5105-132
Solar Thermal Power Systems Project
Parabolic Dish Systems Development

DOE/JPL-1060-68
Distribution Category UC-62

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

L.D. Jaffe

February 15, 1984

Prepared for
U.S. Department of Energy
Through an Agreement with
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The JPL Solar Thermal Power Systems Project is sponsored by the U.S. Department of Energy and is part of the Solar Thermal Program to develop low-cost solar thermal and electric power plants.

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

The work described herein was conducted by the Jet Propulsion Laboratory, California Institute of Technology, for the U.S. Department of Energy through an agreement with the National Aeronautics and Space Administration (NASA Task RE-152, Amendment 327; DOE/ALO/NASA Interagency Agreement No. DE-AM04-80AL13137).

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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 ^{o}C and ^{o}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 choses 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) = (INS*RHO1*BS1*PHI*ALPHA-(1/C1)(EPS*BOLTZ*(TRK**4-TAK**4)
       +HC*(TRK-TAK))-ARATIO*HK*(TRK-TAK))/INS                    (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 RHO1 by RHO1*RHO2, 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:

```
DELTSQ = (2.0*SLOPER/1000.0)**2+(SPECUL/1000.0)**2
         +(SOLSD/1000.0)**2                                    (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:

```
SIG2DF = 2.0*DELTSQ*(1.0/(RMAR*((TAN(RMAR/2.0))**2)))*
         ((-1.0/(3.0*(S**3)*C))+(2.0/(3.0*(S**3)))+(2.0/S)
         -(C/(3.0*(S**3)))-(2.0*C/S)+((4.0*S)/(3.0*C))
         -ALOG(TAN(P4+RMAR/2.0))+ALOG(TAN(P4-RMAR/2.0)))       (3a)
```

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

```
SIG2DF = 2.0*DELTSQ*(1.0+2.0*(C**2))/(3.0*RMAR*C*S)            (3b)
```

if the overall contour is planar. Here

```
S = SIN(RMAR)
C = COS(RMAR)
T = TAN(RMAR)
```

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

```
PHI1 = 1.0-EXP(-1.0/(C1*SIG2DF))                               (4a)
```

or equivalently:

```
C1 = 1.0/(SIG2DF*(-ALOG(1.0-PHI1)))                            (4b)
```

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

```
C1 = 1.0/(SIG2DF*VF)                                           (4c)
```

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

When a secondary concentrator is used, PHI1 and C1 in Equations (4a) and (4c) are replaced by PHI1S and C1S, and the maximum C2 that is optically possible is given by the smaller of the quantities:

```
1.0/(((SIN(RMAR+DELT))**2)*PHI2)                                    (5a)
```

and

```
(1.0/C1S*((SIN(DELT))**2)*PHI2))*VF/(-ALOG(1.0-PHI1S))              (5b)
```

if PHI1S $\neq$ 1.0, or

```
1.0/(C1S*((SIN(DELT))**2)*PHI2)                                     (5c)
```

if PHI1S = 1.0. Here, DELT = SQRT(DELTSQ).

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+COS(RMAR))/(4.0+SIN(RMAR))                                 (6a)
```

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

```
F = 1.0/(2.0*TAN(RMAR))                                             (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:

```
RMAR = ATAN2(1.0,(2.0*F))                                           (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:

```
PHI1 = 1.0-(SIG2DF*EPS*BOLTZ*(TRK**4-TAK**4)+HC(TRK-TAK))
       /(INS*RHO1*BS1*ALPHA)                                        (7a)

C1 = 1.0/(SIG2DF*ALOG(INS*RHO1*BS1*ALPHA
     /(SIG2DF*EPS*BOLTZ*(TRK**4-TAK**4)+HC(TRK-TAK))))              (7b)
```

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

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

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

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 specularity 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 specularity 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 specularity 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 specularity 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 PHI1. Equation (7b) was then derived by substituting this value of PHI1 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

$$A(5) = A(1)*PCSE*PPE \tag{8}$$

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

$$PCSE = PCEFCT*((TIK-TOK)/TIK) \tag{9a}$$

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

$$PCSE = ENGE*GEARE*GENE \tag{9b}$$

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

$$ENGE = ENEFCT*((TIK-TOK)/TIK) \tag{10a}$$

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

$$ENGE = CYCE*MECHE*AUXE \tag{10b}$$

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

$$CYCE = CYCECT*((TIK-TOK/TIK) \tag{11}$$

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

The input temperature, TIK, is calculated as

$$TIK = TRK-DTRE \tag{12}$$

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.

