

WIMSBUILDER

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1. Program Name and Title

WIMSBUILDER – a tool to generate input for the thermal reactor neutronics code WIMS8.

2. Computer for Which Program is designed

UNIX workstations and Windows 9X/NT PCs.

3. Problem Solved

The input requirements for some of the applications of the thermal reactor neutronics code WIMS8 can be demanding to set up. The code is both powerful and flexible enabling a wide range of thermal reactor calculations to be performed. However, for standard calculations there would be some benefit to be gained from a simple user interface, where the major choices concerning module sequence and selected data items are provided for the user. This would leave the user with the much simpler task of specifying basic geometrical, material and operational data. The provision of sensible defaults and the ability to select from pre-checked libraries of such data would further aid the WIMS user. WIMSBUILDER is a package designed to achieve these objectives and provide the user with a framework for easily setting up WIMS models and performing sequences of calculations.

4. Method of Solution

The aim is for WIMSBUILDER to provide a menu of basic application options for the user to select from, for example PWR, BWR, VVER, AGR. However, in this first version, single assembly PWR and VVER options have been provided to demonstrate the capabilities of the package at an early stage. Development of the program is continuing. A version for generating input data for WIMS for PWR supercells (2 x 2 assemblies) is under test.

A typical application of WIMSBUILDER is the generation of few-group macroscopic cross section data for use in the whole reactor code PANTHER. For each distinct type of fuel element, WIMS is asked to perform say 30 burnup cycles through about a dozen code modules.

In addition, at most of these cycles, cross section data are created for up to 20 variants of the standard operating conditions, e.g. temperature changes, coolant density changes, the decay of Xe135 due to a shut-down, or the insertion of control rods, making in all about 600 cycles of input to WIMS.

WIMSBUILDER is an interactive program, which prompts the user to give the names of data files which will be used in the calculation. Some of these files will be provided with the WIMSBUILDER package and can be used unaltered. Others will be created or modified locally for the particular application being modelled and several variants may exist from which the user will be invited to make a selection.

For the PWR single element option, the user must specify individual files containing the following model data:

Element Geometry - i.e. the pin pitch, the thickness of any water gap around the element, and a 'map' showing the layout of pin types in the element. Any pin type which will be changed when control rods are inserted as a variant or branch is also specified here. An example is now given:

```
TITLE PWR 17 X 17 LAYOUT, WITH WATERGAP, WITH G => H WHEN \  
CONTROL RODS ARE INSERTED
```

```
NPIN 17
```

```
PINPITCH 1.26535
```

```
WATERGAP 0.042
```

```
MAP * (19 X 19, including water gap if present)
```

```
W W W W W W W W W W W W W W W W W W W W W W W  
W F F F F F F F F F F F F F F F F F F F F F W  
W F F F F F F F F F F F F F F F F F F F F F W  
W F F F F F G F F G F F G F F F F F F F F F W  
W F F F G F F F F F F F F F F F G F F F F W  
W F F F F F F F F F F F F F F F F F F F F W  
W F F G F F G F F G F F G F F G F F G F F W  
W F F F F F F F F F F F F F F F F F F F F W  
W F F F F F F F F F F F F F F F F F F F F W  
W F F G F F G F F I F F G F F G F F G F F W  
W F F F F F F F F F F F F F F F F F F F F W  
W F F G F F G F F G F F G F F G F F G F F W  
W F F F F F F F F F F F F F F F F F F F F W  
W F F F G F F F F F F F F F F G F F F F W  
W F F F F F G F F G F F G F F F F F F F F W  
W F F F F F F F F F F F F F F F F F F F F W  
W F F F F F F F F F F F F F F F F F F F F W  
W W W W W W W W W W W W W W W W W W W W W W
```

```
REPLACE G H  
END
```

