Contents

1 Introduction

1.1 Background

The NJOY Nuclear Data Processing System [1] is a software system used for nuclear data management. In particular, it is used to convert Evaluated Nuclear Data Files (ENDF) [2] into different formats, as well as performing operations on the nuclear data.

NJOY is currently being used within the MACRO project [3] at the Division of Applied Nuclear Physics, at the Department of Physics and Astronomy at Uppsala University.

1.2 Problem Description

The NJOY input instructions [4] are complex and hard to read compared to e.g. a high-level programming language. For example, algorithm 1 is a *short* and *simple* NJOY job which illustrates what the input instructions look like.

Algorithm 1 NJOY Test Problem 14

```
1  acer
2  20 21 0 31 32
3  1 0 1/
4  'proton + 7-n-14 apt la150 njoy99 mcnpx'/
5  725 0./
6  /
7  /
8  acer
9  0 31 33 34 35
10 7 1 2/
11 'proton + 7-n-14 apt la150 njoy99 mcnpx'/
12 viewr
13 33 36/
14 stop
```

Without consulting the documentation, one might guess that line 4 and 11 are some kind of descriptive titles, which is correct. However, it is not obvious that line 2 denotes input and output files (each number indicates a specific file) that the `acer` module will operate on. It is also hard to deduce

that the first number on line 5 denotes the material to be processed, and that the second number denotes the desired temperature in kelvin.

The input instructions can be annotated with descriptive comments, but even then, working with a large and complex job easily becomes a daunting and error-prone task.

1.3 Objective

The NJOY input instructions is not an optimal input format. Therefore, the scope of this thesis has been to design and implement a more user friendly, and readable input format. The design of the new input format had to be based on some commonly known existing format that is fitting to the task. The basis could for example be a programming language.

In order to make the new input format useable with NJOY, it has to be translated into the original NJOY input instructions. As such, the scope of this work also included developing an accompanying translator for the new input format.

2 Methodology

2.1 Introduction

The NJOY input instructions had to be understood in order to design the new input format. Each module of the NJOY software system, as described in reference [4], was analyzed separately such that a general structure and common language features could be extracted and used for further analysis.

As stated in reference [5], a translator (*compiler*) is a program that can read a program in one language and translate it into an equivalent program in another language. In the following subsections, principles and techniques for constructing a translator presented in reference [5], is described.

2.2 Designing the New Input Format

2.2.1 Syntax Definition

The syntax definition of the input format was specified in a notation called context-free grammar [6]. A context-free grammar is a convenient, and natural method of specifying the syntax of a programming language. For instance, the assignment (*declaration*) of an identifier can have the form

```
material = 9237
```

which can be expressed in a context-free grammar as the production

```
assignment ::= l_value "=" r_value
```

where `l_value` and `r_value` are other productions expressing the structure of the left and right hand side of the assignment, respectively.

2.3 Building the Translator

In reference [5], the translation process is described as a sequence of phases. Each phase inspects and transforms a representation of the source program to another. Phases such as lexical analysis, syntax analysis, and semantic analysis has been used throughout this work.

The translator, which is supposed to translate the input format into NJOY input instructions, was partly constructed using a lexical-analyzer generator [7] and a parser generator [8].

The translator was written in the Python programming language [9], in a Unix-like environment.

2.3.1 Lexical Analysis

Lexical analysis is the process of dividing the source program into sequences of characters, called tokens [10]. Each token describes a group of characters in the source program as an abstract type.

For example, the identifier `material`, the assignment character, `=`, and the integer `9237` could be represented as tokens of the form

`<IDENTIFIER, material>`,

`<ASSIGNMENT, =>`, and

`<INTEGER, 9237>`

PLY Lex [11] was used to generate a lexical analyzer (*lexer*) for the input format. The method of identifying the tokens was implemented by using the notation of regular expressions [12] in PLY Lex.

2.3.2 Syntax Analysis

Syntax analysis is the process of creating a tree-like representation, an abstract syntax tree, composed of the tokens generated by the lexical analyzer [13]. The syntax tree is used to describe the grammatical structure of the source program.

PLY Yacc [11] was used to generate a syntax analyzer (*parser*) for the grammar definition of the input format. The method of building the syntax tree was implemented by using the facilities provided by the PLY tools.

2.3.3 Semantic Analysis

Semantic analysis is the process of checking the syntax tree for errors that have to do with the *meaning* of the program [14].

For example, according to reference [4], card 1, 2 and 3 in module `acer` must always be defined, and they must be defined in sequential order. The translator should report an error if these rules are violated; such as when card 1 has not been defined or when card 3 has been defined prior to card 2.

Type checking is another important part of the semantic analysis where the translator checks that each operator has valid operands.

For example, the identifier `hk`, in card 3 module `acer`, is used to denote a descriptive character string. According to reference [4], `hk` must be declared as a character string and must not exceed 70 characters in length. The translator should report an error if these rules are violated; such as when `hk` has been declared as an integer, or when the character string contains more than 70 characters.

2.4 Testing

Testing was carried out continuously during the design and implementation of the input format and the translator. The NJOY test problems[1] [1] was used to test the functionality of both the input format and the translator.

The NJOY test problems was manually translated into equivalent NJOY jobs in the new input format, which were run through the translator. The resulting output was compared with the expected output, to verify that the translator was working appropriately.

The Python unit testing framework [9] was utilized to set up the testing environment.

[1]The NJOY Test Problems are test runs which are used to test the functionality of the NJOY software system. See `http://t2.lanl.gov/codes/njoy99/`

3 Implementation

3.1 NJOY Input Format (`NIF`)

The new input format, NJOY Input Format (NIF), is basically the NJOY input instructions which have been annotated with a syntax to make it easier to read and express. NIF has been designed to appear more like a high-level programming language.

3.1.1 Grammar Definition

The proposed NJOY Input Format (`NIF`) is illustrated as a context-free grammar definition in algorithm 2. The structure of the grammar is simple. Just like in reference [4], a NIF program is an ordered sequence of modules. Each module is composed by an ordered sequence of cards. A card is an ordered sequence of value definitions.

The start symbol is `program`. The capitalized terminals, such as `MODULE` and `CARD`, are token classes specified by the lexer. Special symbols are denoted within double quotes. `empty` denotes the empty string.

An assignment denotes that a left hand side is assigned to hold the values of a right hand side. A left hand side is an ordered list of elements, where the elements can be an array or identifier. A right hand side is an ordered list of elements, where the elements can be a float, integer, null or a string. As such, a value definition is an array or identifier that has been declared to hold the value of either a floating-point number, natural number, empty string or a character string.

As indicated by the grammar, NIF supports multiple assignment. That is, multiple identifiers can be assigned in the same expression. For example, the expression

```
material, temp = 9237, 300.0;
```

denotes that the identifier `material` holds the integer 9237, and the identifier `temp` holds the float 300.0.

Note that the number of elements on the left hand side of an assignment does not have to be equal to the number of elements on the right hand side. According to the grammar, an assignment such as

```
material = 128, 9237;
```

Algorithm 2 NJOY Input Format (NIF) Grammar Definition

```
program ::= module_list

module_list ::= module module_list
              | empty
module      ::= MODULE "{" card_list "}"

card_list ::= card card_list
            | empty
card      ::= CARD "{" stmt_list "}"

stmt_list  ::= statement stmt_list
             | empty
statement  ::= expression ";"
expression ::= assignment

assignment ::= l_value_list "=" r_value_list

l_value_list ::= l_value
               | l_value "," l_value_list
r_value_list ::= r_value
               | r_value "," r_value_list

l_value ::= array
          | ident
array   ::= IDENTIFIER "[" INTEGER "]"
ident   ::= IDENTIFIER

r_value ::= FLOAT
          | INTEGER
          | NULL
          | STRING
```

is allowed even though it does not make sense. However, the syntax analysis in the parser enforces that the number of elements on both sides are the same.

3.2 NJOY Input Format Translator (`nifty`)

3.2.1 Structure of the Translator

The translator, NJOY Input Format Translator (`nifty`), was constructed as a set of modules where each module implements a specific phase in the translation process. Five phases have been implemented as part of the translation process and are shown in figure 1.

The first phase is the lexical analysis which is implemented by the lexer module. The second phase, syntax analysis, is implemented by the parser module.

The third phase, implemented by the organizer module, is a special phase where the order of the statements in a card are analyzed and possible rearranged.

The fourth phase is the semantic analysis which is implemented by the module named analyzer. The fifth, and final, phase of the translator is the emitter module which implements a NJOY input instructions generator.

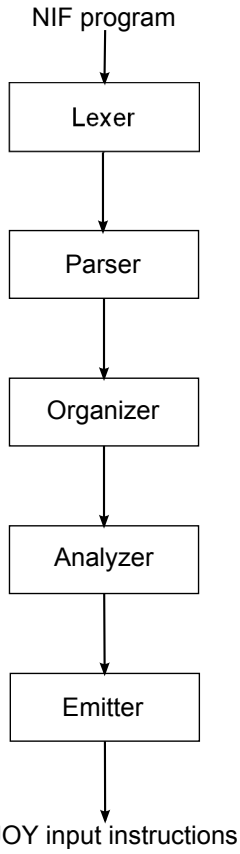

Figure 1: Translation process in nifty

3.2.2 Reserved Keywords

An important design choice is that the translator will enforce the use of reserved keywords to specify NIF programs. It will not only consider card and module names as reserved keywords, but also identifier names. As such, it is not possible to use an identifier name until it has been defined

as an identifier in the translator. Similarly, it is not possible to use a card or module name which has not been defined in the translator. This restricts the expressiveness of the input format, but allows detailed analysis of the semantics in the organizer and analyzer modules. As a consequence, it also forces the user to write consistent and readable input files – which has been the objective of this work.

3.2.3 The Modules

Lexer The lexer is responsible for recognizing character patterns and generating the appropriate NIF tokens. As input, the lexer expects a NIF program and will generate a token stream as its output unless the lexer detects a lexical error. If a lexical error is detected, an error message will be reported and the translation process will stop at this phase. The lexer will only recognize card and module names which are specified in reference [4], thus enforcing the use of a specific set of cards and modules as mentioned previously. The lexer also recognizes comments in the input program. The comments will be discarded during the lexical analysis and thus won't be passed on to the next phase in the translation process. Note that the lexer only recognizes real numbers that starts with a digit. Numbers which has a leading or trailing dot, such as `.005`, `.5e-2`, `300.` or `3.e2`, which are allowed as input to the NJOY software system are thus not allowed by the lexer.

Parser The parser is responsible for enforcing the structure of the NIF grammar and constructing the syntax tree. As input, the parser expects a stream of tokens generated by the lexer. The parser will produce a syntax tree as its output, which represents the structure of the NIF program. If the parser detects a syntax error, an error message will be reported and the translation process will stop at this phase.

Organizer The organizer analyzes the syntax tree produced by the parser. Its purpose is to rearrange the statements in a card such that they appear in the expected, working order. As such, it should be possible to write a NIF program without having to list the statements in a card in the expected order as indicated by reference [4].

The NJOY modules and the cards within the modules still needs to be given in the correct order though. This is due to the fact that the number of possible NJOY jobs is infinite (all may not be functional in the NJOY

software system, though). An infinite number of NJOY jobs can simply be created by just appending another module specification to an existing NJOY job in order to create a new one. Simply stated, the translator can not guess the intention of the job due to the number of possible combinations the modules may be listed in. Hence, the modules must be provided in the expected order by the user. Cards are not arrangeable either, since they also are prone to be repetitive. It is not possible to determine which card should go first from a set of cards (with the same name) which e.g. only contains a descriptive title. The cards must also be provided in the expected order by the user.

Each NJOY module requires its own organizer implementation since each module has its specific set of rules as described in reference [4]. Since the identifier names are hardwired in the translator, the organizer is able to do a detailed analysis of the syntax tree and easily detect if a specific identifier has been defined out of order.

If any statements have been provided out of order in a card, and the organizer is able to arrange the statements, a new syntax tree is returned where the statements have been ordered in the expected sequence. If the organizer somehow fails, it will return the original syntax tree as produced by the parser and pass it on to the next phase in the translation process.

Analyzer The analyzer expects a syntax tree as its input. Like in the organizer phase, the NJOY modules needs to be analyzed separately since each module has its specific set of rules. As such, each module also requires its own analyzer implementation.

The analyzer basically visits every node in the order they appear in the syntax tree and checks if it is the expected one. The analysis can be made very detailed since the translator can, to some extent, predict the next card or identifier due to the ordered nature described in reference [4]. Since the cards and the identifiers have reserved names, the analyzer is able to easily determine whether a card or an identifier is the expected one. Using reserved names also makes type checking easy, since a reserved identifier in a specific card may be associated with a specific type, range, size, length, et cetera.

The analyzer does not alter the syntax tree, it just analyzes it. The input syntax tree will be the output of the analyzer if the syntax tree is semantically correct according to the translator. If the analyzer detects a semantic error in the syntax tree, an error message will be reported and the translation

process will stop at this phase.

Emitter The emitter expects a syntax tree as its input and it is responsible for generating NJOY input instructions from the syntax tree. The emitter simply flattens the tree structure and formats the instructions to their corresponding counterparts in the NJOY input instructions format. The emitter returns a string with the resulting NJOY input instructions. Each card in the resulting output has been annotated with a descriptive comment, indicating which card it is, to make it easier to find errors.

4 Results

4.1 NJOY Input Format Examples

The result of the proposed grammar described in section 3.1 on page 6 is best illustrated with examples. Algorithm 3 illustrates NJOY input instructions (slightly modified to make it shorter for illustrational purposes) from NJOY Test Problem 2 [1]. In algorithm 4 on the next page, lines 1 through 9 from algorithm 3 are expressed in NIF.

Algorithm 3 Modified subset of NJOY Test Problem 2

```
1  moder
2  20 -21/
3  reconr
4  -21 -22/
5  'pendf tape for pu-238 from endf/b-iv tape 404'/
6  1050 1/
7  0.005/
8  '94-pu-238 from endf/b tape t404'/
9  0/
10 broadr
11 -21 -22 -23/
12 1050 3 0 1/
13 0.005/
14 300.0 900.0 2100.0/
15 0/
16 stop
```

Algorithm 4 NIF version of Algorithm 3 on the previous page, lines 1 through 9

```
1  moder {
2      card_1 {
3          pendf_input = 20;
4          pendf_output = -21;
5      }
6  }
7
8  reconr {
9      card_1 {
10         nendf = -21;
11         npend = -22;
12     }
13
14     card_2 {
15         tlabel =  "pendf tape for pu-238 from endf/b
               -iv tape 404";
16     }
17
18     card_3 {
19         mat = 1050;
20         ncards = 1;
21     }
22
23     card_4 {
24         err = 0.005;
25     }
26
27     card_5 {
28         cards = "94-pu-238 from endf/b tape t404";
29     }
30     /* Card 6 not defined since 'ngrid' defaults to
          0 in first card 3. */
31     card_3 { mat = 0; } // Terminate reconr.
32 }
```

Descriptive names for the identifiers on line 3 and 4 have been specified in the translator. The other identifier names has been chosen to reflect the documentation in reference [4] (the identifier names are hardwired in the translator). Line 30 and 31 shows how comments are expressed in NIF. Line 30 illustrates the structure of multiline comments while line 31 illustrates the structure of single line comments.

Algorithm 5 on the following page is a NIF version of the lines 10 through 16 from algorithm 3 on page 12. It shows how arrays are expressed in NIF (lines 24 through 26). The `stop` instruction on line 16 in algorithm 3 on page 12 does not have to be specified in NIF, the translator will automatically append it in the translation process.

When combined, algorithm 4 on the previous page and algorithm 5 on the following page forms the complete NJOY job as listed in algorithm 3 on page 12.

