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INSTRUCTIONS FOR THE OPERATION OF CODES ASSOCIATED WITH THE LOW-ENERGY INTRANUCLEAR CASCADE CALCULATION

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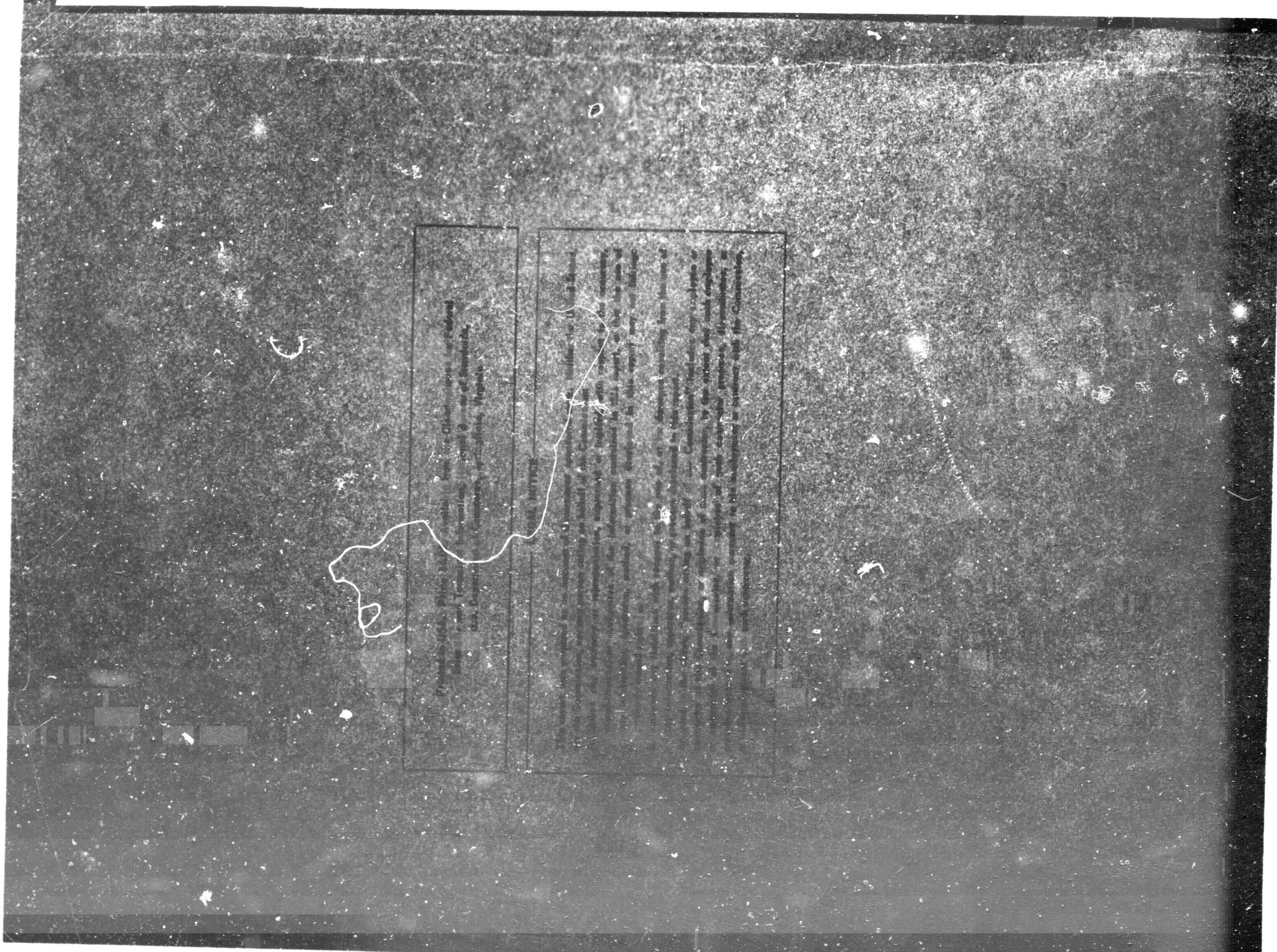
OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION



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Abstract

Instructions are given for processing a tape containing all the programs associated with a low-energy intranuclear cascade calculation. The calculation is valid for incident nucleon energies from about 50 to 350 MeV and for incident charged pion energies from about 50 to 250 MeV. The codes involved are the cascade code, two analysis codes which construct various histograms using the data generated by the cascade, an evaporation code which performs evaporation calculations on the nuclei that are left at the completion of the cascade calculation, an angular momentum code, and a code which allows the cascade calculations to be made with different nucleon density distributions within the nucleus. A detailed description of all the binary outputs is given, and a list of running times is included.

Introduction

These instructions and codes are intended for use at a computing facility using an IBM-7090 computer with the standard IBM Monitor system,* which must be used when the Source Program Tape accompanying this manual is processed and when all codes are run.

In order to get a complete set of results from the intranuclear cascade calculation,[1] not one but several codes are needed. All of these codes, along with the additional data required to operate them, are contained on the Source Program Tape.

The main code is the Cascade Code, and the actual intranuclear cascade calculation is performed using this code. The calculation is valid for incident nucleon energies from about 50 to 350 MeV and for incident charged pion energies from about 50 to 250 MeV. Very briefly, the calculation attempts to trace the history of each incident particle impinging upon the surface of a nucleus. Some of these particles pass through the nucleus, and some will collide inside where the collisions are assumed to take place with individual nucleons in the nucleus. When an incident particle makes a collision, each particle emanating from the collision point is followed by the code to the next collision, and the process is repeated at the new collision points. In this way a cascade is generated. (For further details, see reference 1 below.) When the particles that emanate from any of the collision points escape from the nucleus, the data pertinent to that particle, such as its energy and direction cosines, are recorded on an auxiliary magnetic tape, called the "Primary Output Tape." A record (see Glossary) on this tape consists of the pertinent

1. Hugo W. Bertini, Phys. Rev. 131, 1801 (1963) with erratum Phys. Rev. 138, AB2 (1965); also Monte Carlo Calculations on Intranuclear Cascades, ORNL-3383 (Apr. 23, 1963).

*The specific system required is the Standard IBM Monitor System with Fortran II, version 2, modification 50.

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information for all particles that escape as a result of one incident particle initiating the cascade. Hence there is one record for each incident particle that makes a collision inside the nucleus.

The information in the series of records generated in this way is not directly useful, since each record will contain data that will have been generated by a statistical process,[1] and the numerical values of the pertinent data recorded will have considerable variation. These statistical data must be organized into meaningful distributions by additional codes. A copy of the report ORNL-3433 included with this material describes the printed output from three such codes - Analysis Codes I and II and the Evaporation Code. The binary output from these codes is described in the section entitled "Binary Tapes" in this manual. All three codes are included in the set of codes contained on the reel accompanying this manual.

A fourth analysis code, providing data on angular momentum distributions, and the Nuclear Configuration Code are also included and will be described later in this report.

This manual is intended to assist the user in the processing necessary for the operation of the codes. It consists of a Glossary of computing terms related to this subject, a description of the accompanying tape itself, a set of instructions for processing this tape to get the codes, a description and samples of the supplementary IBM (input) cards needed for the operation of each code, a table of estimated running times for each code, a complete set of outputs for a sample case, an exact format of the information written by the cascade code on the Primary Output Tape, and finally a table of random numbers, which can be used in the Cascade Code input. (See Table of Contents for location of this material.)

Glossary

The following terms are defined only as they relate to the processing of these codes. Where there is a possibility of an "O" being confused with a zero, ∅ is used to represent "O".

A	Mass number of a nucleus.
BCD (Binary Coded Decimal)	A system for representing numerical, alphabetic, and special characters by means of binary notation.
BCD TAPE	Information recorded on the magnetic tape in the BCD system where one six-bit binary number is used to represent each character.
BINARY CARDS	Cards punched in machine language as a result of processing Source Programs.
BINARY TAPE	A magnetic tape containing information in the same form as it is found in the memory or core of the computer.
CARD FIELD	A fixed number of consecutive card columns assigned to a unit of information.
CROSS-SECTION TAPE	A tape containing the basic cross-section data and the parameters from which the various properties of the nucleus can be calculated. This tape is used when operating the Cascade Code.
CUTOFF ENERGY	The energy at which the histories of the cascade particles cease to be followed.
END OF FILE	An indication that all records in the file on a tape have been read or written.

END-OF-FILE MARK — A 3.75-in. blank space, a tape mark followed by its redundancy character, and an end-of-file record gap. This sequence on a tape will signal an end of file to the computer when the tape is read.

EVAPORATION CODE TABLE TAPE — Table of Wapstra's masses on tape from which binding energies are calculated.[2] This tape is used when operating the Evaporation Code.

FIELD WIDTH — The number of columns in a card field.

FILE — One record or a series of records followed by an end-of-file mark on the tape. In the special case of the Primary Output Tape generated by the Cascade Code, one file contains all the records pertaining to a case or particular nuclear reaction (example: 200-MeV Protons on Aluminum using 3000 incident particles). In the special case of the Source Program Tape, each file contains a code or a set of data necessary to operate a code.

FIXED POINT NUMBER — An integer.

FLOATING-POINT NUMBER — A number with a decimal point. The number may be followed by the letter E and the power of 10 by which the number itself is to be multiplied.

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2. See L. Dresner, EVAP-A FORTRAN Program for Calculating the Evaporation of Various Particles from Excited Compound Nuclei, ORNL-CF-61-12-30 (Dec. 19, 1961) for use of Wapstra masses. In Dresner's report the masses were part of the input data on cards, whereas for present purposes they are read into the program from tape.

FORMAT — The arrangement of information for input to a computer or the arrangement desired for output, e.g., Format (E12.8) specifies a field width of 12 columns and a number with 8 significant digits, where the number is represented in floating point form.

FORMAT - A TYPE — A card field containing alphabetic or numeric characters that may be either right- or left-adjusted as established by the program.

FORMAT - E TYPE — A card field containing numeric characters in floating point form with an exponent. Example: the value 0.24405747×10^3 to be entered as a Format (E12.8) in column 55 through column 66 (12 columns) should be entered as 24405747E+03 starting in column 55 and ending in column 66.* The "12" signifies a field width of 12 columns, and the "8" signifies eight places to the right of the decimal point. The value of the exponent must be in the extreme right of the field.

FORMAT - F TYPE — A card field containing numeric characters in floating point form without an exponent. Example: using the same number as above with

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*Note: Commas should never appear in a number punched on a card. The decimal point punched in the card overrides the position indicated in the Format specification; therefore, if the number is of magnitude suitable to the field width, the number with the decimal point positioned correctly may be entered anywhere in the field; e.g., the value 0.24405747×10^3 may be entered as 244.05747 anywhere in the field, and the letter E may be omitted.

the FORMAT(F12.8) in columns 55 through 66, 24405747000 may be entered in columns 56* through 66. However, the number with the decimal point positioned correctly may be entered anywhere in the field, as in the E-type format.

FORMAT - I TYPE A card field containing fixed point numbers only (no decimal points) that must be entered to the extreme right of the card field; e.g., a number to be used by a FORMAT (I5) which is to occupy columns 10 through 20 must be entered as an integer of 5 or less digits which occupies the rightmost section of columns 10 through 20.

FORMAT - ø TYPE A card field containing a specified number of integers of which no integer may be greater than 7. Example: for FORMAT(ø12) the number 455012321765 placed in the designated card field will satisfy the ø type format.

INCIDENT PARTICLE The four types of incident particles that the Cascade Code is capable of handling are:

1. proton
2. neutron
3. π^+
4. π^-

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*This is an example of a number which is "right-adjusted."

LEFT-ADJUSTED	The information in the card field positioned to the extreme left of the field.
MONITOR CONTROL CARDS	The two cards that the user adds to the front of each object program and the "*DATA" cards that he adds to the back. These cards are used by the monitor system only.
OBJECT DECK	The correct arrangement of monitor control cards with the binary cards or object program obtained from a source program. This deck is ready to be combined with input data to be processed.
OBJECT PROGRAM	The binary cards punched as a result of processing a source program.
PRIMARY OUTPUT TAPE	A binary tape created by the Cascade Code to be used as an input tape for Analysis Codes I and II, the Evaporation Code, and the Angular Momentum Code.
PROCESSOR	A machine language program, which performs the functions necessary to convert a source program into the desired object program.
PROGRAM	The plan for the solution of a problem, including the instructions that will cause a computer to perform the desired operation and also such required information as data descriptions and tables.
RECORD	A block of words recorded consecutively on tape followed by a 3/4-in. blank space on the tape.

In the special case of the Primary Output Tape generated by the Cascade Code, each record except the first and last contains all of the information pertaining to the particles escaping from the nucleus for each incident particle making a collision; i.e., there is one record for each incident particle that makes a collision with the nucleus. The first record describes the case, and the last record briefly summarizes some of the results.

RIGHT-ADJUSTED — The information in the card field positioned to the extreme right of the field.

SOURCE PROGRAM — A program coded in other than machine language, such as FORTRAN, FAP, etc., which must be translated into machine language before use.

SOURCE PROGRAM TAPE — The tape supplied to the user containing the source programs for all of the codes.

TAPE ASSIGNMENT — The "logical" tape number is the tape number referred to in the source program.
The "assigned" number designates the actual physical tape drive corresponding to the logical tape number.

TARGET — Element being bombarded.

Z — Atomic number of a nucleus.

Description of Accompanying Reel of Tape

The tape reel accompanying this manual is referred to as the "Source Program Tape." The data on this tape are grouped into eight files.

File 1: Contains the information to be copied (at an IBM installation) as the first file on an auxiliary tape, which is referred to as the Cross Section Tape. The Cross Section Tape must be used in running the Cascade Code (file 3).

File 2: Contains the information to be copied (at an IBM installation) as the first file on an auxiliary tape, which is referred to as the Evaporation Code Table Tape. The Evaporation Code Table Tape must be used in running the Evaporation Code (file 6).

File 3: Contains the Cascade Code, which generates and stores all the raw data pertaining to the escaping cascade particles on the auxiliary tape, the Primary Output Tape.

File 4: Contains Analysis Code I
File 5: Contains Analysis Code II
File 6: Contains the Evaporation Code
File 7: Contains the Angular Momentum Code

} Uses the information from the Primary Output Tape (see file 3) to calculate the useful output.

File 8: Contains the Nuclear Configuration Code, which is used to generate a different cross-section tape from that given by file 1; this cross-section tape contains both the basic cross-section data used by the Cascade Code and the data that determine the nuclear configuration, that is, the size of each nuclear region, etc.[1] The nuclear configuration can be changed by using this code as described later.

How to Use the Source Program Tape

The codes contained on the accompanying Source Program Tape may be processed by the standard IBM Monitor System* to obtain Object Programs in card form. The Object Programs, along with the appropriate monitor and input cards, are then used to run the desired cases.

The Object Programs can be obtained by submitting the Source Program Tape to the computer installation along with instructions to process any or all of the six files that contain the codes.

Steps To Obtain Object Programs and Object Decks

Submit the Source Program Tape to any IBM computing installation. Request the standard IBM Monitor System* for use on this job.

1. Have file 1 (for the Cascade Code) or file 2 (for the Evaporation Code) copied as the first file on an auxiliary tape which is then called either the Cross Section Tape or the Evaporation Code Table Tape.
2. Specify which file or files of the remaining files are desired corresponding to the codes desired and state that you wish both compilation and assembly for each file. After the processing (copying, compiling, and assembling) has been done you will receive a set of binary cards and a list of the assembly and compilation. This list is a stack of IBM paper sheets upon which the source program and corresponding machine language version of each code are printed. Retain these sheets until the codes are run successfully, and then they can be discarded. (They would be of use to an experienced programmer if trouble develops in using the codes.)

*Specifically, one must ask for the Standard IBM Monitor System with Fortran II, version 2, modification 50.

3. Add the following cards to the front and back of each set of binary cards to complete the Object Decks:

   a. In front:

      Card 1

In Column	Punch
1	*
7-72	Any information pertinent to job

      Card 2

In Column	Punch
1	*
7-9	XEQ

   b. Behind each batch of binary cards for the Cascade Code, Analysis Code I, Analysis Code II, the Angular Momentum Code, and the Nuclear Configuration Code add the following card:

In Column	Punch
1	*
7-10	DATA

   c. Behind the batch of binary cards for the Evaporation Code add the following three cards:

      Card 1

In Column	Punch
1	*
7-10	DATA

Card 2*

In Column	Punch
1-4	NEUT
7-12	PRØTØN
13-16	DEUT
19-24	TRITØN
25-27	HE3
31-35	ALPHA

Card 3*

In Column	Punch
1-4	NEUT
7-12	PRØTØN
13-15	PI+
19-21	PI-

4. Place the input cards containing the input data, listed in the following sections describing each code, after the last card of the Object Decks, which will then be ready for use.

5. Submit the completed decks, the tapes needed to run the codes, and a card or sheet specifying the tape assignments** for the tapes to be used with each code to the computer installation with instructions that these programs be run using the standard

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*Strictly speaking adding the "*DATA" card to the Evaporation Code binary cards completes the formation of the Object Deck for this code, but cards 2 and 3 must be supplied in order for the code to operate properly.

**Explained in more detail in the Cascade Code section.

IBM Monitor System,*including the standard input and output tapes that are generally used with this system. In return, you will receive the printed output from each code when the job has been run, and either the tape reels or the reel numbers upon which the data have been written.

Note: The programs on files 4, 5, 6, and 7 are used individually to analyze the Primary Output Tape created by the Cascade Code. Obviously, the Cascade Code must be run before these codes can be used.

*I.e., the Standard IBM Monitor System with Fortran II, version 2, modification 50.

Cascade Code

As already mentioned, the Cascade Code is used to generate data on the Primary Output Tape. The data may be analyzed by Analysis Code I, Analysis Code II, the Evaporation Code, or the Angular Momentum Code to obtain the information desired from the Cascade Code. The Cross-Section Tape containing the basic cross sections and nuclear data must be used in running the Cascade Code. As a reminder, the energy range of validity for the Cascade Code is about 50 to 350 MeV for incident nucleons and 50 to 300 MeV for incident pions. The user must supply the Cross-Section Tape to the IBM installation with the object deck and input cards when operating this code.

The code requires three input cards to specify each case, but any number of cases may be specified by placing the sets of three cards per case in sequence behind one another. However, because of the unreliability of the tapes, it is suggested that not more than five and preferably only three cases be used for every Primary Output Tape generated.

The cards should contain the following information in the format specified:

Input Cards (3 cards/case)

Card 1

Columns		Format
1-3	A (right-adjusted)	F3.0
4-6	Z (right-adjusted)	F3.0
7-12	Incident kinetic energy (MeV) (cannot be a fraction) (right-adjusted)	F6.0
13-18	Incident particle* (left-adjusted)	A6

*The incident particle must be punched as follows: PRØTØN, NEUT, PI+, or PI-.

Columns		Format
19-24	Target (chemical symbol for element) (left-adjusted)	A6
25-29	Number of incident particles to be used* (right-adjusted)	F5.0
30-41	A random number consisting of 12 digits of which no digit may be greater than 7. (A table of random numbers, which can be used, is given at the end of this report.)	Ø12

Card 2

Columns		Format
1-3	File number (positions case on the Primary Output Tape)**	I3

Card 3

Columns		Format
1-6	Cutoff energy (cannot be a fraction) (right-adjusted). If the card is left blank the code will calculate as the cutoff energy one-half the Coulomb potential at the surface of the nucleus. This has been the usual practice in running the code. If the Cascade Code is being run to obtain only inelastic cross-section data, a cutoff energy just slightly less than the incident-particle energy may be specified. This eliminates the calculation of the unnecessary cascade reactions, thereby reducing machine time and expense.	F6.0

Tape Assignments

Each tape needed in running a program has both a logical number and an absolute number assigned to it. The logical number is the number used

*For most applications, reasonable statistics are obtained if 2000 or 3000 incident particles are used. If good statistics are required on results with small cross sections, such as radiochemical cross sections, then 5000 to 10,000 histories should be used.

**If a number of cases (files) are run sequentially, it is necessary to specify the first file only and blank cards may be used for the remaining file numbers (Card 2). The cases will be stacked on the Primary Output Tape in the order they are submitted. Punch a 1 in column 3 of this card for the first case each time a new Primary Output Tape is to be generated. To add files to an existing Primary Output Tape, punch the succeeding file number, i.e., if there are three files on the tape, punch a 4 in column 3.

in the Source Program in referring to the tape. The absolute assignment number designates the physical tape drive at the machine installation that corresponds to the logical tape number. The logical tape numbers and the corresponding absolute tape number assignments are made by the user on the job card, sequence card, or other card or sheet usually supplied by the installation. Generally this card must be filled out by all users for every program submitted to the installation. The following tapes, their description, and assignments must be used in running the Cascade Code:

Description	Logical No.	Absolute Assignment No.	Supplied By
BCD Input Tape*	5	A2	Installation
BCD Output Tape*	6	A3	Installation
Cross-Section Tape	4	A5	User
Primary Output Tape**	2	B5	Installation

Limitations

Both the atomic number, Z, and the number of neutrons, A-Z , must be greater than 1. The mass number A cannot be greater than 239. Incident energies should be no greater than 400 MeV for incident nucleons or 300 MeV for incident pions. The code will operate for energies as low as 1 MeV for both pions and nucleons.

Trouble Shooting

If the printed output message "Illegal Halt Occurred" is received, the following conditions should be investigated:

1. Whether the input data are in error; all data should be right-adjusted except the incident particle (column 13-18) and target (column 19-20) of card 1, which must be left-adjusted.

*BCD Input and Output Tapes are used for every code with the same logical and absolute assignment numbers.

**This tape is furnished by the installation as a POOL tape initially. The user should then request that this tape be assigned to him for as long as it is useful to him.

2. Whether there are three cards for each case (card 2 of all cases except case 1 may be a blank card).

Output

Three sheets of output, illustrated on the following pages, are obtained from the Cascade Code, but since the output was used merely to check the code during the debugging states it can usually be discarded.* Page 1 contains the inelastic cross section and the geometric cross section, which might be of interest. The data given on page 2 of the printed output, starting with "Average Number of Particles...," are incorrect and should not be used at all. The useful data are generated by Analysis Codes I and II and the Evaporation Code.

Example

The following pages contain the input cards for and the printed output from a sample case. The case used is that for 200-MeV π^- on ruthenium where 2000 incident particles were used (Card 1). The escaping cascade particle data are to be placed in file 1 of the Primary Output Tape (Card 2), and the cutoff energy is to be calculated by the code (Card 3 left blank or punched with 0).

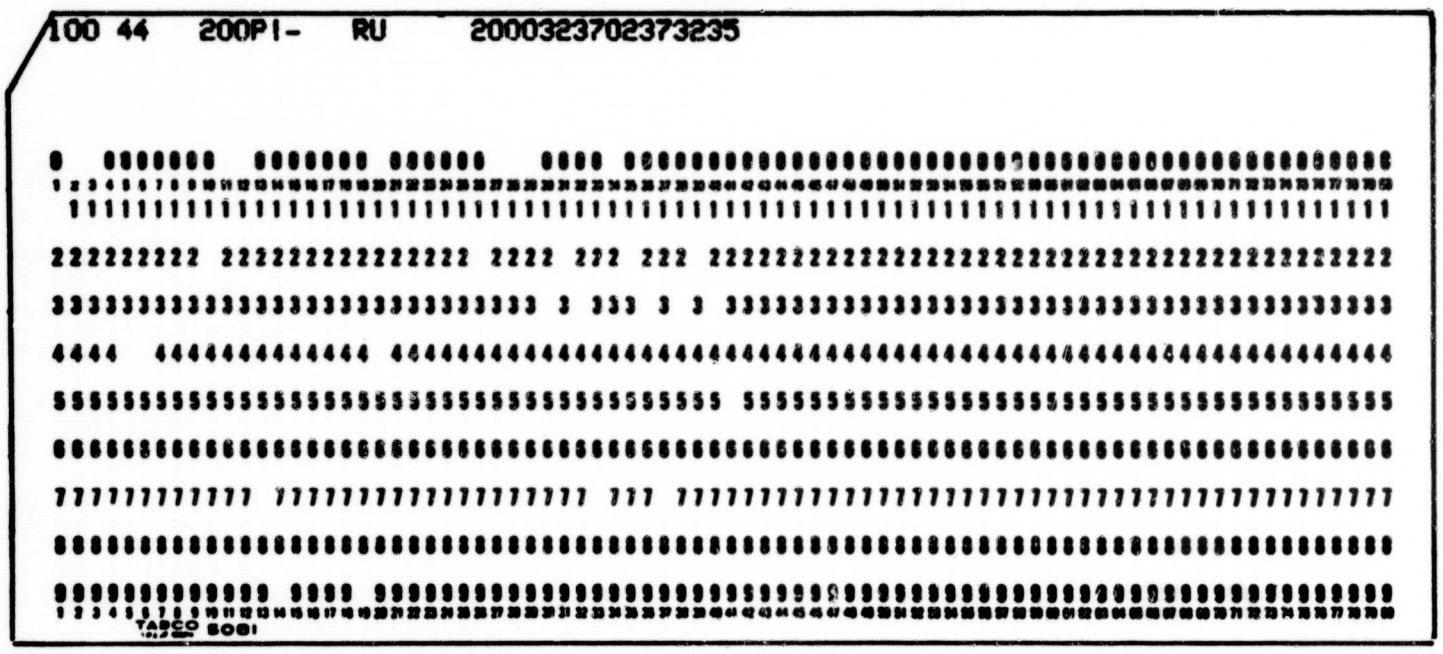
This case may be used as a test case. The printed output the user receives after submitting an identical case for processing should be the same as the printed output illustrated on pages 19 and 21.**

*When the Nuclear Configuration Code is used to get different nuclear configurations on a new Cross Section Tape, page 3 of the Cascade Code may be of interest. Specifically, the numbers under R1, R2, and R3 represent the radii in cm of regions 1, 2, and 3, respectively, while the potential well for the neutrons and protons for each region may be obtained by subtracting the number under the heading "outside the nucleus" from the numbers on the same line. For example, the potential well for neutrons in region 2 is given by 235 - 200 = 35 MeV.

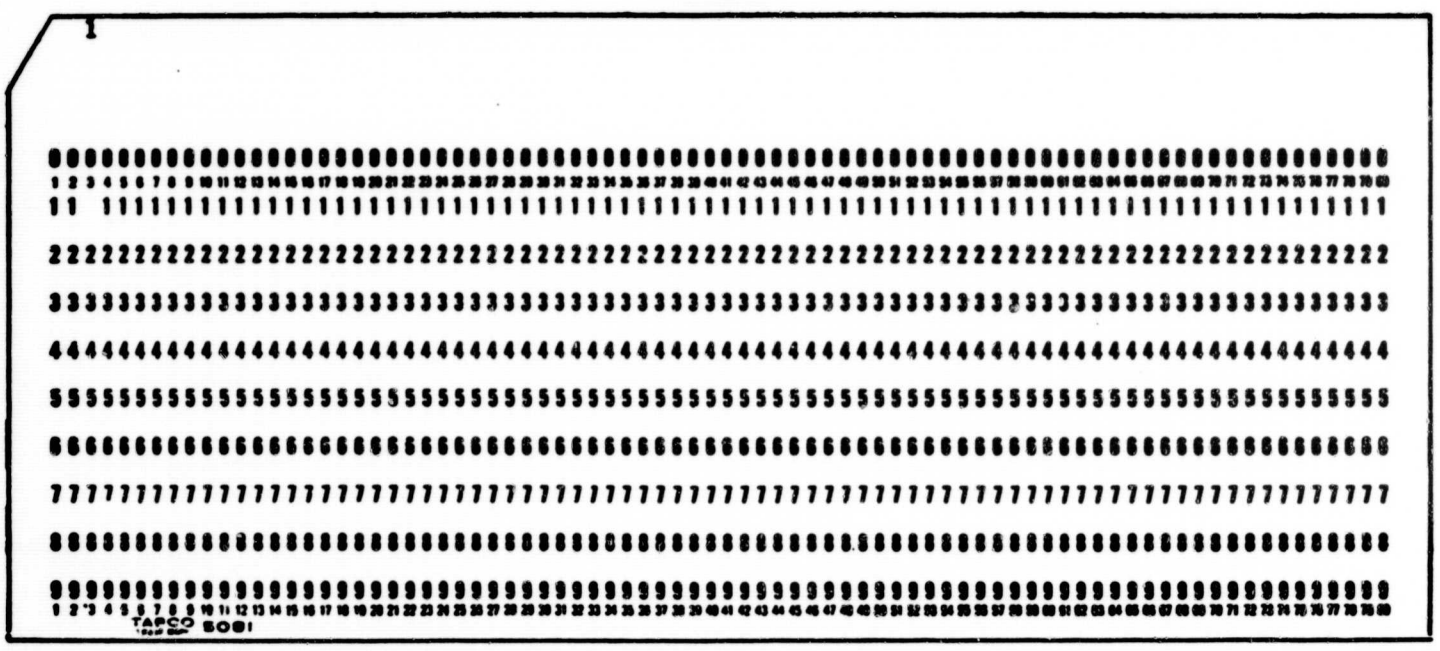
**The numbers below "Number of Tape Errors Detected by Main Program" may not be the same as those in the sample. These numbers are an indication of the number of flaws on the tape.

INPUT CARDS - CASCADE CODE

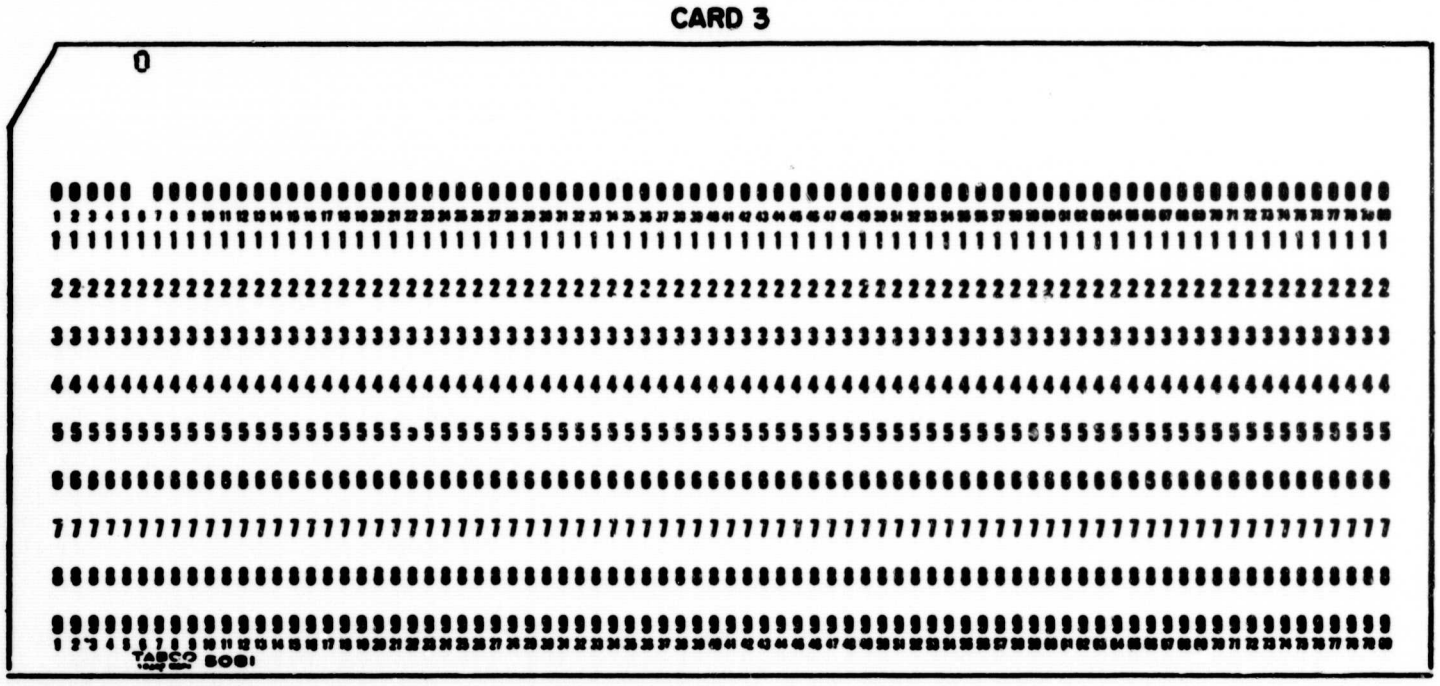
CARD 1



CARD 2



CARD 3



INCIDENT PARTICLE	INCIDENT LAB K.E. (MEV)	TARGET SYMB	A	Z	N	NUMBER OF INCIDENT PARTICLES	CUTOFF ENERGY (MEV)	GEOMETRIC CROSS SECT. (MB)	TRANSPARENCY	INELASTIC CROSS SECT. (MB)
PI-	200.	RU	100.	44.	56.	2000.	4.2	1756.5	0.22050	1369.2

	NUMBER OF INCIDENT PARTICLES DIRECTED TOWARD	FRACTION OF TOTAL	CORRESPONDING FRACTION OF TOT CRS SECTNL AREA	NUMBER OF THESE PARTICLES WHICH ESCAPE
REGION 1	509	0.254	0.255	0
REGION 2	664	0.332	0.332	10
REGION 3	827	0.413	0.413	431
TOTAL	2000			441

	NO. OF INCIDENT PARTICLES DIRECTED TOWARD REG.1 WHICH COLLIDE IN	NO. OF INCIDENT PARTICLES DIRECTED TOWARD REG.2 WHICH COLLIDE IN	NO. OF INCIDENT PARTICLES DIRECTED TOWARD REG.3 WHICH COLLIDE IN	TOTAL
REGION 1	63			63
REGION 2	350	466		816
REGION 3	96	188	396	680

	NO. OF CASCADE PARTICLES, WHOSE ORIGINAL COLLISION WAS IN REG.1, MAKING COLLISIONS IN	NO. OF CASCADE PARTICLES, WHOSE ORIGINAL COLLISION WAS IN REG.2, MAKING COLLISIONS IN	NO. OF CASCADE PARTICLES, WHOSE ORIGINAL COLLISION WAS IN REG.3, MAKING COLLISIONS IN	NO. OF CASCADE PARTICLES ESCAPING WHOSE ORIGINAL COLLISION WAS MADE IN
REGION 1	297	1113	378	181
REGION 2	160	2707	998	2372
REGION 3	72	673	557	1664
TOTAL	529	4493	1933	4217

INCIDENT PARTICLE	INCIDENT LAB K.E. (MEV)	TARGET SYMB	A	Z	N	NUMBER OF INCIDENT PARTICLES	CUTOFF ENERGY (MEV)	GEOMETRIC CROSS SECT. (MB)	TRANSPARENCY	INELASTIC CROSS SECT. (MB)
PI-	200.	RU	100.	44.	56.	2000.	4.2	1756.5	0.22050	1369.2

INITIAL RANDOM NUMBER (OCTAL)	FINAL RANDOM NUMBER (OCTAL)
323702373235	215050125721

FORBIDDEN COLLISIONS
AVERAGE NUMBER OF PARTICLES PER INCIDENT COLLISION BELOW THE PERTINENT FERMI ENERGY

PROTONS	NEUTRONS
3.4	5.6

AVERAGE NUMBER OF PARTICLES PER INCIDENT COLLISION WHOSE ENERGY WAS BELOW THE CUTOFF ENERGY IN ALLOWED COLLISIONS

PROTONS	NEUTRONS	PI+	PIO	PI-
1.6	2.1	0.0	0.0	0.0

AVERAGE NUMBER OF COLLISIONS PER INCIDENT COLLISION WHERE SINGLE PRODUCTION WAS POSSIBLE

P-P	P-N	N-P	N-N	PI+	PIO	PI-
0.	0.00	0.00	0.00	0.	0.	0.

AVERAGE NUMBER OF COLLISIONS PER INCIDENT COLLISION WHERE DOUBLE PRODUCTION WAS POSSIBLE

P-P	P-N	N-P	N-N	PI+	PIO	PI-
0.	0.	0.	0.	0.	0.	0.

AVERAGE NUMBER OF COLLISIONS PER INCIDENT COLLISION WHERE PRODUCTION OF MORE THAN TWO PIONS WAS POSSIBLE

P-P	P-N	N-P	N-N	PI+	PIO	PI-
0.	0.	0.	0.	0.	0.	0.

INCIDENT PARTICLE	INCIDENT LAB K.E. (MEV)	TARGET SYMB	A	Z	N	NUMBER OF INCIDENT PARTICLES	CUTOFF ENERGY (MEV)	GEOMETRIC CROSS SECT. (MB)	TRANSPARENCY	INELASTIC CROSS SECT. (MB)
PI-	200.	RU	100.	44.	56.	2000.	4.2	1756.5	0.22050	1369.2

A	R1	R2	R3	RHO1/A	RHO2/A	RHO3/A	E1	E2	E2
100.	0.377E-12	0.573E-12	0.748E-12	0.169E 07	0.926E 06	0.103E 06	2.8207	1.8875	0.4371

INCIDENT PARTICLE KINETIC ENERGY (MEV) WITHIN THE NUCLEUS

REGION 1		REGION 2		REGION 3		OUTSIDE THE NUCLEUS
PROT PRT	NEUT PRT	PROT PRT	NEUT PRT	PROT PRT	NEUT PRT	
242.	248.	231.	235.	212.	213.	200.

COULOMB ENERGY AT SURFACE (MEV)

8.5

INELASTIC CROSS SECTION (MB) CALCULATED FROM PROBABILITIES OF INCIDENT PARTICLES ESCAPING	INELASTIC CROSS SECTION (MB) CALCULATED FROM RATIO OF INCIDENT COLLISIONS TO INCIDENT PARTICLES
1369.2	1369.2

NUMBER OF TAPE ERRORS DETECTED BY MAIN PROGRAM

READING	WRITING
0	293

Analysis Code I

Analysis Code I is used to analyze the Primary Output Tape created by the Cascade Code. The results are given as printed output and at the same time are written on a magnetic tape in the binary mode. (See section on Binary Tapes.)

The data in columns 1-33 of Card 2 for each case to be analyzed must be the same as the corresponding data used as the input for the Cascade Code, but some of the formats will be different. When more than one case is to be analyzed, a set of cards with the same format as Card 2 through N + 4, for each case, should be placed behind the set of cards for the first case. Columns 73 through 80 on all input cards can be used in any way desired (to number the input cards sequentially, for example). The information in these columns is not used by the program.

Input Cards

Card 1

Column		Format
1-3	Number of files (cases) to be analyzed	I3

Card 2

Column		Format
1-3	File number on the Primary Output Tape where the case to be analyzed is located	I3

Column		Format
4-9	Incident particle* (left-adjusted)	A6
10-21	Incident energy (MeV)	E12.8
22-27	Number of incident particles	I6
28-33	Target (chemical symbol) (left-adjusted)	A6
34-37	Number of energy intervals to be used in constructing a histogram for the emitted proton spectrum (usually 10 or 20 but not more than 300); number of intervals may be different for each type of emitted particle	I4
38-41	Same as columns 34-37, but for the emitted neutron spectrum	I4
42-45	Same as columns 34-37, but for the emitted π^+ spectrum	I4
46-49	Same as columns 34-37, but for the emitted π^0 spectrum	I4
50-53	Same as columns 34-37, but for the emitted π^- spectrum	I4
54	Number of emitted particles for which cross sections are to be calculated** (≤ 9, but usually 9)	I1

---

*See Cascade Code Input, Card 1, columns 13-18.

**If zero, no calculations are performed for the general cascade reactions, but calculations are made for those specific combinations of emitted cascade particles indicated in cards 3 to M. If not zero, cross sections are calculated for the emission of all combinations of cascade particles where the total number of particles in the combination is less than or equal to the number indicated.

