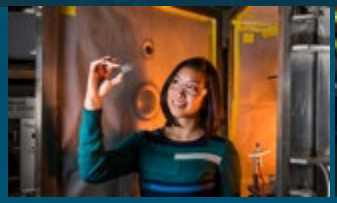
Recent Updates to SNAP MELCOR Plugin



PRESENTED BY

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ENERGY NNSA

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Introduction

SNL interface with APT greatly improved.

APT has full SNL test suite.

APT is completing updates through MELCOR 2.2, Rev 11932 (i.e., MELCOR Plugin 2.4.6 doe not include current efforts)

SNL will release updated documentation for Rev 14959, which will be subsequently addressed by APT

Expanded Support for New Global Variables

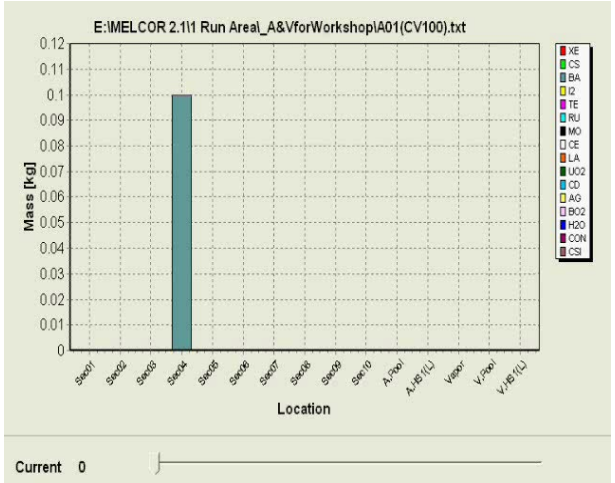
GLOBAL Variables
- Environment variables preceding MELGEN/MELCOR program input

Expanded Keyword Utility
- DEFAULTDIRECTORY path
  - Redirects all output to a directory
- MEL_HTML*FILE filename
  - When present, an HTML file will be generated with each text edit
- PrintDefaultSC filename
  - Prints all sensitivity coefficient to a file
- PrintCurrentSC filename
  - Prints current values of all sensitivity coefficients
- RN1VISUALFILE
  - Creates a file to be used by the RNVisual utility for visualizing distribution of aerosols in a CV
- NOTEPAD++
  - When present adds NotePad++ folding directives to the output
- NewNcycle integer
  - Will change the cycle number on restart to value specified
- KEYWORDF*ILE
  - Prints all plotfile keywords to file
- RESTARTF*ILE filename
  - Provide name for restartfile and cycle or time for starting
- EXEC_CFEXFILE filename
  - CF READ/WRITE Exchange file
- PAUSEFILE filename
  - Calculation pauses when file is present

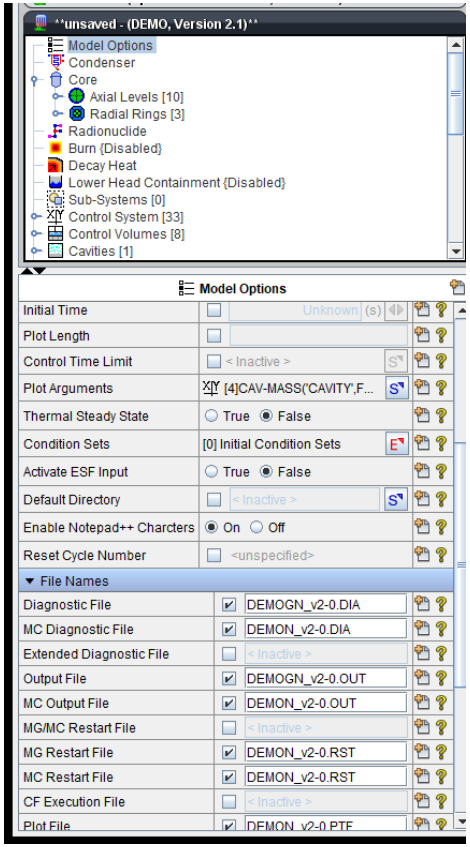
PrintDefaultSC

```
*********************************
*    LIST OF DEFAULT SCs        *
*********************************
(WARNING: This list only contains default values,
 not necessarily the values currently being used)

 *****DECAY HEAT (DCH) PACKAGE*****

*SC3200:  ANS DECAY HEAT MULTIPLIER
  SC3200(1)     1.0
*SC3201:  ENERGY PER FISSION
  SC3201(1)    FISSION ENERGY - U235  199.0
  SC3201(2)    FISSION ENERGY - PU239 210.2
  SC3201(3)    FISSION ENERGY - U238  199.3
*SC3202:  DECAY HEAT TIMES
  SC3202(1)     0.0
  SC3202(2)     1.0
  SC3202(3)     1.5
  SC3202(4)     2.0
  SC3202(5)     4.0
  SC3202(6)     6.0
  SC3202(7)     8.0
  SC3202(8)     10.0
```

