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The logo for Babcock & Wilcox (B&W) is displayed in a large, bold, blue font. The letters 'B' and 'W' are solid blue, while the ampersand '&' is white with a blue outline. The logo is centered and has a subtle drop shadow effect below it.

mPower

# *RelapManager-A B&W mPower Safety Analysis Tool*

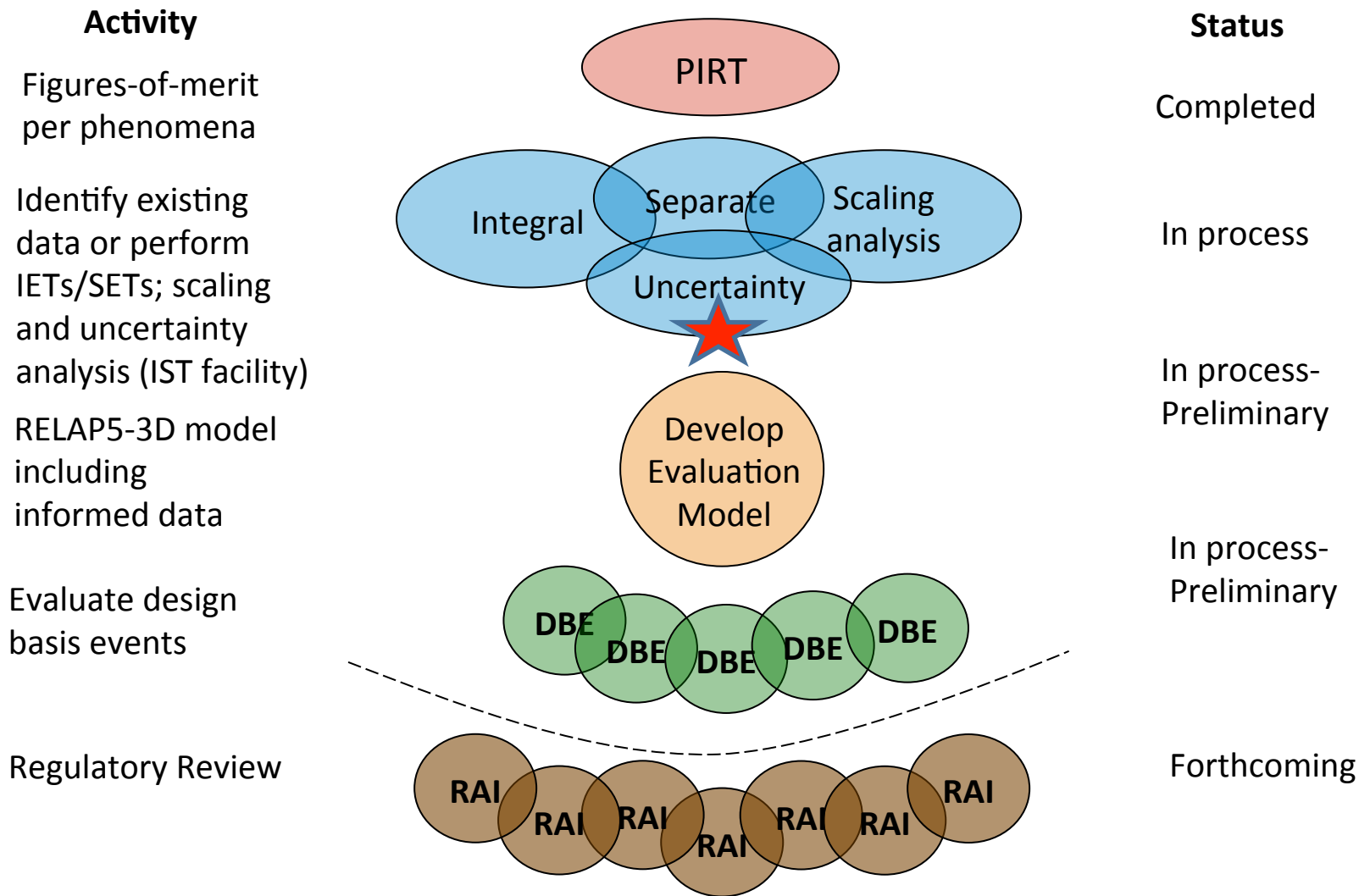
*2013 International RELAP5-3D Users Group Meeting  
Idaho National Laboratory*

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*Safety Analysis and Methods  
Engineer*

# *Overview*

- **NRC Requirements**
- **Uncertainty Analysis Process**
- **What is RelapManager?**
- **Benefits of RelapManager**
- **Development Status**

# NRC Requirements



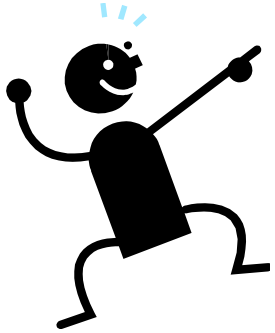
# ***NRC Requirements***

- **Regulatory Guide 1.203, 10 CFR 50.46(a)1(i)**
- **Uncertainties in the analysis method and inputs must be identified and assessed so that *“uncertainty in the calculated results can be estimated”***
- **B&W mPower should be able to provide *“high level of probability”* that key figures-of-merit shall not be exceeded/jeopardized**

