

Chemical Engineering 512

Nuclear Reactor Transient Modeling

Lecture 3

RELAP5-3D Input

RELAP5 Components



Spiritual Thought

“To establish Zion in our homes, branches, wards, and stakes, we need to (1) become unified in one heart and one mind; (2) become holy people; and (3) care for the poor and needy. We cannot wait until Zion comes for these things to happen—Zion will come only as they happen.”

-Elder D. Todd Christopherson



Objectives

- Go over questions from DVDs
- Learn how to build an input deck
- Build a sample input deck



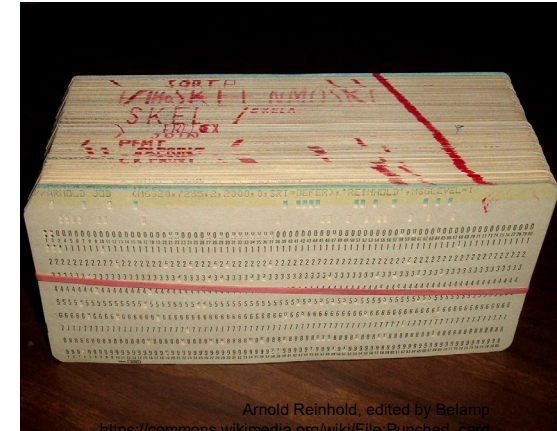
DVD Questions?

- RELAP Code Overview
- RELAP5-3D Code Overview
- Execution Procedures
- Input Description (Part 1)



Input Deck Information

- Use text editor
 - Really anything, Notepad ++ works well
- Files saved with “.i” extension
- 80 Character Length
- * or \$ to comment
- Must end with a “.”
- All lowercase unless in a name
- Do not use TABs
- All input word descriptions can be found in the Appendix



Arnold Reinhold, edited by Belamp
https://commons.wikimedia.org/wiki/File:Punched_card_program_deck.agr.jpg

Comment EVERYTHING

0750001	26	
0750101	0.061977823	26
0750301	.076395	1
0750302	.153416	3
0750303	.153314	23
0750304	.153416	25

VS

*	name	type	
0750000	"Ch1Q1"	pipe	* quadrant 1, channel 1 volume properties
*	nodes		
0750001	26		
*	FlowArea	vol#	
0750101	0.061977823	26	* 2 assemblies *
*	Node Length	vol#	
0750301	.076395	1	
*	Node Length	vol#	
0750302	.153416	3	
*	Node Length	vol#	
0750303	.153314	23	
*	Node Length	vol#	
0750304	.153416	25	



Custom Language in Notepad ++

- Language → User Defined Language → Define Your Language
- Create New → Name is whatever you'd like (RELAP)
- Ext. → .i
- Comment & Number → Comment Line Style → Open → *
- Comment & Number → Comment Style → Open → *
- Then use styler to choose what choose foreground color (text color)
- Exit
- Language tab → Select RELAP
- Now all your comments will be one color and your code will be black



Title Card

- = Title of Deck



Miscellaneous Control Cards (A2-12)

- 100 Problem Type Problem Option
- 101 INP-CHK/RUN
- 102 input units output units
- 105 time remaining 1 time remaining 2 (adv) CPU time allotted
- 110 noncondensable gas
- 120 ref. vol elevation fluid type system name

```
100 new stdy-st
*
102 british si
105 5.0 6.0 5000.0
110 nitrogen
```



Time Step Control Cards (A3-1)

- 201 End Time min time step max time step ssdtt minor
 major restart
- ssdtt – time step options
- Minor*min time step = minor data point every _____ seconds
- Major*min time step = major data point every _____ seconds
- Restart*min time step = generate restart file every _____ seconds

```
201 10000.0 1.0-7 0.01 07003 100 50000 50000
```



Hydrodynamic Components

- Single Volume
 - Holds liquid or gas
- Single Junction
 - Connects two volumes
- Time Dependent Volume
 - Imposes a boundary condition
- Time Dependent Junction
 - Used to supply fluid and specific flow rate



Hydrodynamic Input Numbering

CCCXXNN

- CCC component number
- XX card type
- NN card number within card type



Single Volume (Appendix Page A7-1)

- Component Name and Type
 - CCC0000 name snglvol
- X-Coordinate Volume Data
 - CCC0101 X-area X-length X-volume
 - CCC0102 X-azim X-incl X- Δz
 - CCC0103 X-roughness X-D_h X-tlpvbf
- Initial Conditions
 - CCC0200 ϵ bt initial conditions

```
1060000 isglip snglvol
1060101 28.550 0.0 149.43 0.0 49. 3.958 0.0 6.029 00
1060200 3 2233. 594.14
```