Column		Format
55-66	Energy interval, ΔE, in MeV used in calculating $N(E^*)$ for all cascade reactions.*	E12.8
67	Number of specific combinations of emitted cascade particles for which calculations are desired (≤ 9); if a zero is in this column, the cards 3 to M ($M \leq 11$) are omitted	I1

Cards 3, 4, ... M (If column 67 of card 2 is not zero, there should be 1 card in this set for every specific combination of emitted cascade particles desired.)

Column		Format
1	Number of protons in the specific combination**	I1
2	Number of neutrons in the specific combination**	"
3	Number of π^+ in the specific combination**	"
4	Number of π^0 in the specific combination**	"
5	Number of π^- in the specific combination**	"

---

*$N(E^*)$ is the excitation energy distribution of the residual nucleus resulting from the cascade. The energy interval is usually taken to be approximately one-tenth the maximum excitation energy possible. For incident nucleons the maximum excitation energy is the incident kinetic energy plus the binding energy of the incident particle, taken to be 7 MeV. For incident pions the maximum excitation energy is the incident kinetic energy plus the rest mass energy of the pion, about 145 MeV. ΔE, the energy interval, may be specified as small as desired, but the range of values of $N(E^*)$ produced is only from zero to 10 times ΔE.

**Zero must be punched if the number of protons in the specific combination desired is zero. The same is true for the other types of particles. The combinations that can be calculated are limited to those in which the total number of emitted particles is nine or less, i.e., the sum of the numbers punched in columns 1 through 5 must be less than or equal to nine but it must not be zero. The code will not operate if the sum of the numbers is zero.

Column		Format
6-17	Energy interval, ΔE, in MeV used in calculating $N(E^*)$ for this particular combination (usually, same as columns 55-66 of card 2)	E12.8

Card N (If column 54 of card 2 is zero, omit the following cards.)

Column		Format
1-12	Energy interval to be used in constructing a histogram of the energy spectrum of cascade protons emitted with μ from $-0.6 \leq \mu \leq -0.4$* (usually maximum possible energy divided by 10)**	E12.8
13-24	Same as columns 1-12, but for the energy spectrum of cascade neutrons	E12.8
25-36	Same as columns 1-12, but for the energy spectrum of cascade π^+	E12.8
37-48	Same as columns 1-12, but for the energy spectrum of cascade π^0	E12.8
49-60	Same as columns 1-12, but for the energy spectrum of cascade π^-	E12.8

---

* μ = the cosine of the laboratory angle of emission with respect to the incident particle direction.

** The maximum possible kinetic energy for cascade protons or neutrons when incident protons or neutrons are used is the kinetic energy of the incident particle. The same holds true for cascade and incident π mesons. However, the maximum possible kinetic energy of cascade nucleons for incident π mesons is the incident kinetic energy plus the pion rest energy. This situation occurs because pion absorption is allowed inside the nucleus. For the μ intervals indicated in cards N to N+2 the range of the spectrum calculated is from zero to 10 times ΔE. For the μ intervals indicated in cards N+3 and N+4 the range is from zero to 20 times ΔE.

Card N+1

Same columns and formats as Card N for emitted particles with μ from $-0.1 \leq \mu \leq +0.1$. However, the energy intervals may be different. This also applies to the cards below.

Card N+2

Same columns and formats as Card N for emitted particles with μ from $0.4 \leq \mu \leq 0.6$.

Card N+3

Same columns and formats as Card N for emitted particles with μ from $0.9 \leq \mu \leq 0.95$.

Card N+4

Same columns and formats as Card N for emitted particles with μ from $0.95 \leq \mu \leq 1.0$.

Tape Assignments

The Primary Output Tape created by the Cascade Code must be used in running this code. It is referred to as logical tape 2 in the source program and is assigned to B5. The binary output tape* (see section entitled Binary Tapes) has the logical number 8 and is assigned to B8. The BCD input and output tapes should be included with the same assignments they were given in running the Cascade Code.

Trouble Shooting

Listed below are statements printed as a result of various errors, followed by the condition responsible for the error:

---

*This tape is initially supplied by the installation as a "POOL" tape as is the Primary Output Tape for the Cascade Code.

1. A NEGATIVE OR ZERO AMOUNT OF OUTPUT IS BEING REQUESTED

   There is a negative sign in columns 54 or 67 (card 2) or both numbers are zero. The input card in error will be designated by printed output.

2. EITHER RECORD 1 OR RECORD N CANNOT BE READ IN FROM THE PRIMARY TAPE

   Usually machine error. Try again. If statement continues to be printed, information on Primary Output Tape may have been destroyed. Run Cascade Code again.

3. CARD AND PRIMARY TAPE INPUT DO NOT AGREE

   Incident particle on card 2 does not agree with incident particle on Primary Output Tape,* incident energy on card 2 does not agree with incident energy on Primary Output Tape,* number of incident particles on card 2 does not agree with number of incident particles on Primary Output Tape,* or target on card 2 does not agree with target on Primary Output Tape.*

4. No output (this is not a printed statement).

   Possible machine error. Try again.

5. THE NUMBER OF IP (Incident Particle) COLLISIONS AND THE NUMBER OF ESCAPING PARTICLES DO NOT AGREE

   This may be an error in the Cascade Code, or it may be a machine error. Try again. If statement persists, rerun the Cascade Code.

---

*This information is written on the Primary Output Tape from the input cards for the Cascade Code.

6. AN ESCAPING PARTICLE RECORD ON PRIMARY TAPE WILL NOT READ IN

   Program has made 10 attempts to read this record - bad tape. Rerun Cascade Code, using different reel for primary output tape.

7. THE RESIDUAL MOMENTUM IS ZERO

   Try again. If statement persists, rerun Cascade Code, using different random number as input.

8. PRIMARY TAPE WILL NOT READ IN TO CHECK FINAL RECORD

   Same as 6.

9. BACKWARD MOMENTUM FROM ONE OF THE FIRST HISTOGRAMS IS 0*

   This does not stop calculations. The data obtained are legitimate.

Example

The following pages illustrate the input cards needed to run Analysis Code I for a sample case. The case used for an example here is the same as that used for the Cascade Code. Only one file, which is file number one, is to be analyzed (card 1). The number of energy intervals used in constructing the spectra of emitted particles is taken to be 25 for each type of particle except π^-, for which 10 energy intervals are used. Cross sections are calculated for the emission of combinations of particles whose total number in the combination is nine or less.** The energy interval

---

*See page 4 in ORNL-3433 for an explanation of this statement.

**See page 47 for the results of this calculation.

used in constructing the excitation energy distribution for the general cascade reaction is 35 MeV. There are nine specific combinations of emitted cascade particles for which calculations are desired (all of the information above starting from (card 1) is contained on card 2).

The combinations are:

1. One π^- only, and the energy interval desired in constructing the excitation energy distribution is 35 MeV (card 3) (the energy intervals for all combinations were taken to be the same*),
2. One π^0 only (card 4),
3. One proton only (card 5),
4. One proton and one π^- (card 6),
5. One neutron (card 7),
6. One neutron and one π^- (card 8),
7. One proton and one neutron (card 9),
8. One proton, one neutron, and one π^- (card 10),
9. One proton, one neutron, and one π^0 (card 11 or card M).

The energy interval for construction of the energy spectra of emitted cascade protons and neutrons in the angular ranges $-0.6 \leq \mu \leq -0.4$, $-0.1 \leq \mu \leq 0.1$, and $0.4 \leq \mu \leq 0.6$ is taken to be 35 MeV** (cards N, N+1, and N+2). The energy interval for cascade π^+ and π^- is 20 MeV, and for cascade π^0 is 21 MeV. The energy interval for the angular ranges

---

*The energy intervals can be selected to be different from each other.

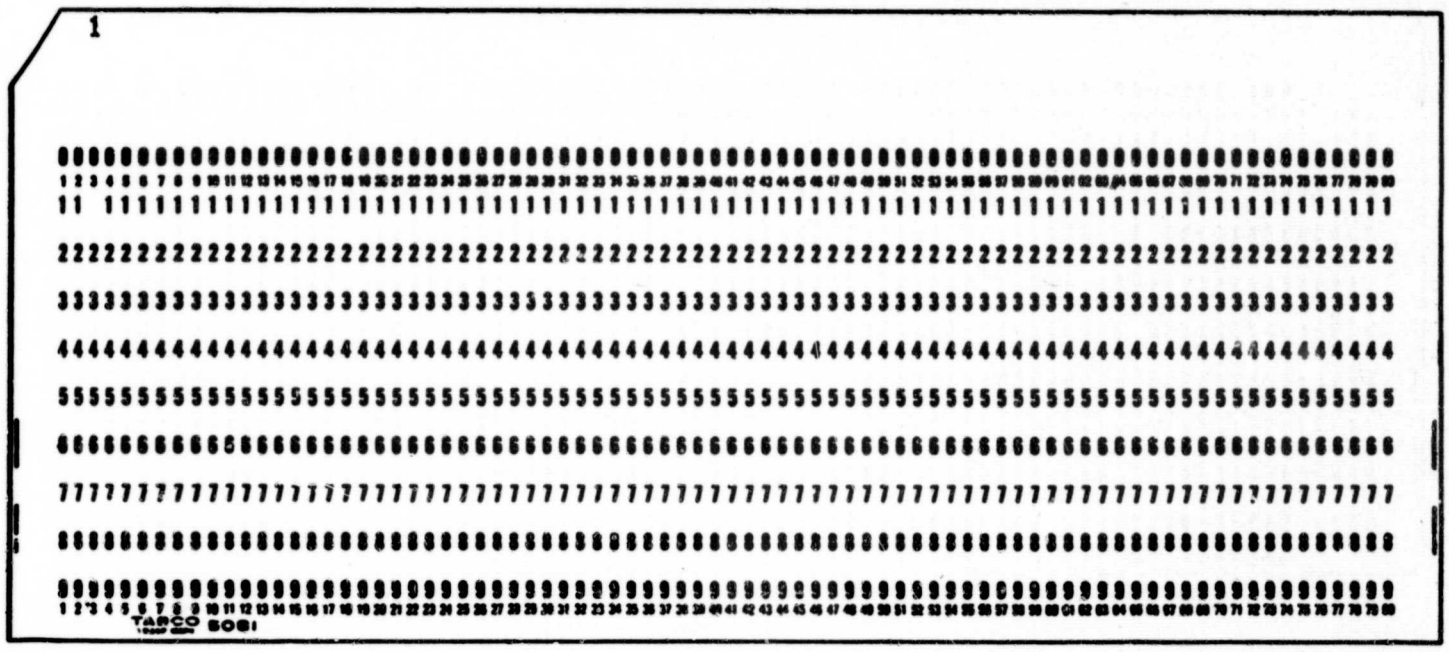
**The energy intervals may be different for each type of emitted particle and each angular interval.

$0.9 \leq \mu \leq 0.95$ and $0.95 \leq \mu \leq 1.0$ is taken to be 17.5 MeV for cascade protons and neutrons (cards N+3 and N+4), for cascade π^+ and π^- it is taken to be 10 MeV, and for cascade π^o it is 10.5 MeV.

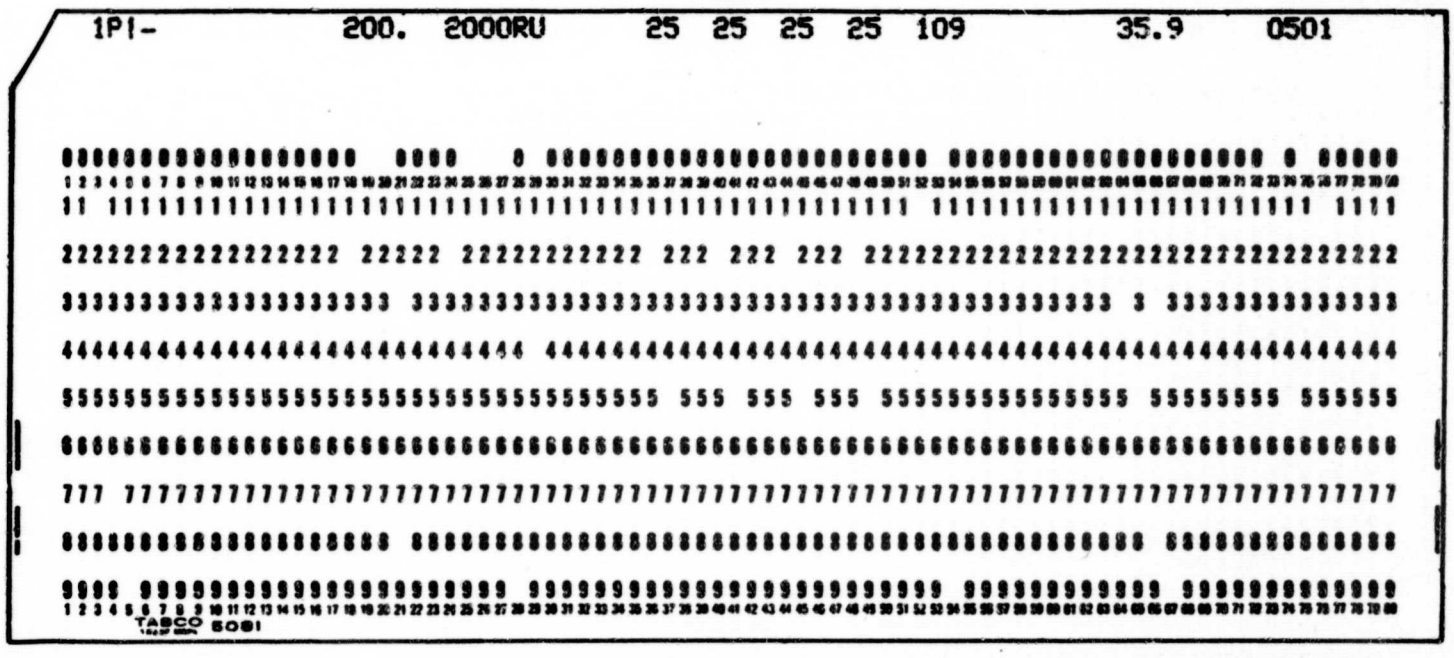
If the user submits an identical case for processing, he should receive the output that is illustrated on pages 37 to 59. The circles, rectangles, underlines, and the words, and numbers in brackets on the pages of printed output illustrated in this manual do not appear on the actual printed output. These marks have been added to provide information about the data stored on the binary tapes. (See section entitled Binary Tapes, page 118 of this manual.)

INPUT CARDS - ANALYSIS CODE I

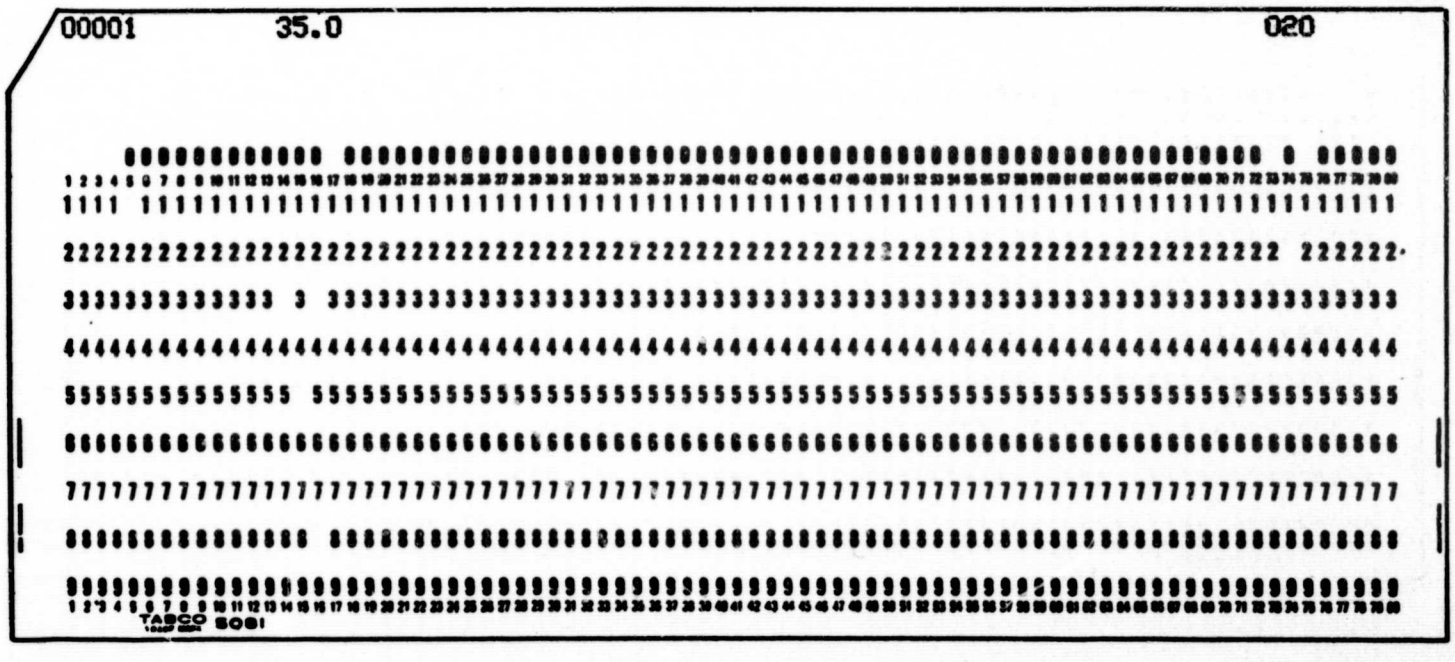
CARD 1



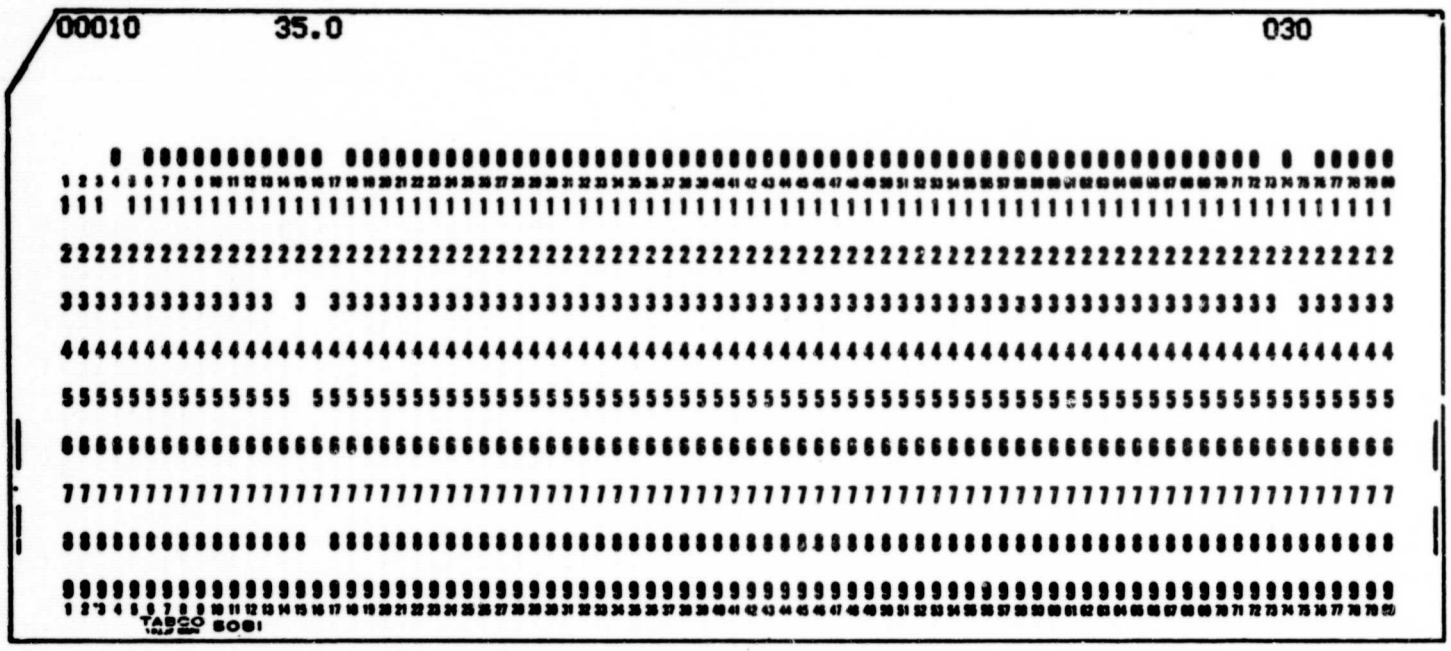
CARD 2



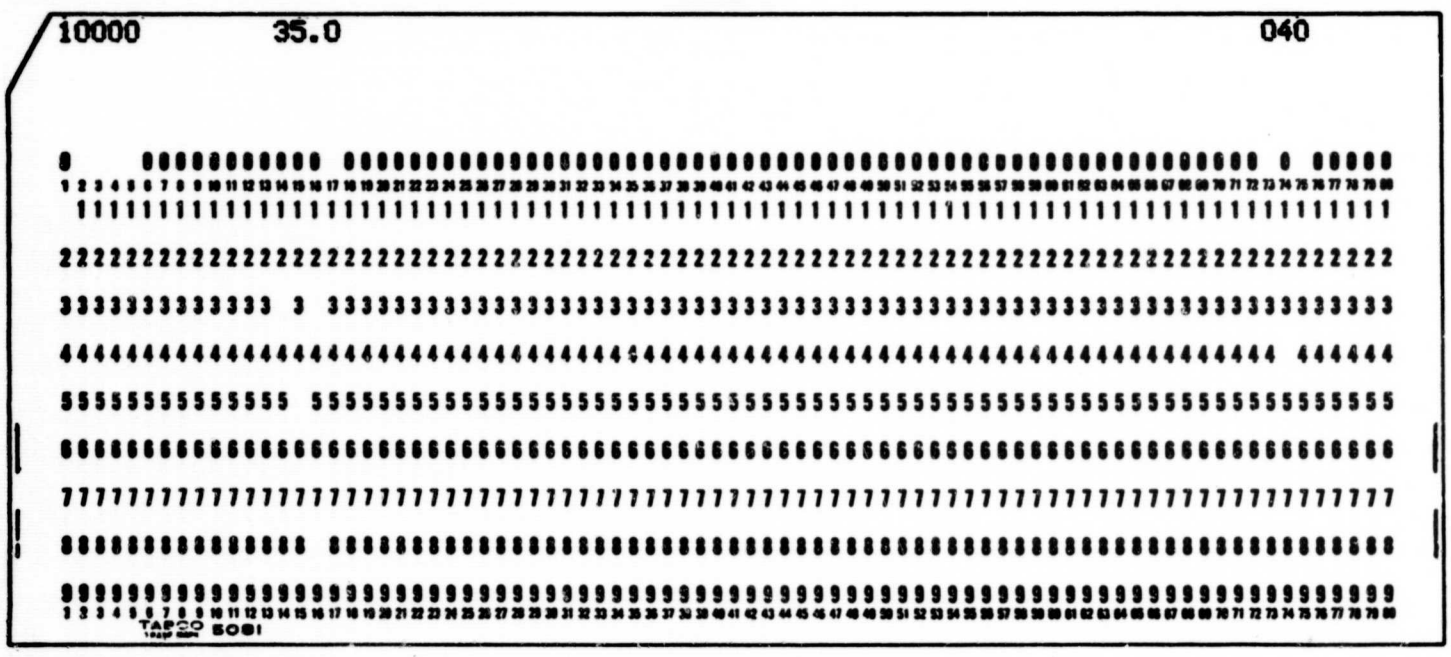
CARD 3



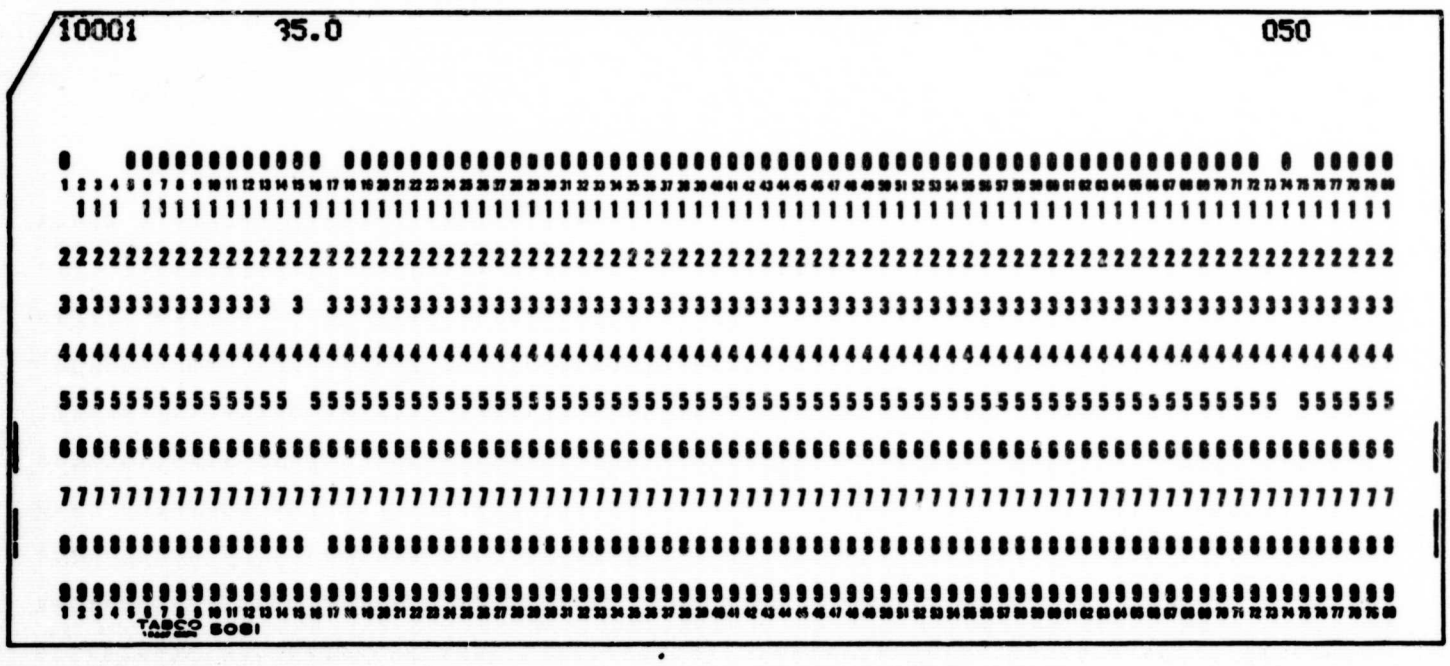
CARD 4



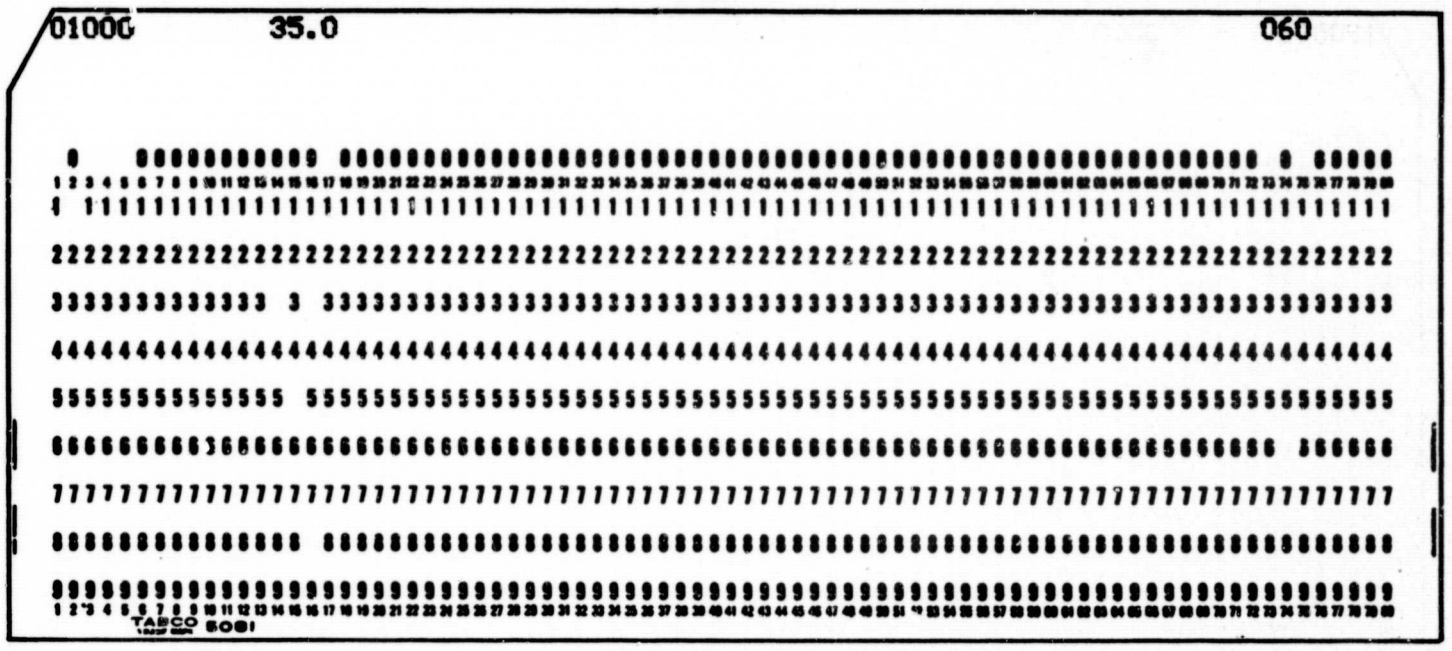
CARD 5



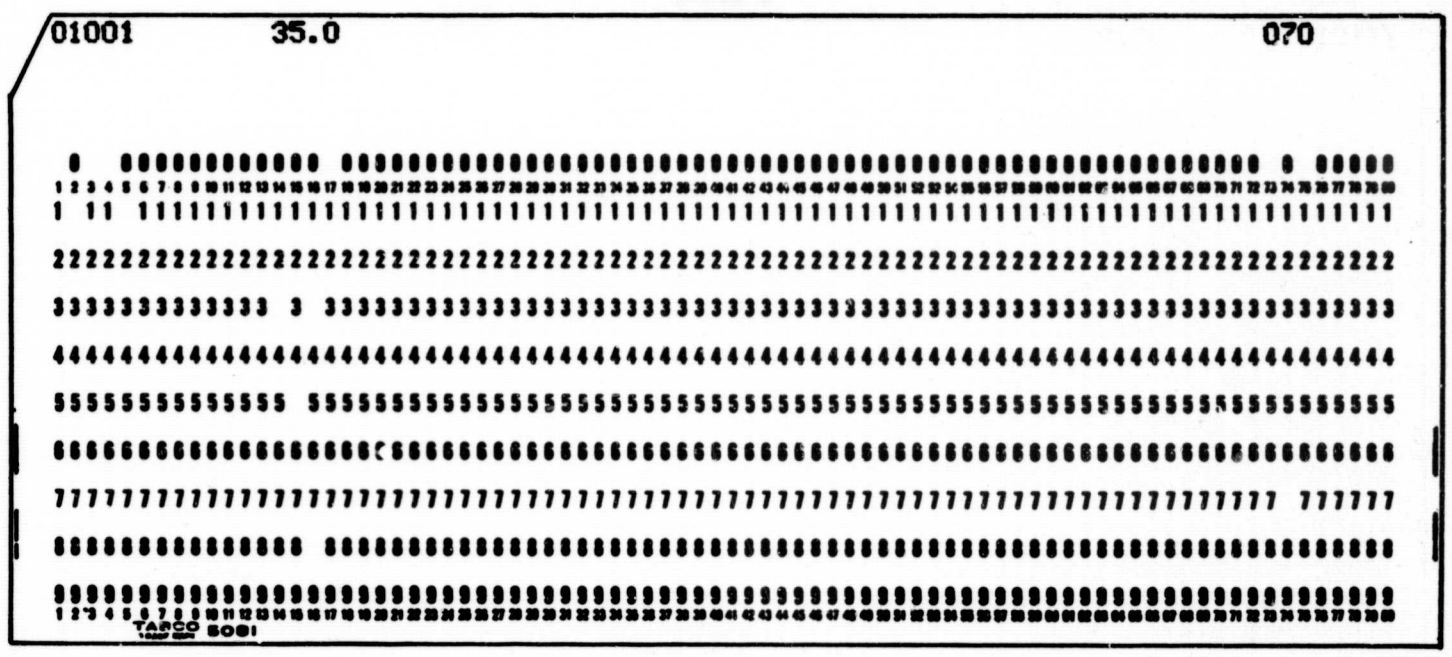
CARD 6



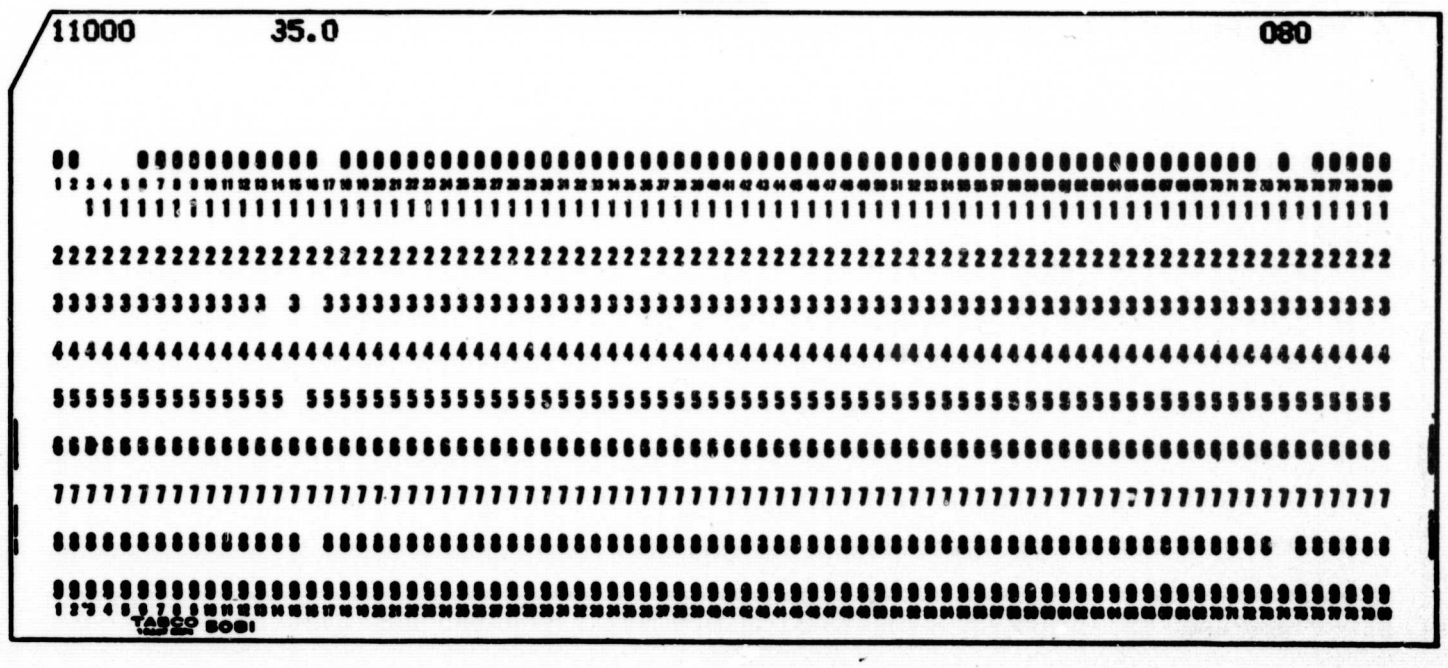
CARD 7



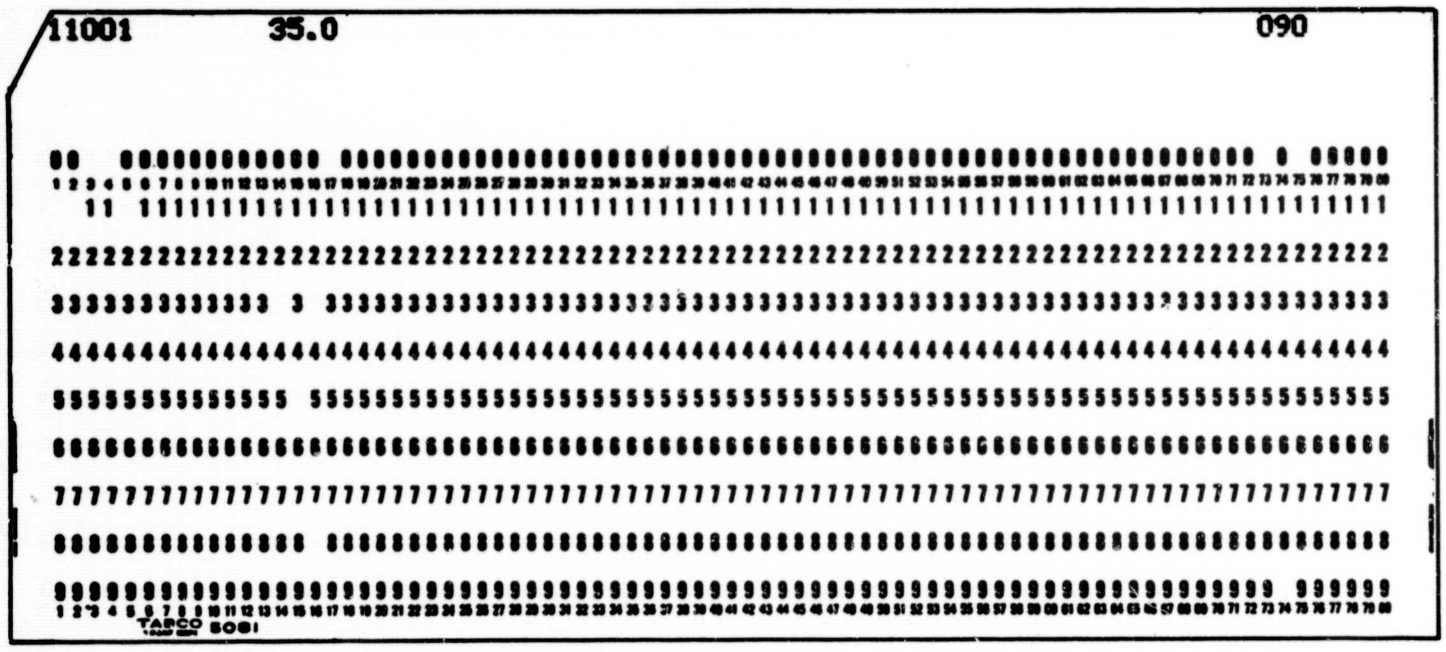
CARD 8



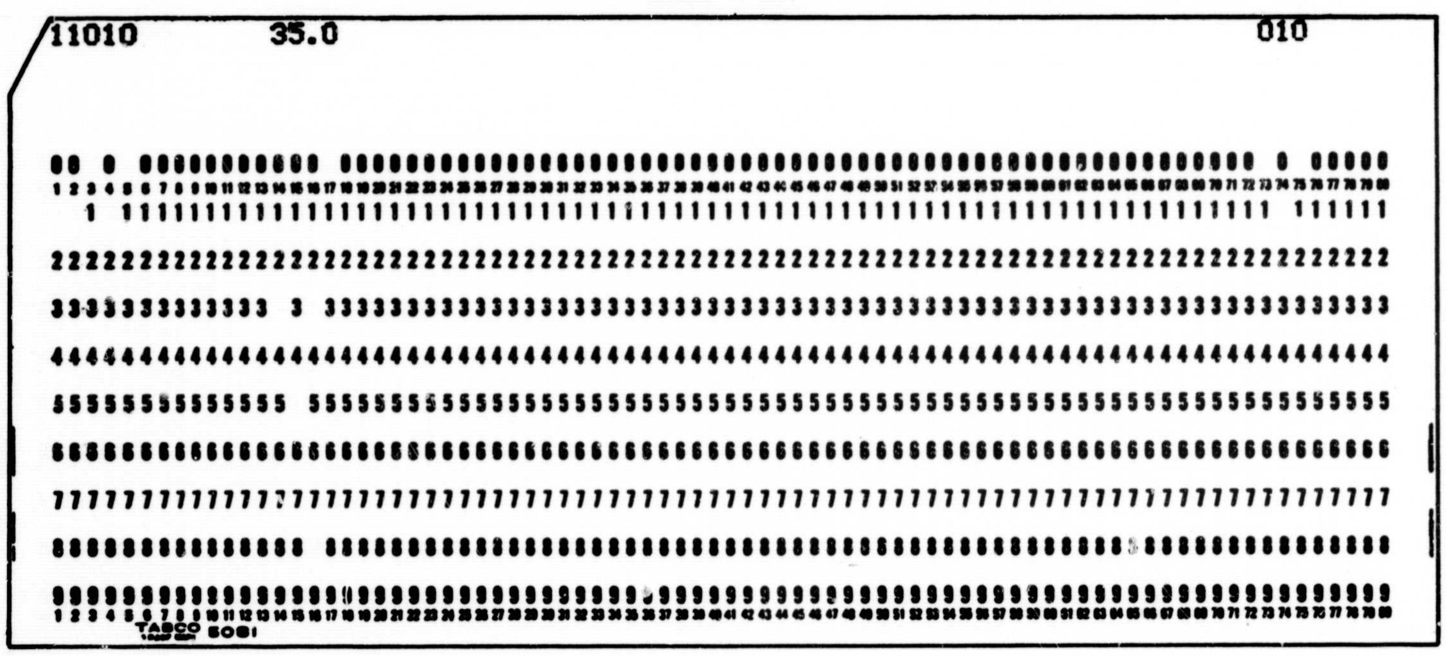
CARD 9



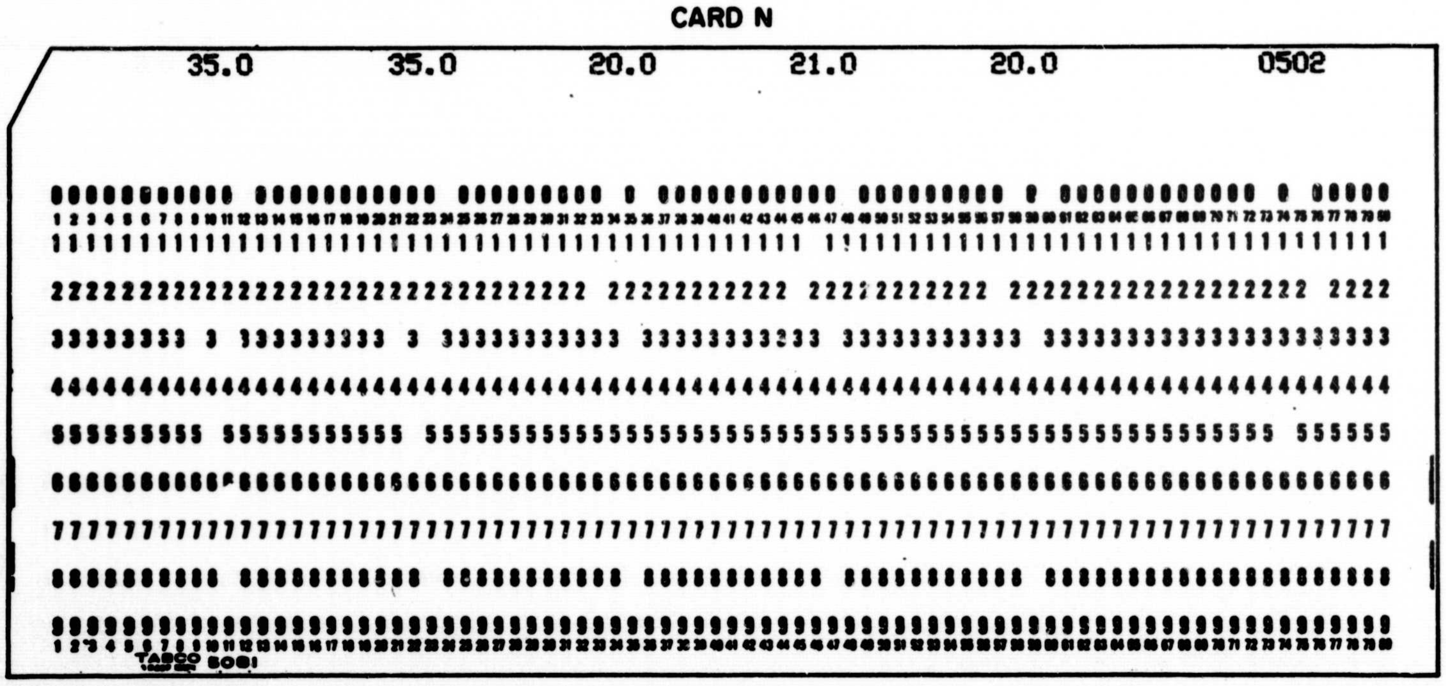
CARD 10



CARD 11 (M)