RN1Visual



SNAP Interface



Named Comment Blocks

MELCOR comment blocks were added as part of the code conversion project. In MELCOR 2.1, a block of input can be commented out by enclosing that block of input within a set of triple parenthesis.

Comment Blocks can be 'activated' through the following input:

- CommentBlock Record

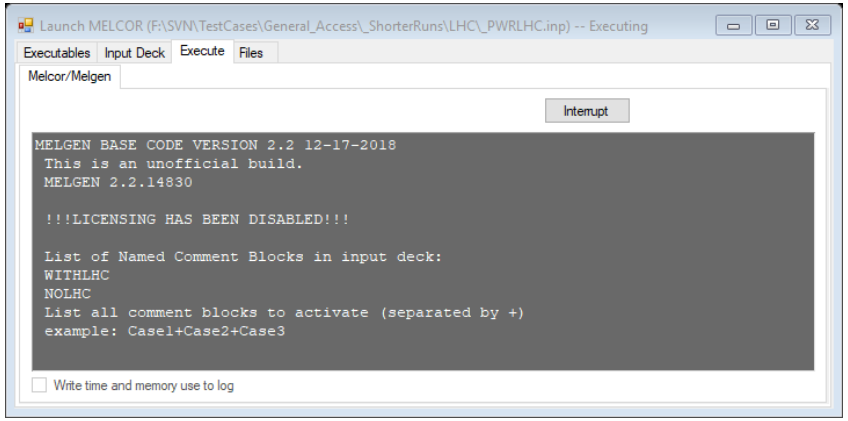
  CommentBlock case1 case2 case3

- Command line arguments

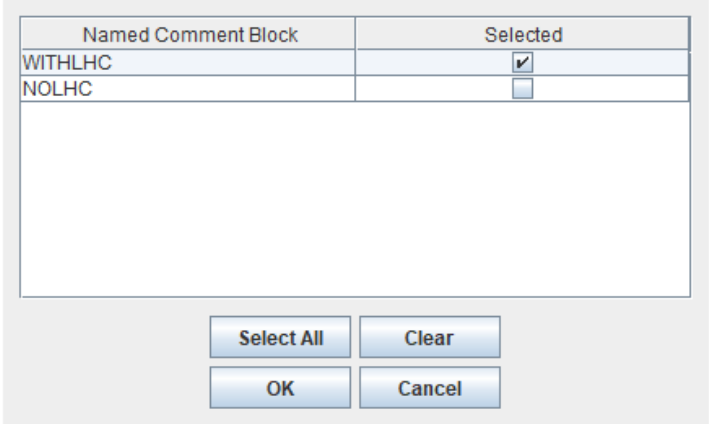
  melgen i=inputfile c=case1+case2+case3

```
CommentBlock  SBO
...
PROGRAM MELGEN
...
(((SBO   !Additional comments placed here
...These input records are not ignored
|||
…Else if not SBO, these input records are not ignored
)))
...
(((LBLOCA   !This is a large break LOCA scenario
...These input records are ignored
)))
```

Running MELGEN/MELCOR from Console:



Importing MELGEN/MELCOR into SNAP



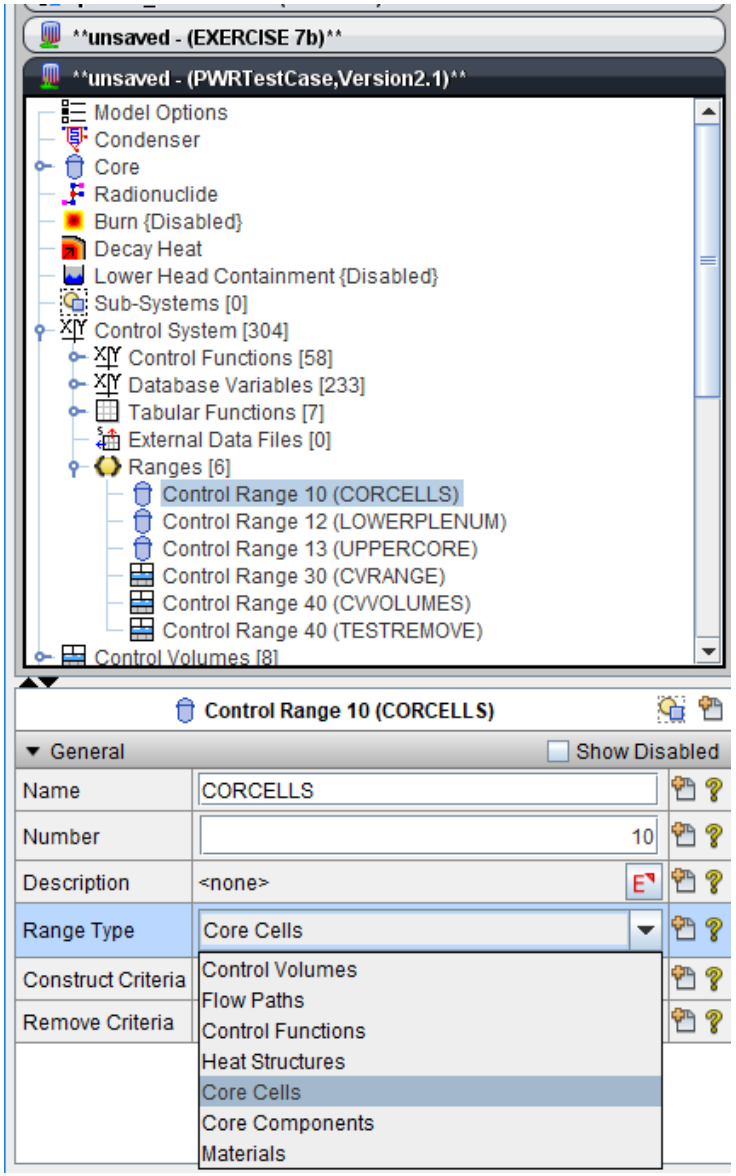
Range Object

Released in r9541 (January 2017)

The range is an object that is defined once in the database and then can be referenced by other control function arguments. The range specifies an ordered list of objects such a control volumes, COR cells, materials, or components

Define a Range:

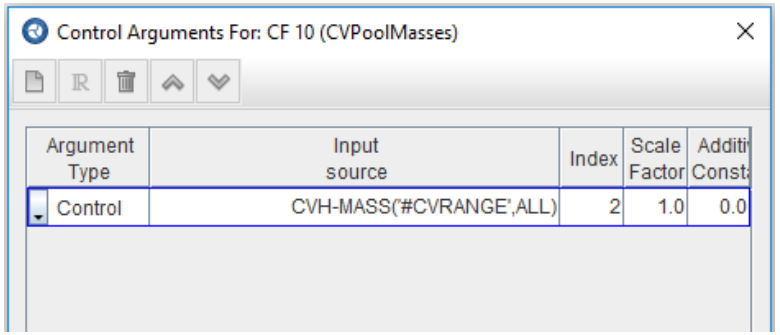
```
                name        type        ndim   Number
CF_RANGE   CVRANGE   CVOLUMES     2       30
CONSTRUCT  2
  1 CVTYPE='PRIMARY'
  2 DC
REMOVE  1
  1  LowerPlenum
```



Vector Control Functions

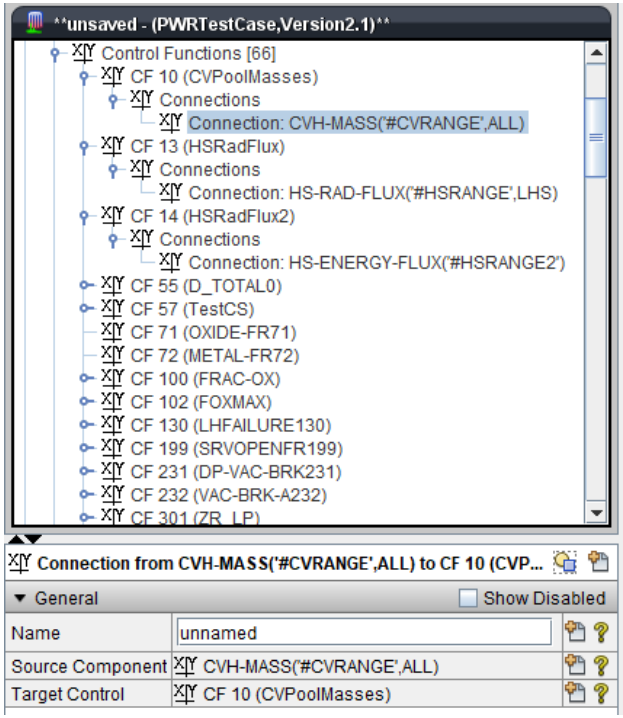
Released in r9541 (January 2017)

