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How to use Non-Default Nuclear Data Files with MCNP

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LA-UR-25-XXXXX

Nuclear Data Files used by MCNP = ACE Files

- **ACE** stands for **A** Compact **E**NDF file
- Helpful ACE format resources:
  (1) A Compact ENDF (ACE) Format Specification (LA-UR-19-29016) (Not Complete)
  (2) How to Read ACE File presentation by K. Tada (JAEA) (link)
- ACE format consists of 2 types and 15 classes of data:
- Type 1: Standard formatted tables containing American Standard Code for Information Interchange (ASCII) text. Machine independent.
- Type 2: Standard unformatted binary tables. Faster to read, BUT machine/platform dependent.
- Data Classes:

Table B.1: MCNP6 Data Classes

	Class description	ZAID suffix
1	S(α,β) data tables	t
2	Continuous-energy neutron data libraries	c
3	Discrete-energy neutron data libraries	d
4	Coupled neutron-photon data multigroup library—neutron	m
5	Coupled neutron-photon data multigroup library—photon	g
6	Photoatomic data libraries	p
7	Photonuclear data libraries	u
8	Dosimetry data libraries	y
9	Electron data libraries	e
10	Proton data libraries	h
11	Photoatomic data libraries with atomic relaxation data	p
12	Deuteron data libraries	o
13	Triton data libraries	r
14	Helion data libraries	s
15	Alpha data libraries	a

Use the Nuclear Data Package Manager

- Download and install nuclear data with Nuclear Data Package Manager (mcnp630/MCNP_DATA/nd_manager) – I am using MCNP Version 6.3.0 (mcnp630)
- The Nuclear Data Package Manager is also able to uninstall nuclear data and create an XSDIR data directory file
- MCNP_DATA folder contents could include the following nuclear data:

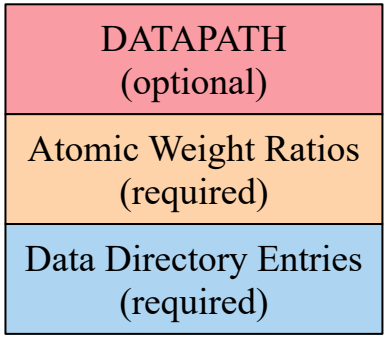
100xs	background_v4.dat	el03	gamman.tbl	newxsd
531dos	barpol.dat	endf5mt	gdr.dat	pace2.data
532dos	barpol2001.dat	endf5p	kcksyst.dat	pelxs.dat
CP2011	bert.dat	endf5u	kidman	pht.dat
CP2020	cgmf	endf60	la150h	ripl-3.dat
DBRC_endf71.txt	cgmf-1.1	endf62mt	la150n	rmccs
DBRC_endf80.txt	channel1.tab	endf66	la150u	rmccsa
ENDF71SaB	cinder.dat	endf6dn	level.tbl	sab2002
ENDF80SaB2	cindergl.dat	endf70	llldos	shell.tbl
ISC_DATA-2.1	cindergl_v1.dat	endf70prot	mass.tbl	skymap.dat
LAQGSM_Atab.dat	database	endf70sab	mcplib	t16_2003
Lib80x	delay_library.dat	endf71x	mcplib02	therxs
actia	delay_library_v2.dat	endf7u	mcplib03	tmccs
actib	delay_library_v3.dat	endl92	mcplib04	uresa
atab.dat	delay_library_v4.dat	endl92fp	mcplib63	vgsld.tab
background	delay_library_v5.dat	eprdata12	mcplib84	xsdir
background.dat	docs	eprdata14	mgxsnp	xsdir_all
background_v1.dat	dre5	flalpha.tab	misc5xs	xsdir_mcnp6.1
background_v2.dat	drmccs	freya	mollnix.tbl	xsdir_mcnp6.2
background_v3.dat	el	frldm.tab	newxs	xsdir_mcnp6.3

ENDF/B-VII.1 ENDF/B-VIII.0 MCNP 6.3.0 XSDIR

- Additional library information can be found on LANL Materials and Physical Data (XCP-5) Nuclear Data Team Website (https://nucleardata.lanl.gov/)

XSDIR Data Directory File Information

- What is an XSDIR? Useful information: Appendix B XSDIR Data Directory File in the MCNP® Code Version 6.3.0 Theory & User Manual (LA-UR-22-30006)
- Structure:



- Data directory entries could point to various libraries – the ordering of the data directory entries matters
- Inside of an XSDIR – Looking at data directory entries for the ENDF/B-VIII.0 nuclear data library (Lib80x):

```
# Library: Lib80x
1001.00c 0.999167 Lib80x/H/1001.800nc 0 1 3 10257 0 0 2.530100E-08
1001.01c 0.999167 Lib80x/H/1001.801nc 0 1 3 10257 0 0 5.170400E-08
1001.02c 0.999167 Lib80x/H/1001.802nc 0 1 3 10257 0 0 7.755600E-08
1001.03c 0.999167 Lib80x/H/1001.803nc 0 1 3 10257 0 0 1.034100E-07
1001.04c 0.999167 Lib80x/H/1001.804nc 0 1 3 10257 0 0 2.154300E-07
1001.05c 0.999167 Lib80x/H/1001.805nc 0 1 3 10257 0 0 8.617400E-12
1001.06c 0.999167 Lib80x/H/1001.806nc 0 1 3 10257 0 0 2.154300E-08
1002.00c 1.996800 Lib80x/H/1002.800nc 0 1 3 43756 0 0 2.530100E-08
1002.01c 1.996800 Lib80x/H/1002.801nc 0 1 3 43922 0 0 5.170400E-08
1002.02c 1.996800 Lib80x/H/1002.802nc 0 1 3 43987 0 0 7.755600E-08
1002.03c 1.996800 Lib80x/H/1002.803nc 0 1 3 44076 0 0 1.034100E-07
```

XSDIR Data Directory Entries

- Example data directory entry for ENDF/B-VIII.0 (Lib80x) ^{239}Pu:

94239.00c 236.998600 Lib80x/Pu/94239.800nc 0 1 3 1039943 0 0 2.530100E-08 ptable
(1) **(2)** **(3)** **(4)** **(5)** **(6)** **(7)** **(8)** **(9)** **(10)** **(11)**

(1) Table Name – Prefix: ZAID (ZAID $= Z * 1000 + A + S * 400$), Suffix: .XX + Data Class ("c" = continuous-energy neutron data library) – Z: atomic number, A: mass number, S: excited state
(2) Atomic Weight Ratio – atomic mass divided by mass of a neutron
(3) File Name – file name includes path to file from DATAPATH
(4) Access Route – string < 70 characters that tells how to access the file if not already accessible, 0 for no access route
(5) File Type – 1 for Type 1, 2 for Type 2
(6) Address – line number in the ACE file where the table begins (1 for "old-style" Header, 4 for 2.0.0 Header, 3 for 2.0.1 Header)
(7) Table Length – ACE files have 2 major blocks: (1) collection of pointers/counters/character information and (2) sequence of numbers – this is the length of the second block
(8) Record Length – 0 for Type 1 files, compiler-dependent attribute for Type 2 files
(9) Number of Entries per Record – 0 for Type 1 files, usually set to 512 for Type 2 files
(10) Temperature (MeV) – entry only used for neutron data
(11) Probability Table Flag – does the continuous-energy neutron nuclide have unresolved resonance range probability tables? If yes, include "ptable"