Pin Description - for each distinct pin type, a pin type file giving the compositions of the various materials used to model the pin, together with their densities and temperatures (which may be keywords if these are likely to vary from cycle to cycle), and the radii and materials of the annuli which constitute the pin type. An example is given, in which items which are such keywords are in bold text:

```
TITLE PWR FUEL PIN
FUEL MATERIAL 1
    SPECIAL URANIUM U235 UENRICHMENT
    DENSITY FUELDENS
    TEMP FUELTEMP
    COMPOSITION U 100.0

CLAD MATERIAL 2
    DENSITY 5.755
    TEMP CLADTEMP
    COMPOSITION Zr 100.0

CLAD MATERIAL 3 *annulus to represent pin grids
    DENSITY 7.08208
    TEMP CLADTEMP
    COMPOSITION Ni 59.4 Cr 20.3 Fe 20.3

COOLANT MATERIAL 4
    DENSITY COOLDENS
    TEMP COOLTEMP
    COMPOSITION H 11.19      O 88.81      B BORONPC

ANNULUS 1 RADIUS 0.4095      MATERIAL 1
ANNULUS 2 RADIUS 0.475      MATERIAL 2
ANNULUS 3 RADIUS 0.476638  MATERIAL 3
ANNULUS 4                      MATERIAL 4
END
```

Branch Data - details of the required sets of variants or branches, e.g. rods in/out, temperature changes. Combinations may be specified, simply by placing several keywords and their values on the same line. A default 'no branches' file is provided for simpler calculations.

Operating Conditions - a list of keywords and their values, e.g. temperatures and densities, which will be used for the main sequence of calculations. Some of these keywords will be default values supplied with the WIMSBUILDER package for the application; others will be keywords used in the Element Geometry or Pin Description files.

Irradiation Sequence - the 'irradiation' file, giving details of the irradiation time and power level at each burnup step.

Calculation Route - a description of the sequence of WIMS modules to be used, and the input options. A Calculation Route file for each application is supplied with the WIMSBUILDER package and for standard applications the appropriate file need not be changed.

5. Restrictions on the Complexity of the Problem

Principally those imposed by the hardware and/or operating system.

The PWR single assembly option will generate input for any PWR single assembly. The VVER option handles a 60 degree cyclic sector, which may be part of a VVER assembly, or part of, say, a zero energy hexagonal geometry reactor.

6. Typical Running Time

A small number of minutes to set up a complex sequence of WIMS calculations.

7. Unusual Features of the Program

WIMSBUILDER is coded mainly in FORTRAN 90, but makes use of the UNIX languages SH, M4 and AWK, or ports of these to PCs provided by the Free Software Foundation (GNU).

The user supplies a prototype 'route' file for WIMS8A, in which items of input data (which may cover many lines) have been replaced by keywords, e.g. 'MATERIALS', 'POWERMAP'. WIMSBUILDER uses the simple element geometry, pin geometry and material specification files to generate M4 macro definitions of these keywords.

Associated with the 'route' file is a 'spec' file containing a list of keywords which are place holders for values which may change in branch or variant calculations, e.g. 'FUELTEMP', 'COOLDENS'. The keywords may have minimum and maximum values associated with them, or an enumerated list of legal values. This list is converted by a AWK language program into another AWK language program which will be used to replace the keywords by the corresponding values, as the input for WIMS is generated, cycle by cycle.

WIMSBUILDER does not use a Graphical User Interface. This was considered, but as experience has grown in using the tool, it was found that users tended to use the interactive mode once, to specify the set of files to be used in the tool, and thereafter used a list of these files, called a "defaults file", and which is editable, as the input.

WIMSBUILDER can, optionally, generate a simple colour Postscript file, to enable the user to check that the element geometry is correct.

8. Related and Auxiliary Programs

WIMS - A General Purpose Neutronics Code (Version 8A)

9. Status

WIMSBUILDER1A – Issued August 1999

10. References

Available from the ANSWERS Software Service, AEA Technology

11. Hardware Requirements

Any UNIX workstation or Windows 9X/NT PC. Core image of the program is ~2.5MB.

12. Programming Languages

FORTRAN 90 (98.766%), Bourne Shell (0.167%), AWK (0.967%), M4 (0.100%)

13. Operating Systems

UNIX (Sun Microsystems SOLARIS 2.6, Hewlett-Packard HP-UX 10.20, DEC OSF1).
PC (Windows 9X/NT).

14. Other Programming or Operating Information or Restrictions

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15. Name and Affiliation of Author or Contributor

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16. Material Available

The executable of WIMSBUILDER, and for both PWR and VVER options, sets of typical inputs, e.g. geometry descriptions, pin descriptions, irradiation files, branch specifications, and WIMS route files. The AWK, M4 and SH language support routines. For the PC port, the Free Software Foundation versions of AWK, M4, SH, etc.

17. Category

Category L – Data Preparation.

18. Sponsor

The ANSWERS Software Service of AEA Technology Nuclear Science.