

NSLINK

Preparing AMPX MASTER (SCALE) library from NJOY output

P.F.A. de Leege

Delft University of Technology

Interfaculty Reactor Institute

Reactor Physics Department

Mekelweg 15

2629 JB Delft

The Netherlands

December 1993

ABSTRACT

The INAS code system (IRI-NJOY-AMPX-SCALE) is a large system of nuclear data bases and computer programs for reactor physics computations used at the Interfaculty Reactor Institute (IRI) at the Delft University of Technology. NSLINK (NJOY-SCALE-LINK) is part of the INAS code system. It is a computer code to convert the data in GENDF format from the NJOY code into SCALE-4 AMPX MASTER format, retaining the Nordheim resolved resonance treatment option. Reich-Moore resonance parameters are converted to multi-level Breit-Wigner resonance parameters. The AMPX MASTER library is the basic library in the SCALE code system.

1. Introduction

The INAS code system (IRI-NJOY-AMPX-SCALE) is a large system of FORTRAN 77 programs and nuclear data bases for reactor physics computations, see figure 1. Most of the codes originate from the Oak Ridge National Laboratory (ORNL) AMPX [1] and SCALE [2] code packages, and were adapted to run under the VAX/VMS operating system on a VAX cluster computer system. SCALE is a well-known code system, well documented, and widely used and accepted. It includes modules for resonance, cell, Monte-Carlo, shielding, and depletion calculations. The basic library in the SCALE code system is the AMPX MASTER library. This is a fine-group structured data library including resonance parameters, one- and two-dimensional cross sections for neutron and gamma reaction types, and some general information. The library can be generated from ENDF/B, JEF or JENDL evaluated data files using the NJOY [3] cross section processing code. The fine-group structured output data from NJOY can be converted to AMPX MASTER library format with the interface program NSLINK (NJOY-SCALE-LINK).

2. Overview of the code

NSLINK is an extensively revised version of the original MILER [4] code. The Netherlands Energy Research Foundation (ECN), in Petten, The Netherlands, contributed to the revision of MILER and tested the present version 4.1 of the code as well. ECN makes use of NSLINK in the PASC (PETTEN-AMPX-SCALE) code system. The 4.1 version of the code is also used to update the AMPX MASTER library at AECL Research in Pinawa, Canada.

NSLINK version 3.0 can be used to generate AMPX MASTER libraries for the obsolete SCALE-3 [5] code system. This version is distributed via NEA DATA BANK, Paris, France and RSIC, Oak Ridge, USA.

NSLINK version 4.0 can be used to generate AMPX MASTER libraries for the SCALE-4 code system. Due to an other representation of the resolved resonance data in the AMPX MASTER library version 4, NSLINK version 4.0 is much simpler than version 3.0. However, the 4.0 version of the code is not distributed. NSLINK version 4.1 includes necessary updates to use ENDF-6 formats and output of the NJOY code version 91. NSLINK version 4.1 will be distributed soon.

3. Functionality of the code

The following overview is a summary of the functionality and adaptations from MILER to the NSLINK version 4.1 code:

- [1] Thermal scattering matrices for different temperatures as generated by NJOY can be included in the library.
 - [2] Bondarenko factors can be generated from NJOY output.
 - [3] 'Nordheim' resolved resonance parameters can be included in the library. The Breit-Wigner parameters are read from the evaluated data files as JEF, ENDF/B or JENDL.
 - [4] The fission matrix available in the GENDF output file of NJOY is converted to a fission spectrum, which can be used in the SCALE code system. Until NJOY89, a full fission matrix was given in the GENDF file. To reduce the size of the fission matrix, this matrix is split into 3 parts: a spectrum part, a production part, and a matrix part. This is done by
-

version 91 of the NJOY code. NSLINK can read and convert fission matrices to fission spectra from the NJOY89 and NJOY91 code version as well.

