COBRA-IIA

A PROGRAM FOR THERMAL-HYDRAULIC
ANALYSIS IN VERY LARGE BUNDLES
OF FUEL PINS

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August 1970

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ABSTRACT

A description is given of the digital computer program COBRA-IIA. This program is an extension of the COBRA II code written at the Pacific Northwest Laboratories for rod bundle subchannel analysis involving steady-state single or two-phase flow. The basic method of calculation used in COBRA has been retained, with a finite difference solution obtained at each axial node. Typically, the volume the axial node approximates is the entire subchannel of incremental depth. An extensive set of refinements has been made to the COBRA II code to allow analysis of very much larger bundles of rods, with significantly less complex input and several model additions, including the effects of rotating spacer wires. Those features which differ from the COBRA II code are described in this report in some detail. Program documentation and input instructions, as well as sample problems are provided.

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INTRODUCTION

The COBRA-IIA digital computer program is an extension of COBRA II.⁽¹⁾ As with the parent code, a solution is found for an initial value problem in a multichannel geometry. Time invariant single and two-phase flow is permitted. The coolant in each channel is described by a lumped model in which the fluid in each nodal cell is presumed to be in a uniform state. Energy and most of the momentum is transferred according to the impressed gradients. Then mass is diverted appropriately to satisfy continuity of mass and momentum requirements with an updating of the energy balance.

The COBRA II program possesses the disadvantage of being limited in the size of the problems it can consider. Furthermore, as the problem size increases, the input complexity leads to long preparation times and extensive input. These limitations, as well as the availability of certain features previously built into a version of COBRA used for FFTF design, led to the development of a specialized Univac 1108 version, COBRA-IIA.

COBRA-IIA employs a scheme to translate full bundle description to adequate program description of a smaller segment cut along lines of symmetry but exclusive of connections. Furthermore, a specialized wire wrap model is included. Testing of this model has been limited by the scant experimental data available. However, the results have been encouraging to date.

Special programming has been employed to reduce the complexity of input. For example, various data can be stored on a tape or on a Fastrand Drum file to be used as partial input for a problem. Consequently, the time to set up a problem is reduced significantly.

Special "fixes" to obtain a stable solution have been required in some problems.

LARGE PROBLEM SOLUTIONS

One of the principal goals in the development of this program was the economic solution of large problems without compromising accuracy or any of the calculational details in COBRA. For example, the 217-pin half-bundle problem required four to five times the available Univac 1108 memory when using COBRA II. In order to be able to solve the problem, several of the large rectangular arrays were eliminated or reshaped to exclude all unnecessary zeroes, and the basic matrix solution was reprogrammed. Because of the bulk of output data, provision is made to collect channel output data on tape for printing and editing in the same or a later run. Misjudgment of program running time may lead to premature execution termination. The adverse effects of this have been circumvented by clock watching (subroutine TCHEK) and incorporating Dump-Restart options.

PARAMETERS

Two Fortran V compiler features are used in COBRA II to allow the user to reshape data memory. The first feature is one which allows DIMENSION statements to be given in terms of parameter variables. The DIMENSION statements are preceded in compilation by a PARAMETER statement assigning values to each of the parameters. The Fortran V INCLUDE statement (used with an FCOPY block in a PDP element) enables the same copy of the PARAMETER, DIMENSION, and other common statements to be used

in all subprograms when they are compiled. Table 1 lists the parameter values compiled into two standard implementations of COBRA-IIA.

TABLE 1. Parameters Used in Two Versions of COBRA-IIA

<u>Parameter Name</u>	<u>Standard Version Value</u>	<u>Large-Problem Version Value</u>	<u>Use of Parameter</u>
MA	10	10	Number of area variation types
MB	5	5	Number of bypass connections
MC	45	227	Number of channels
MD	5	5	Number of spacer types
MG	60	330	Number of gaps (connections)
ML	31	31	Number of nodes, for tabular data
MN	7	7	Number of columns in AAA
MP	30	30	Number of property table entries
MR	25	113	Number of rods
MS	10	10	Number of gap variation types
MT	14	14	Number of wire-wrap types
MW	31	1	Number of axial nodes in core at one time
MAAAS	3600	2310	Mutual total dimension for AAA in DIVERT and DIVERS
NZ	6	6	Number of channels per rod

NEW VERSIONS OF COBRA-IIA

All of the program changes made to accommodate large problems have been incorporated into the standard version of COBRA-IIA, although some are necessary only in large-problem versions. The purpose was to create one working program with capability to handle routinely a large number of anticipated needs. A change in one parameter card in the shared PDP element BASIC and recompilation of the set of Fortran subprograms which use COMMON statements is the only step required to go from standard COBRA-IIA to a large-problem

version. Since there may be some operational differences between versions (matrix inversion, output printing), additional Fortran statements can be added to provide appropriate printout comments. Figure 1 lists a set of cards used to create a large-problem version from the standard version. If the option to use subroutine DIVERT is retained in the new version (option is removed in all large-problem versions), subroutines DIVERT, DECOMP, and SOLVE must also be recompiled, each with a parameter card update for matrix AAA. (See Large Problems, Subroutine DIVERS.)

ARRAY KCHAN

In COBRA II the matrix KCHAN was a square array (which would use 51,529 locations in a 227-channel problem) of connection indices of adjacent channels. The array has been replaced by a Function subprogram with channel numbers as arguments rather than subscripts. The net effect is the same, and no reprogramming of references to KCHAN was necessary.

ARRAY DD

The data arrays DD and AAA used in the solution of the basic transverse momentum equation have been redefined to minimize the storage space they require. DD is now dimensioned (MG, 2), where MG is the number of channel-to-channel (Gap) connections. The first column of DD contains i-to-j data (with the direction of w considered) and the second has the appropriate j-to-i data for each connection.

ARRAY AAA

Matrix AAA, the coefficient array in the solution of $Aw = b$, is used presently in either of two forms. The special new form contains the same data as the original form, but it is organized differently. For all large problems, and for small problems using the MIFLAG = 2 input option, AAA is

```

▽ ASG,W B=U2192(NEWCOD)
▽ XQT CUR
IN B
VITL PDP,* BASIC,BASIC
-24,25
    PARAMETER MA=10,MB=5,MC=227,MG=330,ML=31,MN=7,MP=30,
    X MR=113,MS=10,MT=14,MW=1,MZ=6,MAAAS=2310, MD=5
VIT FR5,* COD,BIGCOD
-242
    606 FORMAT ('OTHIS VERSION ALWAYS USES THE GAUSS SEIDEL'
    1 'MATRIX SOLUTION OF SUBROUTINE DIVERS')
-319
    IF (MIFLAG.NE.2) WRITE (I3,606)
-1089,1090
C WE HAVE NO CHOICE
CALL DIVERS
VIT FR5,* AREA,AREA
VIT FR5,* DIFFER, DIFFER
VIT FR5,* DIVERS, DIVERS
VIT FR5,* FORCE, FORCE
VIT FR5,* FORM,FORM
VIT FR5,* GEOMAT,GEOMAT
VIT FR5,* KCHAN,KCHAN
VIT FR5,* LOCARD,LOCARD
VIT FR5,* MIX,MIX
VIT FR5,* OUT,OUT
VIT FR5,* PROP,PROP
VIT FR5,* SETLOC,SETLOC
VIT FR5,* SPLIT,SPLIT
VIT FR5,* VOID,VOID
▽ XQT CUR
OUT B
TEF B
TRW B
ERS
PEF B
IN B
TRI B
TOC
▽ FIN

```

FIGURE 1. Typical Run to Create Large Problem
Version from Standard COBRA-IIA

dimensioned (MG, MN). MN is 5 for triangular pin arrays, and 7 for square pin arrays. The first column contains the numbers formerly on the diagonal, one for each connection. The remaining columns contain the data terms for each of the related connections.

SUBROUTINE DIVERS

To operate on the new form of AAA, a parallel version of subroutine DIVERT was developed. This subroutine, DIVERS, is always used in large problem versions and may be used in others (MIFLAG = 2). DIVERS contains a standard Gauss-Seidel iterative matrix solution specially devised to handle the sub-scripting relationships developed in compacting AAA to an (MG, MN) array. Ordering and acceleration techniques developed through experience have been included in the subroutine.

OUTPUT SAVE OPTION

One of the parameters which may be adjusted for large size problems is MW, the number of axial nodes of the solution to be kept in memory at one time. In standard COBRA-IIA versions the entire solution resides in core at once. Often, however, MW must be set lower than the desired number of output nodes. The usual large problem implementation, for example, has MW = 1. Subroutine PRINTS is called whenever memory is about to be exceeded and at the end of a case (normal or abnormal termination). PRINTS decides if the output from the last MW nodes should be saved and/or printed. PRINTS saves the output if the input value of OSAVE is nonblank. If output is to be printed it will appear as a block of output, in crude fashion, after each MONITR number of calls to PRINTS (where MONITR is an input value). A separate program, OSEEDIT, is executed during the same Univac 1108 run or later to edit the tape selectively, printing output data by channels in a format similar to that in COBRA-IIA itself. Figure 2 depicts a sample input deck using the OSAVE option and OSEEDIT.

	Remarks
∇φ RUN	
∇ ASG A=Uxxxx	PCF Tape or Fastrand file Identification
∇ ASG,W B	Scratch tape [may also be B=(,AT), etc.]
∇ XQT CUR	
IN A	
TRI A	
∇ DAT DATA/DATA,1	
∇ XQT COBR2A	
-----Title Card---	
-----Methods Card---	col 10=B for OSAVE
-----Data Cards---	
0	separate cases by 0
-----Title Card---	second case
-----Methods Card---	
-----Data Cards---	
∇ XQT OSEDIT	
B 1	1 is file number on tape B
-----Title Card--	duplicate of title card for case in file 1
∇ XQT OSEDIT	
B 2	
-----Title Card--	} one pair of cards for each problem
∇ XQT CUR	
TRW B	
∇ FIN	
or if OSEDIT is run later (B must be a user tape)	
∇φ RUN	
∇ ASG A=Uxxxx	PCF Tape or Fastrand file identification
∇ ASG B=Uyyyy	Tape where output is stored
∇ XQT CUR	
IN A	
TRI A	
∇ XQT OSEDIT	
B 1	
-----Title Card--	
∇ XQT OSEDIT	
B2	
-----Title Card--	
∇ XQT CUR	
TRW B	
∇ FIN	

FIGURE 2. Typical Input Deck

TIME CHECKS

At the beginning of each axial node calculation and at the beginning of each matrix iteration in DIVERS, a check is made of the time elapsed since the start of the run. If the time remaining is less than sufficient to continue, the problem is terminated in a "clean" fashion, and an exit summary is given for the most recently completed node. Provision is made to dump the entire data memory when a case is terminated abnormally (input DUMP is nonblank) and to continue the problem later from this point (input RESTRT is nonblank).

INPUT

The standard COBRA II input scheme has been extensively modified to make COBRA II an easier program to use. Since most users periodically run problems based on the same configuration, provision has been made to store standard data models in one or more data elements in the program complex file (PCF), along with the program itself. Problems may be run with any group-wise combination of data selected from the data element and from data cards in the input stream. As the COBRA-IIA input scheme was being developed, the use of teletypes for problem initiation was considered. To shorten typing time at the terminal, an alternative, free-field, input format is provided for all data cards. In another effort to minimize user effort and errors, the 'type' concept has been used in all data groups possible. In the 'type' concept, all items of a similar type (channels, rods, etc.) are listed as being associated with a numbered type. Data for all such items are given just once.

PCF DATA FILES

The standard data models are stored in a Symbolic Element in the Univac 1108 PCF. In general, a Symbolic Element is created which contains COBRA-IIA data in (card image) blocks

which are complete Groups of data. Each complete Group of data begins with an appropriate Group card which includes the group number and a six-character "Set" name, which identifies the model. This set name is used on an input Group card to specify the source of data for that group. A Univac DAT card links a symbolic data element and the program. As many as four DAT CARDS -- that is, four distinct data files -- may be used in one execution. However, the routine normally followed is to collect all data sets into one comprehensive data element named DATA/DATA.

FORM OF PCF DATA FILES

The order of data on the card images comprising a PCF data file is exactly the same as the order on COBRA-IIA input cards (see Appendix D), but in many cases the card format is different -- different number of pieces of data per card or different number of columns allotted. Depending on the source location for an input group, the appropriate input format and unit are selected by the program. An input option enables the preparation of data cards in data file format, and program LDATA may be used to merge these into an existing data file (see Appendix B).

PROGRAM INPUT LOGIC

The overall program logic is the same as that of COBRA II, as shown in Reference 1 (Figure 3, COBRA II Flow Diagram). In order to simplify the input, the input logic of COBRA-IIA is necessarily complex. Figure 3 is a flowchart outlining the input scheme.

GEOMETRY INPUT

Geometry input (Card Group 4) has been simplified. A new subroutine, GEOMAT, computes the required area and perimeter data for three standard varieties of channels, namely interior, peripheral and corner, in a triangular (hexagonal)

FIGURE 3. COBRA-IIA Input and PCF File Output Logic

array as well as gap spacing and centroid-to-centroid distance for typical channel combinations. GEOMAT also transforms mass input to the full bundle to mass input to the bundle segment chosen for study when the uniform pressure drop option (Card Group 11) is employed. The input on a single card, the GEOMAT card, consists of rather general parameters such as bundle looseness (relative location of pins inside of duct wall), maximum diametric tolerance, and duct corner radius of curvature. Currently, the GEOMAT subroutine is restricted to triangular pin arrays and hexagonal ducts. The fuel bundle design must not possess component overlap as this input deficiency will not be detected or corrected by the program.

For the case where the basic geometry and radial power distribution is already available in the PCF file, the geometry input is abbreviated to a single card, the GEOMAT card.

On standard input cards, channels are described by types, using a successive numbering scheme, in such a manner that a given type has common geometry and friction factor types and the same channel size factor. Area and perimeter data for non-standard channels may be included in the same Group 4 card set. Connection relationships are established in a separate block of Group 4 cards, with gap and distance values input on the cards or used as calculated in GEOMAT. Bypass channels are allowed in the set of non-standard channels; wall thickness is given on the connection card in place of centroid-to-centroid distance.

SPECIAL NEW FEATURES

WIRE WRAP MODEL

Wire-wrap spacers are modeled by the reduction of sub-channel flow area at the axial intervals in which the spacers are in the subchannel. Hydraulic phenomena, induced by the coolant (1) passing over the wire, or (2) being swept by the

wire into an adjacent channel, are disregarded. The attendant diversion cross flow contains the effects of the periodic introduction of a wire into the subchannel. This current model permits diversion to continue by the mechanisms employed in COBRA. Establishment of the contribution of this wire-induced diversion cross flow to the total forced mixing phenomenon must await further experimental study.

To start a problem, coolant is initially distributed to each channel in accordance with the option selected and the assumption that the radial distribution of wires is uniform throughout the bundle. This uniform model presumes that if each fuel pin were wrapped with a single wire, each interior and peripheral channel would contain $1/2$ wire and each corner channel would contain $1/6$ wire. At the first calculational node and beyond, this uniform model is replaced by the rotating wire model. Initially, the wire is located at zero degrees. The coordinate system and direction of wire rotation are arbitrary and implicitly defined by the program user.

Wire rotation data consist of three pairs of angles which define the limits of a subchannel in a triangular pitch, as viewed from the three surrounding fuel pins, and wire-wrap pitch. Figure 4 illustrates the basic characteristics of the coordinate system and shows how wire wrap rotation is manifested in this model. It can be seen that for a triangular pin array a phase shift of 60 degrees alters the direction of wire rotation. Thus the direction of rotation is specified when the angles are identified.

The mechanics of preparing Group 13 cards are as follows: Consider the wire wrap as occupying angular positions from 0 to 360 degrees as it progresses along the length of a pin. The angle pairs for a given channel define the period during which wires from the adjacent pins pass through that channel. The program considers the wire to be in the channel from the

FIGURE 4. Significance of Direction of Wire Rotation on Model

time the wire is 0.00001 degrees beyond the first angle entry, through the time it passes the second angle entry of the pair. The pair of angles entries must be given in increasing algebraic order, so that the second is always larger than the first. To enable this, the first angle entry may be negative, $-360 < \theta < 360$, while the second angle entry must be non-negative, $0 \leq \theta \leq 360$. The standard coordinate reference will be in the direction of the wrap and the location of the wire at the problem inlet is at zero degrees, for the most straightforward analysis. Figure 5 illustrates some of the choices of coordinate system.

It is essential that once the coordinate system is fixed, all pins must possess the same coordinate system if the physical constraint is that the wire rotation of each pin be in phase.

An illustration of the application of these principles is provided in Figure 6. Essential to the consideration of any segment of a full bundle is that any channel artificially divided by a line of symmetry must be defined with regard to angles of the complete channel rather than just the part that is present in the segment. A general rule-of-thumb for a hexagonal arrangement is that the internal portion of a bundle contains two channel types, each corner channel is a unique channel type and each flat has a unique channel type.

FLOW SPLIT

Subroutine SPLIT distributes the flow to the subchannels at the inlet to give equal pressure gradients. The original COBRA II version of SPLIT has been altered to ensure that it is successful even for very large bundles. This is accomplished by specifying at only the inlet a suitably small constant mixing parameter (Beta) of 0.001. At all interior nodes, the user-prescribed Beta is employed.

FIGURE 5. Illustration of Arbitrary Nature of Rotating Wire Coordinate System

EXAMPLE: 61-PIN BUNDLE 1/12 SECTION MODEL

SUBCHANNEL TYPES:

FIGURE 6. Example of Rotating Wire Coordinate System

BYPASS CALCULATIONS

Bypass channels, channels exterior to the principal sub-assemblies, can be included in the set of channels to be studied by flagging them on the channel input card and giving wall thickness between them and adjacent channels on the connection cards. Subroutine MIX computes wall temperatures and film coefficients for such connections for later printing along with other output data. Crossflow across such connections is fixed at zero, so the channel enters into calculations only as a heat sink.

INTRINSIC MATERIAL CORRELATIONS

Subroutine MIX computes parameters for bypass flow energy transport based on sodium and stainless steel data. To compute the film coefficient a Nusselt number correlation for flowing sodium⁽²⁾ is employed. The wall conductivity is specialized to that of stainless steel.⁽³⁾

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APPENDIX A

COBRA-IIA ELEMENTS AND EXTERNAL REFERENCES

APPENDIX A

COBRA-IIA ELEMENTS AND EXTERNAL REFERENCES

The Univac 1108 Program Complex File (PCF) for COBRA-IIA contains Symbolic, Relocatable and Procedure Definition (PDP) elements. Elements for LDATA and OSEDIT may also be present. The first section below is a brief discussion of the function of each of the elements in a COBRA-IIA PCF. In the second section the CSCX system routines referenced by COBRA-IIA are described.