CARD N



CARD N + 1

35.0	35.0	20.0	21.0	20.0	0503

TABSCO 5081

CARD N+2

35.0	35.0	20.0	21.0	20.0	0504

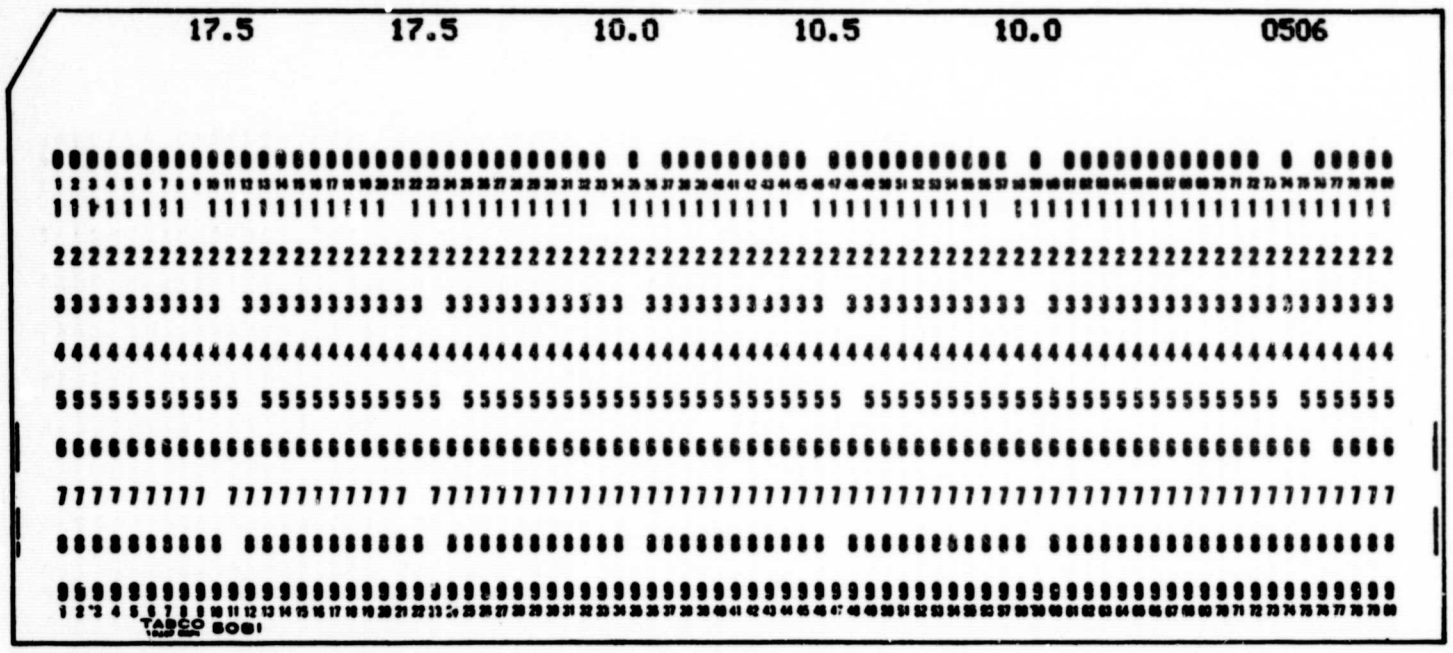
TABSCO 5081

CARD N+3

17.5	17.5	10.0	10.5	10.0	0505

TABSCO 5081

CARD N+4



THE BACKWARD MOMENTUM FROM ONE OF THE FIRST HISTOGRAMS IS 0

[*SEE PAGE 4 IN ORNL-3433 FOR AN EXPLANATION OF THIS STATEMENT*]

NOTE: The circles, rectangles, underlines, and the words, and numbers in brackets on the pages of printed output illustrated in this manual do not appear on the actual printed output. These marks have been added to provide information about the data stored on the binary tapes. (See section entitled Binary Tapes, page 118 of this manual.)

INPUT

[RECORD] [NUMBER OF WORDS IN RECORD]

FROM CARDS

USED FILE (1) INCIDENT PARTICLE [PI-] INCIDENT KINETIC ENERGY 200.000 MEV

TOTAL NUMBER OF INCIDENT PARTICLES (2000) TARGET SYMBOL [RU]

[1] SIZE OF HISTOGRAMS FOR OUTGOING K.E. (25) FOR PROT, (25) FOR NEUT, (25) FOR PI+, (25) FOR PIO, (10) FOR PI-. [13]

CROSS SECTIONS WERE CALCULATED FOR AS MANY AS (9) EMITTED PARTICLE COMBINATIONS.

35.000 MEV INTERVAL WAS USED IN CALCULATING HISTOGRAM FOR N(E•)CE FOR TOTAL REACTION [(✓)]

DELTAS FOR OUTGOING KINETIC ENERGY DISTRIBUTION IN MEV

		-.6 MU -.4 0 (K.E.) 100	-.1 MU +.1 0 (K.E.) 100	+.4 MU +.6 0 (K.E.) 100	+.9 MU +.95 0 (K.E.) 200	+.95 MU +1.0 0 (K.E.) 200	
[2]	PROTONS	35.0000	35.0000	35.0000	17.5000	17.5000	[25]
	NEUTRONS	35.0000	35.0000	35.0000	17.5000	17.5000	
	PI+	20.0000	20.0000	20.0000	10.0000	10.0000	
	PIO	21.0000	21.0000	21.0000	10.5000	10.5000	
	PI-	20.0000	20.0000	20.0000	10.0000	10.0000	

D # DELTA, RESPECTIVE ENERGY INTERVALS OF HISTOGRAMS

[3]	OUTGOING COMBINATIONS	[00001]	[00010]	[10000]	[10001]	[01000]	[01001]	[11000]	[11001]	[11010]	[VARIABLE]
[4]	INTERVAL FOR N(E•)CE IN MEV	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	35.000	[VARIABLE]

FROM RECORD 1

(2000) INCIDENT [PI-] HIT [RU] TARGET WITH 100.000 MASS AND 44.000 ATOMIC NUMBER AT 200.000MEV.

[5] [11]

FROM RECORD N

THERE WERE 1559. INCIDENT PARTICLE COLLISIONS CREATING (1559) ESCAPING PARTICLE RECORDS. THE GEOMETRIC CROSS SECTION WAS 1756.5155487 MB. THE INELASTIC CROSS SECTION WAS 1369.2038574 MB. THE CUT OFF ENERGY WAS 4.2402912 MEV.

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. (2000) INC. HISTORIES 4.2 MEV CUTOFF EN.

[6] MOMENTUM OF COMPOUND NUCLEUS 309.764427MEV/C EXCITATION ENERGY OF COMPOUND NUCLEUS 339.885006MEV [14]

THE MASS OF THE RESIDUAL NUCLEUS WAS ZERO (0) TIMES, WAS MINUS (C) TIMES CUT OFF ENERGY 4.240291MEV

FOR (0) INCIDENT PARTICLE COLLISIONS THERE WERE MORE THAN (9) OUT GOING PARTICLES

[7] [(INV), (IC)] [2]

EMITTED CASCADE PARTICLES

	PROTONS	NEUTRONS	PI+	PI0	PI-
AVERAGE NO.	0.5349583E C0	0.1568954E 01	0.9621552E-02	0.1045542E-00	0.4868505E-03
VARIANCE	0.5451217E C0	0.1258715E C1	0.9528978E-02	C.9362262E-01	0.2498271E-03
AV. K.E. (MEV)	0.4492843E C2	0.5746491E 02	0.5193151E C2	0.8465110E 02	0.8739216E 0_
VARIANCE	0.2348854E C4	0.2766356E C4	0.9326722E 03	0.2231600E 04	0.2507295E 0_

[FL. PT.] [20]

RESIDUAL NUCLEUS [5]

[9] [10]

OUTGOING COMBINATION		CO	CI	ARM	AREE	AAR	
TOTAL CASCADE		0.4023996	0.6628322	292.9540215	75.6642332	97.8960867	
00001	[B.C.D.]	0.5177265	0.5175389	242.1096306	46.9739256	100.0000000	
00010		0.9574312	0.5457834	359.6408730	76.4250746	100.0000000	
10000		-0.0671569	1.0063129	464.6838570	171.3775368	99.0000000	
10001		0.5742939	0.5698C67	282.9036217	57.5822668	99.0000000	
01000		0.7687234	1.3380347	545.2210541	202.0965924	99.0000000	
01001		0.2600221	0.4739242	210.1233521	32.3928051	99.0000000	
11000		0.3737595	0.7548602	319.7263527	101.9162607	98.0000000	
11001		0.4879793	0.5639341	269.1346970	54.4184208	98.0000000	
11010		0.4737962	0.5359121	267.5427589	58.2483826	98.0000000	

[FL. PT.] [FX. PT.] [VARIABLE]

CO # (SUM OF PARALLEL RESIDUAL MOMENTUM/NUMBER OF INCIDENT PARTICLE COLLISIONS)/MOMENTUM OF COMPOUND NUCLEUS

CI # (SUM OF PERPENDICULAR RESIDUAL MOMENTUM/NUMBER OF INCIDENT PARTICLE COLLISIONS)/MOMENTUM OF COMPOUND NUCLEUS

ARM # AVERAGE RESIDUAL MOMENTUM IN MEV/C

AREE # AVERAGE RESIDUAL EXCITATION ENERGY IN MEV

AAR # AVERAGE MASS OF RESIDUAL NUCLEUS FOR TOTAL CASCADE
AAR # MASS OF RESIDUAL NUCLEUS FOR DESIGNATED OUTGOING COMBINATIONS

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. (2000) INC. HISTORIES 4.2 MEV CUTOFF EN.

ANGULAR DISTRIBUTION OF THE CASCADE NUCLEUS (FRACTION IN DELTA MU)/(DELTA MU)

-0.9000000E 00	-0.7000000E 00	-0.5000000E 00	-0.3000000E-00	-0.1000000E-00
0.1000000E-00	0.3000000E-00	0.5000000E 00	0.7000000E 00	0.9000000E 00

TOTAL CASCADE RATIO OF FORWARD /BACKWARD 0.2849383E 01

0.2309173E-00	0.2405388E-00	0.2341244E-00	0.2565747E-00	0.3567543E-00
0.3688262E-00	0.6446440E 00	0.7280308E 00	0.8210391E 00	0.1138550E 01

0 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- RATIO OF FORWARD /BACKWARD 0.

0.	0.	0.	0.	0.
0.1818182E-00	0.1500000E 01	0.1409091E 01	0.8181818E 00	0.1090909E 01

0 PROTONS 0 NEUTRONS 0 PI+ 1 PI0 0 PI- RATIO OF FORWARD /BACKWARD 0.

0.	0.	0.	0.	0.
0.	0.7142857E 00	0.	0.1785714E 01	0.2500000E 01

1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 0 PI- RATIO OF FORWARD /BACKWARD 0.5000000E 00

0.1111111E 01	0.	0.	0.5555556E 00	0.1666667E 01
0.	0.	0.	0.	0.1666667E 01

[11] [VARIABLE]

1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- RATIO OF FORWARD /BACKWARD 0.7375000E 01

0.7462686E-01	0.1492537E-00	0.	0.2238806E-00	0.1492537E-00
0.2238806E-00	0.8208955E 00	0.5970149E 00	0.1044776E 01	0.1716418E 01

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- RATIO OF FORWARD /BACKWARD 0.3000000E 01

0.	0.	0.	0.3125000E-00	0.9375000E 00
0.6250000E 00	0.3125000E-00	0.6250000E 00	0.6250000E 00	0.1562500E 01

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- RATIO OF FORWARD /BACKWARD 0.2082474E 01

0.2842809E-00	0.4515050E-00	0.3177257E-00	0.2508361E-00	0.3177257E-00
0.4849498E-00	0.5016722E 00	0.6688963E 00	0.7859532E 00	0.9364548E 00

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- RATIO OF FORWARD /BACKWARD 0.2386889E 01

0.8196721E-01	0.1639344E-00	0.4098361E-00	0.4098361E-00	0.4098361E-00
0.4918033E-00	0.3278688E-00	0.5737705E 00	0.8196721E 00	0.1311475E 01

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- RATIO OF FORWARD /BACKWARD 0.5142857E 01

0.1162791E-00	0.2325581E-00	0.1162791E-00	0.	0.3488372E-00
0.4069767E-00	0.4651163E-00	0.8720930E 00	0.8139535E 00	0.1627907E 01

1 PROTONS 1 NEUTRONS 0 PI+ 1 PI0 0 PI- RATIO OF FORWARD /BACKWARD 0.3600000E 01

0.2173913E-00	0.2173913E-00	0.4347826E-00	0.	0.2173913E-00
0.4347826E-00	0.4347826E-00	0.6521739E 00	0.6521739E 00	0.1739130E 01

PI- ON RU INC. K.E. (MEV) IS 2CC.0 A IS 1CC. Z IS 44. (2000) INC. HISTORIES 4.2 MEV CUTOFF EN.

EXCITATION ENERGY DISTRIBUTION OF THE CASCADE RESIDUAL NUCLEUS (FRACTION PER UNIT EN.) (DE=DELTA E(MEV))

DEA IS 0.3500000E 02 DEB IS C.35C0000E C2 DEC IS C.3500000E 02 DED IS 0.3500C00E 02 DEE IS 0.3500000E 02
DEF IS 0.3500000E 02 DEG IS 0.3500000E 02 DEH IS 0.3500000E 02 DEI IS 0.3500007E 02 DEJ IS 0.3500000E 02

TOTAL CASCADE (SUM OVER HISTOGRAM)X(DEA) 0.1000000E 01 (0) OFL
0.9786493E-02 0.6157793E-C2 0.4966554E-02 0.2877302E-02 0.2089251E-02
0.1319527E-02 0.7880509E-03 0.3482086E-03 0.1282874E-03 0.1099606E-03

0 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM)X(CEB) 0.1000000E 01 (0) OFL
0.1532468E-01 0.6233766E-C2 0.3636364E-02 0.1298701E-02 0.1818182E-04
0.2597403E-03 0. 0. 0. 0.

0 PROTONS 0 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM)X(DEC) 0.1000000E 01 (0) OFL
0.4081633E-02 0.102C408E-C1 0.6122449E-02 0.6122449E-02 0.2040816E-02
C. 0. 0. 0.

1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM)X(DED) 0.1000000E 01 (0) OFL
0.3174603E-02 0.3174603E-C2 0.6349206E-02 0.3174603E-02 0.
C.3174603E-02 0. 0. 0. 0.9523809E-02

[12] 1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM)X(DEE) 0.1000000E 01 (0) OFL [VARIABLE]
0.1066098E-01 0.8528785E-C2 0.3411514E-02 0.5117271E-02 0.8528785E-04
0. 0. 0. 0. 0.

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM)X(DEF) 0.1000000E 01 (0) OFL
0. 0. 0.1785714E-02 0.7142857E-02 0.3571429E-04
0.5357143E-02 0.1785714E-02 0.3571429E-02 0.1785714E-02 0.3571429E-02

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM)X(DEG) 0.1000000E 01 (0) OFL
0.1853798E-01 0.5446727E-C2 0.3344482E-02 0.1051123E-02 0.1911132E-04
0. 0. 0. 0. 0.

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM)X(DEH) 0.1000000E 01 (0) OFL
0.8430913E-02 0.4215457E-C2 0.5152225E-02 0.1873536E-02 0.2341920E-02
0.1873536E-02 0.2341920E-02 0.1873536E-02 0.4683841E-03 0.

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM)X(DEI) 0.1000000E 01 (0) OFL
0.8970100E-02 0.1029900E-C1 0.6644518E-02 0.2325581E-02 0.3322259E-04
0. 0. 0. 0. 0.

1 PROTONS 1 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM)X(DEJ) 0.1000000E 01 (0) OFL
0.1366460E-01 0.3726708E-C2 0.3726708E-02 0.7453416E-02 0.
0. 0. 0. 0. 0.

DESCRIPTION OF THE FOLLOWING MOMENTUM DISTRIBUTIONS

THE FIRST GROUP OF NUMBERS BELOW THE TITLES SPECIFY THE MIDPOINTS OF THE MOMENTUM INTERVALS.
THE MOMENTUM IS THE NUMBER INDICATED (MEV/C).

THE SUBSEQUENT GROUPS OF NUMBERS ARE THE FRACTION OF THE TOTAL IN EACH INTERVAL DIVIDED BY DELTA P.

PI- ON RU INC. K.E. (MEV) IS 200.0 & IS 100. Z IS 44. (2000) INC. HISTORIES 4.2 MEV CUTOFF EN.

THE MOMENTUM DISTRIBUTION OF THE CASCADE RESIDUAL NUCLEUS

0.3929210E 02 0.1178763E 03 0.1964605E 03 0.2750447E 03 0.3536289E 03 0.4322131E 03 0.5107973E 03
0.5893815E 03 0.6679657E 03 0.7465499E 03 0.8251341E 03 0.9037183E 03 0.9823025E 03 0.1060887E 04

TOTAL CASCADE (SUM OVER HISTOGRAM) (DELTA P) 0.9942271E 00 (9) OFL
0.5599416E-03 0.2205484E-02 0.2102638E-02 0.2022646E-02 0.2182630E-02 0.2136920E-02 0.1851235E-02
0.1725534E-02 0.1051319E-02 0.7884892E-03 0.3999583E-03 0.2971119E-03 0.1828381E-03 0.2056928E-03

0 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 (0) OFL
0.4858714E-03 0.1457614E-02 0.3401100E-02 0.3886971E-02 0.2267400E-02 0.1781529E-02 0.1943486E-02
0.1943486E-02 0.4858714E-03 0.1619571E-03 0. 0. 0. 0.

0 PROTONS 0 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 (0) OFL
0. 0. 0.1272520E-02 0.1272520E-02 0.2545041E-02 0.2545041E-02 0.1272520E-02
0.5090081E-02 0.2545041E-02 0.1272520E-02 0. 0. 0. 0.

1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 (0) OFL
0. 0. 0. 0. 0.3958952E-02 0. 0.
0.5938428E-02 0. 0.1979476E-02 0.3958952E-02 0. 0.1979476E-02 0.

[13] 1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 (0) OFL [VARIABLE]
0.2658998E-03 0.1861298E-02 0.1063599E-02 0.2924898E-02 0.1329499E-02 0.4254396E-02 0.3456697E-02
0.1063599E-02 0.1063599E-02 0.5317996E-03 0. 0. 0. 0.

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.9375000E 00 (1) OFL
0. 0. 0. 0. 0. 0.1113455E-02 0.3340366E-02
0.1113455E-02 0. 0.3340366E-02 0.4453821E-02 0.1113455E-02 0.1113455E-02 0.1113455E-02

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 (0) OFL
0.1191658E-02 0.5362460E-02 0.2025818E-02 0.2025818E-02 0.1847070E-02 0.1906653E-02 0.1072492E-02
0.1191658E-02 0.5958289E-03 0.4170803E-03 0.5958289E-04 0.5958289E-04 0. 0.5958289E-04

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.9836066E 00 (1) OFL
0.1168215E-02 0.1752323E-02 0.2628485E-02 0.1460269E-02 0.1460269E-02 0.1460269E-02 0.2044377E-02
0.8761616E-03 0.1460269E-02 0.1168215E-02 0.8761616E-03 0.2920538E-03 0.2920538E-03 0.5841077E-03

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 (0) OFL
0.2071545E-03 0.1242927E-02 0.2900163E-02 0.2900163E-02 0.2693008E-02 0.2693008E-02 0.2278699E-02
0.1242927E-02 0.6214634E-03 0.4143090E-03 0.6214634E-03 0. 0. 0.

1 PROTONS 1 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 (0) OFL
0.7745776E-03 0.7745776E-03 0.2323733E-02 0.4647466E-02 0. 0.3872888E-02 0.2323733E-02
0.2323733E-02 0. 0.7745776E-03 0. 0. 0. 0.

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF E..

THE PERPENDICULAR MOMENTUM DISTRIBUTION OF THE CASCADE RESIDUAL NUCLEUS

0.3929216E 02 0.1178763E 03 0.1964656E 03 0.2750447E 03 0.3536289E 03 0.4322131E 03 0.5107973E 03
0.5893815E 03 0.6679657E 03 0.7465499E 03 0.8251341E 03 0.9037183E 03 0.9823025E 03 0.1060887E 04

TOTAL CASCADE (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0.1806685E-02 0.3041634E-02 0.3361856E-02 0.2835809E-02 0.2389855E-02 0.1566556E-02 0.9719507E-03
0.9490813E-03 0.2858679E-03 0.2973026E-03 0.1715207E-03 0.6860829E-04 0.5717357E-04 0.1143471E-04

0 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0.8097857E-03 0.2429357E-02 0.5992414E-02 0.6154371E-02 0.2429357E-02 0. 0.
0. 0. 0. 0. 0. 0. 0.

0 PROTONS 0 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0.1272520E-02 0.1272520E-02 0.5090081E-02 0.6362602E-02 0.3817561E-02 0. 0.
0. 0. 0. 0. 0. 0. 0.

1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0. 0.3958952E-02 0.5938428E-02 0. 0. 0. 0.
0.1979476E-02 0. 0.1979476E-02 0.1979476E-02 0. 0.1979476E-02 0.

[14] 1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL [VARIABLE]
0.2393098E-02 0.2924898E-02 0.2924898E-02 0.3456697E-02 0.2658998E-02 0.2658998E-02 0.7976993E-03
0. 0. 0. 0. 0. 0. 0.

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0. 0. 0.2226911E-02 0. 0.1113455E-02 0.3340366E-02 0.2226911E-02
0. 0.1113455E-02 0.4453821E-02 0.2226911E-02 0.1113455E-02 0. 0.

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0.3455808E-02 0.5362460E-02 0.2264150E-02 0.2919562E-02 0.1608738E-02 0.1310824E-02 0.5362460E-03
0.2979145E-03 0. 0.5958289E-04 0. 0. 0. 0.

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0.2044377E-02 0.2336431E-02 0.3796700E-02 0.8761616E-03 0.3504646E-02 0.8761616E-03 0.1460269E-02
0.5841077E-03 0.5841077E-03 0.5841077E-03 0.8761616E-03 0.2920538E-03 0. 0.

1 PROTONS 1 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0.1450081E-02 0.2485854E-02 0.5178862E-02 0.4143090E-02 0.2278699E-02 0.1242927E-02 0.6214634E-03
0.4143090E-03 0. 0. 0. 0. 0. 0.

1 PROTONS 1 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM)(DELTA P) 0.1000000E 01 0 OFL
0.3098310E-02 0.2323733E-02 0.3872888E-02 0.4647466E-02 0.7745776E-03 0.2323733E-02 0.
0.7745776E-03 0. 0. 0. 0. 0. 0.

[SAME SELECTION OF WORDS FOR BINARY TAPE AND SAME FORMATS AS RECORD 13]

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

THE PARALLEL MOMENTUM DISTRIBUTION OF THE CASCADE RESIDUAL NUCLEUS

-0.1060887E 04 -0.9823025E 03 -0.9037183E 03 -0.8251341E 03 -0.7465499E 03 -0.6679657E 03 -0.5893815E 03
-0.5107973E 03 -0.4322131E 03 -0.3536289E 03 -0.2750447E 03 -0.1964605E 03 -0.1178763E 03 -0.3929210E 02
0.3929210E 02 0.1178763E 03 0.1964605E 03 0.2750447E 03 0.3536289E 03 0.4322131E 03 0.5107973E 03
0.5893815E 03 0.6679657E 03 0.7465499E 03 0.8251341E 03 0.9037183E 03 0.9823025E 03 0.1060887E 04

TOTAL CASCADE (SUM OVER HISTOGRAM) (DELTA P) 0.9987171E 00 2 OFL 0 UFL
0. 0. 0. 0. 0. 0.3428214E-04 0.
0.1257012E-03 0.1485559E-03 0.1714107E-03 0.3771035E-03 0.6170785E-03 0.1268439E-02 0.1896945E-02
0.2616870E-02 0.2308331E-02 0.1588606E-02 0.1508414E-02 0.1359858E-02 0.1017037E-02 0.1074174E-02
0.6856428E-03 0.4228131E-03 0.2285476E-03 0.1257012E-03 0.9141904E-04 0.1028464E-03 0.2285476E-04

0 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0.
0.4534800E-02 0.4696757E-02 0.1943486E-02 0.1619571E-02 0.9717428E-03 0.9717428E-03 0.2105443E-02
0.6478286E-03 0.1619571E-03 0.1619571E-03 0. 0. 0. 0.

0 PROTONS 0 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0.
0.1272520E-02 0.1272520E-02 0. 0.5090081E-02 0.1272520E-02 0. 0.2545041E-02
0.5090081E-02 0. 0.1272520E-02 0. 0. 0. 0.

1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0.1979476E-02 0.
0.1979476E-02 0. 0. 0. 0.1979476E-02 0. 0. 0.5938428E-02
0. 0. 0. 0. 0.3958952E-02 0. 0. 0.
0.1979476E-02 0. 0. 0. 0. 0. 0.

1 PROTONS 0 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0.2658998E-03 0.5317996E-03 0.1329499E-02
0.2127198E-02 0.2658998E-02 0.1861298E-02 0.2127198E-02 0.1861298E-02 0.1861298E-02 0.2127198E-02
0.2658998E-03 0.5317996E-03 0.2658998E-03 0. 0. 0. 0.

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0.3340366E-02 0.1113455E-02
0.1113455E-02 0.1113455E-02 0.1113455E-02 0. 0.2226911E-02 0.2226911F-02 0.1113455E-02
0. 0.1113455E-02 0.1113455E-02 0.1113455E-02 0. 0. 0.1113455E-02

[SAME SELECTION OF WORDS FOR BINARY TAPE AND SAME FORMATS AS RECORD 13]

[15] [VARIABLE]

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

THE PARALLEL MOMENTUM DISTRIBUTION OF THE CASCADE RESIDUAL NUCLEUS

-0.1060887E 04 -0.9823025E 03 -0.9037183E 03 -0.8251341E 03 -0.7465499E 03 -0.6679657E 03 -0.5893815E 03
-0.5107973E 03 -0.4322131E 03 -0.3536289E 03 -0.2750447E 03 -0.1964605E 03 -0.1178763E 03 -0.3929210E 02
0.3929210E 02 0.1178763E 03 0.1964605E 03 0.2750447E 03 0.3536289E 03 0.4322131E 03 0.5107973E 03
0.5893815E 03 0.6679657E 03 0.7465499E 03 0.8251341E 03 0.9037183E 03 0.9823025E 03 0.1060887E 04

TOTAL CASCADE (SUM OVER HISTOGRAM) (DELTA P) 0.9987171E 00 2 OFL 0 UFL
0. 0. 0. 0. 0. 0.3428214E-04 0.
0.1257012E-03 0.1485559E-03 0.1714107E-03 0.3771035E-03 0.6170785E-03 0.1268439E-02 0.1896945E-02
0.2616870E-02 0.2308331E-02 0.1588406E-02 0.1508414E-02 0.1359858E-02 0.1017037E-02 0.1074174E-02
0.6856428E-03 0.4228131E-03 0.2285476E-03 0.1257012E-03 0.9141904E-04 0.1028464E-03 0.2285476E-04

0 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0.5958289E-04 0.2979145E-03 0.8937434E-03 0.1727904E-02 0.2800396E-02
0.3813305E-02 0.2442899E-02 0.1608738E-02 0.1072492E-02 0.5958289E-03 0.7149947E-03 0.8341605E-03
0.5958289E-03 0.1191658E-03 0.1191658E-03 0. 0.5958289E-04 0. 0.5958289E-04

[16] [VARIABLE]

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0.2920538E-03 0.2920538E-03 0. 0.5841077E-03 0.2920538E-03 0.2044377E-02 0.1752323E-02
0.3796700E-02 0.8761616E-03 0.2336431E-02 0.2920538E-03 0.8761616E-03 0.1168215E-02 0.8761616E-03
0.1168215E-02 0.2920538E-03 0. 0.5841077E-03 0. 0.2920538E-03 0.

1 PROTONS 1 NEUTRONS 0 PI+ 0 PI0 1 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0.2071545E-03 0.6214634E-03 0.6214634E-03 0.1450081E-02
0.2693008E-02 0.3314472E-02 0.1242927E-02 0.1450081E-02 0.2278699E-02 0.1242927E-02 0.1657236E-02
0. 0.8286179E-03 0. 0.2071545E-03 0. 0. 0.

1 PROTONS 1 NEUTRONS 0 PI+ 1 PI0 0 PI- (SUM OVER HISTOGRAM) (DELTA P) 0.1000000E 01 0 OFL 0 UFL
0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0.7745776E-03 0.7745776E-03 0.7745776E-03 0.1549155E-02
0.2323733E-02 0.7745776E-03 0.1549155E-02 0.2323733E-02 0.3098310E-02 0.1549155E-02 0.1549155E-02
0.7745776E-03 0. 0. 0. 0. 0. 0.

[SAME SELECTION OF WORDS FOR BINARY TAPE AND SAME FORMATS AS RECORD 13]

[17] [KEY 5] [1]

[18] [AIZ] [1]

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. (2000) INC. HISTORIES 4.2 MEV CUTOFF EN.

CROSS SECTIONS (MB) FOR VARIOUS COMBINATIONS OF EMITTED CASCADE PARTICLES
1ST NO. IS NO. OF PROTONS EMITTED 2ND IS NO. OF NEUTRONS 3RD IS NO. OF PI+ 4TH IS NO. OF PI0 5TH IS NO. OF PI-

[19] [B.C.D.] [FL. PT.]

44000	0.87825776E 00
43000	0.87825776E 00
24000	0.70260620E 01
04001	0.43912887E 01
13010	0.87825776E 00
22010	0.87825776E 00
03001	0.20199928E 02
12001	0.32495537E 02
21001	0.61478042E 01
31000	0.61478042E 01
11001	0.75530166E 02
20001	0.12295608E 02
01001	0.26259907E 03
10001	0.58843269E 02
00001	0.96608353E 02
10000	0.79043198E 01

[B.C.D.] [FL. PT.]

16000	0.87825776E 00
0501C	0.87825776E 00
32001	0.87825776E 00
0401C	0.87825776E 00
1310C	0.87825776E 00
23000	0.14930382E 02
0301C	0.26347732E 01
1201C	0.87825774E 01
2101C	0.35130310E 01
02001	0.90460548E 02
1101C	0.20199928E 02
2001C	0.35130310E 01
0101C	0.61478043E 02
10010	0.43912887E 01
0001C	0.12295608E 02
0000C	0.87825776E 00

[B.C.D.] [FL. PT.]

25000	0.87825776E 00
06000	0.17565155E 01
33000	0.26347732E 01
05000	0.10539093E 02
14000	0.20199928E 02
31001	0.87825776E 00
03100	0.17565155E 01
12100	0.87825776E 00
22000	0.35130310E 02
02010	0.22834701E 02
11100	0.35130310E 01
21000	0.26347733E 02
01100	0.35130310E 01
11000	0.53573722E 02
00100	0.26347732E 01

[B.C.D.] [FL. PT.] [VARIABLE]

34000	0.17565155E 01
15000	0.35130310E 01
42000	0.87825776E 00
13001	0.35130310E 01
22001	0.87825776E 00
32000	0.96608352E 01
04000	0.31617279E 02
13000	0.49182434E 02
30001	0.87825776E 00
03000	0.69382362E 0_
12000	0.73773651E 02
30000	0.87825776E 00
02000	0.96608353E 02
20000	0.43912887E 01
01000	0.14052124E 0_

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. (2000) INC. HISTORIES 4.2 MEV CUTOFF EN.

ENERGY SPECTRA OF CASCADE PARTICLES WITH MU FROM 1.00 TO 0.75
(THETA FROM (0) DEG. (0) MIN. TO (18) DEG. (2) MIN.)

[20] N(E) IS (FRACTION OF PARTICLES IN DELTA MU)/(DELTA MU)(DELTA E) [10]

E(MEV) IS CENTER OF INTERVAL N IS (SUM OVER N(E))(DELTA MU)(DELTA E)

PROTONS DELTA E(MEV) 17.5		NEUTRONS DELTA E(MEV) 17.5		PI+ DELTA E(MEV) 10.0		PIO DELTA E(MEV) 10.5		PI- DELTA E(MEV) 10.0	
E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)
8.7	0.389E-00	8.7	0.176E-00	5.0	0.	5.2	0.	5.0	0.
26.2	0.973E-01	26.2	0.849E-01	15.0	0.200E 01	15.7	0.	15.0	0.
43.7	0.146E-00	43.7	0.522E-01	25.0	0.	26.2	0.	25.0	0.
61.2	0.122E-00	61.2	0.653E-01	35.0	0.	36.7	0.	35.0	0.154E-00
78.7	0.729E-01	78.7	0.718E-01	45.0	0.	47.2	0.	45.0	0.
96.2	0.146E-00	96.2	0.202E-00	55.0	0.	57.7	0.190E 01	55.0	0.154E-00
113.7	0.243E-01	113.7	0.176E-00	65.0	0.	68.2	0.	65.0	0.
131.2	0.486E-01	131.2	0.176E-00	75.0	0.	78.7	0.	75.0	0.308E-00
148.7	0.486E-01	148.7	0.392E-01	85.0	0.	89.2	0.	85.0	0.
166.2	0.	166.2	0.196E-01	95.0	0.	99.7	0.	95.0	0.
[21] 183.7	0.	183.7	0.131E-01	105.0	0.	110.2	0.	105.0	0.
201.2	0.	201.2	0.653E-02	115.0	0.	120.7	0.	115.0	0.
218.7	0.	218.7	0.261E-01	125.0	0.	131.2	0.	125.0	0.
236.2	0.243E-01	236.2	0.131E-01	135.0	0.	141.7	0.	135.0	0.
253.7	0.	253.7	0.653E-02	145.0	0.	152.2	0.	145.0	0.
271.2	0.	271.2	0.131E-01	155.0	0.	162.7	0.	155.0	0.
288.7	0.	288.7	0.	165.0	0.	173.2	0.	165.0	0.
306.2	0.243E-01	306.2	0.	175.0	0.	183.7	0.	175.0	0.
323.7	0.	323.7	0.	185.0	0.	194.2	0.	185.0	0.308E-00
341.2	0.	341.2	0.	195.0	0.	204.7	0.	195.0	0.108E 01
[FL. PT.]		[FL. PT.]		[FL. PT.]		[FL. PT.]		[FL. PT.] [205]	
N IS	1.000E 00	N IS	1.000E 00	N IS	0.100E 01	N IS	1.000E 00	N IS	1.000E 00

[RECORDS 22, 24, 26, AND 28 HAVE THE SAME SELECTION OF WORDS FOR THE BINARY TAPE AND THE SAME FORMATS AS RECORD 20]
[RECORDS 23, 25, 27, AND 29 HAVE THE SAME SELECTION OF WORDS FOR THE BINARY TAPE AND THE SAME FORMATS AS RECORD 21]

PI- ON RU INC. K.E. (MEV) IS 200.7 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

ENERGY SPECTRA OF CASCADE PARTICLES WITH MU FROM 0.95 TO 0.90
(THETA FROM 18 DEG. 12 MIN. TO 25 DEG. 51 MIN.)

