066*          IF (DELTSQ.LE. 0.0) THEN
                                <----->
01764 1067*          ERPRINT , 'CANNOT HANDLE ZERO ANGLE SOURCE'          : 04067
01771 1068*          RETURN 1                                           : 04074
01772 1069*          ENDIF                                             @ENDIF DELTSQ          : 04100
                                ----->
01773 1070*          IF (RMA.LE. 0.0) THEN          @NO RMA INPUT
                                <----->
01775 1071*          IF ((F.LE. 0.10).OR.(PARAB .AND. (F.LE. 0.25))) THEN @NO F INPUT
                                <----->
                                : 04104
01777 1072*          IF (MAXC.OR.MAXPHI) THEN
                                <----->
                                : 04120
02001 1073*          ERPRINT , 'CANNOT MAXIMIZE C OR PHI WITHOUT ACCEPTABLE RIM AN
02001 1074*          &GLE OR FOCAL RATIO'
02006 1075*          RETURN 1
                                : 04130
02007 1076*          ELSE
                                : 04134
02010 1077*          IF (((PHI1.EQ. 1.0).AND.(C1.GT.(1.0/DELTSQ)))OR.
                                :
02010 1078*          & ((PHI1.LT. 1.0).AND.(C1.GT.(VF/(DELTSQ*(-ALOG(1.0-PHI1))))))
                                :
02010 1079*          & ERPRINT , 'WARNING! C1 GREATER THAN OPTICALLY POSSIBLE.'
                                :
02016 1080*          IF (SECONC) THEN
                                : 04206
                                <----->
02020 1081*          IF (((PHI1S.EQ. 1.0).AND.(C1S.GT.(1.0/DELTSQ)))OR.
                                :
02020 1082*          & ((PHI1S.LT. 1.0).AND.
                                :
02020 1083*          & (C1S.GT.(VF/(DELTSQ*(-ALOG(1.0-PHI1S))))))
                                :
02020 1084*          & ERPRINT , 'WARNING! C1S GREATER THAN OPTICALLY POSSIBLE.'
                                :
02026 1085*          ERPRINT , 'NOTE: CANNOT VERIFY THAT C2 IS OPTICAL
                                : 04263
02026 1086*          &LY POSSIBLE WITHOUT F OR RMA INPUT.'
                                :
02033 1087*          RETURN
                                : 04270
02034 1088*          ENDIF          @ENDIF SECONC          : 04272
                                ----->
02035 1089*          RETURN
02036 1090*          ENDIF          @ENDIF MAXC/MAXPHI          : 04275
                                ----->
02037 1091*          ELSEIF ((PARAB).AND.(F.LE. 10.0))          @F INPUT
02041 1092*          IF (.NOT. IRFLG) THEN          @PREPARES RMARAY IF NOT
                                <----->
                                : 04303
02043 1093*          DO I=1, 90          @ ALREADY PREPARED
                                <----->
                                : 04310
02046 1094*          RMARAY(I)=I
02047 1095*          ENDLOOP          @ENDLOOP I
                                ----->
                                : 04322
02051 1096*          ,IRFLG=.TRUE.
02052 1097*          ENDIF          @ENDIF IRFLG
                                ----->
                                : 04324
02053 1098*          CALL SLUP(F,RMA,DUMMY,FRAY,RMARAY,90,2)
                                :
02054 1099*          @TABLE LOOKUP AND INTERPOLATION
                                : 04335
02054 1100*          @ TO GET RIM ANGLE FOR
02054 1101*          @ PARABOLOIDAL CONTOUR.
02054 1102*          @CONVERT TO RADIANS
                                :
02055 1103*          ELSE
                                : 04342
02056 1104*          RMAR=ATAN2(1.0,(2.0*F))          @FOCAL LENGTH OUTSIDE
                                :
02057 1105*          RMA=RMAR/(PI/180.0)          @ OF TABLE RANGE,
                                : 04352
02060 1106*          @ OR PLANAR CONTOUR.