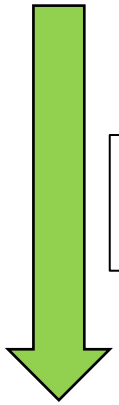
Methods to Specify Nuclear Data

(1) Replace Input File Material Card ZAID Suffix

(2) Manipulate XSDIR Data Directory Entry

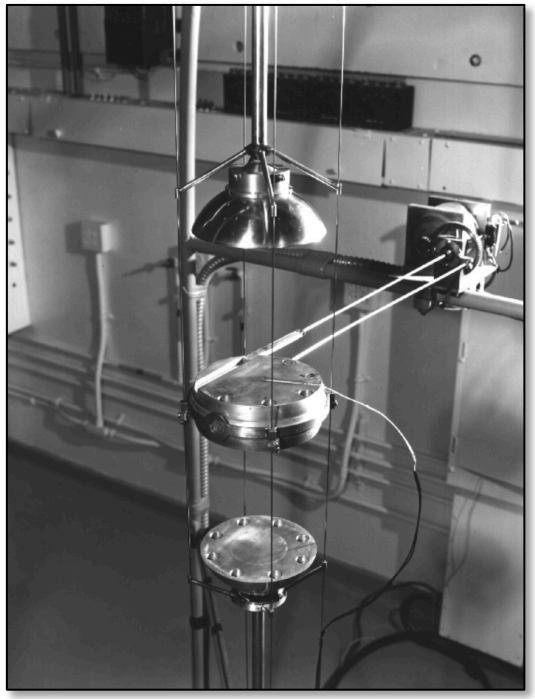
(3) Use the XSn Card in an Input File

Challenge: Modify an ACE file with ACEtk and Use the XSn Card



Increasing Level of Difficulty

- In these examples, we'll be using the simplified Jezebel benchmark (J. Favorite) included in the International Handbook of Evaluated Criticality Safety Benchmark Experiments



New (2021) Simplified Model, Table 57

This input uses 50 settle cycles, 1000 active cycles, and 2,400,000 neutrons per cycle. ENDF/B-VIII.0 cross sections are specified.

```
Pu239 Jezebel 17,065.5 g Pu-alloy (4.5 at% 240Pu, 1.02 wt% Ga)
1   94    0.0402901      -1     imp:n=1
2    0                    1     imp:n=0

1     so      6.39061

mode      n
rand gen=2 seed=2901000001
prdmp j 500
kcode 2400000 1.0 50 1050
totnu
sdef pos=0. 0. 0. rad=d1 erg=d2
si1 0.   6.39061
sp1 -21 2
sp2  -3   0.966   2.842
m94    94239.00c 3.7047E-02
       94240.00c 1.7512E-03
       94241.00c 1.1674E-04
       31069.00c 8.2663E-04
       31071.00c 5.4857E-04
print
```

Method 1: Material Card ZAID Suffix

Original Input

```
Pu239 Jezebel 17,065.5 g Pu-alloy (4.5 at% 240Pu, 1.02 wt% Ga)
1 94 0.0402901 -1 imp:n=1
2  0            1 imp:n=0

1 so 6.39061

mode n
rand gen=2 seed=2901000001
prdmp j 500
kcode 2400000 1.0 50 1050
totnu
sdef pos=0. 0. 0. rad=d1 erg=d2
si1 0. 6.39061
sp1 -21 2
sp2 -3 0.966 2.842
m94   94239.00c 3.7047E-02
      94240.00c 1.7512E-03
      94241.00c 1.1674E-04
      31069.00c 8.2663E-04
      31071.00c 5.4857E-04
print
```

```
m94   nlib=80c
      94239     3.7047E-02
      94240     1.7512E-03
      94241     1.1674E-04
      31069     8.2663E-04
      31071     5.4857E-04
```

Options:
(1) NLIB (neutron)
(2) PLIB (photoatomic)
(3) ELIB (electron)
(4) PNLIB (photonuclear)
(5) HLIB (proton)

Default

```
m94   94239     3.7047E-02
      94240     1.7512E-03
      94241.    1.1674E-04
      31069.    8.2663E-04
      31071     5.4857E-04
```

ENDF/B-VII.1

```
m94   94239.80c 3.7047E-02
      94240.80c 1.7512E-03
      94241.80c 1.1674E-04
      31069.80c 8.2663E-04
      31071.80c 5.4857E-04
```

ENDF/B-VIII.0

```
m94   94239.00c 3.7047E-02
      94240.00c 1.7512E-03
      94241.00c 1.1674E-04
      31069.00c 8.2663E-04
      31071.00c 5.4857E-04
```

Method 1: Material Card ZAID Suffix

ENDF/B-VII.1

```
Pu239 Jezebel 17,065.5 g Pu-alloy (4.5 at% 240Pu, 1.02 wt% Ga)
1 94 0.0402901 -1 imp:n=1
2  0            1 imp:n=0

1 so 6.39061

mode n
rand gen=2 seed=2901000001
prdmp j 500
kcode 2400000 1.0 50 1050
totnu
sdef pos=0. 0. 0. rad=d1 erg=d2
si1 0. 6.39061
sp1 -21 2
sp2 -3 0.966 2.842
m94   94239.80c 3.7047E-02
      94240.80c 1.7512E-03
      94241.80c 1.1674E-04
      31069.80c 8.2663E-04
      31071.80c 5.4857E-04
print
```