# *Uncertainty Analysis Process*

- **Demonstrate and quantify conservatisms in design basis method**
- **Analyze model parameters for a specific phenomena**
- **Use Monte Carlo simulation for samples**
- **Quantify results and determine probability**
- **Time expended=\$ expended**





## *What is RelapManager?*

- **Windows desktop application**
- **Developed in Visual Studio in VB.Net**
- **XML schema defines document architecture and data rules**
- **Input file -> XML -> various renditions, including HTML, RTF, Word, and Relap Input deck**

# *What is RelapManager?*

- **Users**

- SA&M personnel
- Operations and Integration

- **Software/Hardware Interfaces**

- Putty or Cygwin

- Linux Cluster

External

- Altova XML engine

- MS Chart

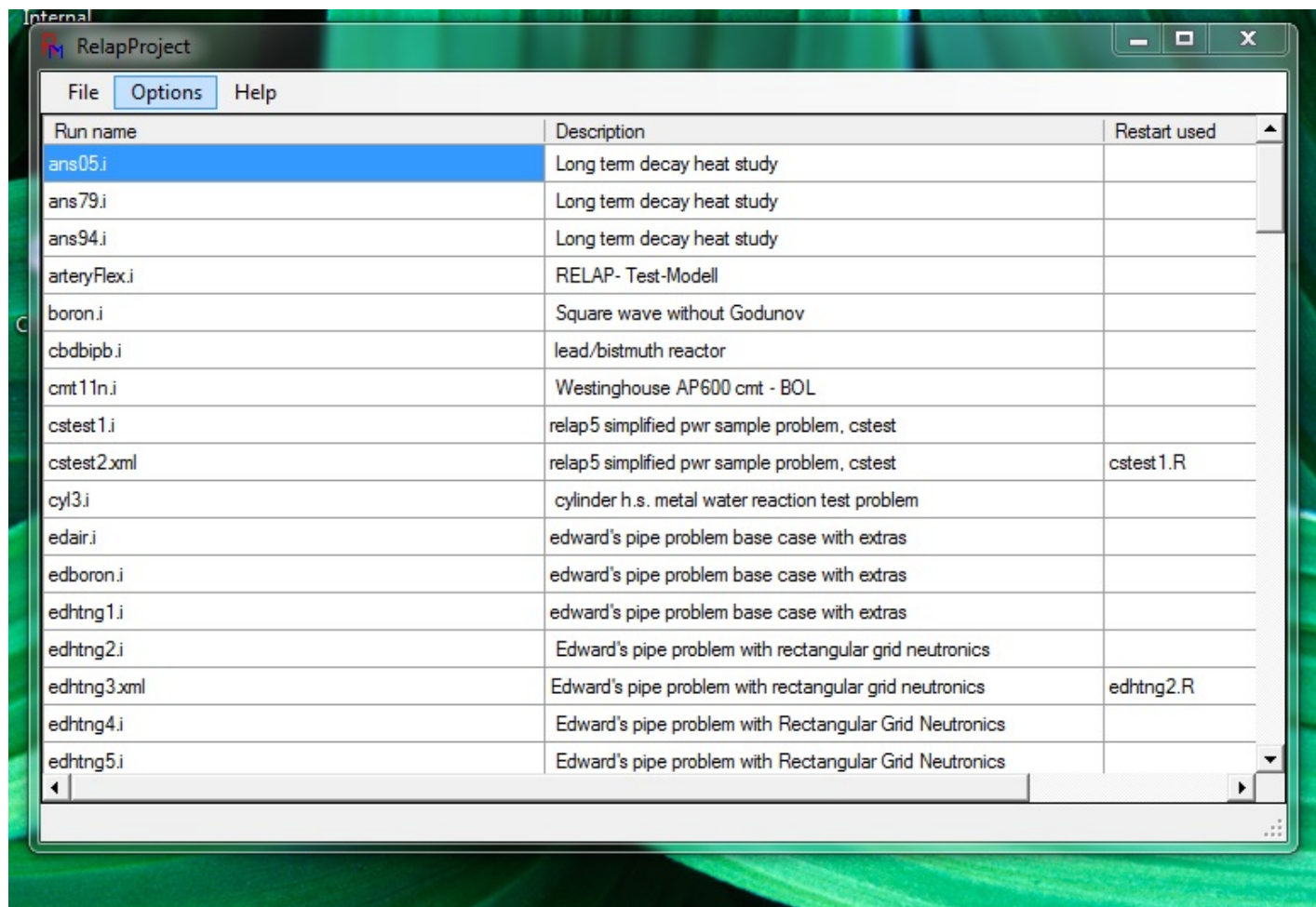
Used w/in RM

# *What is RelapManager?*

- **Functions**
  - Input deck error-checking
  - Executing RELAP5-3D
  - Graphing of results
  - **Performing uncertainty/sensitivity analyses**
  - Creating analysis reports



# Project Files



The screenshot shows a window titled "RelapProject" with a menu bar containing "File", "Options", and "Help". Below the menu bar is a table with three columns: "Run name", "Description", and "Restart used". The table lists various project files, with "ans05.i" selected. The "Restart used" column contains references to restart files like "cstest1.R" and "edhtng2.R".