                                : 04357
02060 1107*          ENDIF          @ENDIF F
                                ----->
02061 1108*          ELSE          @RMA INPUT
                                :

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02062 1109*      RMAR=RMA*(PI/180.0)
02063 1110*      IF (PARAB) THEN
                                :
                                : 04363
                                :
02065 1111*          F=(1.0+C)/(4.0*S)
02066 1112*      ELSE
                                : 04365
02067 1113*          F=1.0/(2.0*T)
                                : 04401
02070 1114*      ENDIF
                                :
                                : 04410
                                :
02071 1115*      ENDIF
                                :
                                :
02072 1116*      IF ((C .LE. 0.0) .OR. (S .LE. 0.0)) THEN @TO PREVENT DIVIDE
                                :
                                :
02074 1117*          ERPRINT , 'NOTE: RIM ANGLE OUTSIDE OF RANGE.' @ BY ZERO OR LOG
02101 1118*          RETURN 1 @ OF NEGATIVE NUMBER.
02102 1119*      ENDIF
                                : 04432
                                : 04437
                                : 04443
                                :
02102 1120*      C
02102 1121*      C *
02102 1122*      C BLOCK E 1.2
02102 1123*      C CALCULATES FOCAL PLANE FLUX DISTRIBUTION.
02102 1124*      C MAXIMIZES CONCENTRATION RATIOS OR INTERCEPT FACTOR IF REQUESTED.
02102 1125*      C
                                :
                                :
02103 1126*      IF (PARAB) THEN
                                :
                                :
02105 1127*          SIG2DF=2.0*DELTSQ*(1.0/(RMAR*((TAN(RMAR/2.0))**2)))* @DUFF-
02105 1128*          & ((-1.0/(3.0*(S**3)*C))+2.0/(3.0*(S**3)))+(2.0/S)- @ LAMEIRO
02105 1129*          & (C/(3.0*(S**3)))-(2.0*C/S)+((4.0*S)/(3.0*C))- @ SPREAD
02105 1130*          & ALOG(TAN(P4+RMAR/2.0))+ALOG(TAN(P4-RMAR/2.0)) @ FUNCTIONS.
02106 1131*      ELSE
                                : 04563
02107 1132*          SIG2DF=2.0*DELTSQ*(1.0+2.0*(C**2))/(3.0*RMAR*C*S)
                                : 04566
02110 1133*      ENDIF
                                : 04607
                                :
02111 1134*      IF (MAXPHI.AND.(.NOT.MAXC)) THEN
                                :
                                :
02113 1135*          PHI1=1.0-EXP(-1.0/(C1*SIG2DF))
02114 1136*      ELSE
                                : 04612
02115 1137*          IF (PHI1.LT. 1.0) THEN
                                : 04625
                                :
02117 1138*              PHI1FC=-ALOG(1.0-PHI1)
02120 1139*          ELSE
                                : 04631
02121 1140*              PHI1FC=VF
                                : 04641
02122 1141*          ENDIF
                                : 04643
                                :
02123 1142*          C1MAX= 1.0/(SIG2DF+PHI1FC)
02124 1143*          IF (MAXC) THEN
                                :
                                : 04650
                                :
02126 1144*              C1=C1MAX
                                : 04652
02127 1145*          ELSEIF ((.NOT.MAXPHI).AND.(C1.GT.C1MAX))
                                : 04655
02131 1146*              ERPRINT , 'WARNING! C1 GREATER THAN OPTICALLY POSSIBLE.'