↑ Input
↓ Output

```
1cross-section tables                                                    print table 100
     XSDIR used: /Users/kleedtke/export/mcnp630/MCNP_DATA/MCNP_DATA/xsdir_mcnp6.3

     table    length

                        tables from file endf71x/Ga/31069.710nc

  31069.80c    69018  Ga69 ENDF71x (jlconlin)  Ref. see jlconlin (ref 09/10/2012  10:00:53)       mat3125      12/16/12
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.

                        tables from file endf71x/Ga/31071.710nc

  31071.80c    58517  Ga71 ENDF71x (jlconlin)  Ref. see jlconlin (ref 09/10/2012  10:00:53)       mat3131      12/14/12
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.

                        tables from file endf71x/Pu/94239.710nc

  94239.80c   586763  Pu239 ENDF71x (jlconlin)  Ref. see jlconlin (ref 09total nu  10:00:53)       mat9437      12/18/12
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.
                      probability tables used from 2.5000E-03 to 3.0000E-02 mev.

                        tables from file endf71x/Pu/94240.710nc

  94240.80c   633923  Pu240 ENDF71x (jlconlin)  Ref. see jlconlin (ref 09total nu  10:00:53)       mat9440      12/17/12
                      Energy range:   1.00000E-11  to  3.00000E+01 MeV.
                      probability tables used from 5.7000E-03 to 4.0000E-02 mev.

                        tables from file endf71x/Pu/94241.710nc

  94241.80c   133343  Pu241 ENDF71x (jlconlin)  Ref. see jlconlin (ref 09total nu  10:00:53)       mat9443      12/17/12
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.
                      probability tables used from 3.0000E-04 to 4.0200E-02 mev.

 total      1481564
```

Default / ENDF/B-VIII.0

```
Pu239 Jezebel 17,065.5 g Pu-alloy (4.5 at% 240Pu, 1.02 wt% Ga)
1 94 0.0402901 -1 imp:n=1
2  0            1 imp:n=0

1 so 6.39061

mode n
rand gen=2 seed=2901000001
prdmp j 500
kcode 2400000 1.0 50 1050
totnu
sdef pos=0. 0. 0. rad=d1 erg=d2
si1 0. 6.39061
sp1 -21 2
sp2 -3 0.966 2.842
m94   94239.00c 3.7047E-02
      94240.00c 1.7512E-03
      94241.00c 1.1674E-04
      31069.00c 8.2663E-04
      31071.00c 5.4857E-04
print
```

↑ Input
↓ Output

```
1cross-section tables                                                    print table 100
     XSDIR used: /Users/kleedtke/export/mcnp630/MCNP_DATA/MCNP_DATA/xsdir_mcnp6.3

     table    length

                        tables from file Lib80x/Ga/31069.800nc

  31069.00c    77064  Ga69 Lib80x (jlconlin)  Reference LA-UR-18-24034 by Conlin, J.L., et a    l. mat3125      05/01/18
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.

                        tables from file Lib80x/Ga/31071.800nc

  31071.00c    84218  Ga71 Lib80x (jlconlin)  Reference LA-UR-18-24034 by Conlin, J.L., et a    l. mat3131      05/01/18
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.

                        tables from file Lib80x/Pu/94239.800nc

  94239.00c   840164  Pu239 Lib80x (jlconlin)  Reference LA-UR-18-24034 btotal nu  J.L., et     al.mat9437      05/02/18
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.
                      probability tables used from 2.5000E-03 to 3.0000E-02 mev.

                        tables from file Lib80x/Pu/94240.800nc

  94240.00c   978253  Pu240 Lib80x (jlconlin)  Reference LA-UR-18-24034 btotal nu  J.L., et     al.mat9440      05/02/18
                      Energy range:   1.00000E-11  to  3.00000E+01 MeV.
                      probability tables used from 5.7000E-03 to 4.0000E-02 mev.

                        tables from file Lib80x/Pu/94241.800nc

  94241.00c   138311  Pu241 Lib80x (jlconlin)  Reference LA-UR-18-24034 btotal nu  J.L., et     al.mat9443      05/01/18
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.
                      probability tables used from 3.0000E-04 to 4.0200E-02 mev.

 total      2118010
```

Method 2: XSDIR Manipulation

(a) Ordering:

```
#
# Example 2(a)
#
94239.00c 236.998600 Lib80x/Pu/94239.800nc 0 1 3 1039943 0 0 2.530100E-08 +
          ptable
94239.80c 236.998600 endf71x/Pu/94239.710nc 0 1 4 811599 0 0 2.530100E-08 +
          ptable
#
#
#
```