[22] N(E) IS (FRACTION OF PARTICLES IN DELTA MU)/(DELTA MU)(DELTA E) [10]

E(MEV) IS CENTER OF INTERVAL N IS (SUM OVER N(E))(DELTA MU)(DELTA E)

PROTONS DELTA E(MEV) 17.5		NEUTRONS DELTA E(MEV) 17.5		PI+ DELTA E(MEV) 10.0		PI0 DELTA E(MEV) 10.5		PI- DELTA E(MEV) 10.0	
E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)
8.7	0.406E-00	8.7	0.225E-00	5.0	0.	5.2	0.	5.0	0.909E-01
26.2	0.258E-00	26.2	0.885E-01	15.0	0.	15.7	0.	15.0	0.
43.7	0.369E-01	43.7	0.129E-00	25.0	0.	26.2	0.	25.0	0.
61.2	0.737E-01	61.2	0.644E-01	35.0	0.	36.7	0.	35.0	0.909E-01
78.7	0.369E-01	78.7	0.193E-00	45.0	0.	47.2	0.	45.0	0.182E-00
96.2	0.369E-01	96.2	0.161E-00	55.0	0.200E 01	57.7	0.	55.0	0.909E-01
113.7	0.147E-00	113.7	0.137E-00	65.0	0.	68.2	0.	65.0	0.909E-01
131.2	0.737E-01	131.2	0.563E-01	75.0	0.	78.7	0.	75.0	0.
148.7	0.	148.7	0.161E-01	85.0	0.	89.2	0.	85.0	0.
166.2	0.369E-01	166.2	0.322E-01	95.0	0.	99.7	0.	95.0	0.
[23] 183.7	0.	183.7	0.805E-02	105.0	0.	110.2	0.	105.0	0. [205]
201.2	0.	201.2	0.	115.0	0.	120.7	0.	115.0	0.
218.7	0.	218.7	0.	125.0	0.	131.2	0.	125.0	0.
236.2	0.	236.2	0.805E-02	135.0	0.	141.7	0.	135.0	0.
253.7	0.	253.7	0.805E-02	145.0	0.	152.2	0.	145.0	0.
271.2	0.369E-01	271.2	0.805E-02	155.0	0.	162.7	0.	155.0	0.
288.7	0.	288.7	0.805E-02	165.0	0.	173.2	0.	165.0	0.909E-01
306.2	0.	306.2	0.	175.0	0.	183.7	0.	175.0	0.182E-00
323.7	0.	323.7	0.	185.0	0.	194.2	0.190E 01	185.0	0.727E 00
341.2	0.	341.2	0.	195.0	0.	204.7	0.	195.0	0.455E-00
N IS	1.000E 00	N IS	1.000E 00	N IS	0.100E 01	N IS	1.000E 00	N IS	1.000E 00

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

ENERGY SPECTRA OF CASCADE PARTICLES WITH MU FROM 0.60 TO 0.40
(THETA FROM 53 DEG. 8 MIN. TO 66 DEG. 25 MIN.)

[24] N(E) IS (FRACTION OF PARTICLES IN DELTA MU)/(DELTA MU)(DELTA E) [10]

E(MEV) IS CENTER OF INTERVAL N IS (SUM OVER N(E))(DELTA MU)(DELTA E)

PROTONS DELTA E(MEV) 35.0		NEUTRONS DELTA E(MEV) 35.0		PI+ DELTA E(MEV) 20.0		PI0 DELTA E(MEV) 21.0		PI- DELTA E(MEV) 20.0	
E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)
17.5	0.939E-01	17.5	0.770E-01	10.0	0.	10.5	0.	10.0	0.245E-01
52.5	0.238E-01	52.5	0.327E-01	30.0	0.	31.5	0.397E-01	30.0	0.980E-02
87.5	0.119E-01	87.5	0.112E-01	50.0	0.	52.5	0.	50.0	0.490E-01
122.5	0.397E-02	122.5	0.103E-01	70.0	0.	73.5	0.198E-01	70.0	0.980E-02
157.5	0.397E-02	157.5	0.403E-02	90.0	0.	94.5	0.198E-01	90.0	0.
[25] 192.5	0.132E-02	192.5	0.627E-02	110.0	0.	115.5	0.198E-01	110.0	0.980E-02 [105]
227.5	0.265E-02	227.5	0.134E-02	130.0	0.	136.5	0.595E-01	130.0	0.245E-01
262.5	0.132E-02	262.5	0.	150.0	0.	157.5	0.397E-01	150.0	0.735E-01
297.5	0.	297.5	0.	170.0	0.	178.5	0.397E-01	170.0	0.441E-01
332.5	0.	332.5	0.	190.0	0.	199.5	0.	190.0	0.490E-02
N IS	1.000E 00	N IS	1.000E 00	N IS	0.	N IS	1.000E 00	N IS	1.000E 00

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

ENERGY SPECTRA OF CASCADE PARTICLES WITH MU FROM 0.10 TO -0.10
(THETA FROM 84 DEG. 16 MIN. TO 95 DEG. 44 MIN.)

[26] N(E) IS (FRACTION OF PARTICLES IN DELTA MU)/(DELTA MU)(DELTA E) [19]

E(MEV) IS CENTER OF INTERVAL N IS (SUM OVER N(E))(DELTA MU)(DELTA E)

PROTONS DELTA E(MEV) 35.0		NEUTRONS DELTA E(MEV) 35.0		PI+ DELTA E(MEV) 20.0		PIO DELTA E(MEV) 21.0		PI- DELTA E(MEV) 20.0	
E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)
17.5	0.978E-01	17.5	0.764E-01	10.0	0.	10.5	0.198E-01	10.0	0.[illegible]
52.5	0.196E-01	52.5	0.264E-01	30.0	0.	31.5	0.198E-01	30.0	0.[illegible]
87.5	0.137E-01	87.5	0.129E-01	50.0	0.	52.5	0.	50.0	0.492E-01
122.5	0.587E-02	122.5	0.179E-01	70.0	0.	73.5	0.	70.0	0.455E-01
157.5	0.587E-02	157.5	0.643E-02	90.0	0.	94.5	0.	90.0	0.303E-01
[27] 192.5	0.	192.5	0.214E-02	110.0	0.	115.5	0.794E-01	110.0	0.379E-01 [105]
227.5	0.	227.5	0.714E-03	130.0	0.	136.5	0.992E-01	130.0	0.265E-01
262.5	0.	262.5	0.	150.0	0.	157.5	0.198E-01	150.0	0.152E-01
297.5	0.	297.5	0.	170.0	0.	178.5	0.	170.0	0.
332.5	0.	332.5	0.	190.0	0.	199.5	0.	190.0	0.
N IS 1.000E 00		N IS 1.000E 00		N IS 0.		N IS 1.000E 00		N IS 1.000E 00	

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

ENERGY SPECTRA OF CASCADE PARTICLES WITH MU FROM -0.40 TO -0.60
(THETA FROM 113 DEG. 35 MIN. TO 126 DEG. 54 MIN.)

[28] N(E) IS (FRACTION OF PARTICLES IN DELTA MU)/(DELTA MU)(DELTA E) [10]

E(MEV) IS CENTER OF INTERVAL N IS (SUM OVER N(E))(DELTA MU)(DELTA E)

PROTONS DELTA E(MEV) 35.0		NEUTRONS DELTA E(MEV) 35.0		PI+ DELTA E(MEV) 20.0		PIO DELTA E(MEV) 21.0		PI- DELTA E(MEV) 20.0	
E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)	E(MEV)	N(E)
17.5	0.698E-01	17.5	0.780E-01	10.0	0.	10.5	0.255E-01	10.0	0.132E-01
52.5	0.399E-01	52.5	0.357E-01	30.0	0.125E-00	31.5	0.170E-01	30.0	0.342E-01
87.5	0.997E-02	87.5	0.160E-01	50.0	0.	52.5	0.425E-01	50.0	0.500E-01
122.5	0.133E-01	122.5	0.658E-02	70.0	0.625E-01	73.5	0.510E-01	70.0	0.553E-01
157.5	0.997E-02	157.5	0.376E-02	90.0	0.625E-01	94.5	0.425E-01	90.0	0.579E-01
[29] 192.5	0.	192.5	0.188E-02	110.0	0.	115.5	0.425E-01	110.0	0.263E-01 [105]
227.5	0.	227.5	0.940E-03	130.0	0.	136.5	0.850E-02	130.0	0.132E-01
262.5	0.	262.5	0.	150.0	0.	157.5	0.850E-02	150.0	0.
297.5	0.	297.5	0.	170.0	0.	178.5	0.	170.0	0.
332.5	0.	332.5	0.	190.0	0.	199.5	0.	190.0	0.
N IS	0.100E 01	N IS	1.000E 00	N IS	1.000E 00	N IS	1.000E 00	N IS	1.000E 00

[30] [(I1), (I2), (I3), (I4), (I5)] [5]

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. (2000) INC. HISTORIES 4.2 MEV CUTOFF EN.

[31] ENERGY SPECTRUM OF EMITTED CASCADE PROTONS [APPEARS ON BINARY TAPE AS TWO WORDS] [13]

0 TO 0.3500010E 03 MEV 0 OFL

K.E. IS THE CENTER OF THE ENERGY INTERVAL IN MEV N(E) IS THE FRACTION OF TOTAL NUMBER OF EMITTED PROTONS /DELTA E

[32] [FL. PT.] [VARIABLE]

K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)
7.00	0.2380946E-01	105.00	0.2141138E-02	189.00	0.6851642E-03	273.00	0.
21.00	0.1430280E-01	119.00	0.1884202E-02	203.00	0.1712911E-03	287.00	0.
35.00	0.7194224E-02	133.00	0.1370328E-02	217.00	0.2569366E-03	301.00	0.8564553E-04
49.00	0.5738250E-02	147.00	0.1027746E-02	231.00	0.3425821E-03	315.00	0.
63.00	0.4282276E-02	161.00	0.9421008E-03	245.00	0.	329.00	0.
77.00	0.3682758E-02	175.00	0.4282276E-03	259.00	0.2569366E-03	343.00	0.
91.00	0.2826302E-02						

[RECORDS 33, 35, 37, AND 39 HAVE THE SAME SELECTION OF WORDS FOR THE BINARY TAPE AND THE SAME FORMATS AS RECORD 31]
[RECORDS 34, 36, 38, AND 40 HAVE THE SAME SELECTION OF WORDS FOR THE BINARY TAPE AND THE SAME FORMATS AS RECORD 32]

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

[33] ENERGY SPECTRUM OF EMITTED CASCADE NEUTRONS [13]

0 TO 0.3500010E 03 MEV 0 OFL

K.E. IS THE CENTER OF THE ENERGY INTERVAL IN MEV N(E) IS THE FRACTION OF TOTAL NUMBER OF EMITTED NEUTRONS/DELTA E

[34] [VARIABLE]

K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)
7.00	0.1722925E-01	105.00	0.3241435E-02	189.00	0.6424465E-03	273.00	0.1168085E-03
21.00	0.1165164E-01	119.00	0.3153828E-02	203.00	0.5840423E-03	287.00	0.2920211E-04
35.00	0.7212922E-02	133.00	0.2277765E-02	217.00	0.5548402E-03	301.00	0.
49.00	0.6424465E-02	147.00	0.1109680E-02	231.00	0.3796275E-03	315.00	0.
63.00	0.5577604E-02	161.00	0.1138882E-02	245.00	0.5840423E-04	329.00	0.
77.00	0.4643136E-02	175.00	0.8468613E-03	259.00	0.1460106E-03	343.00	0.
91.00	0.4409519E-02						

PI- OV RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

[35] ENERGY SPECTRUM OF EMITTED CASCADE PI+ [13]

0 TO 0.21000000E 03 MEV 0 OPL

K.E. IS THE CENTER OF THE ENERGY INTERVAL IN MEV N(E) IS THE FRACTION OF TOTAL NUMBER OF EMITTED PI+ / DELTA E

	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	
	4.20	0.	63.00	0.1587302E-01	113.40	0.	163.80	0.	
	12.60	0.7936508E-02	71.40	0.7936508E-02	121.80	0.	172.20	0.	
	21.00	0.3174603E-01	79.80	0.1587302E-01	130.20	0.	180.60	0.	
[36]	29.40	0.1587302E-01	88.20	0.	138.60	0.	189.00	0.	[VARIABLE]
	37.80	0.	96.60	0.7936508E-02	147.00	0.	197.40	0.	
	46.20	0.	105.00	0.7936508E-02	155.40	0.	205.80	0.	
	54.60	0.7936508E-02							

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

[37] ENERGY SPECTRUM OF EMITTED CASCADE PIO [13]

0 TO 0.2100000E 03 MEV 0 OFL

K.E. IS THE CENTER OF THE ENERGY INTERVAL IN MEV N(E) IS THE FRACTION OF TOTAL NUMBER OF EMITTED PIO / DELTA E

	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	
[38]	4.20	0.14607076-02	63.00	0.9494596E-02	113.40	0.7303535E-02	163.80	0.3651768E-02	[VARIABLE]
	12.60	0.5112474E-02	71.40	0.6573182E-02	121.80	0.2921414E-02	172.20	0.14607076-02	
	21.00	0.7303535E-02	79.80	0.7303535E-02	130.20	0.2921414E-02	180.60	0.2921414E-02	
	29.40	0.2921414E-02	88.20	0.7303535E-02	138.60	0.4382121E-02	189.00	0.14607076-02	
	37.80	0.7303535E-02	96.60	0.2921414E-02	147.00	0.6573182E-02	197.40	0.7303535E-03	
	46.20	0.8033888E-02	105.00	0.8764242E-02	155.40	0.14607076-02	205.80	0.	
	54.60	0.8764242E-02							

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. 2000 INC. HISTORIES 4.2 MEV CUTOFF EN.

[39] ENERGY SPECTRUM OF EMITTED CASCADE PI- [13]

0 TO 0.2100000E 03 MEV 0 OFL

K.E. IS THE CENTER OF THE ENERGY INTERVAL IN MEV N(E) IS THE FRACTION OF TOTAL NUMBER OF EMITTED PI- / DELTA E

	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	K.E.	N(E)	
[40]	10.50	0.2384089E-02	73.50	0.8344313E-02	136.50	0.2760525E-02	178.50	0.3576134E-02	[VARIABLE]
	31.50	0.7403225E-02	94.50	0.6462137E-02	157.50	0.3074220E-02	199.50	0.1254784E-02	
	52.50	0.7967878E-02	115.50	0.4391744E-02					

PI- ON RU INC. K.E. (MEV) IS 200.0 A IS 100. Z IS 44. (2000) INC. HISTORIES 0.2 MEV CUTOFF EN.

ANGULAR DISTRIBUTION OF EMITTED CASCADE PARTICLES

(FRACTION IN EACH INTERVAL)/(DELTA MU)

MU IS COSINE THETA AND SPECIFIES THE CENTER OF THE INTERVAL

MU	PROTON	NEUTRON	PI+	PI0	PI-
0.975	0.1127058E 01	0.1430908E 01	0.1333333E 01	0.1226994E-00	0.3425560E-00
0.925	0.7434053E 00	0.1161079E 01	0.1333333E 01	0.1226994E-00	0.5797101E 00
0.875	0.7434053E 00	0.1062960E 01	0.	0.3680982E-00	0.4479578E-00
0.825	0.8393285E 00	0.9076043E 00	0.	0.1226994E-00	0.5533597E 00
0.775	0.7673861E 00	0.8503679E 00	0.	0.2453988E-00	0.3952569E-00
0.725	0.5995204E 00	0.6704824E 00	0.1333333E 01	0.1226994E-00	0.2635046E-00
0.675	0.7434053E 00	0.6704824E 00	0.1333333E 01	0.2453988E-00	0.4743083E-00
0.625	0.8153477E 00	0.6868357E 00	0.	0.3680982E-00	0.3689065E-00
0.575	0.8872902E 00	0.7195421E 00	0.	0.3680982E-00	0.4479578E-00
0.525	0.6474820E 00	0.6704824E 00	0.	0.7361963E 00	0.2371541E-00
0.475	0.4796163E-00	0.5887163E 00	0.	0.1226994E-00	0.3162055E-00
0.425	0.5755396E 00	0.6295993E 00	0.	0.2453988E-00	0.3425560E-00
0.375	0.9112710E 00	0.5069501E 00	0.	0.3680982E-00	0.3689065E-00
0.325	0.6954436E 00	0.5723630E 00	0.1333333E 01	0.3680982E-00	0.3689065E-00
0.275	0.5755396E 00	0.5560098E 00	0.	0.8588957E 00	0.2371541E-00
0.225	0.6954436E 00	0.5151267E 00	0.1333333E 01	0.1226994E-00	0.2635046E-00
0.175	0.5995204E 00	0.3761243E-00	0.	0.4907975E-00	0.2108037E-00
0.125	0.2637890E-00	0.4170074E-00	0.	0.4907975E-00	0.3689065E-00
0.075	0.5275779E 00	0.3679477E-00	0.	0.1226994E-00	0.3162055E-00
0.025	0.4796163E-00	0.4006541E-00	0.	0.3680982E-00	0.5533597E 00
-0.025	0.3597122E-00	0.4415372E-00	0.	0.3680982E-00	0.4216074E-00
-0.075	0.3836950E-00	0.4251840E-00	0.	0.6134969E 00	0.4479578E-00
-0.125	0.3597122E-00	0.4170074E-00	0.	0.8588957E 00	0.4743083E-00
-0.175	0.3836950E-00	0.3515944E-00	0.	0.3680982E-00	0.6060606E 00
-0.225	0.3117506E-00	0.3107114E-00	0.1333333E 01	0.3680982E-00	0.6851120E 00
-0.275	0.3597122E-00	0.2780049E-00	0.	0.7361963E 00	0.3162055E-00
-0.325	0.4316547E-00	0.3515944E-00	0.	0.2453988E-00	0.6851120E 00
-0.375	0.2398081E-00	0.3188880E-00	0.1333333E 01	0.6134969E 00	0.5797101E 00
-0.425	0.1918465E-00	0.3352412E-00	0.	0.8588957E 00	0.5270092E 00
-0.475	0.3597122E-00	0.3434178E-00	0.1333333E 01	0.8588957E 00	0.6587615E 00
-0.525	0.2398081E-00	0.2534751E-00	0.4000000E 01	0.7361963E 00	0.5797101E 00
-0.575	0.2398081E-00	0.3107114E-00	0.	0.9815951E 00	0.7378129E 00
-0.625	0.4556355E-00	0.2861815E-00	0.	0.8588957E 00	0.6587615E 00
-0.675	0.2877698E-00	0.2780049E-00	0.	0.3680982E-00	0.7641634E 00
-0.725	0.3117506E-00	0.2125920E-00	0.	0.1104294E 01	0.5006588E 00
-0.775	0.3597122E-00	0.3352412E-00	0.	0.9815951E 00	0.9749671E 00
-0.825	0.2158273E-00	0.2371218E-00	0.2666667E 01	0.6134969E 00	0.7114625E 00
-0.875	0.2398081E-00	0.1635323E-00	0.	0.6134969E 00	0.8168643E 00
-0.925	0.3357314E-00	0.2371218E-00	0.	0.8588957E 00	0.6851120E 00
-0.975	0.2158273E-00	0.3515944E-00	0.1333333E 01	0.6134969E 00	0.7114625E 00

[FL. PT.] [FL. PT.] [FL. PT.] [FL. PT.] [FL. PT.]

[401] [407]

[42]	777777	[(THIS RECORD IS MEANINGLESS)]	[1]
[43]	[065343 (OCTAL) OR 27363 (DECIMAL) (END OF TAPE)]		[1]

Analysis Code II

Analysis Code II is also used to analyze the Primary Output Tape created by the Cascade Code. This code produces printed output and output on tape in the binary mode. More than one case may be analyzed at a time by placing behind the first set a complete set of cards of the type described below for each case. It is possible to obtain all or only part of the data that Analysis Code II produces by punching a 1 or a zero (blank) in the various columns of the first input card called the option card described below. The data obtainable are classified according to option numbers, which range from one to seven. Their description follows:

Option 1:

a. Differential cross section in mb $\cdot$ steradian^{-1} MeV^{-1} (i.e., $d^2\sigma/d\Omega dE$) for the spectrum of cascade particles emitted into various angular intervals. Data may be obtained for two types of emitted particles with as many as four angular intervals. The selected angular intervals must apply to both particles. For each angular interval the number of energy intervals (< 1000) desired must be specified for each particle separately. In other words,

the angular intervals apply to both particles, but the energy intervals apply only to each particle for each angular interval.

b. Differential cross section in mb/steradian (i.e., $d\sigma/d\Omega$) for the emission of the cascade particles selected above into the angular intervals selected above. This is the integral over energy for each spectrum.

c. Average energy of the cascade particles selected above emitted into the chosen angular intervals.

Option 2:

The differential cross section in mb/steradian as a function of angle $\left[\text{i.e., } \frac{d\sigma}{d\Omega}(\theta)\right]$, for one type of escaping cascade particle emitted in each of one, two, or three energy intervals.

Option 3:

For one type of escaping cascade particle the cross section in mb for the emission of 0, 1, 2, ... 15 particles of the specified type into one, two, or three energy intervals. The type of particle and the energy intervals can be different from those selected in option 2.

Option 4:

The ratio of the number of times that a particle of a selected type is emitted on the first collision to the number of times that the incident particle type is emitted.

Option 5:

Incident pion absorption cross section.

Option 6:

Incident pion charge exchange cross section, i.e., the cross section for producing at least one π^0.*

Option 7:

Angular distribution of cascade protons with respect to the angle X for the emission of only two protons, any number of neutrons, and no pions, where X is the angle between the two emitted protons.

If additional information is required, such as the differential cross section for two types of emitted particles instead of one as allowed in option 2, then another option card must be filled out, followed by the necessary additional cards, if any, describing the information desired.

When the type of particle needs to be specified on the input cards, a number must be punched into the appropriate column. The numbers to be used and corresponding particle types are given below.

Type of Particle	Number To Be Punched on Cards
Proton	1
Neutron	2
π^+	3
π^0	4
π^-	5

Columns 73-80 of the input cards are not used by the code and may be used by the coder in any way desired.

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*For the present Cascade Code, there can be only one π^0 emitted for an incident charged pion because pion production is not considered. The π^0 comes from the charge exchange reactions.

Input Cards

Option Card (the first input card in the set)

Column		Format
1-2	File number of the Primary Output Tape to be analyzed	I2
4	1 if option 1 is desired; otherwise, 0 or blank	I1
6	1 if option 2 is desired; otherwise, 0 or blank	"
8	1 if option 3 is desired; otherwise, 0 or blank	"
10	1 if option 4 is desired; otherwise, 0 or blank	"
12	1 if option 5 is desired; otherwise, 0 or blank	"
14	1 if option 6 is desired; otherwise, 0 or blank	"
16	1 if option 7 is desired; otherwise, 0 or blank	"
18	Incident particle type	

The following cards are needed only if the corresponding options are desired:

Option 1 desired (two cards needed)

First Card

Column		Format
2	Number of angular intervals (≤ 4)	I1
4	First type of escaping particle to be considered	"
6	Second type of escaping particle to be considered	"
7-14	UL* (degrees) of first angular interval	F8.4
15-22	LL* (degrees) of first angular interval	"

*UL and LL are the upper and lower limits, respectively (in degrees), of the angular intervals desired.

Column		Format
23-30	UL of second angular interval	F8.4
31-38	LL of second angular interval desired	"
39-46	UL of third angular interval desired	"
47-54	LL of third angular interval desired	"
55-62	UL of fourth angular interval desired	"
63-70	LL of fourth angular interval desired	"

Second Card

Column		Format
2-5	Number of energy intervals desired in the spectrum of the first particle in the first angular interval (usually 10 or 20, but not more than 1000)	I4
7-10	Same as above, but for the second particle in the first angular interval	"
12-15	Same as above, but for the first particle, second angular interval	"
17-20	Same, but for the second particle, second interval	"
22-25	Same, but for the first particle, third interval	"
27-30	Same, but for the second particle, third interval	"
32-35	Same, but for the first particle, fourth interval	"
37-40	Same, but for the second particle, fourth interval	"

Option 2 desired (one card needed)

Column		Format
2	Type of escaping particle to be considered	I1
3-12	Lower energy limit (MeV) of first energy interval desired	E10.4
13-22	Upper energy limit (MeV) of first energy interval desired	"
23-32	Lower limit, second energy interval	"
33-42	Upper limit, second interval	"
43-52	Lower limit, third interval	"
53-62	Upper limit, third interval	"

Option 3 desired (one card needed)

The format for punching this card is the same as that specified for option 2. However, the type of escaping particle and the energy intervals may be different.

Option 4 desired (one card needed)

Column		Format
2	Type of escaping particle to be considered	I1

Options 5, 6, 7 (no additional cards needed)

Tape Assignments

The cascade Code Primary Output Tape, logical 2, is assigned to B5. The binary output tape, logical 8, is assigned to B8, and is initially supplied by the installation as a pool tape. The BCD input and output tapes have the same assignments as they do for the Cascade Code.

Trouble Shooting

In case of printed output message ILLEGAL HALT OCCURRED, take the following steps:

1. Examine the input data. The data must be specified according to the formats. If Option 1 has been requested be sure the second card is submitted. In addition, examine the first of the two cards to be sure that the larger value of each angular interval desired is specified first.
2. If there is no error in the input data, rerun the Cascade Code to create a new Primary Output Tape.

Example

The case used as an example is the same as that used for Analysis Code I. The sequence of options is not the same as the one used in the example in ORNL-3433, which was selected for reproduction layout purposes in addition to illustrative purposes. The sequence in this example is the one that would most probably be used if all options were desired.

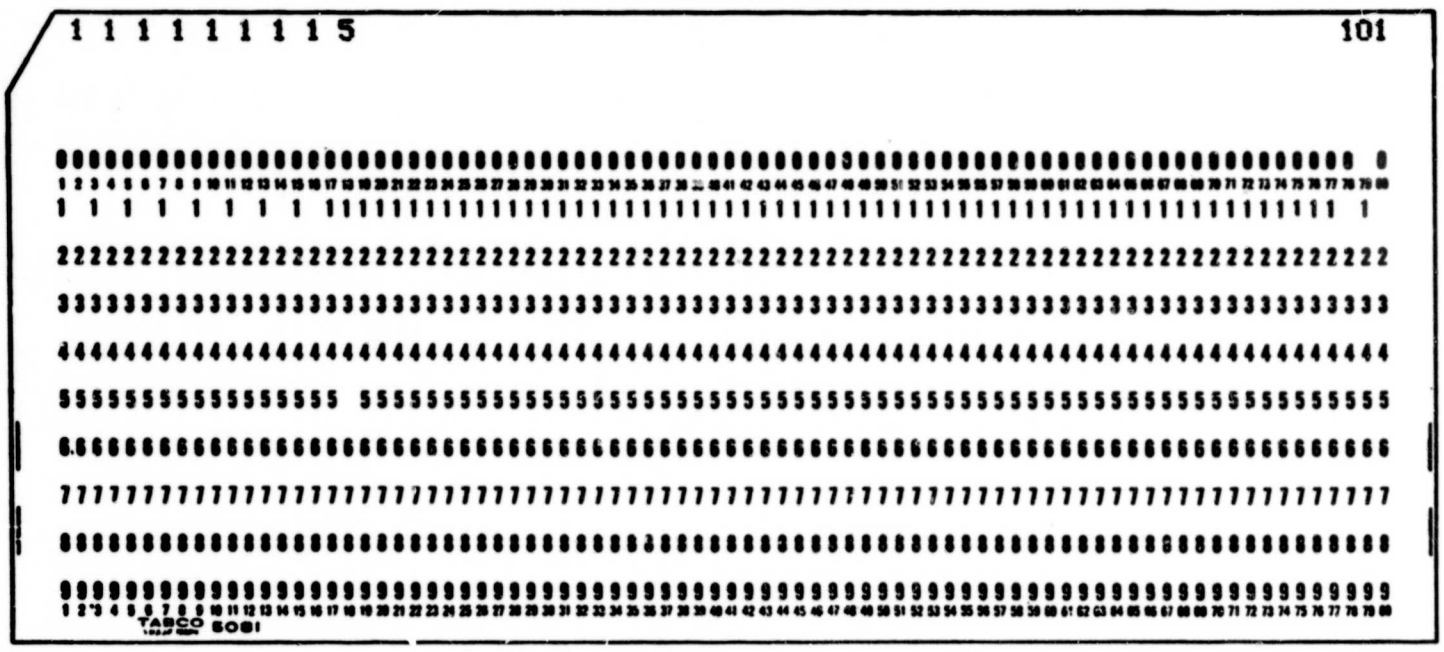
The option card calls for all seven options, where the data to be analyzed are located in file 1 of the Primary Output Tape and the incident particles are π^--mesons (card 1). Using option 1, one is interested in the spectra of emitted neutrons and π^- for four angular intervals, 0 to 60°, 60 to 90°, 90 to 120°, and 120 to 180° (card 2). The number of energy intervals desired in the construction of the energy spectra is 25 for neutrons in each angular interval, 10 for π^- in the angular intervals 0 to 60° and 60 to 90°, and 25 for π^- in the angular intervals 90 to 120° and 120 to 180° (card 3). Using option 2, the differential cross section versus angle is requested for emitted cascade neutrons in each of the energy intervals 0 to 34 MeV, 34 to 170 MeV, and 170 to 340 MeV (card 4). For option 3 the cross section for the emission of various numbers of neutrons into the same energy intervals as in

option 2 is requested (card 5). In option 4 the type of emitted particle called for in calculating the required ratio is π^- (card 6). No additional cards are required for options 5, 6, and 7.

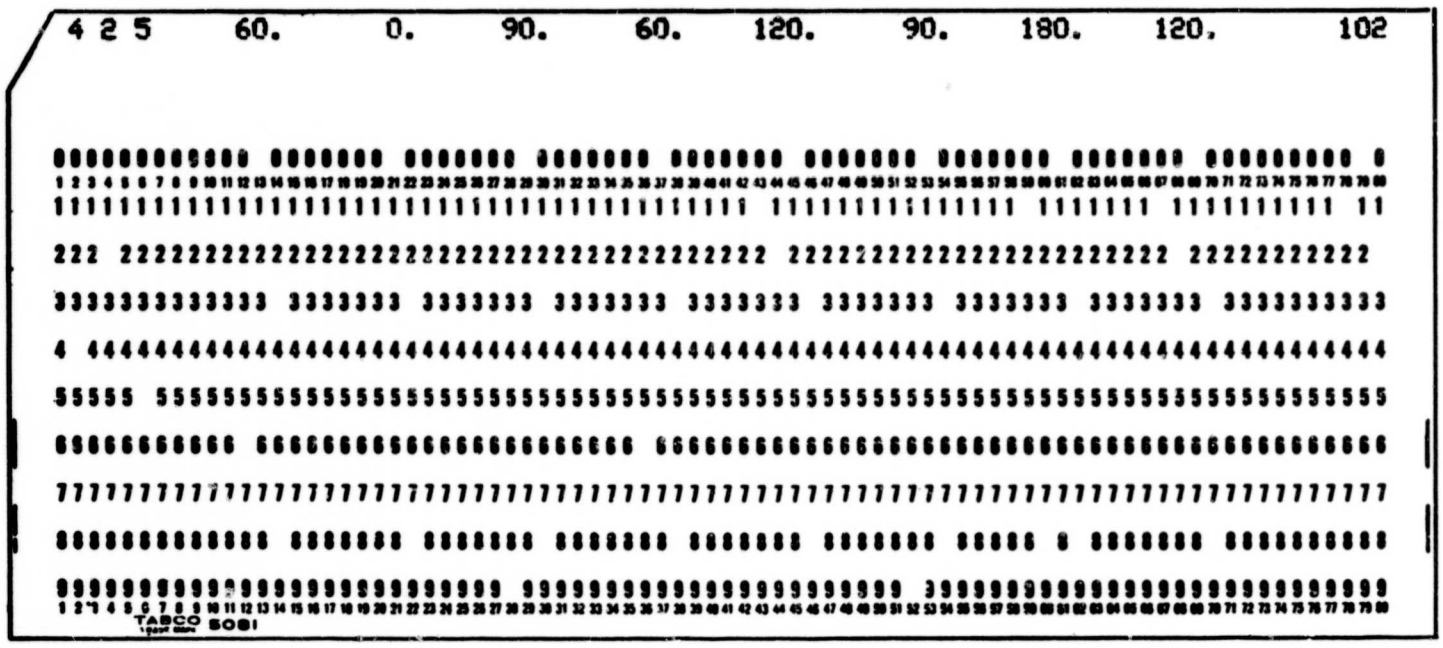
As before, if this case is used as a test or sample case, the data received by the user should correspond to those illustrated on pages 70 to 77.

INPUT CARDS - ANALYSIS CODE II

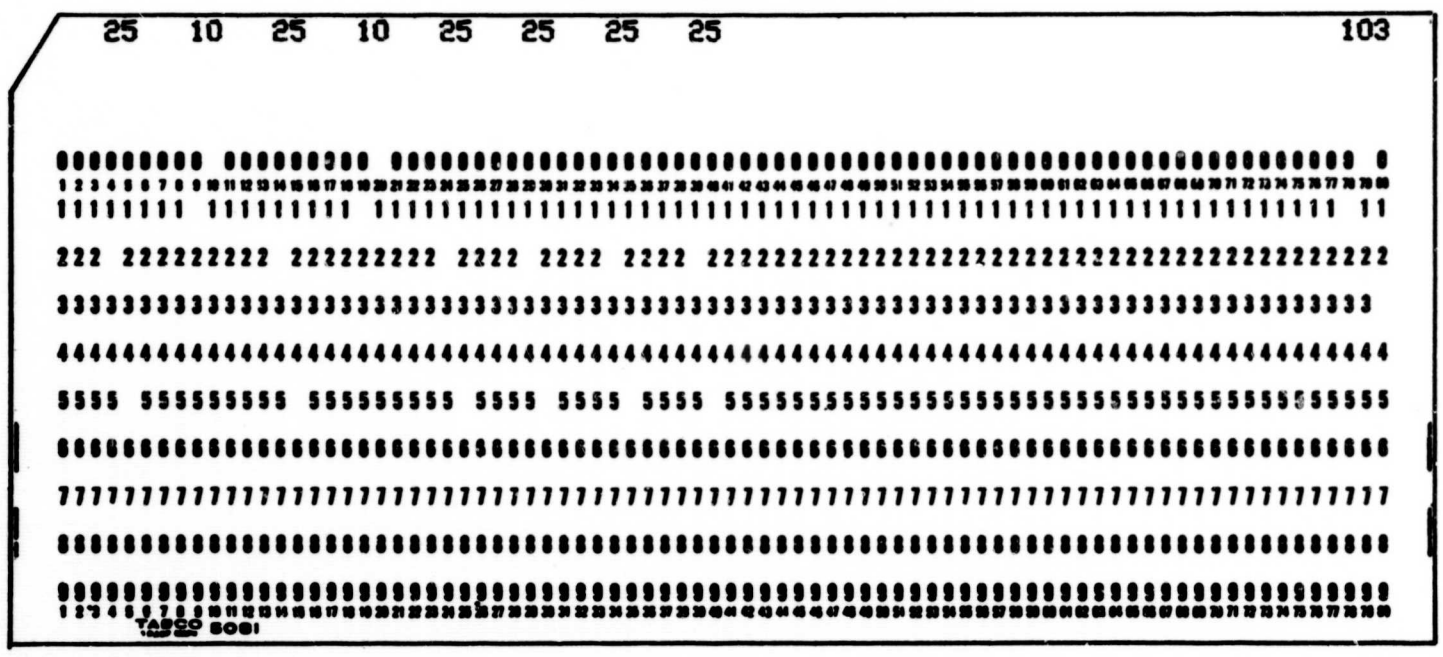
CARD 1 (OPTION CARD)



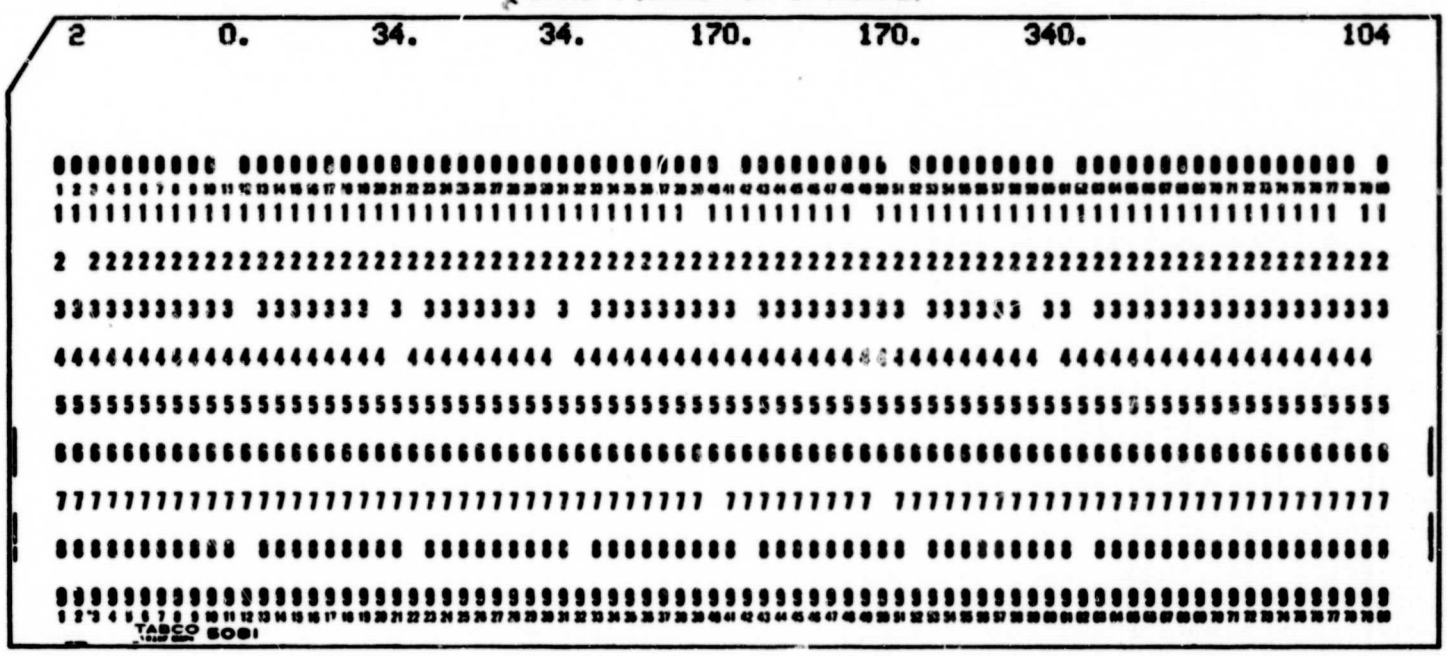
CARD 2 (FIRST CARD FOR OPTION 1)