                                : 04666
02136 1147*          ENDIF
                                : 04673
                                :
02137 1148*      ENDIF
                                :
                                :
02140 1149*      IF (SECONC)
                                :
                                :
02141 1150*          IF (MAXPHI.AND.(.NOT.MAXC))THEN
                                :
                                : 04675
                                :

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02143 1151*          PHI1S=1.0-EXP(-1.0/(C1S*SIG2DF))          :: 04700
02144 1152*          ELSE                                     :: 04713
02145 1153*          IF (PHI1S.LT. 1.0) THEN                  ::
<-----+----->
02147 1154*          PHI1SF=-ALOG(1.0-PHI1S)                   :: 04717
02150 1155*          ELSE                                     :: 04727
02151 1156*          PHI1SF=VF                                ::
02152 1157*          ENDIF                                     @ENDIF PHI1S          :: 04731
-----+-----
02153 1158*          C1SMAX= 1.0/(SIG2DF*PHI1SF)              ::
02154 1159*          IF (MAXC) THEN                            :: 04736
<-----+----->
02156 1160*          C1S=C1SMAX                               :: 04740
02157 1161*          ELSEIF ((.NOT.MAXPHI).AND.(C1S.GT.C1SMAX)) :: 04743
02161 1162*          ERPRINT , 'WARNING! C1S GREATER THAN OPTICALLY POSSIBLE.' :: 04754
02166 1163*          ENDIF                                     @ENDIF MAXC          :: 04761
-----+-----
02167 1164*          ENDIF                                     @ENDIF MAXPHI       ::
-----+-----
02170 1165*          IF ((C2.LE. 0.0).AND.(.NOT.MAXSEC)) THEN <-----+----->
02172 1166*          ERPRINT , 'C2 MUST BE POSITIVE'         :: 04771
02177 1167*          RETURN 1                                  :: 04776
02200 1168*          ENDIF                                     @ENDIF C2           :: 05002
-----+-----
02201 1169*          IF ((PHI2.LE. 0.0).OR.(PHI2.GT. 1.0)) THEN <-----+----->
02203 1170*          ERPRINT , 'WARNING! PHI2 MUST BE POSITIVE AND NOT OVER 1.0' :: 05015
02210 1171*          ERPRINT , 'SETTING PHI2=1.0'           :: 05022
02215 1172*          PHI2=1.0                                 :: 05027
02216 1173*          ENDIF                                     @ENDIF PHI2        :: 05031
-----+-----
02217 1174*          DELT=SQRT(DELT SQ)                         ::
02220 1175*          C2MAX=1.0/(C1S*((SIN(DELT))**2)+PHI2)     :: 05035
02221 1176*          IF (PHI1S.LT.1.0) C2MAX=C2MAX*VF/(-ALOG(1.0-PHI1S)) :: 05046
02223 1177*          C2MAX=AMIN1(C2MAX,1.0/(((SIN(RMAR+DELT))**2)+PHI2)) :: 05064
02224 1178*          IF (MAXSEC) THEN                          :: 05103
<-----+----->
02226 1179*          C2=C2MAX                                  :: 05105
02227 1180*          ELSEIF (C2.GT.C2MAX)                    :: 05110
02231 1181*          ERPRINT , 'WARNING! C2 GREATER THAN OPTICALLY POSSIBLE.' :: 05115
02236 1182*          ENDIF                                     @ENDIF MAXSEC      :: 05122
-----+-----
02237 1183*          ENDIF                                     @ENDIF SECONC      ::
-----+-----
02240 1184*          RETURN                                     ::
02241 1185*          ::                                         :: 05124
02241 1186*          C
02241 1187*          C
02241 1188*          C * * * * * * * * * * * * * * * * * * *
02241 1189*          C * * * * * * * * * * * * * * * * * * *
02241 1190*          C
02241 1191*          C BLOCK E.2
02241 1192*          C OPTICAL CHECKS AND CALCULATIONS.
02241 1193*          C
02241 1194*          C CALLED IF OPTIMIZATION OF RECEIVER APERTURE IS REQUESTED.
02241 1195*          C PERFORMS SAME TASKS AS STATED FOR ENTRY CKNOPT (BLOCK E.1).

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02241 1196* C ALSO SETS UP RECEIVER APERTURE OPTIMIZATION.