Single Volume (Appendix A7-1)

- Area, Length, and Volume
 - Only need 2, leave the other as 0.0
- Azimuthal Angle
 - Not used, enter 0.0
- Inclination Angle
 - 0 – horizontal
 - 90 – vertical upward
 - -90 – vertical downward
- Hydraulic diameter
 - Can be computed by hand
 - Input 0 to allow the computer to complete the calculation



Single Volume (Appendix A7-1)

- Volume Control Flags
 - t thermal front tracking
 - l mixture level tracking
 - p water packing
 - v vertical stratification
 - b interphase friction
 - f wall friction
 - e equilibrium/non-equilibrium
- If default enter 00 or do not input



ε

- 0 default fluid
- 1 H_2O
- 2 D_2O
- 3 H_2

b

- 0 no boron
- 1 boron

t

- 0 $P, u_t, u_g, \text{ and } \alpha$
- 1 $T \text{ and } X$
- 2 $P \text{ and } X$
- 3 $P \text{ and } T$
- 4 $P, T, \text{ and } X_e$
- 5 $T, X, \text{ and } X_{nc}$
- 6 $P, u_t, u_g, \alpha, \text{ and } X_{nc}$



Single Volume Example

- Component Name and Type
 - CCC0000 name snglvol
 - X-Coordinate Volume Data
 - CCC0101 X-area X-length X-volume
 - CCC0102 X-azim X-incl X- Δz
 - CCC0103 X-roughness X-D_h X-tlpvbfe
 - Initial Conditions
 - CCC0200 εbt initial conditions
-
- Create a single volume named “test” that starts out at a pressure of 3000Pa and 400K. This volume is perfectly smooth, has a downwards inclination of 5° and a change in height of 0.7m. The length of “Test” is 5m and its volume is 25m³. You may assume all flags are set to default. Number this volume
105



Single Volume Results

*Answer

	test	snglvol
1050000		
1050101	0.0	5 25
1050102	0.0	-5 -0.7
1050103	0.0	0.0 00
1050200	3	3000 400



Single Junction (Appendix Page A7-17)

- Component Name and Type
 - CCC0000 name sngljun
- Geometry
 - CCC0101 from to area
 - CCC0102 A_F A_R jefvcahs
- Initial Conditions
 - CCC0201 vel/mfr liquid vapor interface

```
1070000    isglptu        sngljun
1070101    106010000    108000000    11.099    0.0    0.0    0100
1070201    1    9737.    0.0    0.0
```



Single Junction (Appendix Page A7-17)

- Connections
 - CCC000000 – inlet of CCC
 - CCC010000 – outlet of CCC
- Area
 - If 0, minimum adjoining area is used
- Input Conditions
 - Vel/mfr
 - 0 to input velocities
 - 1 to enter mass flow rates



Single Junction (Appendix Page A7-17)

- Junction Control Flags

e modified PV term in
energy equations

f CCFL

v horizontal stratification
entrainment

c choking

a smooth/abrupt area

change



Single Junction (Appendix Page A7-17)

- Component Name and Type
 - CCC0000 name sngljun
- Geometry
 - CCC0101 from to area
 - CCC0102 A_F A_R jefvcahs
- Initial Conditions
 - CCC0201 vel/mfr liquid vapor interface

Create a single junction that connects from the outlet of volume 105 to the inlet of 107. Let the computer calculate the minimum area for this connection. You may assume loss coefficients are 0 and there are no flags. Name the junction “test2” and number it 106. Assume there is no gas in the junction and that the initial liquid mass flow rate is 2.11 kg/s.



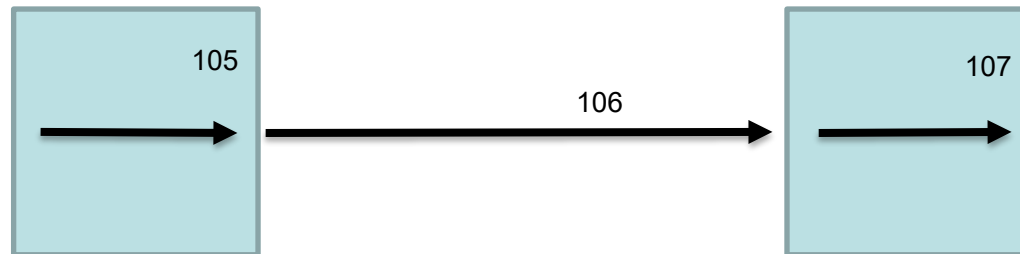
Single Junction (Appendix Page A7-17)

