WIMS-AECL Practice

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Canada

AECL Atomic Energy of Canada Limited

EACL Énergie atomique du Canada limitée

Outline

- Running the code
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  - Nuclear data libraries
  - Environment variables
  - Interfaces
- Input data file
  - Free format data
  - Prelude data group
  - Main data group
    - Geometry, material composition, control data, group condensation, burnup, interface control
  - Edit data group
- Output data file

Code Versions

- **WIMS-AECL Release 2-5d (IST – Industry Standard Toolset)**
  - Validated for CANDU applications
  - CVR bias (CANDU) ~ 1.6 to 2.0 mk
  - Deficiencies in calculation of tight pitch H_20-cooled lattices
- **WIMS-AECL Release 2-6a (ACR specific version)**
  - Improvements to resonance self-shielding calculations
    - 2D calculation of fuel-to-fuel collision probability
    - Library tables of resonance flux integrals
    - Temperature dependent parameter of IR approximation
  - Restrictions
    - PC only
    - Cluster model only
    - New-type libraries

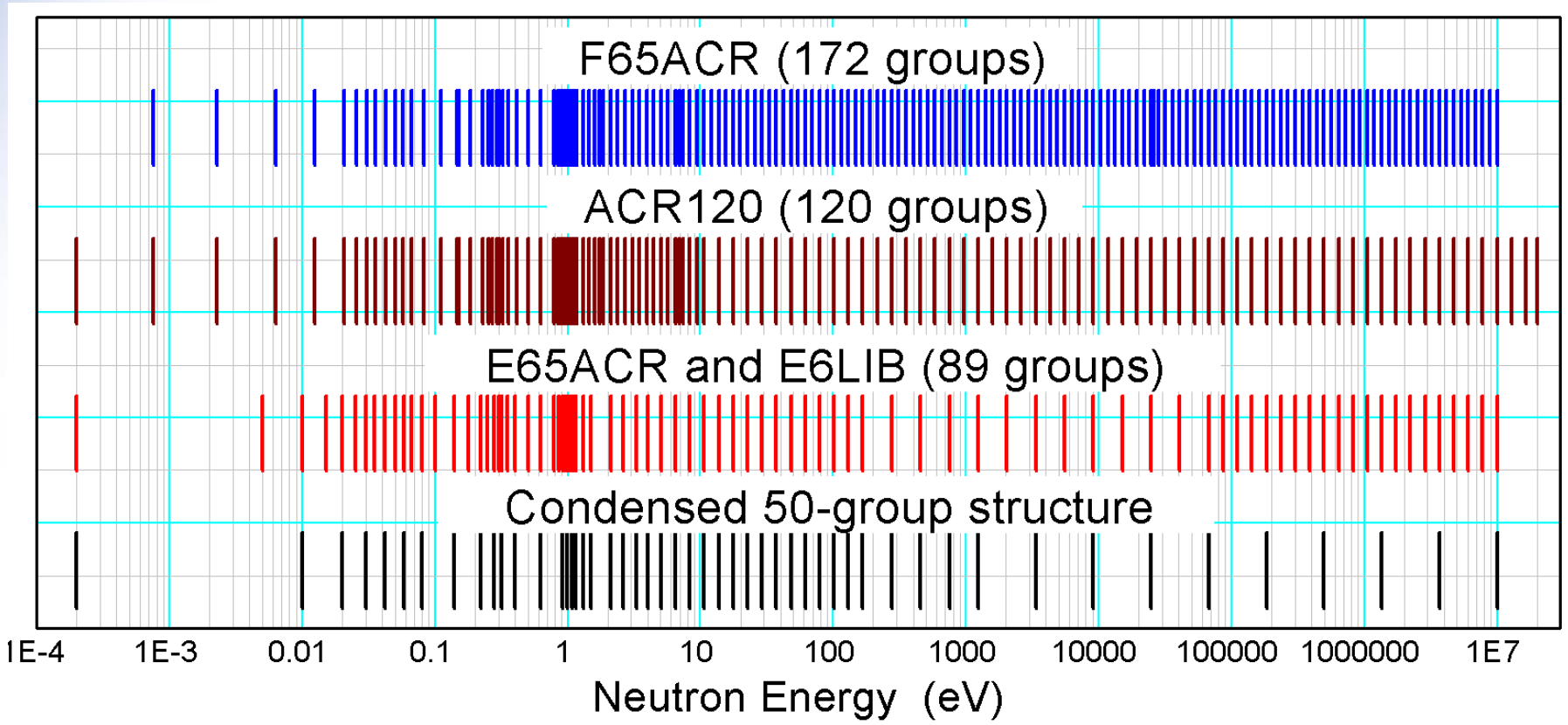
Nuclear Data Libraries

- E5LIB – 89 groups, ENDF/B-V
- E6LIB – 89 groups, ENDF/B-VI Release 2
- E65LIB1 – 89 groups, ENDF/B-VI Release 5
- F65LIB1 – 172 groups, ENDF/B-VI Release 5

ACR-specific libraries (weighting function, self-shielding)

- E65ACR – 89 groups, ENDF/B-VI Release 5
  - E65ACR.sdb : all nuclides, typical spectrum
  - E65ACR-rw.sdb : selected nuclides, self-shielded, 'resonance weight func'
- ACR120 – 120 groups, ENDF/B-VI Release 5
- F65ACR – 172 groups, ENDF/B-VI Release 5
  - F65LIB1.sdb : all nuclides, CANDU spectrum
  - F65ACR.sdb : selected nuclides, self-shielded, ACR spectrum

