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AUTOMATION OF THE PROCEDURE FOR CHECKING INFORMATION CONTAINED IN THE LIBRARY OF EVALUATED NUCLEAR DATA: THE "POSOSHOK" PROGRAMME

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AUTOMATION OF THE PROCEDURE FOR CHECKING INFORMATION CONTAINED IN THE LIBRARY OF EVALUATED NUCLEAR DATA: THE "POSOSHOK" PROGRAMME

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1. INTRODUCTION

Nuclear reactor calculations require a large amount of data of various kinds, characterizing the interaction of neutrons and gamma-rays with the nuclei of fuel elements, moderators and structural materials. There is a real need to accumulate and store data of this kind for use in calculations. For this purpose special computer libraries of recommended nuclear data [1] are being created.

Such libraries substantially enlarge the possibilities of preparing basic information for reactor physics calculations. They permit extensive automation of the processing of recommended nuclear data into group constants with arbitrary energy sub-divisions and thus make it possible to link this processing directly with nuclear reactor calculations by the group method.

Neutron cross-sections and other nuclear physics data recommended for nuclear reactor calculations are stored on punched cards and magnetic tapes in a standard representation suitable for processing on electronic computers. A description of the general structure and formats of the nuclear data library adopted by the Institute of Physics and Power Engineering is given in Ref. [2].

A whole complex of programmes for various purposes is associated with the library of recommended nuclear data. These include:

- Programmes used for creating the actual library of recommended nuclear data and for keeping it operational;
- Various types of processing programmes which make use of data stored in the nuclear data library.

In the present report a description is given of the Programme for the Detection of Random Errors (POSOSHOK), which is written in ALGOL-60 language suitable for type M-220 computers. The POSOSHOK programme is intended for use in checking the correctness of representation and self-consistency of the numerical information contained in the library of recommended nuclear data of the Institute of Physics and Power Engineering.

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2. GENERAL FEATURES OF THE POSOSHOK PROGRAMME

Before fresh nuclear physics data are taken up in the library and thus made available for regular use it is necessary to ensure that they have been correctly entered on the primary carriers, which are usually punched cards. When there is a large volume of data, involving a considerable number of punched cards, it is impossible to ignore the probability of random errors associated with the various kinds of reading in, printing, etc. In these circumstances a check on the correct representation of the data on the punched cards takes on special importance.

A reliable check on the correctness of the printing can be carried out by means of a direct comparison between the contents of the punched cards and the sheets from which the data contained on them were taken. When there is a large volume of information, however, practical difficulties arise as a visual check on punched cards or the printed tables obtained from them is an extremely laborious and exhausting procedure. A check can be carried out, however, with the help of an electronic computer, using special programmes for the purpose.

The POSOSHOK programme is a programme of this type and is intended for the checking of library data. It makes the procedure largely automatic and thus substantially lightens the task of checking the representation of information on punched cards or magnetic tape. When analysing the data set in the library format the programme effects a large number of different logical and arithmetical checks. All errors and discrepancies discovered by this means are printed out in the standard coded form.

The checking of data by computer is worthy of consideration, despite the fact that it requires the inclusion in the library of information that is in a sense superfluous and repetitive. A check of this kind is useful and, as a rule, effective.

The checking programme handles enormous arrays of data in the course of a run, amounting at the present time to 40 000–50 000 numbers for each nucleus of a given type. Moreover, the programme itself, in view of its complex logic and the considerable number of checks to be carried out, is very large and occupies a lot of space in the computer memory. All this means that certain requirements have to be met by the programme and the computer on which it is run. A critical

role is played by the capacity of the internal memory device, and also by the refinement of external storage devices (magnetic drums, discs and tapes,etc.).

An ideal system for checking library information requires an electronic computer with a large internal memory so that, during the whole period the programme is being run, both the programme itself and the necessary volume of information to be checked can be accommodated. In the case of the CHECK programme [3] used on IBM 7030 computers, for example, 70.000 cells in the internal memory are set aside for the storage of information to be processed.

Where the internal memory of a computer is not so large, checking of the data in the library presents certain difficulties. Magnetic drums, tapes and other carriers have to be used to store both the information to be checked and the actual checking programme. All this naturally complicates the work; it means that we must devote careful attention to the possibilities and resources of individual computers when designing a programme.

The checking programme described here is written in ALGOL-60 language and has been translated for an M-220 computer by a TA-2 translator [4], which is in service at the Institute of Physics and Power Engineering and uses during its operation a corresponding mathematical check routine, also partially developed at the Institute. All this, of course, has specialized the programme to a certain extent, and also the check algorithms on which it was based.

The check algorithm adopted is such that at any given moment the internal memory of the computer will contain a comparatively small standard volume of arrays of data for verification. The cards in an array are checked one at a time in sequence. This makes it possible without any special preparatory storage allocation to carry out checks on arrays of varying length, even in cases in which the whole array cannot be accommodated in the internal memory at once.

The POSOSHOK programme checks:

1. That the numbering of the punched cards in a section and of the sections in a file is correct;
2. That the information contained in the zero section corresponds to the headings and the actual contents of the subsequent sections of the file;

3. That the various headings correspond to the actual contents of the arrays of data which they precede within the section;

4. That the values for various quantities are admissible on the basis of physical properties or the method of determination;

5. That the sequence of data within arrays is correct;

6. That quantities linked by a given relationship are not contradictory;

7. That the normalization of angular distributions and energy spectra of secondary neutrons is correct; and

8. That there is a smooth trend in the neutron cross-sections and special quantities specified in the form of a detailed energy relationship (check for rejections).

The POSOSHOK programme processes information presented in the format of the library of evaluated nuclear data, which is described in Ref. [2]. The version of the programme described here handles the following classes of nuclear physics data:

(a) Neutron cross-sections (GCN = 01);

(b) Angular distributions of secondary particles (GCN = 02);

(c) Energy distributions of secondary particles (GCN = 03);

(d) Special quantities for neutrons (GCN = 05).

For these GCNs, the programme encompasses all the basic FTNs which are recommended in Ref. [2] and are in current use.

No provision has been made in the programme as yet for checking data on the energy-angular distribution of thermal-neutron scattering (GCN = 04), the storage format for which is described in Ref. [2]. The reason for this is that we had no data of this kind at our disposal. No other GCN values have been defined in Ref. [2]; in particular, we do not yet have GCNs for data on the interaction of photons with matter, nor indeed are evaluated nuclear data of this type available yet.

As and when new GCNs or new FTNs for already existing GCNs are introduced, the programme will have to be expanded. In particular, an increasing role will be played in the future by many different parametric representations of data, for example representations by means of resonance formulae in the resolved resonance region, or by means of statistical data in the case of unresolved resonances.

The structure of the POSOSHOK programme readily allows an expansion of this kind. Moreover, it is possible to use ready-made units of the nuclear data check programme for checking data on photon interactions and photon products in cases where one can suitably select representation formats for the purpose - for example formats similar to those used for neutron interaction data.

Like any computer programme for the checking of data, the POSOSHOK programme has certain limits to its applicability. It is capable only of detecting certain inconsistencies in data and contradictions in the format. Some errors in nuclear data will therefore not be detected by the check programme and can be brought to light only by visual scrutiny. Thus, for example, the programme is capable of showing up cross-sections which are incorrectly written as negative numbers, but it cannot reveal an error in the value of Q if, for example, 3.067 is printed erroneously instead of 3.607.

Hence, users of library data must always bear in mind the possibility of errors that have remained undetected. Unexpected values obtained for group cross-sections may be the result of errors in the library data used for averaging the group constants.

3. STRUCTURE OF THE PROGRAMME

The POSOSHOK programme at present consists of three units, each of which constitutes an independent programme for checking the data of a particular GCN:

1. NCC unit - neutron cross-section check (GCN = 01). This unit also checks information on special quantities for neutrons (GCN = 05). In addition, there is a special sub-programme at the beginning of the unit for checking the zero (heading) section of the file;
2. ADC unit - angular distribution check (GCN = 02);
3. EDC unit - energy distribution check (GCN = 03).

All units of the POSOSHOK programme are written on separate programme magnetic tapes (PMT). The data to be verified are stored on a special information magnetic tape (IMT) in a section-by-section store.

The operation of the units of the check programme in the required order is ensured by means of a special unit operation control programme (UOCP), which is also recorded on the PMT. With the help of the UOCP, the required unit is retrieved from the PMT, recorded on magnetic drums and adjusted to a given operating regime; the next section of the IMT with data for checking is

also fed in. Throughout the POSOSHOK programme run, the UOCP is contained in the internal memory, in the machine code for the M-220 computer.

For reading the nuclear physics data that are to be checked from the IMT into the internal memory and for the selection of the required code, an administrative system (AS) is used [4]. As the processing of information in the POSOSHOK programme proceeds one card at a time in sequence, the application of the AS is extremely effective.

Each unit of the POSOSHOK programme consists in turn of a number of sub-programmes, written in ALGOL language and individually translated, which are run in the required sequence with the help of the NEXT code procedure. In the version of the POSOSHOK programme described here the units are sub-divided into the following sub-programmes:

NCC unit

HSC	-	heading (zero) section check
OSC	-	overall section check
ACC	-	array consistency check
FTNC	-	FTN check

ADC unit

OSC	-	overall section check
ACC and FTNC	-	check on the consistency of arrays and FTN

EDC unit

OSC	-	overall section check
ACC	-	array consistency check
FTNC	-	FTN check

Block diagrams of the POSOSHOK programmes are given in Annex I. ALGOL texts of all sub-programmes are presented in Annex II, which also contains the UOCP code programme.