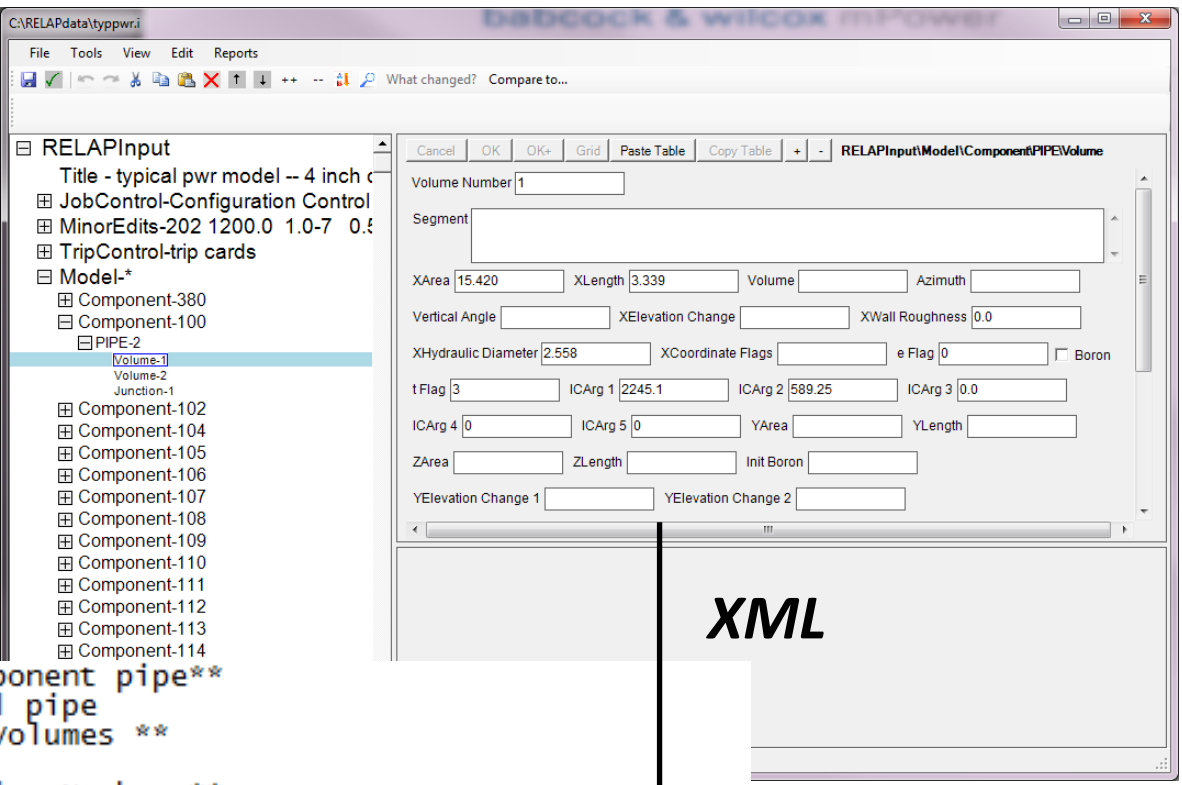
Run name	Description	Restart used
ans05.i	Long term decay heat study	
ans79.i	Long term decay heat study	
ans94.i	Long term decay heat study	
arteryFlex.i	RELAP- Test-Modell	
boron.i	Square wave without Godunov	
cbdbipb.i	lead/bismuth reactor	
cmt11n.i	Westinghouse AP600 cmt - BOL	
cstest1.i	relap5 simplified pwr sample problem, cstest	
cstest2.xml	relap5 simplified pwr sample problem, cstest	cstest1.R
cyl3.i	cylinder h.s. metal water reaction test problem	
edair.i	edward's pipe problem base case with extras	
edboron.i	edward's pipe problem base case with extras	
edhtng1.i	edward's pipe problem base case with extras	
edhtng2.i	Edward's pipe problem with rectangular grid neutronics	
edhtng3.xml	Edward's pipe problem with rectangular grid neutronics	edhtng2.R
edhtng4.i	Edward's pipe problem with Rectangular Grid Neutronics	
edhtng5.i	Edward's pipe problem with Rectangular Grid Neutronics	

```

1000000 ihl pipe
1000001 2
1000101 15.420 1
1000102 13.761 2
1000301 3.339 1
1000302 4.362 2
1000601 0.0 2
1000801 0.0 2.558 1
1000802 0.0 2.417 2
1001001 00 2
1001101 0000 1
1001201 3 2245.1 589.25 0.0
1001202 3 2242.6 589.23 0.0
1001300 1
1001301 30464.55 0.0 0.0 1