Group Structure



Running the Code

- **Batch file wims26a.bat**

```
set WLIBKI35=c:\wims\lib\wimsaecl.kic                    Bickley functions
set   WLIBIDX=c:\wims\lib\e65acr.idx                     Library index file
set WLIBLIST=c:\wims\lib\e65acr-rw.sdb;c:\wims\lib\e65acr.sdb   Library data file(s)

c:\wims\wims26a I=%1.inp >%1.out                         Run the code

rename tape16 %1.t16                                     Rename interface file tape16
del wwwwtrk                                              Delete garbage
del xsdb.log
del ~ResTracks

set WLIBIDX=                                             Release environment  variables
set WLIBKI35=
set WLIBLIST=
```

- **DOS command**

c:\…\wims26a *InputFileName*

Interface files

- **TAPE16 – Unformatted binary file**
  - Used to transfer WIMS results to other application
  - Six basic blocks of data
  - One block is always written, the others are user controlled
- **TAPE50 – Fortran random-access file**
  - Restart file convenient for perturbation cases
  - File contents under user control
- **TAPE7 – ASCII file**
  - Composition of burnable materials
  - Convenient to use material data in other WIMS input files
- **MATLIB – ASCII file**
  - Prepared by the user and contain material specifications

Input Data File

- **Free-format data**
  - ASCII 132-column file
  - Records: *KeyWord* (parameter list)
  - Number of keywords: 22 (prelude) + 66 (main) + 25 (edit)
    supported: 13 + 58 + 19
  - Maximum number of items on a record: 1000
- **Continuation mark: $**
- **Comment mark: ***
- **Delimiters: blank, comma, equal sign**

Prelude Data

- **TITLE** – Specify case title, string of up to 128 characters
- **PRELUDE** – Used for multiple case input
- **SEQUENCE** – Main transport solution method (**PIJ**, PER, DSN)
- **CELL** – Lattice cell type in resonance self-shielding (HOMO, PINC, CPIN, **CLUS**, PART)
- **NDAS** – New Data Access System
- **SCAN** – Determine the problem size
- **SETS** – Specify the number of tracking lines sets
- **PREOUT** – Indicate the end of Prelude data
- **NOPRINT** – Suppress all printing
- **NRODS** – Define Pij calculation

NRODS Card

NRODS n_1 n_2 n_3 n_4 n_5 n_6 n_7 n_8

- n_1 – Number of rods in the cell
- n_2 – Cell symmetry index (n2 > 0, periodic; n2 < 0 symmetric)
- n_3 – Number of integration lines
- n_4 – Number of integration angles
- n_5 – Number of rod arrays (default 5)
- n_6 – Maximum number of rod subdivisions (default 5)
- n_7 – Maximum number of rod sectors (default 2)
- n_8 – Maximum number of annuli sectors (default 1)

An Example of Prelude Data

```
PRELUDE
Title "A simple 2D ACR lattice cell model"
CELL cluster
SEQUENCE Pij
SCAN
NDAS
NRODS   43 -2   310 11   4   3   2   1
PREOUT
```

Main Data: Geometry

- **ANNULUS # r_1 (a r_2)**
- **POLYGON # n_1 a r_1 r_2 (a r_2)**
- **ARRAY # 1 n_2 r_1 r_2**
- **RODSUB # # r_1 (a r_2)**
- **NPIJAN #**
- **SYMMETRY n r_1 r_2**
- **SYMANGLE**
- **MESH #**

ACR Lattice Cell

An Example of Geometry Data

Annular Mesh Refinement

Azimuthal Mesh Refinement

Cylindrical Cell Boundary Model

The “Best” Model

Recommended Practical ACR Model

2D Numerical Integration by Ray Tracing

Main Data: Material Composition

- **MATERIAL** a_1 r_1 r_2 a_2 (a_3 r_3)
- **WATER** a_1 r_1 r_2 a_2 a_3 r_3
- **MIXTURE** a_0 a_1 r_1 a_2 r_2 (a_3 r_3) r_4 a_4
- **DENSITY** (a r)
- **TEMPERATURE** (a r)
- **WTEMPERATURE** (a r)
- **MATLIB** a_1 a_2
- **READ** n
- **WRITE** n
- **INCLUDE** a

An Example of Material Data

Main Data: Control Parameters

- **FEWGROUPS** (n)
- **NEWRES**
- **SUPPRESS** (n)
- **POWER** n_1 r_1 r_2 n_2 r_3 n_3 (a)
- **NOBURNUP** (a)
- **BUCKLING** (r_1 r_2 r_3 r_4)
- **DBSQUARED** i (r_1) (r_2) (n)
- **PCELL** n (r)
- **TOLERANCE** r
- **TRUNCATE** r

Edit Data

- **BEEONE** n
- **BENOIST** n
- **BUCKLING** r_1 r_2
- **LEAKAGE** n
- **PARTITION** (n)
- **REACTION** (a r)
- **ENDCAP** a r_1 r_2 r_3 r_4
- **CELLAV**
- **NORMALIZE** a
- **PRINT** n_1 n_2 n_3 n_4 n_5 n_6

An Example of Control and Edit Data

```
   TOLERANCE 1E-6
   NEWRES
   SUPPRESS  1 1 1 1 1 1 1 1 1 1 1 0 1 0 1 -1
   POWER 1  34.19  1  1   0.00001
BEGIN
   * Edit data
   BENOIST  1
   BEEONE   1
   BUCKLING 1.075061E-04  8.204787E-05
   LEAKAGE -6
BEGIN
   POWER 1  34.19  1  1
BEGIN
BEGIN
```

A Typical Burnup Calculation

Coolant Void Reactivity Calculation

Fuel Temperature Coefficient


AECL
EACL