The reason for the division of the POSOSHOK programme into units, and for the division of the units into individual sub-programmes, is the small capacity of the internalmemory in the class of computer for which the programme is intended. The programme structure described here and the associated three-stage

application of memory devices ensures more or less optimum processing of large arrays of information on computers with comparatively small internal memories. Moreover, and this is very important for the future, a structure of this kind makes it possible to add new units to the programme and to incorporate individual new sub-programmes in existing units, if the need arises, without having to reconstruct the whole programme.

It should also be noted that the structural system developed for checking allows us to use not only the POSOSHOK programme but also other programmes at the disposal of the library of evaluated nuclear data. The system already incorporates, for example, a data translation programme for adapting data from the nuclear data library format [5] to the format used by the Institute of Physics and Power Engineering.

4. COMPUTER MEMORY RESOURCES

It is assumed that the internal memory of the computer consists of a single cube of 4096 cells and that it is arranged for the POSOSHOK programme as follows (the octal addresses of the internal memory cells are indicated):

0000-0012 - operating cells;

0013-0143 - AS programme;

0144-6553 - sub-programme operating in the internal memory operating AS field, fields for variables and arrays. The actual distribution of this part of the internal magnetic store is arranged by the translator;

6554-6777 - operating memory of the programme, which is arranged by a programmer with the help of notes. A description of identifiers used in the variables programme is given in Annex II, together with the texts of the corresponding programmes;

7000-7177 - UOCP controlling programme;

7200-7777 - used during IS-2 operation [6].

For the operation of the POSOSHOK programme, all four magnetic drums available in the computer, with 4096 cells each, can be used*/. The zero

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*/ By "drum" we mean a quarter of a complete (zero) drum of 16 384 cells.

magnetic drum is allocated to IS. The three remaining drums are used to store the programme unit being run at the time.

The sub-programmes of a unit start on the first magnetic drum and, if necessary, continue on to the second and third drums. A programme unit must be fully accommodated on the magnetic drums. The cells with addresses 7640-7777 on magnetic drum number three are occupied by the passport of the operating unit. The passport is compiled during the recording of the unit on the PMT and is used for organizing the sequential transfer from the drum to internal magnetic store of the sub-programmes of the unit with the help of the NEXT code procedure.

The POSOSHOK programme requires two tapes for its operation: the PMT, on which the units of the programme itself are recorded, including the UOCP, and the IMT, where the files of data to be checked are accommodated in section-by-section stores. The information on the magnetic tapes (both the PMT and IMT) is stored in standard zones of 129 codes each.

The programme magnetic tape is laid out in standard zones numbered from one onwards. The first zone of the PMT contains the UOCP. The second zone is occupied by the passport of the programme (system of units) and the zones from the third onwards contain the programme units in sequence. Each new programme unit recorded begins a new zone. Zones can be left unoccupied at the end of a unit and may prove useful if it becomes necessary to rewrite a unit or make corrections in it.

The passport of a system of units is composed, as we have said, during recording on the PMT. Each unit is distinguished in the passport by a code of the following type:

0 52 0000 NZU(i) 0000,

where NZU(i) is the octal number of zones allotted to the i-th unit of the programme. The passport makes it possible to find the location of each programme unit on the PMT. In the case of the POSOSHOK programme this is done with the help of the UOCP.

Each programme unit on the PMT begins in turn with a unit passport which occupies the first zone allocated to the unit. Then follow the sub-programmes of the unit, each begining with a new zone.

The nuclear physics data to be checked are stored on the information magnetic tape and are presented in the format of the library of recommended nuclear data of the Institute of Physics and Power Engineering [2]. We assume that the IMT is divided into sections, each of which in turn is broken down into standard zones with independent numbering. The section-by-section recording makes it possible to handle the sections like independent magnetic tapes. Moreover, the section system enables us to have a considerably larger total number of zones on the magnetic tape without limiting the operation of the AS, which, as has been explained elsewhere [4], requires that the number of standard zones on a magnetic tape should not exceed a certain limit.

Each data file occupies a separate section of the tape. The first section contains the heading of the IMT. The heading provides information on the number of files on the tape and possibly some further information on each file. The transfer of nuclear data from punched cards to the computer's internal magnetic store and the recording of such data on the IMT is carried out with the help of a special programme.

5. INITIAL INFORMATION

The POSOSHOK programme requires the preparation of certain initial information which is punched on cards and arranged for input in the following sequence:

1. Standard IS-2 retrieval card
2. Card for retrieval of the UOCP from the PMT
3. Initial information for operation:

   (a) 0 00 nf 0000 0000

   (b) STDC

   For each i-th ($1 \leq i \leq nf$) file with data to be checked we have:

   (c) 0 00 NS(i) 0000 0000

   For each subsequent file subject to checking, the data under (c) are repeated.

4. Check sum of the initial information for operation.

   Here nf is the number of files being checked,

   NS(i) is the information for the feed-in of the section containing the i-th in the series of files of data for checking (out of the total number of files nf), and

STDC is a sign for the type of data check.

NS and nf are represented as octal numbers punched in the first address.

The first position of the NS number is allocated to the programme number of the magnetic tape data store, and the three low-priority sub-numbers make up the serial number of the section on the magnetic tape. The STDC is a decimal constant with the following values:

STDC = 0 - complete check;

= 1 - general check only.

The card for retrieval of the UOCP from the PMT has the form:

0	16	0000	0020	0000
0	00	0020	0000	0000 KA
0	16	0021	7500	7610
0	23	7000	0001	7176
0	16	NB	7001	7000
0	75	7042 + NB	6524	6006 KS

where NB is the octal number of the unit that must be called in first for the operation.

6. OPERATION OF THE PROGRAMME DURING CHECKING

In a check on any file the sections are taken in sequence. For each section the checking is carried out in two stages:

Stage 1 = general check;

Stage 2 = detailed check.

The first stage comprises the operation of the sub-programme for general checking of a section. This reveals only errors not associated with a specific type of reaction, which we shall henceforth refer to as general errors. In the second stage other sub-programmes are brought into operation which subject the section concerned to a detailed check.

A general check is carried out first on every section. Then, if the STDC in the initial information requires a complete check and if, during the general check no errors were encountered that might render detailed checking of the component parts of the section ineffective, detailed checking of the section concerned is commenced. Otherwise, the programme proceeds to a general check on the following section.

The two-stage check is advantageous for the following reasons. Since in the detailed checking the search for errors proceeds in parallel on all cards it may well be that errors of a general nature which affect all the checking that follows and renders it ineffective will be revealed only at the end of the checking procedure. Clearly a great deal of superfluous work will by then have been carried out and a large volume of worthless information on spurious errors will have been produced which cannot be used for the detection of real errors.

Data checking by the POSOSHOK programme is fully automated; it is accompanied by a periodic print-out of the check results and is accomplished without any operator intervention. We shall outline below the sequence of operations in the POSOSHOK programme (cf. Annex I).

The control programme (UOCP) is called from the PMT to the internal memory and feeds in the basic information necessary for the operation; according to the NS(I) number recorded there, it then feeds in the IMT section with the first in the series of files of data for checking, after which it calls from the PMT to the magnetic drums the programme unit whose number is indicated on the UOCP retrieval card. In the checking regime this will be the first unit of the POSOSHOK programme (the NCC unit), which is recorded at the beginning of the PMT.

However, if for any reason at the beginning of the operation the UOCP is to call onto the magnetic drums not the first unit in the series recorded on the PMT but a unit with a higher number, that higher number must be indicated on the UOCP-ex-PMT retrieval card. Thus, for example, during translation operation the first unit to be called is the initial unit of the translation programme. In the case of the programme for the translation of data from the nuclear data library format [5] to the Institute of Physics and Power Engineering format, this unit is recorded on the PMT as number four, after the three POSOSHOK programme units. This number accordingly has to be indicated on the UOCP retrieval card.

The retrieval of the desired unit from the PMT is accomplished as follows. First of all the passport of the system of units is read from the tape into the internal memory , and on the basis of the specified unit number the beginning of the unit required is sought on the PMT. The unit passport is then read into the internal memory , and with its help all the sub-programmes of the unit are transcribed onto the magnetic drums, together with the unit passport itself, and the first of the series of unit sub-programmes is called from the magnetic drums to the internal memory with the help of the NEXT code.

The POSOSHOK programme always begins operation with a call to the internal memory and operation of the HSC sub-programme of the first programme unit (the NCC unit), as it is assumed that any file for checking will have a heading (zero) section at the beginning of the file. If there is repeated recourse to this unit within a given file the HSC sub-programme is called but does not operate; control passes from it to the next stage, namely retrieval from the magnetic drum of the next sub-programme of the unit concerned - the OSC sub-programme.

