Chemical Engineering 512

Nuclear Reactor Transient Modeling

Lecture 10

Transient Analyses

Spiritual Thought

"Prayers that do not demand much of your thought will hardly merit much attention from our Heavenly Father. When you find yourself getting into a routine with your prayers, step back and think. Meditate for a while on the things for which you really are grateful. Look for them. They don't have to be grand or glorious. Sometimes we should express our gratitude for the small and simple things like the scent of the rain, the taste of your favorite macaroni and cheese recipe, or the sound of a loved one's voice... Think of those things you truly need. Bring your goals and your hopes and your dreams to the Lord and set them before Him. Heavenly Father wants us to approach Him and ask for His divine aid. Explain to Him the trials you are facing. Set before Him your righteous desires. Our prayers can and should be focused on the practical, everyday struggles of life."

-Joseph B Wirthlin

Objectives

- Go over how to input a plant transient
- Practice planning a transient

Reminder about commenting

```
1400000 pipe2 pipe
1400001 10
1400101 1.0 10
1400201 1.0 9
1400301 10.0 10
1400401 0.0 10
1400501 0.0 10
1400601 0.0 10
1400701 0.0 10
1400801 0.0 0.0 10
1400901 0.0 0.0 9
1401001 0000000 10
1401101 00000000 9
1401201 003 2000. 500. 0. 0. 0. 10
1401300 1
1401301 9000 0.0 0.0 9
1401401 0.0 0.0 1.0 1.0 9
```

```
**********************************
*           Pipe - 140           *
**********************************
1400000    pipe2    pipe
1400001    10
1400101    1.0                          10
1400201    1.0                          9
1400301    10.0                         10
1400401    0.0                          10
1400501    0.0                          10
1400601    0.0                          10
1400701    0.0                          10
1400801    0.0         0.0              10
1400901    0.0         0.0              9
1401001    0000000                      10
1401101    00000000                     9
1401201    003   2000.  500.  0.  0.  0.  10
1401300    1
1401301    9000    0.0    0.0          9
1401401    0.0         0.0        1.0   1.0    9
```

```
*          Af          Af               JunNum
1400901    0.0         0.0              9
*          tlpvbfe                      VolNum
1401001    0000000                      10
*          Jefvcahs                     JunNum
1401101    00000000                     9
*          Ebt    Initial-Conditions       VolNum
1401201    003   2000.  500.  0.  0.  0.  10
*          Vel/Mfr
1401300    1
*          Liquid  Vapor  Interface  JunNum
1401301    9000    0.0    0.0        9
*          JunHydDia  Flooding  c     Slope  JunNum
1401401    0.0        0.0       1.0   1.0    9
```

Transients in RELAP

- **Transient**: A change in the reactor coolant system temperature, pressure, or both, often eliciting a change in the reactor's power output. Transients can be caused by (1) adding or removing neutron poisons, (2) increasing or decreasing electrical load on the turbine generator, or (3) accident conditions.
- We will cover part of 1 transient today
- We will learn about other transients on Thursday
- You will be dealing with more complex transients for your final project

Determining What Is Needed

- Figure out what transient you will be monitoring
- Figure out what components are needed for the base model
- Figure out what components are needed for the transient

Ensuring Safety Measures Are In Place

- When modeling a transient we must ensure safety measures are in place once the transient occurs
- Example:
  - Loss of coolant – how to cool the reactor
  - Station blackout – how to keep flowing coolant/safely shutdown
  - Pipe break – alternate coolant flow route?