02241 1197* C
02241 1198* C ENTRY CKOPT ($)
02241 1199* C
02241 1200* C * * * * *
02241 1201* C BLOCK E.2.1
02241 1202* C CHECKS INPUT OF COLLECTOR CHARACTERISTICS.
02241 1203* C CALCULATES CONCENTRATOR RIM ANGLE OR FOCAL RATIO.
02241 1204* C
02242 1205* C1=0.0 @TO CLARIFY PRINTOUT.
02243 1206* PHI1=0.0 @THESE WILL BE DIFFERENT FOR 05125
02244 1207* @ EACH TEMPERATURE. 05126
02244 1208* C1S=0.0
02245 1209* PHI1S=0.0 05127
02246 1210* IF (MAXC.OR.MAXPHI) THEN 05130
02250 1211* ERPRINT , 'WARNING: CANNOT OPTIMIZE AND MAXIMIZE C SIMULTANEOUSLY' <-----+
02255 1212* ERPRINTO, ' WILL IGNORE MAXIMIZATION.' : 05133
02262 1213* ENDIF @ENDIF MAXC/MAXPHI : 05140
: 05145
02263 1214* IF (RMA.LE. 0.0) THEN @NO RMA INPUT <-----+
02265 1215* IF ((F.LE. 0.10).OR.(PARAB .AND. (F.LE. 0.25)) : 05151
02265 1216* & .OR.(F .GT. 25.0)) THEN :
02267 1217* ERPRINT , ' TO OPTIMIZE MUST PROVIDE ACCEPTABLE RIM ANGLE OR FO <-----+
02267 1218* &CAL RATIO' : 05171
02274 1219* RETURN 1 :
02275 1220* ELSEIF ((PARAB).AND.(F.LE. 10.0)) @F INPUT : 05176
02277 1221* IF (.NOT. IRFLG) THEN @PREPARES RMARAY IF NOT : 05202
: 05210
02301 1222* DO I=1, 90 @ ALREADY PREPARED <-----+
: 05215
02304 1223* RMARAY(I)=I <-----+
02305 1224* ENDLOOP @ENDLOOP I :
: 05227
02307 1225* IRFLG=.TRUE. <-----+
02310 1226* ENDIF @ENDIF IRFLG :
: 05231
02311 1227* CALL SLUP(F,RMA,DUMMY,FRAY,RMARAY,90,2) <-----+
02312 1228* @TABLE LOOKUP AND INTERPOLATION : 05242
02312 1229* @ TO GET RIM ANGLE FOR :
02312 1230* @ PARABOLOIDAL CONTOUR. :
02312 1231* RMAR=RMA*PI/180.0 @CONVERT TO RADIANS :
02313 1232* ELSE : 05247
02314 1233* RMAR=ATAN2(1.0,(2.0*F)) @FOCAL LENGTH OUTSIDE :
02315 1234* RMA=RMAR/(PI/180.0) @ OF TABLE RANGE, :
02316 1235* @ OR PLANAR CONTOUR. : 05257
02316 1236* @ 05264
02316 1236* ENDIF @ENDIF F :
:
02317 1237* ELSE IF (RMA.GE. 90.0) <-----+
02321 1238* ERPRINT , 'RIM ANGLE TOO LARGE' : 05270
02326 1239* RETURN 1 : 05275
02327 1240* ELSE @RMA BETWEEN 0.0 AND 90.0 : 05301
02330 1241* RMAR=RMA*(PI/180.0) :
02331 1242* IF (PARAB) THEN : 05305
<-----+

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02416 1288*      C2=0.0      @TO CLARIFY PRINTOUT      :: 05642
02417 1289*      ELSEIF (C2.GT.C2MAX)      :: 05644
02421 1290*      ERPRINT , 'WARNING! C2 GREATER THAN OPTICALLY POSSIBLE.'      :: 05651
02426 1291*      C2HOLD=C2      :: 05656
02427 1292*      ENDIF      @ENDIF MAXSEC      :: 05660
-----+-----
02430 1293*      ENDIF      @ENDIF SECONC      :
-----+-----
02431 1294*      RETURN
02431 1295*      C
02431 1296*      C * * * * * * * * * * * * * * * * * * * *
02431 1297*      C * * * * * * * * * * * * * * * * * * * *
02431 1298*      C
02431 1299*      C BLOCK E.3
02431 1300*      C CALLED IF RECEIVER OPTIMIZATION IS REQUESTED.