At the conclusion of the check on the zero section the programme is set for checking of the following section. This resetting step involves extracting and analysing the GCN of the section to be checked. If during this process it is found that the programme contains a corresponding unit featuring the GCN, but that this unit is not yet present on the magnetic drums, it is called from the PMT. In all other cases a unit already recorded on the magnetic drum is used to check the next section in the sequence. The retrieval of a new unit from the PMT to the magnetic drum is carried out with the help of the UOCP.

When any new unit is retrieved, its operation commences with the first sub-programme in the sequence. On the other hand, if for the checking of the first section a unit already recorded on the magnetic drum is still available, the following sub-programme of that unit is brought forward ready for operation. Thus, after the file heading has been checked and after the programme has been set to check the next section, the OSC sub-programme of one or other unit of the POSOSHOK programme always goes into operation. The first stage of the checking commences, the general checking of a given section.

If only a general check (STDC = 1) is required for a file, the transition to the checking of the next section takes place directly within the OSC sub-programme concerned. Consequently, the general checking of all sections of a given file will be carried out by a single sub-programme, present throughout on the internal magnetic store, without recourse to the magnetic drum or the magnetic tape. In this way the total operating time for the programme can be shortened considerably.

If, on the other hand, a complete check (STDC = 0) is necessary for a file, but during the general check errors have been encountered in a section that affect the course of further checking, the programme is first set to check the following section, as described above. If it is found that the check unit corresponding to this section is already present on the magnetic drum, the general check on the section will also be carried out by the OSC sub-programme present in the internal memory at the time.

Finally, when the STDC requires a complete check for a file and the OSC sub-programme has revealed no errors in the section that affect further checking, the next of the unit's sub-programmes, the ACC sub-programme, is called into the internal memory with the help of the NEXT code.

The ACC and FTNC sub-programmes of a unit implement the second stage of the checking, the detailed checking of a section. During the check they are called into the internal magnetic store in sequence from the magnetic drum, and continue to operate until all FTNs for all temperatures (secondary particle groups) and for all energy intervals in the section concerned have been exhausted. Recourse to the FTNC sub-programme and a check for errors with respect to the FTN concerned will proceed only after a consistency check on all arrays containing the FTN array concerned, and on the FTN array itself, has been found to reveal no errors that might lead to a discontinuation of further checking of any of these arrays. If the section checked in this way is not the last in the file, the programme is set to check the next section and a switch is made to the OSC sub-programme of the unit concerned.

When the last section of a particular file has been checked, the UOCP feeds in the next section with a new file of data for checking and if necessary calls the required programme unit from the PMT to the magnetic drums. The POSOSHOK programme completes its run when all files have been checked whose section numbers appeared in the initial information.

7. CLASSIFICATION OF ERRORS

Any error in the recommended library data which is analysed with the aid of the POSOSHOK programme is characterized by its own special code number, the Error Type Number (ETN). The errors printed out in this coded form under the corresponding ETN constitute the check results.

All the errors sought by the POSOSHOK programme are divided into two categories:

1. Errors which do not affect the course of checking; and
2. Errors which render subsequent checking of an array of data ineffective.

Two similar arrays of information, for example two sections or two arrays containing data for certain energy intervals, will be called arrays of the same rank. On the other hand, if an array completely contains one or more other arrays, we are then concerned with arrays of different ranks. In this case the

containing array will have the higher rank and the contained arrays the lower rank. The ranks of arrays can differ by one or more units. Thus, for example, the ranks of a file and of a section contained in it differ by unity, but the rank of the file and that of an energy interval contained in the section differ by two units.

Among the errors affecting subsequent checking, the following classes may be distinguished:

A. Errors which require a general check on a section only, followed by a switch to checking of the following section;

B. Errors which require checking of only the minimum permissible number of arrays in a series (one or two), and then switch the programme to checking the next array of higher rank;

C. Errors which terminate the checking of a given array and require a switch to the checking of the next array of the same or higher rank.

The ETNs of these classes of error will henceforth be accompanied by the letters under which they are listed above.

A whole series of ETNs relate to the structure of individual arrays and establish a relationship between their contents and the headings. Let us lay down some definitions relating to this type of error. We shall say that:

(a) An array is incompatible if the number of sub-arrays contained in it is not equal to the number stated in the array heading;

(b) An array is contradictory if the number of cards contained in it is not equal to the number stated in the array heading; and

(c) An array is inconsistent if the number of cards contained in it is not equal to the number computed from the headings of all the sub-arrays contained in it, the number of which is shown in the array heading.

A description is given below of the ETNs used for coding the errors sought by the POSOSHOK programme. The data are presented in the form of a table, in which the ETNs are presented, together with an explanation of their codes.

DESCRIPTION OF THE ERRORS SOUGHT BY THE POSOSHOK PROGRAMME

(1) Errors not associated with a particular type of reaction (General errors)

ETN	Explanation of the code
10A	The value of the RTN*/ in the section heading is not equal to the RTN indicated for that section in the file heading (zero section).
11A	The GCN in the section heading is unacceptable ($0 \geqslant GCN \geqslant 6$ or $GCN = 4$).
12	The PCN in the section heading is unacceptable ($0 \geqslant PCN > 108$).
13 on card n	The value of LFN x 10^4 + NS in the mark field of card n is not equal to the corresponding value given on the first section card.
14 on card n	The value of LFN x 10^4 + NS in the mark field of card n is not equal to the corresponding value given on the previous card of the section.
15 on card n (reference to number N)	The card number (N) indicated in the mark field is not equal to the serial number n of this card in the section. (Serial number on the card is incorrect.)
16 on card n (reference to number N)	The card number (N) indicated in the mark field is not one unit higher than the number of the previous (n - 1) card in the section. (Non-monotonic increase in the card numbers in the section).
17	The number of cards in the section is not equal to the number of cards shown for that section in the file heading. (Section contradictory.)
18A	The number of cards in the section is not equal to the number of cards computed from the headings of all the energy intervals included in the section. (Section inconsistent.)
19	The number of energy intervals (ΔE) included in the section is not equal to the number indicated in the section heading. (Section incompatible.)
20.	The number of cards in the file is not equal to the total number of cards for the file shown in its heading. (File contradictory.)
21.	The number of sections in the file is not equal to the number of RTNs shown on the first card of the file heading. (File incompatible).

*/ The Russian original says ETN here. We assume this was a misprint.

(2) Errors in the file heading (in the zero section)

ETN	Explanation of the code
50	The atomic number Z given on the first card is negative ($Z < 0$).
51	The atomic (molecular) weight A given on the first card is negative or equal to zero ($A \leq 0$).
52	The number of RTNs and the number of cards in the zero section shown on the first card are incompatible.
53 Section ℓ (reference to number L)	The section number (L) shown in the file heading is not equal to the serial number ℓ of this section in the same heading. (The section serial number in the file heading is incorrect.)
54	The number of cards in the zero section is not equal to the number of cards shown for this section on the first card. (Zero section is contradictory.)
55	The total number of cards in the file as shown in the heading is not equal to the sum of the numbers of cards for all sections contained in the file as indicated in the same heading. (File inconsistent.)
56.	The number of RTNs for a substance shown on the first card of the file heading does not coincide with the number of RTNs listed in the zero section.

(3) Errors in data on neutron cross-sections (GCN = 01) and on special quantities for neutrons (GCN = 05)

ETN	Explanation of the code
101	The value of Q for the total cross-section or elastic scattering cross-section given on the first card of the section is non-zero.
102	The threshold energy calculated for a given reaction exceeds the lower boundary of the first ΔE.
103 on card n	The lower boundary of the ΔE given on card n is lower than the upper boundary of the previous ΔE (overlap of energy intervals).
104B on card n	The number of temperatures for the ΔE shown on card n is less than 1.
105C on card n	The ΔE array (heading card n) is not consistent.

ETN	Explanation of the code
106 on card n (reference to card m)	The temperature T on card n is non-zero, although the number of temperatures shown in the heading of the ΔE (card m) does not entail the assumption of a temperature dependence (the number of T is equal to 1).
107 on card n (reference to card m)	The temperature T on card n is equal to zero, although the number of temperatures shown in the heading of the ΔE (card m) entails the assumption of a temperature dependence (the number of T is less than 1).
108 on card n	The temperature T given on card n is negative.
109B on card n	The number of FTNs for the temperature T shown on card n is less than 1.
110C on card n	The array for temperature T (heading card n) is not consistent.
111C on card n	The FTN on the heading card n is not acceptable.
112B on card n	For FTN = 101 the number of FTN values shown in the heading for T (card n) is more than 1.
113 on card n	The number of cards for FTN = 101 shown on card n is not equal to 1.
114 on card n	The lower boundary of the ΔE indicated for FTN = 101 on card n is not positive.
115 on card n	The lower boundary of the ΔE indicated for FTN = 101 on card n exceeds (or equals) its upper boundary.
116C on card n	The number of cards and the number of values of E entered for FTN = 111 in the heading (card n) are incompatible.
117B on card n	The number of values of E indicated on card n for a given FTN is less than 2 (for FTN = 111) or less than 1 (for FTN = 121).
118C on card n	The array for FTN = 121 (heading card n) is not consistent.
119 on card n (reference to card m)	The first value of E for a given FTN (card n) does not coincide with the lower boundary of ΔE given on card m.
120 at point S (card n)	The energy E at point S (on card n) is not positive.