Algorithm 5 NIF version of Algorithm 3 on page 12, lines 10 through 16

```
1  broadr {
2      card_1
3      {
4          nendf = -21;
5          nin = -22;
6          nout = -23;
7      }
8
9      card_2
10     {
11         mat1 = 1050;
12         ntemp2 = 3;
13         istart = 0;
14         istrap = 1;
15     }
16
17     card_3
18     {
19         errthn = 0.005;
20     }
21
22     card_4
23     {
24         temp2[0] = 300.0;
25         temp2[1] = 900.0;
26         temp2[2] = 2100.0;
27     }
28
29     /* Terminate execution of broadr with mat1 = 0
          as usual. */
30     card_5
31     {
32         mat1 = 0;
33     }
34 }
```

4.2 NJOY Input Format Translator Implementation

Table 1 shows the implementation status for the NJOY modules. Each column entry indicates the completeness of a translator phase for a given NJOY module.

NJOY Module	Lexer	Parser	Organizer	Analyzer	Emitter
acer	100%		100%	90%	100%
broadr			100%	90%	
ccccr			0%		
covr			100%	90%	
dtfr			0%		
errorr			70%	20%	
gaminr			0%		
gaspr			100%	99%	
groupr			100%	90%	
heatr			100%	90%	
leapr			0%		
matxsr					
mixr					
moder			100%	95%	
plotr			100%	90%	
powr			0%		
purr			100%	90%	
reconr			100%	90%	
resxsr			0%		
thermr			100%	90%	
unresr			100%	95%	
viewr			100%	10%	
wimsr			0%		

Table 1: Implementation status for the NJOY modules

The completeness of the implementation has been rated in a grading scale with percentage. The grades has been set with respect to whether the functionality of the phases presented in section 3.2.3 on page 9 (also see section 2.3 on page 3) has been fulfilled or not. 100% indicates that the functionality has been finished. 0% indicates that the implementation of the functionality has not been started. The other percentages are rough

approximations of how much functionality that has been implemented.

4.3 Test Results

All test problems listed in Appendix B on page 26 passed all the phases in the translation process, i.e. they were successfully translated (no lexical, syntax, nor semantic errors were found)[2]. No differences between the expected output and the resulting output were detected for the test problems.

4.4 Translation Efficiency

Table 2 shows the resulting runtimes, both process time and wall time, for 10 000 repeated runs of the entire translation process on Test Problem 02. Test Problem 02 is listed in section B.2 on page 35.

Runtime	**Seconds**
Process Time	6.55
Wall Time	723.49

Table 2: Runtimes for Test Problem 02 repeated 10 000 times

The repeated runs were conducted on a dedicated, single user, system equipped with a Intel Core i3 2100 CPU at 3,1GHz and 8GiB of RAM. The system was running Mac OS X 10.6.7 and Python 2.XXX.

The Python library functions `time.clock()` and `time.time()` was used to measure the process time and wall time, respectively.

Process time is the time that the entire task spent executing on the processor, measured by `time.clock()` which should be used for timing algorithms [9]. Wall time is the time that elapsed from when the task was started to when the task finished, measured by checking the difference in time using `time.time()` [9].

[2]Note that the organizer's ability to arrange statements in the correct order has not been tested for the test problems, since the instructions in the test problems have been provided in the expected order.

5 Discussion

5.1 NJOY Input Format (`NIF`)

The proposed grammar does not differ much from the NJOY input instructions since it basically is an annotated version of them. The NIF grammar could have been expanded to include more complex programming idioms, such as an `if` expression to allow flow control in a NIF program. Although, the structure of NIF was designed to be simple and to closely resemble the original input instructions such that a user does not need to learn a completely new programming language to specify NJOY jobs. Another intention of this design choice is that the NJOY input instructions documented in reference [4] can be used to specify NJOY jobs in NIF.

As indicated by the examples listed in section 4.1 on page 12, a typical NIF program is vertically long compared to the compact notation of the NJOY input instructions. NIF programs can of course be specified in a compact form as well, e.g. on a single line, but this is not the intended usage of NIF. The purpose of NIF is to make NJOY jobs readable. The readability would be limited if the jobs were expressed on a single line.

5.2 NJOY Input Format Translator (`nifty`)

An organizer and analyzer has not been provided for all modules in the NJOY software system due to time constraints of this thesis. As such, the important semantic analysis of the translator is incomplete. However, much of the needed functionality and structure is provided by the existing implementation such that both the organizer and the analyzer should be easy to complete. Even though the organizer and analyzer phase has not been implemented for all NJOY modules in the translator, NIF programs which include these modules can still be translated into functional NJOY input instructions.

The implementation of the analyzer module has been the most time consuming task when designing the translator. It requires detailed analysis of what kind of input the NJOY modules expect and how they operate on it. The documentation in reference [4] was the main resource used while implementing the semantic analysis in the analyzer. It was evident that this was not a sufficient resource for the task at hand. It does not clearly indicate the expected type for all identifiers, nor the expected integer ranges or length of the character strings. In some cases, it has also been hard to deduce which

cards that must be supplied by just reading the documentation in reference [4]. To fully check the semantics of a NIF program, the source code for the NJOY software system must be studied in greater detail. The ENDF formats must also be studied in greater detail in order to understand the semantics and what kind of values that the NJOY modules accept.

5.3 Testing

The testing that was conducted within this work is not rigorous enough due to time constraints of this thesis. NJOY is a large and complex program[3] with many possible combinations of input within each NJOY module and card.

The NJOY test problems [1] which were used to test the translation functionality is a very small set of possible NJOY jobs. Hence, there is a lot of scenarios within each NJOY module that has not been tested.

Note that modified versions of the original NJOY test problems had to be used as the expected output when when comparing the output from the translator. The floating-point numbers had to be specified such that the lexer in the translator could recognize them, as described in section 3.2.3 on page 9, and thus be changed into this form in the expected output as well. Since the emitter appends descriptive comments to every card (which are not present in the original test problems) as described in section 3.2.3 on page 9, these comments also had to be appended to the expected output such that the comparison could be performed.

5.4 Efficiency

The efficiency testing of the translator as described in section 4.4 on page 17 was conducted in a simple fashion. Only one test problem was used for testing. Other test problems may reveal higher runtimes. Nonetheless, the resulting runtimes reveals that the performance of the translator implementation is not a bottleneck. The performance obstacles are related to other issues in computer systems, as indicated by that the wall time is much greater than the process time. Reducing wall time runtimes are described elsewhere[4].

[3]The source files for the NJOY software system consists of more than 100 000 lines.

[4]See e.g. A. Grama *et al.*, *Introduction to Parallel Computing*, Second Edition. Boston: Pearson Educ., 2003.

6 Conclusions

In this thesis, a new input format, NJOY Input Format (`NIF`), has been proposed. A translator which is able to translate NIF into NJOY input instructions has been implemented.

It is possible to specify basic NJOY jobs in NIF with a syntax to make them easier to read and express. The resulting NIF programs can be translated into NJOY input instructions, which can be run by the NJOY software system. Production use is although not advisable, since it has been challenging to conduct rigorous and complete testing. It has also been evident that analyzing the NJOY input instructions is not enough to design a new input format for the NJOY software system. Analyzing the ENDF formats and the source code for the NJOY software system is required in order to build a translator which can conduct a complete semantic analysis for a NJOY job.

7 Future Work

Future work includes completing the semantic analysis and the organizer feature for all modules in the NJOY software system. The NJOY Input Format and the translator also needs to be systematically evaluated and verified by a complete software quality assurance process as described in reference [15].

A spin-off project, that is related to developing a user friendly and readable input format, is to construct a graphical user interface editor which can display and produce NJOY input instructions in a user friendly fashion.

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A Users Manual

A.1 Structure of `nifty`

The `nifty` directory structure is organized as shown in figure A.1.

```
nifty/
    bin/
        analyzer
        emitter
        lexer
        nifty
        organizer
        parser
        test
    data/
        ...
        test_problems/
    nifty/
        analyzer/
        emitter/
        environment/
        lexer/
        organizer/
        parser/
        tests/
    [ply/]
```

Figure A.1: Directory Structure of `nifty`

The `nifty/bin/` directory includes all executable Python scripts which are used for running and testing the translator. The `nifty` executable in the `nifty/bin/` directory runs the complete translation process on an input NIF program. The `test` executable runs the test suite. The other executables runs their corresponding named phase in the translation process (and all the successive phases that they depend on).

The test problems are located in the `nifty/data/test_problems/` directory. The `nifty/nifty/` directory contains the source code for the translator.

The optional directory `ply/` indicates where PLY can be placed such that the translator is able to locate it.

A.2 Installation

PLY [11] is required to run the translator. It is sufficient to download PLY and put the `ply/` directory in the `nifty/` top directory as indicated by figure A.1 on the previous page.

A.3 Running the Translator

The translator has been implemented as a command-line based interface. To run the entire translation process, the `nifty` executable in the `nifty/bin/` directory should be used. Issuing the command

```
bin/nifty -h
```

in the `nifty/` top directory, will print the usage message shown in figure A.2.

```
usage: nifty [options] [input_file] [output_file]
options:
    -h, --help  show this help message and exit
    -a          don't analyze the input
    -o          don't organize the input
```

Figure A.2: `bin/nifty` usage

The `options` flag(s) are optional. The `input_file` and `output_file` are also optional. If no input file is given, standard input (`stdin`) will be used as the input source. If no output file is given, the result will be redirected to standard output (`stdout`).

As an example, the command

```
bin/nifty input.nif output
```

will simply run the translator on a file named `input.nif` and output the resulting NJOY input instructions on a file named `output`. The analyzer and organizer phase can be skipped by giving the `-a` and `-o` flag

`bin/nifty -a input.nif output`, to skip the analyzer phase

`bin/nifty -o input.nif output`, to skip the organizer phase

To skip both the organizer and analyzer phase, run `nifty` with both flags specified

```
bin/nifty -ao input.nif output
```

B Test Problems

In this section, the test problems that were used for testing the functionality of the translator is listed. Both the NIF versions and the expected NJOY input instructions are provided. The test problems listed in this section are also available in the `nifty/data/test_problems/` directory, as described in section A.1 on page 24.

B.1 Test Problem 01 (`tp01`)

NIF Version of Test Problem 01

```
1  moder
2  {
3      card_1
4      {
5          nin = 20;
6          nout = -21;
7      }
8  }
9
10 reconr
11 {
12     card_1
13     {
14         nendf = -21;
15         npend = -22;
16     }
17
18     card_2
19     {
20         tlabel =  "pendf tape for c-nat from endf/b tape 511";
21     }
22
23     card_3
24     {
25         mat = 1306;
26         ncards = 3;
27     }
```

```
28
29      card_4
30      {
31          err = 0.005; // Use C-style floats.
32      }
33
34      card_5
35      {
36          cards = "6-c-nat from tape 511";
37      }
38
39      card_5
40      {
41          cards = "processed by the njoy nuclear data processing system";
42      }
43
44      card_5
45      {
46          cards = "see original endf/b-v tape for details of evaluation";
47      }
48
49      /* Card 6 skipped since ngrid defaults to 0 in first card 3 */
50
51      card_3
52      {
53          mat = 0;
54      }
55  }
56
57  broadr
58  {
59      card_1
60      {
61          nendf = -21;
62          nin = -22;
63          nout = -23;
64      }
65
66      card_2
67      {
68          mat1 = 1306;
69          ntemp2 = 1;
70      }
71
72      card_3
73      {
74          errthn = 0.005; // Use C-style floats.
75      }
76
77      card_4
78      {
79          temp2[0] = 300.0; // Use C-style floats.
80      }
81
82      card_5
83      {
84          mat1 = 0;
```

```
    }
}

heatr
{
    card_1
    {
        nendf = -21;
        nin = -23;
        nout = -22;
    }

    card_2
    {
        matd = 1306;
        npk = 1;
    }

    card_3
    {
        mtk[0] = 444; // Note that mtk has to be defined as an array.
    }

    /* Card 4, 5, and 5a are skipped since nqa defaults to 0 in card 2. */
}

thermr
{
    card_1
    {
        nendf = 0;
        nin = -22;
        nout = -24;
    }

    card_2
    {
        matde = 0;
        matdp = 1306;
        nbin = 8;
        ntemp = 1;
        iinc = 1;
        icoh = 0;
        natom = 1;
        mtref = 221;
        iprint = 0;
    }

    card_3
    {
        tempr[0] = 300.0; // Use C-style floats.
    }

    card_4
    {
        tol = 0.05; // Use C-style floats.
        emax = 1.2;
```

```
    }
}

thermr
{
    card_1
    {
        nendf = 26;
        nin = -24;
        nout = -23;
    }

    card_2
    {
        matde = 1065;
        matdp = 1306;
        nbin = 8;
        ntemp = 1;
        iinc = 4;
        icoh = 1;
        natom = 1;
        mtref = 229;
        iprint = 0;
    }

    card_3
    {
        tempr[0] = 300.0; // Use C-style floats.
    }

    card_4
    {
        tol = 0.05; // Use C-style floats.
        emax = 1.2;
    }
}

groupr
{
    card_1
    {
        nendf = -21;
        npend = -23;
        ngout1 = 0;
        ngout2 = -24;
    }

    card_2
    {
        matb = 1306;
        ign = 3;
        igg = 3;
        iwt = 3;
        lord = 3;
        ntemp = 1;
        nsigz = 1;
        iprint = 1;
```

```
199     }
200
201     card_3
202     {
203         title = "carbon in graphite";
204     }
205
206     card_4
207     {
208         temp[0] = 300;
209     }
210
211     card_5
212     {
213         sigz[0] = 1.0e10; // No trailing dots. Use C-style floats.
214     }
215
216     card_9
217     {
218         mfd = 3;
219         mtd = 1;
220         mtname = "total";
221     }
222
223     card_9
224     {
225         mfd = 3;
226         mtd = 2;
227         mtname = "elastic";
228     }
229
230     card_9
231     {
232         mfd = 3;
233         mtd = 4;
234         mtname = "inelastic";
235     }
236
237     card_9
238     {
239         mfd = 3;
240         mtd = 51;
241         mtname = "discrete inelastic";
242     }
243
244     card_9
245     {
246         mfd = 3;
247         mtd = -68;
248         mtname = "continued";
249     }
250
251     card_9
252     {
253         mfd = 3;
254         mtd = 91;
255         mtname = "continuum inelastic";
```

```
256     }
257
258     card_9
259     {
260         mfd = 3;
261         mtd = 102;
262         mtname = "n,g";
263     }
264
265     card_9
266     {
267         mfd = 3;
268         mtd = 103;
269         mtname = "(n,p)";
270     }
271
272     card_9
273     {
274         mfd = 3;
275         mtd = 104;
276         mtname = "(n,d)";
277     }
278
279     card_9
280     {
281         mfd = 3;
282         mtd = 107;
283         mtname = "(n,a)";
284     }
285
286     card_9
287     {
288         mfd = 3;
289         mtd = 221;
290         mtname = "free thermal scattering";
291     }
292
293     card_9
294     {
295         mfd = 3;
296         mtd = 229;
297         mtname = "graphite inelastic thermal scattering";
298     }
299
300     card_9
301     {
302         mfd = 3;
303         mtd = 230;
304         mtname = "graphite elastic thermal scattering";
305     }
306
307     card_9
308     {
309         mfd = 3;
310         mtd = 251;
311         mtname = "mubar";
312     }
```

```
313
314       card_9
315       {
316           mfd = 3;
317           mtd = 252;
318           mtname = "xi";
319       }
320
321       card_9
322       {
323           mfd = 3;
324           mtd = 253;
325           mtname = "gamma";
326       }
327
328       card_9
329       {
330           mfd = 3;
331           mtd = 301;
332           mtname = "total heat production";
333       }
334
335       card_9
336       {
337           mfd = 3;
338           mtd = 444;
339           mtname = "total damage energy production";
340       }
341
342       card_9
343       {
344           mfd = 6;
345           mtd = 2;
346           mtname = "elastic";
347       }
348
349       card_9
350       {
351           mfd = 6;
352           mtd = 51;
353           mtname = "discrete inelastic";
354       }
355
356       card_9
357       {
358           mfd = 6;
359           mtd = -68;
360           mtname = "continued";
361       }
362
363       card_9
364       {
365           mfd = 6;
366           mtd = 91;
367           mtname = "continuum inelastic";
368       }
369
```

```
370      card_9
371      {
372          mfd = 6;
373          mtd = 221;
374          mtname = "free thermal scattering";
375      }
376
377      card_9
378      {
379          mfd = 6;
380          mtd = 229;
381          mtname = "graphite inelastic thermal scattering";
382      }
383
384      card_9
385      {
386          mfd = 6;
387          mtd = 230;
388          mtname = "graphite elastic thermal scattering";
389      }
390
391      card_9
392      {
393          mfd = 17;
394          mtd = 51;
395          mtname = "inelastic gamma production";
396      }
397
398      card_9
399      {
400          mfd = 16;
401          mtd = 102;
402          mtname = "capture gamma production";
403      }
404
405      card_9
406      {
407          mfd = 0;
408      }
409
410      card_10
411      {
412          matd = 0;
413      }
414  }
415
416  moder
417  {
418      card_1
419      {
420          nin = -23;
421          nout = 25;
422      }
423  }
```