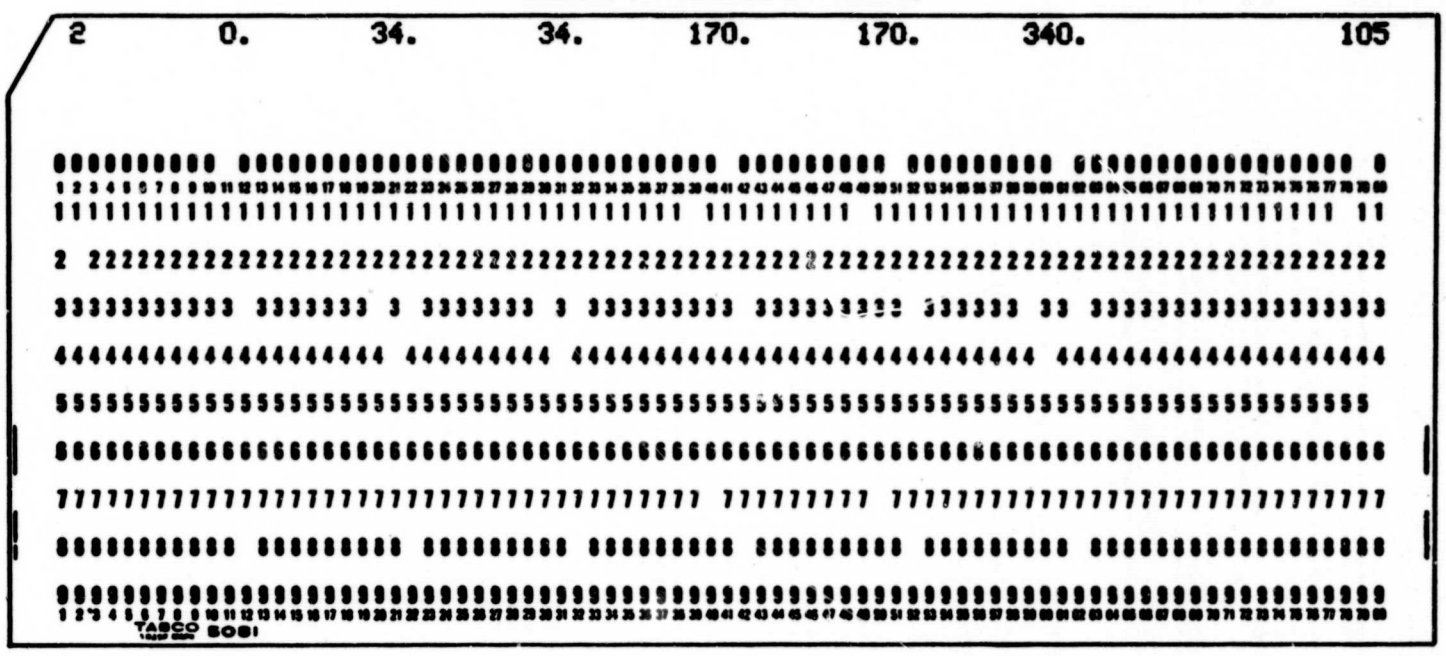
CARD 3 (SECOND CARD FOR OPTION 1)



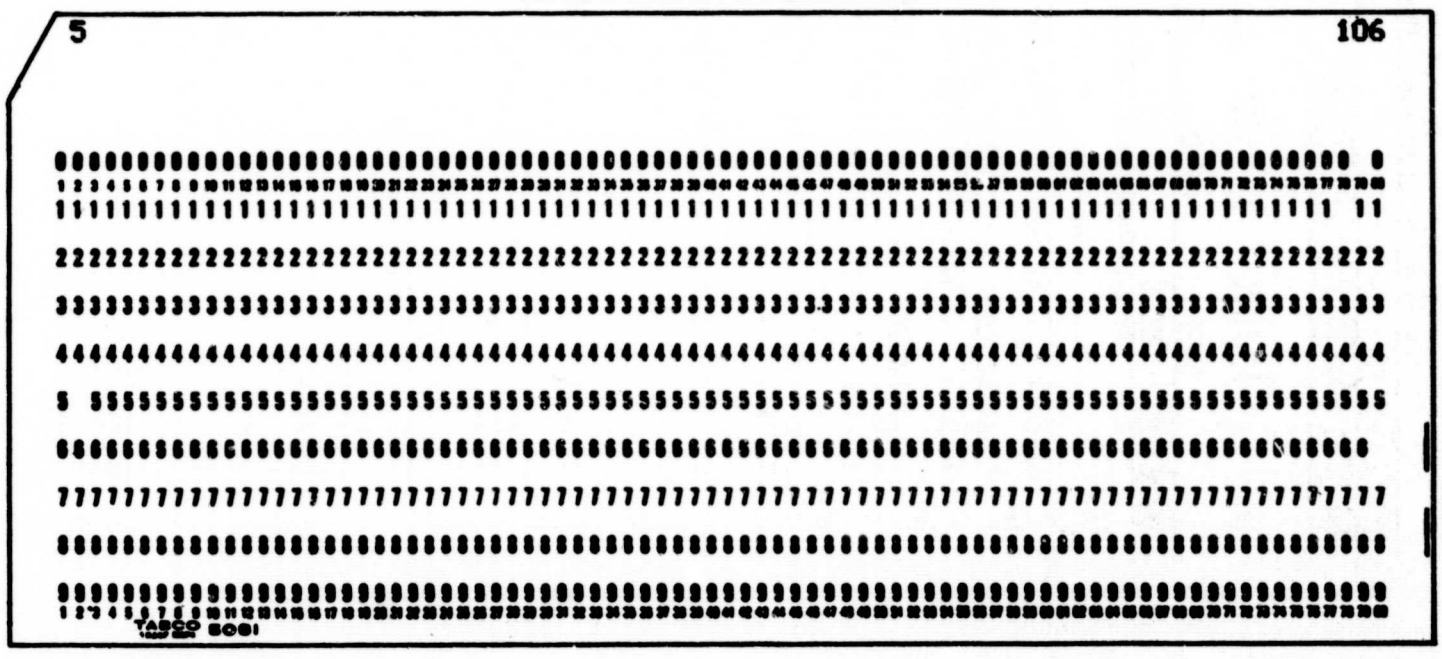
CARD 4 (CARD FOR OPTION 2)



CARD 5 (CARD FOR OPTION 3)



CARD 6 (CARD FOR OPTION 4)



[RECORD]	NOTE: The circles, rectangles, underlines, and the words, and numbers in brackets on the pages of printed output illustrated in this manual do not appear on the actual printed output. These marks have been added to provide information about the data stored on the binary tapes. (See section entitled Binary Tapes, Page 118 of this manual.)	[NUMBER OF WORDS IN RECORD]
[1]	[KEY]	[1]
[2]	[J1, J2, J3, J4, J5, J6, J7]	[7]

PAGE 1

[3]	INCIDENT PARTICLE	INC. LAB. K.E.(MEV)	TARGET SYMB.	A	Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	[9]
	PI-	200	RU	100	45	02000	4.24	1756.5	01559	

[4]	[NTYPE, NB]	(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV)	[2]

[5]	TYPE OF CASCADE PARTICLE	LAB. ANGULAR INTERVAL (DEG)	NO. OF ENERGY INTERVALS	DELTA E (MEV)	[4]
	NEUTRON	0. TO 60.00	25	14.0000	

[6]	INTERVAL 1	INTERVAL 2	INTERVAL 3	INTERVAL 4	INTERVAL 5	INTERVAL 6	INTERVAL 7	INTERVAL 8	[VARIABLE]
	4.0336E 00	2.6558E 00	2.0568E 00	1.8970E 00	1.9968E 00	1.8171E 00	1.8371E 00	1.3179E 00	

[7]	INTERVAL 9	INTERVAL 10	INTERVAL 11	INTERVAL 12	INTERVAL 13	INTERVAL 14	INTERVAL 15	INTERVAL 16	[VARIABLE]
	1.0783E 00	7.3883E-01	2.9953E-01	3.1950E-01	2.3962E-01	2.5959E-01	2.3962E-01	2.9953E-01	

[8]	INTERVAL 17	INTERVAL 18	INTERVAL 19	INTERVAL 20	INTERVAL 21	INTERVAL 22	INTERVAL 23	INTERVAL 24	[VARIABLE]
	2.3962E-01	3.9937E-02	9.9842E-02	7.9874E-02	1.9968E-02	0.	0.	0.	

[9]	INTERVAL 25	[VARIABLE]
	0.	

[10]	TYPE OF CASCADE PARTICLE	(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV) LAB. ANGULAR INTERVAL (DEG)	NO. OF ENERGY INTERVALS	DELTA E (MEV)	[4]
	NEUTRON	60.00 TO 90.00	25	14.0000	

[11]	INTERVAL 1	INTERVAL 2	INTERVAL 3	INTERVAL 4	INTERVAL 5	INTERVAL 6	INTERVAL 7	INTERVAL 8	[VARIABLE]
	3.3946E 00	2.5160E 00	1.3179E 00	1.0184E 00	6.9890E-01	5.1918E-01	4.3931E-01	3.1950E-01	

[12]	INTERVAL 9	INTERVAL 10	INTERVAL 11	INTERVAL 12	INTERVAL 13	INTERVAL 14	INTERVAL 15	INTERVAL 16	[VARIABLE]
	3.3946E-01	3.3946E-01	2.3962E-01	2.5959E-01	2.7956E-01	1.5975E-01	1.3978E-01	3.9937E-02	

[13]	INTERVAL 17	INTERVAL 18	INTERVAL 19	INTERVAL 20	INTERVAL 21	INTERVAL 22	INTERVAL 23	INTERVAL 24	[VARIABLE]
	1.9968E-02	0.	0.	0.	0.	0.	0.	0.	

[14]	INTERVAL 25	[VARIABLE]
	0.	

[15]	TYPE OF CASCADE PARTICLE	(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV) LAB. ANGULAR INTERVAL (DEG)	NO. OF ENERGY INTERVALS	DELTA E (MEV)	[4]
	NEUTRON	90.00 TO 120.00	25	14.0000	

[16]	INTERVAL 1	INTERVAL 2	INTERVAL 3	INTERVAL 4	INTERVAL 5	INTERVAL 6	INTERVAL 7	INTERVAL 8	[VARIABLE]
	2.5160E 00	1.6174E 00	8.3868E-01	7.7877E-01	5.7909E-01	4.1934E-01	3.7940E-01	4.3931E-01	

[17]	INTERVAL 9	INTERVAL 10	INTERVAL 11	INTERVAL 12	INTERVAL 13	INTERVAL 14	INTERVAL 15	INTERVAL 16	[VARIABLE]
	4.1934E-01	3.1950E-01	1.5975E-01	1.3978E-01	3.9937E-02	1.9968E-02	1.9968E-02	3.9937E-02	

[18]	INTERVAL 17 INTERVAL 18 INTERVAL 19 INTERVAL 20 INTERVAL 21 INTERVAL 22 INTERVAL 23 INTERVAL 24 0. 0. 0. 0. 0. 0. 0. 0.	[VARIABLE]
[19]	INTERVAL 25 0.	[VARIABLE]
[20]	(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV) TYPE OF CASCADE PARTICLE LAB. ANGULAR INTERVAL (DEG) NO. OF ENERGY INTERVALS DELTA E (MEV) NEUTRON 120.00 TO 180.00 (25) 14.0000	[4]
[21]	INTERVAL 1 INTERVAL 2 INTERVAL 3 INTERVAL 4 INTERVAL 5 INTERVAL 6 INTERVAL 7 INTERVAL 8 1.8371E 00 1.1781E 00 7.1886E-01 6.9889E-01 5.3915E-01 4.1934E-01 3.5943E-01 1.3978E-01	[VARIABLE]
[22]	INTERVAL 9 INTERVAL 10 INTERVAL 11 INTERVAL 12 INTERVAL 13 INTERVAL 14 INTERVAL 15 INTERVAL 16 3.1949E-01 1.5975E-01 5.9905E-02 5.9905E-02 1.9968E-02 0. 0. 0.	[VARIABLE]
[23]	INTERVAL 17 INTERVAL 18 INTERVAL 19 INTERVAL 20 INTERVAL 21 INTERVAL 22 INTERVAL 23 INTERVAL 24 0. 0. 0. 0. 0. 0. 0. 0.	[VARIABLE]
[24]	INTERVAL 25 0.	[VARIABLE]
[25]	(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV) TYPE OF CASCADE PARTICLE LAB. ANGULAR INTERVAL (DEG) NO. OF ENERGY INTERVALS DELTA E (MEV) PI- 0. TO 60.00 (10) 21.0000	[4]
[26]	INTERVAL 1 INTERVAL 2 INTERVAL 3 INTERVAL 4 INTERVAL 5 INTERVAL 6 INTERVAL 7 INTERVAL 8 9.3186E-02 1.5975E-01 1.4644E-01 7.9874E-02 6.6562E-02 3.9937E-02 6.6562E-02 4.5262E-01	[VARIABLE]
[27]	INTERVAL 9 INTERVAL 10 7.0555E-01 2.6625E-01	[VARIABLE]
[28]	(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV) TYPE OF CASCADE PARTICLE LAB. ANGULAR INTERVAL (DEG) NO. OF ENERGY INTERVALS DELTA E (MEV) PI- 60.00 TO 90.00 (10) 21.0000	[4]
[29]	INTERVAL 1 INTERVAL 2 INTERVAL 3 INTERVAL 4 INTERVAL 5 INTERVAL 6 INTERVAL 7 INTERVAL 8 7.9874E-02 2.6625E-01 2.6625E-01 1.8637E-01 1.4644E-01 1.8637E-01 3.1950E-01 1.8637E-01	[VARIABLE]
[30]	INTERVAL 9 INTERVAL 10 5.3249E-02 0.	[VARIABLE]
[31]	(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV) TYPE OF CASCADE PARTICLE LAB. ANGULAR INTERVAL (DEG) NO. OF ENERGY INTERVALS DELTA E (MEV) PI- 90.00 TO 120.00 (25) 8.4000	[4]

[32]	INTERVAL 1	INTERVAL 2	INTERVAL 3	INTERVAL 4	INTERVAL 5	INTERVAL 6	INTERVAL 7	INTERVAL 8	[VARIABLE]
	6.6562E-02	1.9968E-01	3.3281E-01	3.9937E-01	6.6562E-01	4.9921E-01	5.3249E-01	4.6593E-01	
[33]	INTERVAL 9	INTERVAL 10	INTERVAL 11	INTERVAL 12	INTERVAL 13	INTERVAL 14	INTERVAL 15	INTERVAL 16	[VARIABLE]
	2.9953E-01	4.9921E-01	5.9905E-01	4.9921E-01	3.6609E-01	4.6593E-01	5.3249E-01	1.6640E-01	
[34]	INTERVAL 17	INTERVAL 18	INTERVAL 19	INTERVAL 20	INTERVAL 21	INTERVAL 22	INTERVAL 23	INTERVAL 24	[VARIABLE]
	1.6640E-01	3.3281E-02	0.	3.3281E-02	0.	0.	0.	0.	
[35]	INTERVAL 25								[VARIABLE]
	0.								
[36]	TYPE OF CASCADE PARTICLE			(DSIGMA/(DOMEGA X DE) (MB)/(STERADIAN-MEV) LAB. ANGULAR INTERVAL (DEG)			NO. OF ENERGY INTERVALS	DELTA E (MEV)	[4]
	PI-			120.00 TO 180.00			(25)	8.4000	
[37]	INTERVAL 1	INTERVAL 2	INTERVAL 3	INTERVAL 4	INTERVAL 5	INTERVAL 6	INTERVAL 7	INTERVAL 8	[VARIABLE]
	6.65[illegible]E-02	1.6640E-01	5.6577E-01	6.3233E-01	5.9905E-01	6.9889E-01	8.6530E-01	1.0983E 00	
[38]	INTERVAL 9	INTERVAL 10	INTERVAL 11	INTERVAL 12	INTERVAL 13	INTERVAL 14	INTERVAL 15	INTERVAL 16	[VARIABLE]
	1.0650E 00	9.3186E-01	7.3217E-01	7.6546E-01	4.3265E-01	2.3296E-01	3.3281E-02	9.9842E-02	
[39]	INTERVAL 17	INTERVAL 18	INTERVAL 19	INTERVAL 20	INTERVAL 21	INTERVAL 22	INTERVAL 23	INTERVAL 24	[VARIABLE]
	0.	3.3281E-02	0.	0.	0.	0.	0.	0.	
[40]	INTERVAL 25								[VARIABLE]
	0.								

[41]	INCIDENT PARTICLE	INC. LAB. K.E.(MEV)	TARGET SYMB.	A	Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	[9]
	PI-	200	RU	100	44	02000	4.24	1756.5	01559	

[42] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.3019E 03 MB/STERADIAN FOR CASCADE NEUTRON WITH THETA FROM 0. TO 60.00 DEG
AVERAGE ENERGY EQUALS 0.679519E 02 MEV FOR CASCADE NEUTRON WITH THETA FROM 0. TO 60.00 DEG [6]

[43] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.1686E 03 MB/STERADIAN FOR CASCADE NEUTRON WITH THETA FROM 60.00 TO 90.00 DEG
AVERAGE ENERGY EQUALS 0.509502E 02 MEV FOR CASCADE NEUTRON WITH THETA FROM 60.00 TO 90.00 DEG [6]

[44] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.1222E 03 MB/STERADIAN FOR CASCADE NEUTRON WITH THETA FROM 90.00 TO 120.00 DEG
AVERAGE ENERGY EQUALS 0.493204E 02 MEV FOR CASCADE NEUTRON WITH THETA FROM 90.00 TO 120.00 DEG [6]

[45] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.9114E 02 MB/STERADIAN FOR CASCADE NEUTRON WITH THETA FROM 120.00 TO 180.00 DEG
AVERAGE ENERGY EQUALS 0.448344E 02 MEV FOR CASCADE NEUTRON WITH THETA FROM 120.00 TO 180.00 DEG [6]

[46] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.4351E 02 MB/STERADIAN FOR CASCADE PI- WITH THETA FROM 0. TO 60.00 DEG
AVERAGE ENERGY EQUALS 0.139596E 03 MEV FOR CASCADE PI- WITH THETA FROM 0. TO 60.00 DEG [6]

[47] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.3550E 02 MB/STERADIAN FOR CASCADE PI- WITH THETA FROM 60.00 TO 90.00 DEG
AVERAGE ENERGY EQUALS 0.915236E 02 MEV FOR CASCADE PI- WITH THETA FROM 60.00 TO 90.00 DEG [6]

[48] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.5731E 02 MB/STERADIAN FOR CASCADE PI- WITH THETA FROM 90.00 TO 120.00 DEG
AVERAGE ENERGY EQUALS 0.735307E 02 MEV FOR CASCADE PI- WITH THETA FROM 90.00 TO 120.00 DEG [6]

[49] SUM OF DSIG/(DOMEGA X DE) X DE EQUALS 0.7576E 02 MB/STERADIAN FOR CASCADE PI- WITH THETA FROM 120.00 TO 180.00 DEG
AVERAGE ENERGY EQUALS 0.650767E 02 MEV FOR CASCADE PI- WITH THETA FROM 120.00 TO 180.00 DEG [6]

[50]	INCIDENT PARTICLE	INC. LAB. K.E.(MEV)	TARGET SYMB.	TARGET A	TARGET Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	[9]
	PI-	200	RU	100	44	02000	4.24	1756.5	01559	

[51] DSIGMA / DOMEGA (MB / STERADIAN) [2]

TYPE OF CASCADE PARTICLE: NEUTRON — FOR THE ENERGY INTERVAL (MEV): 0 TO 34

[52] LABORATORY ANGLE FROM	0 - 20 DEG	20 - 40	40 - 60	60 - 80	80 - 100	100 - 120	120 - 140	140 - 160	160 - 180	[9]
	1.136E 02	9.820E 01	1.119E 02	1.037E 02	7.043E 01	5.739E 01	5.096E 01	3.944E 01	6.026E 01	

[53] TYPE OF CASCADE PARTICLE: NEUTRON — FOR THE ENERGY INTERVAL (MEV): 34 TO 170 [2]

[54] LABORATORY ANGLE FROM	0 - 20 DEG	20 - 40	40 - 60	60 - 80	80 - 100	100 - 120	120 - 140	140 - 160	160 - 180	[9]
	3.384E 02	2.117E 02	1.109E 02	7.453E 01	6.238E 01	5.354E 01	4.203E 01	3.703E 01	6.258E 01	

[55] TYPE OF CASCADE PARTICLE: NEUTRON — FOR THE ENERGY INTERVAL (MEV): 170 TO 340 [2]

[56] LABORATORY ANGLE FROM	0 - 20 DEG	20 - 40	40 - 60	60 - 80	80 - 100	100 - 120	120 - 140	140 - 160	160 - 180	[9]
	3.013E 01	2.737E 01	1.524E 01	9.423E 00	3.220E 00	2.142E 00	5.254E-01	0.	0.	

	INCIDENT PARTICLE	INC. LAB. K.E.(MEV)	TARGET SYMB.	A	Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	
[57]	PI-	200	RU	100	44	02000	4.24	1756.5	01559	[9]

CROSS SECTIONS (MB) FOR THE EMISSION OF K PARTICLES OF SPECIFIED TYPE INTO ENERGY INTERVALS INDICATED

[50] (CONTRIBUTIONS TO K EQUAL ZERO ARE MADE ONLY WHEN PARTICLES OF SPECIFIED TYPE ARE EMITTED BUT ARE NOT IN THE ENERGY INTERVALS INDICATED) [2]

EMITTED PARTICLE NEUTRON ENERGY INTERVAL (MEV) 0 TO 34

K EQUALS	0	1	2	3	4	5	6	7
	5.1642E 02	4.0839E 02	1.7126E 02	5.1817E 01	1.3174E 01	2.6348E 00	0.	0.
[59]	8	9	10	11	12	13	14	15 [16]
	0.	0.	0.	0.	0.	0.	0.	0.

[60] EMITTED PARTICLE NEUTRON ENERGY INTERVAL (MEV) 34 TO 170 [2]

K EQUALS	0	1	2	3	4	5	6	7
	3.2583E 02	6.3937E 02	1.5896E 02	3.7765E 01	1.7565E 00	0.	0.	0.
[61]	8	9	10	11	12	13	14	15 [16]
	0.	0.	0.	0.	0.	0.	0.	0.

[62] EMITTED PARTICLE NEUTRON ENERGY INTERVAL (MEV) 170 TO 340 [2]

K EQUALS	0	1	2	3	4	5	6	7
	1.0653E 03	9.8365E 01	0.	0.	0.	0.	0.	0.
[63]	8	9	10	11	12	13	14	15 [16]
	0.	0.	0.	0.	0.	0.	0.	0.

[04]	INCIDENT PARTICLE	INC. LAB. K.E.(MEV)	TARGET SYMB.	TARGET A	TARGET Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	[9]
	PI-	200	RU	100	44	02000	4.24	1756.5	01559	

[05] NO. OF TIMES SPECIFIED PARTICLE IS EMITTED ON THE FIRST INC. PARTICLE COLLISION DIVIDED BY THE NO. OF TIMES THE INC. PARTICLE TYPE IS EMITTED	PION ABSORPTION CROSS SECT. (MB)	PION CHARGE EXCHANGE CROSS SECT. (MB)	[VARIABLE]
PI - 0.57839E 00	0.54540E 03	0.14316E 03	

ANGULAR DISTRIBUTION OF TWO CASCADE PROTONS AS A FUNCTION OF THE ANGLE, X, BETWEEN THEM.

DSIGMA / DOMEGA (MB / STERADIAN)

(REACTIONS CONTRIBUTE WHEN THERE ARE NO PIONS, ONLY TWO PROTONS, AND ANY NUMBER OF NEUTRONS EMITTED)

[05] X FROM [9]

0 - 20 DEG	20 - 40	40 - 60	60 - 80	80 - 100	100 - 120	120 - 140	140 - 160	160 - 180
0.	0.6440E 01	0.4729E 01	0.5568E 01	0.7647E 01	0.5996E 01	0.1208E 02	0.8050E 01	0.1159E 02

[67] 777777	[1]
[68] [653343 (OCTAL) OR 27963 (DECIMAL) (END OF TAPE)]	[1]

Evaporation Code

The evaporation Code is also used to analyze the Primary Output Tape created by the Cascade Code, and it also produces printed output and output on tape in the binary mode. Evaporation reactions are calculated for each cascade particle record on the tape. The code permits no flexibility in the type of data to be produced; hence, the only thing that need be specified is the file number on the Primary Output Tape to be analyzed. In the code used here only six particles are allowed to be evaporated (see ORNL-3433, p. 83), whereas in the original code (ORNL CF-61-12-40, see ref. 2) 19 are allowed.

Two tapes must be supplied by the user to operate this program: the Primary Output Tape and the Evaporation Code Table Tape. The tape assignments are given below. As many files as desired can be analyzed on the Primary Output Tape by supplying one input card for each file.

Data Input (one card/case)

Column		Format
1-10	File to be analyzed	I10

Tape Assignments

1. Logical tape 2 (assigned to B5) is the Primary Output Tape created by the Cascade Code.

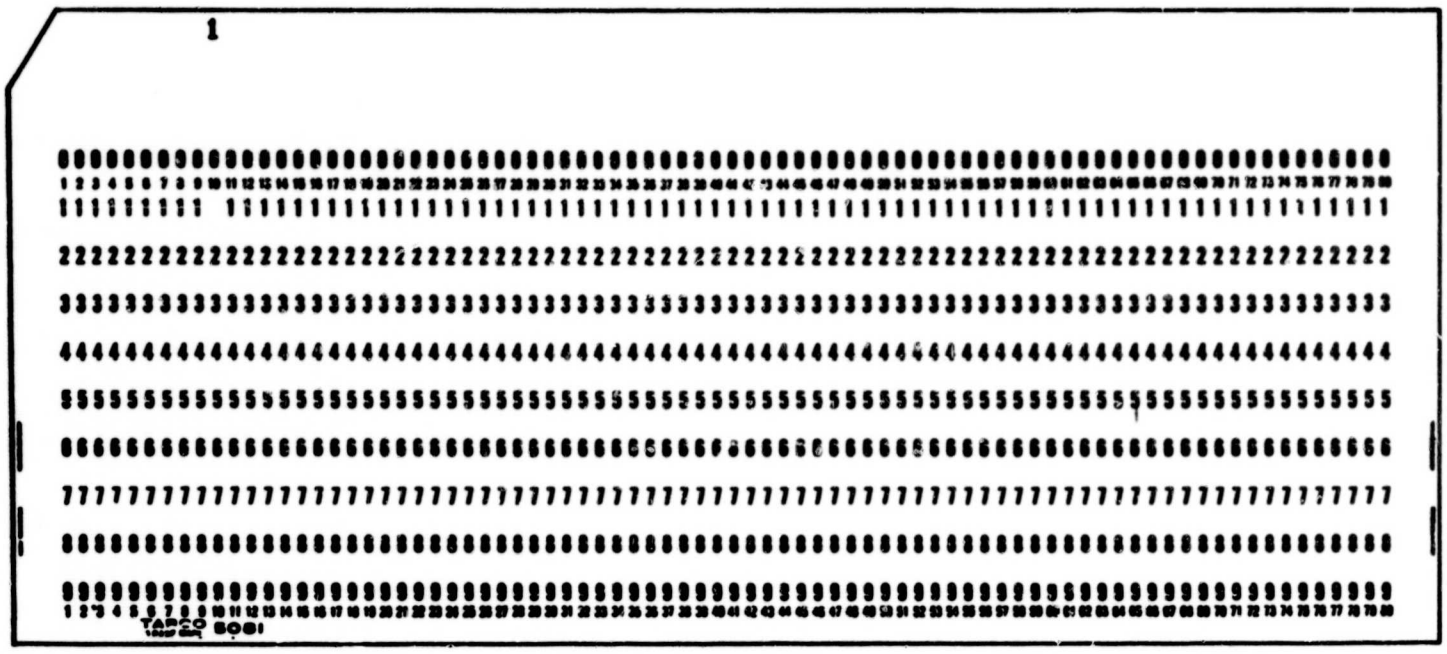
2. Logical tape 3 (assigned to A7) is the Evaporation Code Table Tape.
3. Logical tape 8 (assigned to B8) is the Binary Output Tape. This tape is initially supplied by the installation as a PØØL tape.
4. The BCD input and output tapes, logical 5 and 6, are assigned to A2 and A3 respectively.

Example

The card below illustrates the input card for the Evaporation Code using the same case as discussed previously. The output from this case, illustrated on pages 81 to 87, can serve as an example or test case.

The initial random number in the first case in any sequence of cases run using this code is always the same. But the initial random number in each subsequent case is calculated from the final random number of the previous case. Hence if cases are not run in exactly the same sequence, somewhat different numerical results will be generated.

INPUT CARD - EVAPORATION CODE



[RECORD] NOTE: The circles, rectangles, underlines, and the words, and numbers in brackets on the pages of printed output illustrated in this manual do not appear on the actual printed output. These marks have been added to provide information about the data stored on the binary tapes. (See section entitled Binary Tapes, page 118 of this manual.) [NUMBER OF WORDS IN RECORD]

[1]

A# 100 [WORD 5]
Z# 45
KINETIC ENERGY (MEV)# 200.00
PI-
GEOMETRIC CROSS SECTION (MB)# 1756.52
CUTOFF ENERGY (MEV)# 4.24
2000 CASE HISTORIES
INELASTIC CROSS SECTION (MB) 1369.20

CASE NUMBER 100 45 200 4
[WORDS 1, 2, 3, 4]
[12]

AVERAGE EVAPORATION YIELD PER INELASTIC EVENT

[2]

NEUTRONS	PROTONS	DEUTERONS	TRITONS	HE3	ALPHAS
3.9890956	0.8794099	0.1039128	0.0275818	0.0083387	0.1231559

[6]

[3]

[4] [KEY 2] DISTRIBUTION OF RESIDUAL NUCLEI FOLLOWING EVAPORATION CASE NUMBER 100 44 200 44 [4]

[5] [1]

[6] [7] [8] [KEY 2] [KEY 2]

A	Z	NUMBER OF NUCLEI	CROSS SECTION (MB)	
100	44	26	22.83	[4] = [1] = [3 OR 4] = [1] =
	43	1	0.88	
99	44	141	123.83	
	43	36	31.62	
98	44	57	50.06	
	43	46	40.40	
	42	9	7.90	
97	44	52	45.67	
	43	58	50.94	
	42	10	8.78	
	41	1	0.88	
96	44	46	40.40	
	43	34	29.86	
	42	15	13.17	
	41	1	0.88	
95	44	33	28.98	
	43	47	41.28	
	42	14	12.30	
94	44	6	5.27	
	43	71	62.36	
	42	26	22.83	
	41	2	1.76	
93	43	49	43.03	
	42	49	43.03	
	41	8	7.03	
92	43	29	25.47	
	42	51	44.79	
[FX. PT.]	41 [FX. PT.]	19 [FX. PT.]	16.69 [FL. PT.]	
	40	2	1.76	
91	42	63	55.33	
	41	28	24.59	
	40	4	3.51	
90	42	20	17.57	
	41	62	54.45	
	40	9	7.90	
	39	1	0.88	
89	41	41	36.01	
	40	21	18.44	
	39	7	6.15	
88	41	3	2.63	
	40	49	43.03	
	39	8	7.03	
87	41	1	0.88	
	40	27	23.71	
	39	18	15.81	
	38	3	2.63	
86	40	10	8.78	
	39	27	23.71	
	38	5	4.39	
	37	2	1.76	
85	39	25	21.96	
	38	11	9.66	
	37	1	0.88	
84	39	12	10.54	
	38	22	19.32	

[SAME TO END OF TABLE] [SAME TO END OF TABLE]

[113] [3 OR 4]

[114] [KEY 2] [1]

[115] CASE NUMBER 100 44 200 6 [4]

[116] [KEY 2] DISTRIBUTION OF RESIDUAL NUCLEI FOLLOWING EVAPORATION [1]

[117]

[118] [KEY 2] A	Z	NUMBER OF NUCLEI	CROSS SECTION (MB)
84	37	2	1.76
	36	1	0.88
83	39	2	1.76
	38	22	19.32
	37	10	8.78
82	38	13	11.42
	37	12	10.54
81	38	3	2.63
	37	17	14.93
	36	1	0.88
80	38	1	0.88
	37	8	7.03
	36	5	4.39
79	37	3	2.63
	36	10	8.78
78	36	11	9.66
	35	1	0.88
77	36	5	4.39
	35	3	2.63
	34	2	1.76
76	35	1	0.88
	34	1	0.88
75	35	2	1.76
	34	1	0.88
74	34	1	0.88
73	33	1	0.88
72	33	1	0.88

[SAME TO END OF TABLE] [FX. PT.] [FX. PT.] [FX. PT.] [FL. PT.] [SAME TO END OF TABLE]

[169] [3 OR 4]

[170] [KEY 2] [1]

CASE NUMBER 100 54 200 5

MOMENTS OF THE ENERGY DISTRIBUTIONS FOR THE FOLLOWING EVAPORATION PARTICLES

	NEUTRONS	PROTONS	DEUTERONS	TRITONS	HE3	ALPHAS
1ST MOM.	3.63663E 00	8.95543E 00	1.11969E 01	1.10484E 01	1.85128E 01	1.74497E 01
2ND MOM.	2.58257E 01	9.18450E 01	1.57574E 02	1.39324E 02	3.68299E 02	3.28803E 02
3RD MOM.	2.79230E 02	1.10388E 03	2.29620E 03	2.03284E 03	7.87015E 03	6.86830E 03

NORMALIZED EVAPORATION NEUT SPECTRUM
(E SPECIFIES THE LOWER ENERGY LIMIT OF THE INTERVAL IN MEV)

[SAME TO END OF TABLE]

E										
0	0.104586	0.165728	0.204344	0.217216	0.213998	0.238134	0.204344	0.213998	0.212389	0.223652
1	0.222043	0.228479	0.230088	0.233307	0.201126	0.220434	0.218825	0.196299	0.178600	0.164119
2	0.168946	0.178600	0.176991	0.160901	0.164119	0.165728	0.149638	0.135157	0.131939	0.157683
3	0.143202	0.139984	0.133548	0.114240	0.099759	0.117458	0.101368	0.082060	0.090105	0.091714
4	0.098150	0.107804	0.082060	0.090105	0.070796	0.072405	0.080451	0.075623	0.078842	0.065969
5	0.059533	0.067578	0.062751	0.043443	0.069187	0.051488	0.062751	0.057924	0.049879	0.057924
6	0.051488	0.049879	0.040225	0.037007	0.033789	0.037007	0.049879	0.037007	0.043443	0.040225
7	0.041834	0.041834	0.032180	0.028962	0.025744	0.037007	0.028962	0.028962	0.033789	0.020917
8	0.032180	0.028962	0.030571	0.022526	0.024135	0.025744	0.037007	0.028962	0.022526	0.016090
9	0.020917	0.019308	0.017699	0.028962	0.014481	0.019308	0.016090	0.035398	0.014481	0.008045
10	0.019308	0.011263	0.011263	0.004827	0.017699	0.016090	0.012872	0.011263	0.003218	0.019308
11	0.019308	0.004827	0.008045	0.011263	0.009654	0.012872	0.014481	0.006436	0.009654	0.008045
12	0.006436	0.016090	0.011263	0.006436	0.012872	0.004827	0.006436	0.009654	0.014481	0.004827
13	0.003218	0.011263	0.008045	0.008045	0.008045	0.008045	0.001609	0.004827	0.003218	0.003218
14	0.009654	0.008045	0.006436	0.001609	0.004827	0.003218	0.006436	0.001609	0.003218	0.003218
15	0.004827	0.001609	0.008045	0.006436	0.004827	0.003218	0.006436	0.008045	0.001609	0.003218
16	0.003218	0.003218	0.	0.004827	0.008045	0.004827	0.	0.001609	0.001609	0.003218
17	0.004827	0.004827	0.001609	0.001609	0.003218	0.001609	0.003218	0.	0.	0.
18	0.001609	0.001609	0.	0.	0.003218	0.	0.003218	0.001609	0.	0.001609
19	0.001609	0.001609	0.	0.001609	0.	0.	0.	0.001609	0.001609	0.
20	0.001609	0.	0.001609	0.001609	0.003218	0.	0.	0.	0.	0.001609
21	0.	0.	0.001609	0.001609	0.	0.001609	0.	0.	0.	0.001609
22	0.	0.	0.001609	0.003218	0.	0.	0.	0.	0.003218	0.003218
23	0.001609	0.001609	0.001609	0.	0.001609	0.	0.	0.	0.	0.003218
24	0.	0.	0.	0.001609	0.	0.001609	0.001609	0.	0.	0.001609

[FL. PT.]

[201] CASE NUMBER 100 64 200 8 [4]

[202] [1]

NORMALIZED EVAPCRATION PROTON SPECTRUM
(E SPECIFIES THE LOWER ENERGY LIMIT OF THE INTERVAL IN MEV)

[203] [11]

[204] [11]

[SAME TO END OF TABLE]

E										
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.007305	0.	0.007305	0.014609
5	0.065741	0.029218	0.073046	0.080351	0.080351	0.241052	0.153397	0.175310	0.189920	0.219138
6	0.211833	0.219138	0.211833	0.233747	0.175310	0.182615	0.248356	0.292184	0.189920	0.284879
7	0.138787	0.153397	0.109569	0.146092	0.138787	0.116874	0.241052	0.131483	0.124178	0.138787
8	0.204529	0.138787	0.153397	0.080351	0.146092	0.116874	0.124178	0.116874	0.080351	0.109569
9	0.102264	0.116874	0.102264	0.080351	0.102264	0.109569	0.116874	0.109569	0.102264	0.065741
10	0.080351	0.073046	0.109569	0.087655	0.065741	0.102264	0.014609	0.080351	0.051132	0.058437
11	0.043828	0.051132	0.036523	0.094960	0.021914	0.021914	0.065741	0.051132	0.051132	0.051132
12	0.036523	0.029218	0.058437	0.014609	0.058437	0.043828	0.036523	0.029218	0.014609	0.014609
13	0.036523	0.014609	0.043828	0.043828	0.014609	0.029218	0.007305	0.036523	0.029218	0.014609
14	0.029218	0.021914	0.007305	0.014609	0.043828	0.021914	0.007305	0.043828	0.014609	0.029218
15	0.007305	0.029218	0.029218	0.007305	0.014609	0.	0.	0.021914	0.007305	0.
16	0.021914	0.007305	0.029218	0.007305	0.036523	0.	0.029218	0.007305	0.	0.014609
17	0.021914	0.007305	0.014609	0.	0.021914	0.014609	0.007305	0.	0.007305	0.014609
18	0.007305	0.021914	0.007305	0.007305	0.	0.	0.007305	0.	0.007305	0.
19	0.	0.007305	0.	0.014609	0.014609	0.007305	0.	0.	0.007305	0.007305
20	0.	0.021914	0.007305	0.007305	0.	0.007305	0.	0.	0.	0.007305
21	0.	0.007305	0.	0.007305	0.	0.007305	0.	0.	0.	0.007305
22	0.007305	0.	0.014609	0.	0.007305	0.	0.007305	0.014609	0.007305	0.
23	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.007305	0.	0.	0.	0.

[FL. PT.]

[227] [11]

[228] CASE NUMBER (100) (64) (200) (8) [4]

[229] [1]

NORMALIZED EVAPCRATION DEUT SPECTRUM
(E SPECIFIES THE LOWER ENERGY LIMIT OF THE INTERVAL IN MEV)

[230] [11]

E										
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.061728	0.074074	0.111111	0.086420	0.061728	0.111111	0.098765	0.148148	0.172840	0.111111
10	0.086420	0.098765	0.086420	0.037037	0.049383	0.024691	0.061728	0.086420	0.024691	0.049383
15	0.024691	0.049383	0.037037	0.012346	0.012346	0.049383	0.024691	0.012346	0.024691	0.024691
20	0.	0.	0.	0.	0.	0.024691	0.012346	0.	0.	0.
25	0.	0.	0.024691	0.	0.	0.	0.	0.024691	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

[SAME TO END OF TABLE] ↓ [FL.] [PT.]

[239] [11]

[240] [1]

NORMALIZED EVAPCRATION TRITON SPECTRUM
(E SPECIFIES THE LOWER ENERGY LIMIT OF THE INTERVAL IN MEV)

[241] [11]

E										
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.046512	0.093023	0.186047	0.093023	0.186047	0.186047	0.139535	0.046512
10	0.279070	0.046512	0.046512	0.046512	0.046512	0.093023	0.046512	0.	0.093023	0.046512
15	0.	0.046512	0.	0.046512	0.	0.	0.093023	0.	0.	0.
20	0.	0.	0.	0.	0.046512	0.	0.	0.	0.	0.
25	0.046512	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

[SAME TO END OF TABLE] ↓ [FL.] [PT.]