```

**.i -> XML**



**XML**

**.rlp file**

```

**RelapComponent pipe**
1000000 ihl pipe
**NumberOfVolumes **
1000001 2
**XArea volumeNumber **
1000101 15.420 1
1000102 13.761 2
**XLength volumeNumber **
1000301 3.339 1
1000302 4.362 2
**Azimuth volumeNumber **
**VerticalAngle volumeNumber **
1000601 0.0 2
**XElevationChange volumeNumber **
**xwallRoughness XhydraulicDiameter volumeNumber **
1000801 0.0 2.558 1
1000802 0.0 2.417 2
**YLength volumeNumber **
**XcoordinateFlags volumeNumber **

```

# Examples of Constraints

## Valve Position (certain valves)

```
RELAPInput:InitialPosition
xs:minInclusive:0
xs:maxInclusive:1
```

## Volume Control Flag *tlpvbfe*

```
RELAPInput:VolumeControlFlags
xs:minLength:1
xs:maxLength:7
xs:pattern:\d{1,7}
```

## Fluid Options

```
RELAPInput:FluidType
Choice:h2o
Choice:h2oold
Choice:d2o
Choice:r134a
Choice:he
Choice:ms1
Choice:ms2
Choice:ms3
Choice:ms4
Choice:co2
Choice:hen
Choice:xen
Choice:henxen
Choice:nak
Choice:lipb
Choice:bipb
Choice:h2
Choice:h2on
```

## Trip Relationships

```
RELAPInput:Rel
Choice:lt
Choice:le
Choice:gt
Choice:ge
Choice:eq
Choice:ne
```

## Thermodynamic state IC

```
RELAPInput:tFlag
xs:minInclusive:0
xs:maxInclusive:8
```

# Main Editing Form

C:\RELAPdata\typwr.i

File Tools View Edit Reports

What changed? Compare to...

Junction

- Component-286
- Component-287
- Component-288
- Component-291
- Component-292
- Component-293
- Component-294
- Component-191
- Component-192
- Component-193
- Component-194
- Component-290
- Component-190
- Component-300
- BRANCH-2**
  - Junction-3
  - Junction-4
- Component-305
- Component-310
- Component-315
- Component-320
- Component-322
- Component-323
- Component-325
- Component-330
- Component-335
- Component-336
- Component-340

RELAPInputModel\Component\BRANCH@Length

Number Of Junctions 2 Initial Conditions Control 1 Area 19.7945

Length A  
The 'Length' attribute is invalid - The value 'A' is invalid according to its datatype 'Float' - The string 'A' is not a valid Singl

Elevation Change -2.08329 Wall Roughness 0.0 Hydraulic Diameter 1.3764

Volume Control Flags 00 e Flag 0  Boron t Flag 3

ICArg 1 2275.3 ICArg 2 530.09 ICArg 3 ICArg 4

ICArg 5

Comment

C:\RELAPdata\typwr.i

File Tools View Edit Reports

What changed? Compare to...

Volume Junction

- Component-185
- Component-186
- Component-187
- Component-188
- Component-390
- Component-200
- PIPE-5
  - Volume-1
  - Volume-4
  - Volume-5
  - Volume-3
  - Junction-2
  - Junction-3
  - Junction-4
  - Volume-2
- Component-201
- Component-202
- Component-203
- Component-204
- Component-205
- Component-206
- Component-207
- Component-208
- Component-209
- Component-210
- Component-212
- Component-214
- Component-395
- Component-270
- Component 271

