MASTER

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Subject: Core Orificing
Program Data
Requirements

INFORMATION CATEGORY

Unclassified

A Bournia 9/23/63
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References:

- 1) WANL-TMI-470 Core Orifice Selection Computer Program.
- 2) Advanced Systems Engineering and Analytical Department Report - 62-1002 Double Interpolation Subroutine.

The computer program to select the proper orifice sizes for the fuel element channels has been completed. This memo describes the data required by the programs and the data forms from which the data are keypunched, as well as the sequence in which the programs must be run. The operation of the programs and some sample output are described in reference 1).

The computer program to select orifice sizes is actually a series of programs, namely:

- 1) A program which reads in the orificing program data and checks the tabular data for transcription or keypunch errors. When all errors have been corrected the first title card should be removed from the data and the remaining data are as needed for the orificing program.
- 2) A program to check for keypunch errors in the reactor analysis core physics data and the Astrofuel element data.

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- 3) The program which selects the proper orifice sizes.
- 4) The program which edits the output data and prints it out by the correct format.
- 5) Also used at two stages of 1) through 4) is a sorting routine (I.B.M. 7094 Sort).

During the orificing calculation a large amount of tabular data are used; information is obtained from the tabular data by means of a parabolic interpolation. The tabular data are checked for error by performing many parabolic interpolations and plotting the results; any errors will show up on the plots. The parabolic interpolation subroutine is described in reference 2).

The bulk of the data required by the orificing program describes the nuclear characteristics required for each fuel element position (Reactor Analysis core physics data) and the physical and nuclear characteristics of the fuel elements available (Astrofuel element data). Two I.B.M. cards are required to enter the Reactor Analysis core physics data for each element and a like number of cards are required for the Astrofuel data for each element. The data sheets for these two sets of data are shown in figures (1) and (2).

The order in which the programs should be run will now be described. The program which checks the tabular data of the orificing program should be run as soon as possible since the results must be plotted and analyzed.

The Reactor Analysis core physics data and the Astrofuel element data must be recorded from cards to two separate tapes. These tapes are then sorted by serial number using the I.B.M. 7094 sort program or the cards may be sorted mechanically before the cards are put on tape. The program which checks the Reactor Analysis core physics data and the Astrofuel element data must be run next. The tape containing the Reactor Analysis core physics data must be mounted on tape unit B-6, and the tape containing the Astrofuel data must be mounted on tape unit B-5. Both B-5 and B-6 must be set to 556 density. Blank tapes must be mounted on tape

REACTOR ANALYSIS CORE PHYSICS DATA SHEET - DATA I

REACTOR ANALYSIS CORE PHYSICS DATA SHEET - DATA I				REFERENCE CORE	REFERENCE POWER	REFERENCE AVERAGE	NUMBER OF CHANNELS	DATA LOG NO.	PAGE NO.												
CARD COL:	(1)	(2)	(3)	(4)	(5) CHANNEL RADIAL RELATIVE POWER FACTOR																REMARKS
	SERIAL NO.	SECTOR & ROW	CLUSTER & ELEMENT LOADING & SIZE	NOM. LOADING AXIAL FACTOR	1	2	3	4	5	6	7	8	9	10							
1.																					
2.																					
3.																					
4.																					
5.																					
6.																					
7.																					
8.																					
9.																					
10.																					
11.																					
12.																					
13.																					
14.																					

FIG. (1)

ASTROFUEL ELEMENT DATA SHEET - DATA II

DATA LOG NO

PAGE NO

CARD COL		(1)		(2)		(3)		(4) CHANNEL DIAMETERS																						
ITEM	SERIAL NO	SERIAL NO	AV MEAS	LOADING	GRADE	SIGNATURE	DATE	18	21	23	26	28	31	33	36	38	41	43	46	48	51	53	56	58	61	63	66	SIGNATURE	DATE	REMARKS
								1	2	3	4	5	6	7	8	9	10													
								11	12	13	14	15	16	17	18	19	LOC													
1																														
2																														
3																														
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														
13																														
14																														

FIC(2)

units A-5 and A-6 and these units must be set to 800 density. The checked physics data will be recorded on tape A-5 and the checked fuel data will be recorded on tape A-6. Any errors found by this program must be corrected, and this program must be rerun until no errors are found, before running subsequent programs. The output of this program will be two tapes consisting of the Reactor Analysis core physics data and the corresponding Astrofuel element data. These data are used as input to the orificing program.