ETN	Explanation of the code
121 at point S (card n)	The value of E at point S (on card n) does not fit into the monotonically increasing sequence of energy values for the FTN concerned.
122 at point S (card n)	The cross-section σ at point S (on card n) is not positive.
123 at point S (card n)	The value of σ at point S (on card n) lies outside the smooth energy dependence curve of the cross-sections for a given FTN ("rejection", this value of σ is suspect).
124 on card n (reference to card m)	The last value of E for a given FTN (card n) does not coincide with the upper Δ E boundary given on card m.
125C on card n (reference to card m)	The number of sub-groups at energy E given on card n is not equal to the number of sub-groups indicated in the FTN heading (card m), if the number of sub-groups is independent of E.
126C on card n	The number of sub-groups for a given E shown on card n is less than 1.
127 in sub-group i (card n)	The a_i fraction for sub-group i (on card n) is not positive.
128 in sub-group i (card n)	The cross-section σ_i for sub-group i (on card n) is not positive.
129 in sub-group i (card n)	The value of σ_i for sub-group i (on card n) does not fit into the monotonically increasing (ordered) sequence of sub-group cross-sections at a given E.
130	The sum of the a_i over all sub-groups for a given E differs from 1 by more than $0.5\ N \times 10^{-6}$, where N is the number of sub-groups.

(4) Errors in data on the angular distribution of neutrons (GCN = 02)

ETN	Explanation of the code
200	The values of A in the heading of a given section and in the file heading are not equal to one another.
201 on card n	The lower boundary of the first Δ E shown on card n is not positive.

ETN	Explanation of the code
202 on card n	The lower ΔE boundary shown on card n exceeds (or equals) its upper boundary.
203 on card n	The lower ΔE boundary shown on card n is lower than the upper boundary of the preceding ΔE (overlap of energy intervals).
204 on card n	The values of the ΔE boundaries shown on card n indicate the possibility that the ΔE may not fit into the ΔE sequence for the section as a whole (possible confusion of energy intervals).
205B on card n	The number of groups of secondary particles for a ΔE indicated on card n is less than one.
206C on card n	The number of groups of secondary particles checked for a ΔE (including the present one) is less than the number indicated in the heading of that ΔE (card n), but the number of cards determined from the headings of the groups checked for the ΔE exceeds (or equals) the number of cards for that ΔE shown in its heading.
207C on card n	The number of cards for a ΔE indicated in its heading (card n) is not equal to the number of cards determined for that ΔE from the headings of all the groups of secondary particles included in it, the number of which is also shown in the heading of the ΔE.
208 on card n	The numerical flag of a group of secondary particles given on card n does not fit into the sequence of values for that flag relating to the ΔE concerned.
209	The sum of the numerical flags identifying the groups of secondary particles for a ΔE does not tally with the number of secondary particles in the reaction concerned as fixed by the RTN.
210B on card n	The number of FTNs for a group of particles indicated on card n is less than one.
211C on card n	The FTN on heading card n is not acceptable.
212C on card n	The number of FTNs (including the present one) checked for a group of secondary particles is less than the number indicated in the heading for the group (card n), but the number of cards determined from the headings of the FTNs checked in the group exceeds (or equals) the number of cards for that group indicated in its heading.

ETN	Explanation of the code
213C on card n	The number of cards for a group of secondary particles shown in its heading (card n) is not equal to the number of cards determined for that group from the headings of all the FTNs pertaining to it, the number of which is also shown in the heading for the group of particles concerned.
214 on card n	The numerical flag of the co-ordinate system given for the FTN on card n is not acceptable.
215 on card n	For FTN = 101 or FTN = 201 the number of FTNs shown in the heading of a group of secondary particles (card n) is less than one.
216B on card n	The number of E values for a given FTN shown in its heading on card n is less than two.
217C on card n	The number of values of E checked for an FTN (including the present one) is less than the number indicated in the heading of that FTN (card n), but the number of cards determined from the headings of the E values checked in the FTN concerned exceeds (or equals) the number of cards for that FTN indicated in its heading.
218C on card n	The number of cards for an FTN indicated in its heading (card n) is not equal to the number of cards determined for that FTN from the headings of all the E values included in it, the number of which is also indicated in the heading of the FTN concerned.
219 on card n (reference to card m)	The first value of E for a given FTN (card n) does not coincide with the lower Δ E boundary indicated on card m.
220 on card n	The energy E for an FTN shown on card n is not positive.
221 on card n	The value of E on card n does not fit in the monotonically increasing sequence of energy values for the FTN concerned.
222 on card n (reference to card m)	The last value of E for a given FTN (card n) does not coincide with the upper Δ E boundary given on card m.
223B on card n	The number of a values for a given E (or FTN) shown in the corresponding heading on card n is less than one for E (or less than two for the FTN).

ETN	Explanation of the code
224C on card n	The number of a values (including the present one) checked for an E (or for an FTN) is less than the number shown in the corresponding E (or FTN) heading on card n, but the number of cards determined from the headings of the a values checked for the given E (FTN) exceeds (or equals) the number of cards for that E (FTN) indicated in its heading.
225C on card n	The number of cards for an E (or FTN) shown in the relevant heading (card n) is not equal to the number of cards determined for that E (or FTN) from the headings of all the a values relating to it, the number of which is indicated in the E (FTN) heading.
226 on card n	The part of the a distribution relating to a given E (or FTN) indicated on the heading card n is not positive.
227B on card n	The number of values of μ (or ω) indicated on the relevant card n is less than two.
228 on card n	The first value of μ (card n) is not equal to -1.
229 at point S (card n)	The value of μ at point S (on card n) does not fit into the monotonically increasing sequence of μ values.
230 at point S (card n)	The value of $f(\mu)$ at point S (on card n) is not positive.
231 on card n	The last value of μ (card n) is not equal to +1.
232	The sum of a over all partial distributions in a linear combination for a given E (or FTN) differs from 1 by more than $0.5\ N \times 10^{-6}$, where N is the number of distributions in the combination.

(5) Errors in data on the energy distributions of secondary neutrons (GCN = 03)

ETN	Explanation of the code
301 on card n	The lower boundary of the first ΔE shown on card n is not positive.
302 on card n	The lower ΔE boundary indicated on card n exceeds (or equals) its upper boundary.
303 on card n	The lower ΔE boundary indicated on card n is lower than the upper boundary of the preceding ΔE (overlap of energy intervals).

ETN	Explanation of the code
304 on card n	The values of the ΔE boundaries drawn on card n indicate the possibility that the ΔE may not fit into the ΔE sequence for the section as a whole (possible confusion of energy intervals).
305B on card n	The number of groups of secondary particles for a ΔE indicated on card n is less than one.
306C on card n	The number of groups of secondary particles checked for a ΔE (including the present one) is less than the number indicated in the heading of that ΔE (card n), but the number of cards determined from the headings of the groups checked in the ΔE exceeds (or equals) the number of cards for that ΔE shown in its heading.
307C on card n	The number of cards for a ΔE indicated in its heading (card n) is not equal to the number of cards determined for that ΔE from the headings of all the groups of secondary particles included in it, the number of which is also shown in the ΔE heading.
308 on card n	The numerical flag of a group of secondary particles given on card n does not fit into the sequence of values for that flag relating to the ΔE concerned.
309	The sum of the numerical flags identifying the groups of secondary particles for a ΔE does not tally with the number of secondary particles in the reaction concerned as fixed by the RTN.
310B on card n	The number of FTNs for a group of particles indicated on card n is less than one.
311C on card n	The FTN on heading card n is not acceptable.
312C on card n	The number of FTNs (including the present one) checked for a group of secondary particles is less than the number indicated in the heading for the group (card n), but the number of cards determined from the headings of the FTNs checked in the group exceeds (or equals) the number of cards for that group indicated in its heading.
313C on card n	The number of cards for a group of secondary particles indicated in its heading (card n) is not equal to the number of cards determined for that group from the headings of all the FTNs pertaining to it, the number of which is also shown in the heading for the group of particles concerned.
314B on card n	The number of E_o values for a given FTN shown in its heading on card n is less than two.

ETN	Explanation of the code
315C on card n	The number of E_0 values (including the present one) checked for an FTN is lower than the number indicated in the heading of that FTN (card n), but the number of cards determined from the headings of the E_0 values checked in the FTN concerned exceeds (or equals) the number of cards for that FTN shown in its heading.
316C on card n	The number of cards for an FTN indicated in its heading (card n) is not equal to the number of cards determined for that FTN from the headings of all the E_0 values included in it, the number of which is also indicated in the heading of the FTN concerned.
317 on card n (reference to card m)	The first value of E_0 for a given FTN (card n) does not coincide with the lower ΔE boundary shown on card m.
318 on card n	The energy E_0 for an FTN indicated on card n is not positive.
319 on card n	The value of E_0 for an FTN indicated on card n does not fit into the monotonically increasing sequence of energy values for the FTN concerned.
320 on card n (reference to card m)	The last value of E_0 for a given FTN (card n) does not coincide with the upper ΔE boundary indicated on card m.
321B on card n	The number of different laws in linear combination for a given E_0 (or FTN) indicated in the relevant heading on card n is less than one (or less than two).
322C on card n	The number of the law for a given E_0 (or FTN) in the relevant heading (card n) is not acceptable.
323C on card n	The number of laws checked for E_0 (or for the FTN), including the present one, is less than the number indicated in the relevant E_0 (or FTN) heading on card n, but the number of cards determined from the headings of the laws checked for the E_0 (FTN) concerned exceeds (or equals) the number of cards for that E_0 (FTN) indicated in its heading.
324C on card n	The number of cards for an E_0 (or an FTN) indicated in the relevant heading (card n) is not equal to the number of cards determined for that E_0 (or FTN) from the headings of all the laws relating to it, the number of which is indicated in the E_0 (FTN) heading.