Expected NJOY Input Instructions for Test Problem 01

```
1  moder
2  20 -21/ ### card_1
3  reconr
4  -21 -22/ ### card_1
5  'pendf tape for c-nat from endf/b tape 511'/ ### card_2
6  1306 3/ ### card_3
7  0.005/ ### card_4
8  '6-c-nat from tape 511'/ ### card_5
9  'processed by the njoy nuclear data processing system'/ ### card_5
10 'see original endf/b-v tape for details of evaluation'/ ### card_5
11 0/ ### card_3
12 broadr
13 -21 -22 -23/ ### card_1
14 1306 1/ ### card_2
15 0.005/ ### card_3
16 300.0/ ### card_4
17 0/ ### card_5
18 heatr
19 -21 -23 -22/ ### card_1
20 1306 1/ ### card_2
21 444/ ### card_3
22 thermr
23 0 -22 -24/ ### card_1
24 0 1306 8 1 1 0 1 221 0/ ### card_2
25 300.0/ ### card_3
26 0.05 1.2/ ### card_4
27 thermr
28 26 -24 -23/ ### card_1
29 1065 1306 8 1 4 1 1 229 0/ ### card_2
30 300.0/ ### card_3
31 0.05 1.2/ ### card_4
32 groupr
33 -21 -23 0 -24/ ### card_1
34 1306 3 3 3 3 1 1 1/ ### card_2
35 'carbon in graphite'/ ### card_3
36 300/ ### card_4
37 1.0e10/ ### card_5
38 3 1 'total'/ ### card_9
39 3 2 'elastic'/ ### card_9
40 3 4 'inelastic'/ ### card_9
41 3 51 'discrete inelastic'/ ### card_9
42 3 -68 'continued'/ ### card_9
43 3 91 'continuum inelastic'/ ### card_9
44 3 102 'n,g'/ ### card_9
45 3 103 '(n,p)'/ ### card_9
46 3 104 '(n,d)'/ ### card_9
47 3 107 '(n,a)'/ ### card_9
48 3 221 'free thermal scattering'/ ### card_9
49 3 229 'graphite inelastic thermal scattering'/ ### card_9
50 3 230 'graphite elastic thermal scattering'/ ### card_9
51 3 251 'mubar'/ ### card_9
52 3 252 'xi'/ ### card_9
53 3 253 'gamma'/ ### card_9
54 3 301 'total heat production'/ ### card_9
55 3 444 'total damage energy production'/ ### card_9
56 6 2 'elastic'/ ### card_9
```

```
6 51 'discrete inelastic'/ ### card_9
6 -68 'continued'/ ### card_9
6 91 'continuum inelastic'/ ### card_9
6 221 'free thermal scattering'/ ### card_9
6 229 'graphite inelastic thermal scattering'/ ### card_9
6 230 'graphite elastic thermal scattering'/ ### card_9
17 51 'inelastic gamma production'/ ### card_9
16 102 'capture gamma production'/ ### card_9
0/ ### card_9
0/ ### card_10
moder
-23 25/ ### card_1
stop
```

B.2 Test Problem 02 (tp02)

NIF Version of Test Problem 02

```
moder
{
    card_1
    {
        nin = 20;
        nout = -21;
    }
}

reconr
{
    card_1
    {
        nendf = -21;
        npend = -22;
    }

    card_2
    {
        tlabel =  "pendf tape for pu-238 from endf/b-iv tape 404";
    }

    card_3
    {
        mat = 1050;
        ncards = 3;
    }

    card_4
    {
        err = 0.005; // Use C-style floats instead of ".005".
    }

    card_5
    {
        cards = "94-pu-238 from endf/b tape t404";
    }
```

```
38
39      card_5
40      {
41          cards = "processed by the njoy nuclear data processing system";
42      }
43
44      card_5
45      {
46          cards = "see original endf/b-iv tape for details of evaluation";
47      }
48
49      /* Card 6 skipped since ngrid defaults to 0 in first card 3. */
50
51      card_3
52      {
53          mat = 0;
54      }
55  }
56
57  broadr
58  {
59      card_1
60      {
61          nendf = -21;
62          nin = -22;
63          nout = -23;
64      }
65
66      card_2
67      {
68          mat1 = 1050;
69          ntemp2 = 3;
70          istart = 0;
71          istrap = 1;
72          temp1 = 0;
73      }
74
75      card_3
76      {
77          errthn = 0.005; // Use C-style floats instead of ".005".
78      }
79
80      card_4
81      {
82          /* In this example, Each temperature is declared as an element in an
83             array.
84             ntemp2 in card_2 denotes the number of expected temperatures.
85           */
86          temp2[0] = 300.0;
87          temp2[1] = 900.0;
88          temp2[2] = 2100.0;
89      }
90
91      card_5
92      {
93          mat1 = 0;
94      }
```

```
}

moder
{
    card_1
    {
        nin = -23;
        nout = 33;
    }
}

unresr
{
    card_1
    {
        nendf = -21;
        nin = -23;
        nout = -24;
    }

    card_2
    {
        matd = 1050;
        ntemp = 3;
        nsigz = 7;
        iprint = 1;
    }

    card_3
    {
        temp[0] = 300;
        temp[1] = 900;
        temp[2] = 2100;
    }

    card_4
    {
        sigz[0] = 1.0e10;
        sigz[1] = 1.0e5;
        sigz[2] = 1.0e4;
        sigz[3] = 1000.0;
        sigz[4] = 100.0;
        sigz[5] = 10.0;
        sigz[6] = 1;
    }

    card_2
    {
        matd = 0;
    }
}

groupr
{
    card_1
    {
        nendf = -21;
```

```
152         npend = -24;
153         ngout1 = 0;
154         ngout2 = -25;
155     }
156
157     card_2
158     {
159         matb = 1050;
160         ign = 5;
161         igg = 0;
162         iwt = 4;
163         lord = 3;
164         ntemp = 3;
165         nsigz = 7;
166         iprint = 1;
167     }
168
169     card_3
170     {
171         title = "94-pu-238";
172     }
173
174     card_4
175     {
176         /* ntemp in card_2 denotes the number of expected temperatures. */
177         temp[0] = 300.0;
178         temp[1] = 900.0;
179         temp[2] = 2100.0;
180     }
181
182     card_5
183     {
184         /* nsigz in card_2 denotes the number of expected sigma zeroes. */
185         sigz[0] = 1.0e10;
186         sigz[1] = 1.0e5;
187         sigz[2] = 1.0e4;
188         sigz[3] = 1000.0;
189         sigz[4] = 100.0;
190         sigz[5] = 10.0;
191         sigz[6] = 1;
192     }
193
194     card_8c
195     {
196         eb = 0.1;
197         tb = 0.025;
198         ec = 0.8208e06;
199         tc = 1.4e06;
200     }
201
202     /* Reactions for temperature 300.0. */
203     card_9
204     {
205         mfd = 3;
206         mtd = 1;
207         mtname = "total";
208     }
```

```
209
210     card_9
211     {
212         mfd = 3;
213         mtd = 2;
214         mtname = "elastic";
215     }
216
217     card_9
218     {
219         mfd = 3;
220         mtd = 16;
221         mtname = "n2n";
222     }
223
224     card_9
225     {
226         mfd = 3;
227         mtd = 17;
228         mtname = "n3n";
229     }
230
231     card_9
232     {
233         mfd = 3;
234         mtd = 18;
235         mtname = "fission";
236     }
237
238     card_9
239     {
240         mfd = 3;
241         mtd = 102;
242         mtname = "capture";
243     }
244
245     card_9
246     {
247         mfd = 3;
248         mtd = 251;
249         mtname = "mubar";
250     }
251
252     card_9
253     {
254         mfd = 3;
255         mtd = 252;
256         mtname = "xi";
257     }
258
259     card_9
260     {
261         mfd = 3;
262         mtd = 253;
263         mtname = "gamma";
264     }
265
```

```
266     card_9
267     {
268         mfd = 3;
269         mtd = 259;
270         mtname = "1/v";
271     }
272
273     card_9
274     {
275         mfd = 6;
276         mtd = 2;
277         mtname = "elastic";
278     }
279
280     card_9
281     {
282         mfd = 6;
283         mtd = 16;
284         mtname = "n2n";
285     }
286
287     card_9
288     {
289         mfd = 6;
290         mtd = 17;
291         mtname = "n,3n";
292     }
293
294     card_9
295     {
296         mfd = 6;
297         mtd = 18;
298         mtname = "fission";
299     }
300
301     card_9
302     {
303         mfd = 6;
304         mtd = 51;
305         mtname = "discrete inelastic";
306     }
307
308     card_9
309     {
310         mfd = 6;
311         mtd = -59;
312         mtname = "continued";
313     }
314
315     card_9
316     {
317         mfd = 6;
318         mtd = 91;
319         mtname = "continuum inelastic";
320     }
321
322     /* Terminate temperature 300.0. */
```

```
323     card_9
324     {
325         mfd = 0;
326     }
327
328     /* Reactions for temperature 900.0. */
329     card_9
330     {
331         mfd = 3;
332         mtd = 1;
333         mtname = "total";
334     }
335
336     card_9
337     {
338         mfd = 3;
339         mtd = 2;
340         mtname = "elastic";
341     }
342
343     card_9
344     {
345         mfd = 3;
346         mtd = 18;
347         mtname = "fission";
348     }
349
350     card_9
351     {
352         mfd = 3;
353         mtd = 102;
354         mtname = "capture";
355     }
356
357     card_9
358     {
359         mfd = 6;
360         mtd = 2;
361         mtname = "elastic";
362     }
363
364     /* Terminate temperature 900.0. */
365     card_9
366     {
367         mfd = 0;
368     }
369
370     /* Reactions for temperature 2100.0. */
371     card_9
372     {
373         mfd = 3;
374         mtd = 1;
375         mtname = "total";
376     }
377
378     card_9
379     {
```

```
380         mfd = 3;
381         mtd = 2;
382         mtname = "elastic";
383     }
384
385     card_9
386     {
387         mfd = 3;
388         mtd = 18;
389         mtname = "fission";
390     }
391
392     card_9
393     {
394         mfd = 3;
395         mtd = 102;
396         mtname = "capture";
397     }
398
399     card_9
400     {
401         mfd = 6;
402         mtd = 2;
403         mtname = "elastic";
404     }
405
406     /* Terminate temperature 2100.0. */
407     card_9
408     {
409         mfd = 0;
410     }
411
412     /* Terminate groupr. */
413     card_10
414     {
415         matd = 0;
416     }
417 }
418
419 ccccr
420 {
421     card_1
422     {
423         nin = -25;
424         nisot = 26;
425         nbrks = 27;
426         ndlay = 0; // dlayxs not wanted
427     }
428
429     card_2
430     {
431         lprint = 1;
432         ivers = 1;
433         huse = "t2lanl njoy";
434     }
435
436     card_3
```

```
437     {
438         /* hsetid does not have to be 12 chars? */
439         hsetid = "ccccr tests for njoy87";
440     }
441
442     card_4
443     {
444         ngroup = 50;
445         nggrup = 0;
446         niso = 1; // Denotes number of card_5's.
447         maxord = 4;
448         ifopt = 1; // Blocking by reaction order.
449     }
450
451     card_5
452     {
453         /* Note that the original input does not denote the first four
454            variables as strings.
455            What does the two ' denote? Seems a bit irregular.
456          */
457         hisnm = "pu238";
458         habsid = "pu238";
459         hident = "endfb4";
460         hmat = "1050";
461         imat = 1050;
462         xspo = 10.89;
463     }
464
465     card_1
466     {
467         nsblok = 1;
468         maxup = 0; // Always zero (?).
469         maxdn = 50;
470         ichix = -1; // Vector (using groupr flux).
471     }
472
473     card_4
474     {
475         kbr = 0;
476         amass = 2.3821e02;
477         efiss = 3.3003e-11;
478         ecapt = 1.7461e-12;
479         temp = 0.0;
480         sigpot = 1.0e10;
481         adens = 0.0;
482     }
483
484     card_1
485     {
486         nti = 3;
487         nzi = 6;
488     }
489
490     card_2
491     {
492         /* Number of expected temperatures defined by nti. */
493         atem[0] = 300;
```

```
494          atem[1] = 900;
495          atem[2] = 2100;
496      }
497
498      card_3
499      {
500          /* Number of expected sigpo values defined by nzi. */
501          asig[0] = 1.0e5;
502          asig[1] = 1.0e4;
503          asig[2] = 1000.0;
504          asig[3] = 100.0;
505          asig[4] = 10.0;
506          asig[5] = 1;
507      }
508  }
509
510  moder
511  {
512      card_1
513      {
514          nin = -24;
515          nout = 28;
516      }
517  }
```

Expected NJOY Input Instructions for Test Problem 02

```
 1  moder
 2  20 -21/ ### card_1
 3  reconr
 4  -21 -22/ ### card_1
 5  'pendf tape for pu-238 from endf/b-iv tape 404'/ ### card_2
 6  1050 3/ ### card_3
 7  0.005/ ### card_4
 8  '94-pu-238 from endf/b tape t404'/ ### card_5
 9  'processed by the njoy nuclear data processing system'/ ### card_5
10  'see original endf/b-iv tape for details of evaluation'/ ### card_5
11  0/ ### card_3
12  broadr
13  -21 -22 -23/ ### card_1
14  1050 3 0 1 0/ ### card_2
15  0.005/ ### card_3
16  300.0 900.0 2100.0/ ### card_4
17  0/ ### card_5
18  moder
19  -23 33/ ### card_1
20  unresr
21  -21 -23 -24/ ### card_1
22  1050 3 7 1/ ### card_2
23  300 900 2100/ ### card_3
24  1.0e10 1.0e5 1.0e4 1000.0 100.0 10.0 1/ ### card_4
25  0/ ### card_2
26  groupr
27  -21 -24 0 -25/ ### card_1
28  1050 5 0 4 3 3 7 1/ ### card_2
29  '94-pu-238'/ ### card_3
```

```
300.0 900.0 2100.0/ ### card_4
1.0e10 1.0e5 1.0e4 1000.0 100.0 10.0 1/ ### card_5
0.1 0.025 0.8208e06 1.4e06/ ### card_8c
3 1 'total'/ ### card_9
3 2 'elastic'/ ### card_9
3 16 'n2n'/ ### card_9
3 17 'n3n'/ ### card_9
3 18 'fission'/ ### card_9
3 102 'capture'/ ### card_9
3 251 'mubar'/ ### card_9
3 252 'xi'/ ### card_9
3 253 'gamma'/ ### card_9
3 259 '1/v'/ ### card_9
6 2 'elastic'/ ### card_9
6 16 'n2n'/ ### card_9
6 17 'n,3n'/ ### card_9
6 18 'fission'/ ### card_9
6 51 'discrete inelastic'/ ### card_9
6 -59 'continued'/ ### card_9
6 91 'continuum inelastic'/ ### card_9
0/ ### card_9
3 1 'total'/ ### card_9
3 2 'elastic'/ ### card_9
3 18 'fission'/ ### card_9
3 102 'capture'/ ### card_9
6 2 'elastic'/ ### card_9
0/ ### card_9
3 1 'total'/ ### card_9
3 2 'elastic'/ ### card_9
3 18 'fission'/ ### card_9
3 102 'capture'/ ### card_9
6 2 'elastic'/ ### card_9
0/ ### card_9
0/ ### card_10
ccccr
-25 26 27 0/ ### card_1
1 1 't2lanl njoy'/ ### card_2
'ccccr tests for njoy87'/ ### card_3
50 0 1 4 1/ ### card_4
'pu238' 'pu238' 'endfb4' '1050' 1050 10.89/ ### card_5
1 0 50 -1/ ### card_1
0 2.3821e02 3.3003e-11 1.7461e-12 0.0 1.0e10 0.0/ ### card_4
3 6/ ### card_1
300 900 2100/ ### card_2
1.0e5 1.0e4 1000.0 100.0 10.0 1/ ### card_3
moder
-24 28/ ### card_1
stop
```