The orificing program may now be run. When running this program the checked physics tape must be mounted on tape unit A-5 and the checked fuel tape must be mounted on tape A-6. Both of these tape units must be set to 800 density. A blank tape must be mounted on tape unit A-4; this unit must be set to 800 density. The orificing information will be printed out on the regular output tape, ordered by serial number. The program will also produce a binary tape (on tape unit A-4) which may be sorted in either of two ways:

1. by sector
2. by spiral

This sorted tape is used as input to the final editing program which prints out the output in either or both of two ways:

1. group 1 output
2. group 2 output

Consult reference number 1 for examples of group 1 and group 2 output. When running the final editing program, the sorted tape must be mounted on tape unit A-4, and tape A-4 must be set to 800 density. A blank tape must be mounted on tape unit A-5, and A-5 must be set to 556 density.

The data sheets for the input data for the program mentioned above follow.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

Col 1 Title Card for Checking Program Col 72

--

Col 1 Title Card for Orificing Program Col 72

--

VARIABLE		DESCRIPTION
NAME	VALUE	
SELHAF		SEE DESCRIPTION BELOW
OUTIND		OUTIND = 0; OUTPUT BY POSITION ONLY
		OUTIND = 1.; OUTPUT BY SERIAL NO. ONLY
		OUTIND = 2.; OUTPUT BY SERIAL NO. AND
		POSITION

The above values are to be punched starting in Cols. 1 and 13.

The value of SELHAF is the value of the IHAF entry in the orifice limit table.
See figure (7) for example.

Col																					
1	4	7	10	13	16	19	22	27	30	33	36	39	42	45	48	51	54	57	60	63	66
NOFLSH	ICH2	IORCO	ICHDI	IODIA	MASSCR	INL	ICOUNT	IORTB	IHAF	INDCOD	NOFQPF	NOC	NTEXCF	IBIN	INDWF	ISKIP	INDFAX	IFPTS1	IFPTS2	IFPTS3	IFPTS4

NOFLSH = Number of flux shapes
 ICH2 = Number of entries in channel dia. table used to calculate orifice dia.
 IORCO = Number of power factor table entries for each flux shape (used to find orifice loss coefficient)
 ICHDI = Number of channel Dia. table entries for each flux shape (used to find orifice loss coefficient)
 IODIA = Number of entries in orifice dia. table used to calculate orifice dia.
 MASSCR = 1, use mass correction; = 0, do not use mass correction
 INL = Number of entries in fuel loading code
 ICOUNT = Number of elements to be orificed
 IORTB = Number of orifice sizes
 IHAF = Should be $\approx$ IORTB/2
 INDCOD = 1, use color code for orifice designation; = 0, use configuration code
 NOFQPF = Number of entries in each power factor table used to calculate exit temp.
 NOC = Number of entries in each channel dia. table used to calculate exit temp.
 NTEXCF = Number of entries in each exit temp. table used to calculate corrected flow
 IBIN = 0, read physics data from BCD tape; = 1, read physics data from binary tape
 INDWF = 1, use weight flow correction; = 0, do not use weight flow correction
 ISKIP = 0, do not read in program generated constants; = 1, read in program generated constants
 INDFAX = 0, use corrected power factors; = 1, use uncorrected power factors
 IFPTS1 = The number of interpolated pts. for curves used to find orifice loss coefficient
 IFPTS2 = The number of interpolated pts. for curves used to find exit temp.
 IFPTS3 = The number of interpolated pts. for curves used to find orifice dia.
 IFPTS4 = The number of interpolated pts. for curves used to find corrected flow

All of the above values are fixed point numbers and should be right adjusted.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

VARIABLE	VALUE	REMARKS
DRAWN 1 (1)		These values constitute the drawing number for the orifices.
" 2 (1)		
" 1 (2)		Each drawing number may contain up to 12 characters. The first 6 characters are entered as DRAWN 1 (1) and the second 6 characters are entered as DRAWN 2 (1), etc. If the drawing number is less than 12 characters, the characters should be left adjusted.
" 2 (2)		
" 1 (3)		
" 2 (3)		
" 1 (4)		
" 2 (4)		
" 1 (5)		
" 2 (5)		
" 1 (6)		
" 2 (6)		
" 1 (7)		
" 2 (7)		
" 1 (8)		
" 2 (8)		
" 1 (9)		
" 2 (9)		
" 1 (10)		
" 2 (10)		
" 1 (11)		
" 2 (11)		
" 1 (12)		
" 2 (12)		
" 1 (13)		
" 2 (13)		
" 1 (14)		
" 2 (14)		
" 1 (15)		
" 2 (15)		

The values shown above are to be punched in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

FIG (3)