ETN	Explanation of the code
325 on card n	The number of a given law for an E_o (FTN) on heading card n is not present in the sequence of numbers of the laws making up the linear combination for that E_o (FTN).
326 on card n	The probability of a law in the linear combination for an E_o (or FTN), as indicated on card n, is not positive.
327B on card n	The number of values of an argument (discrete energies, points of a spectrum, etc.) indicated in the relevant heading (card n) is less than one.
328 at point S (card n)	The value of the argument at point S (on card n) is not positive.
329 at point S (card n)	The value of the argument at point S (on card n) does not fit into the monotonically increasing (ordered) sequence of values for that argument.
330 at point S (card n)	For law 2 the value of k at point S (on card n) does not fulfil the condition $0 < k \leqslant 1$.
331 at point S (card n)	The value of the probability p at point S (on card n) is not positive.
332	The sum of the p values corresponding to all values of the argument for law 1 or law 2 differs from 1 by more than $0.5\ N \times 10^{-6}$, where N is the number of values of the argument.
333 on card n	For law 3 or law 4 the values of the quantities A and C or a, c and E_f given on card n are not positive.
334	The sum of the probabilities of the laws figuring in the linear combination for FTN or E_o data differs from 1 by more than $0.5\ N \times 10^{-6}$, where N is the number of laws in the combination.

8. PRINT-OUT OF RESULTS

The results of the POSOSHOK programme receive a wide print-out. The output takes the form of a list of ETNs relating to errors discovered during the check. Wherever necessary, the location of the error in the array of checked data is given. An indication is given of the number of the card or the numbers of the point and card at which an error has been discovered. In some cases there is a further reference to card numbers or numbers defining the value of quantities referred to in the explanation of the ETN code. In

individual cases the actual value of the erroneous quantity is also given in the print-out, where this would be helpful.

The errors are grouped in accordance with the arrays of checked data and given corresponding headings. Each heading of this kind defines an array of information in which the errors have been found.

In addition to the errors, the sums of the probabilities and the integrals of the normalized angular and energy distributions are printed. Such data should be treated with caution as discrepancies brought to light during checks on the normalization do not always indicate the existence of errors. For that reason the normalization values printed out should be carefully analysed before any firm conclusions are drawn as to whether errors are really present or not.

An example of a print-out of the check results for a file is given in Annex III. A complete print-out of the file itself with its errors is reproduced in the same annex.

9. AUXILIARY ROUTINES

These are the routines by which an initial recording of the POSOSHOK programme and the nuclear physics data to be checked is made on magnetic tape. The texts are reproduced in Annex II.

9.1. Routine for the recording of units on tape (RUT)

The search for random errors in library data presupposes that the POSOSHOK programme will already have been recorded on the PMT. For its initial recording on tape there is a special RUT routine ("recording of units on tape"). The RUT programme is written in the codes of an M-220 computer and in the course of a run is accommodated in the internal magnetic store, beginning at address 5747; it occupies 256 address codes.

The RUT routine is read into the internal memory from cards. The array of punched cards is made up as follows:

1. Standard retrieval card IS-2;
2. RUT routine input card;
3. Stack of RUT routine punched cards;
4. Initial information for the operation:
   (a) SROU - sign for RUT routine regime (octal code)

SROU = 0 00 0000 0000 0000 - regime for the initial recording of a system of units on the PMT

SROU = 0 00 0000 0000 0001 - regime for completion of the recording of units on the PMT

SROU = 0 00 0000 0001 0000 - regime for the transcription of individual units onto the PMT.

In the transcription regime for each block which has to be transcribed there is:

(b) Information for the transcription of the next unit onto the PMT

0 00 NU 0000 0000,

where NU is the octal serial number of the unit being transcribed.

For each subsequent unit transcribed the data under (b) are repeated. In the other operating regimes the data listed under (b) are omitted.

5. Check sum of the initial information for the operation;

6. Stack of punched cards of the UOCP programme (only in the initial recording regime).

Further, for each rerecorded or retranscribed unit there is:

7. A stack of punched cards with the routines of the unit concerned;

8. An end-of-unit sign.

7 77 7777 7777 7777

7 77 7777 7777 7777 KS

For each subsequent unit recorded or transcribed the data listed under 7 and 8 above are added.

The units in an array of data are arranged in the order in which they should be recorded on the PMT.

In the initial recording regime the UOCP (control programme) is recorded in the first zone of the PMT; beginning with the third zone, the units of the POSOSHOK programme are recorded in the order in which they occur in the array of data for the RUT routine. At the same time a passport for the system of units (programme passport) is made up and is subsequently accommodated in the second zone of the PMT.

In the completion regime the RUT routine finds (from the passport of the system of units) the last PMT zone occupied by units of the programme, and in the following unoccupied zones records additional units in the order in which they occur in the array of data for the RUT run. At the same time any requisite additions are made in the programme passport stored in the second zone of the PMT.

In the transcription regime the programme passport is used to locate on the PMT the units whose numbers appear in the initial information for the operation of the RUT routine, and in their place the units fed in from punched cards are recorded in the order in which they occur in the array of input information. It is essential to make sure that the volume of a unit fed in from the punched cards does not exceed that of the memory allotted to the programme unit recorded earlier. Unoccupied reserve zones left over after the initial recording of the units can be of particular importance.

The following sequence of operations is carried out in the RUT routine. After input from the punched cards and recording (or transcription) of a unit on tape, the programme reaches "Stop". Input of the next unit is effected by pressing the "Start" button on the control console. In the event of failure during input, the stack of cards together with the end-of-unit sign is again placed in the reading device and the "Start" button is pressed a second time.

9.2. Routine for the recording of data on tape (RDT)

The nuclear physics data to be checked by the POSOSHOK programme are recorded on an IMT. Since the task of recording large arrays of information on tape from punched card input is laborious and tedious in itself, it is well to do this ahead of time with the help of a special RDT (recording of data on tape) routine.

The RDT routine is written in the computer codes and during operation occupies 140 address codes in the internal memory beginning with address 6775. The information is recorded on sections of the IMT previously marked out with the help of a special marking routine.

The array of punched cards for the RDT routine is made up as follows:

1. Standard retrieval card IS-2;
2. A card for input of the RDT routine;
3. A stack of RDT routine punched cards;
4. Initial information for the operation:
   (a) Information on the number of data files being recorded

   0 00 nf 0000 0000

   where nf is the number of files being recorded (octal number occupying the first address);

   (b) SROD - sign for the RDT routine regime (octal code)

   SROD = 0 00 0001 0000 0000 - regime for recording information from the punched cards on the IMT with

subsequent output on the ATsPU (automatic digital printer)*/

SROD = 0 00 0000 0001 0000 - regime for recording information from the punched cards on the IMT without print-out

SROD = 0 00 0000 0000 0001 - regime for printing previously recorded information by means of the automatic digital printer.

For each of the data files recorded there is:

(c) Information for feed-in of the next IMT section

0 00 NS(i) 0000 0000

where NS(i) is the octal number punched in the first address, the three low-priority sub-numbers of which form the number of the tape section on which the i-th data file ($1 \leqslant i \leqslant nf$) is to be recorded, the remaining (high-priority) sub-number being allotted to the programme number of the magnetic tape unit.

For each subsequent file recorded the data listed under (c) above are repeated.

5. Check sum of initial information for the operation.

Then for each data file recorded there is:

6. A stack of cards with the information of the i-th file to be recorded on the IMT. At the end of the file (before the last check sum) an end-of-file sign is inserted:

4 00 0000 0000 0000

For each subsequent file recorded the data listed under 6 above are added.

The stack of punched cards of any nuclear data file prepared for recording is divided into arrays of 320 cards. Each such array ends with a check sum. The last array of a file may contain any number of punched cards not exceeding 320. At the end of the last array an end-of-file sign is inserted before the check sum.

Input and recording of the stack of cards belonging to a file is carried out in arrays with a "Stop" sequence after the recording of each array. The switch to input of the next array is effected by pressing the "Start" button. In the event of failure, the array is again placed in the reading device and the "Start" button is pressed a second time. This procedure for recording data on tape is less sensitive to the operation of the input devices than some others, and in certain cases it represents the optimum procedure.

*/ We are not absolutely certain about this acronym.