A range can be referenced by control functions and control function arguments. The hashtag (#) that precedes range specified for the volume in the CF argument indicates a range of control volumes rather than a single volume.



Referencing a Range:

```
CF_ID        'CVMass2'  1010  ADD
CF_SAI 1.0 0.00
CFVALR (INITIAL VALUE)
CF_ARG 1
  1   CVH-MASS(#CVRANGE,POOL)   1.0    0.0
```



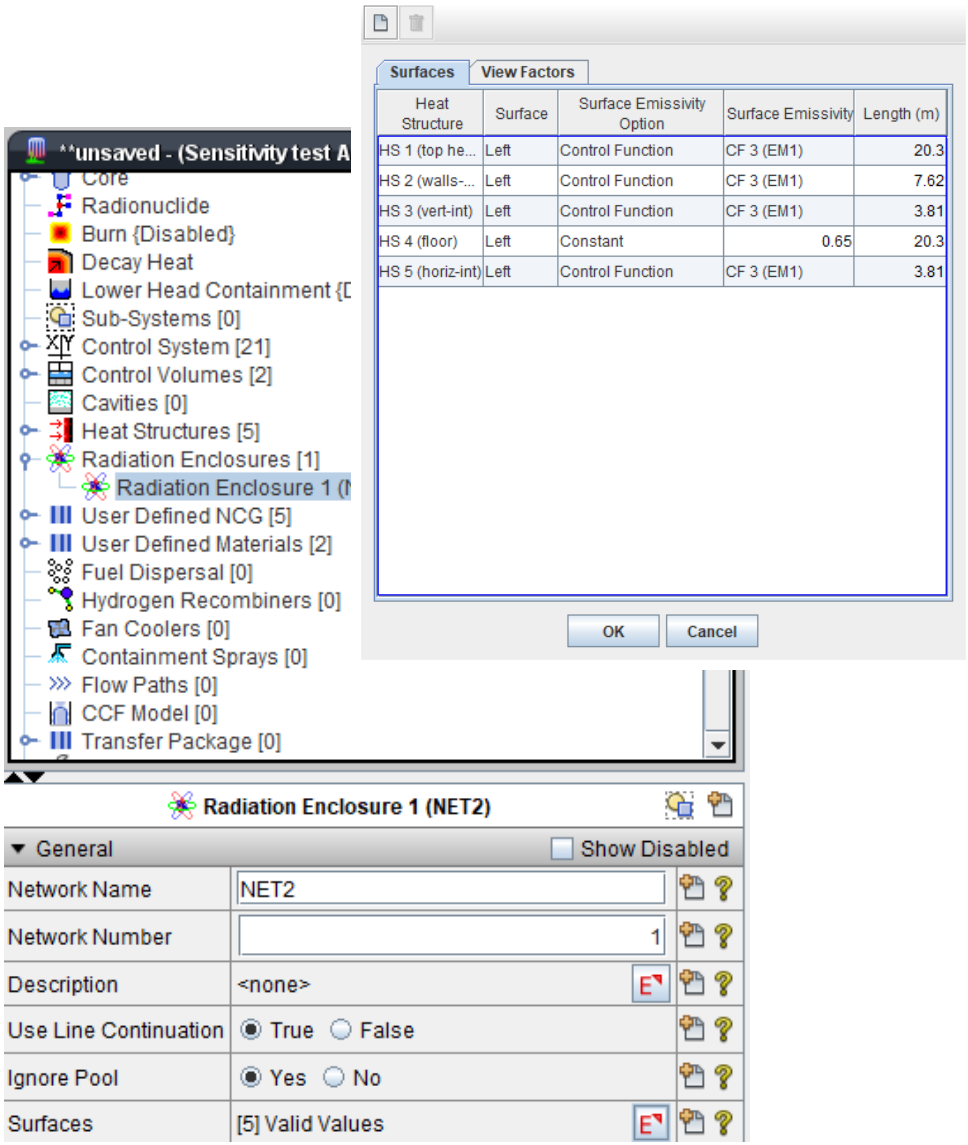
Radiation Enclosures

Released in r9541 (January 2017)