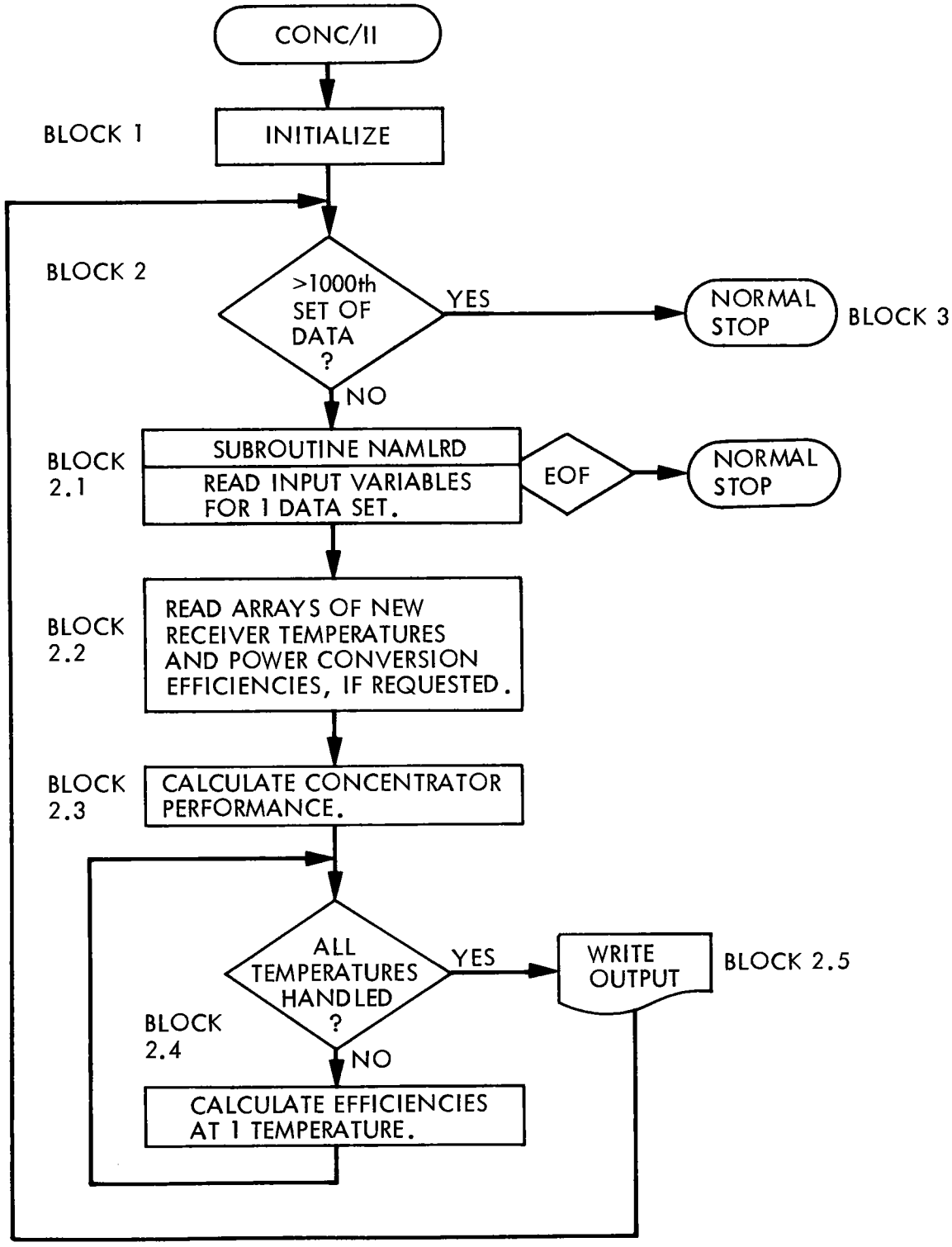

Figure 5-1. Overall Block Diagram of CONC/11

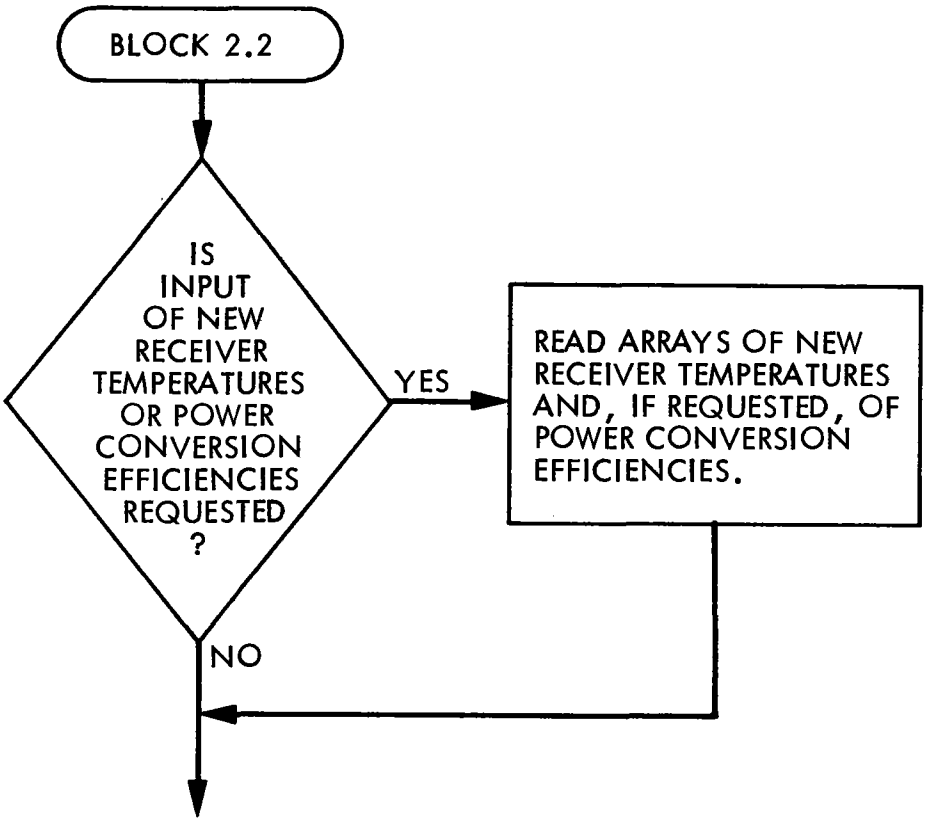

Figure 5-2. Diagram of Block 2.2

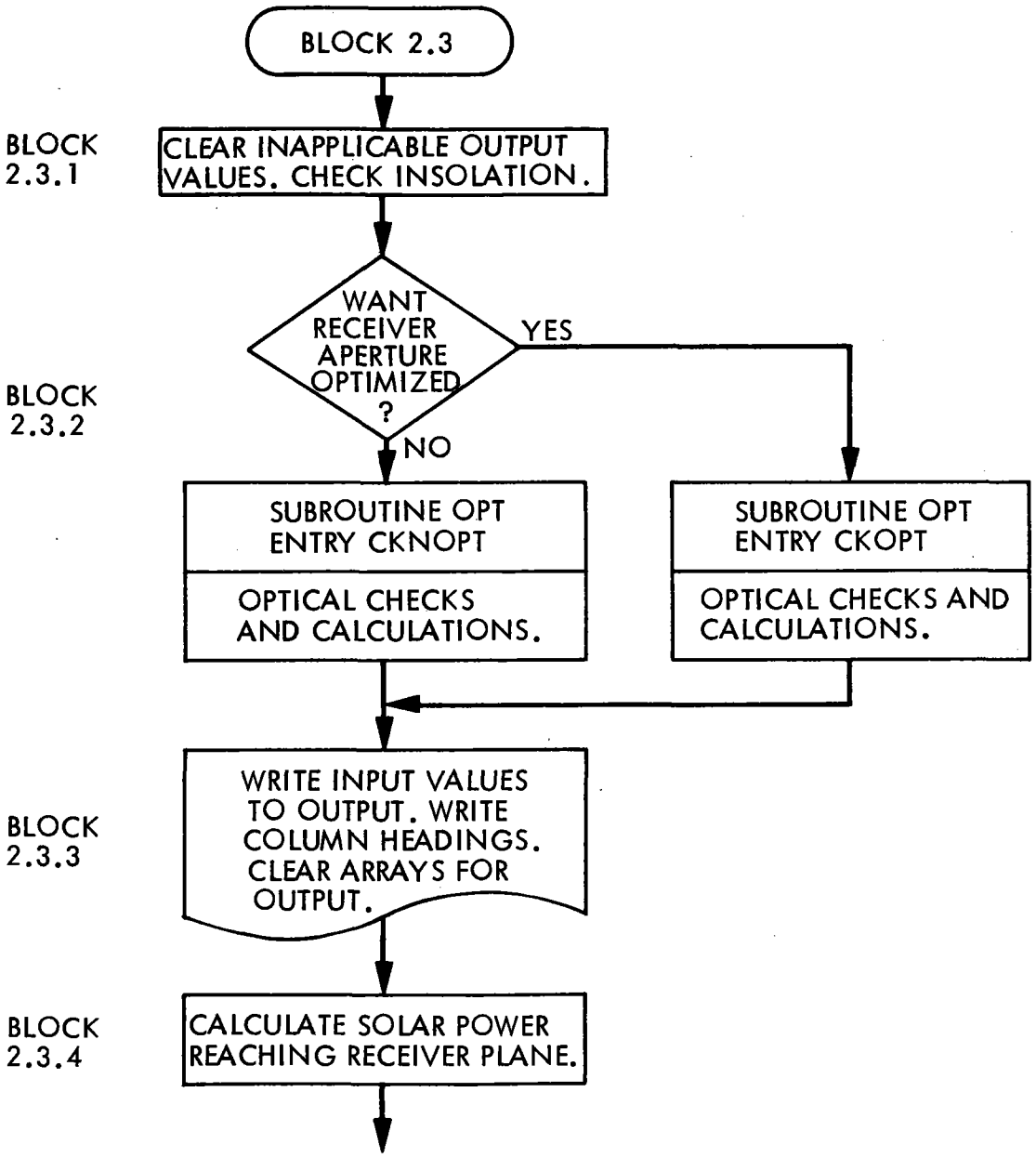

Figure 5-3. Diagram of Block 2.3

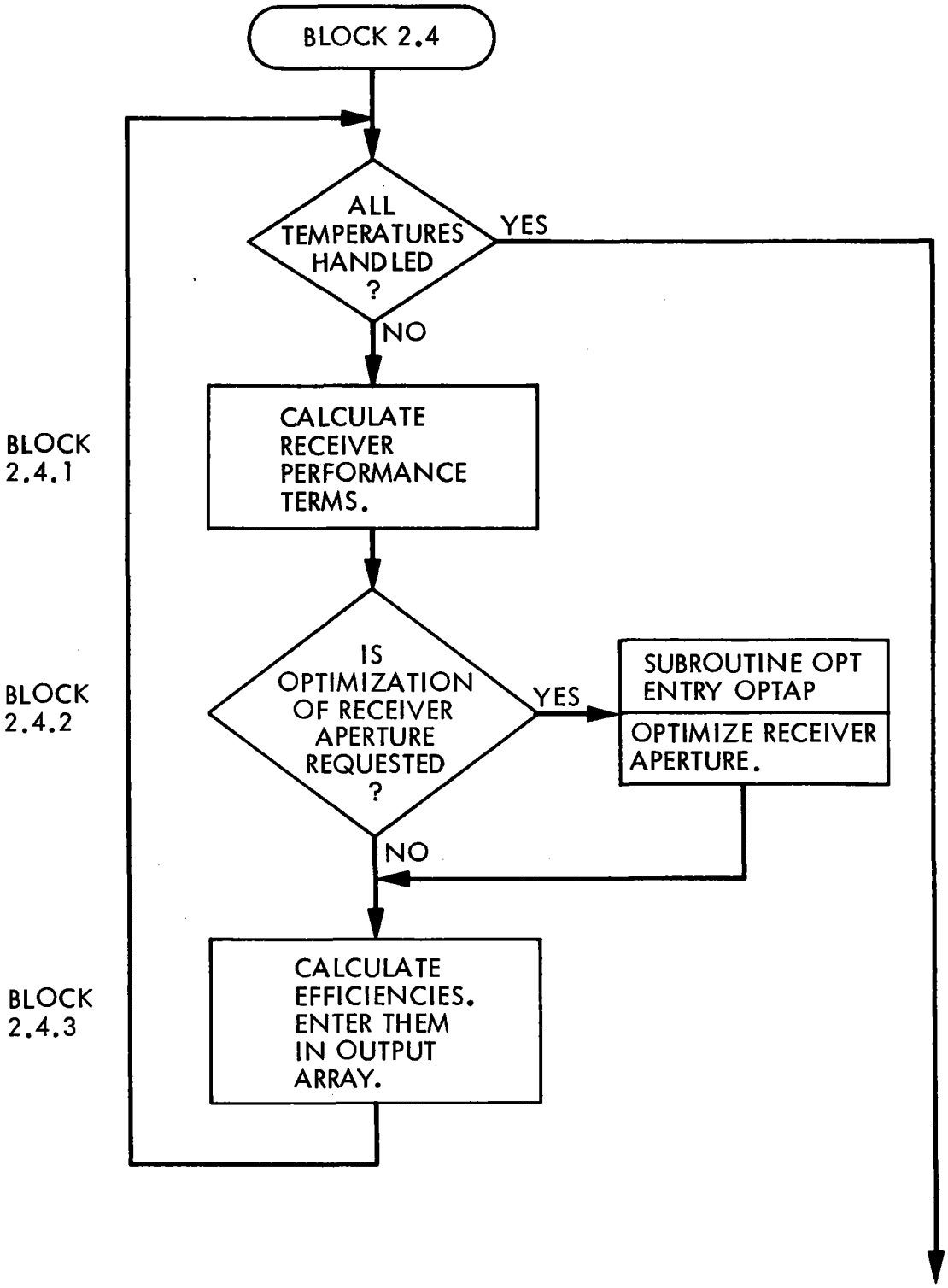

Figure 5-4. Diagram of Block 2.4

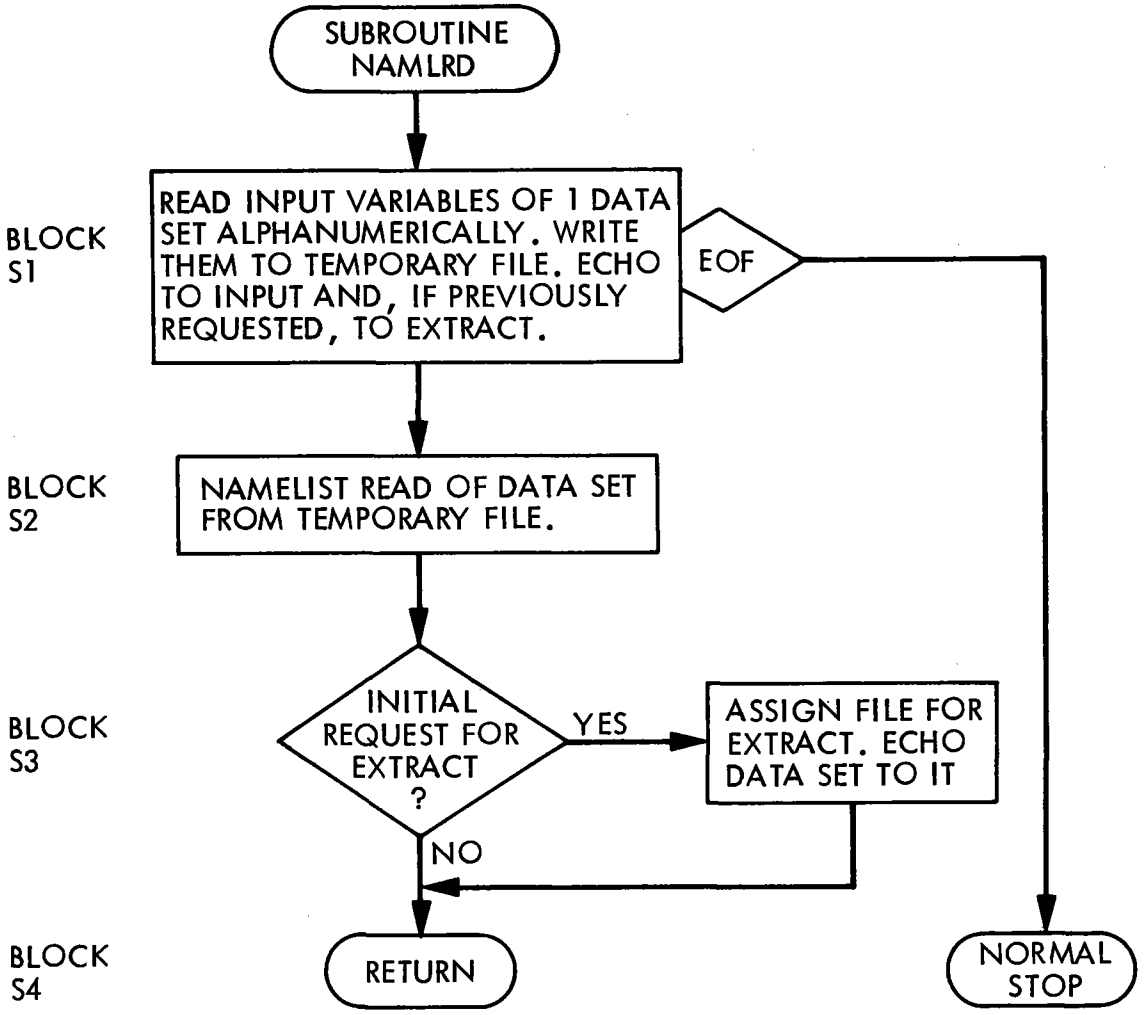

Figure 5-5. Block Diagram of Subroutine NAMLRD

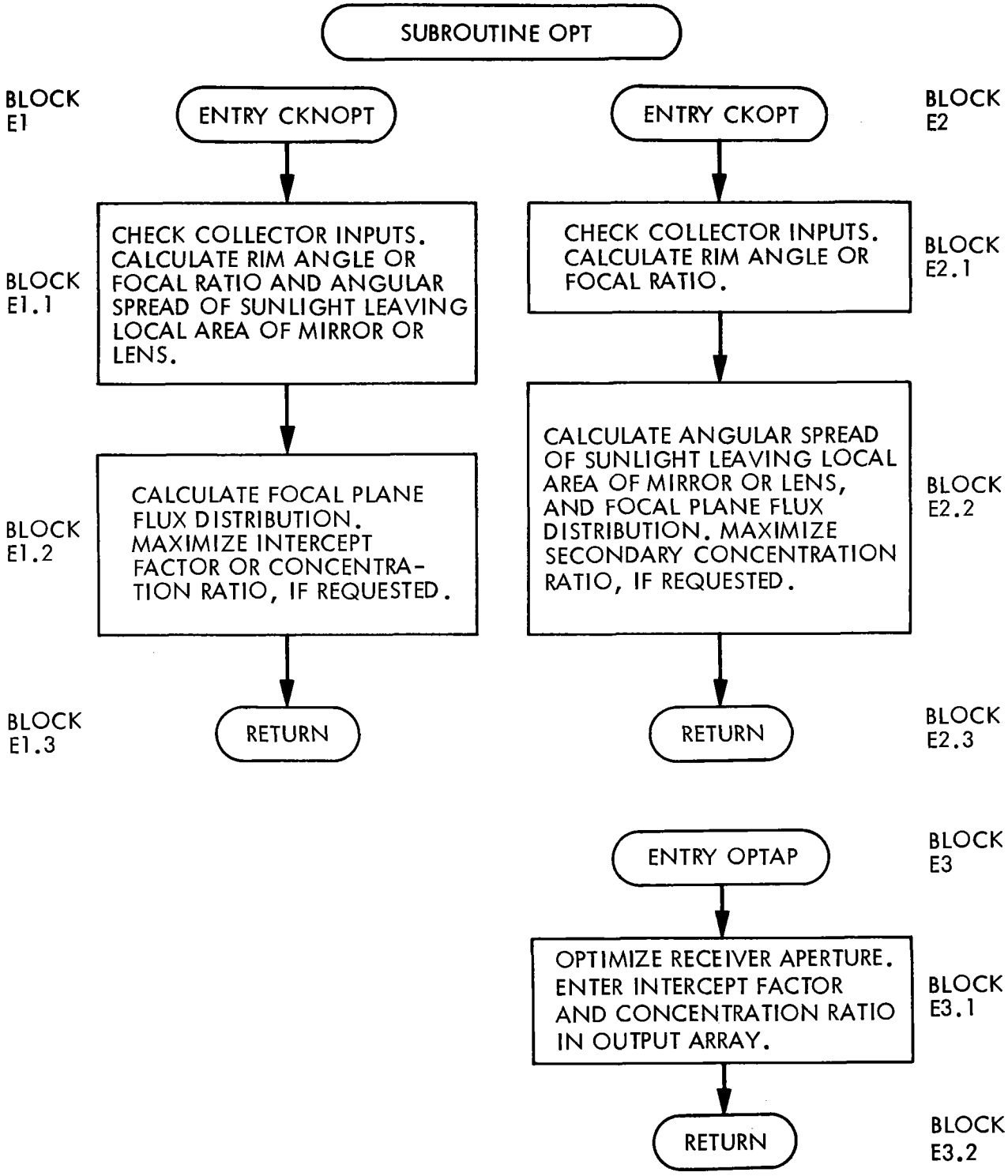

Figure 5-6. Block Diagram of Subroutine OPT

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

```
@BKl
```

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).

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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.