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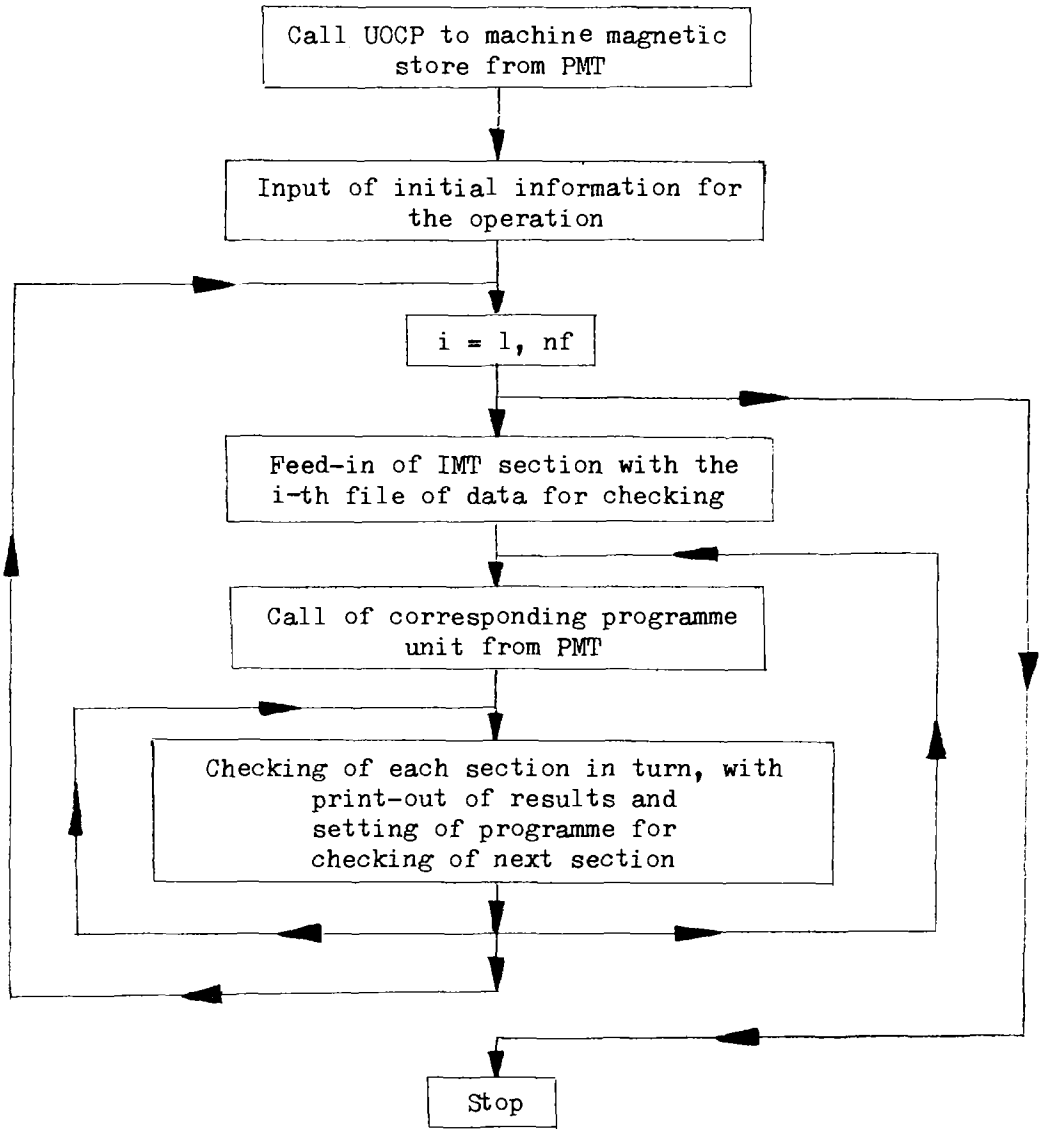
[5] PARKER, K., The Aldermaston Nuclear Data Library as at May 1963, AWRE O-70/63, September 1963.

[6] Biblioteka standartnyh programm (Library of standard programmes) (SHURA-BURA M.R. Ed.) TsBTI Mosgorsovnarkhoz, Moscow, 1961.