PCF ELEMENTS

AREA	Calculates channel areas and gap spacings as a function of axial position. Linear interpolation is used in the input axial variations tables. The effects of the rotating wire pin wrap are then considered.
BASIC	A PDP element used to specify problem size. Statements from the SPEC2 (and/or SPEC3) portions of this are included at a specific location of a symbolic element when it is compiled with the INCLUDE statement. In particular, PARAMETER statements exist and need be changed only in BASIC.
COBR2A	COBRA-IIA Main program.

CLSOUT See OUT.

CURVE (FX,
X,F,Y,N,J,
ISAVE)

A table interpolation routine:

FX	-Quantity to be found.
X	-Independent variable.
F	-Input ordinate array.
Y	-Input abscissa array.
N	-Length of F and Y.
J	-Success (J=1) or Failure (J=2) signal.
ISAVE	-Earlier-use-for-same-X Flag ISAVE=1 normally ISAVE=2 if CURVE was most recently called with same X value and Y array.

DATA/DATA This symbolic element is the master PCF data file used by all versions of COBRA-IIA. It is referenced by a DAT card preceding the XQT card.

DATOUT See OUT.

DECOMP Sets up a working matrix UL to be used in a Forsythe-Moler solution of the matrix equation, $[A] \{w(x + dx)\} = \{B\}$. See note under SOLVE.

DIFFER Calculates spatial derivatives of flow, enthalpy and pressure as discussed in Reference 1, pages 18-20. Processing is performed by stepping through the known connections rather than by examining each channel relative to all others.

DIVERS Sets up $[A] \{w(x + dx)\} = \{B\}$, Equation (14) in Reference 1, and solves for $\{w(x + dx)\}$ using

a Gauss-Seidel iterative routine. Internal subroutine AFILL is used in setting up [A] , designated AAA. Before the attempt at matrix solution, internal subroutine ORDER reorders AAA in what appears to be an optimal manner, with the rows with the largest normalized sum of coefficients towards the upper end of AAA. Then internal subroutine SEIDEL computes W to a relative convergence of EPS (input quantity normally 0.01) for each connection. Because of the character of the problem, convergence is not guaranteed, and a maximum number of iterations is imposed (input NSOLV normally 500). DIVERS must be used in the solution of large problems.

DIVERT

Is the COBRA-II routine adapted to the modified matrix DD. Divert uses subroutines DECOMP and SOLVE in the solution of [AAA] {w(x + dx)} = {B}

FORCE

The forced division features of COBRA-II are included in COBRA-IIA. In addition, FORCE fixes diversion crossflow w=0 across wall connections.

**FORM
(FORMAT,
FORMAD)**

Supplies the appropriate variable formats for card, typewriter and drum input (FORMAT) and drum output (FORMAD).

GEOMAT Calculates typical channel areas and perimeters, gap spacings and centroid-to-centroid distances for a triangular channel array.

KCHAN (I,J) Function to determine the connection number of a pair of channel numbers, I and J, if they are connected.

LENDTA(X) Sleuth routine to determine the length of data memory (in case of dumping) starting at the location of variable X and going through location 163777₈.

LOCARD Locates the first card of a specified set and group of data in a PCF file, leaving drum positioned to read data cards in the set.

MIX Calculates thermal mixing parameters, as in COBRA-II. In addition, MIX computes film coefficient and temperature of walls adjacent to bypass channels.

NORMAL (N1, N2, PEAK, AXIAL) Normalizes values in a list (AXIAL, of length N1) so that the value denoted by N2 equals the specified peak (PEAK).

NTAPE (NAME) Function to translate a tape identification letter (NAME) as used on an ASG card, to a number which references that tape from a Fortran program.

OUT Has three entries, used in preparation of output PCF files (IDOUT non-blank on METHODS card).

SETOUT initializes the PCF element to be used, closing one when a new one is opened, as required by the Univac system.

DATOUT writes the Group card for a set which is to be written out.

CLSOUT finalizes the currently open file.

Internal subroutine CLOSIT closes a PCF file.

PRINTS Works on common block CPRINT, for large problems. PRINTS writes CPRINT to tape OSAVE as one record, if input value of OSAVE is non-blank. If input MONITR is greater than 0, PRINTS prints the contents of CPRINT initially and again every MONITR number of calls to PRINTS (using internal subroutine LINOUT).

PROP(IPART) Calculates saturated fluid properties initially (IPART=1) and all thermal properties needed later (IPART=2), during axial calculations, as in COBRA-II.

SETLOC
(NDATS) Determines the number of DAT cards used to specify PCF data files (NDATS) and initiates references to the files. Standardly, all data

is contained in one PCF file, but up to four may be used.

SETOUT	See OUT.
SOLVE	Solves $[A] \{w(x + dx)\} = \{B\}$ by operations on matrix UL, which is an Upper/Lower/Diagonal version of A created in DECOMP. SOLVE is called by DIVERT and used only in standard-size versions of COBRA-IIA (because it requires considerable space). SOLVE and DECOMP contain Parameter statements and must be recompiled whenever MG (maximum number of gaps) is altered.
SPLIT	Divides the subchannel flow rates at the inlet to give equal pressure gradients. This version assumes uniform mixing correlation with a mixing parameter of 0.001.
SPREAD (IF, IL, X, XS)	Spreads a given data value X through a specified portion of a given data array (locations IF through IL of XS).
TCHEK (I, \$N)	Sleuth routine to test time left in a job execution. If time left is less than or equal to I seconds, control is returned to statement N in the calling program, rather than to the natural place.

VOID Calculates the two-phase flow parameters, as in
COBRA-II.

CSCX SYSTEMS ROUTINES AT RICHLAND CENTER

CLDAWF (LU) Closes card file number LU which was opened by
a call to OPDAWC.

DOY (A) Provides the date (followed by three blanks) in
the two-word array A as DY:MON:YR.

ETIME Initiates a user's clock.

ETIMEI(N) Sets N equal to the number of seconds elapsed
since the last call to ETIME.

NTRAN (LU, Provides a buffered I/O operation:

IOP, N, B, L)

LU is the logical unit number.

IOP is 1 to Write, 2 to Read the unit.

N is the number of words to be transmitted.

B is a buffer of length N or more.

L is a status word maintained by CSCX:

L = -1 transmission incomplete

 = -2 end-of-file or tape encountered

 = -3 device error

 = -4 transmission aborted

If transmission is completed normally, L is set
to the number of words transmitted.

NDCODE (COR)	Establishes array COR as an input unit. A subsequent READ from logical unit -4 will reference this area as an input buffer.
OPDAWC (LU, N1, V1, FLTB)	Equates a logical unit with a PCF drum area address so that a card file may be entered into the PCF.
LU	Logical unit number used in program
N1	Element name to be given the file
V1	Version name for file (PCF name will be N1/V1)
FLTB	Seven-word file table to be used by system I/O routines.
SETDAR (LU, N, FLTB)	Equates a logical unit with the PCF drum area address of an element named on a DAT card.
LU	Logical unit number to be used in the program
N	DAT card number
FLTB	Seven-word file table to be used by system I/O routines
TOD(A)	Provides the time of day (followed by four blanks) in the two-word array A as HR:MN:SC.
TRAP ('NAME')	Allows continued execution of the control card sequence in a job after a MERR\$ exit from program NAME (instead of the usual job termination).

APPENDIX B

LDATA - LIST AND PREPARE DATA PROGRAM

APPENDIX B

LDATA - LIST AND PREPARE DATA PROGRAM

LDATA is an adjunct program used to merge and/or document all or parts of PCF data files. It reads from 0 to 4 existing PCF elements, referenced by DAT cards, and card output from a COBRA-IIA run, by card group. These may be merged to create a new element in the Program Complex File. Tables of contents may be obtained for each of the data files. The contents of each of the PCF files may be printed selectively - by file number, group number, and set name in any combination of requests. The data file made in the run may be accessed by subsequent Complex Utility Routine (CUR) operations and saved on a tape or drum file with the rest of the PCF. It may, in fact, be used immediately by a COBRA-IIA execution in the same run.

LDATA processes data in accordance with a number of conventions which have arisen naturally in the development of the data file concept. The order of the sets of data in a PCF data file, say DATA/DATA, is arbitrary. When a COBRA-IIA input deck contains a request for a particular group with a particular set name, that program searches systematically through DATA/DATA until it encounters a Group card which corresponds to the request. Because of the search procedure, DATA/DATA is most efficiently ordered according to the following rules:

1. All sets for one group are lumped together.
2. Groups are ordered in increasing order of group number.
3. Longer sets are at the end of the group.
4. Most popular sets are at the beginning of the group.

The cards created by COBRA-IIA as data file output (IDO, IDOUT non-blank) are in a format exactly as required for a data file. The first card of each set created is a Drum Group card, with a format designed to make a data file readable as a CUR-listed element. The format has the word "GROUP" in columns numbered from 2 to 6, the group number in Columns 8 and 9, the word "SET" in columns 12 to 14 and a six-character set identification in Columns 16 to 21. COBRA-IIA assigns successive (right-adjusted) integers as set identifications. The user replaces the program-assigned name with one of his own choosing in Columns 16 to 21 before adding the set to his master data file.

Figure B.1 is a listing of the input deck used to add a new model to the standard COBRA-IIA data file. The COBRA-IIA program prepares a PCF file DATA/HBCC containing Drum format cards for Card Groups 3, 4, 8, 9, 10 and 13. Then the version name of the present DATA/DATA element is changed to DATI to avoid a conflict in the execution of LDATA. LDATA is executed with two input files, DATA/DATI and DATA/HBCC, to be merged into a new data file DATA/DATA. The set name assigned by COBRA-IIA to each set of data is changed from "1" to "37HBCC".

```

-O RUN          5              ,300,15000
- ASG A=U2192
- ASG,W B=U2198(COBRA2)
- XQT CUR
PEF A
IN A
TRI A
LIST DATA/DATA
- DAT DATA/DATA,1
-N XQT COBR2A
  11          PNL-17 ONE HALF 37 PIN BUNDLE
  1 1 1 2      HBCC   X
    1          1SODIUM

```

Remainder of COBRA-IIA Deck

Representative Group

```

      9          1
    .01  1.0  1.0  0.0 13.5  0.0  10  3

```

```

- XQT CUR
LIST DATA/HBCC
- DAT DATA/DAT1,1
- DAT DATA/HBCC,2
-N XQT LDATA
  2          1 37HBCC
  7          37HBCC
- XQT CUR
OUT B
TEF B
TRW B
ERS
IN B
TOC
TRI B
LIST DATA/DATA
- FIN

```

FIGURE B-1. Card Input Sequence for LDATA

INPUT INSTRUCTIONS FOR LDATA

LDATA requires one DAT control card for each of the PCF files which are input to it. A version name for the element to be created as a merged data file is given on the parameter card. Because of the way CSCX operates on PCF elements, only one element with a given name may exist at one time. The sample execution in Figure B.1 shows how CUR operations may be used to change the version name of the input element so that the output element can be named DATA/DATA.

Parameter Card - (Optional - if no parameter card is included in the deck, LDATA provides a table of contents for the element named on DAT Card 1. No further processing is performed.)

(I2, 2I1, I2, 6I1, 7A4)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
2	NDATS	Number of DAT cards used to name DATA/elements ($0 \leq \text{NDATS} \leq 4$)
3	LSP	Number of Special Request cards which follow ($0 \leq \text{LSP} \leq 9$)
4	LTOC	Table of Contents (TOC) request LTOC = 1 to request summary TOC 2 to request individual TOC's (Each on a separate page)
6	IFNP	New page signal IFNP = 1 to put each set listed on a new page. Otherwise, IFNP = 0.

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
7	NMERGE	Number of files to be merged ($0 \leq \text{NMERGE} \leq 5$)
8 thru 12	MERGE (I) I=1, MERGE	File numbers to be merged: MERGE (I) is either a DAT card number (1, 2, 3 or 4) or 5 to indicate COBRA-IIA created Data file cards in the input deck.
13-16, 17-20, 21-24, 25-28	NAMED(I), I=1, 4	Version names of files being processed. NAMED(I) is the four-character name (after "DATA/") of the file (PCF element) referenced by DAT card num- bered I.
37-40	NAMED(7)	Version name of output file, if NMERGE>0. If NAMED(7) is "ABCD", the output file will be a PCF Symbolic element named "DATA/ABCD".

Special Request Cards - LSP cards to request specified Set list-
ings. Because of the blank options available, a totally blank
card requests that every set of every group of every file be
listed. (I2, I3, 1XA6)

<u>Columns</u>	<u>Contents</u>
2	File number (DAT card number, or 5 for an input deck, or 7 for a new element created in this run.) If blank, all files present will be considered.

<u>Columns</u>	<u>Contents</u>
4-5	Group number. If blank, all groups will be processed.
7-12	Set name desired. If blank, all sets will be processed.
14-19	New Set Name - If this is present, the designated sets will have their old set name replaced by the name in columns 14-19, in the output file. Only one name change per data file and group can be requested. Separate special request cards are required to obtain a list.

COBRA-IIA Data File Cards - Given when File 5 is referenced anywhere. First card of each set is a Drum Group card, as described in the section entitled Form of PCF Data Files. An appropriate user set name should be inserted by the user in columns 16-21 of each Group Card. Successive cards are as punched by COBRA-IIA according to their group number.

APPENDIX C

OSEDIT OUTPUT-~~SAVED~~ EDIT PROGRAM

APPENDIX C

OSEDIT OUTPUT-MAVED EDIT PROGRAM

OSEDIT is a COBRA-IIA adjunct program to provide output for problems using the OSAVE option. The OSAVE option saves all channel data at each print node on a tape designated by the requestor. OSEDIT may be executed in the same run as the COBRA-IIA problem, or it may be executed at a later time, after COBRA-IIA termination and exit summary results have been examined. Figure 2 depicts the use of OSEDIT.

Output files to be edited may be selected from a multi-file tape on the basis of file number or date of COBRA-IIA run or by external positioning of the tape. To conserve on printed output, a selection may be made of those channels and/or nodes to be printed.

Two or more input cards are used for each edit. Cards for successive edits are simply stacked one set after another. In general, output is one to two pages per channel (where a page is 50 lines); the RUN card contains a sufficiently large maximum lines count.

Card 1 (REQUIRED) Format (A1, I2, 2A6, 13I5)

<u>Cols.</u>	<u>Variable</u>	<u>Definition</u>
1	IT	Tape unit of tape to be edited (Same as the letter on the ASG card)

<u>Cols.</u>	<u>Variable</u>	<u>Definition</u>
2-3	IF	File number to be edited. If IF is positive, OSEDIT rewinds and positions the tape ready to edit file number IF. If IF is negative, 0 or blank, it is assumed to be irrelevant in the location of the desired file. (The first tape file is numbered IF=1.)
4-12	INDATE(2)	Date of run to be edited, used when IF=0. The first file encountered with this date is the one which will be edited. Date must be given exactly as it is in the COBRA-IIA output, and Columns 13 to 15 must be blank. This date is not used when IF>0. If both IF and INDATE are blank, OSEDIT assumes that tape has been positioned by the user.
16-20		Not used.
21-25	NPNODE	Number of nodes to print. Card(s) 3 required if NPNODE is less than number of print nodes in COBRA-IIA problem. If all nodes are desired, NPNODE is blank.
26-30	NPCHAN	Number of channels to print. Card(s) 4 required if NPCHAN is less than number of channels in COBRA-IIA problem. If all channels are desired, NPCHAN is blank.
<u>Card 2</u>	(REQUIRED)	Format (13A6, A2)
1-80	TITLE	This card will be printed as the title on each output page (Original title was not saved.)

<u>Variable</u>	<u>Definition</u>
<u>Card(s) 3</u>	(REQUIRED if NPNODE > 0) Format (20I4)
	IPNODE(I), Node numbers to be printed, in numerical I=1, NPNODE order. The entrance node is node Number 1.
<u>Card(s) 4</u>	(REQUIRED if NPCHAN > 0) Format (20I4)
	IPCHAN(I), Channel numbers to be printed. I=1, NPCHAN

APPENDIX D

INPUT INFORMATION

APPENDIX D

INPUT INFORMATIONGENERAL FORM OF INPUT DECK

An input deck for COBRA-IIA contains CSCX control cards to access the program and the standard data file, DATA/DATA, if it is used. Successive executions of COBRA-IIA may be performed. CUR operations may follow, perhaps to save data file data on cards for later reference. Program LDATA may be executed in the same run to merge generated data file data into other data files or to document data files. OSEDIT may be used to document some or all of OSAVE tapes created.

INPUT DATA CARDS

Input data for each COBRA-IIA case consists of a KASE Card and a METHODS Card, followed by up to 13 groups of input information. Each group starts with a GROUP card to identify the group and specify the options desired for that particular group. In many cases the GROUP card is the only card required for a given group. Successive cases must be separated by a blank card.

The option of using free-format data cards (for card input other than KASE, METHODS and GROUP cards) is designed to make teletype use of the program particularly easy. This option may be specified on the METHODS card and overridden on any GROUP card for that Group only.

KASE Card (I3, I1, 6X, 11A6)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-3	KASE	Case identification number; calculations stop if $KASE \leq 0$.
4	J1	Input data print option J1 = 0 Print new input for this case J1 = 1 Print all input for this case J1 = 2 Print only the operating conditions for this case.
11-76	TEXT	Descriptive title of problem.

METHODS Card (2I2, 2X, I2, 3A2, 2A4, I4)

2	IGEOM	0 or 1 for triangular pin array 2 for square pin array (Card Group 4 not fully implemented)
4	INB	Basic input type, for data in card deck Blank or 1 for column-formatted data, 2 for free format, with data values separated by commas. (This value may be overridden on individual Group cards.)
8	MIFLAG	Matrix inversion flag Blank or 1 for Rowe standard matrix inversion technique 2 for Gauss-Seidel solution method adapted especially for very large problems.