- If the input file material card specifies 94239, the first instance of 94239 in the data directory entries will be used

(b) Comment:

```
#
# Example 2(b)
#
# 94239.00c 236.998600 Lib80x/Pu/94239.800nc 0 1 3 1039943 0 0 2.530100E-08 +
#           ptable
94239.80c 236.998600 endf71x/Pu/94239.710nc 0 1 4 811599 0 0 2.530100E-08 +
          ptable
#
#
#
```

- Comment out the first instance of 94239 in the data directory entries to specify the second instance of 94239

Method 2: XSDIR Manipulation

(c) New XSDIR File:

- Create new XSDIR file with only 1 data directory entry for 94239
- Use **xsdir =** in the MCNP6 execution line

Example: mcnp6 i = input_file.i xsdir = datapath/new_xsdir_file

Method 3: XSn Card

- Method is helpful for ACE files not contained in a particular nuclear data library
- Details from pages 316-317 in MCNP® Code Version 6.3.0 Theory & User Manual (LA-UR-22-30006):

5.6.9 XS: Cross-Section File

The XS*n* card can be used to load cross-section evaluations not listed in the **xsdir** file. The XS*n* cards can be used in addition to the **xsdir** file. Each XS*n* card describes one cross-section table. The entries for the XS*n* card are identical to those that appear in the default cross-section directory file (i.e., **xsdir_mcnp6.3**) provided with the MCNP code, version 6.3, except that the "+" is not used for continuation.

Data-card Form: XS*n z1 a1 z2 a2 ...*

n	Arbitrary cross-section identification number. Restriction: $1 \leq n \leq 99,999,999$.
zk	Nuclide identifier (ZZZAAA.*abx*) used on the M material card.
ak	Atomic weight ratio associated with nuclide k.
...	Remaining **xsdir** file entries for the user-provided cross-section table as described in Appendix B.

Use: Add an **xsdir**-type entry for nuclides not represented in the **xsdir** file.

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
   1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
   1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
   1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
   1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
   1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
   1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
   2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
   2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
   2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
   3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
   3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
   4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
   4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
   5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
   6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
   6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
   7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
   9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
   1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
   1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
   1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
   1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

We need 11 pieces of information:

(1) Table Name
(2) Atomic Weight Ratio
(3) File Name
(4) Access Route
(5) File Type
(6) Address
(7) Table Length
(8) Record Length
(9) Number of Entries per Record
(10) Temperature
(11) Probability Table Flag

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
  1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
  1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
  1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
  1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
  1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
  1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
  2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
  2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
  2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
  3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
  3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
  4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
  4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
  5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
  6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
  6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
  7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
  9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
  1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
  1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
  1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
  1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

We need 11 pieces of information:

(1) Table Name
(2) Atomic Weight Ratio
(3) File Name
(4) Access Route
(5) File Type
(6) Address
(7) Table Length
(8) Record Length
(9) Number of Entries per Record
(10) Temperature
(11) Probability Table Flag

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
   1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
   1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
   1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
   1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
   1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
   1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
   2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
   2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
   2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
   3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
   3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
   4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
   4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
   5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
   6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
   6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
   7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
   9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
   1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
   1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
   1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
   1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

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(6) Address
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(8) Record Length
(9) Number of Entries per Record
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(11) Probability Table Flag

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
   1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
   1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
   1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
   1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
   1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
   1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
   2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
   2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
   2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
   3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
   3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
   4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
   4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
   5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
   6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
   6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
   7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
   9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
   1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
   1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
   1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
   1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

We need 11 pieces of information:

(1) Table Name
(2) Atomic Weight Ratio
(3) File Name
(4) Access Route
(5) File Type
(6) Address
(7) Table Length
(8) Record Length
(9) Number of Entries per Record
(10) Temperature
(11) Probability Table Flag

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
   1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
   1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
   1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
   1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
   1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
   1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
   2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
   2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
   2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
   3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
   3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
   4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
   4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
   5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
   6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
   6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
   7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
   9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
   1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
   1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
   1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
   1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

We need 11 pieces of information:

(1) Table Name
(2) Atomic Weight Ratio
(3) File Name
(4) Access Route – 0, no access route
(5) File Type – Type 1
(6) Address
(7) Table Length
(8) Record Length
(9) Number of Entries per Record
(10) Temperature
(11) Probability Table Flag