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
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.)						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
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^2K^4		
	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.)						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
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						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
DELT	Variable	-	Real	-	radian		
	Variance of Gaussian angular distribution of sunlight leaving a local area of (primary) mirror or lens						
DELTSQ	Variable	-	Real	-	$(radian)^2$		
	Standard deviation of Gaussian angular distribution of sunlight leaving a local area of (primary) mirror or lens						
DTRE	Variable	-	Real	25.0	^oC	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						
ENEFCT	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						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
GENE	Variable	-	Real	0.0	-	X	
	Generator efficiency						
HC	Variable	-	Real	0.0	$W/m^2{}^oC$	X	
	Effective convection coefficient (for receiver aperture)						
HK	Variable	-	Real	0.0	$W/m^2{}^oC$	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^2	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	-	^oC		
	Receiver temperature. (Index of DO loop.)						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
ITRC1	Variable	-	Integer	-	^{o}C	X	
	Initial parameter of DO loop for receiver temperatures						
ITRC2	Variable	-	Integer	-	^{o}C	X	
	Terminal parameter of DO loop for receiver temperatures						
ITRC3	Variable	-	Integer	-	^{o}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					X	
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.)						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
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 PHI1 OPTAA (3,NTCNT): PHI1 OPTAA (4,NTCNT): PHI1S OPTAA (5,NTCNT): C2						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
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	-		
	π						
PPE	Variable	-	Real	0.95	-	X	
	Power processing efficiency						
P4	Variable	-	Real	PI/4.0	-		
	$\pi/4$						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
RHO1	Variable	-	Real	0.9	-	X	
	Effective reflectance or transmittance of (primary) concentrator						
RHO2	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)^2						
SIN	Function	-	Real	-	-		
	Sine. (In Math Library.)						X
SLOPER	Variable	-	Real	2.0	mrad	X	
	Slope error of (primary) reflector						
SLUP	Subroutine	-		-	-		
	Table lookup and interpolation. (In Library LIB*JPL$.)						
SOLSD	Variable	-	Real	2.3	mrad	X	
	Standard deviation of angular spread of incoming sunlight						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
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	^{o}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	^{o}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^2		
	Term pertaining to power into receiver (no secondary concentrator)						
TRMAS	Variable	-	Real	-	W/m^2		
	Term pertaining to power into receiver with secondary concentrator						

Name	Usage	Dimensions	Type	Default Value	Units	Used for Input	Used for Output
TRMB	Variable	-	Real	-	W/m^2		
	Term pertaining to radiation and convection loss from receiver						
TRMC	Variable	-	Real	-	W/m^2		
	Term pertaining to conduction loss from receiver						
TT	Array	2,NT	Real	-	-	X	
	Receiver temperatures TT (1, NT) TT (2, NT)				^oC ^oF		
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.)						

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

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 W/m^2, increasing the receiver temperature from 700 to 800°C lowers collector efficiency from 0.79 to 0.76. If the insolation is increased to 1000 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
  RHO1      =       .90000000E+00
  RHO2      =       .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
```

RECEIVER TEMP. C	RECEIVER TEMP. F	COLLECTOR EFFIC.	PCS EFFIC.	SYSTEM EFFIC.	FRAC.MAX. SYS.EFFIC.
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
 RHO1     =      .90000000E+00
 RHO2     =      .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
```

RECEIVER TEMP.		COLLECTOR	PCS	SYSTEM	FRAC.MAX.
C	F	EFFIC.	EFFIC.	EFFIC.	SYS.EFFIC.
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                                          $END
→ $NLIST      PCEFCT=0.60,
→650,850,25                                                   $END
→ $NLIST      RHO1=0.80,
→@BK2 LSPH,506/13
  @SYM  DEF *BKFIL$ABC(1).,506/13,LSPH
  SYMMED BY  ABC
→@FIN
```

```
 SET     1
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST     PCEFCT=0.60,                                          $END
ENTER RECEIVER TEMPERATURES (M1,M2,M3   INTEGER)
 ITRC1, ITRC2, ITRC3 =       650,       850,        25
 $NLIST
 INS      =      .80000000E+03
 RHO1     =      .90000000E+00
 RHO2     =      .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
```

RECEIVER TEMP. C	RECEIVER TEMP. F	COLLECTOR EFFIC.	PCS EFFIC.	SYSTEM EFFIC.	FRAC. MAX. SYS. EFFIC.
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      RHO1=0.80,                                          $END
 $NLIST
 INS       =      .80000000E+03
 RHO1      =      .80000000E+00
 RHO2      =      .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
```

RECEIVER TEMP. C	RECEIVER TEMP. F	COLLECTOR EFFIC.	PCS EFFIC.	SYSTEM EFFIC.	FRAC.MAX. SYS.EFFIC.
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,
➜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
```

```
 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
 RHO1     =      .90000000E+00
 RHO2     =      .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. C	E	GEOM. CONC. RATIO	INTERCEPT FACTOR	COLLECTOR EFFIC.	PCS EFFIC.	SYSTEM EFFIC.	FRAC. MAX. 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
 RHO1      =       .90000000E+00
 RHO2      =       .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.		GEOM.	INTERCEPT	COLLECTOR	PCS	SYSTEM	FRAC.MAX.
C	F	CONC.RATIO	FACTOR	EFFIC.	EFFIC.	EFFIC.	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
 RHO1     =      .90000000E+00
 RHO2     =      .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
```

RECEIVER TEMP.		GEOM.	INTERCEPT	COLLECTOR	PCS	SYSTEM	FRAC.MAX.
C	E	CONC.RATIO	FACTOR	EFFIC.	EFFIC.	EFFIC.	SYS.EFFIC.
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
 RHO1     =      .90000000E+00
 RHO2     =      .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
```

RECEIVER TEMP.		GEOM.	INTERCEPT	COLLECTOR	PCS	SYSTEM	FRAC.MAX.
C	F	CONC.RATIO	FACTOR	EFFIC.	EFFIC.	EFFIC.	SYS.EFFIC.
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
 RHO1     =      .90000000E+00
 RHO2     =      .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
```

RECEIVER TEMP.		GEOM.	INTERCEPT	COLLECTOR	PCS	SYSTEM	FRAC.MAX.
C	F	CONC.RATIO	FACTOR	EFFIC.	EFFIC.	EFFIC.	SYS.EFFIC.
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
@RLK,F  ,506/13,LSPH
@ASG,A SOLAR
@XQT SOLAR.CONC/11
 $NLIST     F=0.4,     SECONC=T,     RHO2=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
@RLK,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
```

```
@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 FACT.		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. FACT.									
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

			1.23	4309.9		.982								
1150.0	2102.0	3719.5	3561.1	.977	.981	.801	.781	-.020	.397	.302	.295	-.008	.957	.943
			1.23	4387.6		.981								
1175.0	2147.0	3789.6	3625.2	.975	.979	.796	.776	-.019	.403	.305	.297	-.007	.965	.951
			1.23	4466.7		.979								
1200.0	2192.0	3861.1	3690.6	.974	.978	.790	.771	-.019	.408	.306	.299	-.007	.971	.958
			1.23	4547.2		.978								
1225.0	2237.0	3934.0	3757.2	.972	.976	.784	.766	-.018	.415	.309	.302	-.007	.978	.966
			1.23	4629.3		.976								
1250.0	2282.0	4008.5	3825.1	.970	.974	.778	.761	-.017	.420	.310	.304	-.007	.983	.972
			1.23	4712.9		.974								
1275.0	2327.0	4084.6	3894.3	.968	.973	.771	.756	-.016	.426	.312	.306	-.006	.989	.979
			1.23	4798.2		.973								
1300.0	2372.0	4162.3	3964.9	.966	.971	.765	.750	-.015	.431	.313	.307	-.006	.993	.984
			1.23	4885.2		.971								
1325.0	2417.0	4241.8	4036.9	.963	.969	.758	.744	-.014	.437	.314	.309	-.006	.996	.988
			1.23	4973.9		.969								
1350.0	2462.0	4323.0	4110.4	.961	.967	.751	.739	-.013	.441	.315	.309	-.005	.997	.990
			1.23	5064.4		.967								
1375.0	2507.0	4406.0	4185.4	.959	.965	.744	.732	-.012	.445	.315	.310	-.005	.998	.992
			1.23	5156.9		.965								
1400.0	2552.0	4491.0	4262.0	.956	.963	.737	.726	-.011	.451	.316	.311	-.005	.999	.995
			1.23	5251.3		.963								
1425.0	2597.0	4578.0	4340.3	.953	.961	.729	.720	-.010	.455	.315	.311	-.004	.999	.996
			1.23	5347.7		.961								
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								
1475.0	2687.0	4758.3	4502.0	.948	.956	.714	.707	-.007	.465	.315	.312	-.003	.999	.999
			1.23	5547.0		.956								
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
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST     F=0.5,                                                    $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        =      .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 FACT.		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 ICPT. FACT.									
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

			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")
  $NLIST     F=0.6,                                                    $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        =      .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
```

RECEIVER TEMP.		PRIM. GEOM. CONC.		PRIM. INTERCEPT FACT.		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. 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

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

			3.04	5263.3		.986								
1150.0	2102.0	2360.5	1758.5	.956	.985	.738	.797	.059	.397	.278	.300	.022	.994	.922
			3.04	5352.2		.985								
1175.0	2147.0	2414.2	1788.2	.953	.984	.729	.793	.064	.403	.279	.304	.025	.997	.932
			3.04	5442.5		.984								
1200.0	2192.0	2469.5	1818.3	.950	.983	.720	.789	.069	.408	.279	.306	.027	.998	.940
			3.04	5534.3		.983								
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								
1250.0	2282.0	2585.0	1880.2	.943	.980	.701	.780	.079	.420	.280	.311	.032	.999	.956
			3.04	5722.4		.980								
1275.0	2327.0	2645.3	1911.9	.939	.979	.691	.776	.085	.426	.280	.314	.034	1.000	.964
			3.04	5818.9		.979								
1300.0	2372.0	2707.4	1944.1	.935	.978	.681	.771	.090	.431	.279	.316	.037	.997	.970
			3.04	5917.1		.978								
1325.0	2417.0	2771.5	1976.9	.931	.976	.671	.767	.096	.437	.278	.318	.040	.994	.976
			3.04	6017.0		.976								
1350.0	2462.0	2837.6	2010.3	.926	.975	.660	.762	.102	.441	.277	.319	.043	.988	.980
			3.04	6118.7		.975								
1375.0	2507.0	2905.9	2044.4	.921	.973	.650	.757	.107	.445	.275	.320	.045	.982	.983
			3.04	6222.2		.973								
1400.0	2552.0	2976.4	2079.0	.917	.971	.638	.752	.113	.451	.273	.322	.048	.977	.988
			3.04	6327.7		.971								
1425.0	2597.0	3049.3	2114.3	.912	.970	.627	.746	.119	.455	.271	.323	.051	.969	.990
			3.04	6435.1		.970								
1450.0	2642.0	3124.7	2150.3	.906	.968	.616	.741	.125	.460	.269	.324	.055	.962	.995
			3.04	6544.6		.968								
1475.0	2687.0	3202.7	2187.0	.901	.966	.604	.735	.131	.465	.267	.325	.058	.953	.997
			3.04	6656.2		.966								
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
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST      F=1.0,                                                    $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        =      .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. INTERCEPT FACT.		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 ICPT. FACT.									
500.0	932.0	977.4	765.0	.995	.999	.870	.856	-.014	.136	.112	.110	-.002	.433	.339
			4.44	3395.4		.999								
525.0	977.0	1002.3	780.2	.994	.999	.866	.855	-.012	.154	.127	.125	-.002	.490	.384
			4.44	3462.7		.999								
550.0	1022.0	1027.7	795.5	.993	.998	.863	.854	-.009	.172	.141	.139	-.001	.544	.428
			4.44	3530.5		.998								
575.0	1067.0	1053.4	810.8	.992	.998	.859	.852	-.006	.189	.154	.153	-.001	.594	.469
			4.44	3598.6		.998								
600.0	1112.0	1079.7	826.3	.991	.998	.854	.851	-.003	.205	.166	.165	-.001	.641	.507
			4.44	3667.3		.998								
625.0	1157.0	1106.4	841.9	.990	.998	.850	.850	-.000	.220	.177	.177	-.000	.684	.544
			4.44	3736.4		.998								
650.0	1202.0	1133.7	857.6	.989	.997	.845	.848	.003	.234	.188	.188	.001	.724	.578
			4.44	3806.1		.997								
675.0	1247.0	1161.6	873.4	.988	.997	.840	.847	.007	.247	.197	.199	.002	.761	.609
			4.44	3876.4		.997								
700.0	1292.0	1190.0	889.4	.986	.997	.835	.845	.011	.258	.205	.208	.003	.791	.636
			4.44	3947.4		.997								
725.0	1337.0	1219.1	905.6	.985	.996	.829	.844	.015	.271	.213	.217	.004	.823	.665
			4.44	4019.0		.996								
750.0	1382.0	1248.8	921.9	.983	.996	.823	.842	.019	.280	.219	.224	.005	.846	.688
			4.44	4091.4		.996								
775.0	1427.0	1279.2	938.3	.981	.996	.817	.840	.023	.290	.225	.232	.006	.869	.710
			4.44	4164.5		.996								
800.0	1472.0	1310.4	955.0	.980	.995	.810	.838	.027	.299	.230	.238	.008	.888	.730
			4.44	4238.4		.995								
825.0	1517.0	1342.3	971.8	.978	.995	.803	.836	.032	.308	.235	.244	.009	.907	.749
			4.44	4313.1		.995								
850.0	1562.0	1375.0	988.9	.976	.994	.796	.833	.037	.317	.240	.251	.011	.925	.769
			4.44	4388.7		.994								
875.0	1607.0	1408.6	1006.1	.973	.994	.789	.831	.042	.324	.243	.256	.013	.936	.784
			4.44	4465.3		.994								
900.0	1652.0	1443.1	1023.6	.971	.993	.781	.829	.048	.332	.246	.261	.015	.950	.801
			4.44	4542.7		.993								
925.0	1697.0	1478.5	1041.2	.968	.993	.773	.826	.053	.340	.249	.266	.017	.963	.817
			4.44	4621.2		.993								
950.0	1742.0	1514.8	1059.2	.966	.992	.765	.823	.059	.347	.252	.271	.019	.972	.831
			4.44	4700.7		.992								
975.0	1787.0	1552.3	1077.3	.963	.991	.756	.821	.065	.354	.254	.276	.022	.980	.846
			4.44	4781.3		.991								
1000.0	1832.0	1590.7	1095.7	.960	.991	.747	.818	.071	.361	.256	.280	.024	.988	.859
			4.44	4862.9		.991								
1025.0	1877.0	1630.4	1114.4	.956	.990	.738	.815	.077	.367	.257	.284	.027	.992	.871
			4.44	4945.8		.990								
1050.0	1922.0	1671.2	1133.3	.953	.989	.728	.811	.083	.374	.259	.288	.030	.998	.884
			4.44	5029.8		.989								
1075.0	1967.0	1713.3	1152.5	.949	.988	.718	.808	.090	.379	.259	.291	.032	.998	.893
			4.44	5115.0		.988								
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								
1125.0	2057.0	1801.6	1191.8	.941	.986	.697	.801	.104	.391	.259	.297	.039	.999	.912