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
10	OSAVE	<p>Output save flag (necessary for large problem version of COBRA-IIA)</p> <p>Blank if option not wanted</p> <p>Letter between A and H to denote tape on which output is to be saved for later reference (same as on ASG card). (Tape will not be repositioned by COBRA-IIA except in writing.)</p>
12	DUMP	<p>Dump flag</p> <p>Blank if option not wanted</p> <p>Letter between A and H to denote tape on which a memory dump is to be saved. Dump will be taken only when problem doesn't run to completion. If OSAVE is the same letter as DUMP, all OSAVE output will appear in one file. DUMP output will appear in the following file. (COBRA-IIA does not reposition tape except in writing on it.)</p>
14	RESTR	<p>Restart flag</p> <p>Blank if option not wanted</p> <p>Letter between A and H to denote tape which has memory dump for restart of a DUMPed problem. Tape must have been positioned for readying.</p>
15-18	IDOUT	<p>PCF version name (left-adjusted) used for data file of input cards to be created by this run. IDOUT must be blank for no output file. CAUTION: If this version name</p>

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
		already appears in the PCF, the original element will be replaced by the one created in this execution. If IDOUT is the same as in the immediately preceding problem (same execution), that element will be extended by the data in this problem.
19-22	INPUTR	If non-blank, case is terminated after processing input (and creating data file if IDOUT is non-blank).
23-26	MONITR	Request to print a periodic nodal log of channel calculations (large-problem versions). If MONITR is greater than 0, PRINTS prints output as a block on the first call to PRINTS and on every MONITR calls thereafter.

GROUP Card (515, A6, I4, I5)

One GROUP card starts each group of input data. Data on the card is interpreted according to the particular card group. Group cards are column-formatted regardless of the Basic Input type chosen on the METHODS card.

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	NGROUP	Card group number
6-10	N1	N1, N2, N3 are as described in Group Writeups, later
11-15	N2	
16-20	N3	
21-25	INU	Input unit number. Blank if Data is on cards or teletype card images. If data is in a PCF element, INU corresponds to the number on the DAT card referencing that element ($0 \leq \text{INU} \leq 4$).

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
26-31	INS	Set identification of data group if data for this group is to be taken from a data file (file number INU, INU>0). [When COBRA-IIA puts a set into a PCF element the set is given an alphanumeric identification which is a right adjusted integer serial number (starting with "bbbbbb1" for the first set of each group saved in a run). Before the user adds a set to an older element, using LDATA, he may change its name to a more descriptive one.] INS is the 6-character identification in columns 16-21 of the PCF GROUP card.
32-35	IDO	Drum output flag. If IDO>0, this Group of cards will be saved in the output PCF file named on the METHODS Card (IDOUT).
36-40	INF	Input format type, used only for non-PCF data. INF = 1 for column-formatted card images. INF = 2 for data separated by commas. If INF is blank, INB (METHODS CARD) is used for INF.

CARD GROUP 1 Saturated Fluid Property Table

GROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 1
6-10	N1 = Number of property table cards to be read in ($2 \leq N1 \leq MP$)
11-20	N2, N3 = Blank

FLUID PROPERTY Cards N1 cards (E5.2, F5.1, 7F10.0)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	PP(I)	Saturation pressure (lb/in. ²)
6-10	TT(I)	Temperature (°F)
11-20	VVF(I)	Liquid specific volume (ft ³ /lb)
21-30	VVG(I)	Vapor specific volume (ft ³ /lb)
31-40	HHF(I)	Liquid enthalpy (Btu/lb)
41-50	HHG(I)	Vapor enthalpy (Btu/lb)
51-60	UUF(I)	Liquid viscosity (lb/ft-hr)
61-70	KKF(I)	Liquid thermal conductivity (Btu/lb-ft- °F)
71-80	SSIGMA(I)	Surface tension (lb/ft)

CARD GROUP 2 Friction Factor and Two-phase Flow Correlations

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 2
6-10	N1 = Option for subcooled void correlations: N1 = 0, No void correlation N1 = 1, Levy, GEAP 5157
11-15	N2 = Option for bulk void correlation: N2 = 0, Homogeneous model N2 = 1, Modified Armand correlation, HW-65706 N2 = 5, Slip ratio specified as input N2 = 6, Up to 6th order polynomial function of quality
16-20	N3 = Option for two-phase friction multiplier N3 = 0, Homogeneous model N3 = 1, Armand correlation, HW-65706 N3 = 5, Up to 6th order polynomial function of quality

Following the control card, one card is read in with up to four sets of friction factors corresponding to four subchannel types (12F5.3). Channel input, Card Group 4, gives the friction factor type of each subchannel. Each set of friction factors consists of $AA(I)$, $BB(I)$, and $CC(I)$,

where

$$f_I = AA(I) * RE ** BB(I) + CC(I).$$

Order is AA_1 , BB_1 , CC_1 , AA_2 , BB_2 ,

Additional Group 2 cards are read in the following order if the options call for them:

If $N2 = 5$, one card with Slip ratio (5X, E10.5).

If $N2 = 6$, one card with the number of terms in the power series, NV, and the numerical coefficients, $AV(I)$ (I5, 7E10.5).

If $N3 = 5$, one card with the number of terms in the power series, NF, and the numerical coefficients, $AF(I)$ (I5, 7E10.5).

CARD GROUP 3 Relative Axial Heat Flux Table

GROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 3
6-10	N1 = Number of pairs of data to be read, below. ($2 \leq N1 \leq MP$)
11-15	N2 = Node index of axial position, Y, which has specified peak flux value, PEAK. If input flux values are normalized, set $N2 = 0$.
16-20	N3 = Blank

HEAT FLUX Cards

The following cards contain position and heat flux values and the peak flux value if the data has not been normalized (16F5.3):

$Y(I)$ = Relative axial distance (X/L)

$AXIAL(I)$ = Relative axial heat flux at $Y(I)$

PEAK = Peak axial heat flux (data will be normalized so that $AXIAL(N2) = PEAK$). No value for PEAK is given if $N2 = 0$.

Order is ($Y(I)$, $AXIAL(I)$, $I=1$, $N1$) if $N2 \leq 0$.

or ($Y(I)$, $AXIAL(I)$, $I=1$, $N1$), PEAK if $N2 > 0$.

CARD GROUP 4 Channel Layout and Dimensions

NOTE: When running successive cases with new Group 4 cards, Group 11 must be repeated (in order to require the recalculation of quantities which depend on total channel area.)

GROUP Card

<u>Columns</u>	<u>Contents</u>
5	NGROUP = 4
6-10	$N1$ = Number of standard (described on GEOMAT card) channel cards - hexagonal arrays only (Card II, below)
11-15	$N2$ = Number of nonstandard (square pin arrays, bypass channels, etc.) channel cards (Card III, below)
16-20	$N3$ = Number of connection cards (Card IV, below) - required for both standard and nonstandard channels

Data cards - Card I is required, except when the problem has absolutely no standard channels (that is, $N1 = 0$ and there are no

standard channels from the PCF file). Note that automatic GEOMAT input calculations are for hexagonal arrays only - all channels in a square array are nonstandard.

I. GEOMAT Card (2F10.2, 9F5.0)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-10	DIATOL	Diametric tolerance in bundle
11-20	FLOOSE	Fraction of looseness across bundle ($0 \leq \text{FLOOSE} \leq 1$)*
21-25	PINS	Number of pins in a prototype (complete bundle)
26-30	RC	Radius of curvature of duct corner
31-35	DPIN	Diameter of pin (in.)
36-40	WD	Wire diameter (in.)
41-45	WNUMG	Number of wires in a gap at one time
46-50	DEXP	Used in calculation of PDIST, the prototypic flow distribution. DEXP is (1 - exponent in Blasius formula).
51-55	WFACT(1)	Average fractional contribution** of wires of adjacent pins to channel of geometry Type I (Peripheral channel, blank if Card Group 13 is used).

* FLOOSE is 1 if pins are "spread", 0 if pins are "compacted". Let DB = the bundle diameter and DD = the inside duct diameter. Then FLOOSE = 1 if DB = DD; FLOOSE = 0 if DB is as small as possible.

** Concept involves the hypothetical uniform radial distribution of wires. WFACT's are established by summing the angles that the channel subtends on all adjacent pins, i.e. for a triangular pitch WFACT(1) = 0.5, WFACT(2) = 0.5, WFACT(3) = 0.1667.

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
56-60	WFACT(2)	Average fractional contribution of wires of adjacent pins to channel of geometry Type 2 (Interior channel, blank if Card Group 13 is used).
61-65	WFACT(3)	Average fractional contribution of wires of adjacent pins to channel of geometry Type 3 (Corner channel, blank if Card Group 13 is used).

II. STANDARD CHANNEL GEOMETRY Card (N1 cards) (4I6, F10.0)

1-6	IF	First channel number of this <u>Channel</u> type
7-12	IL	Final channel number of this <u>Channel</u> type
13-18	NTY	Friction factor channel type (Card Group 2)
19-24	NTY2	Geometric channel type NTY2 = 1 for Peripheral channel NTY2 = 2 for Interior channel NTY2 = 3 for Corner channel
25-34	SIZE	Channel size factor SIZE = 1.0 for full channels SIZE = 0.5 for half-width channels

III. NONSTANDARD CHANNEL GEOMETRY Card (N2 cards) (4I6, 4F10.0)

1-6	IF	First channel number of this type
7-12	IL	Final channel number of this type
13-18	NTY	Friction-factor channel type (Card Group 2)
19-24	NTY2	Geometric channel type NTY2 = 1 for Peripheral channel NTY2 = 2 for Interior channel NTY2 = 3 for Corner channel NTY2 = 4 for Bypass type channel

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
25-34	SIZE	Channel size factor SIZE = 1.0 for full channels SIZE = 0.5 for half-width channels
35-44	AC	Nominal cross section area for channel type (in. ²)
45-54	PW	Wetted perimeter (in.)
55-64	PH	Heated perimeter (in.)

IV. CONNECTION Card (N3 cards) [I4, 4(I4, 2F7.5)]

Values of S and DIST are calculated by the program for standard channel connections but will be overridden by values on these cards. S and DIST must be given for all nonstandard wall connections (Channel Type 4 with any type not equal to 4). Each channel may be connected to up to four other channels. Each connection need be specified only once.

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-4	I	Channel number
5-8, 23-26, 41-44, 59-62	(LC(I,L),L=1,4)	Connecting channel numbers - negative if line of symmetry splits a gap at a boundary
9-15, 27-33, 45-51, 63-69	(S(I,L),L=1,4)	Nominal gap spacing (optional if GEOMAT calculates)
16-22, 34-40, 52-58, 70-76	(DIST(I,L),L=1,4)	Centroid-to-centroid distance for standard connections. Wall thick- ness for wall-type connections (Optional if GEOMAT calculates)

CARD GROUP 5 Channel Area Variations

If calculations have just been done using area variations, a GROUP card with N2 = 0 will discontinue them.

GROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 5
6-10	N1 = Number of channel types of area variations (NAFACT) (N1≤MA)
11-15	N2 = Number of axial positions (NAXL) (2≤N2≤ML)
16-20	N3 = Blank

AXIAL Cards As many as necessary (16F5.3):

<u>Fortran Name</u>	<u>Contents</u>
(AXL(I), I=1, NAXL)	Relative axial positions where the area factors are to be specified.

Area Variations - One set of cards is given for each channel type, so that there are N1 sets of cards. Each set contains Location card(s) followed by the corresponding Factors card(s).

LOCATION Cards As many as necessary (20I4):

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-4	NUM	Number of channels in this Area type
5-8, 9-12, etc.	NCH(I), I=1, NUM	Channel numbers comprising this Area type.

FACTORS Cards As many as necessary (16F5.3):

Fortran Name	Contents
(AFACT(I), I=1,NAXL)	Area factors for all channels in this Area type, at each axial node.

CARD GROUP 6 Channel-channel Gap Spacings

GROUP Card

Columns	Contents
1-5	NGROUP = 6
6-10	N1 = Number of gap types (NGAPS) ($N1 \leq MS$)
11-15	N2 = Number of axial positions (NGXL) ($N2 \leq ML$)
16-20	N3 = Blank

AXIAL Cards As many as necessary (16F5.3):

Fortran Name	Contents
(GAPXL(I), I=1, NGXL)	Relative axial positions where the gap factors are to be specified.

Gap Spacings are given as N1 sets of cards. Each set contains Location card(s) followed by the appropriate Size card(s).

LOCATION Cards As many as necessary (20I4):

Columns	Fortran Name	Contents
1-4	NUM	Number of channel pairs in this Gap type
5-8, 9-12, etc. I=1, NUM)	(IT(I), JT(I),	Channel numbers of adjacent channels in this Gap type to which spacing factors apply.

SIZE Cards As many as necessary (16F5.3)

Fortran Name	Contents
(GFACT(I), I=1, NGXL)	Relative spacing factors at each axial position.

CARD GROUP 7 Spacer Data

GROUP Card

Columns	Contents
1-5	NGROUP=7
6-10	N1=J6 Spacer Flag. If N1=2, spacer pressure losses are included; otherwise, they are omitted.
11-15	N2=NGRID Number of axial spacer locations
16-20	N3=NGRIDT Number of spacer types

AXIAL LOCATION Cards As many as necessary (6(F5.2,I5))

Columns	Fortran Name	Contents
1-5, 11-15, etc.	GRIDXL	Relative axial location (X/L) of spacer
6-10, 16-20, etc.	IGRID	Type number (set number in Spacer Data cards) of this spacer

SPACER DATA Cards

One set for each spacer type (N3 sets). Each set begins with one card telling how many channels are of this spacer type (NCHTS). Remaining cards supply data for each spacer channel. All channels not in this input group have values of CD = 0 and FXFLOW = 0 at the axial positions for this spacer type.

FIRST Card Format (I5)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	NCHTS	Number of channels of this spacer type

REMAINING SPACER DATA Cards

One card for each of the NCHTS channels. Format (I5, 2E5.2, I5)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	J	Channel number
6-10	CD	Spacer loss coefficient
11-15	FXFLOW	Fraction of flow diverted to channel INFLOW
16-20	INFLOW	Recipient channel number. If INFLOW is 0, there is no forced flow diversion.

CARD GROUP 8 Rod Layout, Dimensions and Power Factors

Card Group 8 has the special feature that parts of a set stored in a PCF file may be used, as modified by input data on cards. If the power fraction data in the PCF file is to be replaced by input data on cards, N2 (only) is greater than 0. If rod size and power data in the data file is to be supplanted, N3 (only) is greater than 0.

GROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 8
6-10	N1 = Number of Type 1 cards (N1≤MR)

<u>Columns</u>	<u>Contents</u>
11-15	N2 = 0, except when drum input is being used (INU>0) and adjacent channel power fraction data will follow on update cards. If card data follows, N2 is the number of Type 2 cards.
16-20	N3 = 0, except when drum input is being used (INU>0) and rod dimension and power data will follow on update cards. If card data follows, N3 is the number of Type 3 cards.

If input is entirely on cards, Card Type 1 below is used. Input may be partly from drum and partly from cards, using Card Type 2 or 3.

Card Type 1 Standard rod layout, one card per rod. (15, 2E5.2, 6(15, E5.2))

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	I	Rod identification number
6-10	DR(I)	Rod diameter (in.)
11-15	RADIAL(I)	Relative power of the rod
16-20, etc.	LR	Adjacent subchannel number
21-25, etc.	PHI	Fraction of rod power to channel LR

} up to 6
adjacent
channels

Card Type 2 Adjacent channel update (N2 cards), (15, 6(15, F5.3))

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	I	Rod identification number
6-10	LR	Adjacent subchannel number
11-15, etc.	PHI	Fraction of rod power to channel LR

} up to 6
adjacent
channels

Card Type 3 Rod dimension and power update (N3 cards,
N3 $\leq$ original number of rods).

(4(213, 2F7.3)) As many cards as necessary.

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-3, 21-23, etc.	IF	First rod number to which data applies
4-6, etc.	IL	Final rod number
7-13, etc.	DR	Rod diameter (in.)
14-20, etc.	RADIAL	Relative power of rods of this type

CARD GROUP 9 Calculation Variables

GROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 9
6-10	N1 = 1 if node values are to be read in from cards N1 = 0 if data is on drum or if calculation nodes are equally spaced.
11-15	N2 = Data card Update Flag; Positive if Data Update card is to be read, otherwise 0.
16-20	N3 = Blank

Card 1 Data card, used only if INU = 0 or blank (6F5.3, 315
F5.0, 315)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	FL	Friction constant (ft)
6-10	FDM	Momentum diversion factor
11-15	FDQ	Energy division factor

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
16-20	FTM	Turbulent momentum factor
21-25	Z	Channel length (in.)
26-30	THETA	Channel orientation from vertical (degrees)
31-35	NPRINT	Number of axial locations for printout of answers
36-40	NX	Number of additional axial subdivisions of NPRINT at which calculations are to be done. [(NPRINT - 1) * NX + 1 ≤ 100]
41-45	KDEBUG	Debug print flag. Normally 0. Any positive number produces masses of debug information during calculation.
46-50	EPS	Maximum residual for Gauss-Seidel iteration. If blank, program uses 0.01.
51-55	NTRIES	Number of allowable iterations for crossflow convergence. If blank, program uses 10.
56-60	NSUM	Node number for which summary data will be printed (if blank, program sets NSUM=NPRINT, or to the final node calculated if run is terminated before completion.)
61-65	NSOLV	Number of Gauss-Seidel iterations allowed. If blank, program uses 500.
<u>DATA UPDATE Card</u>		Used if N2>0 (F7.3, 2I3)
1-7	Z	Channel length (in.)
8-10	NPRINT	Number of nodes to be printed
11-13	NX	Number of axial subdivisions

NODES Card Used whenever node positions are to be specified,
that is, when $N1 > 0$. (16F5.0)

Fortran Name	Contents
XCALC(I), I = 1, NODES	Relative axial positions for defining nodal boundaries, where $NODES = (NPRINT-1) * NX + 1$

CARD GROUP 10 Mixing Parameters

GROUP Card

Columns	Contents
1-5	NGROUP = 10
6-10	N1 = NSCBC, Subcooled mixing correlation option number: N1 = 0 Uniform mixing ($\beta = A$) N1 = 1 Mixing formula $\beta = A * Re^{**}B$ N1 = 2 Mixing formula $\beta = A * (D/s) * Re^{**}B$
11-15	N2 = NBBC, Boiling mixing correlation option numbers: N2 < 2 Mixing is same as for subcooled case N2 ≥ 2 N2 Values of mixing as a function of quality are to be read in as a table ($N2 \leq MP$)
16-20	N3 = 0 for no thermal mixing from conduction 1 for thermal conduction model using centroid-to- centroid distance

PARAMETER Card (2F5.3)

Columns	Fortran Name	Contents
1-5	ABETA	A in calculation of β
6-10	BBETA	Reynolds number exponent, B
11-15	GK	Geometric correction factor to conduction coefficient.