[250] [11]

[251] [1]

NORMALIZED EVAPCRATION HE3 SPECTRUM
(E SPECIFIES THE LOWER ENERGY LIMIT OF THE INTERVAL IN MEV)

[252] [11]

E										
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.153846	0.	0.	0.	0.153846	0.307692	0.
15	0.153846	0.	0.153846	0.	0.153846	0.	0.	0.153846	0.153846	0.
20	0.	0.	0.	0.153846	0.153846	0.	0.	0.	0.	0.
25	0.	0.153846	0.	0.	0.	0.	0.	0.	0.	0.
30	0.153846	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

[SAME TO END OF TABLE] ↓ [FL.] [PT.]

[261] [11]

[262] [1]

NORMALIZED EVAPCRATION ALPHA SPECTRUM
(E SPECIFIES THE LOWER ENERGY LIMIT OF THE INTERVAL IN MEV)

[263] [11]

E										
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.010417	0.010417	0.020833	0.052083	0.062500	0.093750	0.197917	0.177083	0.166667
15	0.052083	0.125000	0.125000	0.072917	0.052083	0.062500	0.104167	0.093750	0.062500	0.083333
20	0.062500	0.020833	0.020833	0.	0.031250	0.031250	0.	0.010417	0.041667	0.010417
25	0.010417	0.010417	0.	0.010417	0.031250	0.	0.010417	0.020833	0.010417	0.
30	0.	0.	0.010417	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.010417	0.	0.	0.	0.010417	0.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.010417
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

[SAME TO END OF TABLE] ↓ [FL.] [PT.]

[272] [11]

[273]	777777 [(THIS RECORD IS MEANINGLESS)]	[1]
[274]	[065343 (OCTAL) OR 27363 (DECIMAL) (END OF TAPE)]	[1]

Angular Momentum Code

The Angular Momentum Code uses data from the Primary Output Tape created by the Cascade Code to provide information on the angular momentum distributions of the incident particles and of the nucleus after the cascade is completed.[3] In addition to the printed output and binary tape, which all of the analysis codes generate (see section entitled Binary Tapes), the Angular Momentum Code generates a "plotting" tape. This tape may be used directly with a Calcomp automatic plotter to plot histograms of the data calculated by this code.

Input Data

The only information required by the Angular Momentum Code, other than the data from the Cascade Code, is the size of the angular momentum intervals in units of $\hbar$ for which the angular momentum distributions are to

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[3] H. W. Bertini, Angular Momentum in Low Energy Cascade Calculations, ORNL-TM-1033 (February 1965).

be calculated. The code will then calculate the distributions for 100 intervals of the selected size or until the entire angular momentum range is covered, if this can be done with fewer than 100 intervals. Distributions are calculated for up to 200 intervals for the parallel component of the angular momentum remaining in the nucleus, since this angular momentum range can have negative as well as positive values. If the entire angular momentum range is covered by the calculation, the "Sum of Values Times Angular Momentum Interval" appearing at the foot of each table will equal 1. An angular momentum interval of 1 $\hbar$ has been found to be an appropriate choice for many distributions.

Input Card

One input card is required for each case to be analyzed.

Column		Format
1-3	File number on the Primary Output Tape where the case to be analyzed is located	I3
4-18	Angular momentum interval for the histogram of the distribution of the angular momentum of the incident particles (see discussion of Input Data)	F15.7
19-33	Angular momentum interval for the histogram of the distribution of total angular momentum of the nucleus	"
34-48	Angular momentum interval for the histogram of the distribution of the parallel component of the angular momentum of the nucleus	"

Column		Format
49-63	Angular momentum interval for the histogram of the distribution of the perpendicular component of angular momentum of the nucleus	F15.7
64-65	Signal for error bars on graphs. 0 or blank: with error bars;+1: without error bars;-1: both with and without error bars (two graphs for each table)	I2
66-72	Signal for generating plotting tape. 0 or blank: no tape generated; 1: tape generated; greater than 1: abscissa contracted by this factor (see following discussion of Plotting Tape); -1: ordinate contracted by 25%	I7

Plotting Tape

No additional information is required to generate the plotting tape. The machine scans the data calculated by the Angular Momentum Code and selects appropriate ranges of values for the ordinate and abscissa of each graph. However, if distributions have been calculated that have fewer than 10 non-zero-valued intervals, it is possible to contract the length of the abscissa by punching a number greater than 1 in columns 66 to 72 of the input card. For example, if the number 3 is punched on the input card, the abscissa will be one-third of its usual length, although the range of values will remain the same. This option was included to improve the appearance of graphs having only a few angular momentum intervals.

If the graph extends into the case identification box in the upper right-hand corner of the page, the ordinate may be contracted by 25% without changing the range of values by punching a -1 in columns 66 to 72 of the input card. No negative number other than one is permitted to be punched, and so the ordinate and abscissa may not be contracted on the same graph.

The program for the plotting tape employs a subroutine "plotting package" entitled INTRIGUE,[4] to which users of the plotting tape should refer if more information is needed.

Tape Assignments

The Primary Output Tape created by the Cascade Code, logical tape 9,* is assigned to B5. The binary tape, logical tape 8, is assigned to B8, and the plotting tape, logical tape 7, is assigned to A6. A scratch tape, logical 3, is assigned to B3. These three tapes are initially provided by the installation as PØØL tapes. The BCD input and output tapes have the same assignments as they do in running the cascade Code.

Trouble Shooting

The Angular Momentum Code prints only one error statement: VALUE FOR LAST RECORD OF NUMBER OF RECORDS AND COUNT OF RECORDS IS DIFFERENT. This is similar to error statement 5 in Analysis Code I. Try once more, and if still unsuccessful, rerun the Cascade Code.

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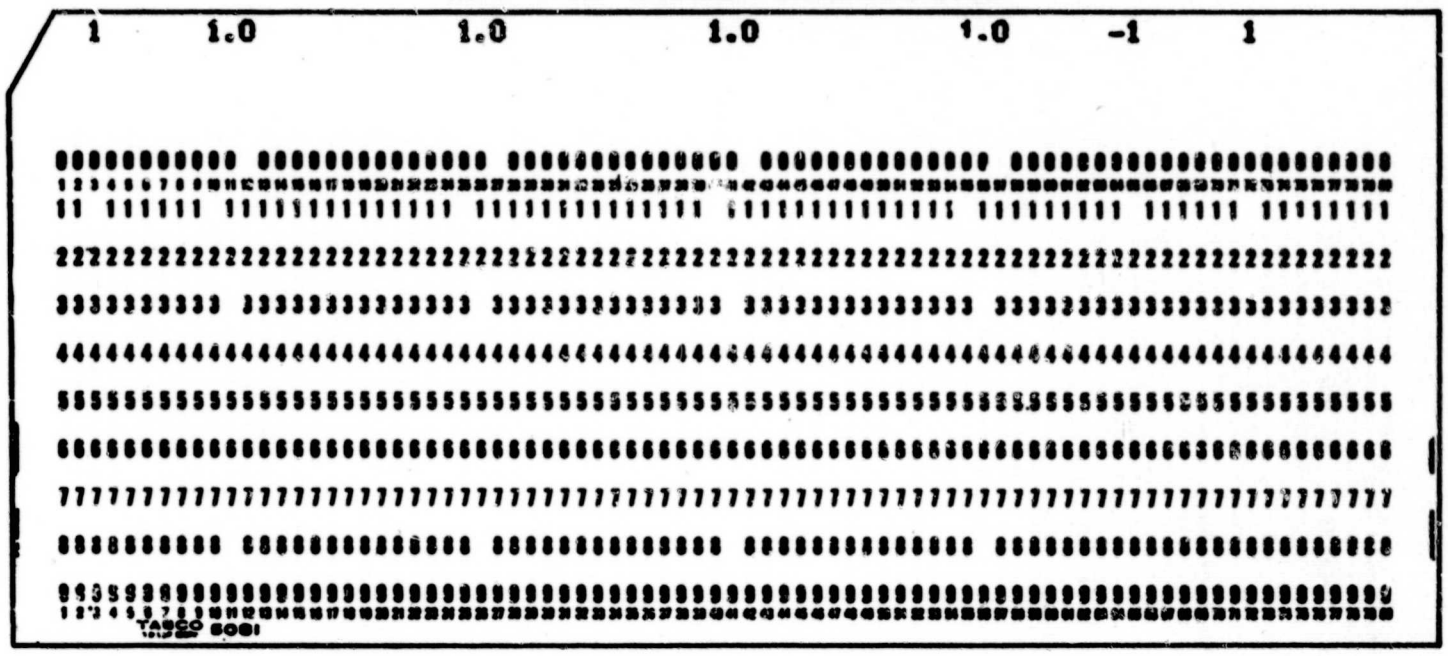
[4] M. B. Emmett, INTRIGUE, An IBM-7090 Subroutine Package for Making Linear, Logarithmic and Semilogarithmic Graphs Using the Calcomp Plotter, ORNL-3581 (March 1964).

*The same tapes are not required to have the same logical numbers in different codes. Although the logical number for the Primary Output Tape is 2 in the Cascade, Analysis I, II, and Evaporation Codes, it is 9 in the Angular Momentum Code.

Example

The input card and printed output for the Angular Momentum Code are illustrated for the sample case used throughout this manual. Angular momentum intervals of 1 h were selected for all four tables, a plotting tape was generated, and graphs both with and without error bars were requested.

INPUT CARD - ANGULAR MOMENTUM CODE



EXPLANATORY NOTES

THE •VALUE OF DISTRIBUTION• APPEARING IN THE FOLLOWING TABLES IS THE FRACTION OF THE TOTAL NUMBER OF EVENTS THAT LIE IN THE ANGULAR MOMENTUM INTERVAL INDICATED DIVIDED BY THE SIZE OF THE ANGULAR MOMENTUM INTERVAL.

•ERROR• REPRESENTS ONE HALF OF A 68-PERCENT CONFIDENCE INTERVAL. THIS •ERROR• IS DUE TO THE STATISTICAL NATURE OF THE CALCULATION.

THE •SUM OF VALUES TIMES ANGULAR MOMENTUM INTERVAL• FOUND AT THE FOOT OF EACH TABLE IS THE AREA OF THE DISTRIBUTION OVER THE ANGULAR MOMENTUM RANGE OF THE TABLE. THIS AREA WILL EQUAL 1.00 WHEN THE ENTIRE ANGULAR MOMENTUM RANGE IS COVERED.

THE •AVERAGE VALUE OF THIS DISTRIBUTION• REPRESENTS THE AVERAGE VALUE OF THE ANGULAR MOMENTUM OVER THE RANGE OF VALUES INCLUDED IN THE TABLE.

NOTE: The circles, rectangles, underlines, and the words, and numbers in brackets on the pages of printed output illustrated in this manual do not appear on the actual printed output. These marks have been added to provide information about the data stored on the binary tapes. (See section entitled Binary Tapes, page 118 of this manual.)

[RECORD] [NUMBER OF WORDS IN RECORD]

PAGE 1

[1] INCIDENT PARTICLE	INC. LAB K.E.(MEV)	TARGET SYMB.	A	Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	INELASTIC X-SEC.(MB)	[10]
PI-	200.	RU	100.	44.	02000	4.24	1756.5	01559	1369.2	

DISTRIBUTION OF THE ANGULAR MOMENTUM OF THE INCIDENT PARTICLES

(THE ANGULAR MOMENTUM IS PERPENDICULAR TO THE INCIDENT PARTICLE DIRECTION)

[2] ANGULAR MOMENTUM INTERVAL (UNITS OF H BAR) [WORD 1] (NUMBER OF WORDS TO FOLLOW IN RECORD)		VALUE OF DISTRIBUTION		ERROR (ONE STANDARD DEVIATION)	
0. TO	1.00000	0.962155E-02		0.247229E-02	[(WORD 1) + 1]
1.00000 TO	2.00000	0.282232E-01		0.419436E-02	
2.00000 TO	3.00000	0.461835E-01		0.531560E-02	
3.00000 TO	4.00000	0.654266E-01		0.626269E-02	
4.00000 TO	5.00000	0.840282E-01		0.702636E-02	
5.00000 TO	6.00000	0.102630E-00		0.768599E-02	
6.00000 TO	7.00000	0.120590E-00		0.824762E-02	
7.00000 TO	8.00000	0.139833E-00		0.878362E-02	
8.00000 TO	9.00000	0.150096E-00		0.904579E-02	
9.00000 TO	10.00000	0.110327E-00		0.793475E-02	
10.00000 TO	11.00000	0.101547E-00		0.764326E-02	
11.00000 TO	12.00000	0.416934E-01		0.506247E-02	

[FL. PT.] [FL. PT.] [FL. PT.]

SUM OF VALUES TIMES ANGULAR MOMENTUM INTERVAL EQUALS 1.00000

AVERAGE VALUE OF THIS DISTRIBUTION EQUALS 7.0360 (IN UNITS OF H BAR)

INCIDENT PARTICLE	INC. LAB K.E.(MEV)	TARGET SYMB.	A	Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	INELASTIC X-SEC.(MB)
PI-	200.	RU	100.	44.	02000	4.24	1756.5	01559	1369.2

DISTRIBUTION OF THE TOTAL ANGULAR MOMENTUM

REMAINING IN THE NUCLEUS AT THE COMPLETION OF THE CASCADE

[3]

ANGULAR MOMENTUM INTERVAL (UNITS OF H BAR) [WORD 1]			VALUE OF DISTRIBUTION	ERROR (ONE STANDARD DEVIATION)
0.	TO	1.00000	0.320718E-02	0.143199E-02
1.00000	TO	2.00000	0.705580E-02	0.211989E-02
2.00000	TO	3.00000	0.173188E-01	0.330402E-02
3.00000	TO	4.00000	0.250160E-01	0.395535E-02
4.00000	TO	5.00000	0.250160E-01	0.395535E-02
5.00000	TO	6.00000	0.397691E-01	0.494923E-02
6.00000	TO	7.00000	0.372033E-01	0.479331E-02
7.00000	TO	8.00000	0.365619E-01	0.475339E-02
8.00000	TO	9.00000	0.545221E-01	0.575028E-02
9.00000	TO	10.00000	0.493906E-01	0.548783E-02
10.00000	TO	11.00000	0.596536E-01	0.599845E-02
11.00000	TO	12.00000	0.500321E-01	0.552148E-02
12.00000	TO	13.00000	0.519564E-01	0.562096E-02
13.00000	TO	14.00000	0.519564E-01	0.562096E-02
14.00000	TO	15.00000	0.609365E-01	0.605847E-02
15.00000	TO	16.00000	0.416934E-01	0.506247E-02
16.00000	TO	17.00000	0.551636E-01	0.578204E-02
17.00000	TO	18.00000	0.628608E-01	0.614708E-02
18.00000	TO	19.00000	0.551636E-01	0.578204E-02
19.00000	TO	20.00000	0.570879E-01	0.587604E-02
20.00000	TO	21.00000	0.481078E-01	0.541974E-02
21.00000	TO	22.00000	0.327133E-01	0.450523E-02
22.00000	TO	23.00000	0.166774E-01	0.324331E-02
23.00000	TO	24.00000	0.218089E-01	0.369918E-02
24.00000	TO	25.00000	0.141116E-01	0.298730E-02
25.00000	TO	26.00000	0.102630E-01	0.255255E-02
26.00000	TO	27.00000	0.449006E-02	0.169327E-02
27.00000	TO	28.00000	0.449006E-02	0.169327E-02
28.00000	TO	29.00000	0.192431E-02	0.110993E-02
29.00000	TO	30.00000	0.641437E-03	0.641231E-03
30.00000	TO	31.00000	0.192431E-02	0.110993E-02
31.00000	TO	32.00000	0.641437E-03	0.641231E-03
32.00000	TO	33.00000	0.641437E-03	0.641231E-03

[FL. PT.] [FL. PT.] [FL. PT.]

[(WORD 1)+1]

SUM OF VALUES TIMES ANGULAR MOMENTUM INTERVAL EQUALS 1.00000

AVERAGE VALUE OF THIS DISTRIBUTION EQUALS 13.7475 (IN UNITS OF H BAR)

INCIDENT PARTICLE	INC. LAB K.E.(MEV)	TARGET SYMB.	A	Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	INELASTIC X-SEC.(MB)
PI-	200.	RU	100.	44.	02000	4.24	1756.5	01559	1369.2

DISTRIBUTION OF THE PARALLEL COMPONENT OF THE ANGULAR MOMENTUM

REMAINING IN THE NUCLEUS AT THE COMPLETION OF THE CASCADE

(PARALLEL WITH RESPECT TO THE DIRECTION OF THE INCIDENT PARTICLE)

[4]

ANGULAR MOMENTUM INTERVAL (UNITS OF H BAR) [(WORD 1)]		VALUE OF DISTRIBUTION	ERROR (ONE STANDARD DEVIATION)
-13.00000 TO	-12.00000	0.641437E-03	0.641231E-03
-12.00000 TO	-11.00000	0.192431E-02	0.110993E-02
-11.00000 TO	-10.00000	0.128287E-02	0.906547E-03
-10.00000 TO	-9.00000	0.256575E-02	0.128123E-02
-9.00000 TO	-8.00000	0.705580E-02	0.211989E-02
-8.00000 TO	-7.00000	0.109044E-01	0.263025E-02
-7.00000 TO	-6.00000	0.173188E-01	0.330402E-02
-6.00000 TO	-5.00000	0.269403E-01	0.410061E-02
-5.00000 TO	-4.00000	0.333547E-01	0.454767E-02
-4.00000 TO	-3.00000	0.545221E-01	0.575028E-02
-3.00000 TO	-2.00000	0.865940E-01	0.712283E-02
-2.00000 TO	-1.00000	0.106479E-00	0.781197E-02
-1.00000 TO	-0.	0.152662E-00	0.910900E-02
-0. TO	1.00000	0.138550E-00	0.874975E-02
1.00000 TO	2.00000	0.106479E-00	0.781197E-02
2.00000 TO	3.00000	0.910840E-01	0.728719E-02
3.00000 TO	4.00000	0.577293E-01	0.590695E-02
4.00000 TO	5.00000	0.391276E-01	0.491079E-02
5.00000 TO	6.00000	0.269403E-01	0.410061E-02
6.00000 TO	7.00000	0.141116E-01	0.298730E-02
7.00000 TO	8.00000	0.833868E-02	0.230307E-02
8.00000 TO	9.00000	0.577293E-02	0.191875E-02
9.00000 TO	10.00000	0.641437E-02	0.202189E-02
10.00000 TO	11.00000	0.641437E-03	0.641231E-03
11.00000 TO	12.00000	0.	0.
12.00000 TO	13.00000	0.	0.
13.00000 TO	14.00000	0.128287E-02	0.906547E-03
14.00000 TO	15.00000	0.	0.
15.00000 TO	16.00000	0.	0.
16.00000 TO	17.00000	0.128287E-02	0.906547E-03

[FL. PT.] [FL. PT.] [FL. PT.] [(WORD 1) + 1]

SUN OF VALUES TIMES ANGULAR MOMENTUM INTERVAL EQUALS 1.00000

AVERAGE VALUE OF THIS DISTRIBUTION EQUALS 0.0233 (IN UNITS OF H BAR)

INCIDENT PARTICLE	INC. LAB K.E.(MEV)	TARGET SYMB.	A	Z	NO. OF INC. PARTICLES	CUTOFF EN.(MEV)	GEOMETRIC X-SEC.(MB)	NO. OF INC. PART. COLLISIONS	INELASTIC X-SEC.(MB)
PI-	200.	RU	100.	44.	02000	4.24	1756.5	01559	1369.2

DISTRIBUTION OF THE PERPENDICULAR COMPONENT OF THE ANGULAR MOMENTUM

REMAINING IN THE NUCLEUS AT THE COMPLETION OF THE CASCADE

(PERPENDICULAR WITH RESPECT TO THE DIRECTION OF THE INCIDENT PARTICLE)

ANGULAR MOMENTUM INTERVAL (UNITS OF H BAR) [(WORD 7)]			VALUE OF DISTRIBUTION	ERROR (ONE STANDARD DEVIATION)
0.	TO	1.00000	0.577293E-02	0.191875E-02
1.00000	TO	2.00000	0.121873E-01	0.277887E-02
2.00000	TO	3.00000	0.211674E-01	0.364557E-02
3.00000	TO	4.00000	0.307890E-01	0.437506E-02
4.00000	TO	5.00000	0.288647E-01	0.424033E-02
5.00000	TO	6.00000	0.436177E-01	0.517278E-02
6.00000	TO	7.00000	0.352790E-01	0.467236E-02
7.00000	TO	8.00000	0.506735E-01	0.555489E-02
8.00000	TO	9.00000	0.538807E-01	0.571829E-02
9.00000	TO	10.00000	0.493906E-01	0.548783E-02
10.00000	TO	11.00000	0.525978E-01	0.565364E-02
11.00000	TO	12.00000	0.487492E-01	0.545391E-02
12.00000	TO	13.00000	0.609365E-01	0.605847E-02
13.00000	TO	14.00000	0.423348E-01	0.509956E-02
14.00000	TO	15.00000	0.538807E-01	0.571829E-02
15.00000	TO	16.00000	0.487492E-01	0.545391E-02
[5] 16.00000	TO	17.00000 [FL. PT.]	0.525978E-01 [FL. PT.]	0.565364E-02 [FL. PT.] [(WORD 1) + 1]
17.00000	TO	18.00000	0.551636E-01	0.578204E-02
18.00000	TO	19.00000	0.538807E-01	0.571829E-02
19.00000	TO	20.00000	0.513149E-01	0.558805E-02
20.00000	TO	21.00000	0.487492E-01	0.545391E-02
21.00000	TO	22.00000	0.295061E-01	0.428577E-02
22.00000	TO	23.00000	0.134702E-01	0.291957E-02
23.00000	TO	24.00000	0.205260E-01	0.359108E-02
24.00000	TO	25.00000	0.134702E-01	0.291957E-02
25.00000	TO	26.00000	0.962155E-02	0.247229E-02
26.00000	TO	27.00000	0.384862E-02	0.156817E-02
27.00000	TO	28.00000	0.320718E-02	0.143199E-02
28.00000	TO	29.00000	0.192431E-02	0.110993E-02
29.00000	TO	30.00000	0.192431E-02	0.110993E-02
30.00000	TO	31.00000	0.641437E-03	0.641231E-03
31.00000	TO	32.00000	0.641437E-03	0.641231E-03
32.00000	TO	33.00000	0.641437E-03	0.641231E-03

SUM OF VALUES TIMES ANGULAR MOMENTUM INTERVAL EQUALS 1.00000

AVERAGE VALUE OF THIS DISTRIBUTION EQUALS 13.2727 (IN UNITS OF H BAR)

[6] [(065343) (OCTAL) OR (27362) (DECIMAL) (END OF TAPE)] [1]

Nuclear Configuration Code

The Cross Section Tape used by the Cascade Code contains both basic particle-particle cross-section data and data pertaining to the target nuclear configuration, where the information of the latter type is given in the first four records. The Nuclear Configuration Code will create a new tape where the target nuclear configuration data have been changed but the particle-particle cross-section data remain the same. The nuclear configuration data consist of the radii of the three regions used to approximate the continuous nucleon density distribution,[1] the density per nucleon (divided by 10^{30} as a scale factor) for each region, and the Fermi energy per nucleon* for each region for all values of A from 1 to 239.** The data for A from 1 to 60 is contained on the first record; that for A from 61 to 120 is contained on the second record, etc.

The nuclear radii are determined by the distances at which the continuous density distribution reaches various fractions of the central density, i.e., the radii R_i are defined by $\rho(R_i) = \alpha_i \rho(0)$, $i = 1, 2, 3$, where $\rho(R_i)$ is the density at radius R_i, $\rho(0)$ is the central density, and α_i is the fraction of the central density. For the configuration used on the Source Program Tape supplied to the user, which is the configuration used

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*Actually a quantity E is given such that the Fermi energy for either protons or neutrons is obtained by multiplying E by the 2/3 power of the number of nucleons (either protons or neutrons) in the nucleus.

**The printed output from this code, described later, contains data for values of A from 1 to 239. The information that is written on the tape created by this code will appear to contain data for values of A from 1 to 240. The data corresponding to A = 240 on the tape is incorrect, therefore the Cascade Code should never be used for nuclei with a mass number of 240.

elsewhere,[1] the fractions of the central density were $\alpha_1 = 0.9$, $\alpha_2 = 0.2$, and $\alpha_3 = 0.01$. The data are normalized so that the sum of the products of proton densities by volumes in each region, as calculated by the Cascade Code, is equal to the atomic number of the nucleus, no matter what fractions of the central density are used. The same type of normalization applies to the neutrons.

In changing the nuclear configuration the user should always be sure that $\alpha_1 > \alpha_2 > \alpha_3$. The α's should not be equal to each other. If desired, a tape can be generated that contains nuclear configuration data applicable to a uniform nucleon density distribution to a very good approximation. This can be accomplished, for example, by setting $\alpha_1 = 0.012$, $\alpha_2 = 0.011$, and $\alpha_3 = 0.010$ when the same nuclear volume as the configuration on the Source Program Tape is desired.

Operation

Two tapes are required in the operation of this code. One is the tape that will serve as the newly generated Cross Section Tape, and the other is any current Cross Section Tape. The code generates the nuclear configuration data, and after writing this information as the first four records on the new tape, it copies the cross-section data from the current tape onto the remaining records of the new tape, thus completing a new Cross Section Tape.

Input (one card only)

Columns		Format
1-10	α_1	F10.4
11-20	α_2	"
21-30	α_3	"
38-40	.05 (a constant used by the code)	

Output

In addition to generating a new Cross Section Tape, the code produces several sheets of printed output. The first few pages give values for the function

$$F_n(x) = \int_0^x \frac{y^n \, dy}{e^y + 1}$$

for n = 0, 1, 2 and for values of x ranging from -14 to +14. This particular function is needed by the code in the calculation of the new quantities associated with the nuclear configuration.

The remainder of the output contains the new data generated by the code and placed on the first four records of the new tape, i.e., for every value of A from 1 to 239 it gives the radii of regions 1, 2, and 3 (labeled R1, R2, R3) in centimeters, the density per nucleon for each region* (labeled RHO1/A, RHO2/A, RHO3/A), and the Fermi energy per nucleon in each region** (labeled E1, E2, and E3). There is one column of output that gives the 1/3 power of A, but this is not written on the new tape.

A binary tape is not created by this code.

Tape Assignments

Logical tape 4 is the existing Cross Section Tape, which is to be modified, and is assigned toB5 . Logical 3 is the tape to be created,

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*For example, the proton density in region 1, the innermost region, will be given by (RHO1/A) x Z x 10^{30} and the units of the product are protons per cm^3. Z is the atomic number of the nucleus. The neutron density in the same region is given by (RHO1/A) x N x 10^{30}, where N is the number of neutrons in the nucleus.

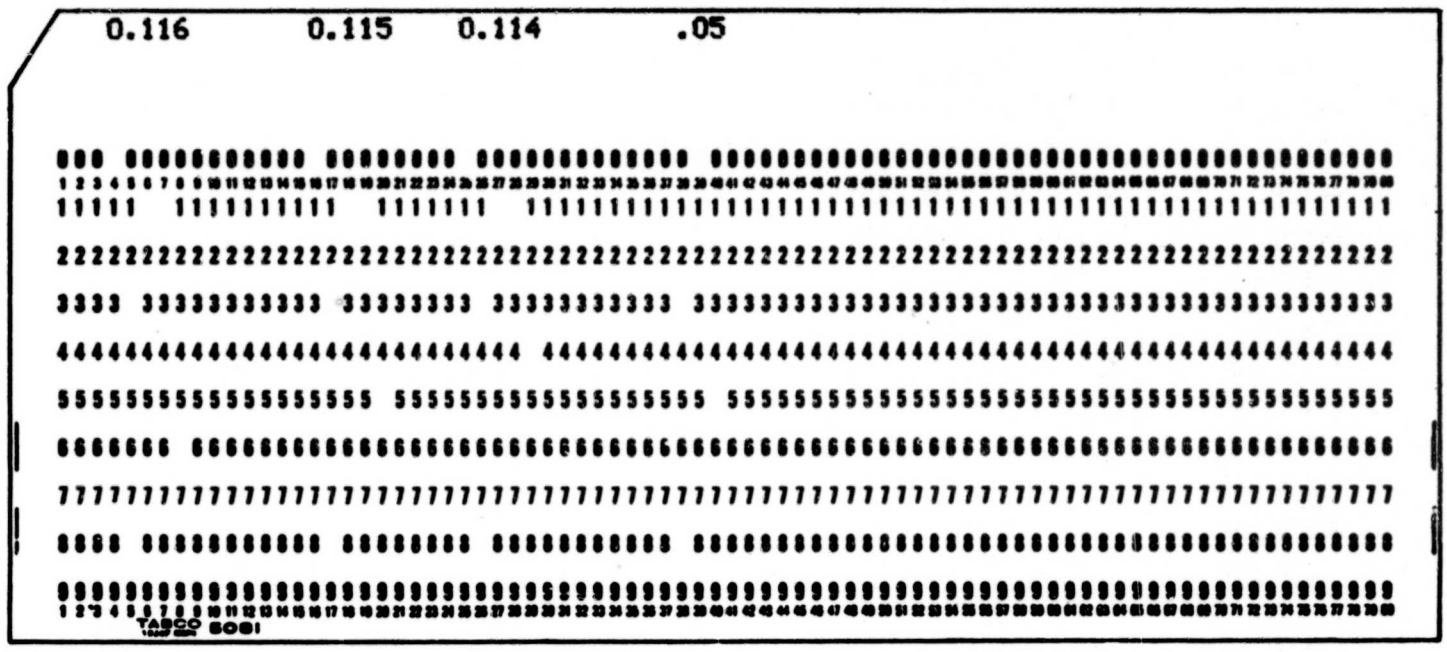
**The Fermi energy in MeV for the protons in region 1 is given by E1 x $Z^{2/3}$. The Fermi energy for the neutrons is E1 x $N^{2/3}$.

and it is assigned to A5. The user should ask that this tape be supplied as a pool tape and then have it registered to him for as long as needed. The BCD input and output tapes have the same assignments as they have had in all of the other codes.

Example

The card illustrated below, if used as input to the Nuclear Configuration Code, will produce a cross-section tape with $\alpha_1 = 0.116$, $\alpha_2 = 0.115$, and $\alpha_3 = 0.114$. The printed output received from this sample is illustrated on pages 104 to 114. The printed output from the cascade code using the newly created Primary Output Tape is illustrated on pages 115 to 117. A comparison of page 117 with page 21 will illustrate some of the differences in the nuclear configurations.

INPUT CARD - NUCLEAR CONFIGURATION CODE



X	F0(X)	F1(X)	F2(X)
-14.0	-13.3068480	97.1775179	-912.8635635
-13.9	-13.2068481	95.7825193	-893.4032516
-13.8	-13.1068484	94.3975210	-874.2209396
-13.7	-13.0068486	93.0225229	-855.3146286
-13.6	-12.9068488	91.6575251	-836.6823196
-13.5	-12.8068490	90.3025274	-818.3220139
-13.4	-12.7068492	88.9575300	-800.2317123
-13.3	-12.6068494	87.6225328	-782.4094086
-13.2	-12.5068496	86.2975359	-764.8531113
-13.1	-12.4068499	84.9825392	-747.5608139
-13.0	-12.3068502	83.6775427	-730.5305252
-12.9	-12.2068505	82.3825464	-713.7602386
-12.8	-12.1068509	81.0975504	-697.2479553
-12.7	-12.0068512	79.8225546	-680.9916763
-12.6	-11.9068515	78.5575590	-664.9893951
-12.5	-11.8068520	77.3025637	-649.2391205
-12.4	-11.7068524	76.0575695	-633.7388535
-12.3	-11.6068529	74.8225756	-618.4865875
-12.2	-11.5068535	73.5975819	-603.4803314
-12.1	-11.4068540	72.3825884	-588.7180786
-12.0	-11.3068547	71.1775961	-574.1978378
-11.9	-11.2068554	69.9826040	-559.9176025
-11.8	-11.1068562	68.7976131	-545.8753738
-11.7	-11.0068570	67.6226225	-532.0691528
-11.6	-10.9068580	66.4576330	-518.4969406
-11.5	-10.8068590	65.3026447	-505.1567421
-11.4	-10.7068602	64.1576576	-492.0465508
-11.3	-10.6068615	63.0226717	-479.1643715
-11.2	-10.5068629	61.8976865	-466.5082054
-11.1	-10.4068644	60.7827029	-454.0760536
-11.0	-10.3068660	59.6777205	-441.8659172
-10.9	-10.2068678	58.5827398	-429.8757973
-10.8	-10.1068698	57.4977612	-418.1036949
-10.7	-10.0068721	56.4227848	-406.5476112
-10.6	-9.9068745	55.3578105	-395.2055473
-10.5	-9.8068773	54.3028383	-384.0755081
-10.4	-9.7068802	53.2578688	-373.1554947
-10.3	-9.6068835	52.2229023	-362.4435081
-10.2	-9.5068871	51.1979389	-351.9375496
-10.1	-9.4068910	50.1829786	-341.6356201
-10.0	-9.3068954	49.1780224	-331.5357246
-9.9	-9.2069002	48.1830702	-321.6358643
-9.8	-9.1069056	47.1981225	-311.9340439
-9.7	-9.0069115	46.2231798	-302.4282684
-9.6	-8.9069180	45.2582421	-293.1165390
-9.5	-8.8069252	44.3033104	-283.9968567
-9.4	-8.7069331	43.3583851	-275.0672302
-9.3	-8.6069419	42.4234667	-266.3256607
-9.2	-8.5069516	41.4985557	-257.7701530
-9.1	-8.4069623	40.5836530	-249.3987122

X	F0(X)	F1(X)	F2(X)
-9.0	-8.3069741	39.6787596	-241.2093410
-8.9	-8.2069871	38.7838759	-233.2000484
-8.8	-8.1070015	37.8990030	-225.3688393
-8.7	-8.0070175	37.0241418	-217.7137203
-8.6	-7.9070351	36.1592937	-210.2326984
-8.5	-7.8070545	35.3044596	-202.9237804
-8.4	-7.7070759	34.4596405	-195.7849751
-8.3	-7.6070996	33.6248384	-188.8142910
-8.2	-7.5071257	32.8000541	-182.0097370
-8.1	-7.4071546	31.9852896	-175.3693218
-8.0	-7.3071865	31.1805465	-168.8910580
-7.9	-7.2072219	30.3858271	-162.5729542
-7.8	-7.1072609	29.6011331	-156.4130230
-7.7	-7.0073040	28.8264670	-150.4092770
-7.6	-6.9073517	28.0618312	-144.5597305
-7.5	-6.8074043	27.3072286	-138.8623962
-7.4	-6.7074624	26.5626616	-133.3152905
-7.3	-6.6075267	25.8281338	-127.9164286
-7.2	-6.5075977	25.1036487	-122.6638269
-7.1	-6.4076762	24.3892097	-117.5555048
-7.0	-6.3077630	23.6848211	-112.5894804
-6.9	-6.2078588	22.9904871	-107.7637749
-6.8	-6.1079647	22.3062124	-103.0764093
-6.7	-6.0080817	21.6320021	-98.5254059
-6.6	-5.9082111	20.9678619	-94.1087894
-6.5	-5.8083540	20.3137977	-89.8245850
-6.4	-5.7085119	19.6698160	-85.6708183
-6.3	-5.6086864	19.0359237	-81.6455183
-6.2	-5.5088792	18.4121284	-77.7467136
-6.1	-5.4090922	17.7984383	-73.9724340
-6.0	-5.3093275	17.1948619	-70.3207130
-5.9	-5.2095876	16.6014090	-66.7895832
-5.8	-5.1098749	16.0180895	-63.3770790
-5.7	-5.0101923	15.4449143	-60.0812373
-5.6	-4.9105430	14.8818954	-56.9000955
-5.5	-4.8109304	14.3290453	-53.8316922
-5.4	-4.7113584	13.7863774	-50.8740673
-5.3	-4.6118312	13.2539064	-48.0252624
-5.2	-4.5123535	12.7316477	-45.2833190
-5.1	-4.4129304	12.2196180	-42.6462808
-5.0	-4.3135675	11.7178349	-40.1121907
-4.9	-4.2142712	11.2263175	-37.6790938
-4.8	-4.1150483	10.7450857	-35.3450341
-4.7	-4.0159064	10.2741611	-33.1080561
-4.6	-3.9168539	9.8135662	-30.9662037
-4.5	-3.8179000	9.3633251	-28.9175203
-4.4	-3.7190549	8.9234632	-26.9600484
-4.3	-3.6203296	8.4940073	-25.0918286
-4.2	-3.5217366	8.0749857	-23.3108995
-4.1	-3.4232892	7.6664279	-21.6152966

X	F0(X)	F1(X)	F2(X)
-4.0	-3.3250023	7.2683645	-20.0030522
-3.9	-3.2268922	6.8808278	-18.4721947
-3.8	-3.1289766	6.5038513	-17.0207469
-3.7	-3.0312753	6.1374694	-15.6467261
-3.6	-2.9338096	5.7817174	-14.3481425
-3.5	-2.8366029	5.4366314	-13.1229985
-3.4	-2.7396810	5.1022483	-11.9692872
-3.3	-2.6430718	4.7786047	-10.8849916
-3.2	-2.5468059	4.4657375	-9.8680832
-3.1	-2.4509165	4.1636827	-8.9165205
-3.0	-2.3554399	3.8724754	-8.0282478
-2.9	-2.2604154	3.5921490	-7.2011942
-2.8	-2.1658854	3.3227344	-6.4332713
-2.7	-2.0718962	3.0642592	-5.7223734
-2.6	-1.9784974	2.8167471	-5.0663748
-2.5	-1.8857424	2.5802164	-4.4631299
-2.4	-1.7936888	2.3546790	-3.9104717
-2.3	-1.7023982	2.1401393	-3.4062117
-2.2	-1.6119360	1.9365923	-2.9481394
-2.1	-1.5223722	1.7440224	-2.5340227
-2.0	-1.4337807	1.5624014	-2.1616085
-1.9	-1.3462395	1.3916868	-1.8286246
-1.8	-1.2598304	1.2318202	-1.5327811
-1.7	-1.1746388	1.0827244	-1.2717741
-1.6	-1.0907535	0.9443024	-1.0432893
-1.5	-1.0082660	0.8164348	-0.8450072
-1.4	-0.9272702	0.6989780	-0.6746087
-1.3	-0.8478612	0.5917623	-0.5297829
-1.2	-0.7701352	0.4945904	-0.4082353
-1.1	-0.6941881	0.4072359	-0.3076969
-1.0	-0.6201145	0.3294426	-0.2259354
-0.9	-0.5480067	0.2609234	-0.1607661
-0.8	-0.4779535	0.2013607	-0.1100646
-0.7	-0.4100389	0.1504066	-0.0717788
-0.6	-0.3443408	0.1076841	-0.0439422
-0.5	-0.2809298	0.0727887	-0.0246863
-0.4	-0.2198681	0.0452911	-0.0122526
-0.3	-0.1612081	0.0247399	-0.0050037
-0.2	-0.1049917	0.0106653	-0.0014331
-0.1	-0.0512495	0.0025833	-0.0001729
0.	0.	0.	0.
0.1	0.0487505	0.0024167	0.0001604
0.2	0.0950083	0.0093347	0.0012336
0.3	0.1387919	0.0202601	0.0039963
0.4	0.1801319	0.0347089	0.0090807
0.5	0.2190702	0.0522113	0.0169803
0.6	0.2556592	0.0723159	0.0280578
0.7	0.2899611	0.0945934	0.0425545
0.8	0.3220465	0.1186392	0.0606020
0.9	0.3519933	0.1440765	0.0822338