The above curves are used to determine the orifice loss coefficient. There must be one of these curves for each flux shape. The maximum number of channel diameters (ICHDI) allowed is ten. For each channel diameter, a power factor table and orifice loss coefficient table is required; the maximum number of entries in each power factor table (IORCO) is 15, and the maximum number of entries in each orifice loss coefficient table (IORCO) is 15. The channel diameter table entries must be entered in increasing order.* The maximum number of flux shapes allowed is ten. The value of J in the subscript (I,J) represents the flux shape.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

VARIABLE	VALUE	REMARKS
AXSHPE		AXIAL SHAPE TABLE.
"		This table is used in finding the
"		corrected flow. The number of
"		entries in this table is NOFLSH.
"		See figure (4). This sheet should
"		be omitted if INDWF = 0, or if
"		NOFLSH < 3.
"		
"		
"		
"		
"		

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

Figure (4)

This curve is used to find the corrected flow. The AXIAL SHAPE table which contains NOFLSH (number of flux shapes) entries must be in increasing order. Only one EXIT TEMP. table is required, and it must have NTEXCF entries. The maximum value NTEXCF is 20. There must be one CORRECTED FLOW table for each axial shape and each of these tables must have NTEXCF entries.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page ____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

FIG (5) EXAMPLE, THREE FLUX SHAPES AND ORIFICE SIZES

CHECK ORIFICING PROGRAM DATA

Eng. _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

FIG (6)

The above curve is used to determine the orifice diameter. There is only one of these curves needed regardless of the number of flux shapes. The number of channel diameters is $ICH2$; the maximum value of $ICH2$ is 10. The entries in the channel diameter table must be in increasing order. There must be an orifice loss coefficient table and an orifice diameter table for each channel diameter table. Each orifice loss coefficient and orifice diameter table must have $IOR2$ entries. The maximum value of $IOR2$ is 20.

CHECK ORIFICING PROGRAM DATA

Eng. _____ Charge No. _____ Date _____ Page _____ of _____

VARIABLE NAME	VALUE	DESCRIPTION
FUELOC		FUEL LOADING CODE.
"		The first value of the fuel
"		loading code is the value of
"		the nominal loading of an
"		element with 11 channels. The
"		ninth value of the fuel loading
"		code is the nominal loading of
"		an element with 19 channels.
"		
"	0.	
"		
"		

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

[illegible]

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

CHECK ORIFICING PROGRAM DATA

Name	Charge No.	Date	Page	of
------	------------	------	------	----

[illegible]

The above values should be keypunched in fields starting in columns 1, 7, 13, 19, 25, 31, 37, 43, 49, 55, 61, and 67.

Figure (7)

Example of orifice limit table, orifice size table, and color code. Given the following table:

orifice diameter between	orifice size to be used	color code
0. - 2.20	2.10	IRY 210
2.20 - 2.40	2.30	DBU 230
2.40 - 2.60	2.50	GRN 250
2.60 - 2.80	2.70	ORG 270
2.80 - 3.00	2.90	GRY 290
3.00 - 3.20	3.10	DBN 310
3.20 - 3.40	3.30	SMN 330
3.40 - 3.60	3.50	YLW 350
3.60 - 3.80	3.70	LBU 370
3.80 - 4.00	3.90	LVN 390
4.00 - 4.20	4.10	TAN 410
4.20 - 4.40	4.30	RED 430
4.40 - 96000.		REJECT

The orifice limit table and orifice size table would then be:

orifice limit table

0.	mils
220.	mils
240.	mils
260.	mils
280.	mils
300.	mils
320.	mils
340.	mils
360.	mils
380.	mils
400.	mils
420.	mils
440.	mils

orifice size table

210.	mils
230.	mils
250.	mils
270.	mils
290.	mils
310.	mils
330.	mils
350.	mils
370.	mils
390.	mils
410.	mils
430.	mils

The value 96000. could be any large number. The symbol REJECT could be replaced by any six characters which implies the channel cannot be orificed. The color code would be as shown above. For this example the values of SELHAF could be ~~210~~ and hence IHAL would be 6. ~~300.~~

CHECK ORIFICING PROGRAM DATA

Name _____ Charge No. _____ Date _____ Page _____ of _____

VARIABLE	VALUE	REMARKS
WFPFQ		WEIGHT FLOW PER POWER FACTOR
"		TABLE
"		There must be NOFLSH (number of
"		flux shapes) values in this
"		table.
"		
"		
"		
"		
"		
"		