MIXING DATA Card Used only if $N2 > 2$ (16F5.0)

$N2$ pairs of numbers, in order of ascending quality:

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5, 11-15, etc.	XQUAL(I)	Steam quality
6-10, 16-20, etc.	BX(I)	Mixing parameter β at the steam quality XQUAL(I).

CARD GROUP 11 Operating Conditions

GROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 11
6-10	N1 = NH Inlet enthalpy option N1 = 0 Input value is uniform inlet enthalpy N1 = 1 Input value is uniform inlet temperature N1 = 2 Inlet enthalpies are to be read in N1 = 3 Inlet temperatures are to be read in
11-15	N2 = NG Inlet flow rate options N2 = 0 Uniform inlet mass velocity, at entrance to each subchannel N2 = 1 Inlet flow is divided among channels to give equal pressure gradients N2 = 2 Flowrates for individual channels are to be read in
16-20	N3 = GIN option N3 = 0 GIN is total mass flow rate (10^6 lb/hr) through entire bundle N3 = 1 GIN is average mass velocity (10^6 lb/hr-ft ²)

DATA Card (5F10.4)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-10	PREF	Reference inlet pressure, psia.
11-20	HIN	If N1 = 0, Average inlet enthalpy, Btu/lb If N1 = 1, Average inlet temperature, °F
21-30	GIN	If N3 = 0, total mass flow rate, 10^6 lb/hr If N3 = 1, average mass velocity, 10^6 lb/hr-ft ²
31-40	AFLUX	Average heat flux, 10^6 Btu/hr-ft ²
41-50	ZC	Core length (used if N3 = 0), in.

REMAINING Cards

If N1 = 2, Inlet enthalpy (16F5.0)

H(I), I = 1, NCHANL Inlet enthalpy for each subchannel (Btu/lb)

If N1 = 3, Inlet temperature (16F5.0)

T(I), I = 1, NCHANL Inlet temperature for each subchannel (°F)

If N2 = 2, Flow rates (16F5.0)

F(I), I = 1, NCHANL Inlet flow rate for each subchannel (lb/hr)

CARD GROUP 12 Output OptionsGROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 12
6-10	N1 = Exit flag-data is printed as requested (NOUT): N1 = 0 Exit summary only N1 = 1 Exit summary, channel data and cross flows N1 = 2 Exit summary and cross flows

<u>Columns</u>	<u>Contents</u>
11-15	N2 = NOUT2 = NPCHAN = Number of channels for which data is to be printed ($1 \leq N2 \leq MC$). If $N2 = 0$, all channels are printed.

16-20 N3 = Blank

CHANNEL PRINT Card (20I4)

PRINTC(I), I = 1, N2 Channel numbers of the channels to be printed.

CARD GROUP 13 Wire Wrap Data

GROUP Card

<u>Columns</u>	<u>Contents</u>
1-5	NGROUP = 13
6-10	N1 = NCTWW Number of channel types of wire wrap data ($1 \leq N1 \leq MT$). The channels with wires in them at the same time comprise one channel type.
11-20	N2, N3, Blank

WIRE WRAP Cards One pair for each channel type

Card 1 (16F5.3)

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
1-5	PITCH	Wire pitch (ft/wrap)
6-10	WNUM	Number of wires per pin
11-15	WWD	Wire diameter
16-20, 21-25		Pair of angles describing the first arc containing a wire wrap (degrees)*

* The pair of angles describing an arc containing a wire wrap are given at the channel base, in the same order as the direction of the wrap (normally clockwise). Angle values are given in degrees, between -360 and 360.

<u>Columns</u>	<u>Fortran Name</u>	<u>Contents</u>
26-30, 31-35		Pair of angles describing the second arc containing a wire wrap*
36-40, 41-45		Pair of angles describing the third arc containing a wire wrap*

Card 2 (2014)

1-4	NC	Number of channels in this channel type
	NCH(I),	Channel numbers in this type
	I = 1, NC	

* The pair of angles describing an arc containing a wire wrap are given at the channel base, in the same order as the direction of the wrap (normally clockwise). Angle values are given in degrees, between -360 and 360.

APPENDIX E

SAMPLE PROBLEMS

APPENDIX E

SAMPLE PROBLEMS

The first example is the input deck for a 1/12 section of a 217-pin bundle. The entire set of input data is on cards. The problem is started in the middle of the core using a detailed channel-by-channel description of enthalpies and flow rates in conjunction with the specification of axial locations for calculation. Figure E-1 illustrates some of the geometric features of the problem. The intricacies of the rotating wire model can be inferred from the description of a similar problem in Figure 6.

A second example is the input deck and an abbreviated output for a 1/2 section of a 217-pin bundle. Data are selected largely from the PCF data file (set 217HB1). The degree of simplification obtainable for the input of a complicated problem is obvious by comparing the input decks of the two sample problems. Figure E-2 illustrates the complexity of the topological arrangement. An 11-minute running time on the Univac 1108 was required.

FIGURE E-1. 217-Pin Bundle 1/2 Section Model

FIGURE E-2. 217-Pin Bundle 1/2 Section Model

*200+20000		D KOLESAR		COBRA-11A	
1	30	01801	999999	303.76	2204.83
2	30	01801	999998	319.44	2212.52
3	30	01801	999997	335.01	2220.54
4	30	01801	999996	350.49	2227.58
5	30	01801	999995	365.88	2234.13
6	30	01801	999994	381.26	2240.16
7	30	01801	999993	396.43	2245.71
8	30	01801	999992	412.66	2250.87
9	30	01801	999991	428.89	2255.57
10	30	01801	999990	445.12	2260.15
11	30	01801	999989	461.35	2264.72
12	30	01801	999988	477.58	2269.29
13	30	01801	999987	493.81	2273.86
14	30	01801	999986	510.04	2278.43
15	30	01801	999985	526.27	2283.00
16	30	01801	999984	542.50	2287.57
17	30	01801	999983	558.73	2292.14
18	30	01801	999982	574.96	2296.71
19	30	01801	999981	591.19	2301.28
20	30	01801	999980	607.42	2305.85
21	30	01801	999979	623.65	2310.42
22	30	01801	999978	639.88	2314.99
23	30	01801	999977	656.11	2319.56
24	30	01801	999976	672.34	2324.13
25	30	01801	999975	688.57	2328.70
26	30	01801	999974	704.80	2333.27
27	30	01801	999973	721.03	2337.84
28	30	01801	999972	737.26	2342.41
29	30	01801	999971	753.49	2346.98
30	30	01801	999970	769.72	2351.55
31	30	01801	999969	785.95	2356.12
32	30	01801	999968	802.18	2360.69
33	30	01801	999967	818.41	2365.26
34	30	01801	999966	834.64	2369.83
35	30	01801	999965	850.87	2374.40
36	30	01801	999964	867.10	2378.97
37	30	01801	999963	883.33	2383.54
38	30	01801	999962	899.56	2388.11
39	30	01801	999961	915.79	2392.68
40	30	01801	999960	932.02	2397.25
41	30	01801	999959	948.25	2401.82
42	30	01801	999958	964.48	2406.39
43	30	01801	999957	980.71	2410.96
44	30	01801	999956	996.94	2415.53
45	30	01801	999955	1013.17	2420.10
46	30	01801	999954	1029.40	2424.67
47	30	01801	999953	1045.63	2429.24
48	30	01801	999952	1061.86	2433.81
49	30	01801	999951	1078.09	2438.38
50	30	01801	999950	1094.32	2442.95
51	30	01801	999949	1110.55	2447.52
52	30	01801	999948	1126.78	2452.09
53	30	01801	999947	1143.01	2456.66
54	30	01801	999946	1159.24	2461.23
55	30	01801	999945	1175.47	2465.80
56	30	01801	999944	1191.70	2470.37
57	30	01801	999943	12	

1	8	1	2	.5
9	12	1	1	.5
13	13	1	3	.5
14	41	1	2	.5
1	-2			
2	14			
3	-4		15	
4	17			
5	-6		20	
6	24			
7	-8		29	
8	35			
9	10		35	
10	11		37	
11	12		39	
12	13		41	
13				
14	15			
15	16			
16	18			
17	18		20	
18	19			
19	22			
20	21			
21	22		25	
22	23			
23	27			
24	25		29	
25	26			
26	27		31	
27	28			
28	33			
29	30			
30	31		36	
31	32			
32	33		38	
33	34			
34	40			
35	36			
36	37			
37	38			
38	39			
39	40			
40	41			
41				
8	25			
1	23	1.	1.083	

1. 1. .056 0. 90. 270. 330.
1 13
F1N

```

-O RUN          5,          900,15000      D KOLESAR  703 BLDG  COBRA 2A
-PRL TEL INF000
-PUL TEL INF000
-ASG A=U2192
-ASG W B=(,AT)
-MSG SCB156 PUNCH INTERPRET BOX80
-XQT CUR
PEF A
IN A
TRI A
- DAT DATA/DATA.1
-A XQT BIGCDD
11 COBRA IIA / HALF 217 PIN BNDL / SAMPLE PROBLEM
1 2 B B
1 ISODIUM
2 IFRICT1
3 21
0 0 .05 0 .1 .55 .15 .683 .2 .805 .25 .915 .31.011 .351.091
.41.156 .451.202 .5 1.23 .55 1.24 .6 1.23 .651.202 .71.156 .751.091
.81.011 .85.915 .9 .805 .95 .683 1 .55
4 1217HB1
8 .03 1.217.171 .23 .056 1.715 .5 .5.1667
5 1217HB1
1 5.23 1.33 6 10.23 1.289 11 16.23 1.248 17 22.23 1.206
23 29.23 1.165 30 36.23 1.124 37 44.23 1.082 45 52.23 1.041
53 61.23 1.82 69.23 .959 70 77.23 .917 78 84.23 .876
85 91.23 .835 92 97.23 .794 98103.23 .752104108.23 .711
109113.23 .67
9 0 0
.001 .1 .1 .5 40. 0. 21 2
10 0 0 1
.06
11 1 1 0
50. 600. .1735 .406 36.
12 1 0
- FIN

```

```

-O RUN          5,SCB156,.420,20000      D KOLESAR      OSEDIT
-PRL TEL INF000
-ASG A=U2198
-ASG B=U1154
-XQT CUR
PEF A
IN A
TRI A
-XQT OSEDIT
B 1
11 COBRA IIA / HALF 217 PIN BNDL / SAMPLE PROBLEM
-XQT CUR
TRI B
- FIN

```

INPUT FOR CASE 1 COBRA IIA / HALF 217 PIN BNGL / SAMPLE PROBLEM

DATE 03 JUN 70 , TIME 09:26:57

METHODS CARD OPTIONS-- IGEOM INB MIFLAG OSAVE DUMP RESTRT IDOUT INPUTR MONITR
-0 -0 2 B B -0

OUTPUT WILL BE SAVED ON TAPE B

IF RUN IS TERMINATED BECAUSE OF LACK OF TIME TO COMPLETE IT, A RESTART DUMP WILL BE SAVED ON TAPE B

GEOMETRY TYPE-0, TRIANGULAR PIN ARRAY

MIFLAG IS 2 TO USE SUBROUTINE DIVERS TO DETERMINE W --SPECIAL GAUSS-SEIDEL MATRIX ITERATIVE SOLUTION FOR LARGE PROBLEMS

BASIC INPUT FORMAT TYPE 1. DATA VALUES ARE GIVEN COLUMNWISE, ACCORDING TO THE COD WRITEUP.

CARD GROUP 1,	N1,N2,N3 ARE	-0	-0	-0.	INPUT UNIT IS FILE NUMBER 1, SET SODIUM
CARD GROUP 2,	N1,N2,N3 ARE	-0	-0	-0.	INPUT UNIT IS FILE NUMBER 1, SET FRICT1
CARD GROUP 3,	N1,N2,N3 ARE	21	-0	-0.	INPUT UNIT IS FILE NUMBER 5
CARD GROUP 4,	N1,N2,N3 ARE	-0	-0	-0.	INPUT UNIT IS FILE NUMBER 1, SET 217HB1
CARD GROUP 8,	N1,N2,N3 ARE	-0	-0	5.	INPUT UNIT IS FILE NUMBER 1, SET 217HB1
CARD GROUP 9,	N1,N2,N3 ARE	0	0	-0.	INPUT UNIT IS FILE NUMBER 5
CARD GROUP 10,	N1,N2,N3 ARE	0	0	1.	INPUT UNIT IS FILE NUMBER 5
CARD GROUP 11,	N1,N2,N3 ARE	1	1	0.	INPUT UNIT IS FILE NUMBER 5
CARD GROUP 12,	N1,N2,N3 ARE	1	0	-0.	INPUT UNIT IS FILE NUMBER 5

INPUT FOR CASE 1 COBRA IIA / HALF 217 PIN BNDL / SAMPLE PROBLEM

DATE 03 JUN 70 , TIME 09:26:57

FLUID PROPERTY TABLE

P	T	VF	VG	HF	HG	VISC.	KF	SIGMA
.0	500.00	.01801	1000000.000	303.76	2204.80	.92350	45.43000	.01238
.0	550.00	.01801	1000000.000	319.44	2212.90	.85910	44.60000	.01219
.0	600.00	.01828	1000000.000	335.01	2220.50	.80380	43.79000	.01200
.0	650.00	.01842	409870.010	350.49	2227.60	.75580	42.98000	.01181
.0	700.00	.01856	178120.000	365.88	2234.10	.71380	42.18000	.01162
.0	750.00	.01870	83102.001	381.19	2240.20	.67670	41.39000	.01143
.0	800.00	.01885	41264.000	396.43	2245.80	.64370	40.62000	.01124
.0	840.00	.01897	24533.001	408.58	2249.90	.61980	40.00000	.01109
.0	880.00	.01909	15060.000	420.69	2253.90	.59800	39.39000	.01094
.1	920.00	.01921	9510.000	432.77	2257.60	.57780	38.79000	.01078
.1	940.00	.01927	7648.000	438.80	2259.30	.56830	38.50000	.01071
.1	960.00	.01933	6180.000	444.83	2261.10	.55920	38.20000	.01063
.1	980.00	.01940	5024.000	450.85	2262.80	.55040	37.91000	.01056
.2	1000.00	.01946	4111.000	456.86	2264.40	.54190	37.61000	.01048
.2	1020.00	.01952	3382.000	462.87	2266.10	.53380	37.42000	.01040
.2	1040.00	.01959	2798.000	468.88	2267.60	.52590	37.03000	.01033
.3	1060.00	.01965	2326.000	474.88	2269.20	.51830	36.74000	.01025
.4	1080.00	.01971	1944.000	480.88	2270.80	.51100	36.46000	.01017
.5	1100.00	.01978	1632.000	486.88	2272.30	.50040	36.03000	.01006
.5	1120.00	.01985	1376.000	492.87	2273.80	.49700	35.89000	.01002
.6	1140.00	.01991	1166.000	498.87	2275.20	.49040	35.61000	.00995
.7	1160.00	.01998	992.000	504.86	2276.70	.48400	35.33000	.00987
.8	1180.00	.02005	847.500	510.86	2278.20	.47780	35.05000	.00979
1.0	1200.00	.02011	724.900	516.85	2279.60	.47170	34.78000	.00972
2.1	1300.00	.02046	356.300	546.85	2286.70	.44420	33.42000	.00934
4.2	1400.00	.02082	189.100	576.95	2293.90	.42040	32.11000	.00896
7.8	1500.00	.02119	107.400	607.21	2301.10	.39950	30.84000	.00857
14.0	1600.00	.02157	64.630	637.70	2308.50	.38110	29.61000	.00819
15.0	1619.00	.02165	59.340	643.40	2310.20	.37790	29.38000	.00812
120.0	2145.00	.02388	8.522	810.92	2351.70	.30940	23.64000	.00612

E-9

BNWL-1422

DIAMETRICAL	FRACTION	NUMBER	PROBLEM GEOMETRY DATA (GEOMAT CARD)						WIRE AREA FRACTIONS		
TOLERANCE	LOOSENESS OF PINS	OF PINS	CORE AVERAGE PIN RADIUS	WIRE DIAMETER	PIN DIAMETER	WIRES	DISTRIBUTION	EXPONENT	CHI 1	CHI 2	CHI 3
.0300	1.0000	217.	.1710	.23000	.0560	1.	.71500		.5000	.5000	.1667

DATE 03 JUN 70 , TIME 09:26:57

INPUT FOR CASE 1 COBRA IIA / HALF 217 PIN BNDL / SAMPLE PROBLEM

CHANNEL INPUT DATA TYPES ARE A FOR AXIAL VARIATIONS

FOR AXIAL VARIATION
FRICTION FACTOR
GEOMETRY -- 1 FOR

```

# G
FRICTION FACTOR
GEOMETRY -- 1 FOR PERIPHERAL, 2 FOR INTERIOR, 3 FOR CORNER -- OF HEXAGONAL BUNDLE

```

[illegible]