			4.44	5289.4		.986								
1150.0	2102.0	1848.0	1211.9	.937	.985	.686	.797	.111	.397	.259	.301	.042	.998	.922
			4.44	5378.6		.985								
1175.0	2147.0	1895.9	1232.3	.932	.984	.675	.793	.118	.403	.258	.304	.045	.997	.932
			4.44	5469.2		.984								
1200.0	2192.0	1945.4	1253.1	.927	.983	.663	.789	.126	.408	.257	.306	.049	.993	.939
			4.44	5561.3		.983								
1225.0	2237.0	1996.7	1274.2	.922	.982	.652	.785	.134	.415	.257	.309	.053	.990	.948
			4.44	5654.9		.982								
1250.0	2282.0	2049.9	1295.6	.917	.981	.639	.781	.141	.420	.255	.311	.056	.984	.955
			4.44	5750.1		.981								
1275.0	2327.0	2105.0	1317.4	.911	.979	.627	.776	.149	.426	.254	.314	.060	.980	.964
			4.44	5846.9		.979								
1300.0	2372.0	2162.3	1339.6	.906	.978	.615	.772	.157	.431	.252	.316	.064	.972	.970
			4.44	5945.3		.978								
1325.0	2417.0	2221.7	1362.2	.899	.976	.602	.767	.166	.437	.250	.318	.069	.963	.976
			4.44	6045.5		.976								
1350.0	2462.0	2283.5	1385.1	.893	.975	.588	.762	.174	.441	.247	.319	.073	.952	.979
			4.44	6147.5		.975								
1375.0	2507.0	2347.8	1408.5	.886	.973	.575	.757	.182	.445	.243	.320	.077	.939	.983
			4.44	6251.4		.973								
1400.0	2552.0	2414.7	1432.4	.879	.972	.561	.752	.191	.451	.240	.322	.082	.928	.988
			4.44	6357.1		.972								
1425.0	2597.0	2484.5	1456.7	.872	.970	.548	.747	.199	.455	.237	.323	.086	.914	.990
			4.44	6464.9		.970								
1450.0	2642.0	2557.4	1481.4	.864	.968	.533	.741	.208	.460	.233	.324	.091	.901	.995
			4.44	6574.7		.968								
1475.0	2687.0	2633.5	1506.6	.856	.966	.519	.736	.217	.465	.229	.325	.096	.885	.997
			4.44	6686.6		.966								
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
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST     F=0.4,      NWTORF=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 FACT.		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. FACT.									
500.0	932.0	2251.7	2192.6	.998	.998	.887	.853	-.034	.224	.189	.182	-.007	.500	.489
			1.23	2701.5	.998									
525.0	977.0	2299.6	2238.0	.998	.998	.886	.852	-.034	.243	.204	.196	-.008	.540	.528
			1.23	2757.5	.998									
550.0	1022.0	2347.9	2283.7	.997	.998	.884	.851	-.033	.260	.219	.210	-.008	.578	.566
			1.23	2813.8	.998									
575.0	1067.0	2396.6	2329.8	.997	.998	.882	.849	-.033	.277	.232	.223	-.009	.614	.601
			1.23	2870.5	.998									
600.0	1112.0	2445.8	2376.3	.997	.997	.880	.848	-.033	.293	.245	.236	-.009	.648	.634
			1.23	2927.8	.997									
625.0	1157.0	2495.5	2423.1	.996	.997	.878	.846	-.032	.308	.257	.247	-.009	.680	.665
			1.23	2985.6	.997									
650.0	1202.0	2545.7	2470.5	.996	.997	.876	.844	-.032	.322	.268	.258	-.010	.709	.695
			1.23	3043.9	.997									
675.0	1247.0	2596.6	2518.3	.996	.996	.874	.842	-.032	.335	.278	.268	-.010	.736	.721
			1.23	3102.8	.996									
700.0	1292.0	2648.0	2566.7	.995	.996	.872	.840	-.031	.347	.287	.277	-.010	.759	.744
			1.23	3162.4	.996									
725.0	1337.0	2700.1	2615.6	.994	.995	.869	.838	-.031	.359	.296	.286	-.011	.784	.769
			1.23	3222.7	.995									
750.0	1382.0	2752.9	2665.1	.994	.995	.866	.836	-.030	.369	.303	.293	-.011	.803	.788
			1.23	3283.7	.995									
775.0	1427.0	2806.4	2715.2	.993	.994	.864	.834	-.030	.378	.310	.300	-.011	.821	.806
			1.23	3345.4	.994									
800.0	1472.0	2860.6	2766.0	.993	.994	.861	.831	-.029	.387	.317	.306	-.011	.838	.822
			1.23	3408.0	.994									
825.0	1517.0	2915.7	2817.4	.992	.993	.858	.829	-.029	.396	.323	.312	-.011	.853	.838
			1.23	3471.3	.993									
850.0	1562.0	2971.5	2869.5	.991	.992	.854	.826	-.028	.405	.329	.318	-.011	.869	.854
			1.23	3535.5	.992									
875.0	1607.0	3028.2	2922.4	.990	.992	.851	.823	-.028	.412	.333	.322	-.011	.881	.866
			1.23	3600.7	.992									
900.0	1652.0	3085.8	2976.0	.989	.991	.847	.820	-.027	.420	.338	.327	-.011	.894	.879
			1.23	3666.7	.991									
925.0	1697.0	3144.4	3030.4	.988	.990	.843	.817	-.027	.428	.343	.332	-.011	.907	.893
			1.23	3733.7	.990									
950.0	1742.0	3203.9	3085.6	.987	.989	.839	.813	-.026	.435	.347	.336	-.011	.917	.904
			1.23	3801.8	.989									
975.0	1787.0	3264.4	3141.7	.986	.989	.835	.810	-.025	.442	.351	.340	-.011	.928	.914
			1.23	3870.9	.989									
1000.0	1832.0	3325.9	3198.7	.985	.988	.831	.806	-.025	.449	.354	.344	-.011	.938	.925
			1.23	3941.1	.988									
1025.0	1877.0	3388.6	3256.5	.984	.987	.826	.802	-.024	.455	.357	.347	-.010	.945	.933
			1.23	4012.4	.987									
1050.0	1922.0	3452.3	3315.4	.983	.985	.822	.798	-.023	.462	.361	.351	-.010	.955	.943
			1.23	4084.9	.985									
1075.0	1967.0	3517.2	3375.2	.982	.984	.817	.794	-.023	.467	.363	.353	-.010	.960	.949
			1.23	4158.6	.984									
1100.0	2012.0	3583.4	3436.1	.980	.983	.812	.790	-.022	.474	.365	.355	-.010	.966	.956
			1.23	4233.6	.983									
1125.0	2057.0	3650.8	3498.0	.979	.982	.807	.786	-.021	.479	.367	.357	-.010	.971	.961

			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
 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        =      .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 FACT.		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. FACT.									
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

