

PRISM Code Introduction

Exercise 1: Negative Reactivity Insertion Transient

Start PRISM with:

- default values, where possible
- 4 loops
- 100% power
- English units

Record the initial values of:

Reactor Power (MWth) _____

Primary Loop Average Temperature (°F) _____

Primary Loop Pressure (psig) _____

Narrow Range Water Level for the Steam Generator in Loop 3 (%) _____

Go to the Primary Loop Control Panel (F3)

Set the Control Rod Drive to Manual Mode (press M) and lower Bank D 30 steps (using the down arrow) at maximum possible rate (follow the directions at the bottom of the screen)

Freeze the run (F10) and record the following information:

Warning alarms (F5) _____

(F1)

Reactor Power (MWth) _____

Primary Loop Average Temperature (°F) _____

Primary Loop Pressure (psig) _____

Pressurizer Surge Flow (lbm/sec) _____

Is this surge flow in or out of the pressurizer? _____

Chemical and Volume Control Charging System (% of max) (F3) _____

Explain changes from initial conditions for power, temperature and pressure readings:

Resume the run (F10)

Allow to run for 1 minute to answer the following:
What happens to the power?

Why?

Freeze the run (F10)

Decrease the turbine load to 1056 MW (F4)
Set the rate of decrease at 3% of full power per minute
(follow directions at the bottom of the screen)

Run for 5 minutes.

Record warning alarms caused during the transient (F5):

After the 5 minutes has passed, sketch the temperature in the hot leg and cold leg of loop 3 as a function of time. (F6) Mark and explain the changes in the plot

Sketch the Primary Pressure as a function of time (F6).

Exercise 2: Increased Steam Demand Transient

Start PRISM with:

- default values, where possible
- 4 loops
- 75% power
- English units

Record the initial values of:

Reactor Power (MWth) _____

Primary Loop Average Temperature (°F) _____

Primary Loop Pressure (psig) _____

Narrow Range Water Level for the Steam Generator in Loop 3 (%) _____

Go to the Primary Loop Control Panel (F3)

Prevent the control rods from moving automatically by changing the control rod mode to manual

Go to the Secondary Loop Control Panel (F4)

Increase the Turbine Load to 997 MW at a rate of 3% full power/min

Run for 1 minute

Freeze the run (F10)

Record the values of (F1 or F3):

Reactor Power (MWth) _____

Primary Loop Average Temperature (°F) _____

Primary Loop Pressure (psig) _____

Dilute the Boron Concentration to 1235 ppm at a rate of -3 ppm/minute (F3)

(follow directions at the bottom of the screen)

(press "C" to access the Control Menu to activate the RCS Boron Control panel)

Run for 5 minutes

(suggestion: switch to the RCS Strip Charts (F6) during the 5 minutes to watch the variables change during the transient)

For the full 6 minutes, sketch the following parameters as a function of time and explain the major changes in shape (F6):

Reactor Power

Primary Loop 3 Hot Leg and Cold Leg temperatures

Feedwater and steam flow for loop 3

Why are the flow rates of Loop 1 slightly different from those of the other loops?
(check the NSSS screen to see this effect)

Exercise 3: Change of Grid Power Demand

This exercise illustrates the “load following” capability of a PWR.
This transient is characterized by the following sequence of events:

1. The grid demands more power
2. Higher steam flow rate is supplied to the turbine
3. As the outgoing steam rate is greater than the incoming feedwater rate, the pressure in the secondary side of the steam generator (SG) decreases
4. Primary coolant temperature at the SG exit decreases
5. Colder and denser water enters the core
 - ⇒ more efficient neutron moderation
 - ⇒ reactivity increases
 - ⇒ core power increases
6. Fuel temperature increases
 - ⇒ neutron capture (parasitic absorption) increases (due to the Doppler effect)
 - ⇒ reactivity decreases
7. New steady-state condition at a higher power is reached

Start PRISM with:

- default values, where possible
- 1 loop
- 90% power
- SI units

Got to the Primary Plant Control Panel (F3)

Set Control Rod Drive mode to “manual”, this will prevent an automatic insertion or removal of reactivity during the transient and will enable a “cleaner” observation of the natural load following capability of the reactor.

Record the values of:

- a) Reactor Power (%) _____
- b) Net Reactivity (pcm) _____
- c) Cold Leg Temperature (°C) _____
- d) Hot Leg Temperature (°C) _____
- e) Pressurizer (PRZ) Level (%) _____
- f) Calculate the change in temperature (ΔT) across the core (°C) _____
((d) – (c))

Go to the Secondary System Control Panel (F4)

Record the Secondary Pressure (MPa) _____

Following the instructions at the bottom of the screen, set the Turbine Load to 1065 MWe and the rate of change to 10% of full power per minute.

Observe the increasing Steam Flow Rate supplied to the turbine and the slightly decreasing pressure in the secondary side of the SG.

Go to the Primary Plant Control Panel (F3)

Observe:

- the decreasing Cold Leg Temperature
- the positive Net Reactivity
- the increasing Reactor Power

Switch to Fast Time (F9) and run until the transient is over, a couple minutes after the Net Reactivity returns to 0 will do.

Record the value of:

- g) Reactor Power (%) _____
- h) Net Reactivity (pcm) _____
- i) Cold Leg Temperature (°C) _____
- j) Hot Let Temperature (°C) _____
- k) Pressurizer (PRZ) Level (%) _____
- l) Calculate the change in temperature (ΔT) across the core (°C) _____
((j) – (i))
- m) Secondary Pressure (MPa) _____

Note that:

- the Reactor Power has increased
- Cold Leg and Hot Leg Temperatures have decreased
- However, the ΔT across the core (which is proportional to Reactor Power) has increased
- Pressurizer Level is lower because the average temperature in the RCS is lower; normally, the automatic Control Rod System operates such that the average temperature of the primary coolant does not deviate too much and the PRZ Level is kept at a more or less constant value. If desired, this exercise could be run without setting the Control Rod System to “manual” for comparison

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