B.3 Test Problem 03 (`tp03`)

NIF Version of Test Problem 03

```
reconr
{
```

```
3       card_1
4       {
5           nendf = 30;
6           npend = 31;
7       }
8
9       card_2
10      {
11          tlabel = "pendf tape for photon interaction cross sections from
                dlc7e";
12      }
13
14      card_3
15      {
16          mat = 1;
17          ncards = 1;
18          ngrid = 0;
19      }
20
21      card_4
22      {
23          err = 0.001; // Note the C-style float format with preceding 0.
24      }
25
26      card_5
27      {
28          cards = "1-hydrogen";
29      }
30
31      card_3
32      {
33          mat = 92;
34          ncards = 1;
35          ngrid = 0;
36      }
37
38      card_4
39      {
40          err = 0.001; // Note the C-style float format with preceding 0.
41      }
42
43      card_5
44      {
45          cards = "92-uranium";
46      }
47
48      card_3
49      {
50          mat = 0;
51      }
52  }
53
54  gaminr
55  {
56      card_1
57      {
58          nendf = 32;
```

```
59          npend = 31;
60          ngam1 = 0;
61          ngam2 = 33;
62      }
63
64      card_2
65      {
66          matb = 1;
67          igg = 3;
68          iwt = 3;
69          lord = 4;
70          iprint = 1;
71      }
72
73      card_3
74      {
75          title = "12 group photon interaction library";
76      }
77
78      card_6
79      {
80          mfd = -1;
81          mtd = 0;
82      }
83
84      card_7
85      {
86          matd = 92;
87      }
88
89      card_6
90      {
91          mfd = -1;
92          mtd = 0;
93      }
94
95      card_7
96      {
97          matd = 0;
98      }
99  }
100
101 dtfr
102 {
103     card_1
104     {
105         nin = 33;
106         nout = 34;
107         npend = 31;
108         nplot = 36;
109     }
110
111     card_2
112     {
113         iprint = 1;
114         ifilm = 1;
115         iedit = 0;
```

```
116      }
117
118      card_3
119      {
120          nlmax = 5;
121          ng = 12;
122          iptotl = 4;
123          ipingp = 5;
124          itabl = 16;
125          ned = 1;
126          ntherm = 0;
127      }
128
129      card_4
130      {
131          /* iptotl-3 names will be read, i.e. 4-3 = 1 in this case. */
132          edits[0] = "pheat";
133      }
134
135      card_5
136      {
137          /* ned triplets, i.e. 1 triplet in this case. */
138          jpos[0] = 1;
139          mt[0] = 621;
140          mult[0] = 1;
141      }
142
143      card_7
144      {
145          nptabl = 0;
146      }
147
148      /* One card_8 for each table set desired. Empty card denotes termination
149         of dtfr.
150       */
151      card_8
152      {
153          hisnam = "h";
154          mat = 1;
155          jsigz = 1;
156          dtemp = 0.0;
157      }
158
159      card_8
160      {
161          hisnam = "u";
162          mat = 92;
163          jsigz = 1;
164          dtemp = 0.0;
165      }
166
167      card_8 {} // Terminate dtfr.
168  }
169
170  matxsr
171  {
172      card_1
```

```
173     {
174         ngen1 = 0;
175         ngen2 = 33;
176         nmatx = 35;
177     }
178
179     card_2
180     {
181         ivers = 1;
182         huse = "t2lanl njoy";
183     }
184
185     card_3
186     {
187         npart = 1;
188         ntype = 1;
189         nholl = 1;
190         nmat = 2;
191     }
192
193     card_4
194     {
195         hsetid = "12-group photon interaction library";
196     }
197
198     card_5
199     {
200         hpart = "g";
201     }
202
203     card_6
204     {
205         ngrp = 12;
206     }
207
208     card_7
209     {
210         htype = "gscat";
211     }
212
213     card_8
214     {
215         jinp = 1;
216     }
217
218     card_9
219     {
220         joutp = 1;
221     }
222
223     /* One card_10 per material. */
224     card_10
225     {
226         hmat = "h";
227         matno = 1;
228         matgg = 1;
229     }
```

```
230
231      card_10
232      {
233          hmat = "u";
234          matno = 92;
235          matgg = 92;
236      }
237  }
238
239  viewr
240  {
241      /* Documentation names the first two cards as card 1. Use card 0 to
             denote
242         the first card, just like in plotr.
243       */
244      card_0
245      {
246          infile = 36;
247          nps = 37;
248      }
249  }
```

Expected NJOY Input Instructions for Test Problem 03

```
 1  reconr
 2  30 31/ ### card_1
 3  'pendf tape for photon interaction cross sections from dlc7e'/ ### card_2
 4  1 1 0/ ### card_3
 5  0.001/ ### card_4
 6  '1-hydrogen'/ ### card_5
 7  92 1 0/ ### card_3
 8  0.001/ ### card_4
 9  '92-uranium'/ ### card_5
10  0/ ### card_3
11  gaminr
12  32 31 0 33/ ### card_1
13  1 3 3 4 1/ ### card_2
14  '12 group photon interaction library'/ ### card_3
15  -1 0/ ### card_6
16  92/ ### card_7
17  -1 0/ ### card_6
18  0/ ### card_7
19  dtfr
20  33 34 31 36/ ### card_1
21  1 1 0/ ### card_2
22  5 12 4 5 16 1 0/ ### card_3
23  'pheat'/ ### card_4
24  1 621 1/ ### card_5
25  0/ ### card_7
26  'h' 1 1 0.0/ ### card_8
27  'u' 92 1 0.0/ ### card_8
28  / ### card_8
29  matxsr
30  0 33 35/ ### card_1
31  1 't2lanl njoy'/ ### card_2
32  1 1 1 2/ ### card_3
```

```
'12-group photon interaction library'/ ### card_4
'g'/ ### card_5
12/ ### card_6
'gscat'/ ### card_7
1/ ### card_8
1/ ### card_9
'h' 1 1/ ### card_10
'u' 92 92/ ### card_10
viewr
36 37/ ### card_0
stop
```

B.4 Test Problem 04 (tp04)

NIF Version of Test Problem 04

```
moder
{
    card_1
    {
        nin = 20;
        nout = -21;
    }
}

reconr
{
    card_1
    {
        nendf = -21;
        npend = -22;
    }

    card_2
    {
        tlabel =  "u-235 10% pendf for errorr test problem from t511";
    }

    card_3
    {
        mat = 1395;
    }

    card_4
    {
        err = 0.10; // Use C-style floats.
    }

    card_3
    {
        mat = 0;
    }
}

errorr
```

```
{
    card_1
    {
        nendf = -21;
        npend = -22;
        ngout = 0;
        nout = 23;
        nin = 0;
    }

    card_2
    {
        matd = 1395;
        ign = 19;
        iwt = 3;
        iprint = 1;
        irelco = 1;
    }

    card_3
    {
        mprint = 0;
        tempin = 0;
    }

    /* Test problem 04 is using a file of the endf-5 format (iverf = 5) */

    card_7
    {
        iread = 0;
        mfcov = 33;
    }

    card_12a
    {
        ngn = 1;
    }

    card_12b
    {
        egn[0] = 1.0e0;
        egn[1] = 1.0e3;
    }
}

groupr
{
    card_1
    {
        nendf = -21;
        npend = -22;
        ngout1 = 0;
        ngout2 = 24;
    }

    card_2
    {
```

```
97          matb = 1395;
98          ign = 3;
99          igg = 0;
100         iwt = 3;
101         lord = 0;
102         ntemp = 1;
103         nsigz = 1;
104         iprint = 1;
105     }
106
107     card_3
108     {
109         title = "u-235 multigroup nubar calculation";
110     }
111
112     card_4
113     {
114         temp[0] = 0.0;
115     }
116
117     card_5
118     {
119         sigz[0] = 1.0e10;
120     }
121
122     card_9
123     {
124         mfd = 3;
125         mtd = 452;
126         mtname = "total nubar";
127     }
128
129     /* Terminate temperature/material with mfd = 0 as usual. */
130     card_9
131     {
132         mfd = 0;
133     }
134
135     /* Terminate groupr run with matd = 0 as usual. */
136     card_10
137     {
138         matd = 0;
139     }
140 }
141
142 errorr
143 {
144     card_1
145     {
146         nendf = -21;
147         npend = 0;
148         ngout = 24;
149         nout = 25;
150         nin = 23;
151     }
152
153     card_2
```

```
154     {
155         matd = 1395;
156         ign = 1;
157         iwt = 2;
158         iprint = 1;
159         irelco = 1;
160     }
161
162     /* Card 3 omitted since ngout != 0. */
163
164     /* Test problem 04 is using a file of the endf-5 format (iverf = 5) */
165
166     card_7
167     {
168         iread = 0;
169         mfcov = 31;
170     }
171
172     card_12a
173     {
174         ngn = 7;
175     }
176
177     card_12b
178     {
179         egn[0] = 1.0e0;
180         egn[1] = 1.0e1;
181         egn[2] = 1.0e2;
182         egn[3] = 1.0e3;
183         egn[4] = 1.0e4;
184         egn[5] = 1.0e5;
185         egn[6] = 1.0e6;
186         egn[7] = 1.0e7;
187     }
188 }
```

Expected NJOY Input Instructions for Test Problem 04

```
 1 moder
 2 20 -21/ ### card_1
 3 reconr
 4 -21 -22/ ### card_1
 5 'u-235 10% pendf for errorr test problem from t511'/ ### card_2
 6 1395/ ### card_3
 7 0.10/ ### card_4
 8 0/ ### card_3
 9 errorr
10 -21 -22 0 23 0/ ### card_1
11 1395 19 3 1 1/ ### card_2
12 0 0/ ### card_3
13 0 33/ ### card_7
14 1/ ### card_12a
15 1.0e0 1.0e3/ ### card_12b
16 groupr
17 -21 -22 0 24/ ### card_1
18 1395 3 0 3 0 1 1 1/ ### card_2
```

```
'u-235 multigroup nubar calculation'/ ### card_3
0.0/ ### card_4
1.0e10/ ### card_5
3 452 'total nubar'/ ### card_9
0/ ### card_9
0/ ### card_10
errorr
-21 0 24 25 23/ ### card_1
1395 1 2 1 1/ ### card_2
0 31/ ### card_7
7/ ### card_12a
1.0e0 1.0e1 1.0e2 1.0e3 1.0e4 1.0e5 1.0e6 1.0e7/ ### card_12b
stop
```

B.5 Test Problem 05 (tp05)

NIF Version of Test Problem 05

```
moder
{
    card_1
    {
        nin = 30;
        nout = -31;
    }
}

moder
{
    card_1
    {
        nin = -31;
        nout = -32;
    }
}

errorr
{
    card_1
    {
        nendf = -31;
        npend = -32;
        ngout = 0;
        nout = -33;
    }

    card_2
    {
        matd = 1306;
        ign = 19;
        iwt = 2;
        iprint = 1;
    }

    card_3
```

```
38      {
39          mprint = 0;
40          tempin = 0;
41      }
42
43      /* Test problem 05 is using a file of the endf-5 format (iverf=5) */
44
45      card_7
46      {
47          iread = 0;
48          mfcov = 33;
49      }
50
51      card_12a
52      {
53          ngn = 1;
54      }
55
56      card_12b
57      {
58          egn = 1e-5;
59          egn = 2e7;
60      }
61  }
62
63  covr
64  {
65      card_1
66      {
67          nin = -33;
68          nout = 0;
69          nplot = 34;
70      }
71
72      card_2
73      {
74          icolor = 1;
75      }
76
77      card_2a
78      {
79      }
80
81      card_3a
82      {
83      }
84
85      card_4
86      {
87          mat = 1306;
88      }
89  }
90
91  viewr
92  {
93      /* Documentation names the first two cards as card 1. Use card 0 to
           denote
```

```
94          the first card, just like in plotr.
95       */
96      card_0
97      {
98          infile = 34;
99          nps = 35;
100     }
101 }
```

Expected NJOY Input Instructions for Test Problem 05

```
1  moder
2  30 -31/ ### card_1
3  moder
4  -31 -32/ ### card_1
5  errorr
6  -31 -32 0 -33/ ### card_1
7  1306 19 2 1/ ### card_2
8  0 0/ ### card_3
9  0 33/ ### card_7
10 1/ ### card_12a
11 1e-5 2e7/ ### card_12b
12 covr
13 -33 0 34/ ### card_1
14 1/ ### card_2
15 / ### card_2a
16 / ### card_3a
17 1306/ ### card_4
18 viewr
19 34 35/ ### card_0
20 stop
```

B.6 Test Problem 06 (tp06)