			1.55	4905.1		.985								
1150.0	2102.0	3560.8	3215.7	.976	.984	.797	.792	-.005	.485	.367	.365	-.002	.980	.956
			1.55	4989.8		.984								
1175.0	2147.0	3628.9	3271.2	.974	.982	.791	.788	-.003	.491	.369	.368	-.001	.985	.963
			1.55	5075.9		.982								
1200.0	2192.0	3698.5	3327.6	.972	.981	.785	.783	-.001	.497	.370	.369	-.001	.988	.968
			1.55	5163.5		.981								
1225.0	2237.0	3769.6	3385.0	.970	.980	.778	.779	.000	.503	.372	.372	.000	.992	.974
			1.55	5252.6		.980								
1250.0	2282.0	3842.2	3443.5	.968	.979	.772	.774	.002	.508	.373	.374	.001	.994	.979
			1.55	5343.3		.979								
1275.0	2327.0	3916.4	3503.0	.966	.977	.765	.769	.004	.514	.374	.376	.002	.998	.985
			1.55	5435.6		.977								
1300.0	2372.0	3992.3	3563.5	.964	.976	.759	.764	.006	.519	.374	.377	.003	.999	.988
			1.55	5529.6		.976								
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								
1350.0	2462.0	4149.2	3688.0	.959	.972	.744	.754	.010	.529	.374	.379	.005	.999	.993
			1.55	5722.8		.972								
1375.0	2507.0	4230.5	3752.1	.956	.971	.737	.749	.012	.534	.374	.380	.006	.997	.995
			1.55	5822.2		.971								
1400.0	2552.0	4313.7	3817.4	.953	.969	.729	.743	.014	.539	.373	.381	.007	.997	.997
			1.55	5923.5		.969								
1425.0	2597.0	4398.9	3884.0	.951	.967	.722	.738	.016	.543	.372	.381	.008	.994	.997
			1.55	6026.8		.967								
1450.0	2642.0	4486.2	3951.9	.948	.965	.714	.732	.018	.549	.372	.381	.009	.993	.999
			1.55	6132.2		.965								
1475.0	2687.0	4575.7	4021.2	.944	.963	.705	.726	.020	.553	.371	.381	.011	.989	.999
			1.55	6239.7		.963								
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
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST     F=0.6,                                                    $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        =      .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
```

RECEIVER TEMP.		PRIM.GEOM.CONC.		PRIM.INTERCEPT FACT.		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 INTERCEPT FACT.									
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

			1.97	5127.9		.986								
1150.0	2102.0	3130.1	2653.6	.971	.985	.781	.795	.014	.485	.360	.366	.006	.988	.952
			1.97	5215.2		.985								
1175.0	2147.0	3193.1	2698.8	.969	.983	.774	.791	.017	.491	.361	.369	.008	.992	.959
			1.97	5304.0		.983								
1200.0	2192.0	3257.6	2744.7	.967	.982	.768	.787	.019	.497	.362	.371	.009	.994	.964
			1.97	5394.2		.982								
1225.0	2237.0	3323.5	2791.4	.964	.981	.761	.783	.022	.503	.363	.374	.011	.997	.971
			1.97	5485.9		.981								
1250.0	2282.0	3391.0	2838.8	.962	.980	.753	.778	.025	.508	.364	.376	.012	.998	.976
			1.97	5579.2		.980								
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								
1300.0	2372.0	3531.0	2936.3	.956	.977	.738	.769	.031	.519	.364	.379	.015	1.000	.986
			1.97	5770.7		.977								
1325.0	2417.0	3603.6	2986.3	.954	.975	.730	.764	.034	.525	.364	.381	.017	.999	.989
			1.97	5869.0		.975								
1350.0	2462.0	3678.0	3037.2	.951	.974	.722	.759	.037	.529	.363	.382	.019	.996	.991
			1.97	5969.1		.974								
1375.0	2507.0	3754.4	3089.1	.948	.972	.714	.754	.040	.534	.362	.382	.020	.993	.993
			1.97	6071.1		.972								
1400.0	2552.0	3832.8	3142.0	.944	.970	.705	.749	.044	.539	.361	.383	.022	.991	.995
			1.97	6175.0		.970								
1425.0	2597.0	3913.2	3195.8	.941	.969	.696	.743	.047	.543	.359	.384	.024	.987	.996
			1.97	6280.9		.969								
1450.0	2642.0	3995.9	3250.8	.937	.967	.687	.738	.050	.549	.358	.384	.026	.983	.998
			1.97	6388.8		.967								
1475.0	2687.0	4080.9	3306.8	.934	.965	.678	.732	.054	.553	.356	.384	.028	.978	.999
			1.97	6498.9		.965								
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
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 FACT.		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 ICPT. FACT.									
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

			3.04	5263.3		.986								
1150.0	2102.0	2360.5	1758.5	.956	.985	.738	.797	.059	.485	.340	.367	.027	.999	.949
			3.04	5352.2		.985								
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								
1200.0	2192.0	2469.5	1818.3	.950	.983	.720	.789	.069	.497	.340	.372	.033	.998	.962
			3.04	5534.3		.983								
1225.0	2237.0	2526.4	1849.0	.946	.982	.711	.785	.074	.503	.339	.375	.035	.998	.969
			3.04	5627.6		.982								
1250.0	2282.0	2585.0	1880.2	.943	.980	.701	.780	.079	.508	.338	.377	.038	.995	.974
			3.04	5722.4		.980								
1275.0	2327.0	2645.3	1911.9	.939	.979	.691	.776	.085	.514	.338	.379	.041	.993	.980
			3.04	5818.9		.979								
1300.0	2372.0	2707.4	1944.1	.935	.978	.681	.771	.090	.519	.336	.381	.045	.988	.984
			3.04	5917.1		.978								
1325.0	2417.0	2771.5	1976.9	.931	.976	.671	.767	.096	.525	.334	.382	.048	.983	.988
			3.04	6017.0		.976								
1350.0	2462.0	2837.6	2010.3	.926	.975	.660	.762	.102	.529	.332	.383	.051	.976	.990
			3.04	6118.7		.975								
1375.0	2507.0	2905.9	2044.4	.921	.973	.650	.757	.107	.534	.329	.384	.054	.968	.992
			3.04	6222.2		.973								
1400.0	2552.0	2976.4	2079.0	.917	.971	.638	.752	.113	.539	.327	.385	.058	.961	.995
			3.04	6327.7		.971								
1425.0	2597.0	3049.3	2114.3	.912	.970	.627	.746	.119	.543	.324	.385	.061	.952	.996
			3.04	6435.1		.970								
1450.0	2642.0	3124.7	2150.3	.906	.968	.616	.741	.125	.549	.321	.386	.065	.943	.998
			3.04	6544.6		.968								
1475.0	2687.0	3202.7	2187.0	.901	.966	.604	.735	.131	.553	.317	.386	.069	.933	.998
			3.04	6656.2		.966								
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
ENTER INPUT VALUES (NAMELIST, WITH NAME "NLIST")
  $NLIST     F=1.0,                                                    $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        =      .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. INTERCEPT FACT.		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. FACT.									
500.0	932.0	977.4	765.0	.995	.999	.870	.856	-.014	.224	.185	.182	-.003	.579	.470
			4.44	3395.4		.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								
550.0	1022.0	1027.7	795.5	.993	.998	.863	.854	-.009	.260	.213	.211	-.002	.667	.545
			4.44	3530.5		.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								
600.0	1112.0	1079.7	826.3	.991	.998	.854	.851	-.003	.293	.238	.237	-.001	.744	.611
			4.44	3667.3		.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								
650.0	1202.0	1133.7	857.6	.989	.997	.845	.848	.003	.322	.258	.259	.001	.809	.670
			4.44	3806.1		.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								
700.0	1292.0	1190.0	889.4	.986	.997	.835	.845	.011	.347	.275	.278	.003	.860	.719
			4.44	3947.4		.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								
750.0	1382.0	1248.8	921.9	.983	.996	.823	.842	.019	.369	.288	.295	.007	.902	.761
			4.44	4091.4		.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								
800.0	1472.0	1310.4	955.0	.980	.995	.810	.838	.027	.387	.298	.308	.010	.933	.796
			4.44	4238.4		.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								
850.0	1562.0	1375.0	988.9	.976	.994	.796	.833	.037	.405	.306	.321	.014	.958	.828
			4.44	4388.7		.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								
900.0	1652.0	1443.1	1023.6	.971	.993	.781	.829	.048	.420	.312	.331	.019	.975	.853
			4.44	4542.7		.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								
950.0	1742.0	1514.8	1059.2	.966	.992	.765	.823	.059	.435	.316	.340	.024	.988	.878
			4.44	4700.7		.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								
1000.0	1832.0	1590.7	1095.7	.960	.991	.747	.818	.071	.449	.319	.349	.030	.997	.900
			4.44	4862.9		.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								
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								
1075.0	1967.0	1713.3	1152.5	.949	.988	.718	.808	.090	.467	.319	.359	.040	.998	.927
			4.44	5115.0		.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								
1125.0	2057.0	1801.6	1191.8	.941	.986	.697	.801	.104	.479	.317	.364	.047	.992	.941

			4.44	5289.4		.986								
1150.0	2102.0	1848.0	1211.9	.937	.985	.686	.797	.111	.485	.316	.367	.051	.989	.949
			4.44	5378.6		.985								
1175.0	2147.0	1895.9	1232.3	.932	.984	.675	.793	.118	.491	.315	.370	.055	.986	.956
			4.44	5469.2		.984								
1200.0	2192.0	1945.4	1253.1	.927	.983	.663	.789	.126	.497	.313	.372	.059	.979	.962
			4.44	5561.3		.983								
1225.0	2237.0	1996.7	1274.2	.922	.982	.652	.785	.134	.503	.311	.375	.064	.974	.968
			4.44	5654.9		.982								
1250.0	2282.0	2049.9	1295.6	.917	.981	.639	.781	.141	.508	.309	.377	.068	.966	.973
			4.44	5750.1		.981								
1275.0	2327.0	2105.0	1317.4	.911	.979	.627	.776	.149	.514	.306	.379	.073	.959	.979
			4.44	5846.9		.979								
1300.0	2372.0	2162.3	1339.6	.906	.978	.615	.772	.157	.519	.303	.381	.078	.949	.984
			4.44	5945.3		.978								
1325.0	2417.0	2221.7	1362.2	.899	.976	.602	.767	.166	.525	.300	.382	.083	.939	.988
			4.44	6045.5		.976								
1350.0	2462.0	2283.5	1385.1	.893	.975	.588	.762	.174	.529	.296	.383	.087	.926	.990
			4.44	6147.5		.975								
1375.0	2507.0	2347.8	1408.5	.886	.973	.575	.757	.182	.534	.292	.384	.092	.912	.991
			4.44	6251.4		.973								
1400.0	2552.0	2414.7	1432.4	.879	.972	.561	.752	.191	.539	.287	.385	.098	.899	.994
			4.44	6357.1		.972								
1425.0	2597.0	2484.5	1456.7	.872	.970	.548	.747	.199	.543	.283	.386	.103	.884	.995
			4.44	6464.9		.970								
1450.0	2642.0	2557.4	1481.4	.864	.968	.533	.741	.208	.549	.278	.386	.108	.870	.998
			4.44	6574.7		.968								
1475.0	2687.0	2633.5	1506.6	.856	.966	.519	.736	.217	.553	.273	.387	.114	.854	.998
			4.44	6686.6		.966								
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
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*SOLAR1.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   NIO2$
         0022   NWDU$
         0023   NWNL$
         0024   NSTOP$
         0025   NIO1$
         0026   ATH4$
         0027   NIO3$
         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	A5MAX	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	CINVS
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	DELTSQ	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	PCEFCT
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	RHO1	0010	R	002075	RHO2
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	1001I	0001		003346	1002O2	0001		001553	1006O	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	2006O	0001		004205	2014I	0001		003533	2015I	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*                                                                                                  00003
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=PCEFCT*(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.
```

```
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*         COMPILER (DATA=IBM)
00103    96*         PARAMETER NT=50                  @MAX NO. OF TEMPERATURES
00105    97*         MONITOR
```

```
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)),(RHO1,Z(2)),(RHO2,Z(3)),(BS1,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)),(PCEFCT,Z(25)),
00113  112*         & (ENEFCT,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,RHO1,RHO2,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,PCEFCT,ENEFCT,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*          RHO1=0.9                         @REFLECTANCE OR TRANSMITTANCE                00021
00117  128*                                           @ OF (PRIMARY) CONCENTRATOR.                 00023
00117  129*          RHO2=0.9                         @EFFECTIVE REFLECTANCE OR
00120  130*                                           @ TRANSMITTANCE OF SECONDARY                 00025
00120  131*                                           @  CONCENTRATOR, CONSIDERING
00120  132*                                           @  AVERAGE NUMBER OF REFLECTIONS
00120  133*                                           @  AT SECONDARY. (IGNORED IF NO
00120  134*                                           @  SECONDARY CONCENTRATOR.)
00120  135*          BS1=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, ENEFCT,
00146  208*                    @ OR CYCECT, OR ELSE SET IPCSEF,
00146  209*                    @ IENGEF, OR ICYCEF=T AND SUPPLY
00146  210*                    @ LIST OF EFFICIENCIES).
00146  211*      ENEFCT=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*   C
00154  222*   C          DEFAULT VALUES FOR OPTIONS
00154  223*   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.
```

```
00167  269*          XTRACT=.FALSE.                    @PROVIDES EXTRACT OF OUTPUT, IN
00170  270*                                            @ FILE XTRACT.                          00121
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                00122
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.               00123
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                 00125
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             00127
00175  297*          NSET=0                            @NO. OF DATA SETS ENTERED.              00131
00176  298*          BOUND=1.0E-7                      @BOUND FOR EQUALITY COMPARISONS         00132
00177  299*                                            @ OF REAL NUMBERS AND TO PREVENT        00134
00177  300*                                            @ DIVIDE BY ZERO.
00177  301*          ASG100=.FALSE.                    @FLAG TO INDICATE ASSIGNMENT OF
00200  302*                                            @ EXTRACT FILE XTRACT, WHICH IS         00135
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.                      00136
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           : 00202
00205  319*                                            @ VALUES.                             : 00205
00205  320*    C                                                                             :
00205  321*    C     *     *     *     *     *     *     *     *     *     *     *     *     :
00205  322*    C     *     *     *     *     *     *     *     *     *     *     *     *     :
00205  323*    C      BLOCK 2.1.                                                           :
00205  324*    C       READ 1 SET OF INPUT DATA                                            :
```

```
00205  325*   C       (EXCEPT RECEIVER TEMPERATURES AND ARRAY OF EFFICIENCIES FOR
00205  326*   C       POWER CONVERSION).
00205  327*   C
00205  328*           CALL NAMLRD                     @PROVIDE NAMELIST INPUT
00206  329*           DO J=1,32                       @SAVES INPUT VALUES

00211  330*             Y(J)=Z(J)
00212  331*           ENDLOOP                         @ENDLOOP J
00212  332*   C
00212  333*   C     *     *     *     *     *     *     *     *     *     *     *     *
00212  334*   C     *     *     *     *     *     *     *     *     *     *     *     *
00212  335*   C      BLOCK 2.2.
00212  336*   C       READ  RECEIVER TEMPERATURES AND POWER CONVERSION, ENGINE, OR
00212  337*   C        CYCLE EFFICIENCY ARRAY, IF DESIRED.
00212  338*   C

00214  339*           IF (NWTORF) THEN

00216  340*             ERPRINT ,'ENTER RECEIVER TEMPERATURES (M1,M2,M3   INTEGER)'
00216  341*   C
00216  342*   C ***************************************************************************
00216  343*   C ***************************************************************************
00216  344*   C **                                                                       **
00216  345*   C **   INPUT NEW RECEIVER TEMPERATURES.                                    **
00216  346*   C **                                                                       **
00216  347*   C ***************************************************************************
00216  348*   C ***************************************************************************
00225  349*
00225  350*             READ (5,110,ERR=90,END=80) ITRC1,ITRC2,ITRC3  @INPUT RECEIVER
00233  351*                                        @ TEMPERATURES, CELSIUS, IN FORM
00233  352*                                        @ OF DO LIST PARAMETERS (FROM
00233  353*                                        @ ITRC TO ITRC2 BY ITRC3)
00233  354*             WRITE (6,215) ITRC1,ITRC2,ITRC3
00241  355*             IF (XTRACT) WRITE (100,215) ITRC1,ITRC2,ITRC3
00250  356*             IF (ITRC3.LE.0) THEN

00252  357*               WRITE (6,NLIST)
00256  358*               ERPRINT , 'BAD ITRC3'
00263  359*               STOP BDREAD
00264  360*             ENDIF                         @ENDIF ITRC3

00265  361*             NTRC=1+(ITRC2-ITRC1)/ITRC3   @NO. OF TEMPERATURES
00266  362*             IF (IPCSEF.OR.IENGEF.OR.ICYCEF) THEN   @WILL READ EFFICIENCIES

00270  363*                                        @ OF POWER CONVERSION, ENGINE,
00270  364*                                        @ OR CYCLE.
00270  365*               MNT=NTRC
00271  366*               IF (NTRC.GT.NT) THEN

00273  367*                 MNT=NT                  @TO PREVENT ARRAY OVERFLOW
00274  368*                 ERPRINT ,'  *    *  WARNING: INPUT LIST OF EFFICIENCIES IS
00274  369*        &TOO LONG FOR ARRAY SIZE ALLOCATED.    *    *'
00301  370*                 ERPRINTO,'END OF OUTPUT MAY BE ERRONEOUS.'
00306  371*                 ERPRINTO,'USE SHORTER LIST OR RECOMPILE WITH LARGER VALUE
00306  372*        &OF PARAMETER NT'
00313  373*               ENDIF                     @ENDIF NTRC
```

```
00314  374*              IF (IPCSEF) THEN
00316  375*                ERPRINT ,'ENTER PCS EFFICIENCIES (FREE-FIELD, REAL)'
00323  376*              ELSEIF (IENGEF)
00325  377*                ERPRINT ,'ENTER ENGINE EFFICIENCIES (FREE-FIELD, REAL)'
00332  378*              ELSE
00333  379*                ERPRINT ,'ENTER CYCLE EFFICIENCIES (FREE-FIELD, REAL)'
00340  380*              ENDIF                          @ENDIF IPCSEF
00340  381*   C
00340  382*   C ***************************************************************************
00340  383*   C ***************************************************************************
00340  384*   C **                                                                       **
00340  385*   C **       INPUT TABLE OF EFFICIENCIES                                     **
00340  386*   C **                                                                       **
00340  387*   C ***************************************************************************
00340  388*   C ***************************************************************************
00340  389*   C
00341  390*                READ (5,110, ERR=92, END=80) (EFF(K), K=1,MNT)
00350  391*                ERPRINT ,' EFFICIENCIES ENTERED'
00355  392*             ENDIF                          @ENDIF IPCSEF,IENGEF,ICYCEF
00356  393*           ENDIF                            @ENDIF NWTORF
00356  394*   C
00356  395*   C    *     *     *     *     *     *     *     *     *     *     *     *
00356  396*   C    *     *     *     *     *     *     *     *     *     *     *     *
00356  397*   C
00356  398*   C     BLOCK 2.3.
00356  399*   C      CALCULATE CONCENTRATOR PERFORMANCE.
00356  400*   C
00356  401*   C    *     *     *     *     *     *     *     *     *     *     *     *
00356  402*   C         BLOCK 2.3.1
00356  403*   C          CLEAR INAPPLICABLE OUTPUT VALUES.
00356  404*   C          CHECK CONSISTENCY OF INSOLATION INPUT.
00356  405*   C
00357  406*           IF (IPCSEF.OR.IENGEF.OR.ICYCEF) THEN
00361  407*               PCEFCT=0.0                   @TO CLARIFY PRINTOUT
00362  408*               ENEFCT=0.0
00363  409*               CYCECT=0.0
00364  410*           ENDIF                            @ENDIF IPCSEF,IENGEF,ICYCEF
00365  411*           IF (HK.LE. 0.0) ARATIO=0.0       @TO CLARIFY PRINTOUT
00367  412*           IF (.NOT.SECONC)  THEN
00371  413*             RHO2=0.0                       @TO CLARIFY PRINTOUT
00372  414*             BS2 =0.0
00373  415*             PHI2=0.0
00374  416*             C2  =0.0
00375  417*           ENDIF                            @ENDIF SECONC
00376  418*           IF (INS .LE. 0.0) THEN
00400  419*             ERPRINT ,'INS MUST BE POSITIVE.'
00405  420*             CYCLE M
00406  421*           ENDIF                            @ENDIF INS
```

```
00406  422*   C
00406  423*   C     *     *     *     *     *     *     *     *     *     *     *     *
00406  424*   C          BLOCK 2.3.2.
00406  425*   C           CALL APPROPRIATE ENTRY OF SUBROUTINE OPT TO CHECK CONSISTENCY
00406  426*   C            OF INPUTS AND TO PERFORM PRELIMINARY CALCULATIONS STATED
00406  427*   C            THERE.
00406  428*   C

00407  429*             IF (OPTMZE) THEN

00411  430*               CALL CKOPT ($60)                                          00427
00412  431*             ELSE                                                        00433
00413  432*               CALL CKNOPT ($60)
00414  433*             ENDIF                          @ENDIF OPTMZE              00436
00414  434*   C
00414  435*   C *   *     *     *     *     *     *     *     *     *     *     *   *
00414  436*   C *        BLOCK 2.3.3.                                             *
00414  437*   C *         WRITE INPUT VALUES TO OUTPUT.                           *
00414  438*   C *         WRITE COLUMN HEADINGS FOR OUTPUT TABLE.                 *
00414  439*   C *         CLEAR ARRAYS FOR OUTPUT.                                *
00414  440*   C *   *     *     *     *     *     *     *     *     *     *     *   *
00414  441*   C

00415  442*             WRITE (6,NLIST)                @OUTPUT THE PARAMETERS USED.
00421  443*             IF ((NTRC+JJ+(2*NWTORF).GE. 5)                            00442
00421  444*          &   .OR.(NWTORF.AND.(.NOT.(IPCSEF.OR.IENGEF.OR.ICYCEF)))
00421  445*          &   .OR.(SECONC.AND.OPTMZE.AND.(.NOT.SUP2))) THEN

00423  446*                                            @START NEW PAGE IF WILL WRITE  00472
00423  447*               WRITE (6,'(1H1)')            @ A LOT
00427  448*             ELSE                           @ELSE DOUBLE-SPACE            00500
00430  449*               WRITE (6,'(1H0)')
00434  450*             ENDIF                          @ENDIF NTRC                   00505

00435  451*             IF (OPTMZE) THEN               @WRITE COLUMN HEADS

00437  452*                                            @ WHEN OPTIMIZE OR MAXIMIZE.  00507
00437  453*               IF (SECONC)

00440  454*                 WRITE (6,270)                @COLUMN HEADS WITH            00511
00443  455*                 WRITE (6,271)                @ SECONDARY CONCENTRATOR      00516
00446  456*                 WRITE (6,272)                                              00523
00451  457*                 WRITE (6,273)                                              00530
00454  458*                 IF (.NOT.SUP2) THEN                                        00535

00456  459*                   IF (MAXSEC) THEN                                         00537

00460  460*                     WRITE (6,290)          @SECOND LINE OF COLUMN HEADS  00541
00463  461*                     WRITE (6,291)                                        00546
00466  462*                     WRITE (6,292)                                        00553
00471  463*                     WRITE (6,293)                                        00560
00474  464*                   ELSE                                                   00566
00475  465*                     WRITE (6,295)
00500  466*                     WRITE (6,296)                                        00573
00503  467*                     WRITE (6,297)                                        00600
00506  468*                     WRITE (6,298)                                        00605
00511  469*                   ENDIF                    @ENDIF MAXSEC               00613
```