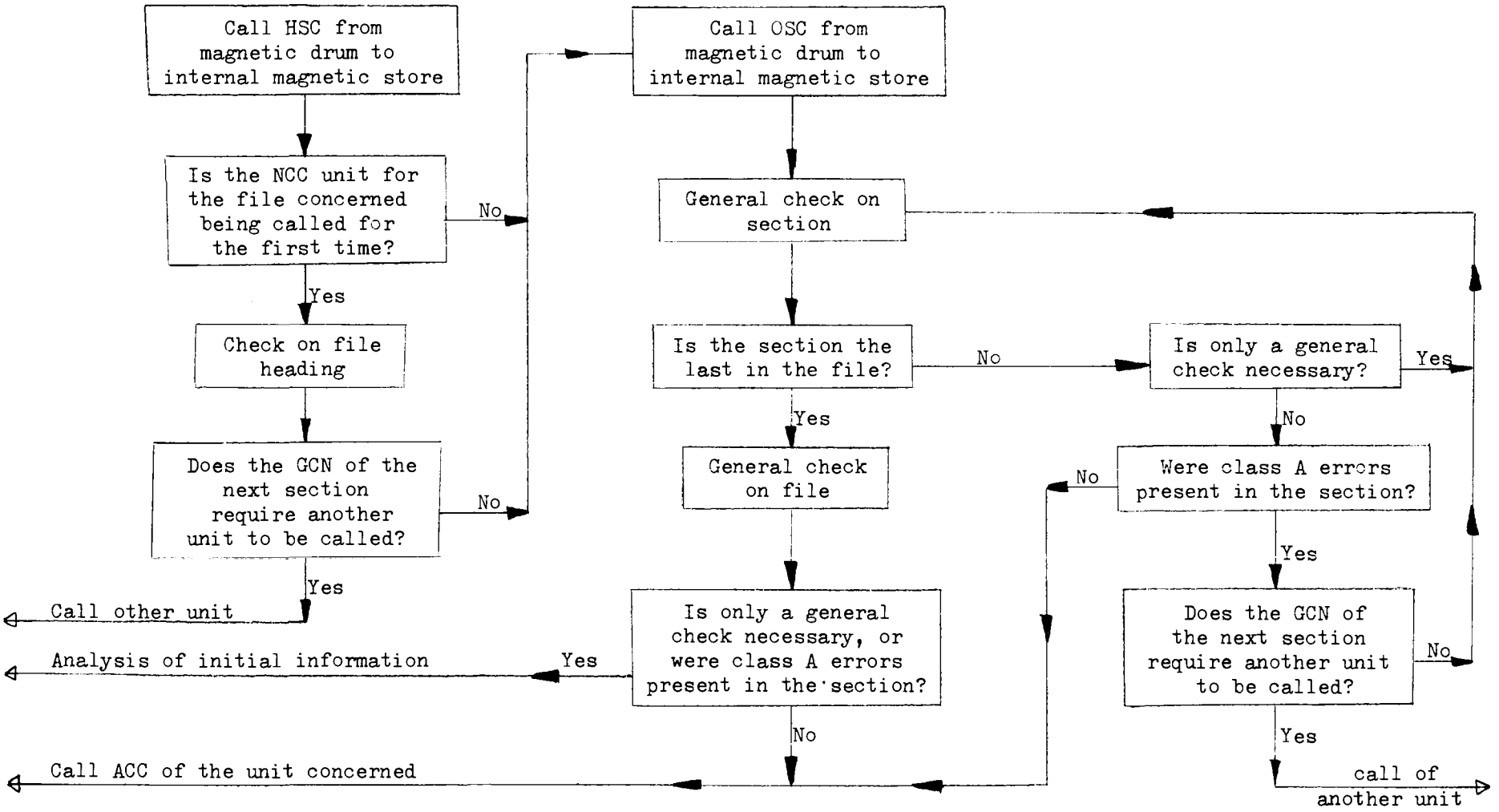
ANNEX I

BLOCK DIAGRAM OF THE POSOSHOK PROGRAMME

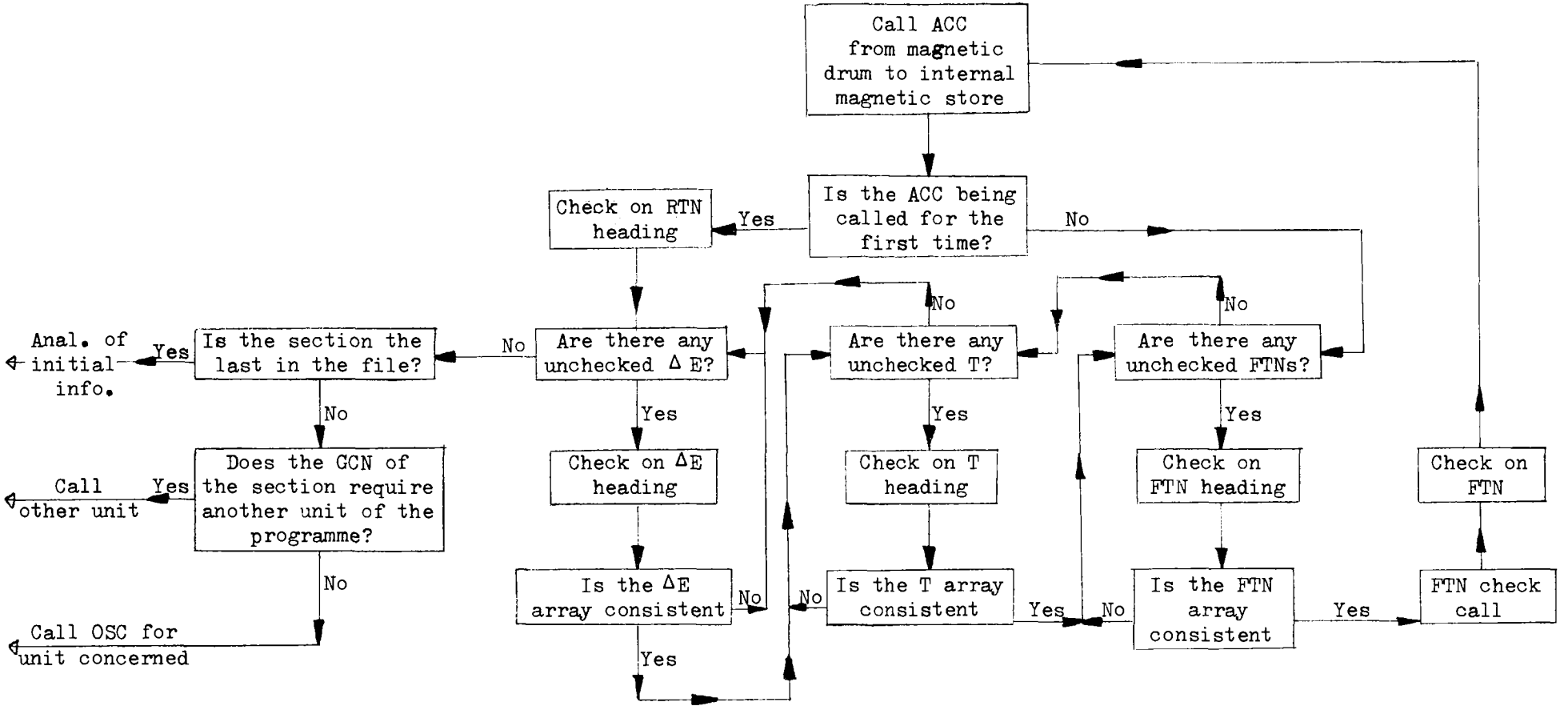
General diagram showing the operation of the programme



Block diagram showing operation of the HSC and OSC sub-programmes



Block diagram showing operation of the ACC and FTN check sub-programmes



EXAMPLE OF PRINT-OUT

I. Print-out of file being checked

11	141	5	1	-2.01471 00	8	11		1
1	1001	18	2	1002	18	11		2
3	1003	18	4	1016	13	12		3
5	1102	3	5	2002	54	11		4
7	2315	4	8	3016	6	11		5
1001	1	1	0. 00	0. 00	0. 00	11	1	1
1.00000-09	14	17	1	0. 00	0. 00	11	1	2
0. 00	1	16	0. 00	0. 00	0. 00	11	1	3
111	43	15	0. 00	1.00000-09	3.40000 00	11	1	4
2.50000-08	3.40000 00	1.00000-06	3.40000 00	1.00000-02	3.40000 00	11	1	5
1.00000-01	3.35000 00	2.00000-01	3.25000 00	3.00000-01	3.20000 00	11	1	6
4.00000-01	3.14330 00	5.00000-01	3.10000 00	6.00000-01	3.02890 00	11	1	7
7.00000-01	2.97000 00	1	2.99000 00	1.50000 00	2.72000 00	11	1	8
2	2.55000 00	2.50000 00	2.38000 00	3	2.20000 00	11	1	9
3.34000 00	2.09440 00	3.50000 00	2.05000 00	3.60000 00	2.01960 00	11	1	10
3.70000 00	1.99050 00	3.90000 00	1.93550 00	4	1.91000 00	11	1	11
4.50000 00	1.77000 00	5	1.68000 00	5.50000 00	1.58000 00	11	1	12
6	1.50000 00	6.20000 00	1.46440 00	6.50000 00	1.41470 00	11	1	13
7	1.34000 00	7.50000 00	1.28290 00	8	1.25000 00	11	1	14
8.50000 00	1.19250 00	9	1.14090 00	9.50000 00	1.09820 00	11	1	15
10	1.05000 00	1.05000 01	1.02090 00	11	9.95000-01	11	1	16
1.15000 01	9.53850-01	12	9.25000-01	1.25000 01	8.93900-01	11	1	17
13	9.65000-01	1.35000 01	8.32320-01	140	9.02000-01	11	1	18
1002	1	0. 00	0. 00	0. 00	0. 00	11	2	1
1.00000-09	14	17	1	0. 00	0. 00	11	2	2
0. 00	1	16	0. 00	0. 00	0. 00	11	2	3
111	43	15	0. 00	1.00000-09	3.39740 00	11	2	4
2.50000-08	3.39940 00	1.00000-06	3.39990 00	1.00000-02	3.40000 00	11	2	5
1.00000-01	3.35000 00	2.00000-01	3.25000 00	3.00000-01	3.20000 00	11	2	6
4.00000-01	3.14330 00	5.00000-01	3.10000 00	6.00000-01	3.02890 00	11	2	7
1. 00	2.97000 00	1	2.99000 00	1.50000 00	2.72000 00	11	2	8
2	2.55000 00	2.50000 00	2.38000 00	3	2.20000 00	11	2	9
3.34000 00	2.09340 00	3.50000 00	2.04000 00	3.60000 00	2.09460 00	11	2	10
3.70000 00	1.97250 00	3.90000 00	1.91270 00	4	1.88490 00	11	2	11
4.50000 00	1.73000 00	5	1.62520 00	5.50000 00	1.51000 00	11	2	12
6	1.41470 00	6.20000 00	1.37430 00	6.50000 00	1.31780 00	11	2	13
7	1.23280 00	7.50000 00	1.16730 00	8	1.10730 00	11	2	14
8.50000 00	1.05160 00	9	0. 00	9.50000 00	9.52460-01	11	2	15
10	9.07000-01	1.05000 01	8.60780-01	11	8.18000-01	11	2	16
1.15000 01	7.81880-01	12	7.44000-01	1.25000 01	7.08130-01	11	2	17
13	6.74000-01	1.35000 01	6.36950-01	14	6.02000-01	11	2	18
1003	1	0. 00	0. 00	0. 00	0. 00	11	3	1
1.00000-09	14	17	1	0. 00	0. 00	11	3	2
0. 00	1	16	0. 00	0. 00	0. 00	11	3	3
111	43	15	0. 00	1.00000-09	2.61740-03	11	3	4
2.50000-08	5.70000-04	1.00000-06	9.96370-05	1.00000-02	1.00000-06	11	5	5
1.00000-01	1.00000-09	2.00000-01	1.00000-09	3.00000-01	1.00000-09	11	3	6
4.00000-01	1.00000-09	5.00000-01	1.00000-09	6.00000-01	1.00000-09	11	3	7
7.00000-01	1.00000-09		1.00000-09	1.50000 00	1.00000-09	11	3	8
90000	1.00000-09	2.50000 00	1.00000-09	3	1.00000-09	11	3	9
3.34000 00	1.00290-03	3.50000 00	1.00000-02	3.60000 00	1.49960-02	11	3	10
3.70000 00	1.89060-02	3.90000 00	2.30410-02	4	2.50660-02	11	3	11
4.50000 00	4.00000-02	5	5.48370-02	5.50000 00	7.00000-02	11	3	12
6	8.52840-02	6.20000 00	9.01250-02	6.50000 00	9.60400-02	11	3	13
7	1.07240-01	7.50000 00	1.14730-01	8	1.22700-01	11	3	14
8.50000 00	1.31200-01	9	1.39120-01	9.50000 00	1.45760-01	11	3	15
10	1.53000-01	1.05000 01	1.60140-01	11	1.67000-01	11	3	16
1.15000 01	1.71990-01	12	1.81000-01	1.25000 01	1.85770-01	11	3	17
13	1.91000-01	1.35000 01	1.95370-01	14	2.00000-01	11	3	18
1016	1	-2.33050 00	0. 00	0. 00	0. 00	11	4	1
3.34000 00	14	12	1	0. 00	0. 00	11	4	2
0. 00	1	11	0. 00	0. 00	0. 00	11	4	3
111	27	10	0. 00	3.34000 00	1.00290-03	11	4	4
3.50000 00	1.00000-02	3.60000 00	1.49960-02	3.70000 00	1.80060-02	11	4	5