Ensure Everything is Running Correctly

- No errors
- Trips are starting correctly and tripping at the correct time
- Correct VALUES, not just absence of errors

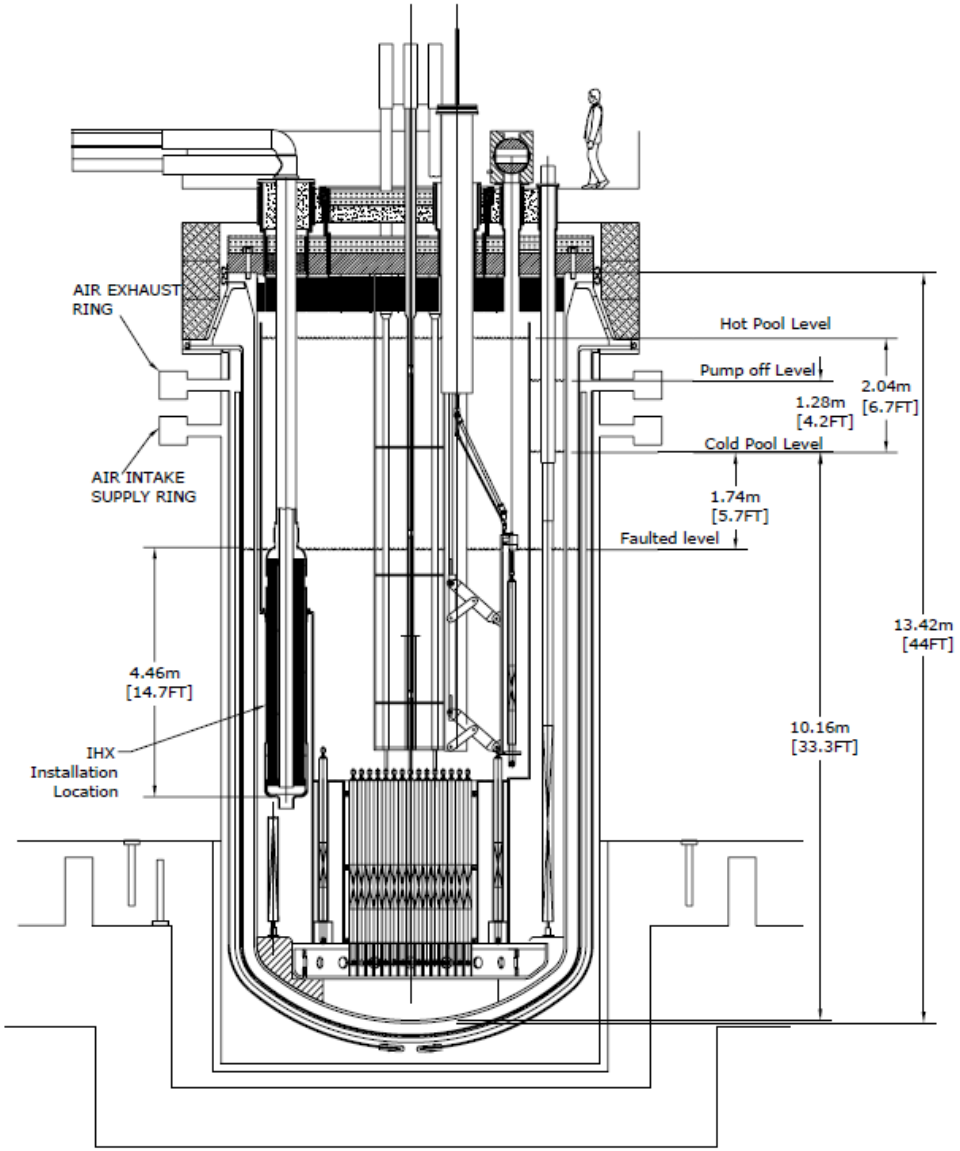
Determine Variable

- What variables are you interested in?
  - Pressures?
  - Temperatures?
  - Flow Rates?
  - Liquid Levels?
  - Fuel-to-coolant heat transfer
- Determine if you need to create control variables
  - We will cover this in a few weeks

Some Typical Components Used

- Trips – to initialize events
- Trip valves – to “break” pipes
- Time dependent volumes – sinks for leaks
- Tables – change reactor power