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
  1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
  1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
  1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
  1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
  1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
  1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
  2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
  2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
  2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
  3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
  3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
  4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
  4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
  5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
  6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
  6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
  7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
  9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
  1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
  1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
  1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
  1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

We need 11 pieces of information:

(1) Table Name
(2) Atomic Weight Ratio
(3) File Name
(4) Access Route
(5) File Type
(6) Address – 1
(7) Table Length
(8) Record Length
(9) Number of Entries per Record
(10) Temperature
(11) Probability Table Flag

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
 1039943    94239    72095       47       45      155        0        6
       0       94      239        0        0        0        0        0
       1   360476   373151   373198   373245   373292   373339   600148
  600194   727862   727907   918604   990699   990854   991009   992427
  992582   992582   992737  1039919   373526  1039943   900912   907805
  907816   907858   907864        0        0        0        0        0
  1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
  1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
  1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
  1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
  1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
  1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
  2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
  2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
  2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
  3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
  3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
  4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
  4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
  5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
  6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
  6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
  7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
  9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
  1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
  1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
  1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
  1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

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Pu239 [ Altered file made by MCNP Super User ]
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     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
  1.00000000000E-11  1.03125000000E-11  1.06250000000E-11  1.09375000000E-11
  1.12500000000E-11  1.15625000000E-11  1.18750000000E-11  1.21875000000E-11
  1.25000000000E-11  1.28125000000E-11  1.31250000000E-11  1.34375000000E-11
  1.37500000000E-11  1.43750000000E-11  1.50000000000E-11  1.56250000000E-11
  1.62500000000E-11  1.68750000000E-11  1.75000000000E-11  1.81250000000E-11
  1.87500000000E-11  1.93750000000E-11  2.00000000000E-11  2.09375000000E-11
  2.18750000000E-11  2.28125000000E-11  2.37500000000E-11  2.46875000000E-11
  2.56250000000E-11  2.65625000000E-11  2.75000000000E-11  2.84375000000E-11
  2.93750000000E-11  3.03125000000E-11  3.12500000000E-11  3.21875000000E-11
  3.31250000000E-11  3.40625000000E-11  3.50000000000E-11  3.59375000000E-11
  3.68750000000E-11  3.78125000000E-11  3.87500000000E-11  3.96875000000E-11
  4.06250000000E-11  4.25000000000E-11  4.43750000000E-11  4.62500000000E-11
  4.81250000000E-11  5.00000000000E-11  5.15625000000E-11  5.31250000000E-11
  5.46875000000E-11  5.62500000000E-11  5.78125000000E-11  5.93750000000E-11
  6.09375000000E-11  6.25000000000E-11  6.40625000000E-11  6.56250000000E-11
  6.71875000000E-11  6.87500000000E-11  7.18750000000E-11  7.50000000000E-11
  7.81250000000E-11  8.12500000000E-11  8.43750000000E-11  8.75000000000E-11
  9.06250000000E-11  9.37500000000E-11  9.68750000000E-11  1.00000000000E-10
  1.03125000000E-10  1.06250000000E-10  1.09375000000E-10  1.12500000000E-10
  1.15625000000E-10  1.18750000000E-10  1.21875000000E-10  1.25000000000E-10
  1.28125000000E-10  1.31250000000E-10  1.34375000000E-10  1.37500000000E-10
  1.43750000000E-10  1.50000000000E-10  1.56250000000E-10  1.62500000000E-10
```

We need 11 pieces of information:

(1) Table Name
(2) Atomic Weight Ratio
(3) File Name
(4) Access Route
(5) File Type
(6) Address
(7) Table Length
(8) Record Length – 0
(9) Number of Entries per Record – 0
(10) Temperature
(11) Probability Table Flag

Method 3: XSn Card

- Example Scenario: You are given a new ^{239}Pu ACE file called pu239_nFission.ace that has an altered fission cross section. Your colleague asks you to see how this change to the fission cross section will impact the criticality of the simplified Jezebel benchmark.
- Step 1: Open the ACE file with a text editor

```
 94239.00c  236.998600  2.5301E-08   01/01/25
Pu239 [ Altered file made by MCNP Super User ]
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
      0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
   1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
   1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
   1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
   1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
   1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
   1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
   2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
   2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
   2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
   3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
   3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
   4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
   4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
   5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
   6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
   6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
   7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
   9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
   1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
   1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
   1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
   1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