NIF Version of Test Problem 06

```
1  plotr
2  {
3      card_0
4      {
5          nplt = 31;
6      }
7
8      card_1 {}
9
10     /* New axes, new page. */
11     card_2
12     {
13         iplot = 1;
14     }
15
16     card_3
17     {
```

```
18          /* e should be delimited by < >? Oh well. */
19          t1 = "<endf/b-v carbon";
20      }
21
22      card_3a
23      {
24          t2 = "<t>otal <c>ross <s>ection";
25      }
26
27      card_4
28      {
29          itype = 4;
30      }
31
32      card_5
33      {
34          el = 1e3;
35          eh = 2e7;
36      }
37
38      card_5a {}
39
40      card_6
41      {
42          yl = 0.5;
43          yh = 10;
44      }
45
46      card_6a {}
47
48      /* card_7 and card_7a skipped since jtype = 0. */
49
50      card_8
51      {
52          iverf = 5;
53          nin = 30;
54          matd = 1306;
55          mfd = 3;
56          mtd = 1;
57      }
58
59      /* card_9 since it's a 2d plot (indicated by sign of itype in card_4) */
60      card_9 {}
61
62      /* New axes, new page. */
63      card_2
64      {
65          iplot = 1;
66      }
67
68      card_3
69      {
70          /* e should be delimited by < >? Oh well. */
71          t1 = "<endf/b-v carbon";
72      }
73
74      card_3a
```

```
75      {
76          t2 = "(n,]a>) with fake data";
77      }
78
79      card_4
80      {
81          itype = 1;
82          jtype = 0;
83          igrid = 2;
84          ileg = 1;
85          xtag = 1.3e7;
86          ytag = 0.32;
87      }
88
89      card_5 {}
90      card_5a {}
91      card_6 {}
92      card_6a {}
93      /* card_7 and card_7a skipped since jtype = 0 */
94
95      card_8
96      {
97          iverf = 5;
98          nin = 30;
99          matd = 1306;
100         mfd = 3;
101         mtd = 107;
102     }
103
104     card_9 {}
105
106     card_10
107     {
108         aleg = "<endf/b-v mat1306";
109     }
110
111     /* Add plot on existing axes. */
112     card_2
113     {
114         iplot = 2;
115     }
116
117     /* card 3-7 skipped since iplot = 2. */
118
119     card_8
120     {
121         iverf = 0; // Ignore rest of parameters on card.
122     }
123
124     card_9
125     {
126         icon = -1;
127         isym = 0;
128     }
129
130     /* card_10 since ileg = 1. */
131     card_10
```

```
132     {
133         aleg = "<s>mith & <s>mith 1914";
134     }
135
136     /* card_12 since iverf = 0. */
137     card_12
138     {
139         nform = 0;
140     }
141
142     /* card_13 since nform = 0. */
143     card_13
144     {
145         xdata = 1.1e7;
146         ydata = 0.08;
147         yerr1 = 0.05;
148         yerr2 = 0.05;
149     }
150
151     card_13
152     {
153         xdata = 1.2e7;
154         ydata = 0.10;
155         yerr1 = 0.05;
156         yerr2 = 0.05;
157     }
158
159     card_13
160     {
161         xdata = 1.3e7;
162         ydata = 0.09;
163         yerr1 = 0.04;
164         yerr2 = 0.04;
165     }
166
167     card_13
168     {
169         xdata = 1.4e7;
170         ydata = 0.08;
171         yerr1 = 0.03;
172         yerr2 = 0.03;
173     }
174
175     /* Terminate card_13 with empty card. */
176     card_13 {}
177
178     /* Add plot on existing axes. */
179     card_2
180     {
181         iplot = 3;
182     }
183
184     /* Card 3-7 skipped since iplot = 3. */
185
186     card_8
187     {
188         iverf = 0; // Ignore rest of parameters on card.
```

```
189     }
190
191     card_9
192     {
193         icon = -1;
194         isym = 2;
195     }
196
197     /* card_10 since ileg = 1. */
198     card_10
199     {
200         aleg = "<b>lack & <b>lue 2008";
201     }
202
203     /* card_12 since iverf = 0. */
204     card_12
205     {
206         nform = 0;
207     }
208
209     /* card_13 since nform = 0. */
210     card_13
211     {
212         xdata = 1.15e7;
213         ydata = 0.07;
214         yerr1 = 0.02;
215         yerr2 = 0.0;
216         xerr1 = 0.2e6;
217         xerr2 = 0.0;
218     }
219
220     card_13
221     {
222         xdata = 1.25e7;
223         ydata = 0.11;
224         yerr1 = 0.02;
225         yerr2 = 0.0;
226         xerr1 = 0.2e6;
227         xerr2 = 0.0;
228     }
229
230     card_13
231     {
232         xdata = 1.35e7;
233         ydata = 0.08;
234         yerr1 = 0.015;
235         yerr2 = 0.0;
236         xerr1 = 0.2e6;
237         xerr2 = 0.0;
238     }
239
240     card_13
241     {
242         xdata = 1.45e7;
243         ydata = 0.075;
244         yerr1 = 0.01;
245         yerr2 = 0.0;
```

```
246         xerr1 = 0.2e6;
247         xerr2 = 0.0;
248     }
249
250     /* Terminate card_13 with empty card. */
251     card_13 {}
252
253     /* New axes, new page. */
254     card_2
255     {
256         iplot = 1;
257     }
258
259     card_3
260     {
261         /* e should be delimited by < >? Oh well. */
262         t1 = "<endf/b-v carbon";
263     }
264
265     card_3a
266     {
267         t2 = "<e>lastic <mf4>";
268     }
269
270     card_4
271     {
272         itype = -1; // 3d axes.
273         jtype = 2;
274     }
275
276     card_5 {}
277     card_5a {}
278     card_6 {}
279     card_6a {}
280     card_7 {}
281     card_7a {}
282
283     card_8
284     {
285         iverf = 5;
286         nin = 30;
287         matd = 1306;
288         mfd = 4;
289         mtd = 2;
290     }
291
292     card_11 {}
293
294     /* New axes, new page. */
295     card_2
296     {
297         iplot = 1;
298     }
299
300     card_3
301     {
302         t1 = "<endf/b-v l>i-6";
```

```
303     }
304
305     card_3a
306     {
307         t2 = "(n,2n)]a >neutron distribution";
308     }
309
310     card_4
311     {
312         itype = -1;
313         jtype = 2;
314     }
315
316     card_5 {}
317     card_5a {}
318
319     card_6
320     {
321         yl = 0;
322         yh = 12e6;
323         ystep = 2e6;
324     }
325
326     card_6a {}
327     card_7 {}
328     card_7a {}
329
330     card_8
331     {
332         iverf = 5;
333         nin = 30;
334         matd = 1303;
335         mfd = 5;
336         mtd = 24;
337     }
338
339     /* 3D plot. */
340     card_11 {}
341
342     /* New axes, new page. */
343     card_2
344     {
345         iplot = 1;
346     }
347
348     card_3
349     {
350         t1 = "<endf/b-v l>i-6";
351     }
352
353     card_3a
354     {
355         t2 = "(n,2n)]a >neutron spectra vs <E>";
356     }
357
358     card_4
359     {
```

```
360         itype = 4;
361         jtype = 0;
362         igrid = 2;
363         ileg = 2;
364     }
365
366     card_5
367     {
368         el = 10.0;
369         eh = 2.0e7;
370     }
371
372     card_5a {}
373
374     card_6
375     {
376         yl = 1e-11;
377         yh = 1e-6;
378     }
379
380     card_6a
381     {
382         ylabl = "<c>ross <s>ection (barns/e<v>)";
383     }
384
385     card_8
386     {
387         iverf = 5;
388         nin = 30;
389         matd = 1303;
390         mfd = 5;
391         mtd = 24;
392         temper = 0.0;
393         nth = 12;
394     }
395
396     card_9 {}
397
398     card_10
399     {
400         aleg = "10 <m>e<v";
401     }
402
403     card_10a
404     {
405         xtag = 1e3;
406         ytag = 2e-11;
407         xpoint = 1e2;
408     }
409
410     /* 2th additional plot on existing axes. */
411     card_2
412     {
413         iplot = 2;
414     }
415
416     card_8
```

```
417     {
418         iverf = 5;
419         nin = 30;
420         matd = 1303;
421         mfd = 5;
422         mtd = 24;
423         temper = 0.0;
424         nth = 16;
425     }
426
427     card_9 {}
428
429     /* card 10, 10a since ileg = 2 for the current axes. */
430     card_10
431     {
432         aleg = "14 <m>e<v";
433     }
434
435     card_10a
436     {
437         xtag = 1e4;
438         ytag = 2e-10;
439         xpoint = 2e3;
440     }
441
442     /* 3rd additional plot on existing axes. */
443     card_2
444     {
445         iplot = 3;
446     }
447
448     card_8
449     {
450         iverf = 5;
451         nin = 30;
452         matd = 1303;
453         mfd = 5;
454         mtd = 24;
455         temper = 0.0;
456         nth = 20;
457     }
458
459     card_9 {}
460
461     card_10
462     {
463         aleg = "20 <m>e<v";
464     }
465
466     card_10a
467     {
468         xtag = 1e5;
469         ytag = 2e-9;
470         xpoint = 4e4;
471     }
472
473     /* Terminate plotting job. */
```

```
474      card_2
475      {
476          iplot = 99;
477      }
478  }
479
480  viewr
481  {
482      /* Documentation names the first two cards as card 1. Use card 0 to
             denote
483         the first card, just like in plotr.
484       */
485      card_0
486      {
487          infile = 31;
488          nps = 32;
489      }
490  }
```

Expected NJOY Input Instructions for Test Problem 06

```
 1  plotr
 2  31/ ### card_0
 3  / ### card_1
 4  1/ ### card_2
 5  '<endf/b-v carbon'/ ### card_3
 6  '<t>otal <c>ross <s>ection'/ ### card_3a
 7  4/ ### card_4
 8  1e3 2e7/ ### card_5
 9  / ### card_5a
10  0.5 10/ ### card_6
11  / ### card_6a
12  5 30 1306 3 1/ ### card_8
13  / ### card_9
14  1/ ### card_2
15  '<endf/b-v carbon'/ ### card_3
16  '(n,]a>) with fake data'/ ### card_3a
17  1 0 2 1 1.3e7 0.32/ ### card_4
18  / ### card_5
19  / ### card_5a
20  / ### card_6
21  / ### card_6a
22  5 30 1306 3 107/ ### card_8
23  / ### card_9
24  '<endf/b-v mat1306'/ ### card_10
25  2/ ### card_2
26  0/ ### card_8
27  -1 0/ ### card_9
28  '<s>mith & <s>mith 1914'/ ### card_10
29  0/ ### card_12
30  1.1e7 0.08 0.05 0.05/ ### card_13
31  1.2e7 0.10 0.05 0.05/ ### card_13
32  1.3e7 0.09 0.04 0.04/ ### card_13
33  1.4e7 0.08 0.03 0.03/ ### card_13
34  / ### card_13
35  3/ ### card_2
```

```
0/ ### card_8
-1 2/ ### card_9
'<b>lack & <b>lue 2008'/ ### card_10
0/ ### card_12
1.15e7 0.07 0.02 0.0 0.2e6 0.0/ ### card_13
1.25e7 0.11 0.02 0.0 0.2e6 0.0/ ### card_13
1.35e7 0.08 0.015 0.0 0.2e6 0.0/ ### card_13
1.45e7 0.075 0.01 0.0 0.2e6 0.0/ ### card_13
/ ### card_13
1/ ### card_2
'<endf/b-v carbon'/ ### card_3
'<e>lastic <mf4>'/ ### card_3a
-1 2/ ### card_4
/ ### card_5
/ ### card_5a
/ ### card_6
/ ### card_6a
/ ### card_7
/ ### card_7a
5 30 1306 4 2/ ### card_8
/ ### card_11
1/ ### card_2
'<endf/b-v l>i-6'/ ### card_3
'(n,2n)]a >neutron distribution'/ ### card_3a
-1 2/ ### card_4
/ ### card_5
/ ### card_5a
0 12e6 2e6/ ### card_6
/ ### card_6a
/ ### card_7
/ ### card_7a
5 30 1303 5 24/ ### card_8
/ ### card_11
1/ ### card_2
'<endf/b-v l>i-6'/ ### card_3
'(n,2n)]a >neutron spectra vs <E>'/ ### card_3a
4 0 2 2/ ### card_4
10.0 2.0e7/ ### card_5
/ ### card_5a
1e-11 1e-6/ ### card_6
'<c>ross <s>ection (barns/e<v>)'/ ### card_6a
5 30 1303 5 24 0.0 12/ ### card_8
/ ### card_9
'10 <m>e<v'/ ### card_10
1e3 2e-11 1e2/ ### card_10a
2/ ### card_2
5 30 1303 5 24 0.0 16/ ### card_8
/ ### card_9
'14 <m>e<v'/ ### card_10
1e4 2e-10 2e3/ ### card_10a
3/ ### card_2
5 30 1303 5 24 0.0 20/ ### card_8
/ ### card_9
'20 <m>e<v'/ ### card_10
1e5 2e-9 4e4/ ### card_10a
99/ ### card_2
viewr
```

```
31 32/ ### card_0
stop
```

B.7 Test Problem 07 (tp07)

NIF Version of Test Problem 07

```
moder
{
    card_1
    {
        nin = 20;
        nout = -21;
    }
}

reconr
{
    card_1
    {
        nendf = -21;
        npend = -22;
    }

    card_2
    {
        tlabel = "pendf tape for u-235 from endf/b-v tape 511";
    }

    card_3
    {
        mat = 1395;
        ncards = 3;
    }

    card_4
    {
        /* Note C-style float compared to the original declaration above. */
        err = 0.005;
    }

    card_5
    {
        cards = "92-u-235 from endf/b-v tape 511 ";
    }

    card_5
    {
        cards = "processed by the njoy nuclear data processing system";
    }

    card_5
    {
        cards = "see original endf/b-v tape for details of evaluation";
    }
```

```
49
50      /* Terminate execution of reconr with mat = 0 as usual. */
51      card_3
52      {
53          mat = 0;
54      }
55  }
56
57  broadr
58  {
59      card_1
60      {
61          nendf = -21;
62          nin = -22;
63          nout = -23;
64      }
65
66      card_2
67      {
68          mat1 = 1395;
69          ntemp2 = 1;
70          istart = 0;
71          istrap = 1;
72          temp1 = 0;
73      }
74
75      card_3
76      {
77          errthn = 0.005;
78      }
79
80      card_4
81      {
82          temp2[0] = 300;
83      }
84
85      /* Terminate execution of broadr with mat1 = 0 as usual. */
86      card_5
87      {
88          mat1 = 0;
89      }
90  }
91
92  heatr
93  {
94      card_1
95      {
96          nendf = -21;
97          nin = -23;
98          nout = -24;
99          /* nplot not supplied, defaulted to 0? */
100     }
101
102     card_2
103     {
104         matd = 1395;
105     }
```

```
}

moder
{
    card_1
    {
        nin = -24;
        nout = 28;
    }
}

groupr
{
    card_1
    {
        nendf = -21;
        npend = -24;
        ngout1 = 0;
        ngout2 = -25;
    }

    card_2
    {
        matb = 1395;
        ign = 3;
        igg = 2;
        iwt = 9;
        lord = 0;
        ntemp = 1;
        nsigz = 1;
        iprint = 1;
    }

    card_3
    {
        title = "u-235 from tape 511";
    }

    card_4
    {
        temp[0] = 300.0;
    }

    card_5
    {
        sigz[0] = 1.0e10;
    }

    card_9
    {
        mfd = 16;
        /* mtd and mtname does not have to be supplied? */
    }

    /* Terminate temperature/material with mfd = 0 as usual. */
    card_9
    {
```

```
163          mfd = 0;
164      }
165
166      /* Terminate groupr run with matd = 0 as usual. */
167      card_10
168      {
169          matd = 0;
170      }
171  }
172
173  acer
174  {
175      card_1
176      {
177          nendf = -21;
178          npend = -24;
179          ngend = -25;
180          nace = 26;
181          ndir = 27;
182      }
183
184      card_2
185      {
186          iopt = 1;
187      }
188
189      card_3
190      {
191          hk = "njoy test problem 7";
192      }
193
194      card_5
195      {
196          matd = 1395;
197          tempd = 300.0;
198      }
199
200      card_6
201      {
202          newfor = 0;
203      }
204
205      card_7 {}
206  }
```

Expected NJOY Input Instructions for Test Problem 07

```
1  moder
2  20 -21/ ### card_1
3  reconr
4  -21 -22/ ### card_1
5  'pendf tape for u-235 from endf/b-v tape 511'/ ### card_2
6  1395 3/ ### card_3
7  0.005/ ### card_4
8  '92-u-235 from endf/b-v tape 511 '/ ### card_5
9  'processed by the njoy nuclear data processing system'/ ### card_5
```

```
'see original endf/b-v tape for details of evaluation'/ ### card_5
0/ ### card_3
broadr
-21 -22 -23/ ### card_1
1395 1 0 1 0/ ### card_2
0.005/ ### card_3
300/ ### card_4
0/ ### card_5
heatr
-21 -23 -24/ ### card_1
1395/ ### card_2
moder
-24 28/ ### card_1
groupr
-21 -24 0 -25/ ### card_1
1395 3 2 9 0 1 1 1/ ### card_2
'u-235 from tape 511'/ ### card_3
300.0/ ### card_4
1.0e10/ ### card_5
16/ ### card_9
0/ ### card_9
0/ ### card_10
acer
-21 -24 -25 26 27/ ### card_1
1/ ### card_2
'njoy test problem 7'/ ### card_3
1395 300.0/ ### card_5
0/ ### card_6
/ ### card_7
stop
```

B.8 Test Problem 08 (tp08)