Advanced Burner Test Reactor



ABTR Top Down View

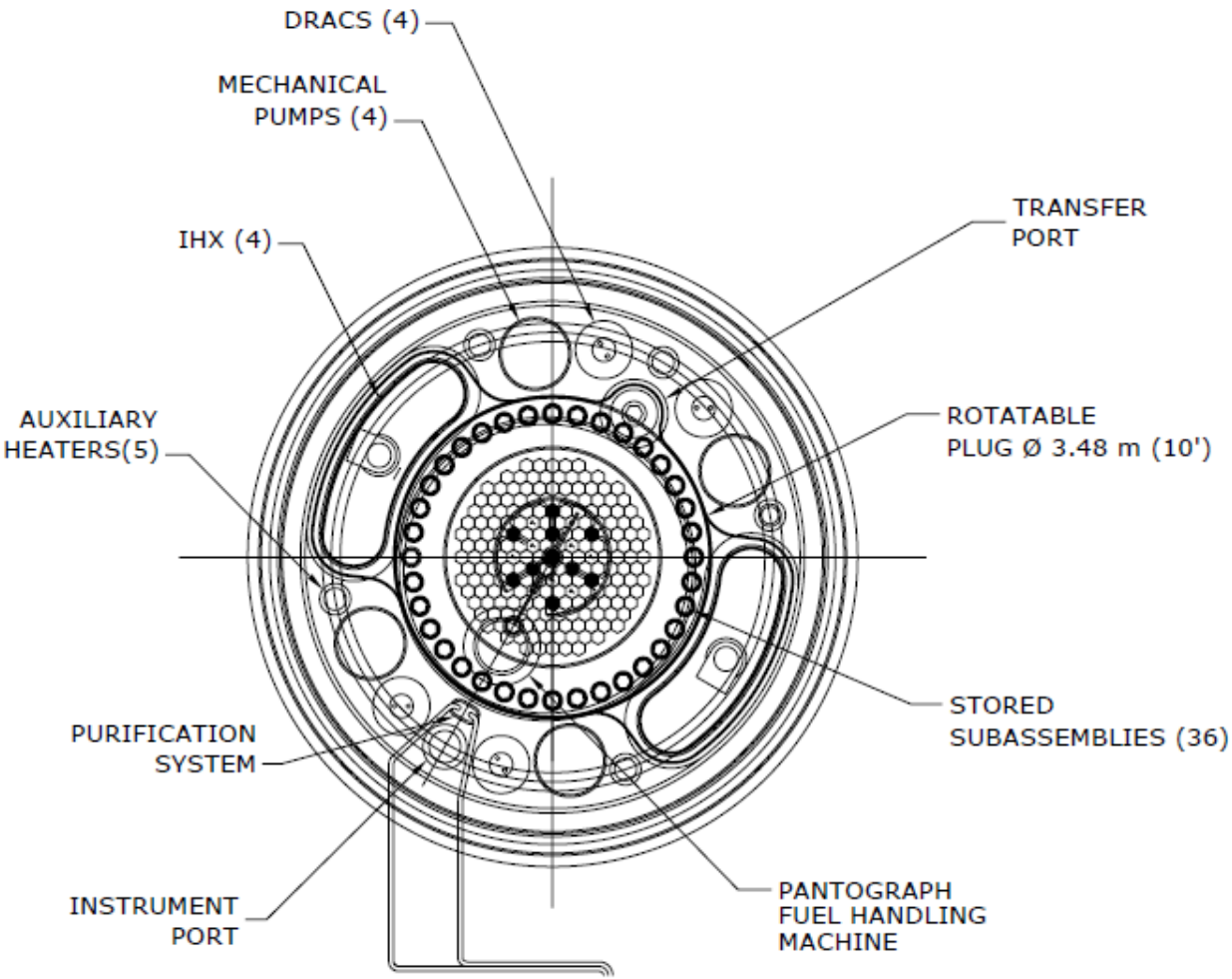