37	0	1	2	.006976	.224624	.180641	.124225	(-36, .058, .166)	(53, .058, .166)	(-0, -.000, -.000)	(-0, -.000, -.000)
38	0	1	2	.006976	.224624	.180641	.124225	(-39, .058, .166)	(54, .058, .166)	(-0, -.000, -.000)	(-0, -.000, -.000)
39	0	1	2	.006976	.224624	.180641	.124225	(-38, .058, .166)	(55, .058, .166)	(-0, -.000, -.000)	(-0, -.000, -.000)
40	0	1	2	.006976	.224624	.180641	.124225	(-41, .058, .166)	(56, .058, .166)	(-0, -.000, -.000)	(-0, -.000, -.000)
41	0	1	2	.006976	.224624	.180641	.124225	(-40, .058, .166)	(57, .058, .166)	(-0, -.000, -.000)	(-0, -.000, -.000)
42	0	1	2	.006976	.224624	.180641	.124225	(-43, .058, .166)	(58, .058, .166)	(-0, -.000, -.000)	(-0, -.000, -.000)
43	0	1	2	.006976	.224624	.180641	.124225	(-42, .058, .166)	(59, .058, .166)	(-0, -.000, -.000)	(-0, -.000, -.000)
44	0	1	2	.013952	.449247	.361283	.124225	(4, .058, .195)	(28, .058, .166)	(60, .058, .166)	(-0, -.000, -.000)
45	0	1	2	.013952	.449247	.361283	.124225	(29, .058, .166)	(46, .058, .166)	(61, .058, .166)	(-0, -.000, -.000)
46	0	1	2	.013952	.449247	.361283	.124225	(30, .058, .166)	(45, .058, .166)	(62, .058, .166)	(-0, -.000, -.000)
47	0	1	2	.013952	.449247	.361283	.124225	(31, .058, .166)	(48, .058, .166)	(63, .058, .166)	(-0, -.000, -.000)
48	0	1	2	.013952	.449247	.361283	.124225	(32, .058, .166)	(47, .058, .166)	(64, .058, .166)	(-0, -.000, -.000)
49	0	1	2	.013952	.449247	.361283	.124225	(33, .058, .166)	(50, .058, .166)	(65, .058, .166)	(-0, -.000, -.000)
50	0	1	2	.013952	.449247	.361283	.124225	(34, .058, .166)	(49, .058, .166)	(66, .058, .166)	(-0, -.000, -.000)
51	0	1	2	.013952	.449247	.361283	.124225	(35, .058, .166)	(52, .058, .166)	(67, .058, .166)	(-0, -.000, -.000)
52	0	1	2	.013952	.449247	.361283	.124225	(36, .058, .166)	(51, .058, .166)	(68, .058, .166)	(-0, -.000, -.000)
53	0	1	2	.013952	.449247	.361283	.124225	(37, .058, .166)	(54, .058, .166)	(69, .058, .166)	(-0, -.000, -.000)
54	0	1	2	.013952	.449247	.361283	.124225	(38, .058, .166)	(53, .058, .166)	(70, .058, .166)	(-0, -.000, -.000)
55	0	1	2	.013952	.449247	.361283	.124225	(39, .058, .166)	(56, .058, .166)	(71, .058, .166)	(-0, -.000, -.000)
56	0	1	2	.013952	.449247	.361283	.124225	(40, .058, .166)	(55, .058, .166)	(72, .058, .166)	(-0, -.000, -.000)
57	0	1	2	.013952	.449247	.361283	.124225	(41, .058, .166)	(58, .058, .166)	(73, .058, .166)	(-0, -.000, -.000)
58	0	1	2	.013952	.449247	.361283	.124225	(42, .058, .166)	(57, .058, .166)	(74, .058, .166)	(-0, -.000, -.000)
59	0	1	2	.013952	.449247	.361283	.124225	(27, .058, .195)	(43, .058, .166)	(75, .058, .166)	(-0, -.000, -.000)
60	0	1	2	.013952	.449247	.361283	.124225	(44, .058, .166)	(61, .058, .166)	(76, .058, .166)	(-0, -.000, -.000)
61	0	1	2	.013952	.449247	.361283	.124225	(45, .058, .166)	(60, .058, .166)	(77, .058, .166)	(-0, -.000, -.000)
62	0	1	2	.013952	.449247	.361283	.124225	(46, .058, .166)	(63, .058, .166)	(78, .058, .166)	(-0, -.000, -.000)
63	0	1	2	.013952	.449247	.361283	.124225	(47, .058, .166)	(62, .058, .166)	(79, .058, .166)	(-0, -.000, -.000)
64	0	1	2	.013952	.449247	.361283	.124225	(48, .058, .166)	(65, .058, .166)	(80, .058, .166)	(-0, -.000, -.000)
65	0	1	2	.013952	.449247	.361283	.124225	(49, .058, .166)	(64, .058, .166)	(81, .058, .166)	(-0, -.000, -.000)

INPUT FOR CASE 1 COBRA IIA / HALF 217 PIN BNOL / SAMPLE PROBLEM DATE 03 JUN 70 , TIME 09:26:57

BNWL-1422

CONNECTION DATA

CONNECTION	CHANNELS	FACTOR	GAP (FT)	LENGTH (FT)	GAP TYPE
1	1 7	1.0	.004667	.018246	0
2	1 8	1.0	.004667	.018246	0
3	2 15	1.0	.004667	.018246	0
4	2 16	1.0	.004667	.018246	0
5	3 23	1.0	.004667	.018246	0
6	3 24	1.0	.004667	.018246	0
7	4 5	1.0	.004667	.024014	0
8	4 44	1.0	.004847	.016286	0
9	5 6	1.0	.004667	.024014	0
10	5 76	1.0	.004847	.016286	0
11	6 7	1.0	.004667	.024014	0
12	6 108	1.0	.004847	.016286	0
13	7 140	1.0	.004847	.016286	0
14	8 9	1.0	.004667	.024014	0
15	8 156	1.0	.004847	.016286	0
16	9 10	1.0	.004667	.024014	0
17	9 172	1.0	.004847	.016286	0
18	10 11	1.0	.004667	.024014	0
19	10 186	1.0	.004847	.016286	0
20	11 12	1.0	.004667	.024014	0
21	11 198	1.0	.004847	.016286	0
22	12 13	1.0	.004667	.024014	0
23	12 208	1.0	.004847	.016286	0
24	13 14	1.0	.004667	.024014	0
25	13 216	1.0	.004847	.016286	0
26	14 15	1.0	.004667	.024014	0
27	14 222	1.0	.004847	.016286	0
28	15 226	1.0	.004847	.016286	0
29	16 17	1.0	.004667	.024014	0
30	16 227	1.0	.004847	.016286	0
31	17 18	1.0	.004667	.024014	0
32	17 225	1.0	.004847	.016286	0
33	18 19	1.0	.004667	.024014	0
34	18 221	1.0	.004847	.016286	0
35	19 20	1.0	.004667	.024014	0
36	19 215	1.0	.004847	.016286	0
37	20 21	1.0	.004667	.024014	0
38	20 207	1.0	.004847	.016286	0

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39	21	22	1.0	.004667	.024014	0
40	21	197	1.0	.004847	.016286	0
41	22	23	1.0	.004667	.024014	0
42	22	185	1.0	.004847	.016286	0
43	23	171	1.0	.004847	.016286	0
44	24	25	1.0	.004667	.024014	0
45	24	155	1.0	.004847	.016286	0
46	25	26	1.0	.004667	.024014	0
47	25	123	1.0	.004847	.016286	0
48	26	27	1.0	.004667	.024014	0
49	26	91	1.0	.004847	.016286	0
50	27	59	1.0	.004847	.016286	0
51	28	29	.5	.004847	.013864	0
52	28	44	1.0	.004847	.013864	0
53	29	45	1.0	.004847	.013864	0
54	30	31	.5	.004847	.013864	0
55	30	46	1.0	.004847	.013864	0
56	31	47	1.0	.004847	.013864	0
57	32	33	.5	.004847	.013864	0
58	32	48	1.0	.004847	.013864	0
59	33	49	1.0	.004847	.013864	0
60	34	35	.5	.004847	.013864	0
61	34	50	1.0	.004847	.013864	0
62	35	51	1.0	.004847	.013864	0
63	36	37	.5	.004847	.013864	0
64	36	52	1.0	.004847	.013864	0
65	37	53	1.0	.004847	.013864	0
66	38	39	.5	.004847	.013864	0
67	38	54	1.0	.004847	.013864	0
68	39	55	1.0	.004847	.013864	0
69	40	41	.5	.004847	.013864	0
70	40	56	1.0	.004847	.013864	0
71	41	57	1.0	.004847	.013864	0
72	42	43	.5	.004847	.013864	0
73	42	58	1.0	.004847	.013864	0
74	43	59	1.0	.004847	.013864	0
75	44	60	1.0	.004847	.013864	0
76	45	46	1.0	.004847	.013864	0
77	45	61	1.0	.004847	.013864	0
78	46	62	1.0	.004847	.013864	0
79	47	48	1.0	.004847	.013864	0
80	47	63	1.0	.004847	.013864	0
81	48	64	1.0	.004847	.013864	0
82	49	50	1.0	.004847	.013864	0
83	49	65	1.0	.004847	.013864	0
84	50	66	1.0	.004847	.013864	0
85	51	52	1.0	.004847	.013864	0
86	51	67	1.0	.004847	.013864	0
87	52	68	1.0	.004847	.013864	0

88	53	54	1.0	.004847	.013864	0
89	54	69	1.0	.004847	.013864	0
90	53	70	1.0	.004847	.013864	0
91	55	56	1.0	.004847	.013864	0
92	55	71	1.0	.004847	.013864	0
93	56	72	1.0	.004847	.013864	0
94	57	58	1.0	.004847	.013864	0
95	57	73	1.0	.004847	.013864	0
96	58	74	1.0	.004847	.013864	0
97	59	75	1.0	.004847	.013864	0
98	60	61	1.0	.004847	.013864	0
99	60	76	1.0	.004847	.013864	0
100	61	77	1.0	.004847	.013864	0
101	62	63	1.0	.004847	.013864	0
102	62	78	1.0	.004847	.013864	0
103	63	79	1.0	.004847	.013864	0
104	64	65	1.0	.004847	.013864	0
105	64	80	1.0	.004847	.013864	0
106	65	81	1.0	.004847	.013864	0
107	66	67	1.0	.004847	.013864	0
108	66	82	1.0	.004847	.013864	0
109	67	83	1.0	.004847	.013864	0
110	68	69	1.0	.004847	.013864	0
111	68	84	1.0	.004847	.013864	0
112	69	85	1.0	.004847	.013864	0
113	70	71	1.0	.004847	.013864	0
114	70	86	1.0	.004847	.013864	0
115	71	87	1.0	.004847	.013864	0
116	72	73	1.0	.004847	.013864	0
117	72	88	1.0	.004847	.013864	0
118	73	89	1.0	.004847	.013864	0
119	74	75	1.0	.004847	.013864	0
120	74	90	1.0	.004847	.013864	0
121	75	91	1.0	.004847	.013864	0
122	76	92	1.0	.004847	.013864	0
123	77	78	1.0	.004847	.013864	0
124	77	93	1.0	.004847	.013864	0
125	78	94	1.0	.004847	.013864	0
126	79	80	1.0	.004847	.013864	0
127	79	95	1.0	.004847	.013864	0
128	80	96	1.0	.004847	.013864	0
129	81	82	1.0	.004847	.013864	0
130	81	97	1.0	.004847	.013864	0
131	82	98	1.0	.004847	.013864	0
132	83	84	1.0	.004847	.013864	0
133	83	99	1.0	.004847	.013864	0
134	84	100	1.0	.004847	.013864	0
135	85	86	1.0	.004847	.013864	0
136	85	101	1.0	.004847	.013864	0

137	86	102	1.0	.004847	.013864	0
138	87	88	1.0	.004847	.013864	0
139	87	103	1.0	.004847	.013864	0
140	88	104	1.0	.004847	.013864	0
141	89	90	1.0	.004847	.013864	0
142	89	105	1.0	.004847	.013864	0
143	90	106	1.0	.004847	.013864	0
144	91	107	1.0	.004847	.013864	0
145	92	93	1.0	.004847	.013864	0
146	92	108	1.0	.004847	.013864	0
147	93	109	1.0	.004847	.013864	0
148	94	95	1.0	.004847	.013864	0
149	94	110	1.0	.004847	.013864	0
150	95	111	1.0	.004847	.013864	0
151	96	97	1.0	.004847	.013864	0
152	96	112	1.0	.004847	.013864	0
153	97	113	1.0	.004847	.013864	0
154	98	99	1.0	.004847	.013864	0
155	98	114	1.0	.004847	.013864	0
156	99	115	1.0	.004847	.013864	0
157	100	101	1.0	.004847	.013864	0
158	100	116	1.0	.004847	.013864	0
159	101	117	1.0	.004847	.013864	0
160	102	103	1.0	.004847	.013864	0
161	102	118	1.0	.004847	.013864	0
162	103	119	1.0	.004847	.013864	0
163	104	105	1.0	.004847	.013864	0
164	104	120	1.0	.004847	.013864	0
165	105	121	1.0	.004847	.013864	0
166	106	107	1.0	.004847	.013864	0
167	106	122	1.0	.004847	.013864	0
168	107	123	1.0	.004847	.013864	0
169	108	124	1.0	.004847	.013864	0
170	109	110	1.0	.004847	.013864	0
171	109	125	1.0	.004847	.013864	0
172	110	126	1.0	.004847	.013864	0
173	111	112	1.0	.004847	.013864	0
174	111	127	1.0	.004847	.013864	0
175	112	128	1.0	.004847	.013864	0
176	113	114	1.0	.004847	.013864	0
177	113	129	1.0	.004847	.013864	0
178	114	130	1.0	.004847	.013864	0
179	115	116	1.0	.004847	.013864	0
180	115	131	1.0	.004847	.013864	0
181	116	132	1.0	.004847	.013864	0
182	117	118	1.0	.004847	.013864	0
183	117	133	1.0	.004847	.013864	0
184	118	134	1.0	.004847	.013864	0
185	119	120	1.0	.004847	.013864	0

	186	119	135	1.0	.004847	.013864	0
	187	120	136	1.0	.004847	.013864	0
	188	121	122	1.0	.004847	.013864	0
	189	121	137	1.0	.004847	.013864	0
	190	122	138	1.0	.004847	.013864	0
	191	123	139	1.0	.004847	.013864	0
	192	124	125	1.0	.004847	.013864	0
	193	124	140	1.0	.004847	.013864	0
	194	125	141	1.0	.004847	.013864	0
	195	126	127	1.0	.004847	.013864	0
	196	126	142	1.0	.004847	.013864	0
	197	127	143	1.0	.004847	.013864	0
	198	128	129	1.0	.004847	.013864	0
	199	128	144	1.0	.004847	.013864	0
	200	129	145	1.0	.004847	.013864	0
	201	130	131	1.0	.004847	.013864	0
	202	130	146	1.0	.004847	.013864	0
	203	131	147	1.0	.004847	.013864	0
	204	132	133	1.0	.004847	.013864	0
	205	132	148	1.0	.004847	.013864	0
	206	133	149	1.0	.004847	.013864	0
	207	134	135	1.0	.004847	.013864	0
	208	134	150	1.0	.004847	.013864	0
E-20	209	135	151	1.0	.004847	.013864	0
	210	136	137	1.0	.004847	.013864	0
	211	136	152	1.0	.004847	.013864	0
	212	137	153	1.0	.004847	.013864	0
	213	138	139	1.0	.004847	.013864	0
	214	138	154	1.0	.004847	.013864	0
	215	139	155	1.0	.004847	.013864	0
	216	140	156	1.0	.004847	.013864	0
	217	141	142	1.0	.004847	.013864	0
	218	141	157	1.0	.004847	.013864	0
	219	142	158	1.0	.004847	.013864	0
	220	143	144	1.0	.004847	.013864	0
	221	143	159	1.0	.004847	.013864	0
	222	144	160	1.0	.004847	.013864	0
	223	145	146	1.0	.004847	.013864	0
	224	145	161	1.0	.004847	.013864	0
	225	146	162	1.0	.004847	.013864	0
	226	147	148	1.0	.004847	.013864	0
	227	147	163	1.0	.004847	.013864	0
	228	148	164	1.0	.004847	.013864	0
	229	149	150	1.0	.004847	.013864	0
	230	149	165	1.0	.004847	.013864	0
	231	150	166	1.0	.004847	.013864	0
	232	151	152	1.0	.004847	.013864	0
	233	151	167	1.0	.004847	.013864	0
	234	152	168	1.0	.004847	.013864	0

235	153	154	1.0	.004847	.013864	0
236	153	169	1.0	.004847	.013864	0
237	154	170	1.0	.004847	.013864	0
238	155	171	1.0	.004847	.013864	0
239	156	157	1.0	.004847	.013864	0
240	157	172	1.0	.004847	.013864	0
241	158	159	1.0	.004847	.013864	0
242	158	173	1.0	.004847	.013864	0
243	159	174	1.0	.004847	.013864	0
244	160	161	1.0	.004847	.013864	0
245	160	175	1.0	.004847	.013864	0
246	161	176	1.0	.004847	.013864	0
247	162	162	1.0	.004847	.013864	0
248	162	177	1.0	.004847	.013864	0
249	163	178	1.0	.004847	.013864	0
250	164	165	1.0	.004847	.013864	0
251	164	179	1.0	.004847	.013864	0
252	165	180	1.0	.004847	.013864	0
253	166	167	1.0	.004847	.013864	0
254	166	181	1.0	.004847	.013864	0
255	167	182	1.0	.004847	.013864	0
256	168	169	1.0	.004847	.013864	0
257	168	183	1.0	.004847	.013864	0
258	169	184	1.0	.004847	.013864	0
259	170	171	1.0	.004847	.013864	0
260	170	185	1.0	.004847	.013864	0
261	172	173	1.0	.004847	.013864	0
262	173	186	1.0	.004847	.013864	0
263	174	175	1.0	.004847	.013864	0
264	174	187	1.0	.004847	.013864	0
265	175	188	1.0	.004847	.013864	0
266	176	177	1.0	.004847	.013864	0
267	176	189	1.0	.004847	.013864	0
268	177	190	1.0	.004847	.013864	0
269	178	179	1.0	.004847	.013864	0
270	178	191	1.0	.004847	.013864	0
271	179	192	1.0	.004847	.013864	0
272	180	181	1.0	.004847	.013864	0
273	180	193	1.0	.004847	.013864	0
274	181	194	1.0	.004847	.013864	0
275	182	183	1.0	.004847	.013864	0
276	182	195	1.0	.004847	.013864	0
277	183	196	1.0	.004847	.013864	0
278	184	185	1.0	.004847	.013864	0
279	184	197	1.0	.004847	.013864	0
280	186	187	1.0	.004847	.013864	0
281	187	198	1.0	.004847	.013864	0
282	188	189	1.0	.004847	.013864	0
283	188	199	1.0	.004847	.013864	0