Radiation enclosure model

- Multiple enclosure networks, each with multiple heat structures defined by the user.
  - Memory dynamically allocated
- User defines <u>all</u> surfaces exchanging radiant heat
  - Matrix of view factors connecting surfaces
  - View factors are constants and cannot change
  - Does not account for surfaces submerged below pool.
- Participating gas
  - Transmissivity accounts for reduction in radiation between surfaces
  - Only 1 CV associated with all surfaces
    - Does not account for rising pool in CV (yet)
  - User supplies beam length (similar to COR package)

```
HS_Rad 4  NET3      !EM     BeamL   VF
  1   HS1C      RIGHT  EM1     0.5       0.0  0.2  0.4   &
                                        'MyLongNamedCF'
  2   HS2C      LEFT   EM2     0.5       0.2  0.0  0.3  0.5
  3   HS3C      LEFT     -       0.5       0.4  0.3  0.2  0.1
  4   HS4C      RIGHT    -       0.5       0.4  0.5  0.1  0.0
```

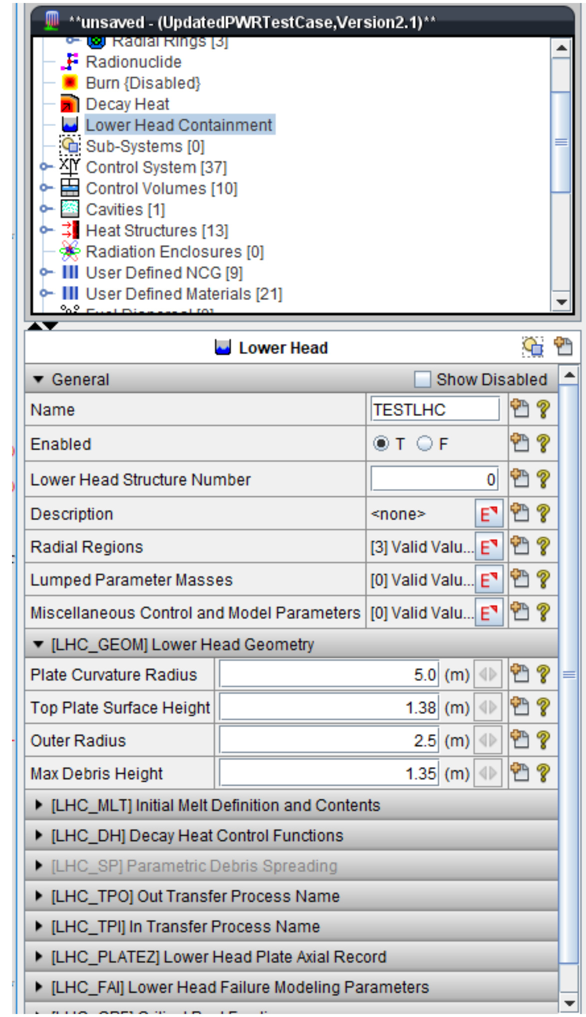


Lower Head Components

Released in r9541 (January 2017)