Figure II.2-2 Plan View of the Primary System

ABTR Core

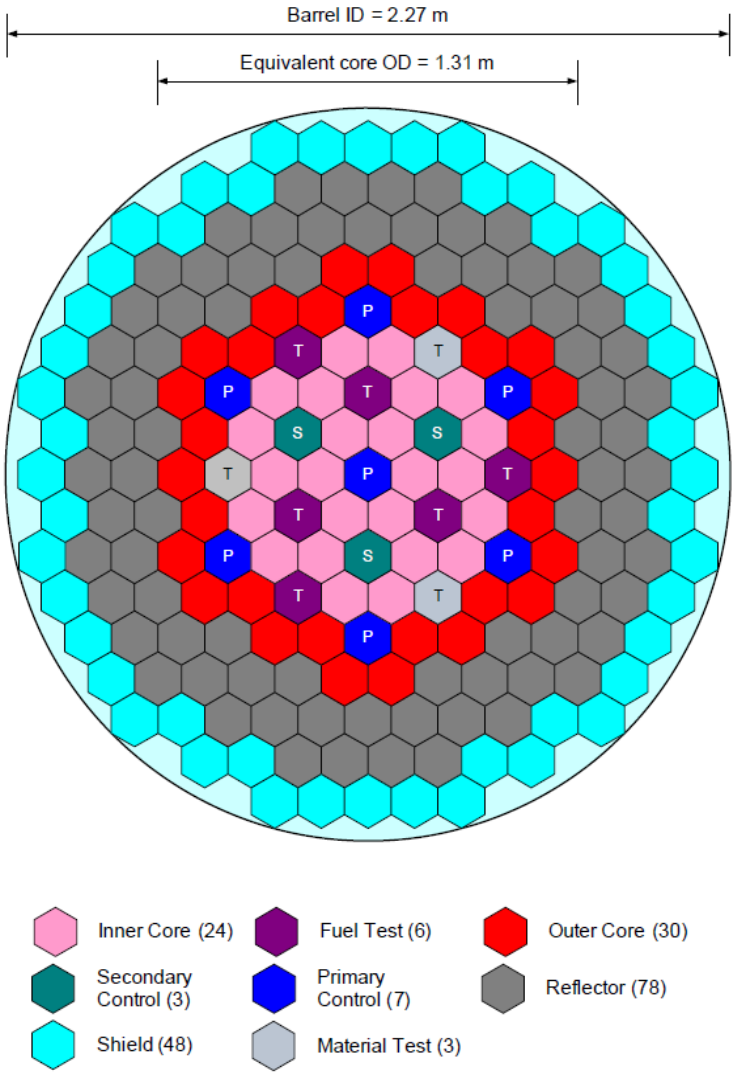
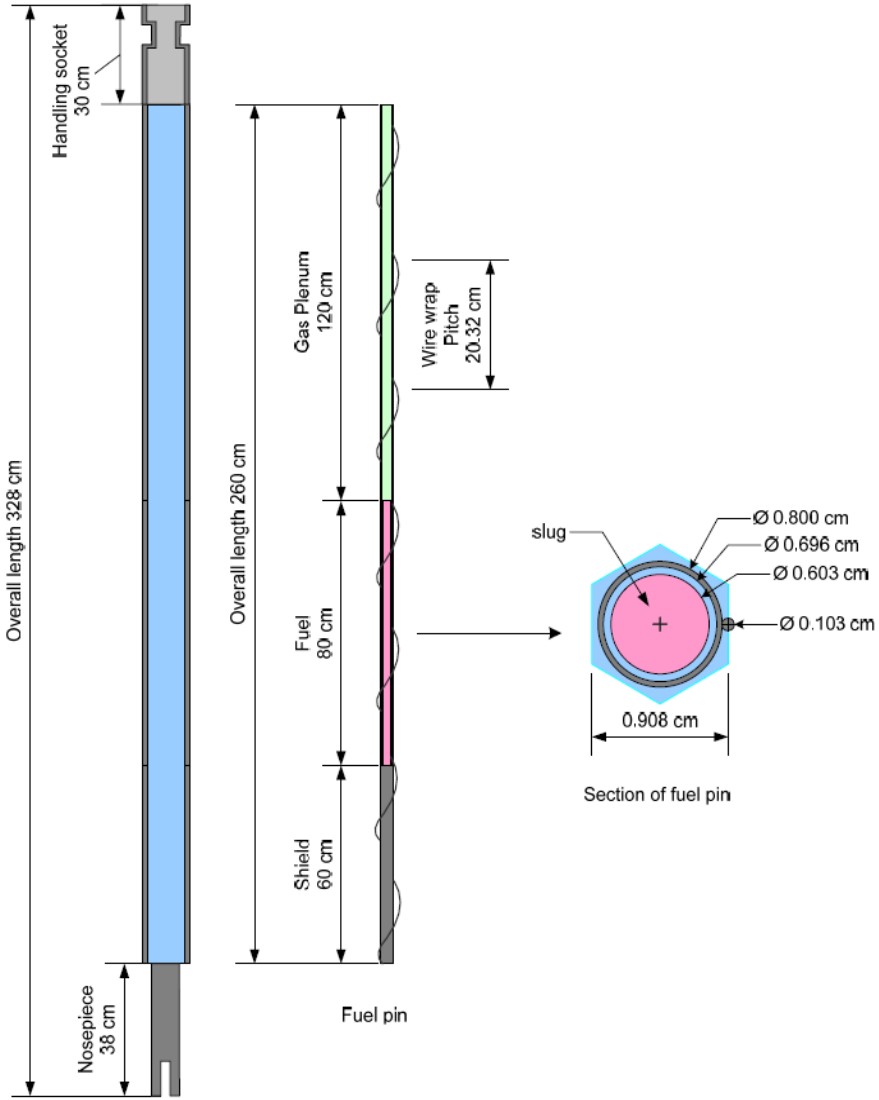