Punch the numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

PHYSICS AND FUEL DATA CHECKING PROGRAM

Name _____ Charge No. _____ Date _____

	Col 1		Col 72
TITLE CARD			

Col 1	Col 4	Col 5	Col 8	
	1 0			
	INL		ICOUNT	

INL = THE NUMBER OF ENTRIES IN THE FUEL LOADING CODE
 ICOUNT = THE NUMBER OF ELEMENTS TO BE ORIFICED

VARIABLE	VALUE	REMARKS
FUELOC (1)		FUEL LOADING CODE
(2)		
(3)		
(4)		
(5)		
(6)		
(7)		
(8)		
(9)		
(10)	0.0	
FNLLJM		Limit within which nominal and measured loading must check
DIANOM		Nominal channel dia.
DIALIM		Limit within which nominal and meas. dia. must check
FQLOW		Lowest allowed value of power factor (FQ)
FQHIGH		Highest allowed value of power factor (FQ)

Col 1	2	3	4	5	6	7	8	9	10
0	A	B	C	D	E	F	G	H	J

The above are values of IALP(J) which are used to check the rows.

COL 1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9

The above are values of I22CK(J) which are used to check the number of channels.

Col 1	2	3	4	5	6	7	8
	\$	\$	\$	\$	\$	\$	\$

The above value is used to indicate when the end of physics data have been reached.

PHYSICS AND FUEL DATA CHECKING PROGRAM

Name _____ Charge No. _____ Date _____ Page _____ of _____

Col.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W

The values of IELEMT are permanent and should not need to be changed.

Col.	1	4	5	8	9	12	13	16	17	20	21	24	25	28	29

The above are values of NOEPCC(I) and represent the total number of elements in row J as the clusters 3 through 9 are accumulated.

The above two cards should be inserted between the last two cards of the previous page.

FINAL ORIFICE SELECTION EDITING PROGRAM

Name _____ Charge No. _____ Date _____ Page _____ of _____

TITLE CARD No. 1	Col 1		Col 72

TITLE CARD No. 2	
---------------------	--

Col 1	Col 6	Col 11	Col 16	Col 20
INDGRP	ICOUNT	IORTB	INDCOD	

The above values are fixed point variables and must be right adjusted.

VARIABLE NAME	VALUE	DESCRIPTION
ORCDE (1)		ORIFICE CODE
(2)		(A color and size for each entry,
(3)		going from small to large size.
(4)		Each entry must not exceed 6 charac-
(5)		ters.)
(6)		
(7)		
(8)		
(9)		
(10)		
(11)		
(12)		

The above values start in columns 1, 7, 13, 19, 25, 31, 37, 43, 49, 55, 61, 66.

INDGRP = 1, Output by group 1 only
INDGRP = 2, Output by group 1 and group 2
INDGRP = 3, Output by group 2 only
INDCOD = 1, Use color code
INDCOD = 2, Use configuration code
ICOUNT = Number of elements to be orificed
IORTB = The number of orifice sizes.

FINAL ORIFICE SELECTION EDITING PROGRAM

Name _____ Charge No. _____ Date _____ Page _____ of _____

	Col 1	Col 72
TITLE CARD No. 3		
TITLE CARD No. 4		
TITLE CARD No. 5		
TITLE CARD No. 6		
TITLE CARD No. 7		
TITLE CARD No. 8		

Each of the above title cards may contain up to 72 columns of information.

VARIABLE

NAME	VALUE	DESCRIPTION
FUELOC		FUEL LOADING CODE
"		The first value of the fuel loading
"		code is the value of the nominal
"		loading of an element with 11
"		channels. The ninth value of the
"		fuel loading code is the nominal
"		loading of an element with 19
"		channels.
"		
"	0.	
"		
"		

Punch these numbers in fields starting in columns 1, 13, 25, 37, 49, 61.

FINAL ORIFICE SELECTION EDITING PROGRAM

Name _____ Charge No. _____ Date _____ Page _____ of _____

VARIABLE	VALUE	REMARKS
DRAWN 1 (1)		These values constitute the
" 2 (1)		drawing number for the orifices.
" 1 (2)		Each drawing number may contain
" 2 (2)		up to 12 characters. The first
" 1 (3)		6 characters are entered as
" 2 (3)		DRAWN 1 (1) and the second 6
" 1 (4)		characters are entered as
" 2 (4)		DRAWN 2 (1), etc. If the drawing
" 1 (5)		number is less than 12 characters,
" 2 (5)		the characters should be left
" 1 (6)		adjusted.
" 2 (6)		
" 1 (7)		
" 2 (7)		
" 1 (8)		
" 2 (8)		
" 1 (9)		
" 2 (9)		
" 1 (10)		
" 2 (10)		
" 1 (11)		
" 2 (11)		
" 1 (12)		
" 2 (12)		
" 1 (13)		
" 2 (13)		
" 1 (14)		
" 2 (14)		
" 1 (15)		
" 2 (15)		

The values shown above are to be punched in fields starting in columns 1, 13, 25, 37, 49, 61.