A new 'LHC' (Lower Head and Containment) package has been added to MELCOR to model a "second lower head" or a "core-catcher" structure around/about the COR lower head. This new model calculates the thermal response of a new LHC structure and debris supported by this structure. The user specifies the LHC plate geometry, material, nodalization, etc. as well as CVH connections and COR/RN interfaces via TP.

```
!          LHCNAM    LHCNUM
LHC_ID  'TESTLHC'     1     ! LHC structure object name and (optional) sequence number

!              RADLH    HGTLH     RADOUT     MAXHGT
LHC_GEOM    2.9401    1.38      1.632        1.5     ! Plate geometry

!              NREGZ       TEMPI
LHC_PLATEZ     3        311.0
          1     1     0.00318   'SS'    ! 1 node, total thickness 0.003 m, SS
          2     5     0.01717   'CS'    ! 5 nodes equally thick, total thickness 0.017 m,CS
          3     2     0.00318   'SS'    ! 2 nodes equally thick, total thickness 0.003 m, SS

!              NREGR
LHC_PLATER     2     ! Plate radial/transverse nodalization
!         N     NNR   DRR       CVB     IBCB   CVT       IBCT
                1     6    0.28835   3     'CAVITY'  3    'TESTLHC'    ! 6 nodes equally thick, total thickness 0.28 m
                2     3    0.24750   3     'CAVITY'  3    'TESTLHC'    ! 3 nodes equally thick, total thickness 0.24 m

!         IPDHCF
LHC_DH  'UseDCH'    ! Decay heat option

!          NTPOT     RNTPOT
LHC_TPI  'TP102'  'TP602'    ! Out transfer processes (out from COR, out from RNCOR)

!          NTPIN     RNTPIN
LHC_TPI  'TP105'   'TP605'    ! In transfer processes (in to CAV, in to RNCAV)
```



CAVITY Changes

Released in r9541 (January 2017)

ASCII

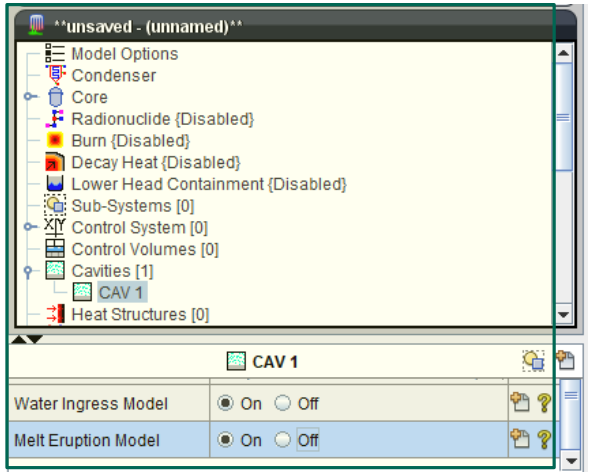
CAV_SP (Parametric Debris Spreading)

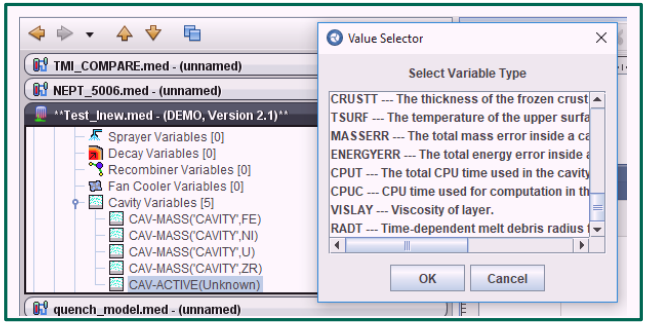
CAV_U (Misc. Control and Model Parameters
- WATINGR
- ERUPT
- MEVAL

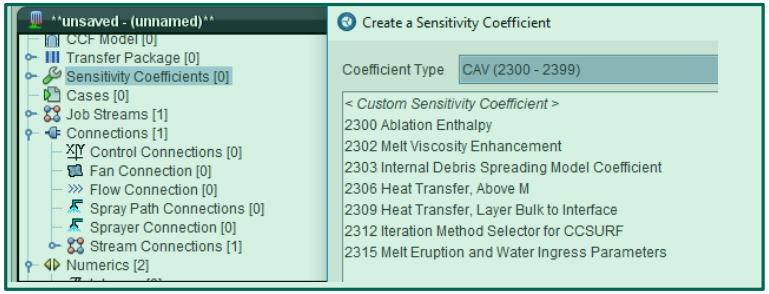
Support for new CF arguments
- CAV-VISLAY
- CAV-RADT

CAV Sensitivity Coefficients
- 2302: Melt Viscosity Enhancement
- 2303: Internal Debris Spreading Model Coefficient
- 2309: Heat Transfer, Layer Bulk to Interface/Added support for the HTRINT on top crust flag.
- 2312: Iteration Method Selector for CCSURF
- 2315: Melt Eruption and Water Ingress Parameters

SNAP







BONUS Model: Bateman Equations for Activity Calculations

General Radioactive Decay Chain

$$N_1 \rightarrow N_2 \rightarrow N_3 \rightarrow \cdots N_j \rightarrow \cdots N_i$$