Figure II.1-1 Reference ABTR Core Configuration

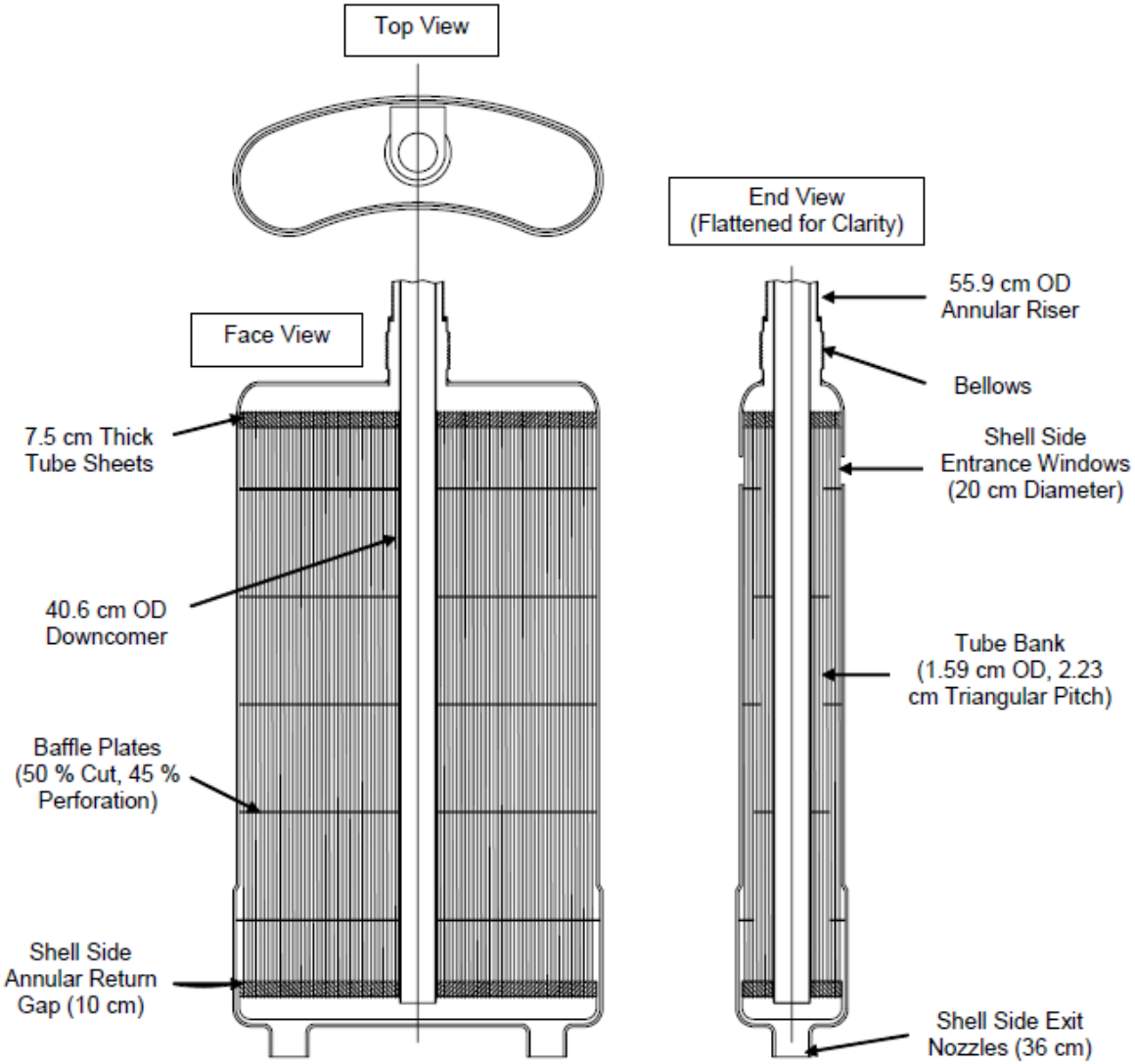
Table II.1-1 TRU Isotopic Composition (%)

	WG-Pu	LWR-SF TRU
Np-237	0.00	4.60
Pu-238	0.01	1.35
Pu-239	93.81	51.77
Pu-240	5.81	23.67
Pu-241	0.35	7.80
Pu-242	0.02	4.67
Am-241	0.00	5.08
Am-242m	0.00	0.01
Am-243	0.00	0.88
Cm-243	0.00	0.00
Cm-244	0.00	0.17
Cm-245	0.00	0.01
Cm-246	0.00	0.00