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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*          ENDLOOP                                    @ENDLOOP J

00602  494*          DO K=1,NT

00605  495*            DO J=1,2

00610  496*              TT(J,K)=0.0
00611  497*            ENDLOOP                                  @ENDLOOP J

00613  498*            DO J=1,5

00616  499*              OPTAA(J,K)=0.0
00617  500*            ENDLOOP                                  @ENDLOOP J

00621  501*            DO J=1,9

00624  502*              AA(J,K)=0.0
00625  503*            ENDLOOP                                  @ENDLOOP J

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

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                                                                00620
                                                                00625
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                                                                00642
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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)
```

```
00673  564*        &                                @COLLECTOR EFFICIENCY,                                    :::
00674  565*                                         @ WITH SECONDARY                                          ::: 01171
00674  566*          A(3)= A(2)-A(1)                @COLLECTOR EFFICIENCY                                     :::
00674  567*        &                                @ INCREASE DUE TO SECONDARY                               :::
00675  568*        ENDIF                            @ENDIF SECONC                                             ::: 01205
                                                                                                  ----------+:::
00676  569*        IF (IPCSEF) THEN                                                                          :::
                                                                                                  <---------+:::
00700  570*          A(4)=EFF(NTCNT)                @POWER CONVERSION SUBSYSTEM                               ::: 01207
00701  571*                                         @ EFFICIENCY USING PCSEFF.                                ::: 01224
00701  572*          IF (A(4).GT.CARNOT) THEN                                                                  :::
                                                                                                  <---------+:::
00703  573*            ERPRINT ,'PCS EFFICIENCY GREATER THAN CARNOT.'                                          :::: 01236
00710  574*            CYCLE ITRC                                                                              :::: 01240
00711  575*          ENDIF                          @ENDIF A(4)                                               :::: 01242
                                                                                                  ----------+:::
00712  576*        ELSEIF (PCEFCT.GT.0.0)                                                                    :::
00714  577*          A(4)=PCEFCT*CARNOT             @PCS EFFICIENCY                                           ::: 01246
00715  578*                                         @ USING PCEFCT OF CARNOT                                  ::: 01257
00715  579*        ELSE                             @USING PCSE=ENGE*GEARE*GENE                               :::
00716  580*          IF (IENGEF) THEN               @USING ENGEFF(T)                                          :::
                                                                                                  <---------+:::
00720  581*            ENGE=EFF(NTCNT)                                                                       :::: 01261
00721  582*            IF (ENGE.GT.CARNOT) THEN                                                              :::: 01271
                                                                                                  <---------+::::
00723  583*              ERPRINT ,'ENG EFFICIENCY GREATER THAN CARNOT.'                                      ::::: 01276
00730  584*              CYCLE ITRC                                                                          ::::: 01300
00731  585*            ENDIF                          @ENDIF ENGE                                           ::::: 01302
                                                                                                  ----------+::::
00732  586*          ELSEIF (ENEFCT.GT.0.0)           @USING ENGINE EFFICIENCY                                 ::::
00734  587*                                           @ ENEFCT OF CARNOT                                       :::: 01306
00734  588*            ENGE=ENEFCT*CARNOT                                                                     ::::
00735  589*          ELSE                             @USING ENGE=CYCE*MECHE*AUXE                              :::: 01312
00736  590*            IF (ICYCEF) THEN               @USING CYCEFF(T)                                         ::::
                                                                                                  <---------+::::
00740  591*              CYCE=EFF(NTCNT)                                                                     ::::: 01314
00741  592*              IF (CYCE.GT.CARNOT) THEN                                                            ::::: 01324
                                                                                                  <---------+:::::
00743  593*                ERPRINT ,'CYCLE EFFICIENCY GREATER THAN CARNOT.'                                  :::::: 01331
00750  594*                CYCLE ITRC                                                                        :::::: 01333
00751  595*              ENDIF                            @ENDIF CYCE                                         :::::: 01335
                                                                                                  ----------+:::::
00752  596*              ELSE                                                                                :::::
00753  597*                CYCE=CYCECT*CARNOT                                                                :::::
00754  598*              ENDIF                          @ENDIF ICYCEF                                         ::::: 01340
                                                                                                  ----------+::::
00755  599*              ENGE=CYCE*MECHE*AUXE                                                                 ::::
00756  600*            ENDIF                          @ENDIF IENGEF                                           :::: 01344
                                                                                                  ----------+:::
00757  601*            A(4)=ENGE*GEARE*GENE                                                                  :::
00760  602*          ENDIF                            @ENDIF IPCSEF                                           ::: 01355
                                                                                                  ----------+::
00761  603*          A(5)=A(1)*A(4)*PPE               @SYSTEM EFFICIENCY                                      ::
00762  604*                                           @ W/O SECONDARY                                         :: 01400
00762  605*          A5MAX=AMAX1(A5MAX,A(5))                                                                 ::
00763  606*          IF (SECONC) THEN                                                                        :: 01405
                                                                                                  <---------+::
```

```
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)                                                                :::: 01470
00774  614*                ENDLOOP                     @ENDLOOP J                                          :::: 01506
                                                                                                        ----+:::
00776  615*              ELSE                          @NO SECONDARY CONCENTRATOR                          :::
00777  616*                AA(1,NTCNT)=A(1)                                                                ::: 01510
01000  617*                AA(2,NTCNT)=A(4)                                                                ::: 01524
01001  618*                AA(3,NTCNT)=A(5)                                                                ::: 01540
01002  619*              ENDIF                         @ENDIF SECONC                                       ::: 01556
                                                                                                        ----+::
01003  620*    50          CONTINUE                    @ERROR RETURN FOR                                   ::
01004  621*                                            @ SUBROUTINE OPTAP                                  ::
01004  622*            ENDLOOP                         @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                                                                    : 01564
                                                                                                        <---+:
01011  634*              DO K=1,NTCNT                                                                      :: 01571
                                                                                                        <---+::
01014  635*                AA(8,K)=AA(5,K)/A5MAX                                                           ::: 01600
01015  636*                AA(9,K)=AA(6,K)/A6MAX                                                           ::: 01615
01016  637*                XFLAG=.FALSE.               @FLAG, SET TRUE TO IDENTIFY THOSE                   ::: 01632
01017  638*                                            @ LINES OF OUTPUT TABLE TO BE                       ::: 01633
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.                                      :::: 01635
01023  643*                  IF ((AA(8,K).GT.(1.0-BOUND)).OR.(AA(9,K).GT.(1.0-BOUND)))                       :::: 01652
01023  644*         &         XFLAG=.TRUE.                                                                   ::::
01025  645*                ENDIF                       @ENDIF XTRACT                                       :::: 01704
                                                                                                        ----+:::
01026  646*                IF (OPTMZE) THEN                                                                :::
                                                                                                        <---+:::
01030  647*                  IF (MORDEC) THEN                                                              :::: 01706
                                                                                                        <---+::::
01032  648*                    WRITE (6,780) ((TT(J,K),J=1,2),(OPTAA(J,K),J=1,4),                            ::::: 01710
01032  649*         &           (AA(J,K),J=1,9))                                                           :::::
01051  650*                  ELSE                                                                          ::::: 02001
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*                  ENDIF                     @ENDIF MORDEC                                       ::::: 02071
```

```
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*             ENDLOOP                          @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)
```

```
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                          @ENDIF MORDEC
01357  704*                   IF (XFLAG)
01357  705*        &            WRITE (100,235) ((TT(J,K),J=1,2), (AA(J,K), J=1,4))
01373  706*                 ENDIF                          @ENDIF OPTMZE
01374  707*               ENDLOOP                          @ENDLOOP K
01376  708*             ENDIF                              @ENDIF SECONC
01377  709*    60       CONTINUE                         @ERROR RETURN FOR
01400  710*                                              @ SUBROUTINES CKNOPT AND CKOPT.
01400  711*             NWTORF=.FALSE.                   @MUST INPUT NAMELIST NWTORF=T IN
01401  712*                                              @ NEXT SET OF DATA IF WANT NEW
01401  713*                                              @ RECEIVER TEMPERATURES OR
01401  714*                                              @ NEW EFFICIENCIES FOR POWER
01401  715*                                              @ CONVERSION..
01401  716*             DO J=1,32                        @RESTORES INPUT VALUES THAT WERE
01404  717*               Z(J)=Y(J)                      @ SAVED.
01405  718*             ENDLOOP                          @ENDLOOP J
01407  719*           ENDLOOP                            @ENDLOOP M
01411  720*                                              @GO BACK AND READ NEW INPUTS
01411  721*    C
01411  722*    C *    *     *     *     *     *     *     *     *     *     *     *   *
01411  723*    C *    *     *     *     *     *     *     *     *     *     *     *   *
01411  724*    C *    *     *     *     *     *     *     *     *     *     *     *   *
01411  725*    C
01411  726*    C BLOCK 3.
01411  727*    C  NORMAL STOP OF PROGRAM AFTER 1000 SETS OF DATA.
01411  728*    C
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
```