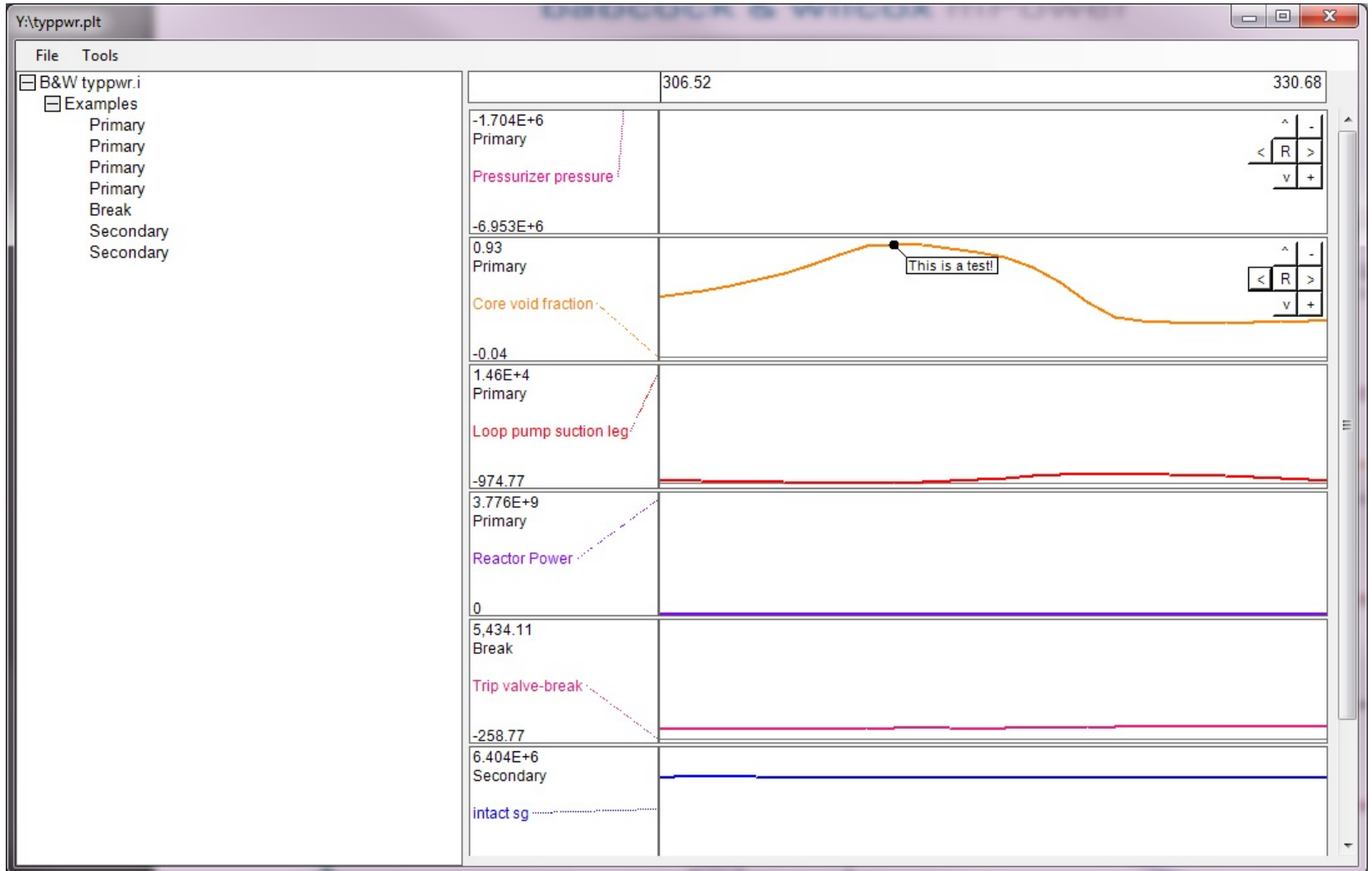
RELAPInputModelComponentPIPE

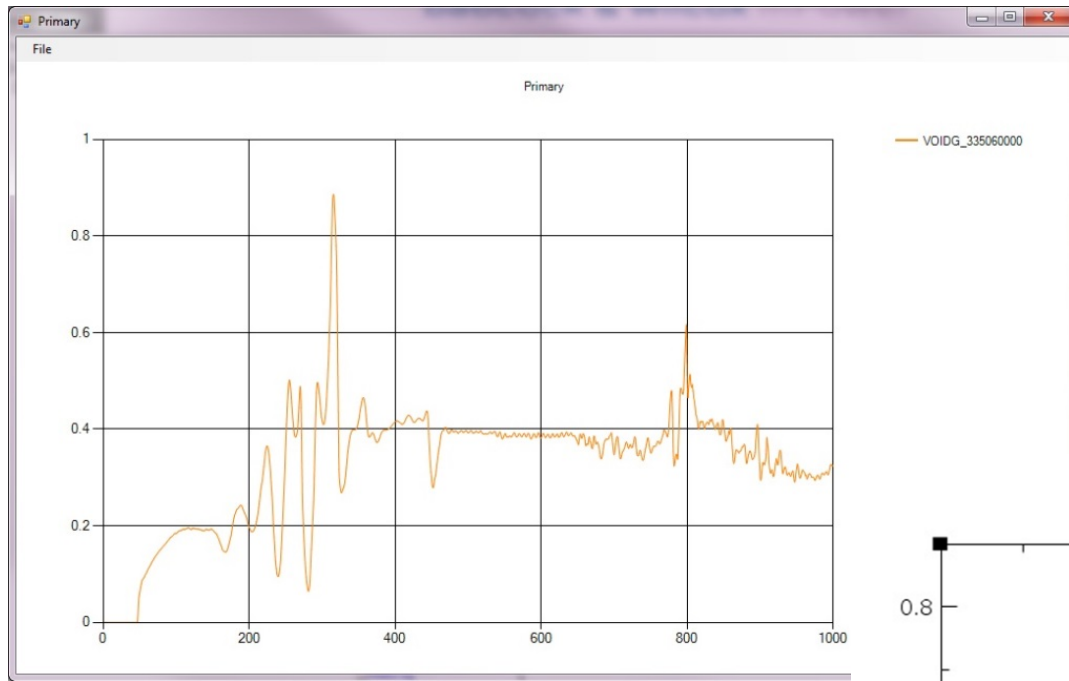
VolumeNumber	Segment	XArea	XLength	Volume	Azimuth
1		5.140	3.339		
4		4.587	0.0	32.	
5		0.0	5.418	27.079	
3			4.362	0.0	
2					

typwr.i-comp 200

VolumeNumber	Segment	XArea	XLength	Volume	Azimuth	VerticalAngle
1		5.14	3.339			
4		4.587	0	32		0
5		0	5.418	27.079		34
3			4.362	0		
2						