284	189	200	1.0	.004847	.013864	0
285	190	191	1.0	.004847	.013864	0
286	190	201	1.0	.004847	.013864	0
287	191	202	1.0	.004847	.013864	0
288	192	193	1.0	.004847	.013864	0
289	192	203	1.0	.004847	.013864	0
290	193	204	1.0	.004847	.013864	0
291	194	195	1.0	.004847	.013864	0
292	194	205	1.0	.004847	.013864	0
293	195	206	1.0	.004847	.013864	0
294	196	197	1.0	.004847	.013864	0
295	196	207	1.0	.004847	.013864	0
296	198	199	1.0	.004847	.013864	0
297	199	208	1.0	.004847	.013864	0
298	200	201	1.0	.004847	.013864	0
299	200	209	1.0	.004847	.013864	0
300	201	210	1.0	.004847	.013864	0
301	202	203	1.0	.004847	.013864	0
302	202	211	1.0	.004847	.013864	0
303	203	212	1.0	.004847	.013864	0
304	204	205	1.0	.004847	.013864	0
305	204	213	1.0	.004847	.013864	0
306	205	214	1.0	.004847	.013864	0
307	206	207	1.0	.004847	.013864	0
308	206	215	1.0	.004847	.013864	0
309	208	209	1.0	.004847	.013864	0
310	209	216	1.0	.004847	.013864	0
311	210	211	1.0	.004847	.013864	0
312	210	217	1.0	.004847	.013864	0
313	211	218	1.0	.004847	.013864	0
314	212	213	1.0	.004847	.013864	0
315	212	219	1.0	.004847	.013864	0
316	213	220	1.0	.004847	.013864	0
317	214	215	1.0	.004847	.013864	0
318	214	221	1.0	.004847	.013864	0
319	216	217	1.0	.004847	.013864	0
320	217	222	1.0	.004847	.013864	0
321	218	219	1.0	.004847	.013864	0
322	218	223	1.0	.004847	.013864	0
323	219	224	1.0	.004847	.013864	0
324	220	221	1.0	.004847	.013864	0
325	220	225	1.0	.004847	.013864	0
326	222	223	1.0	.004847	.013864	0
327	223	226	1.0	.004847	.013864	0
328	224	225	1.0	.004847	.013864	0
329	224	227	1.0	.004847	.013864	0
330	226	227	1.0	.004847	.013864	0

DATE 03 JUN 70 , TIME 09:26:57

 INPUT FOR CASE 1 COBRA IIA / HALF 217 PIN BNDL / SAMPLE PROBLEM

ROD INPUT DATA

ROD NO.	DIAMETER (IN.)	RADIAL POWER FACTOR	FRACTION OF POWER TO ADJACENT CHANNELS (ADJ. CHANNEL NO.)									
1	.2300	1.3300	.1670(1)	.2500(7)	.2500(8)	.1670(140)	.1670(156)	.1670(140)	.1670(156)	.1670(140)	.1670(156)	-.0000(-0)
2	.2300	1.3300	.2500(6)	.2500(7)	.1670(108)	.1670(124)	.1670(140)	.1670(124)	.1670(140)	.1670(124)	.1670(140)	-.0000(-0)
3	.2300	1.3300	.2500(5)	.2500(6)	.1670(76)	.1670(92)	.1670(108)	.1670(92)	.1670(108)	.1670(92)	.1670(108)	-.0000(-0)
4	.2300	1.3300	.2500(4)	.2500(5)	.1670(44)	.1670(60)	.1670(76)	.1670(60)	.1670(76)	.1670(60)	.1670(76)	-.0000(-0)
5	.2300	1.3300	.2500(4)	.0830(28)	.1670(44)	-.0000(-0)	-.0000(-0)	-.0000(-0)	-.0000(-0)	-.0000(-0)	-.0000(-0)	-.0000(-0)
6	.2300	1.2890	.2500(8)	.2500(9)	.1670(156)	.1670(157)	.1670(172)	.1670(157)	.1670(172)	.1670(157)	.1670(172)	-.0000(-0)
7	.2300	1.2890	.1670(124)	.1670(125)	.1670(140)	.1670(141)	.1670(156)	.1670(141)	.1670(156)	.1670(141)	.1670(156)	.1670(157)
8	.2300	1.2890	.1670(92)	.1670(93)	.1670(108)	.1670(109)	.1670(124)	.1670(109)	.1670(124)	.1670(109)	.1670(124)	.1670(125)
9	.2300	1.2890	.1670(60)	.1670(61)	.1670(76)	.1670(77)	.1670(92)	.1670(77)	.1670(92)	.1670(77)	.1670(92)	.1670(93)
10	.2300	1.2890	.1670(28)	.1670(29)	.1670(44)	.1670(45)	.1670(60)	.1670(45)	.1670(60)	.1670(45)	.1670(60)	.1670(61)
11	.2300	1.2480	.2500(9)	.2500(10)	.1670(172)	.1670(173)	.1670(186)	.1670(173)	.1670(186)	.1670(173)	.1670(186)	-.0000(-0)
12	.2300	1.2480	.1670(141)	.1670(142)	.1670(157)	.1670(158)	.1670(172)	.1670(158)	.1670(172)	.1670(158)	.1670(172)	.1670(173)
13	.2300	1.2480	.1670(109)	.1670(110)	.1670(125)	.1670(126)	.1670(141)	.1670(126)	.1670(141)	.1670(126)	.1670(141)	.1670(142)
14	.2300	1.2480	.1670(77)	.1670(78)	.1670(93)	.1670(94)	.1670(109)	.1670(94)	.1670(109)	.1670(94)	.1670(109)	.1670(110)
15	.2300	1.2480	.1670(45)	.1670(46)	.1670(62)	.1670(62)	.1670(77)	.1670(62)	.1670(77)	.1670(62)	.1670(77)	.1670(78)
16	.2300	1.2480	.0830(29)	.0830(30)	.1670(45)	.1670(46)	-.0000(-0)	.1670(46)	-.0000(-0)	.1670(46)	-.0000(-0)	.1670(78)
17	.2300	1.2060	.2500(10)	.2500(11)	.1670(186)	.1670(187)	.1670(198)	.1670(187)	.1670(198)	.1670(187)	.1670(198)	-.0000(-0)
18	.2300	1.2060	.1670(158)	.1670(159)	.1670(173)	.1670(174)	.1670(186)	.1670(174)	.1670(186)	.1670(174)	.1670(186)	.1670(187)
19	.2300	1.2060	.1670(126)	.1670(127)	.1670(142)	.1670(143)	.1670(158)	.1670(143)	.1670(158)	.1670(143)	.1670(158)	.1670(159)
20	.2300	1.2060	.1670(94)	.1670(95)	.1670(110)	.1670(111)	.1670(126)	.1670(111)	.1670(126)	.1670(111)	.1670(126)	.1670(127)
21	.2300	1.2060	.1670(62)	.1670(63)	.1670(78)	.1670(79)	.1670(94)	.1670(79)	.1670(94)	.1670(79)	.1670(94)	.1670(95)
22	.2300	1.2060	.1670(30)	.1670(31)	.1670(46)	.1670(47)	.1670(62)	.1670(47)	.1670(62)	.1670(47)	.1670(62)	.1670(63)
23	.2300	1.1650	.2500(11)	.2500(12)	.1670(198)	.1670(199)	.1670(208)	.1670(199)	.1670(208)	.1670(199)	.1670(208)	-.0000(-0)
24	.2300	1.1650	.1670(174)	.1670(175)	.1670(187)	.1670(188)	.1670(199)	.1670(188)	.1670(199)	.1670(188)	.1670(199)	.1670(199)
25	.2300	1.1650	.1670(143)	.1670(144)	.1670(159)	.1670(160)	.1670(174)	.1670(160)	.1670(174)	.1670(160)	.1670(174)	.1670(175)
26	.2300	1.1650	.1670(111)	.1670(112)	.1670(127)	.1670(128)	.1670(143)	.1670(128)	.1670(143)	.1670(128)	.1670(143)	.1670(144)
27	.2300	1.1650	.1670(79)	.1670(80)	.1670(95)	.1670(96)	.1670(111)	.1670(96)	.1670(111)	.1670(96)	.1670(111)	.1670(112)
28	.2300	1.1650	.1670(47)	.1670(48)	.1670(64)	.1670(64)	.1670(79)	.1670(64)	.1670(79)	.1670(64)	.1670(79)	.1670(80)
29	.2300	1.1650	.0830(31)	.0830(32)	.1670(47)	.1670(48)	-.0000(-0)	.1670(48)	-.0000(-0)	.1670(48)	-.0000(-0)	.1670(199)
30	.2300	1.1240	.2500(12)	.2500(13)	.1670(208)	.1670(209)	.1670(216)	.1670(209)	.1670(216)	.1670(209)	.1670(216)	-.0000(-0)
31	.2300	1.1240	.1670(188)	.1670(189)	.1670(199)	.1670(200)	.1670(208)	.1670(200)	.1670(208)	.1670(200)	.1670(208)	.1670(209)
32	.2300	1.1240	.1670(160)	.1670(161)	.1670(175)	.1670(176)	.1670(188)	.1670(176)	.1670(188)	.1670(176)	.1670(188)	.1670(189)
33	.2300	1.1240	.1670(128)	.1670(129)	.1670(144)	.1670(145)	.1670(160)	.1670(145)	.1670(160)	.1670(145)	.1670(160)	.1670(161)
34	.2300	1.1240	.1670(96)	.1670(97)	.1670(112)	.1670(113)	.1670(128)	.1670(113)	.1670(128)	.1670(113)	.1670(128)	.1670(129)
35	.2300	1.1240	.1670(64)	.1670(65)	.1670(80)	.1670(81)	.1670(96)	.1670(81)	.1670(96)	.1670(81)	.1670(96)	.1670(97)
36	.2300	1.1240	.1670(32)	.1670(33)	.1670(48)	.1670(49)	.1670(64)	.1670(49)	.1670(64)	.1670(49)	.1670(64)	.1670(65)
37	1.0820	1.0820	.2500(13)	.2500(14)	.1670(216)	.1670(217)	.1670(222)	.1670(217)	.1670(222)	.1670(217)	.1670(222)	-.0000(-0)
38	.2300	1.0820	.1670(200)	.1670(201)	.1670(209)	.1670(210)	.1670(216)	.1670(210)	.1670(216)	.1670(210)	.1670(216)	.1670(217)

39	.2300	1.0820	.1670(176)	.1670(177)	.1670(189)	.1670(190)	.1670(200)	.1670(201)
40	.2300	1.0820	.1670(145)	.1670(146)	.1670(161)	.1670(162)	.1670(176)	.1670(177)
41	.2300	1.0820	.1670(113)	.1670(114)	.1670(129)	.1670(130)	.1670(145)	.1670(146)
42	.2300	1.0820	.1670(81)	.1670(82)	.1670(97)	.1670(98)	.1670(113)	.1670(114)
43	.2300	1.0820	.1670(49)	.1670(50)	.1670(65)	.1670(66)	.1670(81)	.1670(82)
44	.2300	1.0820	.0830(33)	.0830(34)	.1670(49)	.1670(50)	-.0000(-0)	-.0000(-0)
45	.2300	1.0410	.2500(14)	.2500(15)	.1670(222)	.1670(223)	.1670(226)	-.0000(-0)
46	.2300	1.0410	.1670(210)	.1670(211)	.1670(217)	.1670(218)	.1670(222)	.1670(223)
47	.2300	1.0410	.1670(190)	.1670(191)	.1670(201)	.1670(202)	.1670(222)	.1670(223)
48	.2300	1.0410	.1670(162)	.1670(163)	.1670(177)	.1670(178)	.1670(190)	.1670(191)
49	.2300	1.0410	.1670(130)	.1670(131)	.1670(146)	.1670(147)	.1670(162)	.1670(163)
50	.2300	1.0410	.1670(98)	.1670(99)	.1670(114)	.1670(115)	.1670(130)	.1670(131)
51	.2300	1.0410	.1670(66)	.1670(67)	.1670(82)	.1670(83)	.1670(98)	.1670(99)
52	.2300	1.0410	.1670(34)	.1670(35)	.1670(50)	.1670(51)	.1670(66)	.1670(67)
53	.2300	1.0000	.1670(2)	.2500(15)	.2500(16)	.1670(226)	.1670(227)	-.0000(-0)
54	.2300	1.0000	.1670(218)	.1670(219)	.1670(223)	.1670(224)	.1670(226)	.1670(227)
55	.2300	1.0000	.1670(202)	.1670(203)	.1670(211)	.1670(212)	.1670(218)	.1670(219)
56	.2300	1.0000	.1670(178)	.1670(179)	.1670(191)	.1670(192)	.1670(202)	.1670(203)
57	.2300	1.0000	.1670(147)	.1670(148)	.1670(163)	.1670(164)	.1670(178)	.1670(179)
58	.2300	1.0000	.1670(115)	.1670(116)	.1670(131)	.1670(132)	.1670(147)	.1670(148)
59	.2300	1.0000	.1670(83)	.1670(84)	.1670(99)	.1670(100)	.1670(115)	.1670(116)
60	.2300	1.0000	.1670(51)	.1670(52)	.1670(67)	.1670(68)	.1670(83)	.1670(84)
61	.2300	1.0000	.0830(35)	.0830(36)	.1670(51)	.1670(52)	-.0000(-0)	-.0000(-0)
62	.2300	.9590	.2500(16)	.2500(17)	.1670(224)	.1670(225)	.1670(227)	-.0000(-0)
63	.2300	.9590	.1670(12)	.1670(13)	.1670(219)	.1670(220)	.1670(224)	.1670(225)
64	.2300	.9590	.1670(192)	.1670(193)	.1670(203)	.1670(204)	.1670(212)	.1670(213)
65	.2300	.9590	.1670(164)	.1670(165)	.1670(179)	.1670(180)	.1670(192)	.1670(193)
66	.2300	.9590	.1670(132)	.1670(133)	.1670(148)	.1670(149)	.1670(164)	.1670(165)
67	.2300	.9590	.1670(100)	.1670(101)	.1670(116)	.1670(117)	.1670(132)	.1670(133)
68	.2300	.9590	.1670(68)	.1670(69)	.1670(84)	.1670(85)	.1670(100)	.1670(101)
69	.2300	.9590	.1670(36)	.1670(37)	.1670(52)	.1670(53)	.1670(68)	.1670(69)
70	.2300	.9170	.2500(17)	.2500(18)	.1670(220)	.1670(221)	.1670(225)	-.0000(-0)
71	.2300	.9170	.1670(204)	.1670(205)	.1670(213)	.1670(214)	.1670(220)	.1670(221)
72	.2300	.9170	.1670(180)	.1670(181)	.1670(193)	.1670(194)	.1670(204)	.1670(205)
73	.2300	.9170	.1670(149)	.1670(150)	.1670(165)	.1670(166)	.1670(180)	.1670(181)
74	.2300	.9170	.1670(117)	.1670(118)	.1670(133)	.1670(134)	.1670(149)	.1670(150)
75	.2300	.9170	.1670(85)	.1670(86)	.1670(101)	.1670(102)	.1670(117)	.1670(118)
76	.2300	.9170	.1670(53)	.1670(54)	.1670(69)	.1670(70)	.1670(85)	.1670(86)
77	.2300	.9170	.0830(37)	.0830(38)	.1670(53)	.1670(54)	-.0000(-0)	-.0000(-0)
78	.2300	.8760	.2500(18)	.2500(19)	.1670(214)	.1670(215)	.1670(221)	-.0000(-0)
79	.2300	.8760	.1670(194)	.1670(195)	.1670(205)	.1670(206)	.1670(214)	.1670(215)
80	.2300	.8760	.1670(166)	.1670(167)	.1670(181)	.1670(182)	.1670(194)	.1670(195)
81	.2300	.8760	.1670(134)	.1670(135)	.1670(150)	.1670(151)	.1670(166)	.1670(167)
82	.2300	.8760	.1670(102)	.1670(103)	.1670(118)	.1670(119)	.1670(134)	.1670(135)
83	.2300	.8760	.1670(70)	.1670(71)	.1670(86)	.1670(87)	.1670(102)	.1670(103)
84	.2300	.8760	.1670(38)	.1670(39)	.1670(54)	.1670(55)	.1670(70)	.1670(71)
85	.2300	.8350	.2500(19)	.2500(20)	.1670(206)	.1670(207)	.1670(215)	-.0000(-0)
86	.2300	.8350	.1670(182)	.1670(183)	.1670(195)	.1670(196)	.1670(206)	.1670(207)
87	.2300	.8350	.1670(151)	.1670(152)	.1670(167)	.1670(168)	.1670(182)	.1670(183)

88	.2300	.8350	.1670(119)	.1670(120)	.1670(135)	.1670(136)	.1670(151)	.1670(152)
89	.2300	.8350	.1670(87)	.1670(88)	.1670(103)	.1670(104)	.1670(119)	.1670(120)
90	.2300	.8350	.1670(55)	.1670(56)	.1670(71)	.1670(72)	.1670(87)	.1670(88)
91	.2300	.8350	.0830(39)	.0830(40)	.1670(55)	.1670(56)	-.0000(-0)	-.0000(-0)
92	.2300	.7940	.2500(20)	.2500(21)	.1670(196)	.1670(197)	.1670(207)	-.0000(-0)
93	.2300	.7940	.1670(168)	.1670(169)	.1670(183)	.1670(184)	.1670(196)	.1670(197)
94	.2300	.7940	.1670(136)	.1670(137)	.1670(152)	.1670(153)	.1670(168)	.1670(169)
95	.2300	.7940	.1670(104)	.1670(105)	.1670(120)	.1670(121)	.1670(136)	.1670(137)
96	.2300	.7940	.1670(72)	.1670(73)	.1670(88)	.1670(89)	.1670(104)	.1670(105)
97	.2300	.7940	.1670(40)	.1670(41)	.1670(56)	.1670(57)	.1670(72)	.1670(73)
98	.2300	.7520	.2500(21)	.2500(22)	.1670(184)	.1670(185)	.1670(197)	-.0000(-0)
99	.2300	.7520	.1670(153)	.1670(154)	.1670(169)	.1670(170)	.1670(184)	.1670(185)
100	.2300	.7520	.1670(121)	.1670(122)	.1670(137)	.1670(138)	.1670(153)	.1670(154)
101	.2300	.7520	.1670(89)	.1670(90)	.1670(105)	.1670(106)	.1670(121)	.1670(122)
102	.2300	.7520	.1670(57)	.1670(58)	.1670(73)	.1670(74)	.1670(89)	.1670(90)
103	.2300	.7520	.0830(41)	.0830(42)	.1670(57)	.1670(58)	-.0000(-0)	-.0000(-0)
104	.2300	.7110	.2500(22)	.2500(23)	.1670(170)	.1670(171)	.1670(185)	-.0000(-0)
105	.2300	.7110	.1670(138)	.1670(139)	.1670(154)	.1670(155)	.1670(170)	.1670(171)
106	.2300	.7110	.1670(106)	.1670(107)	.1670(122)	.1670(123)	.1670(138)	.1670(139)
107	.2300	.7110	.1670(74)	.1670(75)	.1670(90)	.1670(91)	.1670(106)	.1670(107)
108	.2300	.7110	.1670(42)	.1670(43)	.1670(58)	.1670(59)	.1670(74)	.1670(75)
109	.2300	.6700	.1670(3)	.2500(23)	.2500(24)	.1670(155)	.1670(171)	-.0000(-0)
110	.2300	.6700	.2500(24)	.2500(25)	.1670(123)	.1670(139)	.1670(155)	-.0000(-0)
111	.2300	.6700	.2500(25)	.2500(26)	.1670(91)	.1670(107)	.1670(123)	-.0000(-0)
112	.2300	.6700	.2500(26)	.2500(27)	.1670(59)	.1670(75)	.1670(91)	-.0000(-0)
113	.2300	.6700	.2500(27)	.0830(43)	.1670(59)	-.0000(-0)	-.0000(-0)	-.0000(-0)