X	F0(X)	F1(X)	F2(X)
1.0	0.3798855	0.1705573	0.1073979
1.1	0.4058118	0.1977640	0.1359698
1.2	0.4298647	0.2254096	0.1677647
1.3	0.4521387	0.2532377	0.2025504
1.4	0.4727297	0.2810220	0.2400579
1.5	0.4917339	0.3085651	0.2799927
1.6	0.5092464	0.3356975	0.3220439
1.7	0.5253611	0.3622755	0.3658925
1.8	0.5401695	0.3881797	0.4112188
1.9	0.5537604	0.4133130	0.4577086
2.0	0.5662191	0.4375985	0.5050579
2.1	0.5776276	0.4609775	0.5529771
2.2	0.5880638	0.4834075	0.6011936
2.3	0.5976017	0.5048605	0.6494546
2.4	0.6063110	0.5253208	0.6975279
2.5	0.6142574	0.5447834	0.7452030
2.6	0.6215024	0.5632526	0.7922914
2.7	0.6281035	0.5807405	0.8386261
2.8	0.6341143	0.5972653	0.8840614
2.9	0.6395843	0.6128506	0.9284719
3.0	0.6445597	0.6275242	0.9717514
3.1	0.6490831	0.6413169	1.0138120
3.2	0.6531938	0.6542621	1.0545825
3.3	0.6569278	0.6663949	1.0940073
3.4	0.6603186	0.6777513	1.1320450
3.5	0.6633967	0.6883681	1.1686669
3.6	0.6661900	0.6982821	1.2038560
3.7	0.6687242	0.7075300	1.2376056
3.8	0.6710228	0.7161480	1.2699180
3.9	0.6731073	0.7241715	1.3008033
4.0	0.6749971	0.7316348	1.3302789
4.1	0.6767102	0.7385713	1.3583678
4.2	0.6782628	0.7450133	1.3850980
4.3	0.6796697	0.7509916	1.4105020
4.4	0.6809445	0.7565357	1.4346153
4.5	0.6820993	0.7616738	1.4574765
4.6	0.6831454	0.7664326	1.4791262
4.7	0.6840929	0.7708377	1.4996068
4.8	0.6849510	0.7749129	1.5189616
4.9	0.6857280	0.7786811	1.5372347
5.0	0.6864317	0.7821635	1.5544706
5.1	0.6870688	0.7853804	1.5707137
5.2	0.6876456	0.7883506	1.5860083
5.3	0.6881678	0.7910919	1.6003981
5.4	0.6886406	0.7936208	1.6139260
5.5	0.6890686	0.7959528	1.6266342
5.6	0.6894559	0.7981026	1.6385638
5.7	0.6898066	0.8000835	1.6497549
5.8	0.6901240	0.8019083	1.6602461
5.9	0.6904113	0.8035887	1.6700750

X	F0(X)	F1(X)	F2(X)
6.0	0.6906713	0.8051355	1.6792778
6.1	0.6909066	0.8065591	1.6878893
6.2	0.6911196	0.8078687	1.6959428
6.3	0.6913123	0.8090733	1.7034704
6.4	0.6914868	0.8101808	1.7105026
6.5	0.6916446	0.8111989	1.7170687
6.6	0.6917875	0.8121346	1.7231966
6.7	0.6919168	0.8129942	1.7289128
6.8	0.6920338	0.8137839	1.7342423
6.9	0.6921397	0.8145091	1.7392092
7.0	0.6922355	0.8151749	1.7438361
7.1	0.6923222	0.8157860	1.7481445
7.2	0.6924006	0.8163469	1.7521545
7.3	0.6924716	0.8168616	1.7558855
7.4	0.6925358	0.8173338	1.7593554
7.5	0.6925940	0.8177668	1.7625813
7.6	0.6926466	0.8181639	1.7655794
7.7	0.6926942	0.8185280	1.7683645
7.8	0.6927372	0.8188618	1.7709511
7.9	0.6927762	0.8191677	1.7733525
8.0	0.6928115	0.8194481	1.7755811
8.1	0.6928434	0.8197050	1.7776487
8.2	0.6928723	0.8199403	1.7795664
8.3	0.6928984	0.8201558	1.7813446
8.4	0.6929220	0.8203532	1.7829928
8.5	0.6929434	0.8205340	1.7845201
8.6	0.6929628	0.8206995	1.7859350
8.7	0.6929803	0.8208510	1.7872454
8.8	0.6929961	0.8209897	1.7884587
8.9	0.6930105	0.8211166	1.7895818
9.0	0.6930235	0.8212327	1.7906212
9.1	0.6930352	0.8213390	1.7915827
9.2	0.6930458	0.8214362	1.7924722
9.3	0.6930554	0.8215251	1.7932946
9.4	0.6930641	0.8216064	1.7940550
9.5	0.6930720	0.8216808	1.7947578
9.6	0.6930791	0.8217488	1.7954073
9.7	0.6930856	0.8218110	1.7960074
9.8	0.6930914	0.8218678	1.7965616
9.9	0.6930967	0.8219198	1.7970735
10.0	0.6931014	0.8219673	1.7975461
10.1	0.6931057	0.8220107	1.7979824
10.2	0.6931096	0.8220504	1.7983851
10.3	0.6931132	0.8220866	1.7987566
10.4	0.6931164	0.8221198	1.7990994
10.5	0.6931193	0.8221500	1.7994156
10.6	0.6931219	0.8221776	1.7997072
10.7	0.6931242	0.8222029	1.7999761
10.8	0.6931264	0.8222260	1.8002239
10.9	0.6931283	0.8222470	1.8004524

X	F0(X)	F1(X)	F2(X)
11.0	0.6931301	0.8222662	1.8006630
11.1	0.6931317	0.8222838	1.8008570
11.2	0.6931331	0.8222998	1.8010358
11.3	0.6931344	0.8223145	1.8012004
11.4	0.6931356	0.8223278	1.8013521
11.5	0.6931366	0.8223400	1.8014917
11.6	0.6931376	0.8223511	1.8016203
11.7	0.6931385	0.8223613	1.8017386
11.8	0.6931392	0.8223706	1.8018476
11.9	0.6931399	0.8223790	1.8019478
12.0	0.6931406	0.8223867	1.8020401
12.1	0.6931412	0.8223938	1.8021250
12.2	0.6931417	0.8224002	1.8022031
12.3	0.6931422	0.8224061	1.8022749
12.4	0.6931426	0.8224114	1.8023409
12.5	0.6931430	0.8224163	1.8024017
12.6	0.6931433	0.8224207	1.8024575
12.7	0.6931437	0.8224248	1.8025088
12.8	0.6931439	0.8224285	1.8025560
12.9	0.6931442	0.8224319	1.8025994
13.0	0.6931444	0.8224349	1.8026393
13.1	0.6931446	0.8224377	1.8026759
13.2	0.6931448	0.8224403	1.8027095
13.3	0.6931450	0.8224426	1.8027404
13.4	0.6931452	0.8224447	1.8027688
13.5	0.6931453	0.8224467	1.8027949
13.6	0.6931454	0.8224484	1.8028188
13.7	0.6931456	0.8224501	1.8028408
13.8	0.6931457	0.8224515	1.8028610
13.9	0.6931457	0.8224529	1.8028796
14.0	0.6931458	0.8224541	1.8028966

A	A**(1/3)	R1	R2	R3	RHO1/A	RHO2/A	RHO3/A	E1	E2	E3
1	1.00000	0.22592E-12	0.22645E-12	0.22698E-12	0.20591E 08	0.79709E 07	0.79339E 07	0.14928E 02	0.79292E 01	0.79046E 01
2	1.25992	0.25068E-12	0.25121E-12	0.25174E-12	0.15087E 08	0.53288E 07	0.53063E 07	0.12133E 02	0.60624E 01	0.60453E 01
3	1.44225	0.26876E-12	0.26929E-12	0.26982E-12	0.12249E 08	0.41682E 07	0.40567E 07	0.10559E 02	0.51466E 01	0.50544E 01
4	1.58740	0.28345E-12	0.28398E-12	0.28452E-12	0.10443E 08	0.34916E 07	0.34785E 07	0.94941E 01	0.45734E 01	0.45620E 01
5	1.70998	0.29602E-12	0.29655E-12	0.29708E-12	0.91716E 07	0.29621E 07	0.29514E 07	0.87067E 01	0.40985E 01	0.40886E 01
6	1.81712	0.30710E-12	0.30763E-12	0.30817E-12	0.82161E 07	0.25778E 07	0.25689E 07	0.80910E 01	0.37358E 01	0.37272E 01
7	1.91293	0.31707E-12	0.31760E-12	0.31814E-12	0.74665E 07	0.22851E 07	0.22774E 07	0.75910E 01	0.34474E 01	0.34397E 01
8	2.00000	0.32617E-12	0.32670E-12	0.32724E-12	0.68597E 07	0.20541E 07	0.20474E 07	0.71740E 01	0.32110E 01	0.32040E 01
9	2.08008	0.33457E-12	0.33510E-12	0.33564E-12	0.63565E 07	0.18670E 07	0.18611E 07	0.68187E 01	0.30129E 01	0.30065E 01
10	2.15443	0.34239E-12	0.34293E-12	0.34347E-12	0.59314E 07	0.17121E 07	0.17068E 07	0.65112E 01	0.28438E 01	0.28380E 01
11	2.22398	0.34973E-12	0.35026E-12	0.35080E-12	0.55665E 07	0.15816E 07	0.15767E 07	0.62414E 01	0.26974E 01	0.26919E 01
12	2.28943	0.35664E-12	0.35718E-12	0.35772E-12	0.52494E 07	0.14700E 07	0.14656E 07	0.60020E 01	0.25691E 01	0.25640E 01
13	2.35133	0.36320E-12	0.36373E-12	0.36427E-12	0.49708E 07	0.13736E 07	0.13696E 07	0.57877E 01	0.24554E 01	0.24506E 01
14	2.41014	0.36943E-12	0.36996E-12	0.37050E-12	0.47238E 07	0.12893E 07	0.12856E 07	0.55944E 01	0.23539E 01	0.23494E 01
15	2.46621	0.37538E-12	0.37591E-12	0.37645E-12	0.45031E 07	0.12150E 07	0.12115E 07	0.54187E 01	0.22626E 01	0.22583E 01
16	2.51984	0.38107E-12	0.38160E-12	0.38214E-12	0.43044E 07	0.11490E 07	0.11458E 07	0.52582E 01	0.21799E 01	0.21758E 01
17	2.57128	0.38654E-12	0.38707E-12	0.38761E-12	0.41246E 07	0.10899E 07	0.10869E 07	0.51107E 01	0.21045E 01	0.21007E 01
18	2.62074	0.39180E-12	0.39233E-12	0.39287E-12	0.39609E 07	0.10368E 07	0.10339E 07	0.49745E 01	0.20355E 01	0.20318E 01
19	2.66840	0.39687E-12	0.39740E-12	0.39794E-12	0.38111E 07	0.98865E 06	0.98596E 06	0.48484E 01	0.19721E 01	0.19685E 01
20	2.71442	0.40177E-12	0.40230E-12	0.40284E-12	0.36736E 07	0.94487E 06	0.94236E 06	0.47310E 01	0.19134E 01	0.19100E 01
21	2.75892	0.40651E-12	0.40704E-12	0.40758E-12	0.35467E 07	0.90488E 06	0.90254E 06	0.46214E 01	0.18590E 01	0.18558E 01
22	2.80204	0.41111E-12	0.41164E-12	0.41218E-12	0.34292E 07	0.86821E 06	0.86593E 06	0.45188E 01	0.18084E 01	0.18053E 01
23	2.84387	0.41556E-12	0.41610E-12	0.41664E-12	0.33201E 07	0.83443E 06	0.83229E 06	0.44224E 01	0.17612E 01	0.17582E 01
24	2.88450	0.41990E-12	0.42043E-12	0.42097E-12	0.32185E 07	0.80324E 06	0.80119E 06	0.43317E 01	0.17171E 01	0.17141E 01
25	2.92402	0.42411E-12	0.42465E-12	0.42519E-12	0.31235E 07	0.77432E 06	0.77240E 06	0.42461E 01	0.16756E 01	0.16728E 01
26	2.96250	0.42822E-12	0.42875E-12	0.42929E-12	0.30346E 07	0.74745E 06	0.74557E 06	0.41651E 01	0.16366E 01	0.16336E 01
27	3.00000	0.43222E-12	0.43276E-12	0.43330E-12	0.29512E 07	0.72242E 06	0.72060E 06	0.40884E 01	0.15999E 01	0.15972E 01
28	3.03659	0.43613E-12	0.43666E-12	0.43720E-12	0.28727E 07	0.69902E 06	0.69731E 06	0.40156E 01	0.15651E 01	0.15626E 01
29	3.07232	0.43995E-12	0.44048E-12	0.44102E-12	0.27986E 07	0.67712E 06	0.67546E 06	0.39463E 01	0.15323E 01	0.15298E 01
30	3.10723	0.44367E-12	0.44421E-12	0.44475E-12	0.27287E 07	0.65657E 06	0.65499E 06	0.38803E 01	0.15011E 01	0.14987E 01
31	3.14138	0.44732E-12	0.44786E-12	0.44839E-12	0.26626E 07	0.63725E 06	0.63572E 06	0.38173E 01	0.14715E 01	0.14692E 01
32	3.17480	0.45089E-12	0.45143E-12	0.45197E-12	0.25999E 07	0.61905E 06	0.61760E 06	0.37572E 01	0.14434E 01	0.14411E 01
33	3.20753	0.45439E-12	0.45493E-12	0.45546E-12	0.25403E 07	0.60187E 06	0.60047E 06	0.36996E 01	0.14165E 01	0.14143E 01
34	3.23961	0.45782E-12	0.45835E-12	0.45889E-12	0.24838E 07	0.58563E 06	0.58424E 06	0.36444E 01	0.13909E 01	0.13887E 01
35	3.27107	0.46118E-12	0.46172E-12	0.46225E-12	0.24299E 07	0.57026E 06	0.56893E 06	0.35915E 01	0.13665E 01	0.13644E 01
36	3.30193	0.46448E-12	0.46501E-12	0.46555E-12	0.23785E 07	0.55569E 06	0.55439E 06	0.35408E 01	0.13431E 01	0.13410E 01
37	3.33222	0.46772E-12	0.46825E-12	0.46879E-12	0.23295E 07	0.54184E 06	0.54063E 06	0.34919E 01	0.13207E 01	0.13187E 01
38	3.36198	0.47090E-12	0.47143E-12	0.47197E-12	0.22826E 07	0.52868E 06	0.52752E 06	0.34449E 01	0.12992E 01	0.12973E 01
39	3.39121	0.47403E-12	0.47456E-12	0.47510E-12	0.22378E 07	0.51615E 06	0.51500E 06	0.33997E 01	0.12786E 01	0.12767E 01
40	3.41995	0.47710E-12	0.47763E-12	0.47817E-12	0.21949E 07	0.50422E 06	0.50311E 06	0.33561E 01	0.12588E 01	0.12570E 01
41	3.44822	0.48012E-12	0.48066E-12	0.48119E-12	0.21537E 07	0.49281E 06	0.49172E 06	0.33140E 01	0.12398E 01	0.12379E 01
42	3.47603	0.48310E-12	0.48363E-12	0.48417E-12	0.21142E 07	0.48193E 06	0.48086E 06	0.32733E 01	0.12215E 01	0.12197E 01
43	3.50340	0.48602E-12	0.48656E-12	0.48710E-12	0.20763E 07	0.47153E 06	0.47048E 06	0.32341E 01	0.12038E 01	0.12020E 01
44	3.53035	0.48891E-12	0.48944E-12	0.48998E-12	0.20398E 07	0.46156E 06	0.46055E 06	0.31961E 01	0.11868E 01	0.11851E 01
45	3.55689	0.49175E-12	0.49228E-12	0.49282E-12	0.20047E 07	0.45202E 06	0.45101E 06	0.31593E 01	0.11704E 01	0.11686E 01
46	3.58305	0.49454E-12	0.49508E-12	0.49562E-12	0.19709E 07	0.44286E 06	0.44190E 06	0.31237E 01	0.11545E 01	0.11528E 01
47	3.60883	0.49730E-12	0.49784E-12	0.49837E-12	0.19383E 07	0.43407E 06	0.43311E 06	0.30891E 01	0.11392E 01	0.11375E 01
48	3.63424	0.50002E-12	0.50056E-12	0.50109E-12	0.19069E 07	0.42563E 06	0.42472E 06	0.30557E 01	0.11244E 01	0.11228E 01
49	3.65931	0.50270E-12	0.50324E-12	0.50378E-12	0.18765E 07	0.41751E 06	0.41662E 06	0.30232E 01	0.11100E 01	0.11085E 01
50	3.68403	0.50535E-12	0.50588E-12	0.50642E-12	0.18472E 07	0.40970E 06	0.40881E 06	0.29916E 01	0.10961E 01	0.10946E 01

A	A**(1/3)	R1	R2	R3	RHO1/A	RHO2/A	RHO3/A	E1	E2	E3
51	3.70843	0.50796E-12	0.50849E-12	0.50903E-12	0.18189E 07	0.40218E 06	0.40134E 06	0.29610E 01	0.10827E 01	0.10812E 01
52	3.73251	0.51054E-12	0.51107E-12	0.51161E-12	0.17915E 07	0.39493E 06	0.39412E 06	0.29312E 01	0.10696E 01	0.10682E 01
53	3.75629	0.51308E-12	0.51361E-12	0.51415E-12	0.17650E 07	0.38794E 06	0.38712E 06	0.29022E 01	0.10570E 01	0.10555E 01
54	3.77976	0.51559E-12	0.51613E-12	0.51667E-12	0.17394E 07	0.38120E 06	0.38043E 06	0.28740E 01	0.10447E 01	0.10433E 01
55	3.80295	0.51807E-12	0.51861E-12	0.51915E-12	0.17145E 07	0.37469E 06	0.37389E 06	0.28466E 01	0.10328E 01	0.10313E 01
56	3.82586	0.52053E-12	0.52106E-12	0.52160E-12	0.16904E 07	0.36840E 06	0.36765E 06	0.28198E 01	0.10212E 01	0.10198E 01
57	3.84850	0.52295E-12	0.52348E-12	0.52402E-12	0.16671E 07	0.36232E 06	0.36158E 06	0.27938E 01	0.10099E 01	0.10085E 01
58	3.87088	0.52534E-12	0.52588E-12	0.52642E-12	0.16444E 07	0.35643E 06	0.35572E 06	0.27684E 01	0.99895E 00	0.99762E 00
59	3.89300	0.52771E-12	0.52825E-12	0.52878E-12	0.16224E 07	0.35074E 06	0.35002E 06	0.27436E 01	0.98829E 00	0.98693E 00
60	3.91487	0.53005E-12	0.53059E-12	0.53112E-12	0.16010E 07	0.34524E 06	0.34454E 06	0.27195E 01	0.97792E 00	0.97660E 00
61	3.93650	0.53237E-12	0.53290E-12	0.53344E-12	0.15802E 07	0.33989E 06	0.33922E 06	0.26959E 01	0.96780E 00	0.96653E 00
62	3.95789	0.53466E-12	0.53519E-12	0.53573E-12	0.15600E 07	0.33472E 06	0.33403E 06	0.26728E 01	0.95796E 00	0.95663E 00
63	3.97906	0.53692E-12	0.53746E-12	0.53800E-12	0.15403E 07	0.32970E 06	0.32905E 06	0.26503E 01	0.94836E 00	0.94710E 00
64	4.00000	0.53916E-12	0.53970E-12	0.54024E-12	0.15212E 07	0.32483E 06	0.32418E 06	0.26284E 01	0.93900E 00	0.93774E 00
65	4.02073	0.54138E-12	0.54192E-12	0.54246E-12	0.15026E 07	0.32010E 06	0.31947E 06	0.26069E 01	0.92986E 00	0.92863E 00
66	4.04124	0.54358E-12	0.54411E-12	0.54465E-12	0.14845E 07	0.31552E 06	0.31489E 06	0.25859E 01	0.92096E 00	0.91973E 00
67	4.06155	0.54575E-12	0.54629E-12	0.54683E-12	0.14668E 07	0.31106E 06	0.31045E 06	0.25653E 01	0.91226E 00	0.91107E 00
68	4.08166	0.54791E-12	0.54844E-12	0.54898E-12	0.14496E 07	0.30673E 06	0.30615E 06	0.25452E 01	0.90377E 00	0.90263E 00
69	4.10157	0.55004E-12	0.55057E-12	0.55111E-12	0.14328E 07	0.30251E 06	0.30193E 06	0.25256E 01	0.89547E 00	0.89432E 00
70	4.12129	0.55215E-12	0.55268E-12	0.55322E-12	0.14165E 07	0.29841E 06	0.29782E 06	0.25063E 01	0.88737E 00	0.88618E 00
71	4.14082	0.55424E-12	0.55477E-12	0.55531E-12	0.14005E 07	0.29443E 06	0.29386E 06	0.24874E 01	0.87944E 00	0.87832E 00
72	4.16017	0.55631E-12	0.55684E-12	0.55738E-12	0.13849E 07	0.29054E 06	0.29000E 06	0.24690E 01	0.87170E 00	0.87061E 00
73	4.17934	0.55836E-12	0.55890E-12	0.55943E-12	0.13697E 07	0.28676E 06	0.28622E 06	0.24508E 01	0.86412E 00	0.86303E 00
74	4.19834	0.56040E-12	0.56093E-12	0.56147E-12	0.13549E 07	0.28308E 06	0.28255E 06	0.24331E 01	0.85670E 00	0.85563E 00
75	4.21716	0.56241E-12	0.56295E-12	0.56348E-12	0.13404E 07	0.27949E 06	0.27894E 06	0.24157E 01	0.84945E 00	0.84833E 00
76	4.23582	0.56441E-12	0.56494E-12	0.56548E-12	0.13262E 07	0.27599E 06	0.27546E 06	0.23986E 01	0.84235E 00	0.84126E 00
77	4.25432	0.56639E-12	0.56692E-12	0.56746E-12	0.13124E 07	0.27258E 06	0.27203E 06	0.23819E 01	0.83539E 00	0.83426E 00
78	4.27266	0.56835E-12	0.56889E-12	0.56943E-12	0.12988E 07	0.26926E 06	0.26876E 06	0.23655E 01	0.82858E 00	0.82757E 00
79	4.29084	0.57030E-12	0.57083E-12	0.57137E-12	0.12856E 07	0.26601E 06	0.26550E 06	0.23494E 01	0.82191E 00	0.82085E 00
80	4.30887	0.57223E-12	0.57276E-12	0.57330E-12	0.12726E 07	0.26284E 06	0.26234E 06	0.23336E 01	0.81537E 00	0.81434E 00
81	4.32675	0.57414E-12	0.57468E-12	0.57522E-12	0.12599E 07	0.25975E 06	0.25927E 06	0.23180E 01	0.80896E 00	0.80796E 00
82	4.34448	0.57604E-12	0.57658E-12	0.57711E-12	0.12475E 07	0.25673E 06	0.25627E 06	0.23028E 01	0.80267E 00	0.80172E 00
83	4.36207	0.57793E-12	0.57846E-12	0.57900E-12	0.12354E 07	0.25378E 06	0.25330E 06	0.22878E 01	0.79651E 00	0.79551E 00
84	4.37952	0.57979E-12	0.58033E-12	0.58087E-12	0.12235E 07	0.25089E 06	0.25045E 06	0.22731E 01	0.79046E 00	0.78953E 00
85	4.39683	0.58165E-12	0.58218E-12	0.58272E-12	0.12118E 07	0.24807E 06	0.24759E 06	0.22587E 01	0.78453E 00	0.78352E 00
86	4.41400	0.58349E-12	0.58402E-12	0.58456E-12	0.12004E 07	0.24532E 06	0.24489E 06	0.22445E 01	0.77872E 00	0.77780E 00
87	4.43105	0.58531E-12	0.58585E-12	0.58638E-12	0.11892E 07	0.24262E 06	0.24217E 06	0.22305E 01	0.77300E 00	0.77204E 00
88	4.44796	0.58712E-12	0.58766E-12	0.58819E-12	0.11783E 07	0.23999E 06	0.23958E 06	0.22168E 01	0.76740E 00	0.76652E 00
89	4.46474	0.58892E-12	0.58945E-12	0.58999E-12	0.11675E 07	0.23741E 06	0.23697E 06	0.22033E 01	0.76189E 00	0.76094E 00
90	4.48140	0.59070E-12	0.59124E-12	0.59177E-12	0.11570E 07	0.23489E 06	0.23446E 06	0.21900E 01	0.75648E 00	0.75555E 00
91	4.49794	0.59247E-12	0.59301E-12	0.59355E-12	0.11466E 07	0.23242E 06	0.23200E 06	0.21769E 01	0.75117E 00	0.75026E 00
92	4.51436	0.59423E-12	0.59476E-12	0.59530E-12	0.11365E 07	0.23000E 06	0.22958E 06	0.21641E 01	0.74596E 00	0.74504E 00
93	4.53065	0.59598E-12	0.59651E-12	0.59705E-12	0.11266E 07	0.22763E 06	0.22724E 06	0.21514E 01	0.74082E 00	0.73997E 00
94	4.54684	0.59771E-12	0.59824E-12	0.59878E-12	0.11168E 07	0.22531E 06	0.22494E 06	0.21390E 01	0.73578E 00	0.73496E 00
95	4.56290	0.59943E-12	0.59996E-12	0.60050E-12	0.11072E 07	0.22304E 06	0.22265E 06	0.21267E 01	0.73083E 00	0.72997E 00
96	4.57886	0.60114E-12	0.60167E-12	0.60221E-12	0.10978E 07	0.22081E 06	0.22041E 06	0.21147E 01	0.72595E 00	0.72507E 00
97	4.59470	0.60283E-12	0.60337E-12	0.60391E-12	0.10886E 07	0.21863E 06	0.21825E 06	0.21028E 01	0.72116E 00	0.72033E 00
98	4.61044	0.60452E-12	0.60505E-12	0.60559E-12	0.10795E 07	0.21649E 06	0.21613E 06	0.20911E 01	0.71645E 00	0.71565E 00
99	4.62606	0.60619E-12	0.60673E-12	0.60726E-12	0.10706E 07	0.21439E 06	0.21402E 06	0.20796E 01	0.71181E 00	0.71098E 00
100	4.64159	0.60785E-12	0.60839E-12	0.60893E-12	0.10618E 07	0.21234E 06	0.21196E 06	0.20682E 01	0.70725E 00	0.70641E 00

A	A**(1/3)	R1	R2	R3	RHO1/A	RHO2/A	RHO3/A	E1	E2	E3
1	1.00000	0.22592E-12	0.22645E-12	0.22698E-12	0.20591E 08	0.79709E 07	0.79339E 07	0.14928E 02	0.79292E 01	0.79046E 01
2	1.25992	0.25068E-12	0.25121E-12	0.25174E-12	0.15087E 08	0.53288E 07	0.53063E 07	0.12133E 02	0.60624E 01	0.60453E 01
3	1.44225	0.26876E-12	0.26929E-12	0.26982E-12	0.12249E 08	0.41682E 07	0.40567E 07	0.10559E 02	0.51466E 01	0.50544E 01
4	1.58740	0.28345E-12	0.28398E-12	0.28452E-12	0.10443E 08	0.34916E 07	0.34785E 07	0.94941E 01	0.45734E 01	0.45620E 01
5	1.70998	0.29602E-12	0.29655E-12	0.29708E-12	0.91716E 07	0.29621E 07	0.29514E 07	0.87067E 01	0.40985E 01	0.40886E 01
6	1.81712	0.30710E-12	0.30763E-12	0.30817E-12	0.82161E 07	0.25778E 07	0.25689E 07	0.80910E 01	0.37358E 01	0.37272E 01
7	1.91293	0.31707E-12	0.31760E-12	0.31814E-12	0.74665E 07	0.22851E 07	0.22774E 07	0.75910E 01	0.34474E 01	0.34397E 01
8	2.00000	0.32617E-12	0.32670E-12	0.32724E-12	0.68597E 07	0.20541E 07	0.20474E 07	0.71740E 01	0.32190E 01	0.32040E 01
9	2.08008	0.33457E-12	0.33510E-12	0.33564E-12	0.63565E 07	0.18670E 07	0.18611E 07	0.68187E 01	0.30129E 01	0.30065E 01
10	2.15443	0.34239E-12	0.34293E-12	0.34347E-12	0.59314E 07	0.17121E 07	0.17068E 07	0.65112E 01	0.28438E 01	0.28380E 01
11	2.22398	0.34973E-12	0.35026E-12	0.35080E-12	0.55665E 07	0.15816E 07	0.15767E 07	0.62414E 01	0.26974E 01	0.26919E 01
12	2.28943	0.35664E-12	0.35718E-12	0.35772E-12	0.52494E 07	0.14700E 07	0.14656E 07	0.60020E 01	0.25691E 01	0.25640E 01
13	2.35133	0.36320E-12	0.36373E-12	0.36427E-12	0.49708E 07	0.13736E 07	0.13696E 07	0.57877E 01	0.24554E 01	0.24506E 01
14	2.41014	0.36943E-12	0.36996E-12	0.37050E-12	0.47238E 07	0.12893E 07	0.12856E 07	0.55944E 01	0.23539E 01	0.23494E 01
15	2.46621	0.37538E-12	0.37591E-12	0.37645E-12	0.45031E 07	0.12150E 07	0.12115E 07	0.54187E 01	0.22626E 01	0.22583E 01
16	2.51984	0.38107E-12	0.38160E-12	0.38214E-12	0.43044E 07	0.11490E 07	0.11458E 07	0.52582E 01	0.21799E 01	0.21758E 01
17	2.57128	0.38654E-12	0.38707E-12	0.38761E-12	0.41246E 07	0.10899E 07	0.10869E 07	0.51107E 01	0.21045E 01	0.21007E 01
18	2.62074	0.39180E-12	0.39233E-12	0.39287E-12	0.39609E 07	0.10368E 07	0.10339E 07	0.49745E 01	0.20355E 01	0.20318E 01
19	2.66840	0.39687E-12	0.39740E-12	0.39794E-12	0.38111E 07	0.98865E 06	0.98596E 06	0.48484E 01	0.19721E 01	0.19685E 01
20	2.71442	0.40177E-12	0.40230E-12	0.40284E-12	0.36736E 07	0.94487E 06	0.94236E 06	0.47310E 01	0.19134E 01	0.19100E 01
21	2.75892	0.40651E-12	0.40704E-12	0.40758E-12	0.35467E 07	0.90488E 06	0.90254E 06	0.46214E 01	0.18590E 01	0.18558E 01
22	2.80204	0.41111E-12	0.41164E-12	0.41218E-12	0.34292E 07	0.86821E 06	0.86593E 06	0.45188E 01	0.18084E 01	0.18053E 01
23	2.84387	0.41556E-12	0.41610E-12	0.41664E-12	0.33201E 07	0.83443E 06	0.83229E 06	0.44224E 01	0.17612E 01	0.17582E 01
24	2.88450	0.41990E-12	0.42043E-12	0.42097E-12	0.32185E 07	0.80324E 06	0.80119E 06	0.43317E 01	0.17171E 01	0.17141E 01
25	2.92402	0.42411E-12	0.42465E-12	0.42519E-12	0.31235E 07	0.77432E 06	0.77240E 06	0.42461E 01	0.16756E 01	0.16728E 01
26	2.96250	0.42822E-12	0.42875E-12	0.42929E-12	0.30346E 07	0.74745E 06	0.74557E 06	0.41651E 01	0.16366E 01	0.16339E 01
27	3.00000	0.43222E-12	0.43276E-12	0.43330E-12	0.29512E 07	0.72242E 06	0.72060E 06	0.40884E 01	0.15999E 01	0.15972E 01
28	3.03659	0.43613E-12	0.43666E-12	0.43720E-12	0.28727E 07	0.69902E 06	0.69731E 06	0.40156E 01	0.15651E 01	0.15626E 01
29	3.07232	0.43995E-12	0.44048E-12	0.44102E-12	0.27986E 07	0.67712E 06	0.67546E 06	0.39463E 01	0.15323E 01	0.15298E 01
30	3.10723	0.44367E-12	0.44421E-12	0.44475E-12	0.27287E 07	0.65657E 06	0.65499E 06	0.38803E 01	0.15011E 01	0.14987E 01
31	3.14138	0.44732E-12	0.44786E-12	0.44839E-12	0.26626E 07	0.63725E 06	0.63572E 06	0.38173E 01	0.14715E 01	0.14692E 01
32	3.17480	0.45089E-12	0.45143E-12	0.45197E-12	0.25999E 07	0.61905E 06	0.61760E 06	0.37572E 01	0.14434E 01	0.14411E 01
33	3.20753	0.45439E-12	0.45493E-12	0.45546E-12	0.25403E 07	0.60187E 06	0.60047E 06	0.36996E 01	0.14165E 01	0.14143E 01
34	3.23961	0.45782E-12	0.45835E-12	0.45889E-12	0.24838E 07	0.58563E 06	0.58424E 06	0.36444E 01	0.13909E 01	0.13887E 01
35	3.27107	0.46118E-12	0.46172E-12	0.46225E-12	0.24299E 07	0.57026E 06	0.56893E 06	0.35915E 01	0.13665E 01	0.13644E 01
36	3.30193	0.46448E-12	0.46501E-12	0.46555E-12	0.23785E 07	0.55569E 06	0.55439E 06	0.35408E 01	0.13431E 01	0.13410E 01
37	3.33222	0.46772E-12	0.46825E-12	0.46879E-12	0.23295E 07	0.54184E 06	0.54063E 06	0.34919E 01	0.13207E 01	0.13187E 01
38	3.36198	0.47090E-12	0.47143E-12	0.47197E-12	0.22826E 07	0.52868E 06	0.52752E 06	0.34449E 01	0.12992E 01	0.12973E 01
39	3.39121	0.47403E-12	0.47456E-12	0.47510E-12	0.22378E 07	0.51615E 06	0.51500E 06	0.33997E 01	0.12786E 01	0.12767E 01
40	3.41995	0.47710E-12	0.47763E-12	0.47817E-12	0.21949E 07	0.50422E 06	0.50311E 06	0.33561E 01	0.12588E 01	0.12570E 01
41	3.44822	0.48012E-12	0.48066E-12	0.48119E-12	0.21537E 07	0.49281E 06	0.49172E 06	0.33140E 01	0.12398E 01	0.12379E 01
42	3.47603	0.48310E-12	0.48363E-12	0.48417E-12	0.21142E 07	0.48193E 06	0.48086E 06	0.32733E 01	0.12215E 01	0.12197E 01
43	3.50340	0.48602E-12	0.48656E-12	0.48710E-12	0.20763E 07	0.47153E 06	0.47048E 06	0.32341E 01	0.12038E 01	0.12020E 01
44	3.53035	0.48891E-12	0.48944E-12	0.48998E-12	0.20398E 07	0.46156E 06	0.46055E 06	0.31961E 01	0.11868E 01	0.11851E 01
45	3.55689	0.49175E-12	0.49228E-12	0.49282E-12	0.20047E 07	0.45202E 06	0.45101E 06	0.31593E 01	0.11704E 01	0.11686E 01
46	3.58305	0.49454E-12	0.49508E-12	0.49562E-12	0.19709E 07	0.44286E 06	0.44190E 06	0.31237E 01	0.11545E 01	0.11528E 01
47	3.60883	0.49730E-12	0.49784E-12	0.49837E-12	0.19383E 07	0.43407E 06	0.43311E 06	0.30891E 01	0.11392E 01	0.11375E 01
48	3.63424	0.50002E-12	0.50056E-12	0.50109E-12	0.19069E 07	0.42563E 06	0.42472E 06	0.30557E 01	0.11244E 01	0.11228E 01
49	3.65931	0.50270E-12	0.50324E-12	0.50378E-12	0.18765E 07	0.41751E 06	0.41662E 06	0.30232E 01	0.11100E 01	0.11085E 01
50	3.68403	0.50535E-12	0.50588E-12	0.50642E-12	0.18472E 07	0.40970E 06	0.40881E 06	0.29916E 01	0.10961E 01	0.10946E 01