*Answer

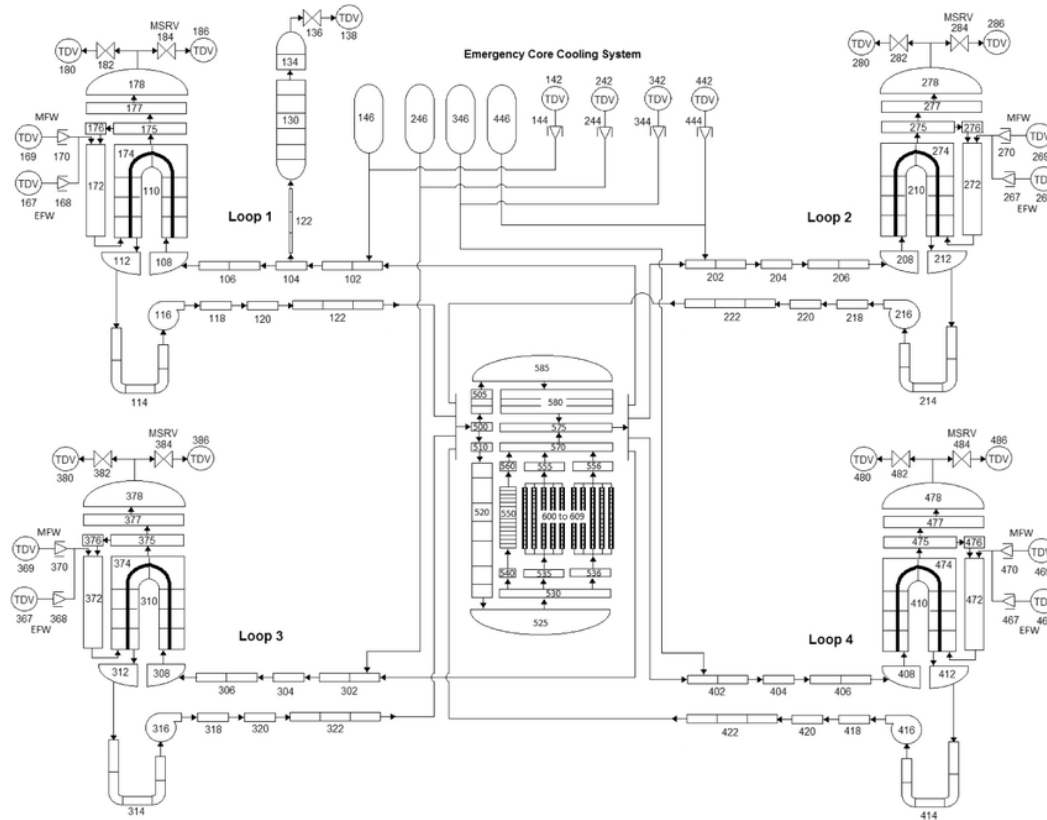
	test2	sngljun		
1060000				
1060101	105010000	107000000	0.0	
1060102	0.0	0.0	00000000	
1060201	1	2.11	0.0	0.0



What did we just do?



What is our goal?



Time Dependent Volume (A7-10)

- Component Name and Type
 - CCC0000 name snglvol
- X-Coordinate Volume Data
 - CCC0101 X-area X-length
X-volume
 - CCC0102 X-azim X-incl
X- Δz
 - CCC0103 X-roughness X-D_h
X-tlpvbf
- Data Control
 - CCC0200 εbt trip #
search variable
 - CCC0201 search variable data

```
* inj
7500000    injvol tmdpvol
7500101    1000. 1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7500200      2
7500201    0.0 2500. 0.
```



Time Dependent Volume (A7-10)

- Same as single volume but card 200 is different
- ϵ_{bt} is same as single volume
- Trip is optional
 - Don't worry about this now
- If no search variable is entered, time is used
- Used where fluid is coming into the model at specific conditions



Time Dependent Junction (A7-22)

- Component Name and Type
 - CCC0000 name tmdpjun
- Geometry
 - CCC0101 from to area jefvcahs
- Data Control
 - CCC0200 vel/mfr trip # search variable
 - CCC0201 search variable liquid vapor

```
1810000  mnfeedl  tmdpjun
1810101  182000000  174000000  0.736
1810200  1      506
1810201  -1.0  968.25  0.0  0.0
1810202  0.0  968.25  0.0  0.0
1810203  20.  968.25  0.0  0.0
1810204  20.1 0.0    0.0  0.0
```