- [5] In the ENDF-6 format of the evaluated data files, the Reich-Moore (RM) representation of the resolved resonance parameters is used for some structural materials and actinides. The Nordheim resonance treatment can only be used with Breit-Wigner (BW) resolved resonance parameters. NSLINK converts RM parameters to BW parameters for actinides only (developed by ECN, Petten [6]).
- [6] A nuclide or a material with scattering or absorption cross sections only can be processed properly.
- [7] The (n,2n) cross section of a nuclide is recognized by the SCALE code system and by most other post processing codes properly, if reaction type MT=16 is used as identification. In the JEF 1.1 library, the reaction types MT=6,7,8,9, and 46,47,48,49 are used for the (n,2n) cross sections. Reaction types MT=51 until 83 are used for the (n,2n) cross sections in the JEF 2.2 library. A patch in the NJOY code was needed to process the (n,2n) cross sections from JEF 2.2! NSLINK version 4.1 converts these (n,2n) cross sections from both JEF 1.1 and JEF 2.2 to reaction type MT=16. In the ENDF/B-VI library, reaction type MT=16 is used for the (n,2n) cross section. In future format specifications of ENDF, only reaction type MT=16 is allowed for the (n,2n) cross section.
- [8] Some small errors in NJOY and evaluation problems (zero values for some levels) are circumvented in NSLINK.
- [9] Reaction types available in the GENDF output file of NJOY, but not used in the SCALE code system and/or other post processing codes at present, are removed.

Restrictions:

- [1] Gamma production and/or photon interaction data cannot be processed correctly yet.
- [2] Consistency of redundant cross sections is not tested. The RADE module of the AMPX code package can be used.
- [3] BCD (ASCII) format of the GENDF output file of NJOY can be processed at present.

4. Benchmarking

Validation and verification of nuclear data and code package that are used for reactor physics calculations are a continuous care of our group. A number of standard criticality PWR and BWR reactor benchmarks are carried out to validate our AMPX MASTER libraries (XMAS structure, 172 groups). These libraries are generated from the JEF 1.1 and JEF 2.2 library as well. The reactor benchmarks are partly done in cooperation with other Dutch institutes (ECN at Petten, GKN at Dodewaard, and KEMA at Arnhem, The Netherlands).

5. Conclusions

The NSLINK version 4.1 is a powerful code to generate cross section libraries in AMPX MASTER format as used in the SCALE-4 code system. Bondarenko factors and/or Nordheim resonance parameters can be included in the library. ENDF formats 3, 4, 5, and 6 can be read as well. Reich-Moore resonance parameters are converted to Breit-Wigner resonance parameters for the actinides only. Fission spectra can be generated from NJOY89 and

NJOY91 output as well. The option to process gamma production and/or photon interaction data, and GENDF output from NJOY in binary format, will be made operational in the NSLINK code.

References

- [1] N.M. Greene et al. AMPX - A Modular Code System for Generating Coupled Multi-group Neutron Gamma libraries from ENDF/B, (March 1976). Revised to level of AMPX II, ORNL/TM-3706 (December 1978).
 - [2] SCALE-4 - A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation, CCC-545 (February 1990).
 - [3] R.E. MacFarlane and D.W. Muir, NJOY87 - A Code System for Producing Pointwise and Multigroup Neutron and Photon Cross Sections from ENDF/B Evaluated Nuclear Data, PSR-171 (November 1987).
 - [4] G.C. Panini, MILER - Master Interface Library maker, abstract NEA 1198 (July 1988).
 - [5] SCALE-3.1 - A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation, CCC-466 (March 1985; July 1986).
 - [6] R.C.L. van der Stad, C. Chonghai and H. Gruppelaar, Generation of a 219-group neutron cross-section library based upon JEF2.2 for actinides and long-lived fission products. ECN Petten, Contribution to the seminar on NJOY91 and THEMIS (April 1992).
-