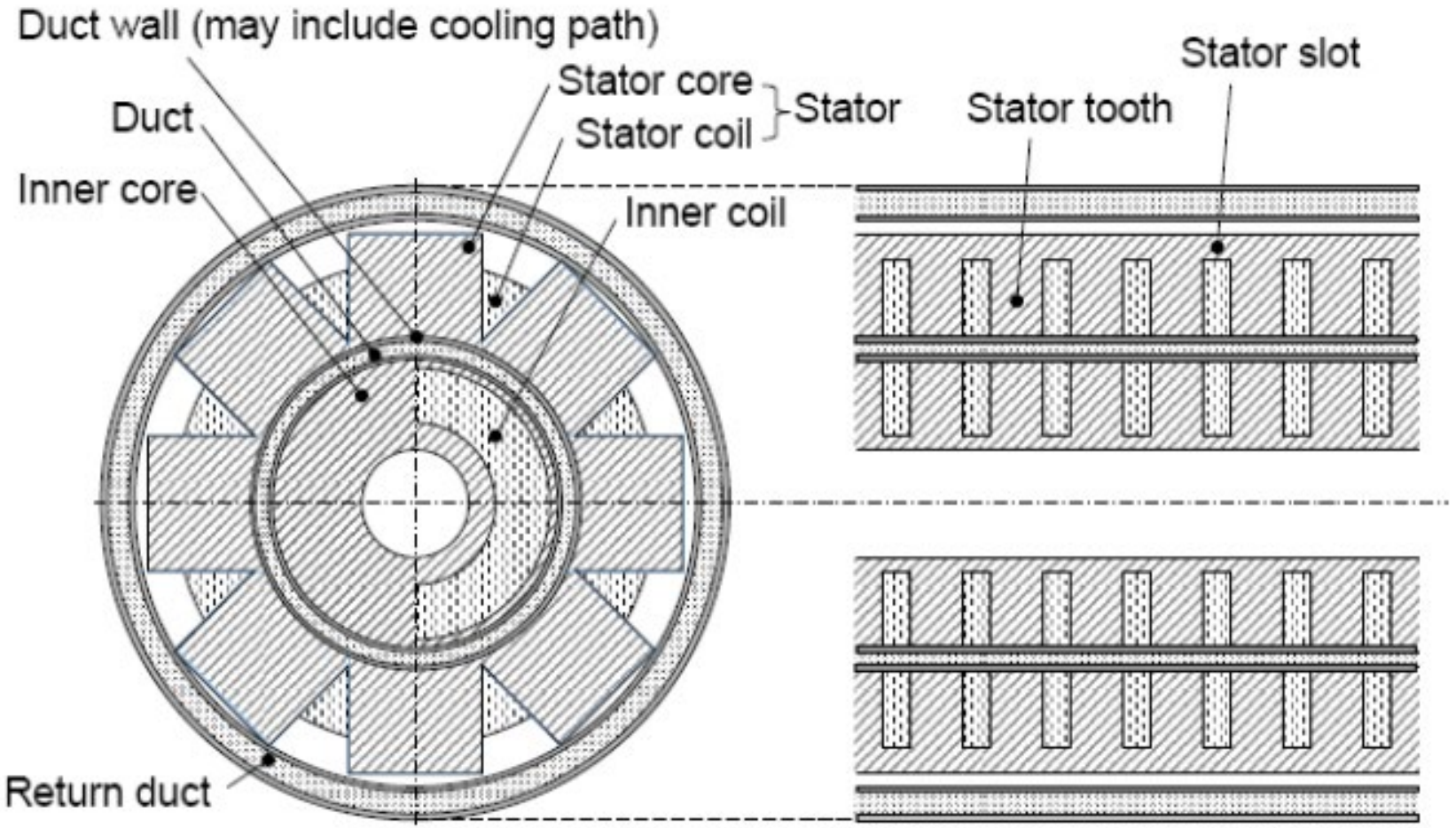
ABTR Fuel


Handling socket
30 cm
Overall length 328 cm
Nosepiece
38 cm
Overall length 260 cm
Gas Plenum
120 cm
Wire wrap
Pitch
20.32 cm
Fuel
80 cm
Shield
60 cm
Fuel pin
slug
Ø 0.800 cm
Ø 0.696 cm
Ø 0.603 cm
Ø 0.103 cm
0.908 cm
Section of fuel pin

ABTR HX


Top View
Face View
End View
(Flattened for Clarity)
7.5 cm Thick
Tube Sheets
40.6 cm OD
Downcomer
Baffle Plates
(50 % Cut, 45 %
Perforation)
Shell Side
Annular Return
Gap (10 cm)
55.9 cm OD
Annular Riser
Bellows
Shell Side
Entrance Windows
(20 cm Diameter)
Tube Bank
(1.59 cm OD, 2.23
cm Triangular Pitch)
Shell Side Exit
Nozzles (36 cm)

ABTR Pump


Duct wall (may include cooling path)
Duct
Inner core
Stator core
Stator coil
Stator
Inner coil
Stator slot
Stator tooth
Return duct

RELAP Model of ABTR (LOFA)

See ABTR Files

Assignment

- Watch DVD sections 53-57 before next class
- Homework 5 due Tuesday (10/10)