Sources and losses

$$\frac{dN_i}{dt} = \sum_{j=1}^{i-1} \lambda_j N_j - \lambda_i N_i$$

Solution

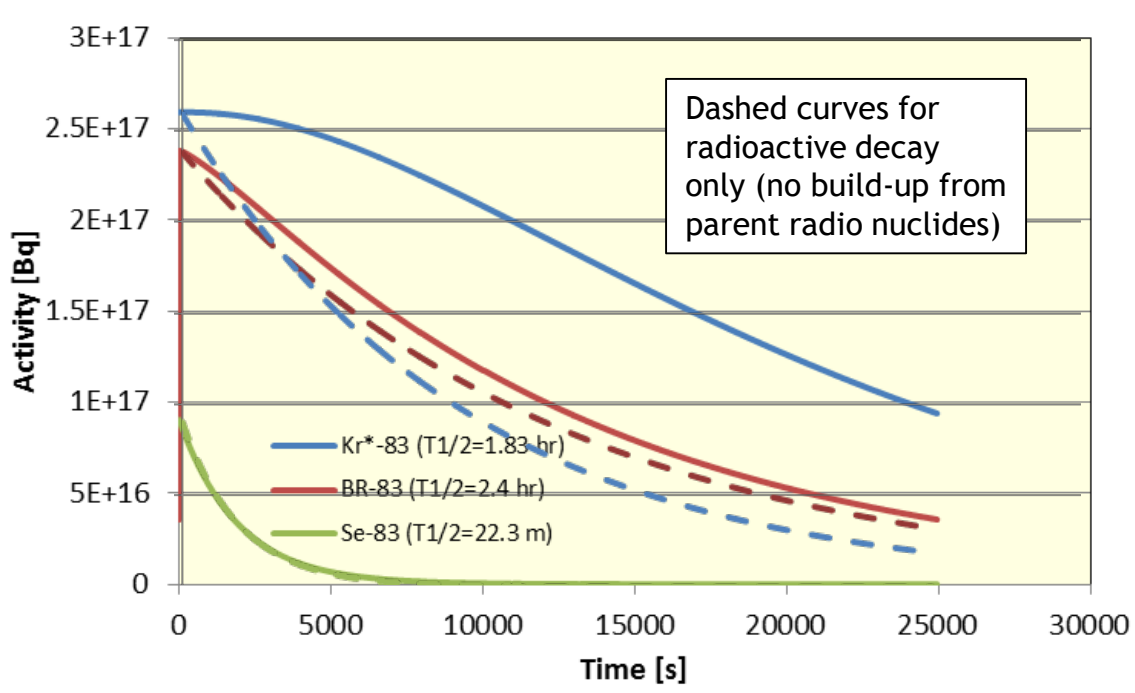
$$N_i(t) = \lambda_1 \lambda_2 \cdots \lambda_{i-1} N_1(0) \sum_{j=1}^{i} \frac{e^{-\lambda_i t}}{\prod_{k \neq j}(\lambda_k - \lambda_j)}$$

Isobaric β and γ decays of fission products are considered

Thermal neutron capture also taken into account

Daughter products defined in file Fpchains.in

- Placement of chains is arbitrary
- Coupled chains should follow each other




```
83
Se   Br
Se*  Br
Br   Kr*  Kr      .999754
Kr*  Kr
Kr
```

Support for New BONUS Input

- DCH_ACT - Activity Calculation Options

```
DCH_ACT          ON        OLD
```

- DCH_SUR - Output Activity Data

```
DCH_SUR    1 !n        type        name        ikey
             1         CVH   'CV110-CORE'       ALL
```

- DCH_RCT - Reactor Type/Added support for the FILE and BLOCK words.

InitInventory.in can contain multiple inventories. This user input specifies which inventory (Reactor type) to use:

```
!                Reactp  file         block
DCH_RCT    PWR  FissProd.in  'REACTOR_PWR'
```

```
REACTOR_PWR
!  2  3  4  5  6  7  8  9  0  1  2  3  4  5  6
Se-80    4.06E-01
Se-81    1.31E-05
Br-81    8.16E-01
Se-82    1.04E+00
Se-83    1.78E-05
Se*-83      7.74E-07
Br-83    2.20E-04
Kr*-83      1.67E-04
Kr-83    1.64E+00
Se-84    8.23E-06
```