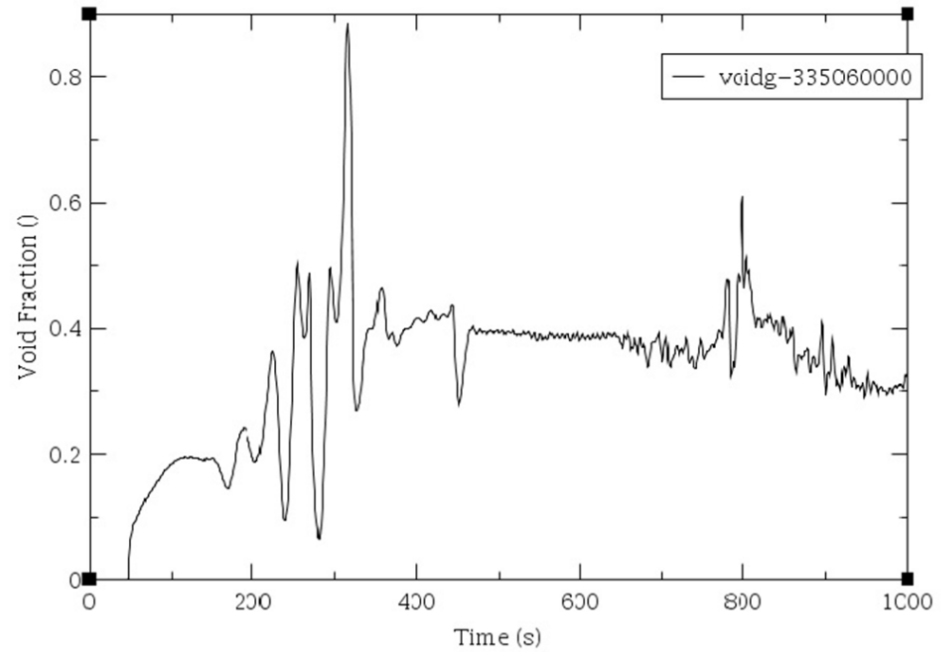
# Graphing of Results





**Aptplot**

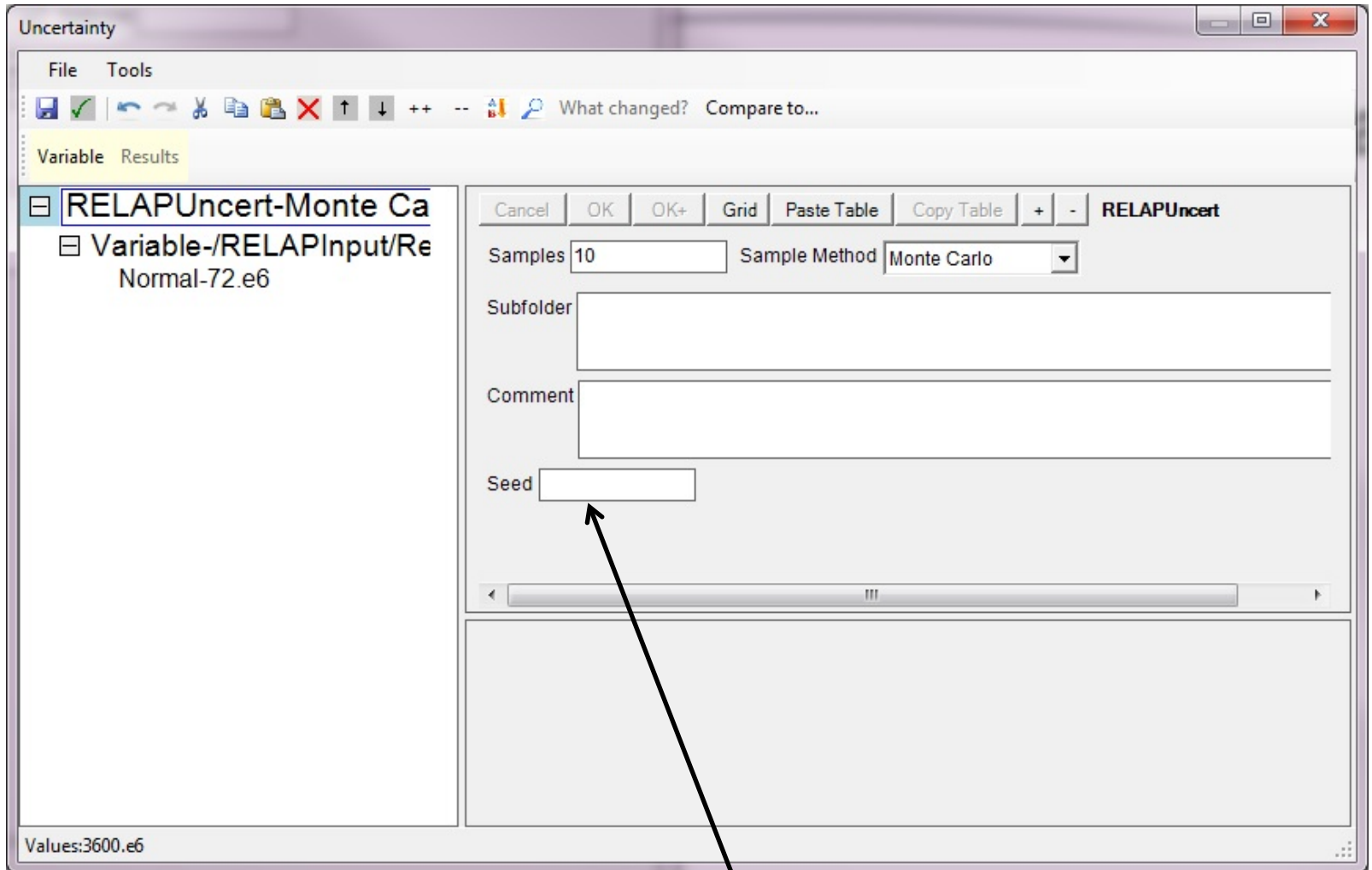
**RelapManager**



\*run was extended to 1000 secs



# Defining Uncertainties



Specify a seed to reproduce specific case



- [-] RELAPUncert-Monte Carlo
  - [-] Variable-/RELAPInput/React
    - Normal-72.e6