3.90000 00	2.30410-02	4	2.30660-02	4.50000 00	4.00000-02	11	4	6
5	3.43350-02	5.50000 00	7.00000-02	6	6.52840-02	11	4	7
6.20000 00	9.01250-02	6.50000 00	9.68400-02	7	1.07240-01	11	4	8
7.50000 00	1.14730-01	8	1.22700-01	8.50000 00	1.31200-01	11	4	9
9	1.38120-01	9.50000 00	1.45750-01	10	1.55000-01	11	4	10
1.05000 01	1.60140-01	11	1.67000-01	1.15000 01	1.71990-01	11	4	11
12	1.81000-01	1.25000 01	1.85770-01	13	1.91000 00	11	4	12
1.35000 01	1.95370-01	14	2.00000-01	0. 00	0. 00	11	4	13
1102	1	0. 00	0. 00	0. 00	0. 00	11	5	1
1.00000-09	1.00000-02	4	1	0. 00	0. 00	11	5	2
0. 00	1	3	0. 00	0. 00	0. 00	11	5	3
111	4	2	0. 00	1.00000-09	2.61740-03	11	5	4
2.50000-08	5.70000-04	1.00000-06	9.06870-05	1.00000-02	1.00000-06	11	5	5
2002	6	2.01471 00	0. 00	0. 00	0. 00	11	6	1
1.00000-09	1.00000-03	3	1	0. 00	0. 00	11	6	2
1	1	2	0. 00	0. 00	0. 00	11	6	3
101	2	0. 00	0. 00	0. 00	0. 00	11	6	4
1.00000-04	5.00000-01	10	1	0. 00	0. 00	11	6	5
1	1	9	0. 00	0. 00	0. 00	11	6	6
102	2	21	0. 00	-1.00000 00	4.12000-01	11	6	7
-9.00000-01	4.28000-01	-8.00000-01	4.27000-01	-7.00000-01	4.37000-01	11	6	8
-6.00000-01	4.44000-01	-5.00000-01	4.53000-01	-4.00000-01	4.61000-01	11	6	9
-3.00000-02	4.70000-01	-2.00000-01	4.90000-01	-1.00000-01	4.87000-01	11	6	10
0. 00	4.97000-01	1.00000-01	5.06000-01	2.00000-01	5.15000-01	11	6	11
3.00000-01	5.27000-01	4.00000-01	5.36000-01	5.00000-01	5.45000-01	11	6	12
6.00000-01	5.56000-01	7.00000-01	5.58000-01	8.00000-01	5.77000-01	11	6	13
9.00000-01	5.89000-01	1	6.00000-01	0. 00	0. 00	11	6	14
5.50000-01	1.25000 00	10	1	0. 00	0. 00	11	6	15
1	1	9	0. 00	0. 00	0. 00	11	6	16
102	2	21	0. 00	-1.00000 00	9.03000-01	11	6	17
-9.00000-01	8.35000-01	-8.00000-01	7.79000-01	-7.00000-01	7.27000-01	11	6	18
-6.00000-01	6.66000-01	-5.00000-01	6.32000-01	-4.00000-01	5.78000-01	11	6	19
-3.00000-01	5.44000-01	-2.00000-01	5.21000-01	-1.00000-01	4.63000-01			
0. 00	4.45000-01	1.00000-01	4.24000-01	2.00000-01	4.02000-01	11	6	21
3.00000-01	3.79000-01	4.00000-01	3.61000-01	5.00000-01	3.50000-01	11	6	22
6.00000-01	3.39000-01	7.00000-01	3.27000-01	8.00000-01	3.21000-01	11	6	23
9.00000-01	3.15000-01	1	3.14000-01	0. 00	0. 00	11	6	24
1.25000 00	4	10	1	0. 00	0. 00	11	6	25
1	1	9	0. 00	0. 00	0. 00	11	6	26
102	2	21	0. 00	-1.00000 00	9.99000-01	11	6	27
-9.00000-01	7.64000-01	-8.00000-01	5.98000-01	-7.00000-01	4.85000-01	11	6	28
-6.00000-01	4.03000-01	-5.00000-01	3.47000-01	-4.00000-01	3.37000-01	11	6	29
-3.00000-01	2.94000-01	-2.00000-01	2.79000-01	-1.00000-01	2.70000-01	11	6	30
0. 00	2.67000-01	1.00000-01	2.70000-01	2.00000-01	2.79000-01	11	6	31
3.00000-01	3.00000-01	4.00000-01	3.29000-01	5.00000-01	3.68000-01	11	6	32
6.00000-01	4.64000-01	7.00000-01	6.02000-01	8.00000-01	8.08000-01	11	6	33
9.00000-01	1.20000 00	1	1.95000 00	0. 00	0. 00	11	6	34
4	0. 00	10	1	0. 00	0. 00	11	6	35
1	1	9	0. 00	0. 00	0. 00	11	6	36
102	2	21	0. 00	-1.00000 00	8.58000-01	11	6	37
-9.00000-01	5.63000-01	-8.00000-01	3.87000-01	-7.00000-01	2.80000-01	11	6	38
-6.00000-01	2.21000-01	-5.00000-01	1.84000-01	-4.00000-01	1.67000-01	11	6	39
-3.00000-01	1.63000-01	-2.00000-01	1.60000-01	-1.00000-01	1.67000-01	11	6	40
0. 00	1.87000-01	1.00000-01	2.24000-01	2.00000-01	2.67000-01	11	6	41
3.00000-01	3.41000-01	4.00000-01	4.27000-01	5.00000-01	5.28000-01	11	6	42
6.00000-01	0. 00	7.00000-01	8.95000-01	8.00000-01	1.17000 00	11	6	43
9.00000-01	1.57000 00	1	2.20000 00	0. 00	0. 00	11	6	44
9	14	10	1	0. 00	0. 00	11	6	45
1	1	9	0. 00	0. 00	0. 00	11	6	46
102	2	21	0. 00	-1.00000 00	1	11	6	47
-9.00000-01	5.31000-01	-8.00000-01	2.59000-01	-7.00000-01	1.25000-01	11	6	48
-6.00000-01	9.45000-02	-5.00000-01	9.61000-02	-4.00000-01	1.09000-01	11	6	49
-3.00000-01	1.25000-01	-2.00000-01	1.49000-01	-1.00000-01	1.80000-01	11	6	50
0. 00	2.17000-01	1.00000-01	2.68000-01	2.00000-01	3.22000-01	11	6	51

```
3.00000-01 3.89000-01 4.00000-01 4.85000-01 5.00000-01 6.02000-01   11 6  32
6.00000-01 7.36000-01 7.00000-01 9.61000-01 8.00000-01 1.21000 00   11 6  33
9.00000-01 1.61000 00       1    2.30000 00 0.       00 0.       00  11 6  34
  2016           1     2.01471 00 0.       00 0.       00 0.       00  11 7   1
3.34000 00      14          3          1    0.       00 0.       00  11 7   2
    11           1          2       0.      00 0.       00 0.       00  11 7   3
   101           2       0.      00 0.       00 0.       00 0.       00  11 7   4
  3016           1       0.      00 0.       00 0.       00 0.       00  11 8   1
3.34000 00      14          5             2     0.       00 0.       00  11 8   2
     1           1          2       0.      00 0.       00 0.       00  11 8   3
   102           1       0.      00 3.34000 00 3.33000-01    1          11 8   4
    10           1          2       0.      00 0.       00 0.       00  11 8   5
   102           1       0.      00 3.34000 00 6.67000-01 -1.00000 00   11 8   6
```

2. Check results

Check on data for File No. 11

List of errors for section 0

Error type 51

Error type 13 on card 3

Error type 53 section 6

List of errors for section 1

Error type 101

Energy region 1

Temperature 1

Representation type 1 (FTN = 111)

Error type 124 on card 18

List of errors for section 2

Energy region 1

Temperature 1

Representation type 1 (FTN = 111)

Error type 120 at point 11 (0.00000 00) on card 8

Error type 122 at point 33 (0.00000 00) on card 15

List of errors for section 3

Error type 13 on card 5

Energy region 1

Temperature 1

Representation type 1 (FTN = 111)

Error type 121 at point 15 (0.25000 01) on card

List of errors for section 4

Energy region 1

Temperature 1

Representation type 1 (FTN = 111)

Error type 123 at point 7 (0.40000-01) on card 6

Error type 123 at point 8 (0.54837-02) on card 7

Error type 123 at point 25 (0.19100-01) on card 12

List of errors for section 5

Energy region 1

Temperature 1

Representation type 1 (FTN = 111)

List of errors for section 6

Error type 13 on card 20

Error type 15 on card 20

Error type 200

Energy region 1

Group of secondary particles 1 (UCh = 001)

Representation type 1 (FTN = 101)

Energy region 2

Error type 203 on card 5

Group of secondary particles 1 (UCh = 001)

Representation type 1 (FTN = 102)

Error type 229 at point 9 (-0.199999) on card 10

Integral of standardized distribution equals 0.997435

Energy region 3

Group of secondary particles 1 (UCh = 001)

Representation type 1 (FTN = 102)

Integral of standardized distribution equals 0.999750

Energy region 4

Group of secondary particles 1 (UCh = 001)

Representation type 1 (FTN = 102)

Integral of standardized distribution equals 1.007850

Energy region 5

Error type 202 on card 35

Group of secondary particles 1 (UCh = 001)

Representation type 1 (FTN = 102)

Error type 230 at point 17 (0.000000) on card 43

Integral of standardized distribution equals 0.942600

Energy region 6

Group of secondary particles 1 (UCh = 001)

Representation type 1 (FTN = 102)

Integral of standardized distribution equals 1.011860

List of errors for section 7

Error type 200

Energy region 1

Group of secondary particles 1 (UCh = 011)

Representation type 1 (FTN = 101)

List of errors for section 8

Energy region 1

Group of secondary particles 1 (UCh = 001)

Representation type 1 (FTN = 102)

Group of secondary particles 2 (UCh = 010)

Representation type 1 (FTN = 102)

Error type 331 at point 1 (-0.999999) on card

Error type 332

Sum of probabilities of argument = -0.999999

File check completed