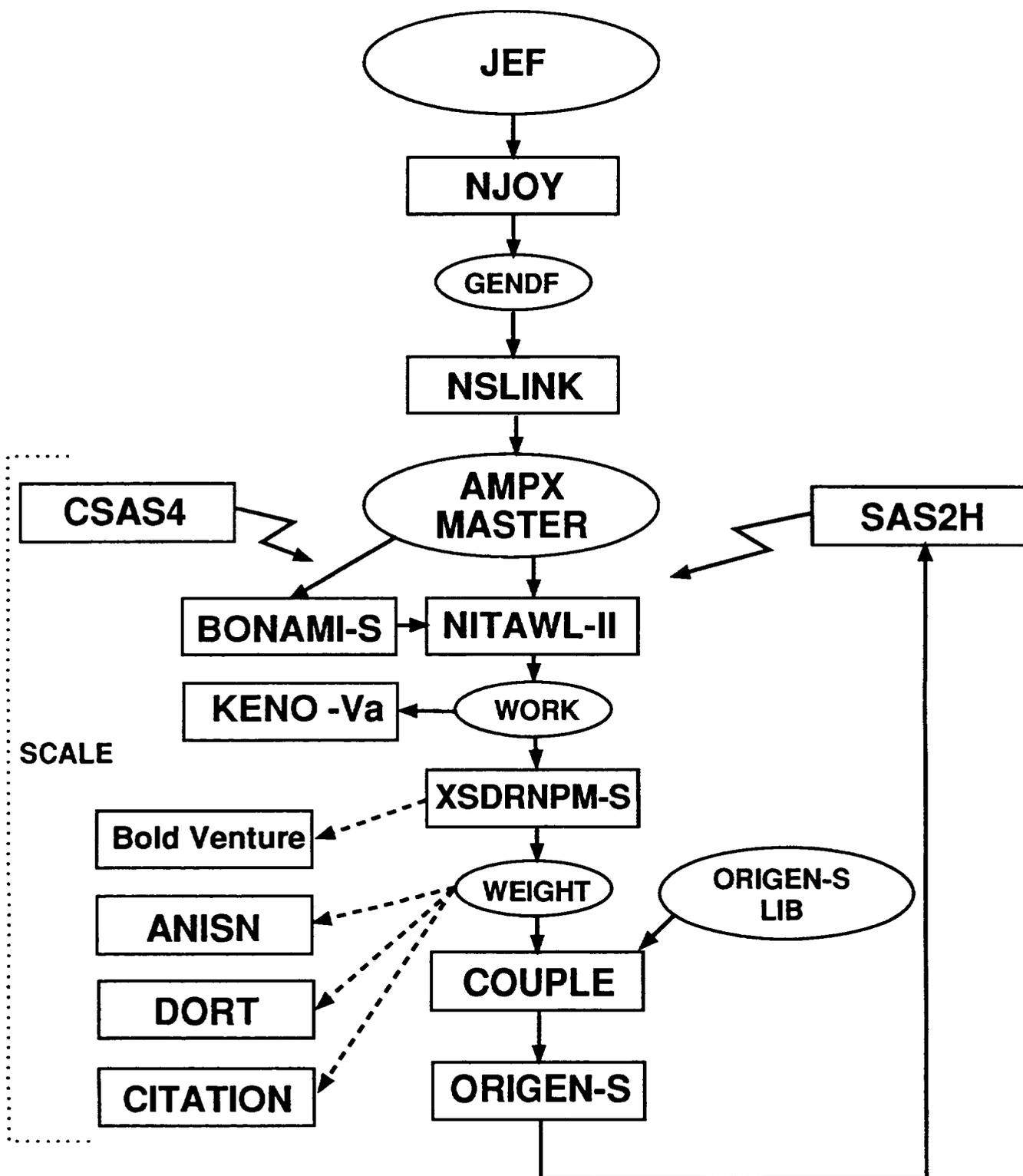


Fig. 1. Overview of the INAS code package