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Pu239 [ Altered file made by MCNP Super User ]
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     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
     0         0.      0         0.      0         0.      0         0.
  1039943    94239    72095       47       45      155        0        6
        0       94      239        0        0        0        0        0
        1   360476   373151   373198   373245   373292   373339   600148
   600194   727862   727907   918604   990699   990854   991009   992427
   992582   992582   992737  1039919   373526  1039943   900912   907805
   907816   907858   907864        0        0        0        0        0
   1.00000000000E-11   1.03125000000E-11   1.06250000000E-11   1.09375000000E-11
   1.12500000000E-11   1.15625000000E-11   1.18750000000E-11   1.21875000000E-11
   1.25000000000E-11   1.28125000000E-11   1.31250000000E-11   1.34375000000E-11
   1.37500000000E-11   1.43750000000E-11   1.50000000000E-11   1.56250000000E-11
   1.62500000000E-11   1.68750000000E-11   1.75000000000E-11   1.81250000000E-11
   1.87500000000E-11   1.93750000000E-11   2.00000000000E-11   2.09375000000E-11
   2.18750000000E-11   2.28125000000E-11   2.37500000000E-11   2.46875000000E-11
   2.56250000000E-11   2.65625000000E-11   2.75000000000E-11   2.84375000000E-11
   2.93750000000E-11   3.03125000000E-11   3.12500000000E-11   3.21875000000E-11
   3.31250000000E-11   3.40625000000E-11   3.50000000000E-11   3.59375000000E-11
   3.68750000000E-11   3.78125000000E-11   3.87500000000E-11   3.96875000000E-11
   4.06250000000E-11   4.25000000000E-11   4.43750000000E-11   4.62500000000E-11
   4.81250000000E-11   5.00000000000E-11   5.15625000000E-11   5.31250000000E-11
   5.46875000000E-11   5.62500000000E-11   5.78125000000E-11   5.93750000000E-11
   6.09375000000E-11   6.25000000000E-11   6.40625000000E-11   6.56250000000E-11
   6.71875000000E-11   6.87500000000E-11   7.18750000000E-11   7.50000000000E-11
   7.81250000000E-11   8.12500000000E-11   8.43750000000E-11   8.75000000000E-11
   9.06250000000E-11   9.37500000000E-11   9.68750000000E-11   1.00000000000E-10
   1.03125000000E-10   1.06250000000E-10   1.09375000000E-10   1.12500000000E-10
   1.15625000000E-10   1.18750000000E-10   1.21875000000E-10   1.25000000000E-10
   1.28125000000E-10   1.31250000000E-10   1.34375000000E-10   1.37500000000E-10
   1.43750000000E-10   1.50000000000E-10   1.56250000000E-10   1.62500000000E-10
```

We need 11 pieces of information:

(1) Table Name
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(11) Probability Table Flag

Method 3: XSn Card

- Step 2: Put new ACE file in same location as MCNP input file
- Step 3: Define XSn card in MCNP input file
- Step 4: Run MCNP input file / Check MCNP output file Print Table 100
- Step 5: Check MCNP output file for new value of k_{eff}

```
1cross-section tables                                                                    print table 100
     XSDIR used: /Users/kleedtke/export/mcnp630/MCNP_DATA/MCNP_DATA/xsdir_mcnp6.3

     table    length

                        tables from file Lib80x/Ga/31069.800nc

  31069.00c    77064  Ga69 Lib80x (jlconlin)  Reference LA-UR-18-24034 by Conlin, J.L., et a    l. mat3125      05/01/18
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.

                        tables from file Lib80x/Ga/31071.800nc

  31071.00c    84218  Ga71 Lib80x (jlconlin)  Reference LA-UR-18-24034 by Conlin, J.L., et a    l. mat3131      05/01/18
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.

                        tables from file pu239_nfission.ace

  94239.00c   840164  Pu239 [ Altered file made by MCNP Super User ]     total nu                 01/01/25
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.
                      probability tables used from 2.5000E-03 to 3.0000E-02 mev.

                        tables from file Lib80x/Pu/94240.800nc

  94240.00c   978253  Pu240 Lib80x (jlconlin)  Reference LA-UR-18-24034 btotal nu  J.L., et     al.mat9440      05/02/18
                      Energy range:   1.00000E-11  to  3.00000E+01 MeV.
                      probability tables used from 5.7000E-03 to 4.0000E-02 mev.