```
                                                                                  03132
                                                                                  03134
                                                                                  03204
                                                                                  03253
                                                                                  03327
                                                                                  03332
                                                                                  03351
                                                                                  03353
                                                                                  03360
                                                                                  03362
                                                                                  03367
```

```
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.',' 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
```

```
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                  03401
01506  819*                                           @ EXTRACT HAS BEEN REQUESTED.               03411
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.             03421
                                                                  <-------------------------+
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).          : 03423
01523  840*           WRITE (98,105)  INREAD           @ USES FILE 98 FOR TEMPORARY             : 03435
01527  841*                                           @ STORE AND RE-READ (NAMELIST).           : 03445
01527  842*           WRITE (6,205) INREAD             @ECHO PRINT                              :
01533  843*           IF (XTRON) WRITE (100,205) INREAD   @ECHO TO EXTRACT, IF                  : 03455
01540  844*                                           @ EXTRACT REQUESTED IN PRECEDING          : 03472
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)           : : 03512
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 '&'          : : :
```

```
01550           ENDLOOP                    @ENDLOOP L                                                   ::: 03534
                                                                              --------------------------+::
01552          ENDLOOP                     @ENDLOOP K                                                    ::
                                                                              --------------------------+:
01554         ENDLOOP                      @ENDLOOP J.                                                    :
                                                                              --------------------------+
01556                                      @ ENDS FIRST READ (ALPHANUMERIC).
01556         REWIND 98                    @RESETS FILE 98 FOR
01560                                      @ NAMELIST READ                                                  03537
01560   C
01560   C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
01560   C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
01560   C
01560   C BLOCK S.2
01560   C  NAMELIST READ OF DATA FROM TEMPORARY FILE.
01560   C
01560         READ (98, NLIST, ERR=95, END=96)
01564         REWIND 98                    @RESET                                                           03545
01564   C
01564   C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
01564   C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
01564   C
01564   C BLOCK S.3
01564   C  ON INITIAL REQUEST FOR EXTRACT, CATALOGS AND ASSIGNS FILE FOR THIS
01564   C    OUTPUT.
01564   C
01566         IF ((XTRACT).AND.(.NOT.ASG100)) THEN                                                          03550
                                                                              <-------------------------+
01570           CALL ASSIGN('@CAT,P XTRACT(+1)',IDUMM,1,$97)                                            : 03553
01571           CALL ASSIGN('@ASG,A XTRACT',IDUMM,1,$97)                                                : 03561
01572           ISTAT=CSF8(3,'@USE 100,XTRACT')                                                         : 03567
01573           IF (ISTAT.LT.0) GO TO 97                                                                : 03574
01575           ASG100=.TRUE.                                                                           : 03600
01576         ENDIF                        @ENDIF XTRACT/ASG100                                         : 03602
01576   C                                                                                               :
01576   C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *                                     :
01576   C                                                                                               :
01576   C    IF EXTRACT IS REQUESTED NOW AND HAS NOT BEEN PREVIOUSLY REQUESTED,                         :
01576   C     ECHOES INPUT TO EXTRACT FILE.                                                             :
01576   C                                                                                               :
                                                                              --------------------------+
01577         IF ((XTRACT).AND.(.NOT. XTRON)) THEN
                                                                              <-------------------------+
01601           WRITE (100,212) NSET                                                                    : 03605
01605           DO J=1,JJ                                                                               : 03613
                                                                              <------------------------+:
01610             READ (98, 105, ERR=95, END=96)  INREAD                                               :: 03620
01614             WRITE (100,205) INREAD       @TO EXTRACT FILE.                                       :: 03632
01620           ENDLOOP                    @ENDLOOP JJ                                                 :: 03644
                                                                              ------------------------+:
01622           REWIND 98                                                                               :
01624         ENDIF                        @ENDIF XTRACT/XTRON                                          : 03647
                                                                              --------------------------+
01625         IF (XTRACT) THEN
                                                                              <-------------------------+
01627           XTRON=.TRUE.                                                                            : 03651
01630         ELSE                                                                                      : 03654
```

```
01631  903*            XTRON=.FALSE.
01632  904*          ENDIF                                  @ENDIF XTRACT                                    03655
01632  905*    C
01632  906*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01632  907*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01632  908*    C
01632  909*    C BLOCK S.4
01632  910*    C  RETURN AND STOPS
01632  911*    C
01632  912*    C   NORMAL STOP WHEN @EOF READ IN INPUT.
01633  913*          RETURN
01634  914*    70    STOP NORMAL                                                                              03657
01634  915*    C
01634  916*    C   ABNORMAL STOPS.
01635  917*    75    ERPRINT , 'BAD NAMELIST FIRST READ'                                                      03661
01642  918*          STOP BDREAD                                                                              03666
01643  919*    95    ERPRINT , 'BAD NAMELIST REREAD'                                                          03670
01650  920*          STOP BDREAD                                                                              03675
01651  921*    96    ERPRINT , '@EOF ON NAMELIST REREAD'                                                      03677
01656  922*          STOP BDREAD                                                                              03704
01657  923*    97    ERPRINT ,'BAD @CAT/ASG/USE OF FILE 100. NO EXTRACT FILE PREPARED.'                       03706
01664  924*          XTRACT=.FALSE.                                                                           03713
01665  925*          RETURN                                                                                   03714
01665  926*    C
01665  927*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01665  928*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01665  929*    C
01665  930*    C BLOCK S.5
01665  931*    C  SUBROUTINE INPUT AND OUTPUT FORMATS.
01665  932*    C
01666  933*    105   FORMAT (13A6,A2)                                                                         03740
01667  934*    205   FORMAT (1H ,13A6,A2)
01670  935*    211   FORMAT (1H1,'SET',I6)
01671  936*    212   FORMAT (1H0,'SET',I6)
01671  937*    C
```

```
01671  938*    C
01671  939*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01671  940*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01671  941*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01671  942*    C
01672  943*          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.
```

```
01672  959*    C
01672  960*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01672  961*    C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
01672  962*    C BLOCK E.0
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/                      @VARIENCE 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*         & /                                    @TABLE OF FOCAL RATIOS AT
01707  998*                                                @ 1 DEGREE INCREMENTS OF RIM
01707  999*                                                @ ANGLE (1 TO 60 DEGREES,
01707 1000*                                                @ 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 *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
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*DELTSQ*(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*DELTSQ*(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      DELTSQ=(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*              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*           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*             ERPRINT0,'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*           DELTSQ=(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'
01771 1068*         RETURN 1
01772 1069*       ENDIF                            @ENDIF DELTSQ

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

01777 1072*           IF (MAXC.OR.MAXPHI) THEN

02001 1073*             ERPRINT ,'CANNOT MAXIMIZE C OR PHI WITHOUT ACCEPTABLE RIM AN
02001 1074*     &GLE OR FOCAL RATIO'
02006 1075*             RETURN 1
02007 1076*           ELSE
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

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
02026 1086*     &LY POSSIBLE WITHOUT F OR RMA INPUT.'
02033 1087*               RETURN
02034 1088*             ENDIF                        @ENDIF SECONC

02035 1089*             RETURN
02036 1090*           ENDIF                          @ENDIF MAXC/MAXPHI

02037 1091*         ELSEIF ((PARAB).AND.(F.LE. 10.0))     @F INPUT
02041 1092*           IF (.NOT. IRFLG) THEN          @PREPARES RMARAY IF NOT

02043 1093*             DO I=1, 90                   @ ALREADY PREPARED

02046 1094*               RMARAY(I)=I
02047 1095*             ENDLOOP                      @ENDLOOP I

02051 1096*             IRFLG=.TRUE.
02052 1097*           ENDIF                          @ENDIF IRFLG

02053 1098*           CALL SLUP(F,RMA,DUMMY,FRAY,RMARAY,90,2)
02054 1099*                                          @TABLE LOOKUP AND INTERPOLATION
02054 1100*                                          @ TO GET RIM ANGLE FOR
02054 1101*                                          @ PARABOLOIDAL CONTOUR.
02054 1102*           RMAR=RMA*PI/180.0              @CONVERT TO RADIANS
02055 1103*         ELSE
02056 1104*           RMAR=ATAN2(1.0,(2.0*F))        @FOCAL LENGTH OUTSIDE
02057 1105*           RMA=RMAR/(PI/180.0)            @ OF TABLE RANGE,
02060 1106*                                          @ OR PLANAR CONTOUR.
02060 1107*         ENDIF                            @ENDIF F

02061 1108*       ELSE                               @RMA INPUT
```
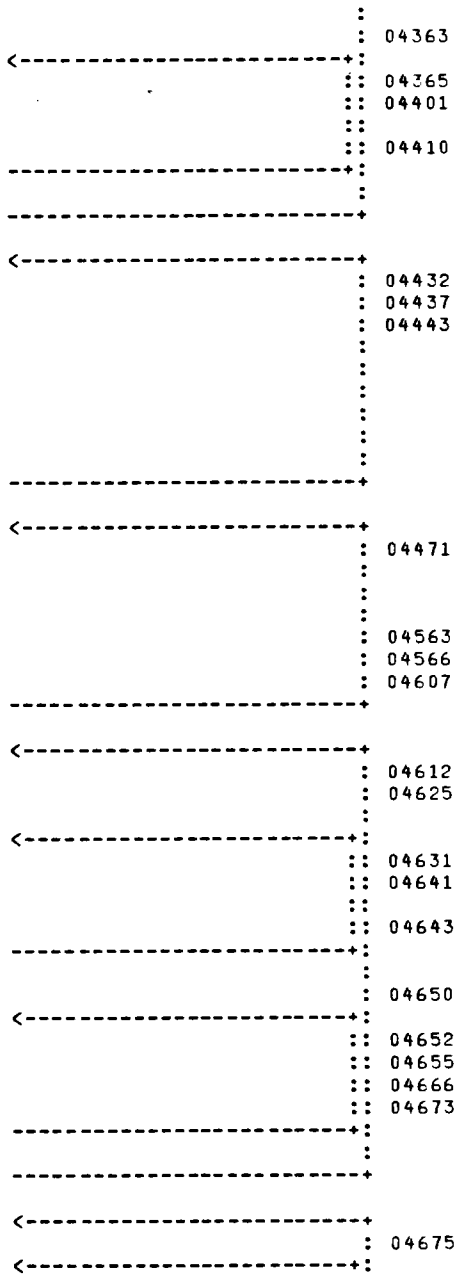

```
02062 1109*           RMAR=RMA*(PI/180.0)
02063 1110*           IF (PARAB) THEN

02065 1111*             F=(1.0+C)/(4.0*S)
02066 1112*           ELSE
02067 1113*             F=1.0/(2.0*T)
02070 1114*           ENDIF                                  @ENDIF PARAB

02071 1115*         ENDIF                                    @ENDIF RMA

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                                    @ENDIF C,S
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
02107 1132*           SIG2DF=2.0*DELTSQ*(1.0+2.0*(C**2))/(3.0*RMAR*C*S)
02110 1133*         ENDIF                                    @ENDIF PARAB

02111 1134*         IF (MAXPHI.AND.(.NOT.MAXC)) THEN

02113 1135*           PHI1=1.0-EXP(-1.0/(C1*SIG2DF))
02114 1136*         ELSE
02115 1137*           IF (PHI1.LT. 1.0) THEN

02117 1138*             PHI1FC=-ALOG(1.0-PHI1)
02120 1139*           ELSE
02121 1140*             PHI1FC=VF
02122 1141*           ENDIF                                  @ENDIF PHI1

02123 1142*           C1MAX= 1.0/(SIG2DF*PHI1FC)
02124 1143*           IF (MAXC) THEN

02126 1144*             C1=C1MAX
02127 1145*           ELSEIF ((.NOT.MAXPHI).AND.(C1.GT.C1MAX))
02131 1146*             ERPRINT ,'WARNING! C1 GREATER THAN OPTICALLY POSSIBLE.'
02136 1147*           ENDIF                                  @ENDIF MAXC

02137 1148*         ENDIF                                    @ENDIF MAXPHI

02140 1149*         IF (SECONC)

02141 1150*           IF (MAXPHI.AND.(.NOT.MAXC))THEN
```



```
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(DELTSQ)                                                   :
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).
```