Time Dependent Junction (A7-22)

- Again, much like single junction
- Used to supply fluid as specified flow rate or velocity



Pipe (A7-26)

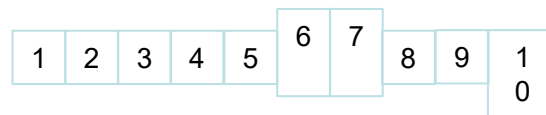
- CCC0000 name pipe
- CCC0001 number of volumes
- CCC0101 X-area vol #
- CCC0301 X-length vol #
- CCC0601 X-incl vol #
- CCC0801 X-rough X-D_h vol #
- CCC1001 tlpvbfe vol #
- CCC1101 jefvcahs jun #
- CCC1201 εbt initial conditions vo
- CCC1300 vel/mfr
- CCC1301 liquid vapor interface jun#

```

1000000 ihl1 pipe
1000001 2
1000101 5.14 1
1000102 4.587 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 2233. 594.14 0.0 0 0 1
1001202 3 2233. 594.14 0.0 0 0 2
1001300 1
1001301 9737. 0.0 0.0 1
  
```

Pipe (A7-26)

- Annulus is same just put annulus as type
- Number of junctions
 - Number of volumes – 1
- Sequential Expansion Notation
 - 1000101 0.5 5
 - 1000102 0.75 7
 - 1000103 0.5 10



End of Deck Card

- .
- DO NOT FORGET THIS CARD!!!!

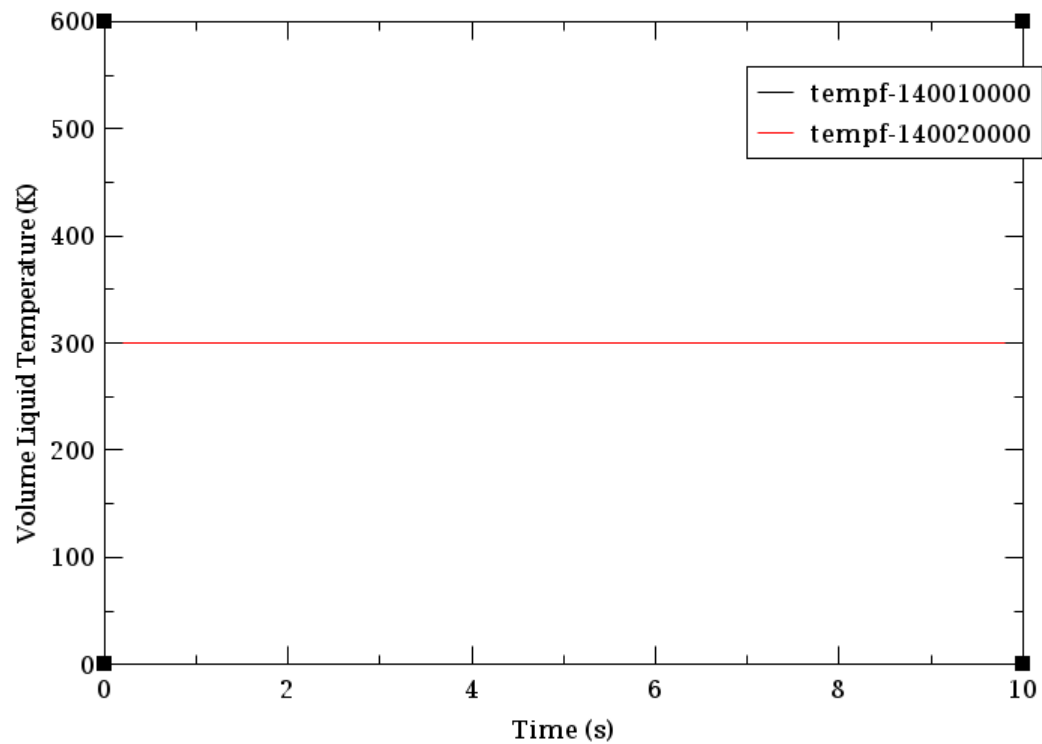


Lets Practice!

- Create and input deck for a 2-volume pipe of any size with an initial temperature and pressure of 300K and 100000Pa with the water being stagnant.
- Run the input deck for 10sec and generate a plot of the temperature of the fluid in that volume.
- What do we expect to happen?
What did happen?



Results



Assignment

- Before next class, watch sections 7 and 11 on DVDs
- Homework 2 is due Thursday (9/18)