Cancel OK OK+ Grid Paste Table Copy Table + - RELAPUncertVariable

XPath

Att Name

Type  Elements Found

Comment

Min Value  Max Value   Multiplier



RELAPUncert-Monte Carlo  
Variable-/RELAPInput/React  
Normal-72.e6

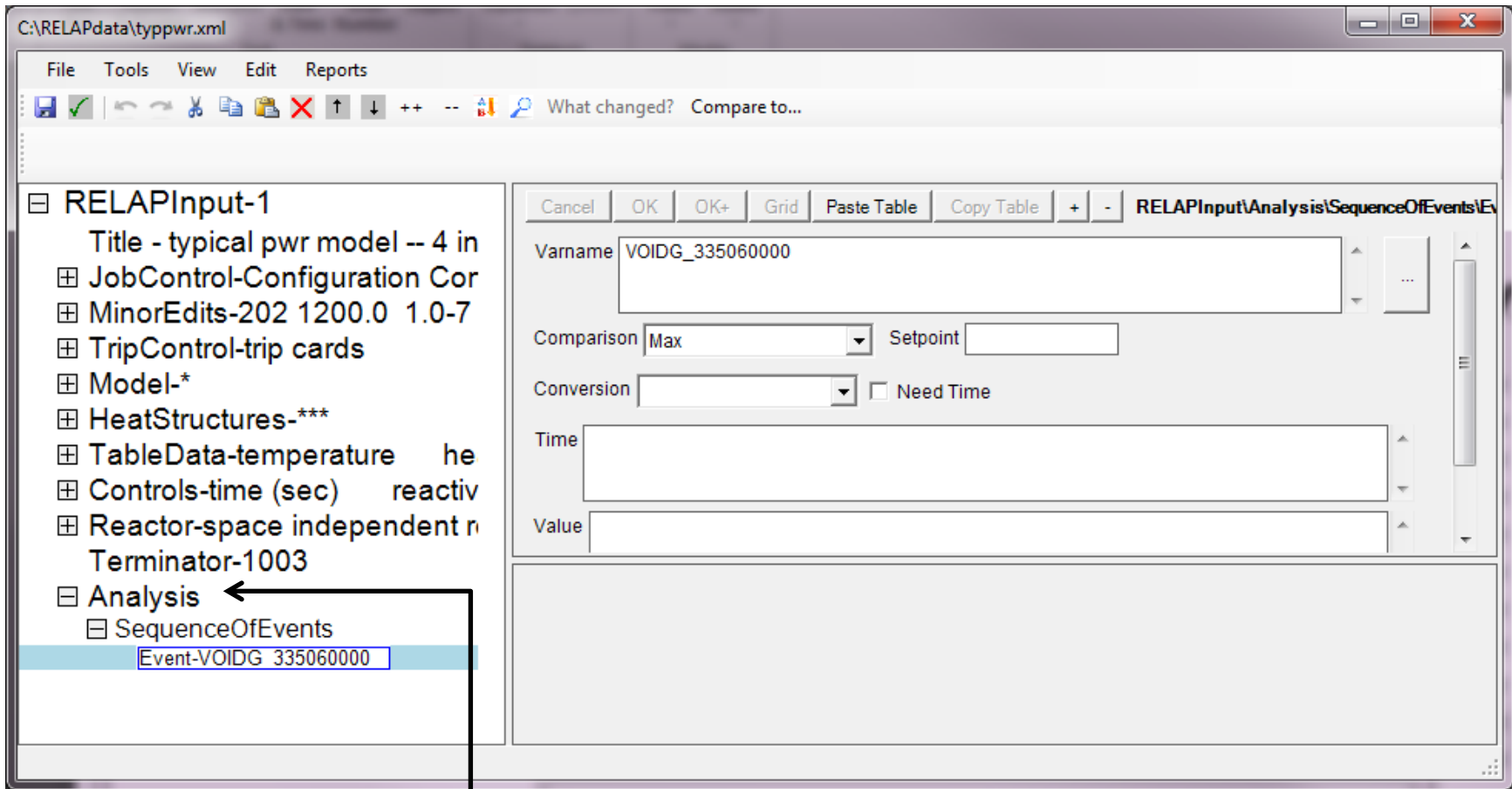
Cancel OK OK+ Grid Paste Table Copy Table + - RELAPUncertVariableNormal