                        tables from file Lib80x/Pu/94241.800nc

  94241.00c   138311  Pu241 Lib80x (jlconlin)  Reference LA-UR-18-24034 btotal nu  J.L., et     al.mat9443      05/01/18
                      Energy range:   1.00000E-11  to  2.00000E+01 MeV.
                      probability tables used from 3.0000E-04 to 4.0200E-02 mev.

  total      2118010
```

Challenge: ACEtk + XSn Card

- Use method in

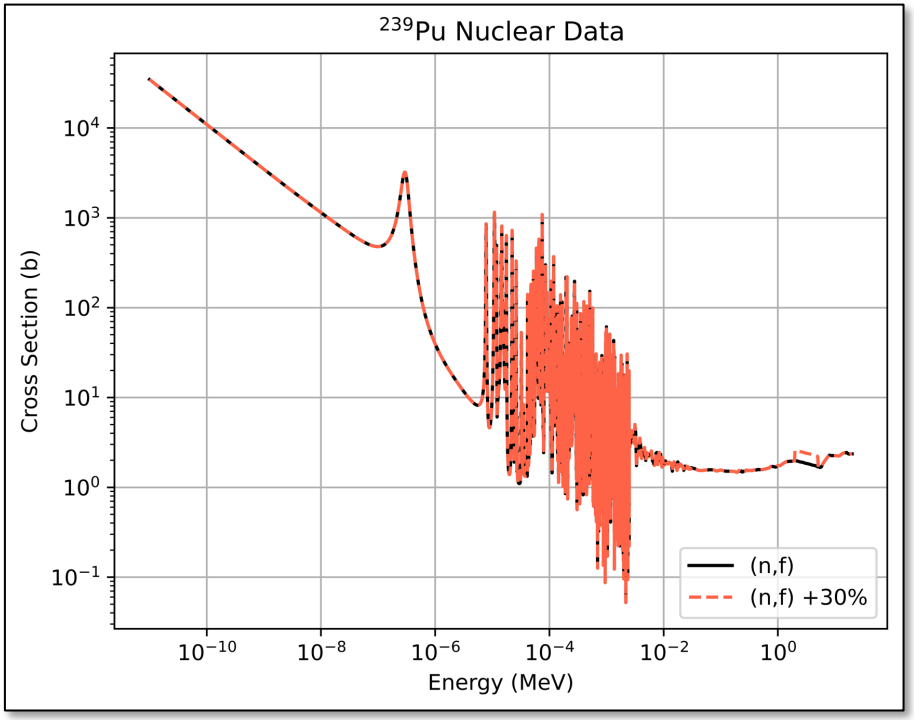
N. Kleedtke, W. Haeck, J. Hutchinson, "Utilization of ACE nuclear data file toolkit ACEtk (https://github.com/njoy/ACEtk) to calculate relative sensitivity coefficients of point-kinetics parameters," *Annals of Nuclear Energy* 193 (2023). DOI:10.1016/j.anucene.2023.110031

..to perturb ENDF/B-VIII.0 ^{239}Pu(n,f) +30% from 2 MeV – 5 MeV

- Use Method 3 from this presentation to define an XSn card:

XS1 94239.00c 236.9986 pu239_e80_mt18_p30.ace 0 1 1 911710 0 0 2.5301e-8 ptable

- Compare MCNP output with default nuclear data and ^{239}Pu replacement



Test	k_{eff}
Experiment	1.00000(130)
Benchmark, E8.0 Original	1.00056(1)
Benchmark, E8.0 +30%	1.06823(1)

Summary

- The nuclear data files used by MCNP are called ACE files
- ACE files are defined in the XSDIR data directory file
- The data directory entries have 11 pieces of information that must be specified
- 3 methods presented to specify non-default nuclear data:
  (1) Replace Input File Material Card ZAID Suffix
  (2) Manipulate XSDIR Data Directory Entry
  (3) Use the XSn Card in an Input File
- The successful implementation of any of these methods would allow users to quantify changes to output (e.g., criticality) for single-file nuclear data replacement and/or combinations of nuclear data changes

Acknowledgments

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Questions?

Thursday (June 10) General Q&A Session!

Contact the Los Alamos National Laboratory Nuclear Data Team by email at nucldata@lanl.gov