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INPUT FOR CASE 1 COBRA IIA / HALF 217 PIN BNDL / SAMPLE PROBLEM

DATE 03 JUN 70 , TIME 09:26:57

CALCULATION PARAMETERS

TRANSV. FRICTION (FT.)	.0010
MOMENTUM DIVERSION FACTOR	.1000
ENERGY DIVERSION FACTOR	.1000
MOMENTUM TURBULENT FACTOR	.5000
CHANNEL LENGTH	40.00 INCHES
CHANNEL ORIENTATION	.0 DEGREES
DIVISION FOR PRINT-OUT	21
CALCULATION SUBDIVISION	2
CALCULATION INCREMENT	1.000 INCHES

SUBCOOLED MIXING CORRELATION BETA = .0600

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STANDARD THERMAL CONDUCTION MODEL.
BOILING MIXING CORRELATION
(SAME AS SUBCOOLED)

CHANNEL OPERATING CONDITIONS

SYSTEM PRESSURE	=	50.0 PSIA
INLET ENTHALPY	=	335.0 BTU/LB
AVG. MASS VELOCITY	=	3.721 MILLION LB/(HR-SQFT)
INLET TEMPERATURE	=	600.0 DEGREES F
AVG. HEAT FLUX	=	.406 MILLION BTU/(HR-SQFT)

INITIAL CHANNEL CONDITIONS

UNIFORM INLET TEMPERATURE SPECIFIED
FLOWS SPLIT TO GIVE EQUAL DP/DX

EXPECTED OUTLET ENTHALPY	HHP =	426.738
EXPECTED OUTLET TEMPERATURE	TOUT =	900.028

BNWL-1422

CHANNEL RESULTS

CASE 1 COBRA IIA / HALF 217 PIN BNDL / SAMPLE PROBLEM

DATE 03 JUN 70 TIME 09:33.44

SUMMARY OF RESULTS: EXIT CONDITIONS AT NODE 21, HEIGHT 40.000 INCHES

CHANNEL	DELTA-P (PSI)	ENTHALPY (BTU/LB)	DELTA-H (BTU/LB)	TEMP. (DEG-F)	DELTA-T (DEG-F)	QUALITY	MASS VEL (M-LB/HR-FT2)	FLOW (LB/HR)
1	-15.230	429.84	94.83	910.31	310.31	.0000	3.8398	212.67
2	-15.231	409.17	74.16	841.94	241.94	.0000	3.8387	212.60
3	-15.232	388.53	53.52	774.07	174.07	.0000	3.8357	212.44
4	-15.167	435.67	100.66	929.61	329.61	.0000	3.9776	753.29
5	-15.167	435.08	100.07	927.67	327.67	.0000	3.9767	753.11
6	-15.166	433.70	98.69	923.10	323.10	.0000	3.9720	752.23
7	-15.163	431.49	96.48	915.76	315.76	.0000	3.9506	748.17
8	-15.163	429.88	94.87	910.44	310.44	.0000	3.9507	748.20
9	-15.166	429.67	94.66	909.72	309.72	.0000	3.9723	752.29
10	-15.168	428.19	93.18	904.85	304.85	.0000	3.9771	753.20
11	-15.168	425.75	90.74	896.76	296.76	.0000	3.9783	753.41
12	-15.168	422.72	87.71	886.72	286.72	.0000	3.9784	753.44
13	-15.168	419.27	84.26	875.30	275.30	.0000	3.9775	753.27
14	-15.167	415.45	80.44	862.71	262.71	.0000	3.9729	752.39
15	-15.164	411.56	76.55	849.83	249.83	.0000	3.9512	748.28
16	-15.164	408.35	73.34	839.24	239.24	.0000	3.9511	748.27
17	-15.167	407.38	72.37	836.06	236.06	.0000	3.9729	752.39
18	-15.169	405.49	70.48	829.83	229.83	.0000	3.9776	753.29
19	-15.169	402.89	67.88	821.26	221.26	.0000	3.9786	753.46
20	-15.169	399.86	64.85	811.30	211.30	.0000	3.9784	753.44
21	-15.169	396.59	61.58	800.53	200.53	.0000	3.9772	753.22
22	-15.168	393.20	58.19	789.41	189.41	.0000	3.9722	752.26
23	-15.165	390.06	55.05	779.09	179.09	.0000	3.9499	748.04
24	-15.165	388.45	53.44	773.83	173.83	.0000	3.9498	748.01
25	-15.168	389.17	54.16	776.17	176.17	.0000	3.9719	752.20
26	-15.170	389.71	54.70	777.94	177.94	.0000	3.9767	753.12
27	-15.170	389.95	54.94	778.73	178.73	.0000	3.9778	753.32
28	-15.187	447.97	112.96	970.43	370.43	.0000	3.6938	178.94
29	-15.178	453.71	118.70	989.52	389.52	.0000	3.6525	176.94
30	-15.177	458.01	123.00	1003.84	403.84	.0000	3.6349	176.09
31	-15.177	457.49	122.48	1002.10	402.10	.0000	3.6339	176.04
32	-15.178	453.79	118.78	989.79	389.79	.0000	3.6337	176.03
33	-15.178	451.25	116.24	981.34	381.34	.0000	3.6339	176.04
34	-15.178	445.72	110.71	962.95	362.95	.0000	3.6349	176.09
35	-15.178	442.86	107.85	953.47	353.47	.0000	3.6350	176.10
36	-15.178	437.09	102.08	934.33	334.33	.0000	3.6351	176.10
37	-15.178	434.18	99.17	924.68	324.68	.0000	3.6352	176.10
38	-15.179	428.27	93.26	905.11	305.11	.0000	3.6351	176.10

	39	-15.179	425.22	90.21	895.00	295.00	.0000	3.6351	176.10
	40	-15.179	418.53	83.52	872.86	272.86	.0000	3.6353	176.11
	41	-15.179	414.64	79.63	860.01	260.01	.0000	3.6361	176.15
	42	-15.181	404.91	69.90	827.93	227.93	.0000	3.6525	176.94
	43	-15.189	398.97	63.96	808.35	208.35	.0000	3.6922	178.87
	44	-15.194	444.19	109.18	957.86	357.86	.0000	3.7485	363.18
	45	-15.177	455.58	120.57	995.75	395.75	.0000	3.6433	352.99
	46	-15.177	457.64	122.63	1002.60	402.60	.0000	3.6365	352.33
	47	-15.177	456.81	121.80	999.83	399.83	.0000	3.6337	352.06
	48	-15.177	454.91	119.90	993.51	393.51	.0000	3.6336	352.05
	49	-15.178	449.90	114.89	976.86	376.86	.0000	3.6342	352.11
	50	-15.178	447.13	112.12	967.64	367.64	.0000	3.6347	352.16
	51	-15.178	441.43	106.42	948.71	348.71	.0000	3.6351	352.19
	52	-15.178	438.54	103.53	939.14	339.14	.0000	3.6351	352.20
	53	-15.178	432.72	97.71	919.82	319.82	.0000	3.6352	352.20
	54	-15.179	429.76	94.75	910.05	310.05	.0000	3.6351	352.20
	55	-15.179	423.62	88.61	889.72	289.72	.0000	3.6351	352.20
	56	-15.179	420.30	85.29	878.70	278.70	.0000	3.6352	352.20
	57	-15.179	412.44	77.43	852.76	252.76	.0000	3.6374	352.43
	58	-15.180	407.60	72.59	836.77	236.77	.0000	3.6436	353.03
	59	-15.197	395.86	60.85	798.13	198.13	.0000	3.7464	362.99
	60	-15.187	447.71	112.70	969.58	369.58	.0000	3.6938	357.88
	61	-15.178	453.45	118.44	988.66	388.66	.0000	3.6525	353.88
	62	-15.177	457.80	122.79	1003.13	403.13	.0000	3.6350	352.19
	63	-15.177	457.32	122.31	1001.53	401.53	.0000	3.6339	352.08
	64	-15.178	453.70	118.69	989.48	389.48	.0000	3.6337	352.06
	65	-15.178	451.19	116.18	981.14	381.14	.0000	3.6339	352.08
	66	-15.178	445.70	110.69	962.88	362.88	.0000	3.6349	352.18
	67	-15.178	442.85	107.84	953.43	353.43	.0000	3.6350	352.19
	68	-15.178	437.08	102.07	934.30	334.30	.0000	3.6351	352.20
	69	-15.178	434.17	99.16	924.63	324.63	.0000	3.6352	352.20
	70	-15.179	428.24	93.23	904.99	304.99	.0000	3.6351	352.20
	71	-15.179	425.16	90.15	894.81	294.81	.0000	3.6351	352.20
	72	-15.179	418.43	83.42	872.54	272.54	.0000	3.6353	352.22
	73	-15.179	414.52	79.51	859.62	259.62	.0000	3.6361	352.30
	74	-15.181	404.78	69.77	827.50	227.50	.0000	3.6524	353.88
	75	-15.189	398.85	63.84	807.97	207.97	.0000	3.6921	357.72
	76	-15.194	443.58	108.57	955.87	355.87	.0000	3.7481	363.15
	77	-15.177	454.98	119.97	993.73	393.73	.0000	3.6434	353.00
	78	-15.177	457.08	122.07	1000.75	400.75	.0000	3.6366	352.35
	79	-15.177	456.43	121.42	998.56	398.56	.0000	3.6338	352.07
	80	-15.178	454.63	119.62	992.57	392.57	.0000	3.6337	352.06
	81	-15.178	449.76	114.75	976.39	376.39	.0000	3.6342	352.11
	82	-15.178	447.04	112.03	967.34	367.34	.0000	3.6347	352.16
	83	-15.178	441.38	106.37	948.55	348.55	.0000	3.6351	352.20
	84	-15.178	438.50	103.49	939.00	339.00	.0000	3.6351	352.20
	85	-15.178	432.65	97.64	919.61	319.61	.0000	3.6352	352.21
	86	-15.179	429.67	94.66	909.75	309.75	.0000	3.6352	352.20
	87	-15.179	423.45	88.44	889.15	289.15	.0000	3.6351	352.20

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88	-15.179	420.07	85.06	877.97	277.97	.0000	3.6352	352.21
89	-15.179	412.14	77.13	851.77	251.77	.0000	3.6375	352.43
90	-15.180	407.28	72.27	835.73	235.73	.0000	3.6437	353.03
91	-15.197	395.59	60.58	797.23	197.23	.0000	3.7460	362.94
92	-15.186	446.62	111.61	965.96	365.96	.0000	3.6938	357.89
93	-15.179	452.30	117.29	984.82	384.82	.0000	3.6529	353.92
94	-15.177	456.81	121.80	999.82	399.82	.0000	3.6354	352.22
95	-15.177	456.50	121.49	998.82	398.82	.0000	3.6342	352.11
96	-15.178	453.22	118.21	987.88	387.88	.0000	3.6338	352.07
97	-15.178	450.85	115.84	980.02	380.02	.0000	3.6340	352.09
98	-15.178	445.53	110.52	962.32	362.32	.0000	3.6349	352.18
99	-15.178	442.73	107.72	953.02	353.02	.0000	3.6351	352.19
100	-15.178	436.98	101.97	933.96	333.96	.0000	3.6352	352.20
101	-15.178	434.04	98.03	924.22	324.22	.0000	3.6352	352.21
102	-15.179	428.02	93.01	904.26	304.26	.0000	3.6352	352.21
103	-15.179	424.87	89.86	893.82	293.82	.0000	3.6352	352.21
104	-15.179	417.96	82.95	870.98	270.98	.0000	3.6355	352.23
105	-15.179	413.97	78.96	857.80	257.80	.0000	3.6364	352.32
106	-15.181	404.20	69.19	825.58	225.58	.0000	3.6526	353.89
107	-15.189	398.34	63.33	806.27	206.27	.0000	3.6918	357.69
108	-15.194	441.88	106.87	950.21	350.21	.0000	3.7476	363.10
109	-15.177	453.00	117.99	987.17	387.17	.0000	3.6447	353.13
110	-15.177	455.26	120.25	994.67	394.67	.0000	3.6376	352.44
111	-15.177	455.15	120.14	994.31	394.31	.0000	3.6343	352.12
112	-15.178	453.65	118.64	989.33	389.33	.0000	3.6340	352.09
113	-15.178	449.24	114.23	974.65	374.65	.0000	3.6344	352.13
114	-15.178	446.67	111.66	966.10	366.10	.0000	3.6348	352.17
115	-15.178	441.16	106.15	947.82	347.82	.0000	3.6351	352.20
116	-15.178	438.29	103.28	938.32	338.32	.0000	3.6352	352.20
117	-15.178	432.38	97.37	918.71	318.71	.0000	3.6352	352.21
118	-15.179	429.32	94.31	908.56	308.56	.0000	3.6352	352.21
119	-15.179	422.85	87.84	887.16	287.16	.0000	3.6353	352.22
120	-15.179	419.32	84.31	875.47	275.47	.0000	3.6355	352.24
121	-15.179	411.14	76.13	848.47	248.47	.0000	3.6383	352.51
122	-15.180	406.26	71.25	832.36	232.36	.0000	3.6447	353.13
123	-15.197	394.82	59.81	794.72	194.72	.0000	3.7453	362.88
124	-15.186	443.76	108.75	956.43	356.43	.0000	3.6971	358.20
125	-15.179	449.10	114.09	974.19	374.19	.0000	3.6574	354.35
126	-15.177	454.00	118.99	990.49	390.49	.0000	3.6377	352.45
127	-15.177	454.18	119.17	991.08	391.08	.0000	3.6356	352.24
128	-15.178	451.80	116.79	983.17	383.17	.0000	3.6344	352.13
129	-15.178	449.81	114.80	976.55	376.55	.0000	3.6345	352.14
130	-15.178	444.96	109.95	960.42	360.42	.0000	3.6351	352.20
131	-15.178	442.28	107.27	951.55	351.55	.0000	3.6351	352.20
132	-15.178	436.59	101.58	932.68	332.68	.0000	3.6352	352.21
133	-15.178	433.60	98.59	922.75	322.75	.0000	3.6353	352.22
134	-15.179	427.31	92.30	901.93	301.93	.0000	3.6354	352.22
135	-15.179	423.96	88.95	890.82	290.82	.0000	3.6356	352.24
136	-15.179	416.60	81.59	866.48	266.48	.0000	3.6365	352.34

	137	-15.179	412.40	77.39	852.62	252.62	.0000	3.6384	352.52
	138	-15.181	402.59	67.58	820.27	220.27	.0000	3.6562	354.25
	139	-15.189	397.00	61.99	801.89	201.89	.0000	3.6946	357.97
	140	-15.196	437.99	102.98	937.32	337.32	.0000	3.7570	364.01
	141	-15.179	448.01	113.00	970.56	370.56	.0000	3.6576	354.38
	142	-15.178	450.65	115.64	979.32	379.32	.0000	3.6450	353.16
	143	-15.178	451.88	116.87	983.43	383.43	.0000	3.6371	352.39
	144	-15.178	451.10	116.09	980.82	380.82	.0000	3.6356	352.25
	145	-15.178	447.77	112.76	969.75	369.75	.0000	3.6352	352.20
	146	-15.178	445.57	110.56	962.44	362.44	.0000	3.6353	352.21
	147	-15.178	440.45	105.44	945.47	345.47	.0000	3.6353	352.21
	148	-15.178	437.63	102.62	936.12	336.12	.0000	3.6353	352.22
	149	-15.178	431.55	96.54	915.96	315.96	.0000	3.6354	352.23
	150	-15.179	428.28	93.27	905.13	305.13	.0000	3.6356	352.25
	151	-15.179	421.23	86.22	881.80	281.80	.0000	3.6365	352.34
	152	-15.179	417.35	82.34	868.96	268.96	.0000	3.6379	352.47
	153	-15.180	408.61	73.60	840.11	240.11	.0000	3.6450	353.16
	154	-15.181	403.68	68.67	823.86	223.86	.0000	3.6564	354.26
	155	-15.199	393.15	58.14	789.24	189.24	.0000	3.7544	363.76
	156	-15.196	437.08	102.07	934.31	334.31	.0000	3.7571	364.02
	157	-15.186	441.79	106.78	949.92	349.92	.0000	3.6971	358.21
	158	-15.179	447.67	112.66	969.42	369.42	.0000	3.6539	354.02
	159	-15.178	448.83	113.82	973.31	373.31	.0000	3.6443	353.09
E-30	160	-15.178	448.38	113.37	971.80	371.80	.0000	3.6376	352.45
	161	-15.178	447.18	112.17	967.81	367.81	.0000	3.6364	352.32
	162	-15.178	443.39	108.38	955.24	355.24	.0000	3.6356	352.25
	163	-15.178	441.02	106.01	947.36	347.36	.0000	3.6355	352.24
	164	-15.178	435.47	100.46	928.96	328.96	.0000	3.6355	352.24
	165	-15.178	432.35	97.34	918.61	318.61	.0000	3.6357	352.26
	166	-15.179	425.49	90.48	895.90	295.90	.0000	3.6366	352.35
	167	-15.179	421.72	86.71	883.40	283.40	.0000	3.6380	352.48
	168	-15.179	413.42	78.41	856.00	256.00	.0000	3.6442	353.08
	169	-15.181	408.83	73.82	840.83	240.83	.0000	3.6531	353.95
	170	-15.189	398.96	63.95	809.34	208.34	.0000	3.6949	357.99
	171	-15.199	394.05	58.04	792.20	192.20	.0000	3.7545	363.77
	172	-15.194	438.08	103.07	937.61	337.61	.0000	3.7477	363.11
	173	-15.186	441.40	106.39	948.62	348.62	.0000	3.6941	357.91
	174	-15.178	445.07	110.06	960.79	360.79	.0000	3.6540	354.03
	175	-15.178	445.55	110.54	962.38	362.38	.0000	3.6448	353.14
	176	-15.177	444.31	109.30	958.27	358.27	.0000	3.6382	352.50
	177	-15.178	442.86	107.85	953.46	353.46	.0000	3.6368	352.36
	178	-15.178	438.58	103.57	939.25	339.25	.0000	3.6359	352.28
	179	-15.178	435.86	100.85	930.26	330.26	.0000	3.6359	352.28
	180	-15.178	429.45	94.44	909.00	309.00	.0000	3.6368	352.36
	181	-15.179	425.78	90.77	896.85	296.85	.0000	3.6381	352.49
	182	-15.179	417.65	82.64	869.96	269.96	.0000	3.6444	353.10
	183	-15.180	413.18	78.17	855.18	255.18	.0000	3.6532	353.95
	184	-15.189	403.56	68.55	823.46	223.46	.0000	3.6924	357.75
	185	-15.197	398.61	63.60	807.19	207.19	.0000	3.7458	362.93