02431 1301*      C OPTIMIZES RECEIVER APERTURE, SETTING CONCENTRATION RATIO
02431 1302*      C C=1/((SIG2DF*LN((INS*RHO*BS*ALPHA/
02431 1303*      C (SIG2DF*EPS*BOLTZ*(TRK**4-TAK**4)+H*(TRK-TAK))))
02431 1304*      C ENTERS CONCENTRATION RATIOS AND INTERCEPT FACTOR IN OUTPUT ARRAY.
02431 1305*      C
02432 1306*      ENTRY OPTAP ($)      05662
02433 1307*      IF (TRMB.LE. 0.0) THEN
-----+-----
02435 1308*      ERPRINT , 'CANNOT OPTIMIZE. NO RECEIVER APERTURE LOSSES.'      : 05666
02442 1309*      RETURN 1      : 05673
02443 1310*      ENDIF      @ENDIF TRMB      : 05677
-----+-----
02444 1311*      CINV=SIG2DF*ALOG(TRMA/(SIG2DF*TRMB))      05701
02445 1312*      C1=AMAX1(1.0/CINV,BOUND)      05712
02446 1313*      PHI1=AMAX1(1.0-SIG2DF*TRMB/TRMA,0.0)      05721
02447 1314*      OPTAA(1,NTCNT)=C1      05731
02450 1315*      IF (SECONC) THEN      05742
-----+-----
02452 1316*      CINVS=SIG2DF*ALOG((TRMAS*PHI2*C2HOLD)/(SIG2DF*TRMB))      : 05747
02453 1317*      C1S=AMAX1(1.0/CINVS,BOUND)      : 05761
02454 1318*      PHI1S=AMAX1(1.0-SIG2DF*TRMB/(TRMAS*PHI2*C2HOLD),0.0)      : 05770
02455 1319*      C2MAX=1.0/(C1S*((SIN(DELT))**2))      : 06003
02456 1320*      IF (PHI1S.LT. 1.0) C2MAX=C2MAX*VF/(-ALOG(1.0-PHI1S))      : 06013
02460 1321*      IF (MAXSEC) THEN      : 06031
-----+-----
02462 1322*      C2=AMIN1(C2HOLD,C2MAX)      : 06033
02463 1323*      OPTAA(5,NTCNT)=C2      : 06041
02464 1324*      ELSEIF (C2.GT.C2MAX)      : 06052
02466 1325*      ERPRINT , 'WARNING! C2 GREATER THAN OPTICALLY POSSIBLE'      : 06057
02473 1326*      ENDIF      @ENDIF MAXSEC      : 06064
-----+-----
02474 1327*      OPTAA(2,NTCNT)=C1S      : 06066
02475 1328*      OPTAA(3,NTCNT)=PHI1      : 06075
02476 1329*      OPTAA(4,NTCNT)=PHI1S      : 06104
02477 1330*      ELSE      : 06114
02500 1331*      OPTAA(2,NTCNT)=PHI1      :
02501 1332*      ENDIF      @ENDIF SECONC      : 06125
-----+-----
02502 1333*      RETURN
02503 1334*      END      06170

```

0 DIAGNOSTICS

## CROSS REFERENCE

SLGIF\$	*332, *412, *427, *474, *513, *531, *547, *715, *735, *752, *776, *1051, *1133, *1151, *1167, *1223, *1263, *1324
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