NIF Version of Test Problem 08

```
moder
{
    card_1
    {
        nin = 20;
        nout = -21;
    }
}

reconr
{
    card_1
    {
        nendf = -21;
        npend = -22;
    }

    card_2
    {
        tlabel = "pendf tape for endf/b-vi.1 28-ni-61a";
```

```
21      }
22
23      card_3
24      {
25          mat = 2834;
26          ncards = 1;
27          ngrid = 0;
28      }
29
30      card_4
31      {
32          /* Note C-style float compared to the original declaration above. */
33          err = 0.01;
34      }
35
36      card_5
37      {
38          cards = "28-ni-61a from endf/b-vi.1 t124 (hetrick,fu;ornl)";
39      }
40
41      /* Terminate execution of reconr with mat = 0 as usual. */
42      card_3
43      {
44          mat = 0;
45      }
46  }
47
48  broadr
49  {
50      card_1
51      {
52          nendf = -21;
53          nin = -22;
54          nout = -23;
55      }
56
57      card_2
58      {
59          mat1 = 2834;
60          ntemp2 = 1;
61      }
62
63      card_3
64      {
65          errthn = 0.01;
66      }
67
68      card_4
69      {
70          temp2[0] = 300;
71      }
72
73      /* Terminate execution of broadr with mat1 = 0 as usual. */
74      card_5
75      {
76          mat1 = 0;
77      }
```

```
}

heatr
{
    card_1
    {
        nendf = -21;
        nin = -23;
        nout = -24;
        /* nplot not supplied, defaulted to 0? */
    }

    card_2
    {
        matd = 2834;
        npk = 6;
        nqa = 0;
        ntemp = 1;
        local = 0;
        iprint = 2;
    }

    card_3
    {
        mtk[0] = 302;
        mtk[1] = 303;
        mtk[2] = 304;
        mtk[3] = 402;
        mtk[4] = 443;
        mtk[5] = 444;
    }
}

moder
{
    card_1
    {
        nin = -24;
        nout = 28;
    }
}

groupr
{
    card_1
    {
        nendf = -21;
        npend = -24;
        ngout1 = 0;
        ngout2 = -22;
    }

    card_2
    {
        matb = 2834;
        ign = 3;
        igg = 3;
```

```
135         iwt = 9;
136         lord = 4;
137         ntemp = 1;
138         nsigz = 1;
139         iprint = 1;
140     }
141
142     card_3
143     {
144         title = "ni61a endf/b-vi.1 30x12";
145     }
146
147     card_4
148     {
149         temp[0] = 300;
150     }
151
152     card_5
153     {
154         sigz[0] = 1e10; // No trailing dots. Use C-style floats.
155     }
156
157     card_9
158     {
159         mfd = 3;
160         /* mtd and mtname does not have to be supplied? */
161     }
162
163     card_9
164     {
165         mfd = 3;
166         mtd = 251;
167         mtname = "mubar";
168     }
169
170     card_9
171     {
172         mfd = 3;
173         mtd = 252;
174         mtname = "xi";
175     }
176
177     card_9
178     {
179         mfd = 3;
180         mtd = 253;
181         mtname = "gamma";
182     }
183
184     card_9
185     {
186         mfd = 3;
187         mtd = 259;
188         mtname = "1/v";
189     }
190
191     card_9
```

```
    {
        mfd = 6;
        /* mtd and mtname does not have to be supplied? */
    }

    card_9
    {
        mfd = 16;
        /* mtd and mtname does not have to be supplied? */
    }

    /* Terminate temperature/material with mfd = 0 as usual. */
    card_9
    {
        mfd = 0;
    }

    /* Terminate groupr run with matd = 0 as usual. */
    card_10
    {
        matd = 0;
    }
}

acer
{
    card_1
    {
        nendf = -21;
        npend = -24;
        ngend = 0;
        nace = 25;
        ndir = 26;
    }

    card_2
    {
        iopt = 1;
        iprint = 1;
        ntype = 1;
    }

    card_3
    {
        hk = "28-ni-61a from endf-vi.1";
    }

    card_5
    {
        matd = 2834;
        tempd = 300.0;
    }

    card_6
    {
        newfor = 0;
    }
```

```
249
250     card_7 {}
251 }
```

Expected NJOY Input Instructions for Test Problem 08

```
moder
20 -21/ ### card_1
reconr
-21 -22/ ### card_1
'pendf tape for endf/b-vi.1 28-ni-61a'/ ### card_2
2834 1 0/ ### card_3
0.01/ ### card_4
'28-ni-61a from endf/b-vi.1 t124 (hetrick,fu;ornl)'/ ### card_5
0/ ### card_3
broadr
-21 -22 -23/ ### card_1
2834 1/ ### card_2
0.01/ ### card_3
300/ ### card_4
0/ ### card_5
heatr
-21 -23 -24/ ### card_1
2834 6 0 1 0 2/ ### card_2
302 303 304 402 443 444/ ### card_3
moder
-24 28/ ### card_1
groupr
-21 -24 0 -22/ ### card_1
2834 3 3 9 4 1 1 1/ ### card_2
'ni61a endf/b-vi.1 30x12'/ ### card_3
300/ ### card_4
1e10/ ### card_5
3/ ### card_9
3 251 'mubar'/ ### card_9
3 252 'xi'/ ### card_9
3 253 'gamma'/ ### card_9
3 259 '1/v'/ ### card_9
6/ ### card_9
16/ ### card_9
0/ ### card_9
0/ ### card_10
acer
-21 -24 0 25 26/ ### card_1
1 1 1/ ### card_2
'28-ni-61a from endf-vi.1'/ ### card_3
2834 300.0/ ### card_5
0/ ### card_6
/ ### card_7
stop
```

B.9 Test Problem 10 (`tp10`)

NIF Version of Test Problem 10

```
moder
{
    card_1
    {
        nin = 20;
        nout = -21;
    }
}

reconr
{
    card_1
    {
        nendf = -21;
        npend = -22;
    }

    card_2
    {
        tlabel = "pendf tape for pu-238 from endf/b-iv tape 404";
    }

    card_3
    {
        mat = 1050;
        ncards = 3;
    }

    card_4
    {
        /* Note C-style float compared to the original declaration above. */
        err = 0.005;
    }

    card_5
    {
        cards = "94-pu-238 from endf/b tape t404";
    }

    card_5
    {
        cards = "processed by the njoy nuclear data processing system";
    }

    card_5
    {
        cards = "see original endf/b-iv tape for details of evaluation";
    }

    /* Terminate execution of reconr with mat = 0 as usual. */
    card_3
    {
        mat = 0;
    }
}

broadr
```

```
{
    card_1
    {
        nendf = -21;
        nin = -22;
        nout = -23;
    }

    card_2
    {
        mat1 = 1050;
        ntemp2 = 3;
        istart = 0;
        istrap = 1;
        temp1 = 0;
    }

    card_3
    {
        errthn = 0.005;
    }

    card_4
    {
        temp2[0] = 300.0;
        temp2[1] = 900.0;
        temp2[2] = 2100.0;
    }

    /* Terminate execution of broadr with mat1 = 0 as usual. */
    card_5
    {
        mat1 = 0;
    }
}

unresr
{
    card_1
    {
        nendf = -21;
        nin = -23;
        nout = -24;
    }

    card_2
    {
        matd = 1050;
        ntemp = 3;
        nsigz = 7;
        iprint = 1;
    }

    card_3
    {
        temp[0] = 300;
        temp[1] = 900;
```

```
115         temp[2] = 2100;
116     }
117
118     card_4
119     {
120         sigz[0] = 1.0e10;
121         sigz[1] = 1.0e5;
122         sigz[2] = 1.0e4;
123         sigz[3] = 1000.0;
124         sigz[4] = 100.0;
125         sigz[5] = 10.0;
126         sigz[6] = 1;
127     }
128
129     card_2
130     {
131         matd = 0;
132     }
133 }
134
135 purr
136 {
137     card_1
138     {
139         nendf = -21;
140         nin = -24;
141         nout = -25;
142     }
143
144     card_2
145     {
146         matd = 1050;
147         ntemp = 3;
148         nsigz = 7;
149         nbin = 20;
150         nladr = 4;
151     }
152
153     card_3
154     {
155         temp[0] = 300;
156         temp[1] = 900;
157         temp[2] = 2100;
158     }
159
160     card_4
161     {
162         sigz[0] = 1.0e10;
163         sigz[1] = 1.0e5;
164         sigz[2] = 1.0e4;
165         sigz[3] = 1000.0;
166         sigz[4] = 100.0;
167         sigz[5] = 10.0;
168         sigz[6] = 1;
169     }
170
171     card_2
```

```
172     {
173         matd = 0;
174     }
175 }
176
177 acer
178 {
179     card_1
180     {
181         nendf = -21;
182         npend = -25;
183         ngend = 0;
184         nace = 26;
185         ndir = 27;
186     }
187
188     card_2
189     {
190         iopt = 1;
191     }
192
193     card_3
194     {
195         hk = "njoy test problem 10";
196     }
197
198     card_5
199     {
200         matd = 1050;
201         tempd = 300.0;
202     }
203
204     card_6 {}
205     card_7 {}
206 }
207
208 moder
209 {
210     card_1
211     {
212         nin = -25;
213         nout = 28;
214     }
215 }
```

Expected NJOY Input Instructions for Test Problem 10

```
1 moder
2 20 -21/ ### card_1
3 reconr
4 -21 -22/ ### card_1
5 'pendf tape for pu-238 from endf/b-iv tape 404'/ ### card_2
6 1050 3/ ### card_3
7 0.005/ ### card_4
8 '94-pu-238 from endf/b tape t404'/ ### card_5
9 'processed by the njoy nuclear data processing system'/ ### card_5
```

```
'see original endf/b-iv tape for details of evaluation'/ ### card_5
0/ ### card_3
broadr
-21 -22 -23/ ### card_1
1050 3 0 1 0/ ### card_2
0.005/ ### card_3
300.0 900.0 2100.0/ ### card_4
0/ ### card_5
unresr
-21 -23 -24/ ### card_1
1050 3 7 1/ ### card_2
300 900 2100/ ### card_3
1.0e10 1.0e5 1.0e4 1000.0 100.0 10.0 1/ ### card_4
0/ ### card_2
purr
-21 -24 -25/ ### card_1
1050 3 7 20 4/ ### card_2
300 900 2100/ ### card_3
1.0e10 1.0e5 1.0e4 1000.0 100.0 10.0 1/ ### card_4
0/ ### card_2
acer
-21 -25 0 26 27/ ### card_1
1/ ### card_2
'njoy test problem 10'/ ### card_3
1050 300.0/ ### card_5
/ ### card_6
/ ### card_7
moder
-25 28/ ### card_1
stop
```

B.10 Test Problem 11 (tp11)

NIF Version of Test Problem 11

```
moder
{
    card_1
    {
        nin = 20;
        nout = -21;
    }
}

reconr
{
    card_1
    {
        nendf = -21;
        npend = -22;
    }

    card_2
    {
        tlabel =  "pendf tape for pu-238 from endf/b-iv tape 404";
```

```
21      }
22
23      card_3
24      {
25          mat = 1050;
26          ncards = 3;
27      }
28
29      card_4
30      {
31          err = 0.005; // Use C-style floats.
32      }
33
34      card_5
35      {
36          cards = "94-pu-238 from endf/b tape t404";
37      }
38
39      card_5
40      {
41          cards = "processed by the njoy nuclear data processing system";
42      }
43
44      card_5
45      {
46          cards = "see original endf/b-iv tape for details of evaluation";
47      }
48
49      /* Card 6 skipped since ngrid defaults to 0 in first card 3 */
50
51      /* Terminate reconr. */
52      card_3
53      {
54          mat = 0;
55      }
56  }
57
58  broadr
59  {
60      card_1
61      {
62          nendf = -21;
63          nin = -22;
64          nout = -23;
65      }
66
67      card_2
68      {
69          mat1 = 1050;
70          ntemp2 = 3;
71          istart = 0;
72          istrap = 1;
73          temp1 = 0;
74      }
75
76      card_3
77      {
```

```
78          errthn = 0.005; // Use C-style floats.
79      }
80
81      card_4
82      {
83          temp2[0] = 300.0; // Use C-style floats.
84          temp2[1] = 900.0;
85          temp2[2] = 2100.0;
86      }
87
88      /* Terminate broadr. */
89      card_5
90      {
91          mat1 = 0;
92      }
93  }
94
95  unresr
96  {
97      card_1
98      {
99          nendf = -21;
100         nin = -23;
101         nout = -24;
102     }
103
104     card_2
105     {
106         matd = 1050;
107         ntemp = 3;
108         nsigz = 7;
109         iprint = 1;
110     }
111
112     card_3
113     {
114         temp[0] = 300;
115         temp[1] = 900;
116         temp[2] = 2100;
117     }
118
119     card_4
120     {
121         sigz[0] = 1.0e10;
122         sigz[1] = 1.0e5;
123         sigz[2] = 1.0e4;
124         sigz[3] = 1000.0;
125         sigz[4] = 100.0;
126         sigz[5] = 10.0;
127         sigz[6] = 1;
128     }
129
130     /* Terminate unresr. */
131     card_2
132     {
133         matd = 0;
134     }
```

```
}

thermr
{
    card_1
    {
        nendf = 0;
        nin = -24;
        nout = -25;
    }

    card_2
    {
        matde = 0;
        matdp = 1050;
        nbin = 8;
        ntemp = 3;
        iinc = 1;
        icoh = 0;
        natom = 1;
        mtref = 221;
        iprint = 0;
    }

    card_3
    {
        tempr[0] = 300.0; // Use C-style floats.
        tempr[1] = 900.0;
        tempr[2] = 2100.0;
    }

    card_4
    {
        tol = 0.05; // Use C-style floats.
        emax = 4.2;
    }
}

groupr
{
    card_1
    {
        nendf = -21;
        npend = -25;
        ngout1 = 0;
        ngout2 = -26;
    }

    card_2
    {
        matb = 1050;
        ign = 9;
        igg = 0;
        iwt = 5;
        lord = 3;
        ntemp = 3;
        nsigz = 7;
```

```
192         iprint = 1;
193     }
194
195     card_3
196     {
197         title = "94-pu-238";
198     }
199
200     card_4
201     {
202         /* ntemp in card_2 denotes the number of expected temperatures. */
203         temp[0] = 300.0;
204         temp[1] = 900.0;
205         temp[2] = 2100.0;
206     }
207
208     card_5
209     {
210         /* nsigz in card_2 denotes the number of expected sigma zeroes. */
211         sigz[0] = 1.0e10;
212         sigz[1] = 1.0e5;
213         sigz[2] = 1.0e4;
214         sigz[3] = 1000.0;
215         sigz[4] = 100.0;
216         sigz[5] = 10.0;
217         sigz[6] = 1;
218     }
219
220     /* Reactions for temperature 300.0. */
221     card_9
222     {
223         mfd = 3;
224         mtd = 1;
225         mtname = "total";
226     }
227
228     card_9
229     {
230         mfd = 3;
231         mtd = 2;
232         mtname = "elastic";
233     }
234
235     card_9
236     {
237         mfd = 3;
238         mtd = 16;
239         mtname = "n2n";
240     }
241
242     card_9
243     {
244         mfd = 3;
245         mtd = 17;
246         mtname = "n3n";
247     }
248
```

```
249     card_9
250     {
251         mfd = 3;
252         mtd = 18;
253         mtname = "fission";
254     }
255
256     card_9
257     {
258         mfd = 3;
259         mtd = 102;
260         mtname = "capture";
261     }
262
263     card_9
264     {
265         mfd = 3;
266         mtd = 221;
267         mtname = "free gas thermal";
268     }
269
270     card_9
271     {
272         mfd = 6;
273         mtd = 2;
274         mtname = "elastic";
275     }
276
277     card_9
278     {
279         mfd = 6;
280         mtd = 16;
281         mtname = "n2n";
282     }
283
284     card_9
285     {
286         mfd = 6;
287         mtd = 17;
288         mtname = "n,3n";
289     }
290
291     card_9
292     {
293         mfd = 6;
294         mtd = 18;
295         mtname = "fission";
296     }
297
298     card_9
299     {
300         mfd = 6;
301         mtd = 51;
302         mtname = "discrete inelastic";
303     }
304
305     card_9
```

```
306     {
307         mfd = 6;
308         mtd = -59;
309         mtname = "continued";
310     }
311
312     card_9
313     {
314         mfd = 6;
315         mtd = 91;
316         mtname = "continuum inelastic";
317     }
318
319     card_9
320     {
321         mfd = 6;
322         mtd = 221;
323         mtname = "free gas thermal";
324     }
325
326     /* Terminate temperature 300.0. */
327     card_9
328     {
329         mfd = 0;
330     }
331
332     /* Reactions for temperature 900.0. */
333     card_9
334     {
335         mfd = 3;
336         mtd = 1;
337         mtname = "total";
338     }
339
340     card_9
341     {
342         mfd = 3;
343         mtd = 2;
344         mtname = "elastic";
345     }
346
347     card_9
348     {
349         mfd = 3;
350         mtd = 18;
351         mtname = "fission";
352     }
353
354     card_9
355     {
356         mfd = 3;
357         mtd = 102;
358         mtname = "capture";
359     }
360
361     card_9
362     {
```

```
363         mfd = 3;
364         mtd = 221;
365         mtname = "free gas thermal";
366     }
367
368     card_9
369     {
370         mfd = 6;
371         mtd = 2;
372         mtname = "elastic";
373     }
374
375     card_9
376     {
377         mfd = 6;
378         mtd = 221;
379         mtname = "free gas thermal";
380     }
381
382     /* Terminate temperature 900.0. */
383     card_9
384     {
385         mfd = 0;
386     }
387
388     /* Reactions for temperature 2100.0. */
389     card_9
390     {
391         mfd = 3;
392         mtd = 1;
393         mtname = "total";
394     }
395
396     card_9
397     {
398         mfd = 3;
399         mtd = 2;
400         mtname = "elastic";
401     }
402
403     card_9
404     {
405         mfd = 3;
406         mtd = 18;
407         mtname = "fission";
408     }
409
410     card_9
411     {
412         mfd = 3;
413         mtd = 102;
414         mtname = "capture";
415     }
416
417     card_9
418     {
419         mfd = 3;
```

```
420         mtd = 221;
421         mtname = "free gas thermal";
422     }
423
424     card_9
425     {
426         mfd = 6;
427         mtd = 2;
428         mtname = "elastic";
429     }
430
431     card_9
432     {
433         mfd = 6;
434         mtd = 221;
435         mtname = "free gas thermal";
436     }
437
438     /* Terminate temperature 2100.0. */
439     card_9
440     {
441         mfd = 0;
442     }
443
444     /* Terminate groupr. */
445     card_10
446     {
447         matd = 0;
448     }
449 }
450
451 wimsr
452 {
453     card_1
454     {
455         ngendf = -26;
456         nout = 27;
457     }
458
459     card_2
460     {
461         iprint = 1;
462     }
463
464     card_3
465     {
466         mat = 1050;
467         nfid = 1;
468         rdfid = 1050.0;
469     }
470
471     card_4
472     {
473         ntemp = 3;
474         nsigz = 7;
475         sgref = 1e10;
476         ires = 3;
```

```
477           sigp = 10.890;
478           mti = 221;
479           mtc = 0;
480       }
481
482       card_7
483       {
484           lambda[0] = 1.0;
485           lambda[1] = 1.0;
486           lambda[2] = 1.0;
487           lambda[3] = 1.0;
488           lambda[4] = 1.0;
489           lambda[5] = 1.0;
490           lambda[6] = 1.0;
491           lambda[7] = 1.0;
492           lambda[8] = 1.0;
493           lambda[9] = 1.0;
494           lambda[10] = 1.0;
495           lambda[11] = 1.0;
496           lambda[12] = 1.0;
497       }
498   }
```