186	-15.195	436.56	101.55	932.57	332.57	.0000	3.7483	363.16
187	-15.187	439.01	104.00	940.70	340.70	.0000	3.6942	357.93
188	-15.179	441.52	106.51	949.04	349.04	.0000	3.6540	354.03
189	-15.178	441.63	106.62	949.40	349.40	.0000	3.6449	353.15
190	-15.178	439.79	104.78	943.30	343.30	.0000	3.6384	352.52
191	-15.178	437.99	102.98	937.33	337.33	.0000	3.6371	352.40
192	-15.178	432.75	97.74	919.93	319.93	.0000	3.6371	352.39
193	-15.178	429.40	94.39	908.84	308.84	.0000	3.6383	352.51
194	-15.179	421.55	86.54	882.84	282.84	.0000	3.6446	353.12
195	-15.180	417.12	82.11	868.22	268.22	.0000	3.6535	353.98
196	-15.188	407.56	72.55	836.63	236.63	.0000	3.6931	357.81
197	-15.197	402.61	67.60	820.33	220.33	.0000	3.7469	363.03
198	-15.195	433.80	98.79	923.40	323.40	.0000	3.7486	363.20
199	-15.187	435.73	100.72	929.83	329.83	.0000	3.6943	357.94
200	-15.179	437.49	102.48	935.66	335.66	.0000	3.6541	354.03
201	-15.178	437.24	102.23	934.84	334.84	.0000	3.6451	353.16
202	-15.178	434.43	99.42	925.52	325.52	.0000	3.6393	352.61
203	-15.178	431.93	96.92	917.21	317.21	.0000	3.6393	352.60
204	-15.179	424.98	89.97	894.20	294.20	.0000	3.6449	353.14
205	-15.180	420.73	85.72	880.12	280.12	.0000	3.6537	354.00
206	-15.188	411.23	76.22	848.75	248.75	.0000	3.6934	357.85
207	-15.197	406.26	71.25	832.35	232.35	.0000	3.7476	363.09
208	-15.195	430.42	95.41	912.21	312.21	.0000	3.7486	363.20
209	-15.187	431.98	96.97	917.37	317.37	.0000	3.6943	357.93
210	-15.179	432.85	97.84	920.27	320.27	.0000	3.6543	354.06
211	-15.178	431.96	96.95	917.32	317.32	.0000	3.6462	353.28
212	-15.178	427.26	92.25	901.74	301.74	.0000	3.6461	353.27
213	-15.180	423.60	88.59	889.64	289.64	.0000	3.6541	354.04
214	-15.188	414.57	79.56	859.78	259.78	.0000	3.6936	357.87
215	-15.196	409.63	74.62	843.45	243.45	.0000	3.7479	363.12
216	-15.195	426.59	91.58	899.53	299.53	.0000	3.7483	363.16
217	-15.187	427.68	92.67	903.14	303.14	.0000	3.6940	357.91
218	-15.179	426.91	91.90	900.60	300.60	.0000	3.6580	354.42
219	-15.180	424.73	89.72	893.38	293.38	.0000	3.6580	354.42
220	-15.188	417.24	82.23	868.60	268.60	.0000	3.6937	357.87
221	-15.196	412.55	77.54	853.10	253.10	.0000	3.7478	363.12
222	-15.195	422.12	87.11	884.75	284.75	.0000	3.7476	363.10
223	-15.188	422.32	87.31	885.39	285.39	.0000	3.6969	358.19
224	-15.188	418.40	83.39	872.42	272.42	.0000	3.6967	358.17
225	-15.196	414.53	79.52	859.66	259.66	.0000	3.7473	363.07
226	-15.197	416.45	81.44	866.01	266.01	.0000	3.7567	363.98
227	-15.197	414.65	79.64	860.04	260.04	.0000	3.7566	363.97
AVG	-15.179	427.49	92.48	902.52	302.52	.0000	3.7210	86749.93

E-31

CHANNEL RESULTS FOR CHANNEL 1

DISTANCE	DELTA-P	ENTHALPY	TEMP.	QUALITY	MASS VEL	FLOW	FLUX
.000	.000	335.01	610.00	.0000	3.5377	195.93	.0000
2.000	-.745	335.01	600.00	.0000	3.7153	205.77	.0000
4.000	-1.526	335.61	601.93	.0000	3.7983	210.37	.2976
6.000	-2.301	337.89	609.30	.0000	3.8325	212.26	.3695
8.000	-3.085	340.90	619.01	.0000	3.8535	213.42	.4356
10.000	-3.866	344.61	631.00	.0000	3.8587	213.71	.4951
12.000	-4.637	348.95	645.03	.0000	3.8559	213.56	.5470
14.000	-5.402	353.86	660.94	.0000	3.8513	213.30	.5903
16.000	-6.163	359.25	678.46	.0000	3.8476	213.10	.6255
18.000	-6.924	365.05	697.30	.0000	3.8454	212.98	.6504
20.000	-7.684	371.17	717.28	.0000	3.8442	212.91	.6655
22.000	-8.444	377.53	738.04	.0000	3.8436	212.88	.6709
24.000	-9.203	384.03	759.31	.0000	3.8432	212.85	.6655
26.000	-9.961	390.57	780.78	.0000	3.8427	212.82	.6504
28.000	-10.718	397.07	802.09	.0000	3.8422	212.80	.6255
30.000	-11.474	403.42	823.00	.0000	3.8417	212.77	.5903
32.000	-12.228	409.52	843.12	.0000	3.8412	212.74	.5470
34.000	-12.981	415.30	862.21	.0000	3.8408	212.72	.4951
36.000	-13.732	420.67	879.93	.0000	3.8404	212.70	.4356
38.000	-14.482	425.54	896.06	.0000	3.8401	212.68	.3695
40.000	-15.230	429.84	910.31	.0000	3.8398	212.67	.2976

CHANNEL RESULTS FOR CHANNEL 213

DISTANCE	DELTA-P	ENTHALPY	TEMP.	QUALITY	MASS VEL	FLOW	FLUX
.000	.000	335.01	600.00	.0000	3.6367	352.35	.0000
2.000	-.760	335.01	600.00	.0000	3.6355	352.23	.0000
4.000	-1.522	335.76	602.43	.0000	3.6354	352.23	.2114
6.000	-2.287	338.95	612.74	.0000	3.6365	352.33	.2626
8.000	-3.051	342.60	625.15	.0000	3.6380	352.48	.3095
10.000	-3.816	347.20	639.36	.0000	3.6399	352.66	.3518
12.000	-4.580	352.08	655.15	.0000	3.6421	352.88	.3887
14.000	-5.344	357.36	672.32	.0000	3.6442	353.04	.4194
16.000	-6.107	362.96	690.53	.0000	3.6460	353.26	.4444
18.000	-6.870	368.81	709.58	.0000	3.6476	353.41	.4621
20.000	-7.631	374.81	729.15	.0000	3.6489	353.53	.4729
22.000	-8.392	380.86	748.93	.0000	3.6501	353.65	.4767
24.000	-9.151	386.88	768.68	.0000	3.6509	353.73	.4729
26.000	-9.910	392.78	788.02	.0000	3.6515	353.79	.4621
28.000	-10.667	398.46	806.68	.0000	3.6520	353.84	.4444
30.000	-11.423	403.84	824.40	.0000	3.6525	353.88	.4194
32.000	-12.177	408.84	840.85	.0000	3.6529	353.92	.3887
34.000	-12.930	413.38	855.84	.0000	3.6532	353.96	.3518
36.000	-13.681	417.39	869.10	.0000	3.6535	353.98	.3095
38.000	-14.431	420.81	880.41	.0000	3.6538	354.01	.2626
40.000	-15.180	423.60	889.64	.0000	3.6541	354.04	.2114

COBRA OUTPUT EDIT PERFORMED 06 JUN 70 ON PROBLEM RUN 03 JUN 70 AT 09:26:57
 11 COBRA IIA / HALF 217 PIN BNWL / SAMPLE PROBLEM

DISTANCE	W	1	WP	2	W	2	WP	3	W	3	WP	4	W	4	WP	5	W	5	WP
0.00	.00	.00	1105.40	.00	.00	.00	1105.40	.00	.00	.00	1105.40	.00	.00	.00	1105.40	.00	.00	.00	1105.40
2.00	-33.65	-33.65	1106.46	-26.04	-26.04	-26.04	1106.46	-34.62	-34.62	-34.62	1106.46	-25.07	-25.07	-25.07	1106.46	-33.98	-33.98	-33.98	1106.46
4.00	-20.98	-20.98	1107.45	-6.01	-6.01	-6.01	1107.45	-22.73	-22.73	-22.73	1107.45	-4.24	-4.24	-4.24	1107.45	-22.65	-22.65	-22.65	1107.45
6.00	-12.18	-12.18	1107.02	1.12	1.12	1.12	1107.02	-15.39	-15.39	-15.39	1107.03	4.28	4.28	4.28	1107.03	-14.47	-14.47	-14.47	1107.03
8.00	-8.13	-8.13	1106.20	2.68	2.68	2.68	1106.20	-11.39	-11.39	-11.39	1106.26	5.88	5.88	5.88	1106.27	-10.43	-10.43	-10.43	1106.32
10.00	-4.60	-4.60	1105.21	3.89	3.89	3.89	1105.22	-7.50	-7.50	-7.50	1105.34	6.76	6.76	6.76	1105.35	-7.06	-7.06	-7.06	1105.46
12.00	-3.70	-3.70	1104.21	4.98	4.98	4.98	1104.23	-5.67	-5.67	-5.67	1104.39	6.94	6.94	6.94	1104.40	-5.89	-5.89	-5.89	1104.56
14.00	-3.64	-3.64	1103.33	5.16	5.16	5.16	1103.35	-5.22	-5.22	-5.22	1103.55	6.71	6.71	6.71	1103.57	-5.92	-5.92	-5.92	1103.74
16.00	-3.92	-3.92	1102.59	5.00	5.00	5.00	1102.61	-5.27	-5.27	-5.27	1102.85	6.36	6.36	6.36	1102.88	-6.19	-6.19	-6.19	1103.07
18.00	-4.09	-4.09	1102.02	4.72	4.72	4.72	1102.04	-5.29	-5.29	-5.29	1102.29	5.96	5.96	5.96	1102.31	-6.36	-6.36	-6.36	1102.52
20.00	-4.59	-4.59	1101.56	4.94	4.94	4.94	1101.59	-5.62	-5.62	-5.62	1101.83	5.99	5.99	5.99	1101.86	-6.52	-6.52	-6.52	1102.05
22.00	-4.79	-4.79	1101.22	4.95	4.95	4.95	1101.24	-5.91	-5.91	-5.91	1101.48	6.14	6.14	6.14	1101.50	-6.70	-6.70	-6.70	1101.64
24.00	-4.83	-4.83	1100.97	4.99	4.99	4.99	1101.00	-5.93	-5.93	-5.93	1101.19	6.09	6.09	6.09	1101.21	-6.83	-6.83	-6.83	1101.29
26.00	-4.61	-4.61	1100.69	4.79	4.79	4.79	1100.72	-5.83	-5.83	-5.83	1100.96	5.94	5.94	5.94	1100.98	-6.81	-6.81	-6.81	1101.00
28.00	-4.45	-4.45	1100.41	4.62	4.62	4.62	1100.46	-5.57	-5.57	-5.57	1100.78	5.71	5.71	5.71	1100.79	-6.65	-6.65	-6.65	1100.73
30.00	-4.25	-4.25	1100.16	4.41	4.41	4.41	1100.20	-5.07	-5.07	-5.07	1100.54	5.27	5.27	5.27	1100.57	-6.55	-6.55	-6.55	1100.46
32.00	-4.06	-4.06	1099.93	4.21	4.21	4.21	1099.98	-4.65	-4.65	-4.65	1100.28	4.86	4.86	4.86	1100.31	-6.38	-6.38	-6.38	1100.19
34.00	-3.86	-3.86	1099.72	4.00	4.00	4.00	1099.76	-4.35	-4.35	-4.35	1100.03	4.56	4.56	4.56	1100.06	-6.24	-6.24	-6.24	1099.93
36.00	-3.98	-3.98	1099.52	4.10	4.10	4.10	1099.56	-4.09	-4.09	-4.09	1099.78	4.31	4.31	4.31	1099.80	-5.96	-5.96	-5.96	1099.65
38.00	-4.01	-4.01	1099.36	4.11	4.11	4.11	1099.40	-4.00	-4.00	-4.00	1099.54	4.21	4.21	4.21	1099.55	-5.74	-5.74	-5.74	1099.30
40.00	-3.65	-3.65	1099.21	3.74	3.74	3.74	1099.25	-3.65	-3.65	-3.65	1099.31	3.87	3.87	3.87	1099.31	-5.50	-5.50	-5.50	1098.93

DISTANCE	W	6	WP	7	W	7	WP	8	W	8	WP	9	W	9	WP	10	W	10	WP
0.00	.00	.00	1105.40	.00	.00	.00	1105.40	.00	.00	.00	1105.40	.00	.00	.00	1105.40	.00	.00	.00	1105.40
2.00	-25.70	-25.70	1106.46	-3.16	-3.16	-3.16	1106.46	26.29	26.29	26.29	1106.46	-1.44	-1.44	-1.44	1106.46	20.35	20.35	20.35	1106.46
4.00	-4.31	-4.31	1107.43	-3.26	-3.26	-3.26	1107.43	20.66	20.66	20.66	1107.43	-2.10	-2.10	-2.10	1107.43	15.67	15.67	15.67	1107.43
6.00	3.31	3.31	1107.03	-3.58	-3.58	-3.58	1107.03	16.12	16.12	16.12	1107.03	-2.53	-2.53	-2.53	1107.03	11.21	11.21	11.21	1107.03
8.00	4.88	4.88	1106.33	-3.98	-3.98	-3.98	1106.33	14.40	14.40	14.40	1106.33	-3.00	-3.00	-3.00	1106.33	9.15	9.15	9.15	1106.33
10.00	6.29	6.29	1105.47	-4.40	-4.40	-4.40	1105.47	12.38	12.38	12.38	1105.47	-3.31	-3.31	-3.31	1105.47	6.78	6.78	6.78	1105.47
12.00	7.16	7.16	1104.56	-4.71	-4.71	-4.71	1104.56	10.69	10.69	10.69	1104.56	-3.57	-3.57	-3.57	1104.56	4.79	4.79	4.79	1104.56
14.00	7.43	7.43	1103.75	-4.98	-4.98	-4.98	1103.75	9.64	9.64	9.64	1103.75	-3.75	-3.75	-3.75	1103.75	3.42	3.42	3.42	1103.75
16.00	7.28	7.28	1103.08	-5.19	-5.19	-5.19	1103.08	8.81	8.81	8.81	1103.08	-4.01	-4.01	-4.01	1103.08	2.31	2.31	2.31	1103.08
18.00	7.06	7.06	1102.53	-5.27	-5.27	-5.27	1102.53	8.20	8.20	8.20	1102.53	-3.80	-3.80	-3.80	1102.53	1.74	1.74	1.74	1102.53
20.00	6.98	6.98	1102.06	-5.07	-5.07	-5.07	1102.06	7.39	7.39	7.39	1102.06	-3.97	-3.97	-3.97	1102.06	1.09	1.09	1.09	1102.06
22.00	7.04	7.04	1101.65	-5.10	-5.10	-5.10	1101.65	6.84	6.84	6.84	1101.65	-4.02	-4.02	-4.02	1101.65	.61	.61	.61	1101.65
24.00	7.09	7.09	1101.30	-5.15	-5.15	-5.15	1101.30	6.94	6.94	6.94	1101.30	-4.36	-4.36	-4.36	1101.30	.65	.65	.65	1101.30
26.00	7.04	7.04	1101.00	-5.29	-5.29	-5.29	1101.00	6.91	6.91	6.91	1101.00	-4.58	-4.58	-4.58	1101.00	.67	.67	.67	1101.00
28.00	6.89	6.89	1100.72	-5.37	-5.37	-5.37	1100.72	6.87	6.87	6.87	1100.72	-4.84	-4.84	-4.84	1100.72	.67	.67	.67	1100.72
30.00	6.80	6.80	1100.45	-5.47	-5.47	-5.47	1100.45	6.79	6.79	6.79	1100.45	-5.01	-5.01	-5.01	1100.45	.67	.67	.67	1100.45
32.00	6.63	6.63	1100.17	-5.52	-5.52	-5.52	1100.17	6.73	6.73	6.73	1100.17	-5.18	-5.18	-5.18	1100.17	.66	.66	.66	1100.17
34.00	6.50	6.50	1099.90	-5.57	-5.57	-5.57	1099.90	6.64	6.64	6.64	1099.90	-4.99	-4.99	-4.99	1099.90	.56	.56	.56	1099.90
36.00	6.27	6.27	1099.62	-5.32	-5.32	-5.32	1099.62	6.23	6.23	6.23	1099.62	-4.97	-4.97	-4.97	1099.62	.34	.34	.34	1099.62
38.00	6.11	6.11	1099.28	-5.35	-5.35	-5.35	1099.28	6.07	6.07	6.07	1099.28	-5.34	-5.34	-5.34	1099.28	.45	.45	.45	1099.28
40.00	5.92	5.92	1098.91	-5.52	-5.52	-5.52	1098.91	6.16	6.16	6.16	1098.91								

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