```
02241 1196*    C  ALSO SETS UP RECEIVER APERTURE OPTIMIZATION.
02241 1197*    C
02241 1198*           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
02244 1207*                                               @ EACH TEMPERATURE.
02244 1208*           C1S=0.0
02245 1209*           PHI1S=0.0
02246 1210*           IF (MAXC.OR.MAXPHI) THEN
02250 1211*            ERPRINT ,'WARNING: CANNOT OPTIMIZE AND MAXIMIZE C SIMULTANEOUSLY'
02255 1212*            ERPRINTO,' WILL IGNORE MAXIMIZATION.'
02262 1213*           ENDIF                               @ENDIF MAXC/MAXPHI
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))
02265 1216*          &    .OR.(F .GT. 25.0)) THEN
02267 1217*              ERPRINT ,' TO OPTIMIZE MUST PROVIDE ACCEPTABLE RIM ANGLE OR FO
02267 1218*          &CAL RATIO'
02274 1219*              RETURN 1
02275 1220*             ELSEIF ((PARAB).AND.(F.LE. 10.0))     @F INPUT
02277 1221*               IF (.NOT. IRFLG) THEN             @PREPARES RMARAY IF NOT
02301 1222*                 DO I=1, 90                      @ ALREADY PREPARED
02304 1223*                   RMARAY(I)=I
02305 1224*                 ENDLOOP                         @ENDLOOP I
02307 1225*                 IRFLG=.TRUE.
02310 1226*               ENDIF                             @ENDIF IRFLG
02311 1227*               CALL SLUP(F,RMA,DUMMY,FRAY,RMARAY,90,2)
02312 1228*                                                 @TABLE LOOKUP AND INTERPOLATION
02312 1229*                                                 @ TO GET RIM ANGLE FOR
02312 1230*                                                 @ PARABOLOIDAL CONTOUR.
02312 1231*               RMAR=RMA*PI/180.0                 @CONVERT TO RADIANS
02313 1232*             ELSE
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.
02316 1236*             ENDIF                               @ENDIF F
02317 1237*            ELSE IF (RMA.GE. 90.0)
02321 1238*              ERPRINT ,'RIM ANGLE TOO LARGE'
02326 1239*              RETURN 1
02327 1240*            ELSE                                 @RMA BETWEEN 0.0 AND 90.0
02330 1241*              RMAR=RMA*(PI/180.0)
02331 1242*              IF (PARAB) THEN
```

```
02333 1243*            F=(1.0+C)/(4.0*S)                                                    :: 05307
02334 1244*          ELSE                                                                   :: 05323
02335 1245*            F=1.0/(2.0*T)                                                        ::
02336 1246*          ENDIF                              @ENDIF PARAB                       :: 05332
                                                                                          -----------+
02337 1247*        ENDIF                                @ENDIF RMA                          :
02337 1248*   C                                                                             :
02337 1249*   C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *     :
02337 1250*   C                                                                             :
02337 1251*   C     BLOCK E.2.2.                                                            :
02337 1252*   C      CALCULATES ANGULAR SPREAD OF SUNLIGHT LEAVING LOCAL AREA OF            :
02337 1253*   C       MIRROR OR LENS.                                                       :
02337 1254*   C      CALCULATES FOCAL PLANE FLUX DISTRIBUTION.                              :
02337 1255*   C      MAXIMIZES SECONDARY CONCENTRATION RATIO, IF REQUESTED.                 :
02337 1256*   C                                                                             :
                                                                                          -----------+
02340 1257*        DELTSQ=(2.0*SLOPER/1000.0)**2+(SPECUL/1000.0)**2+(SOLSD/1000.0)**2
02341 1258*                                           @VARIANCE OF GAUSSIAN ANGULAR                  05347
02341 1259*                                           @ DISTRIBUTION OF SUNLIGHT
02341 1260*                                           @ LEAVING A LOCAL AREA OF MIRROR
02341 1261*                                           @ OR LENS.
02341 1262*        IF ((C .LE. 0.0) .OR. (S .LE. 0.0)) THEN     @TO PREVENT DIVIDE
                                                                                          <-----------+
02343 1263*          ERPRINT ,'NOTE* RIM ANGLE OUTSIDE OF RANGE.'    @ BY ZERO OR LOG     : 05371
02350 1264*          RETURN 1                         @ OF NEGATIVE NUMBER.               : 05376
02351 1265*        ENDIF                              @ENDIF C,S                          : 05402
                                                                                          -----------+
02352 1266*        IF (PARAB) THEN
                                                                                          <-----------+
02354 1267*          SIG2DF=2.0*DELTSQ*(1.0/(RMAR*((TAN(RMAR/2.0))**2)))*    @DUFF-       : 05430
02354 1268*       &   ((-1.0/(3.0*(S**3)*C))+(2.0/(3.0*(S**3)))+(2.0/S)-    @ LAMEIRO     :
02354 1269*       &   (C/(3.0*(S**3)))-(2.0*C/S)+((4.0*S)/(3.0*C))-         @ SPREAD      :
02354 1270*       &   ALOG(TAN(P4+RMAR/2.0))+ALOG(TAN(P4-RMAR/2.0)))     @ FUNCTIONS.     :
02355 1271*        ELSE                                                                   : 05522
02356 1272*          SIG2DF=2.0*DELTSQ*(1.0+2.0*(C**2))/(3.0*RMAR*C*S)                    : 05525
02357 1273*        ENDIF                              @ENDIF PARAB                        : 05546
                                                                                          -----------+
02360 1274*        IF (SECONC) THEN
                                                                                          <-----------+
02362 1275*          IF ((C2 .LE. 0.0).AND.(.NOT.MAXSEC)) THEN                            : 05550
                                                                                          <----------+:
02364 1276*            ERPRINT ,'C2 MUST BE POSITIVE.'                                    :: 05560
02371 1277*            RETURN 1                                                           :: 05565
02372 1278*          ENDIF                              @ENDIF C2                       :: 05571
                                                                                          ----------+:
02373 1279*          IF ((PHI2.LE. 0.0).OR.(PHI2.GT. 1.0)) THEN                           :
                                                                                          <----------+:
02375 1280*            ERPRINT ,'WARNING!  PHI2 MUST BE POSITIVE AND NOT OVER 1.0'        :: 05604
02402 1281*            ERPRINT ,'SETTING PHI2=1.0'                                        :: 05611
02407 1282*            PHI2=1.0                                                           :: 05616
02410 1283*          ENDIF                              @ENDIF PHI2                     :: 05620
                                                                                          ----------+:
02411 1284*          DELT=SQRT(DELTSQ)                                                    :
02412 1285*          C2MAX=1.0/(((SIN(RMAR+DELT))**2)*PHI2)                               : 05624
02413 1286*          IF (MAXSEC) THEN                                                     : 05636
                                                                                          <----------+:
02415 1287*            C2HOLD=C2MAX                                                       :: 05640
```

```
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

```
$LGIF$          *332, *412, *427, *474, *513, *531, *547, *715, *735, *752, *776, *1051, *1133, *1151, *1167, *1223, *1263, *1324
                *1342, *1630, *2007, *2055, *2061, *2066, *2106, *2114, *2120, *2144, *2150, *2313, *2327, *2334, *2355, *2477
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80L             225, 341, *1411
90L             225, *1415
92L             341, *1423
95L             1560, 1610, *1646
96L             1560, 1610, *1654
```

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            2346, 2367, 2400, 2405, 2424, 2440, 2471
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            2476, 2500
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PHI1S       113, 114, *123, 673, *1560, 1756, *1757, 2020, *2143, 2145, 2147, 2221, 2222, *2245, *2454, 2456, 2457, 2476
PHI1SF      *2147, *2151, 2153
PHI2        113, 114, *124, *373, 673, 1116, 1125, 1134, 1142, *1560, 2201, *2215, 2220, 2223, 2373, *2407, 2412, 2452, 2454
PI          *172, 173, 2054, 2057, 2062, 2312, 2315, 2330
PPE         113, 114, *154, 761, 765, *1560
PRINT$      221, *223, *261, *277, *304, *311, *321, *330, *336, *353, *403, *572, *654, *706, *726, *746, *1415, *1423, *1511
            *1640, *1646, *1654, *1662, *1720, *1731, *1742, *1747, *1767, *2004, *2014, *2024, *2031, *2077, *2134, *2164, *2175
            *2206, *2213, *2234, *2253, *2260, *2272, *2324, *2346, *2367, *2400, *2405, *2424, *2440, *2471
P4          *173, 2105, 2354
RHO1        113, 114, *116, 634, *1560
RHO2        113, 114, *117, *371, 635, *1560
RMA         113, 114, *131, *1560, 1773, *2053, 2054, *2057, 2062, 2263, *2311, 2312, *2315, 2317, 2330
RMAR        1707, 1710, 1711, *2054, *2056, 2057, *2062, 2065(S), 2065(C), 2067(T), 2072(C), 2072(S), 2105, 2105(S), 2105(C)
            2105(S), 2105(C), 2105(S), 2105(C), 2105(S), 2105(C), 2107, 2107(S), 2107(C), 2223, *2312, *2314, 2315, *2330, 2333(S)
            2333(C), 2335(T), 2341(S), 2341(C), 2354, 2354(S), 2354(C), 2354(S), 2354(C), 2354(S), 2354(C), 2354(S), 2356, 2356(C)
            2356(S), 2412
RMARAY      1676, *2046, *2053, *2304, *2311
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S             1707, 2065, 2072, 2105, 2107, 2333, 2341, 2354, 2356
SECONC        111, 114, *161, 367, 421, 437, 532, 671, 763, 1007, *1560, 1752, 2016, 2140, 2360, 2450
SIG2DF        *2105, *2107, 2113, 2123, 2143, 2153, *2354, *2356, 2444, 2446, 2452, 2454
SIN           1707, 2065(S), 2072(S), 2105(S), 2107(S), 2220, 2223, 2333(S), 2341(S), 2354(S), 2356(S), 2412, 2455
SLOPER        113, 114, *132, *1560, 1761, 2340
SLUP          *2053, *2311
SOLSD         113, 114, *134, *1560, 1761, 2340
SPECUL        113, 114, *133, *1560, 1761, 2340
SQRT          2217, 2411
SUP2          111, 114, *170, 421, 454, 1112, *1560
T             1711, 2067, 2335
TAC           113, 114, *137, 631, *1560
TAK           *631, 664, 665
TAN           1711, 2067(T), 2105, 2335(T), 2354
TIK           *646, 647, 661
TOC           113, 114, *144, 660, *1560
TOK           *660, 661
TRK           *645, 646, 664, 665
TRMA          *634, 635, 670, 2444, 2446
TRMAS         *635, 673, 2452, 2454
TRMB          *664, 670, 673, 2433, 2444, 2446, 2452, 2454
TRMC          *665, 670, 673
TT            112, *610, *662, *663, 1032, 1052, 1073, 1154, 1170, 1205, 1244, 1264, 1305, 1327, 1343, 1360
VF            1701, 2010, 2020, 2121, 2151, 2222, 2457
XFLAG         111, *1016, *1022, *1024, 1072, 1124, 1141, 1204, *1230, *1234, *1236, 1304, 1357
XTRACT        111, 114, *167, 241, 1017, 1231, *1560, 1566, 1577, 1625, *1664
XTRON         111, *200, 1501, 1533, 1577, *1627, *1631
Y             112, *211, 1404
Z             112, 113, 211, *1404
        REFERENCE TO EXTERNAL FUNCTION    ASSIGN
           ARGUMENT           1
               1570   B/C   ,   1571   B/C
           ARGUMENT           2
               1570   I/V   ,   1571   I/V
           ARGUMENT           3
               1570   I/C   ,   1571   I/C
           ARGUMENT           4
               1570   L/L   ,   1571   L/L
        FUNCTION        CKNOPT    1712
           ARGUMENT      1     LABLE/LABLE
               413   L/L
        FUNCTION        CKOPT     2241
           ARGUMENT      1     LABLE/LABLE
               411   L/L
        REFERENCE TO EXTERNAL FUNCTION    CSF8
           ARGUMENT           1
               1572   I/C
           ARGUMENT           2
               1572   B/C
        FUNCTION        OPTAP     2432
           ARGUMENT      1     LABLE/LABLE
               667   L/L
        REFERENCE TO EXTERNAL FUNCTION    PRINT$
           ARGUMENT           1
               223   I/EX  ,   261   I/EX  ,   277   I/EX  ,   304   I/EX  ,   311   I/EX  ,   321   I/EX  ,
               330   I/EX  ,   336   I/EX  ,   353   I/EX  ,   403   I/EX  ,   572   I/EX  ,   654   I/EX  ,
               706   I/EX  ,   726   I/EX  ,   746   I/EX  ,   1415  I/EX  ,   1423  I/EX  ,   1511  I/EX  ,
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          1640   I/EX  ,   1646   I/EX  ,   1654   I/EX  ,   1662   I/EX  ,   1720   I/EX  ,   1731   I/EX  ,
          1742   I/EX  ,   1747   I/EX  ,   1767   I/EX  ,   2004   I/EX  ,   2014   I/EX  ,   2024   I/EX  ,
          2031   I/EX  ,   2077   I/EX  ,   2134   I/EX  ,   2164   I/EX  ,   2175   I/EX  ,   2206   I/EX  ,
          2213   I/EX  ,   2234   I/EX  ,   2253   I/EX  ,   2260   I/EX  ,   2272   I/EX  ,   2324   I/EX  ,
          2346   I/EX  ,   2367   I/EX  ,   2400   I/EX  ,   2405   I/EX  ,   2424   I/EX  ,   2440   I/EX  ,
          2471   I/EX
     REFERENCE TO EXTERNAL FUNCTION    SLUP
        ARGUMENT          1
          2053   R/V   ,   2311   R/V
        ARGUMENT          2
          2053   R/V   ,   2311   R/V
        ARGUMENT          3
          2053   R/V   ,   2311   R/V
        ARGUMENT          4
          2053   R/A   ,   2311   R/A
        ARGUMENT          5
          2053   R/A   ,   2311   R/A
        ARGUMENT          6
          2053   I/C   ,   2311   I/C
        ARGUMENT          7
          2053   I/C   ,   2311   I/C

CTP=32.164  SUP=24.702  CPU=4.538  IO=16.310  CC-ER=3.853
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