Expected NJOY Input Instructions for Test Problem 11

```
 1  moder
 2  20 -21/ ### card_1
 3  reconr
 4  -21 -22/ ### card_1
 5  'pendf tape for pu-238 from endf/b-iv tape 404'/ ### card_2
 6  1050 3/ ### card_3
 7  0.005/ ### card_4
 8  '94-pu-238 from endf/b tape t404'/ ### card_5
 9  'processed by the njoy nuclear data processing system'/ ### card_5
10  'see original endf/b-iv tape for details of evaluation'/ ### card_5
11  0/ ### card_3
12  broadr
13  -21 -22 -23/ ### card_1
14  1050 3 0 1 0/ ### card_2
15  0.005/ ### card_3
16  300.0 900.0 2100.0/ ### card_4
17  0/ ### card_5
18  unresr
19  -21 -23 -24/ ### card_1
20  1050 3 7 1/ ### card_2
21  300 900 2100/ ### card_3
22  1.0e10 1.0e5 1.0e4 1000.0 100.0 10.0 1/ ### card_4
23  0/ ### card_2
24  thermr
25  0 -24 -25/ ### card_1
26  0 1050 8 3 1 0 1 221 0/ ### card_2
27  300.0 900.0 2100.0/ ### card_3
28  0.05 4.2/ ### card_4
29  groupr
30  -21 -25 0 -26/ ### card_1
31  1050 9 0 5 3 3 7 1/ ### card_2
```

```
'94-pu-238'/ ### card_3
300.0 900.0 2100.0/ ### card_4
1.0e10 1.0e5 1.0e4 1000.0 100.0 10.0 1/ ### card_5
3 1 'total'/ ### card_9
3 2 'elastic'/ ### card_9
3 16 'n2n'/ ### card_9
3 17 'n3n'/ ### card_9
3 18 'fission'/ ### card_9
3 102 'capture'/ ### card_9
3 221 'free gas thermal'/ ### card_9
6 2 'elastic'/ ### card_9
6 16 'n2n'/ ### card_9
6 17 'n,3n'/ ### card_9
6 18 'fission'/ ### card_9
6 51 'discrete inelastic'/ ### card_9
6 -59 'continued'/ ### card_9
6 91 'continuum inelastic'/ ### card_9
6 221 'free gas thermal'/ ### card_9
0/ ### card_9
3 1 'total'/ ### card_9
3 2 'elastic'/ ### card_9
3 18 'fission'/ ### card_9
3 102 'capture'/ ### card_9
3 221 'free gas thermal'/ ### card_9
6 2 'elastic'/ ### card_9
6 221 'free gas thermal'/ ### card_9
0/ ### card_9
3 1 'total'/ ### card_9
3 2 'elastic'/ ### card_9
3 18 'fission'/ ### card_9
3 102 'capture'/ ### card_9
3 221 'free gas thermal'/ ### card_9
6 2 'elastic'/ ### card_9
6 221 'free gas thermal'/ ### card_9
0/ ### card_9
0/ ### card_10
wimsr
-26 27/ ### card_1
1/ ### card_2
1050 1 1050.0/ ### card_3
3 7 1e10 3 10.890 221 0/ ### card_4
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0/ ### card_7
stop
```

B.11 Test Problem 12 (tp12)

NIF Version of Test Problem 12

```
reconr
{
    card_1
    {
        nendf = 20;
        npend = 21;
    }
```

```
 8
 9      card_2
10      {
11          tlabel = "pendf tape for endf/b-vi.1 28-ni-61a";
12      }
13
14      card_3
15      {
16          mat = 2834;
17          ncards = 1;
18          ngrid = 0;
19      }
20
21      card_4
22      {
23          /* Note C-style float compared to the original declaration above. */
24          err = 0.01;
25      }
26
27      card_5
28      {
29          cards = "28-ni-61a from endf/b-vi.1 t124 (hetrick,fu;ornl)";
30      }
31
32      /* Terminate execution of reconr with mat = 0 as usual. */
33      card_3
34      {
35          mat = 0;
36      }
37  }
38
39  gaspr
40  {
41      card_1
42      {
43          nendf = 20;
44          nin = 21;
45          nout = 22;
46      }
47  }
48
49  plotr
50  {
51      card_0
52      {
53          nplt = 23;
54      }
55
56      card_1
57      {
58          lori = 1;
59          istyle = 1;
60          size = 0.3;
61          ipcol = 2;
62      }
63
64      /* New axes, new page. */
```

```
65      card_2
66      {
67          iplot = 1;
68          iwcol = 3;
69      }
70
71      card_3
72      {
73          t1 = "<endf/b-vi n>i-61";
74      }
75      card_3a
76      {
77          t2 = "<r>esonance <c>ross <s>ections";
78      }
79
80      card_4
81      {
82          itype = 2;
83          jtype = 0;
84          igrid = 3;
85          ileg = 1;
86          xtag = 23e3;
87          ytag = 5e2;
88      }
89
90      card_5
91      {
92          el = 0.5e4;
93          eh = 3e4;
94          xstep = 0.5e4;
95      }
96      card_5a {}
97
98      card_6
99      {
100         yl = 1e-3;
101         yh = 1e3;
102     }
103     card_6a {}
104
105     /* card 7 and card 7a skipped since jtype = 0. */
106
107     card_8
108     {
109         iverf = 6;
110         nin = 22;
111         matd = 2834;
112         mfd = 3;
113         mtd = 2;
114     }
115
116     /* itype is positive, resulting in 2d plot. */
117     card_9
118     {
119         icon = 0;
120         isym = 0;
121         idash = 0;
```

```
122         iccol = 3;
123         ithick = 2;
124     }
125
126     /* ileg = 1, resulting in card 10 but no card 10a. */
127     card_10
128     {
129         aleg = "elastic";
130     }
131
132     /* card 11-13 skipped since it's a 2d plot and iverf != 0. */
133
134     /* New curve; 2nd additional plot on existing axes. */
135     card_2
136     {
137         iplot = 2;
138     }
139
140     /* card 2-7 skipped since iplot = 2. */
141
142     card_8
143     {
144         iverf = 6;
145         nin = 22;
146         matd = 2834;
147         mfd = 3;
148         mtd = 102;
149     }
150
151     /* itype is positive on the current axes, resulting in 2d plot. */
152     card_9
153     {
154         icon = 0;
155         isym = 0;
156         idash = 0;
157         iccol = 1;
158         ithick = 2;
159     }
160
161     /* ileg = 1 on current axes, resulting in card 10 but no card 10a. */
162     card_10
163     {
164         aleg = "capture";
165     }
166
167     /* New axes, new page. */
168     card_2
169     {
170         iplot = 1;
171         iwcol = 7;
172     }
173
174     card_3
175     {
176         t1 = "<endf/b-vi n>i-61";
177     }
178     card_3a
```

```
179     {
180         t2 = "<g>as <p>roduction";
181     }
182
183     card_4
184     {
185         itype = 1;
186         jtype = 0;
187         igrid = 3;
188         ileg = 1;
189     }
190
191     card_5
192     {
193         el = 0;
194         eh = 2e7;
195         xstep = 5e6;
196     }
197     card_5a {}
198
199     card_6 {}
200     card_6a {}
201
202     /* card 7 and card 7a skipped since jtype = 0. */
203
204     card_8
205     {
206         iverf = 6;
207         nin = 22;
208         matd = 2834;
209         mfd = 3;
210         mtd = 203;
211         temper = 0.0;
212     }
213
214     /* itype is positive, resulting in 2d plot. */
215     card_9
216     {
217         icon = 0;
218         isym = 0;
219         idash = 0;
220         iccol = 1;
221         ithick = 2;
222     }
223
224     /* ileg = 1, resulting in card 10 but no card 10a. */
225     card_10
226     {
227         aleg = "hydrogen";
228     }
229
230     /* card 11-13 skipped since it's a 2d plot and iverf != 0. */
231
232     /* New curve; 2nd additional plot on existing axes. */
233     card_2
234     {
235         iplot = 2;
```

```
236     }
237
238     /* card 2-7 skipped since iplot = 2. */
239
240     card_8
241     {
242         iverf = 6;
243         nin = 22;
244         matd = 2834;
245         mfd = 3;
246         mtd = 207;
247         temper = 0.0;
248     }
249
250     /* itype is positive on the current axes, resulting in 2d plot. */
251     card_9
252     {
253         icon = 0;
254         isym = 0;
255         idash = 0;
256         iccol = 2;
257         ithick = 2;
258     }
259
260     /* ileg = 1 on current axes, resulting in card 10 but no card 10a. */
261     card_10
262     {
263         aleg = "helium-4";
264     }
265
266     /* Terminate plotting job. */
267     card_2
268     {
269         iplot = 99;
270     }
271 }
272
273 viewr
274 {
275     /* Documentation names the first two cards as card 1. Use card 0 to
            denote
276        the first card, just like in plotr.
277      */
278     card_0
279     {
280         infile = 23;
281         nps = 24;
282     }
283 }
```

Expected NJOY Input Instructions for Test Problem 12

```
1 reconr
2 20 21/ ### card_1
3 'pendf tape for endf/b-vi.1 28-ni-61a'/ ### card_2
4 2834 1 0/ ### card_3
```

```
0.01/ ### card_4
'28-ni-61a from endf/b-vi.1 t124 (hetrick,fu;ornl)'/ ### card_5
0/ ### card_3
gaspr
20 21 22/ ### card_1
plotr
23/ ### card_0
1 1 0.3 2/ ### card_1
1 3/ ### card_2
'<endf/b-vi n>i-61'/ ### card_3
'<r>esonance <c>ross <s>ections'/ ### card_3a
2 0 3 1 23e3 5e2/ ### card_4
0.5e4 3e4 0.5e4/ ### card_5
/ ### card_5a
1e-3 1e3/ ### card_6
/ ### card_6a
6 22 2834 3 2/ ### card_8
0 0 0 3 2/ ### card_9
'elastic'/ ### card_10
2/ ### card_2
6 22 2834 3 102/ ### card_8
0 0 0 1 2/ ### card_9
'capture'/ ### card_10
1 7/ ### card_2
'<endf/b-vi n>i-61'/ ### card_3
'<g>as <p>roduction'/ ### card_3a
1 0 3 1/ ### card_4
0 2e7 5e6/ ### card_5
/ ### card_5a
/ ### card_6
/ ### card_6a
6 22 2834 3 203 0.0/ ### card_8
0 0 0 1 2/ ### card_9
'hydrogen'/ ### card_10
2/ ### card_2
6 22 2834 3 207 0.0/ ### card_8
0 0 0 2 2/ ### card_9
'helium-4'/ ### card_10
99/ ### card_2
viewr
23 24/ ### card_0
stop
```

B.12 Test Problem 13 (tp13)

NIF Version of Test Problem 13

```
moder
{
    card_1
    {
        nin = 20;
        nout = -21;
    }
}
```

```
 9
10  reconr
11  {
12      card_1
13      {
14          nendf = -21;
15          npend = -22;
16      }
17
18      card_2
19      {
20          tlabel = "pendf tape for endf/b-vi.1 28-ni-61a";
21      }
22
23      card_3
24      {
25          mat = 2834;
26          ncards = 1;
27          ngrid = 0;
28      }
29
30      card_4
31      {
32          err = 0.01;
33      }
34
35      card_5
36      {
37          cards = "28-ni-61a from endf/b-vi.1 t124 (hetrick,fu;ornl)";
38      }
39
40      card_3
41      {
42          mat = 0;
43      }
44  }
45
46  broadr
47  {
48      card_1
49      {
50          nendf = -21;
51          nin = -22;
52          nout = -23;
53      }
54
55      card_2
56      {
57          mat1 = 2834;
58          ntemp2 = 1;
59      }
60
61      card_3
62      {
63          errthn = 0.01;
64      }
65
```

```
    card_4
    {
        temp2[0] = 300;
    }

    card_5
    {
        mat1 = 0;
    }
}

heatr
{
    card_1
    {
        nendf = -21;
        nin = -23;
        nout = -24;
        /* nplot is not required? */
    }

    card_2
    {
        matd = 2834;
        npk = 6;
        nqa = 0;
        ntemp = 1;
        local = 0;
        iprint = 2;
    }

    card_3
    {
        /* npk = 6 -> 6 values for mtk */
        /* Note that mtk has been defined as an array. */
        mtk[0] = 302;
        mtk[1] = 303;
        mtk[2] = 304;
        mtk[3] = 402;
        mtk[4] = 443;
        mtk[5] = 444;
    }
}

gaspr
{
    card_1
    {
        nendf = -21;
        nin = -24;
        nout = -25;
    }
}

moder
{
    card_1
```

```
    {
        nin = -25;
        nout = 28;
    }
}

acer
{
    card_1
    {
        nendf = -21;
        npend = -25;
        ngend = 0;
        nace = 26;
        ndir = 27;
    }

    card_2
    {
        iopt = 1;
        iprint = 0;
        ntype = 1;
    }

    card_3
    {
        hk = "28-ni-61a endf-vi.1 njoy99";
    }

    card_5
    {
        matd = 2834;
        tempd = 300;
    }

    card_6 {}
    card_7 {}
}

acer
{
    card_1
    {
        nendf = 0;
        npend = 26;
        ngend = 33;
        nace = 34;
        ndir = 35;
    }

    card_2
    {
        iopt = 7;
        iprint = 1;
        ntype = 2;
    }