Standard Deviation

Comment

typpwr.sh	SH File	2 KB	8/29/2013 3:14 PM
typpwr_1.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_2.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_3.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_4.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_5.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_6.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_7.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_8.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_9.sh	SH File	1 KB	8/29/2013 3:14 PM
typpwr_10.sh	SH File	1 KB	8/29/2013 3:14 PM

```
#Job1
cp typpwr.rlp typpwr_1.rlp
sed 's/%VAR1%/3.535556E+09/g'
<typpwr_1.rlp> temp.rlp
cp temp.rlp typpwr_1.rlp
#Queue the Job
qsub -V -d `pwd` -N Relap5.typpwr_1 -j oe ./
typpwr_1.sh
```



Add criteria per analysis

# Report Generation

## Relap Uncertainty Definition

Number of samples: 10

Folder to create files in:

Sampling method: Monte Carlo

Comment:

### Parameters to vary

Selection	Parameter	Type	Distribution data	Samples			
				Pass	Counter	Point Est.	Sample
<u>RELAPInput/Reactor[@ID='982']</u>	<u>TotalReactorPower</u>	Individual	Normal - SD=72.e6	1	1	3.6E+09	3.535556E+09
				2	1	3.6E+09	3.639594E+09
				3	1	3.6E+09	3.756218E+09
				4	1	3.6E+09	3.558804E+09
				5	1	3.6E+09	3.653432E+09
				6	1	3.6E+09	3.713401E+09
				7	1	3.6E+09	3.578479E+09
				8	1	3.6E+09	3.642868E+09
				9	1	3.6E+09	3.697747E+09
				10	1	3.6E+09	3.684468E+09

## Results

<u>Vamame</u>	Comparison	Samples			Average	<u>Standard Dev</u>
VOIDG_335060000	Max	Pass	Value	Time	0.8039271	0.1775656
		1	1	891		
		2	0.671271860599518	315		
		3	0.99998551607132	944		
		4	0.719223380088806	317		
		5	0.628379702568054	954		
		6	0.627355098724365	311		
		7	0.796990990638733	317		
		8	0.999964892864227	956		
		9	1	902		
10	0.596099495887756	895				

# Html document



## TRIP CONTROL

### VARIABLE TRIPS

TripNo	Var1	Parm1	Rel	Var2	Parm2	AddConst	Latch	Comment
501	p	150010000	le	null	0	1860.0	1	
502	time	0	ge	timeof	501	3.4	1	
503	p	150010000	le	null	0	1830.0	1	
504	time	0	ge	timeof	503	5.0	1	
505	time	0	ge	timeof	501	14.0	1	
506	time	0	ge	null	0	0.01	1	
507	time	0	ge	null	0	0.0	1	
508	p	150010000	ge	null	0	2350.0	0	
509	p	150010000	ge	null	0	2330.0	0	
510	p	180010000	le	null	0	14.7	1	
511	voidg	172010000	le	null	0	0.30838	0	
512	voidg	172010000	ge	null	0	0.39578	0	

Title:typical pwr model – 4 inch cold leg break 36.05 check case

**Purpose:**  
**Copyright:**  
**Credits:**  
**URL:**  
**Version:**



### LOGICAL TRIPS

TripNo	TripNumber1	Operator	TripNumber2	Latch
601	603	and	509	0
602	601	or	508	0
603	602	and	509	0
604	505	and	511	0
605	505	and	512	0
606	608	and	604	0
607	606	xor	605	0
608	607	and	605	0

# Word document

# ***Benefits of RelapManager***

- **Integral analysis tool**
- **Maintains function and integrity of RELAP5-3D**
- **Performs uncertainty/sensitivity analyses**
- **Improves post-processing uncertainty results**
- ***Promotes efficiency and productivity!***

# *Development Status*

- **Phase 1**
  - SRS and SVVP
- **Phase 2**
  - SDS
- **Phase 3**
  - Source code, User Manual, test cases
- **Phase 4**
  - Testing
- **Phase 5**
  - Approval and release-ready to use!





***Questions?***