A	A**(1/3)	R1	R2	R3	RHO1/A	RHO2/A	RHO3/A	E1	E2	E3
151	5.32507	0.68104E-12	0.68158E-12	0.68211E-12	0.75510E 06	0.14267E 06	0.14243E 06	0.16478E 01	0.54255E 00	0.54196E 00
152	5.33680	0.68230E-12	0.68283E-12	0.68337E-12	0.75094E 06	0.14176E 06	0.14153E 06	0.16417E 01	0.54024E 00	0.53965E 00
153	5.34848	0.68355E-12	0.68408E-12	0.68462E-12	0.74682E 06	0.14086E 06	0.14062E 06	0.16357E 01	0.53795E 00	0.53736E 00
154	5.36011	0.68479E-12	0.68533E-12	0.68587E-12	0.74276E 06	0.13997E 06	0.13975E 06	0.16298E 01	0.53569E 00	0.53513E 00
155	5.37169	0.68603E-12	0.68657E-12	0.68711E-12	0.73874E 06	0.13909E 06	0.13888E 06	0.16239E 01	0.53345E 00	0.53292E 00
156	5.38321	0.68727E-12	0.68780E-12	0.68834E-12	0.73477E 06	0.13823E 06	0.13802E 06	0.16181E 01	0.53123E 00	0.53071E 00
157	5.39469	0.68850E-12	0.68903E-12	0.68957E-12	0.73084E 06	0.13737E 06	0.13716E 06	0.16123E 01	0.52904E 00	0.52849E 00
158	5.40612	0.68972E-12	0.69025E-12	0.69079E-12	0.72696E 06	0.13653E 06	0.13633E 06	0.16066E 01	0.52687E 00	0.52635E 00
159	5.41750	0.69094E-12	0.69147E-12	0.69201E-12	0.72312E 06	0.13569E 06	0.13550E 06	0.16009E 01	0.52472E 00	0.52421E 00
160	5.42884	0.69215E-12	0.69269E-12	0.69323E-12	0.71933E 06	0.13487E 06	0.13466E 06	0.15953E 01	0.52260E 00	0.52207E 00
161	5.44012	0.69336E-12	0.69390E-12	0.69443E-12	0.71557E 06	0.13406E 06	0.13386E 06	0.15897E 01	0.52049E 00	0.51998E 00
162	5.45136	0.69457E-12	0.69510E-12	0.69564E-12	0.71186E 06	0.13325E 06	0.13304E 06	0.15842E 01	0.51841E 00	0.51786E 00
163	5.46256	0.69576E-12	0.69630E-12	0.69684E-12	0.70819E 06	0.13246E 06	0.13226E 06	0.15788E 01	0.51635E 00	0.51583E 00
164	5.47370	0.69696E-12	0.69749E-12	0.69803E-12	0.70456E 06	0.13168E 06	0.13146E 06	0.15734E 01	0.51431E 00	0.51376E 00
165	5.48481	0.69815E-12	0.69868E-12	0.69922E-12	0.70097E 06	0.13090E 06	0.13070E 06	0.15680E 01	0.51229E 00	0.51178E 00
166	5.49586	0.69933E-12	0.69986E-12	0.70040E-12	0.69741E 06	0.13013E 06	0.12993E 06	0.15627E 01	0.51028E 00	0.50975E 00
167	5.50688	0.70051E-12	0.70104E-12	0.70158E-12	0.69390E 06	0.12937E 06	0.12917E 06	0.15575E 01	0.50830E 00	0.50777E 00
168	5.51785	0.70168E-12	0.70222E-12	0.70276E-12	0.69042E 06	0.12863E 06	0.12843E 06	0.15523E 01	0.50634E 00	0.50583E 00
169	5.52877	0.70286E-12	0.70339E-12	0.70393E-12	0.68698E 06	0.12789E 06	0.12768E 06	0.15471E 01	0.50440E 00	0.50386E 00
170	5.53966	0.70402E-12	0.70455E-12	0.70509E-12	0.68358E 06	0.12715E 06	0.12695E 06	0.15420E 01	0.50247E 00	0.50194E 00
171	5.55050	0.70518E-12	0.70572E-12	0.70625E-12	0.68021E 06	0.12643E 06	0.12624E 06	0.15369E 01	0.50056E 00	0.50005E 00
172	5.56130	0.70634E-12	0.70687E-12	0.70741E-12	0.67687E 06	0.12571E 06	0.12553E 06	0.15319E 01	0.49867E-00	0.49818E-00
173	5.57205	0.70749E-12	0.70802E-12	0.70856E-12	0.67357E 06	0.12501E 06	0.12483E 06	0.15269E 01	0.49680E-00	0.49633E-00
174	5.58277	0.70864E-12	0.70917E-12	0.70971E-12	0.67031E 06	0.12431E 06	0.12413E 06	0.15220E 01	0.49495E-00	0.49449E-00
175	5.59344	0.70978E-12	0.71031E-12	0.71085E-12	0.66708E 06	0.12362E 06	0.12343E 06	0.15171E 01	0.49311E-00	0.49261E-00
176	5.60408	0.71092E-12	0.71145E-12	0.71199E-12	0.66388E 06	0.12294E 06	0.12276E 06	0.15122E 01	0.49130E-00	0.49083E-00
177	5.61467	0.71205E-12	0.71259E-12	0.71313E-12	0.66071E 06	0.12226E 06	0.12208E 06	0.15074E 01	0.48949E-00	0.48901E-00
178	5.62523	0.71318E-12	0.71372E-12	0.71426E-12	0.65757E 06	0.12159E 06	0.12139E 06	0.15026E 01	0.48771E-00	0.48716E-00
179	5.63574	0.71431E-12	0.71484E-12	0.71538E-12	0.65447E 06	0.12093E 06	0.12075E 06	0.14979E 01	0.48593E-00	0.48544E-00
180	5.64622	0.71543E-12	0.71597E-12	0.71650E-12	0.65140E 06	0.12027E 06	0.12010E 06	0.14932E 01	0.48418E-00	0.48370E-00
181	5.65665	0.71655E-12	0.71708E-12	0.71762E-12	0.64836E 06	0.11963E 06	0.11944E 06	0.14886E 01	0.48244E-00	0.48193E-00
182	5.66705	0.71766E-12	0.71820E-12	0.71873E-12	0.64534E 06	0.11899E 06	0.11881E 06	0.14839E 01	0.48072E-00	0.48024E-00
183	5.67741	0.71877E-12	0.71931E-12	0.71984E-12	0.64236E 06	0.11835E 06	0.11818E 06	0.14794E 01	0.47901E-00	0.47854E-00
184	5.68773	0.71988E-12	0.72041E-12	0.72095E-12	0.63941E 06	0.11773E 06	0.11756E 06	0.14748E 01	0.47732E-00	0.47687E-00
185	5.69802	0.72098E-12	0.72151E-12	0.72205E-12	0.63648E 06	0.11711E 06	0.11692E 06	0.14703E 01	0.47565E-00	0.47515E-00
186	5.70827	0.72208E-12	0.72261E-12	0.72315E-12	0.63359E 06	0.11649E 06	0.11633E 06	0.14659E 01	0.47398E-00	0.47355E-00
187	5.71848	0.72317E-12	0.72370E-12	0.72424E-12	0.63072E 06	0.11589E 06	0.11572E 06	0.14614E 01	0.47234E-00	0.47187E-00
188	5.72865	0.72426E-12	0.72479E-12	0.72533E-12	0.62788E 06	0.11529E 06	0.11510E 06	0.14570E 01	0.47070E-00	0.47019E-00
189	5.73879	0.72535E-12	0.72588E-12	0.72642E-12	0.62506E 06	0.11469E 06	0.11453E 06	0.14527E 01	0.46908E-00	0.46864E-00
190	5.74890	0.72643E-12	0.72696E-12	0.72750E-12	0.62228E 06	0.11411E 06	0.11393E 06	0.14484E 01	0.46748E-00	0.46701E-00
191	5.75897	0.72751E-12	0.72804E-12	0.72858E-12	0.61951E 06	0.11352E 06	0.11336E 06	0.14441E 01	0.46589E-00	0.46544E-00
192	5.76900	0.72858E-12	0.72911E-12	0.72965E-12	0.61678E 06	0.11295E 06	0.11278E 06	0.14398E 01	0.46431E-00	0.46386E-00
193	5.77900	0.72965E-12	0.73018E-12	0.73072E-12	0.61407E 06	0.11237E 06	0.11223E 06	0.14356E 01	0.46274E-00	0.46233E-00
194	5.78896	0.73072E-12	0.73125E-12	0.73179E-12	0.61138E 06	0.11181E 06	0.11164E 06	0.14314E 01	0.46119E-00	0.46072E-00
195	5.79889	0.73178E-12	0.73231E-12	0.73285E-12	0.60872E 06	0.11125E 06	0.11110E 06	0.14273E 01	0.45965E-00	0.45923E-00
196	5.80879	0.73284E-12	0.73337E-12	0.73391E-12	0.60609E 06	0.11070E 06	0.11053E 06	0.14231E 01	0.45812E-00	0.45767E-00
197	5.81865	0.73390E-12	0.73443E-12	0.73497E-12	0.60348E 06	0.11015E 06	0.10998E 06	0.14190E 01	0.45661E-00	0.45614E-00
198	5.82848	0.73495E-12	0.73548E-12	0.73602E-12	0.60089E 06	0.10961E 06	0.10945E 06	0.14150E 01	0.45511E-00	0.45466E-00
199	5.83827	0.73600E-12	0.73653E-12	0.73707E-12	0.59832E 06	0.10907E 06	0.10892E 06	0.14110E 01	0.45362E-00	0.45319E-00
200	5.84804	0.73704E-12	0.73758E-12	0.73812E-12	0.59578E 06	0.10854E 06	0.10839E 06	0.14070E 01	0.45214E-00	0.45173E-00

A	A**(1/3)	R1	R2	R3	RHO1/A	RHO2/A	RHO3/A	E1	E2	E3
201	5.85777	0.73809E-12	0.73862E-12	0.73916E-12	0.59326E 06	0.10801E 06	0.10786E 06	0.14030E 01	0.45068E-00	0.45026E-00
202	5.86746	0.73912E-12	0.73966E-12	0.74020E-12	0.59077E 06	0.10749E 06	0.10735E 06	0.13991E 01	0.44923E-00	0.44883E-00
203	5.87713	0.74016E-12	0.74069E-12	0.74123E-12	0.58829E 06	0.10697E 06	0.10683E 06	0.13951E 01	0.44779E-00	0.44739E-00
204	5.88677	0.74119E-12	0.74172E-12	0.74226E-12	0.58584E 06	0.10646E 06	0.10632E 06	0.13913E 01	0.44636E-00	0.44595E-00
205	5.89637	0.74222E-12	0.74275E-12	0.74329E-12	0.58341E 06	0.10595E 06	0.10580E 06	0.13874E 01	0.44494E-00	0.44452E-00
206	5.90594	0.74324E-12	0.74378E-12	0.74432E-12	0.58100E 06	0.10545E 06	0.10531E 06	0.13836E 01	0.44353E-00	0.44315E-00
207	5.91548	0.74427E-12	0.74480E-12	0.74534E-12	0.57861E 06	0.10495E 06	0.10481E 06	0.13798E 01	0.44213E-00	0.44174E-00
208	5.92499	0.74528E-12	0.74582E-12	0.74636E-12	0.57624E 06	0.10446E 06	0.10432E 06	0.13760E 01	0.44076E-00	0.44035E-00
209	5.93447	0.74630E-12	0.74683E-12	0.74737E-12	0.57390E 06	0.10397E 06	0.10383E 06	0.13723E 01	0.43938E-00	0.43897E-00
210	5.94392	0.74731E-12	0.74785E-12	0.74838E-12	0.57157E 06	0.10349E 06	0.10334E 06	0.13686E 01	0.43802E-00	0.43758E-00
211	5.95334	0.74832E-12	0.74885E-12	0.74939E-12	0.56926E 06	0.10301E 06	0.10287E 06	0.13649E 01	0.43666E-00	0.43625E-00
212	5.96273	0.74933E-12	0.74986E-12	0.75040E-12	0.56697E 06	0.10254E 06	0.10239E 06	0.13612E 01	0.43532E-00	0.43490E-00
213	5.97209	0.75033E-12	0.75086E-12	0.75140E-12	0.56470E 06	0.10207E 06	0.10192E 06	0.13576E 01	0.43399E-00	0.43358E-00
214	5.98142	0.75133E-12	0.75186E-12	0.75240E-12	0.56245E 06	0.10160E 06	0.10145E 06	0.13540E 01	0.43267E-00	0.43225E-00
215	5.99073	0.75232E-12	0.75286E-12	0.75340E-12	0.56022E 06	0.10114E 06	0.10100E 06	0.13504E 01	0.43136E-00	0.43095E-00
216	6.00000	0.75332E-12	0.75385E-12	0.75439E-12	0.55801E 06	0.10068E 06	0.10053E 06	0.13469E 01	0.43005E-00	0.42963E-00
217	6.00924	0.75431E-12	0.75484E-12	0.75538E-12	0.55582E 06	0.10023E 06	0.10008E 06	0.13433E 01	0.42876E-00	0.42834E-00
218	6.01846	0.75529E-12	0.75583E-12	0.75637E-12	0.55364E 06	0.99778E 05	0.99626E 05	0.13398E 01	0.42748E-00	0.42704E-00
219	6.02765	0.75628E-12	0.75681E-12	0.75735E-12	0.55149E 06	0.99332E 05	0.99185E 05	0.13363E 01	0.42620E-00	0.42578E-00
220	6.03681	0.75726E-12	0.75779E-12	0.75833E-12	0.54935E 06	0.98893E 05	0.98751E 05	0.13329E 01	0.42495E-00	0.42454E-00
221	6.04594	0.75824E-12	0.75877E-12	0.75931E-12	0.54722E 06	0.98454E 05	0.98315E 05	0.13294E 01	0.42369E-00	0.42329E-00
222	6.05505	0.75921E-12	0.75975E-12	0.76028E-12	0.54512E 06	0.98021E 05	0.97887E 05	0.13260E 01	0.42245E-00	0.42206E-00
223	6.06413	0.76018E-12	0.76072E-12	0.76126E-12	0.54303E 06	0.97591E 05	0.97459E 05	0.13226E 01	0.42121E-00	0.42083E-00
224	6.07318	0.76115E-12	0.76169E-12	0.76223E-12	0.54096E 06	0.97165E 05	0.97027E 05	0.13193E 01	0.41998E-00	0.41958E-00
225	6.08220	0.76212E-12	0.76265E-12	0.76319E-12	0.53891E 06	0.96744E 05	0.96612E 05	0.13159E 01	0.41877E-00	0.41839E-00
226	6.09120	0.76308E-12	0.76362E-12	0.76416E-12	0.53687E 06	0.96325E 05	0.96192E 05	0.13126E 01	0.41756E-00	0.41717E-00
227	6.10017	0.76404E-12	0.76458E-12	0.76512E-12	0.53485E 06	0.95909E 05	0.95777E 05	0.13093E 01	0.41635E-00	0.41597E-00
228	6.10911	0.76500E-12	0.76554E-12	0.76607E-12	0.53284E 06	0.95497E 05	0.95367E 05	0.13060E 01	0.41516E-00	0.41479E-00
229	6.11803	0.76596E-12	0.76649E-12	0.76703E-12	0.53085E 06	0.95089E 05	0.94964E 05	0.13028E 01	0.41398E-00	0.41361E-00
230	6.12693	0.76691E-12	0.76744E-12	0.76798E-12	0.52888E 06	0.94687E 05	0.94558E 05	0.12996E 01	0.41281E-00	0.41244E-00
231	6.13579	0.76786E-12	0.76839E-12	0.76893E-12	0.52692E 06	0.94285E 05	0.94165E 05	0.12963E 01	0.41164E-00	0.41129E-00
232	6.14463	0.76881E-12	0.76934E-12	0.76988E-12	0.52497E 06	0.93887E 05	0.93750E 05	0.12932E 01	0.41048E-00	0.41008E-00
233	6.15345	0.76975E-12	0.77028E-12	0.77082E-12	0.52305E 06	0.93492E 05	0.93373E 05	0.12900E 01	0.40933E-00	0.40898E-00
234	6.16224	0.77069E-12	0.77122E-12	0.77176E-12	0.52113E 06	0.93102E 05	0.92974E 05	0.12868E 01	0.40819E-00	0.40782E-00
235	6.17101	0.77163E-12	0.77216E-12	0.77270E-12	0.51923E 06	0.92714E 05	0.92591E 05	0.12837E 01	0.40706E-00	0.40670E-00
236	6.17975	0.77257E-12	0.77310E-12	0.77364E-12	0.51735E 06	0.92331E 05	0.92197E 05	0.12806E 01	0.40593E-00	0.40554E-00
237	6.18846	0.77350E-12	0.77403E-12	0.77457E-12	0.51548E 06	0.91949E 05	0.91832E 05	0.12775E 01	0.40481E-00	0.40447E-00
238	6.19715	0.77443E-12	0.77496E-12	0.77550E-12	0.51362E 06	0.91570E 05	0.91449E 05	0.12744E 01	0.40370E-00	0.40335E-00
239	6.20582	0.77536E-12	0.77589E-12	0.77643E-12	0.51178E 06	0.91196E 05	0.91058E 05	0.12714E 01	0.40260E-00	0.40219E-00

INCIDENT PARTICLE	INCIDENT LAB K.E. (MEV)	TARGET SYMB	A	Z	N	NUMBER OF INCIDENT PARTICLES	CUTOFF ENERGY (MEV)	GEOMETRIC CROSS SECT. (MB)	TRANSPARENCY	INELASTIC CROSS SECT. (MB)
PI-	200.	RU	100.	44.	56.	2000.	5.2	1164.9	0.01750	1144.5

	NUMBER OF INCIDENT PARTICLES DIRECTED TOWARD	FRACTION OF TOTAL	CORRESPONDING FRACTION OF TOT CRS SECTNL AREA	NUMBER OF THESE PARTICLES WHICH ESCAPE
REGION 1	1993	0.996	0.996	31
REGION 2	4	0.002	0.002	2
REGION 3	3	0.001	0.002	2
TOTAL	2000			35

	NO. OF INCIDENT PARTICLES DIRECTED TOWARD REG.1 WHICH COLLIDE IN	NO. OF INCIDENT PARTICLES DIRECTED TOWARD REG.2 WHICH COLLIDE IN	NO. OF INCIDENT PARTICLES DIRECTED TOWARD REG.3 WHICH COLLIDE IN	TOTAL
REGION 1	1948			1948
REGION 2	8	1		9
REGION 3	6	1	1	8

	NO. OF CASCADE PARTICLES, WHOSE ORIGINAL COLLISION WAS IN REG.1, MAKING COLLISIONS IN	NO. OF CASCADE PARTICLES, WHOSE ORIGINAL COLLISION WAS IN REG.2, MAKING COLLISIONS IN	NO. OF CASCADE PARTICLES, WHOSE ORIGINAL COLLISION WAS IN REG.3, MAKING COLLISIONS IN	NO. OF CASCADE PARTICLES ESCAPING WHOSE ORIGINAL COLLISION WAS MADE IN
REGION 1	9776	34	31	5787
REGION 2	8	0	0	22
REGION 3	7	1	0	19
TOTAL	9791	35	31	5828

INCIDENT PARTICLE	INCIDENT LAB K.E. (MEV)	TARGET SYMB	A	Z	N	NUMBER OF INCIDENT PARTICLES	CUTOFF ENERGY (MEV)	GEOMETRIC CROSS SECT. (MB)	TRANSPARENCY	INELASTIC CROSS SECT. (MB)
PI-	200.	RU	100.	44.	56.	2000.	5.2	1164.9	0.01750	1144.5

INITIAL RANDOM NUMBER (OCTAL)	FINAL RANDOM NUMBER (OCTAL)
323702373235	344512227355

FORBIDDEN COLLISIONS
AVERAGE NUMBER OF PARTICLES PER INCIDENT COLLISION BELOW THE PERTINENT FERMI ENERGY

PROTONS	NEUTRONS
3.8	6.2

AVERAGE NUMBER OF PARTICLES PER INCIDENT COLLISION WHOSE ENERGY WAS BELOW THE CUTOFF ENERGY IN ALLOWED COLLISIONS

PROTONS	NEUTRONS	PI+	PIO	PI-
1.7	2.3	0.0	0.0	0.0

AVERAGE NUMBER OF COLLISIONS PER INCIDENT COLLISION WHERE SINGLE PRODUCTION WAS POSSIBLE

P-P	P-N	N-P	N-N	PI+	PIO	PI-
0.00	0.00	0.00	0.01	0.	0.	0.

AVERAGE NUMBER OF COLLISIONS PER INCIDENT COLLISION WHERE DOUBLE PRODUCTION WAS POSSIBLE

P-P	P-N	N-P	N-N	PI+	PIO	PI-
0.	0.	0.	0.	0.	0.	0.

AVERAGE NUMBER OF COLLISIONS PER INCIDENT COLLISION WHERE PRODUCTION OF MORE THAN TWO PIONS WAS POSSIBLE

P-P	P-N	N-P	N-N	PI+	PIO	PI-
0.	0.	0.	0.	0.	0.	0.

INCIDENT PARTICLE	INCIDENT LAB K.E. (MEV)	TARGET SYMB	A	Z	N	NUMBER OF INCIDENT PARTICLES	CUTOFF ENERGY (MEV)	GEOMETRIC CROSS SECT. (MB)	TRANSPARENCY	INELASTIC CROSS SECT. (MB)
PI-	200.	RU	100.	44.	56.	2000.	5.2	1164.9	0.01750	1144.5

A	R1	R2	R3	RHO1/A	RHO2/A	RHO3/A	E1	E2	E2
100.	0.608E-12	0.608E-12	0.609E-12	0.106E 07	0.212E 06	0.212E 06	2.0682	0.7073	0.7064

INCIDENT PARTICLE KINETIC ENERGY (MEV) WITHIN THE NUCLEUS

REGION 1		REGION 2		REGION 3		OUTSIDE THE NUCLEUS
PROT PRT	NEUT PRT	PROT PRT	NEUT PRT	PROT PRT	NEUT PRT	
233.	237.	216.	217.	216.	217.	200.

COULOMB ENERGY AT SURFACE (MEV)

10.4

INELASTIC CROSS SECTION (MB) CALCULATED FROM PROBABILITIES OF INCIDENT PARTICLES ESCAPING	INELASTIC CROSS SECTION (MB) CALCULATED FROM RATIO OF INCIDENT COLLISIONS TO INCIDENT PARTICLES
1144.5	1144.5

NUMBER OF TAPE ERRORS DETECTED BY MAIN PROGRAM

READING	WRITING
0	3

Binary Tapes

Analysis Codes I and II, the Evaporation Code, and the Angular Momentum Code generate binary tapes in addition to the printed output described in ORNL-3433 and in this manual. The binary tapes are magnetic tapes on which data from the analysis codes are stored in the binary mode, so that the data may be retrieved easily by programming. The tapes are specifically intended to be used in writing programs to plot automatically the data provided by the analysis codes.

Data Retrieval

To retrieve the data, the programmer must know what words are stored on the binary tape, in what record and where in the record they are stored, and the format used in storing them. This information is provided on the printed output of the sample case in this manual.

Each word on the binary tapes is marked on the sample printed output, the format of the words being indicated by an underline for floating point, a rectangle for binary coded decimal, and a circle for fixed point. There are a few words on the binary tape that do not appear in the printed output. Only the ones useful for data retrieval will be discussed. All of them are marked on the sample printed output, however, to avoid confusion if dumps of the binary tapes are referred to.

The words on the binary tape are grouped into records. This grouping is indicated on the sample printed output by horizontal lines. The records are numbered in the left margin of the sample printed output. The numbers will not necessarily correspond to the actual record numbers, which are always consecutive on the binary tape, since it is possible to eliminate some records in some analysis codes by choosing different optional outputs. Also, if there are more than 256 words in a record, the logical record will occupy more than one physical record on the binary tape.

The number of words in the record, excluding the first word, which is not retrievable in Fortran, is given in the right margin on the sample printed output. The number of words in some records depends upon the case being run or the selected input, and in these cases the word "variable" instead of a number will be written in the right margin for these records. The number of words in these records may be determined for a specific case by counting the appropriate words in the printed output. Since the computer must write at least three words in each record, records containing only one word of information will actually have two more words in the tape dump: the first and unretrievable word, and the third word which is a copy of the word in the same position in the preceding record and is therefore meaningless.

Analysis Code I

In Analysis Code I the following words are of special significance to the writer of a retrieval program.

Word 11 in Record 1.

If Word 11 = 0, Records 2, 8, 9, and all records after 18 do not appear.

Word 13 in Record 1.

This word appears on the binary tape and not in the printed output. Its value may be determined from the printed output by counting the number of words in Record 3 (Outgoing Combinations). If Record 3 does not appear in the printed output, Records 4 and 10 will not appear either. The lengths of Records 3, 4, and 10 through 16 depend upon the value of word 13, the number of outgoing combinations.

Word 1 in Record 41.

If this word equals 25402 in the decimal dump of the binary tape, record 41 will contain only this one informative word, and an extra record will have been added following record 41. In this case, record 42 will be a special option which will only be used with higher energy cascade calculations and therefore will not appear with the calculations on these tapes. The record numbered 41 in the sample printed output would then be record 43.

Analysis Code II

In Analysis Code II the sequence of the records depends upon the options selected (see pp 60-62 of this manual). The sample printed output in this manual illustrates the most probable sequence of records if all of the options are selected and therefore as an example the records are numbered consecutively for this case. The actual record numbers for

a desired case may be determined by comparing the printed output for the desired case with the sample printed output and numbering the records in a similar manner. Wherever the word "PAGE 1" appears on the printed output (this may occur as many as four times in different parts of the printed output, as in the example in ORNL-3433), there will be three records on the binary tape that do not appear in the printed output. The location of these records and the words they contain are indicated on the sample printed output. The words in these records indicate what options have been selected or how many times certain types of records are repeated. They are useful but not necessary for a retrieval program.

There are no words in Analysis Code II that are of special significance, in general, to the writer of a retrieval program.

Evaporation Code

In the Evaporation Code extra records, which do not appear in the printed output, have been added to the binary tape between each line of the first table in the Evaporation Code. These records, called KEY2 on the printed output illustrated on pages 82 and 83, are one informative word in length and indicate the length of the succeeding record. They are not necessary for a retrieval program.

If the first table occupies more than one page of printed output, a record identical to Record 3 containing the case number will occur on the binary tape before the table is continued.

Angular Momentum Code

The first word in Records 2 through 5 on the binary tape is the number of words to follow in that record. This word does not appear on the printed output.

Running Times

Table I. Approximate Running Times in Hours per 1000 Incident Particles*

Codes	Targets		
	O^{16}	Ru^{100}	U^{238}
Cascade Code	0.11	0.22	0.35
Analysis Code I	0.04	0.03	0.04
Analysis Code II	0.04	0.04	0.03
Evaporation Code	0.03	.05	0.11
Angular Momentum Code**	0.01-0.02	0.01-0.02	0.01-0.02
Nuclear Configuration Code***	0.04		

* The running times will vary depending upon the energy.

** Without plotting routine.

*** The running time of this code is, of course, independent of the targets.

The running time for Analysis Code II is very sensitive to the quantity of information desired. The values listed here are for the use of all the options. The running time for the Angular Momentum Code depends primarily upon the size chosen for the angular momentum intervals. Estimated machine times based on the use of this table should not be considered as more accurate than about 50%.

IOU Subroutine

An IOU subroutine is included in each code to provide the proper assignment of a logical tape number to an absolute tape and channel. If a change in any of the assignments is desired, then a change must be made in the twenty-second card of the listing shown below, which is an example for Analysis Code II and the Evaporation Code. The meaning of this card is:

IOU (Logical 1, Logical 2, Logical 3, ..., Logical n) ,

where the absolute number is inserted for the appropriate logical number. If an absolute number is not required for a given logical number, then nothing is inserted between the commas surrounding that space. For example:

IOU (A6, A5, , A3)

assigns logical 1 to A6

logical 2 to A5

logical 4 to A3

```
*       FAP                                                          30500100
         PCC                                                         30500200
         LBL      IO,X                                               30500300
         COUNT    19                                                 30500400
         ENTRY    (IOU)                                              30500500
 IOU     MACRO    A                                                  30500600
         PMC      ON                                                 30500700
         OCT      1361                                               30500800
         OCT      1341                                               30500900
         OCT      1321                                               30501000
 (IOU)   PZE      N                                                  30501100
         PMC      OFF                                                30501200
         IRP      A                                                  30501300
         IFF      A,A                                                30501400
 A       TAPENO   A                                                  30501500
         PMC      ON                                                 30501600
         PZE      A                                                  30501700
         PMC      OFF                                                30501800
         IRP                                                         30501900
 N       EQU      *-(IOU)-1                                          30502000
 IOU     END                                                         30502100
         IOU      (B3,B5,A7,A4,A2,A3,B4,B8,A5,A6)                    30502200
         END                                                         30502300
```

FORMAT OF OUTPUT WRITTEN ON THE PRIMARY OUTPUT TAPE FROM THE CASCADE CODE

(All of the records below are written in the binary mode.)

Notation:

fl. = Floating point

fx. = Fixed point (integers written starting at the right side of the word)

O = Octal

BCD = Binary coded decimal

Record 1

Word No.	Description	Format
1	Target mass number	fl.
2	Target atomic number	fl.
3	Incident particle kinetic energy (MeV)	fl.
4	Type of incident particle One of { PROTON, NEUT, PI+, PI- } (left-adjusted)	BCD
5	Chemical symbol of target (left-adjusted)	BCD
6	Number of incident particles	fl.

Record 2

Word No.	Description	Format
1	Number of escaping particles in this record	fx.
2	Type of particle escaping first 377777000000 indicating proton 377776000000 " neutron 377775000000 " π^+ 377774000000 " π^0 377773000000 " π^-	0
3	Kinetic energy of this escaping particle (MeV)	fl.
4	Cosine of angle that this escaping particle makes with x axis	fl.
5	Cosine of angle that this escaping particle makes with y axis	fl.
6	Cosine of angle that this escaping particle makes with z axis	fl.
7 8 9	x, y, and z coordinates, respectively, of point from which this particle made its last collision. (The origin is at the center of the nucleus.)	fl.
10	Type of particle escaping second	
11	Kinetic energy of particle escaping second	
12	Cosine of angle that second escaping particle makes with x axis	
etc.		
Last Word	x coordinate of the collision point of the incident particle initiating the cascade. The collision at this point was the first in the cascade collisions that led to the particles in this record escaping.	fl.

Note: There is a set of 8 words for each escaping particle. If no particles escape, there will be only 2 words in the record. The first word will be zero and the second word will be the value of the x coordinate of the incident particle.

The order in which the particles are tabulated, i.e., first escaping particle, second escaping particle, etc., has no physical significance. The order was determined by coding convenience.

The coordinates are oriented so that the incident particle is directed along the positive z axis and lies in the x-z plane. Therefore, the y coordinate is zero for all incident particles.

Record 3

Same format as Record 2

Record 4

Same format as Record 2

Record 5

etc.

Last Record

Word No.	Description	Format
1	Total number of incident particles making collisions	fl.
2	Geometric cross section of target in mb (millibarns), σ_g	fl.
3	Inelastic cross section of reaction in mb, σ_{inel}	fl.
4	Number of escaping particle records	fx.
5	Cutoff energy (MeV)	fl.

END OF FILE

Note: In the last record, words Nos. 1 and 4 will have the same value. They are equal to the total number of records in the file minus two.

There is one escaping particle record of some kind for every incident particle that makes a collision. If the incident particle passes through the nucleus without making a collision, nothing is recorded. Therefore,

$$\sigma_{inel} = \left(\frac{\text{number of escaping particle records}}{\text{number of incident particles}}\right) \text{X } \sigma_g.$$

TABLE OF RANDOM NUMBERS
(OCTAL)

RANDOM = PREVIOUS RANDOM RAISED TO 5TH POWER MODULO 2 TO THE 35TH
INITIAL RANDOM = 343277244615

+156550420575	+342547677215	+111023565335	+163716155555	+312322614475	+274212210515
+216032262235	+142701334055	+113305342375	+145404524015	+146344671135	+222375774355
+102502562275	+042642001315	+011171752035	+357505256655	+077601634175	+062766160615
+160215244735	+143571723155	+351036700075	+251516202115	+326457511635	+276417111455
+126113075775	+366240025415	+065176470535	+270171361755	+204774565675	+017572412715
+226524721435	+104236254255	+001436707575	+273765502215	+230372164335	+354504130555
+127701623475	+354642233515	+363723201235	+155202327055	+150512471375	+250572367015
+144421530135	+110461407355	+070243431275	+170321064315	+305544131035	+214132711655
+120553623175	+320502063615	+276246343735	+175650776155	+115047407075	+160642325115
+323221130635	+151327204455	+250557724775	+055757770415	+070152027535	+107042074755
+150043134675	+042101575715	+066663600435	+161667007255	+264224376575	+270267505215
+204735763335	+047044303555	+001274032475	+215152456515	+140365320235	+005711522055
+326547020375	+233534432015	+312523567135	+107507222355	+322147500275	+256550347315
+271117510035	+350356544655	+375705012175	+217062166615	+225754642735	+170462251155
+017753316075	+346026650115	+345613747635	+316025477455	+255333753775	+114034133415
+154632566535	+116635007755	+107134703675	+174341160715	+252103657435	+013475742255
+251451265575	+045215710215	+001436762335	+143116656555	+326441441475	+113703101515
+153740637235	+145567115055	+102172547375	+275612675015	+006013026135	+261437235355
+011756747275	+206110032315	+125634267035	+377340577655	+075755401175	+337646471615
+236300341735	+027765724155	+325312425075	+233613373115	+032177766635	+151252172455
+144757202775	+164004476415	+164160525535	+365312122755	+060011652675	+103070743715
+126545136435	+320423075255	+254075354575	+230130313215	+151435161335	+350643431555
+017122250475	+237213724515	+226365356235	+115552710055	+377745476375	+326345340015
+353627465135	+260231450355	+001231416275	+207117715315	+365652246035	+124021032655
+257505170175	+174177174615	+346601240735	+047723577155	+151044734075	+354340316115

TABLE OF RANDOM NUMBERS
(OCTAL)

RANDOM = PREVIOUS RANDOM RAISED TO 5TH POWER MODULO 2 TO THE 35TH
INITIAL RANDOM = 34327.244615

+144715205635	+100165065455	+170011631775	+021211241415	+127513664535	+150611435755
+130212021675	+142450726715	+212567615435	+007426430255	+056460643575	+356367116215
+200070560335	+010002404555	+012656257475	+305644747515	+110223275235	+006604703055
+014407625375	+365114203015	+271131324135	+165626063355	+001707265275	+002140000315
+333331425035	+361137465655	+231454157175	+145634077615	+346217337735	+174253652155
+276532443075	+372365441115	+241723624635	+337526160455	+067213460775	+327212204415
+210214223535	+336673150755	+035475370675	+217221111715	+174333474435	+177450163255
+113543332575	+115512121215	+160321357335	+030513557555	+121225466475	+305756172515
+321432414235	+141645076055	+014501154375	+161237246015	+023260363135	+073764676355
+175330334275	+017530263315	+060612004035	+151654320655	+352402346175	+345735202615
+174112636735	+361136125155	+361713352075	+260252764115	+225363443635	+134455453455
+233324507775	+301547347415	+337221762535	+225477063755	+005604137675	+105521474715
+111760553435	+217450116255	+306065221575	+043061324215	+315507356335	+172537132555
+222150075475	+156107615515	+152352733235	+267653471055	+114761703375	+352276511015
+007374622135	+104625711355	+015454603275	+220030746315	+010033563035	+330727353655
+071047735175	+216042505615	+357423335735	+152312600155	+106327461075	+300340507115
+353614462635	+123733146455	+105104736775	+023200712415	+235674721535	+322765176755
+276276 06675	+312112257715	+371427032435	+026366251255	+010406310575	+044214727215
+222772555335	+226034705555	+245205704475	+124621440515	+063144452235	+351570264055
+302171632375	+107612154015	+012636261135	+332131124355	+164044252275	+053601631315
+133356542035	+341300606655	+303774524175	+067514210615	+357511234735	+323721453155
+047736770075	+245166432115	+070776701635	+352477041455	+175074365775	+130066455415
+155155060535	+344675511755	+035113255675	+051133242715	+171256511435	+173162604255
+045466577575	+116474532215	+043513154335	+332544660555	+212116713475	+330253463515
+063747371235	+140353257055	+011070761375	+270742017015	+372365120135	+116036537355

TABLE OF RANDOM NUMBERS
(OCTAL)

RANDOM = PREVIOUS RANDOM RAISED TO 5TH POWER MODULO 2 TO THE 35TH
INITIAL RANDOM = 343277244615

+232437121275	+123162714315	+015142721035	+256110241655	+161740513175	+004072113615
+223514333735	+041522526155	+052101477075	+241114555115	+371252320635	+315471134455
+064033214775	+143350420415	+136402417535	+041170224755	+037613624675	+067144425715
+237427370435	+254575337255	+330046266575	+347440535215	+112630753335	+300427033555
+150443122475	+037165706515	+134723510235	+014744452055	+146217310375	+265246062015
+033541157135	+372306352355	+222575170275	+076714177315	+347330300035	+362116074655
+321463702175	+134714216615	+132574632735	+117456001155	+010537406075	+276503100115
+220757137635	+061651427455	+002501243775	+120566563415	+352735156535	+346005137755
+353737373675	+220506010715	+052261447435	+041766272255	+202465155575	+174430740215
+073503752335	+307423406555	+220142531475	+027720331515	+206211027235	+150104045055
+306335037375	+374266325015	+033502416135	+101060365355	+226236437275	+357155662315
+234257057035	+350262127655	+031526271175	+363342521615	+054072331735	+141503454155
+247230515075	+320071623115	+114055156635	+324160122455	+051416472775	+203301126415
+363535115535	+231104252755	+317246342675	+231737573715	+277734726435	+331675425255
+057703244575	+343005343215	+221254151335	+167472161555	+170555340475	+170633154515
+160147546235	+162751640055	+276201766375	+225362770015	+017371055135	+214074600355
+006743106275	+054467545315	+306107036035	+127524362655	+050650060175	+301135224615
+126745230735	+143563327155	+021515024075	+160020546115	+136704375635	+371555015455
+221343121775	+246647671415	+301742254535	+250425565755	+077500511675	+177421556715
+356371405435	+133262760255	+222460533575	+070306146215	+117061550335	+140553134555
+301643347475	+300266177515	+302717465235	+266265633055	+212336115375	+320073633015
+164344714135	+115313213355	+156252755275	+207411630315	+347000215035	+177025015655
+205611047175	+007434127615	+222335327735	+151635402155	+173334533075	+000647671115
+345425014635	+157200110455	+313036750775	+256412634415	+006714613535	+212131300755
+332416060675	+065673741715	+054147264435	+265266513255	+005335222575	+342073151215

TABLE OF RANDOM NUMBERS
(OCTAL)

RANDOM = PREVIOUS RANDOM RAISED TO 5TH POWER MODULO 2 TO THE 35TH
INITIAL RANDOM = 343277244615

+340064347335	+032606307555	+063144556475	+065001422515	+016440604235	+103210026055
+017521444375	+103560676015	+057545753135	+376674026355	+176126024275	+130304113315
+151072574035	+075323650655	+137131236175	+117777232615	+375602626735	+217641655155
+100247442075	+254737214115	+344176633635	+211611403455	+017041777775	+325711777415
+333574352535	+273757213755	+145556627675	+171276324715	+327206343435	+176650446255
+213051111575	+215504354215	+027424346335	+105553662555	+274421165475	+345135045515
+313273123235	+262500421055	+332474173375	+317562141015	+216334212135	+042357041355
+020104273275	+277506576315	+236526353035	+351560703655	+213570625175	+153746535615
+040065325735	+371540330155	+344015551075	+146626737115	+107141652635	+046151076455
+076114226775	+240305342415	+301521311535	+303667326755	+316702576675	+316371107715
+065666622435	+326550601255	+316164200575	+060301757215	+060461545335	+211373435555
+165410774475	+247250670515	+131376642235	+045277214055	+037776122375	+233437604015
+105647651135	+102104254355	+045725742275	+245561461315	+301663332035	+146714136655
+212107414175	+164662240615	+350525224735	+323271203155	+022157060075	+350656662115
+342434071635	+251376771455	+340775655775	+331335105415	+241653450535	+057621641755
+053551745675	+201514072715	+166130301435	+143727134255	+041436467575	+007623562215
+316354144335	+226025410555	+235654003475	+031704713515	+001113561235	+104344207055
+274367251375	+026531447015	+163050510135	+357633667355	+351152611275	+273044544315
+364661511035	+037705571655	+201045403175	+314102143615	+256502323735	+120614256155
+236453567075	+265407005115	+162423510635	+000453064455	+050226504775	+224361050415
+315353007535	+225536354755	+271704314675	+247227255715	+256313160435	+125323667255
+177610156575	+231231565215	+374243743335	+043231563555	+235132212475	+243221136515
+362401700235	+100617402055	+064607600375	+370377512015	+233276547135	+305325502355
+253542660275	+170100027315	+101661070035	+007475424655	+077162572175	+033166246615
+061134622735	+255671531155	+204643476075	+027177330115	+233242327635	+240315357455

TABLE OF RANDOM NUMBERS
(OCTAL)

RANDOM = PREVIOUS RANDOM RAISED TO 5TH POWER MODULO 2 TO THE 35TH
INITIAL RANDOM = 343277244615

+354566533775	+054741213415	+375557546535	+223375267755	+337062063675	+033672640715
+334557237435	+142076622255	+213421045575	+262263770215	+055270742335	+361150136555
+003163621475	+161755561515	+105601217235	+323240775055	+265417327375	+100361755015
+253712006135	+144721515355	+347036127275	+035243512315	+233021647035	+231023457655
+073217161175	+123456551615	+227404321735	+056441204155	+350466605075	+040370053115
+351052346635	+205706052455	+256775762775	+106215556415	+123631505535	+317116402755
+051023032675	+203626423715	+347244516435	+310767755255	+217431134575	+150302373215
+074613141335	+307540711555	+207530430475	+174272404515	+373051736235	+074770570055
+023356256375	+066020420015	+371652445135	+170157730355	+074774576275	+263057375315
+332463626035	+327047712655	+223732750175	+256513254615	+160631220735	+036643057155
+025505114075	+253520776115	+320013565635	+065764745455	+227614411775	+313726321415
+130710644535	+366461715755	+115307201675	+113412406715	+234313175435	+120737310255
+176400423575	+030645176215	+155572540335	+166543664555	+012150437475	+200727427515
+372533655235	+106566563055	+313204405375	+150473263015	+102300304135	+261220343355
+167136445275	+011703460315	+302567005035	+114532345655	+017665737175	+255654157615
+264173317735	+322437132155	+177456623075	+133152121115	+254246204635	+275472040455
+167602240775	+361233264415	+376135203535	+277607430755	+051656550675	+247366571715
+262103054435	+110725043255	+363047112575	+151074201215	+153347337335	+326121037555
+222403646475	+006044652515	+024566774235	+101372756055	+001461734375	+257522326015
+252553343135	+312023156355	+207243514275	+272077743315	+375473364035	+014613200655
+035600126175	+032461262615	+301012616735	+245565405155	+302123532075	+231443444115
+302132023635	+261565333455	+307477267775	+061674427415	+234666742535	+350457343755
+304051317675	+224073154715	+306554133435	+207670776255	+057755001575	+106547404215
+111061336335	+306010412555	+120212255475	+132202275515	+001333313235	+006145351055
+203126463375	+052465571015	+300013602135	+204330171355	+207053763275	+044204426315