```

```
180      card_3
181      {
182          hk = "28-ni-61a endf-vi.1 njoy99";
183      }
184  }
185
186  viewr
187  {
188      /* Documentation names the first two cards as card 1. Use card 0 to
             denote
189         the first card, just like in plotr.
190       */
191      card_0
192      {
193          infile = 33;
194          nps = 36;
195      }
196  }
```

Expected NJOY Input Instructions for Test Problem 13

```
 1  moder
 2  20 -21/ ### card_1
 3  reconr
 4  -21 -22/ ### card_1
 5  'pendf tape for endf/b-vi.1 28-ni-61a'/ ### card_2
 6  2834 1 0/ ### card_3
 7  0.01/ ### card_4
 8  '28-ni-61a from endf/b-vi.1 t124 (hetrick,fu;ornl)'/ ### card_5
 9  0/ ### card_3
10  broadr
11  -21 -22 -23/ ### card_1
12  2834 1/ ### card_2
13  0.01/ ### card_3
14  300/ ### card_4
15  0/ ### card_5
16  heatr
17  -21 -23 -24/ ### card_1
18  2834 6 0 1 0 2/ ### card_2
19  302 303 304 402 443 444/ ### card_3
20  gaspr
21  -21 -24 -25/ ### card_1
22  moder
23  -25 28/ ### card_1
24  acer
25  -21 -25 0 26 27/ ### card_1
26  1 0 1/ ### card_2
27  '28-ni-61a endf-vi.1 njoy99'/ ### card_3
28  2834 300/ ### card_5
29  / ### card_6
30  / ### card_7
31  acer
32  0 26 33 34 35/ ### card_1
33  7 1 2/ ### card_2
34  '28-ni-61a endf-vi.1 njoy99'/ ### card_3
35  viewr
```

```
33 36/ ### card_0
stop
```

B.13 Test Problem 14 (tp14)

NIF Version of Test Problem 14

```
acer
{
    card_1
    {
        endf_input = 20;
        pendf_input = 21;
        multigroup_photon_input = 0;
        ace_output = 31;
        mcnp_directory_output = 32;
    }

    card_2
    {
        acer_run_option = 1;
        print_control = 0;
        ace_output_type = 1;

        /* id suffix for zaid (default = 0.00), and
           number of iz,aw pairs to read in (default = 0) are set to their
           default values since they are not provided.
         */
    }

    card_3
    {
        description = "proton + 7-n-14 apt la150 njoy99 mcnpx";
    }

    card_5
    {
        material = 725;
        temperature = 0; // No trailing dots allowed. Use C-style floats.
    }

    /* Card 6 and 7 are empty; the default values will be used. */
    card_6 {} // Use new cummulative angle distributions.
    card_7 {} // No thinning.
}

acer
{
    card_1
    {
        endf_input = 0;
        pendf_input = 31;
        multigroup_photon_input = 33;
        ace_output = 34;
        mcnp_directory_output = 35;
```

```
49      }
50
51      card_2
52      {
53          acer_run_option = 7;
54          print_control = 1;
55          ace_output_type = 2;
56      }
57
58      card_3
59      {
60          description = "proton + 7-n-14 apt la150 njoy99 mcnpx";
61      }
62  }
63
64  viewr
65  {
66      /* Documentation names the first two cards as card 1. Use card 0 to
            denote
67         the first card, just like in plotr.
68       */
69      card_0
70      {
71          input = 33;
72          output = 36;
73      }
74  }
75
76  /* The translator appends the 'stop' instruction, no neep to explicitly
77     declare it.
78   */
```

Expected NJOY Input Instructions for Test Problem 14

```
1   acer
2   20 21 0 31 32/ ### card_1
3   1 0 1/ ### card_2
4   'proton + 7-n-14 apt la150 njoy99 mcnpx'/ ### card_3
5   725 0/ ### card_5
6   / ### card_6
7   / ### card_7
8   acer
9   0 31 33 34 35/ ### card_1
10  7 1 2/ ### card_2
11  'proton + 7-n-14 apt la150 njoy99 mcnpx'/ ### card_3
12  viewr
13  33 36/ ### card_0
14  stop
```

B.14 Test Problem 17 (tp17)

NIF Version of Test Problem 17

```
reconr
{
    card_1
    {
        nendf = 21;
        npend = 41;
    }

    card_2
    {
        tlabel = "processing jendl-3.3 238u.";
    }

    card_3
    {
        mat = 9237;
        ncards = 0;
        ngrid = 0;
    }

    card_4
    {
        err = 0.001;
    }

    card_3
    {
        mat = 0;
    }
}

broadr
{
    card_1
    {
        nendf = 21;
        nin = 41;
        nout = 31;
    }

    card_2
    {
        mat1 = 9237;
        ntemp2 = 1;
        istart = 0;
        istrap = 0;
        temp1 = 0;
    }

    card_3
    {
        errthn = 0.001;
    }

    card_4
    {
        temp2[0] = 300.0;
```

```
    }

    card_5
    {
        mat1 = 0;
    }
}

reconr
{
    card_1
    {
        nendf = 22;
        npend = 42;
    }

    card_2
    {
        tlabel = "processing jendl-3.3 235u.";
    }

    card_3
    {
        mat = 9228;
        ncards = 0;
        ngrid = 0;
    }

    card_4
    {
        err = 0.001;
    }

    card_3
    {
        mat = 0;
    }
}

broadr
{
    card_1
    {
        nendf = 22;
        nin = 42;
        nout = 32;
    }

    card_2
    {
        mat1 = 9228;
        ntemp2 = 1;
        istart = 0;
        istrap = 0;
        temp1 = 0;
    }

```

```
115      card_3
116      {
117          errthn = 0.001;
118      }
119
120      card_4
121      {
122          temp2[0] = 300.0;
123      }
124
125      card_5
126      {
127          mat1 = 0;
128      }
129  }
130
131  reconr
132  {
133      card_1
134      {
135          nendf = 23;
136          npend = 43;
137      }
138
139      card_2
140      {
141          tlabel = "processing jendl-3.3 239pu.";
142      }
143
144      card_3
145      {
146          mat = 9437;
147          ncards = 0;
148          ngrid = 0;
149      }
150
151      card_4
152      {
153          err = 0.001;
154      }
155
156      card_3
157      {
158          mat = 0;
159      }
160  }
161
162  broadr
163  {
164      card_1
165      {
166          nendf = 23;
167          nin = 43;
168          nout = 33;
169      }
170
171      card_2
```

```
172     {
173         mat1 = 9437;
174         ntemp2 = 1;
175         istart = 0;
176         istrap = 0;
177         temp1 = 0;
178     }
179
180     card_3
181     {
182         errthn = 0.001;
183     }
184
185     card_4
186     {
187         temp2[0] = 300.0;
188     }
189
190     card_5
191     {
192         mat1 = 0;
193     }
194 }
195
196 groupr
197 {
198     card_1
199     {
200         nendf = 21;
201         npend = 31;
202         ngout1 = 0;
203         ngout2 = 91;
204     }
205
206     card_2
207     {
208         matb = 9237;
209         ign = 3;
210         igg = 0;
211         iwt = 6;
212         lord = 1;
213         ntemp = 1;
214         nsigz = 1;
215         iprint = 0;
216     }
217
218     card_3
219     {
220         title = "u-238";
221     }
222
223     card_4
224     {
225         temp[0] = 300.0;
226     }
227
228     card_5
```

```
229     {
230         sigz[0] = 1.0e10; // No trailing dots. Use C-style floats.
231     }
232
233     card_9
234     {
235         mfd = 3;
236         /* mtd and mtname does not have to be supplied? */
237     }
238
239     card_9
240     {
241         mfd = 3;
242         mtd = 251;
243         mtname = "mubar";
244     }
245
246     card_9
247     {
248         mfd = 3;
249         mtd = 252;
250         mtname = "xi";
251     }
252
253     card_9
254     {
255         mfd = 3;
256         mtd = 452;
257         mtname = "nu";
258     }
259
260     card_9
261     {
262         mfd = 3;
263         mtd = 455;
264         mtname = "nu";
265     }
266
267     card_9
268     {
269         mfd = 3;
270         mtd = 456;
271         mtname = "nu";
272     }
273
274     card_9
275     {
276         mfd = 5;
277         mtd = 18;
278         mtname = "xi";
279     }
280
281     /* Terminate temperature/material with mfd = 0 as usual. */
282     card_9
283     {
284         mfd = 0;
285     }
```

```
286
287     /* Terminate groupr run with matd = 0 as usual. */
288     card_10
289     {
290         matd = 0;
291     }
292 }
293
294 groupr
295 {
296     card_1
297     {
298         nendf = 22;
299         npend = 32;
300         ngout1 = 0;
301         ngout2 = 92;
302     }
303
304     card_2
305     {
306         matb = 9228;
307         ign = 3;
308         igg = 0;
309         iwt = 6;
310         lord = 1;
311         ntemp = 1;
312         nsigz = 1;
313         iprint = 0;
314     }
315
316     card_3
317     {
318         title = "u-235";
319     }
320
321     card_4
322     {
323         temp[0] = 300.0;
324     }
325
326     card_5
327     {
328         sigz[0] = 1.0e10; // No trailing dots. Use C-style floats.
329     }
330
331     card_9
332     {
333         mfd = 3;
334         /* mtd and mtname does not have to be supplied? */
335     }
336
337     /* Terminate temperature/material with mfd = 0 as usual. */
338     card_9
339     {
340         mfd = 0;
341     }
342
```

```
343      /* Terminate groupr run with matd = 0 as usual. */
344      card_10
345      {
346          matd = 0;
347      }
348  }
349
350  groupr
351  {
352      card_1
353      {
354          nendf = 23;
355          npend = 33;
356          ngout1 = 0;
357          ngout2 = 93;
358      }
359
360      card_2
361      {
362          matb = 9437;
363          ign = 3;
364          igg = 0;
365          iwt = 6;
366          lord = 1;
367          ntemp = 1;
368          nsigz = 1;
369          iprint = 0;
370      }
371
372      card_3
373      {
374          title = "pu-239";
375      }
376
377      card_4
378      {
379          temp[0] = 300.0;
380      }
381
382      card_5
383      {
384          sigz[0] = 1.0e10; // No trailing dots. Use C-style floats.
385      }
386
387      card_9
388      {
389          mfd = 3;
390          /* mtd and mtname does not have to be supplied? */
391      }
392
393      /* Terminate temperature/material with mfd = 0 as usual. */
394      card_9
395      {
396          mfd = 0;
397      }
398
399      /* Terminate groupr run with matd = 0 as usual. */
```

```
400       card_10
401       {
402           matd = 0;
403       }
404   }
405
406   moder
407   {
408       card_1
409       {
410           nin = 2;
411           nout = 99;
412       }
413
414       card_2
415       {
416           tpid = "merge u235, u-238 and pu-239";
417       }
418
419       card_3
420       {
421           nin = 92;
422           matd = 9228;
423       }
424
425       card_3
426       {
427           nin = 91;
428           matd = 9237;
429       }
430
431       card_3
432       {
433           nin = 93;
434           matd = 9437;
435       }
436
437       /* Terminate moder by setting nin = 0. */
438       card_3
439       {
440           nin = 0;
441       }
442   }
443
444   errorr
445   {
446       card_1
447       {
448           nendf = 21;
449           npend = 0;
450           ngout = 99;
451           nout = 26;
452           nin = 0;
453           nstan = 0;
454       }
455
456       card_2
```

```
457     {
458         matd = 9237;
459         ign = 3;
460         iwt = 6;
461         iprint = 1;
462     }
463
464     /* Test problem 17 is using a file of the endf-5 format (iverf = 5) */
465
466     card_7
467     {
468         iread = 2;
469         mfcov = 33;
470         irespr = 1;
471         legord = 1;
472         ifissp = -1;
473     }
474
475     card_10
476     {
477         mat1 = 9228;
478         mt1 = 18;
479     }
480
481     card_10
482     {
483         mat1 = 9437;
484         mt1 = 18;
485     }
486
487     card_10
488     {
489         mat1 = 0;
490     }
491 }
```

Expected NJOY Input Instructions for Test Problem 17

```
 1 reconr
 2 21 41/ ### card_1
 3 'processing jendl-3.3 238u.'/ ### card_2
 4 9237 0 0/ ### card_3
 5 0.001/ ### card_4
 6 0/ ### card_3
 7 broadr
 8 21 41 31/ ### card_1
 9 9237 1 0 0 0/ ### card_2
10 0.001/ ### card_3
11 300.0/ ### card_4
12 0/ ### card_5
13 reconr
14 22 42/ ### card_1
15 'processing jendl-3.3 235u.'/ ### card_2
16 9228 0 0/ ### card_3
17 0.001/ ### card_4
18 0/ ### card_3
```

```
broadr
22 42 32/ ### card_1
9228 1 0 0 0/ ### card_2
0.001/ ### card_3
300.0/ ### card_4
0/ ### card_5
reconr
23 43/ ### card_1
'processing jendl-3.3 239pu.'/ ### card_2
9437 0 0/ ### card_3
0.001/ ### card_4
0/ ### card_3
broadr
23 43 33/ ### card_1
9437 1 0 0 0/ ### card_2
0.001/ ### card_3
300.0/ ### card_4
0/ ### card_5
groupr
21 31 0 91/ ### card_1
9237 3 0 6 1 1 1 0/ ### card_2
'u-238'/ ### card_3
300.0/ ### card_4
1.0e10/ ### card_5
3/ ### card_9
3 251 'mubar'/ ### card_9
3 252 'xi'/ ### card_9
3 452 'nu'/ ### card_9
3 455 'nu'/ ### card_9
3 456 'nu'/ ### card_9
5 18 'xi'/ ### card_9
0/ ### card_9
0/ ### card_10
groupr
22 32 0 92/ ### card_1
9228 3 0 6 1 1 1 0/ ### card_2
'u-235'/ ### card_3
300.0/ ### card_4
1.0e10/ ### card_5
3/ ### card_9
0/ ### card_9
0/ ### card_10
groupr
23 33 0 93/ ### card_1
9437 3 0 6 1 1 1 0/ ### card_2
'pu-239'/ ### card_3
300.0/ ### card_4
1.0e10/ ### card_5
3/ ### card_9
0/ ### card_9
0/ ### card_10
moder
2 99/ ### card_1
'merge u235, u-238 and pu-239'/ ### card_2
92 9228/ ### card_3
91 9237/ ### card_3
93 9437/ ### card_3
```

```
0/ ### card_3
errorr
21 0 99 26 0 0/ ### card_1
9237 3 6 1/ ### card_2
2 33 1 1 -1/ ### card_7
9228 18/ ### card_10
9437 18/ ### card_10
0/ ### card_10
stop
```