International Summer School 2013

Selected issues of safety engineering and exploitation of nuclear power plants in the context of EU energy policy

Trnava, 1-12.09.2013

nuclear reactor simulator

"The investigation and analysis of the main reactor parameters variation during normal operation and load reduction routine"

Laboratory is devoted to simulate and analysis of the main reactor parameters variation during normal operation and load reduction routine.

1) Calculation of the working parameters of the reactor and estimation the energy extracted from the Uranium 235

Exercise 1.

What is the mass of ^{235}U fissioned per year in a nuclear reactor operating at a power of 900 MW_e with an average load factor of 80% and thermal efficiency of 32%. (Recall: one fission yields $E_f \sim 200$ MeV).

Exercise 2.

How many atoms of ^{235}U there are in UO_2 of physical density 10.8 g/cm^3, if the uranium is enriched to 2.8% in ^{235}U.

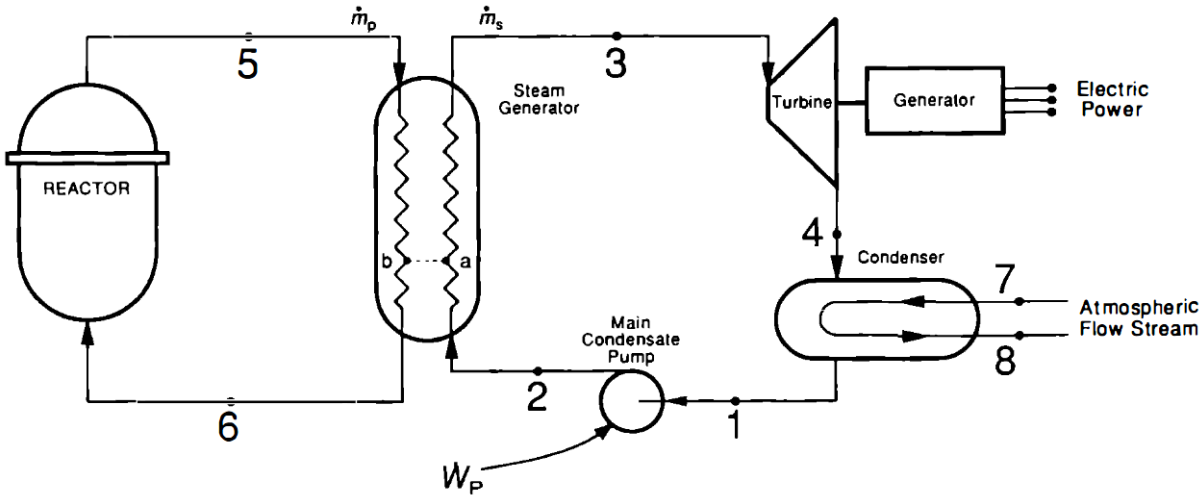

Figure 1. Scheme of NPP with pressure water reactor

Exercise 3.

The scheme of PWR nuclear power plant is shown on figure 1. The main parameters of primer and secondary circle are given in table 1. Please assume the condensate pump efficiency 0.83 and steam turbine efficiency 0.84.

a) Compute the ratio of the primary to secondary flow rates

b) Compute the nuclear plant thermodynamic efficiency.

Table 1. Data of main parameters

State	Temperature, °C	Pressure, MPa	Condition
1		0.007	Saturated liquid
2		7.75	Subcooled liquid
3		7.75	Saturated vapor
4		0.007	Two-phase mixture
5	326	15.5	Subcooled liquid
6	292	15.5	Subcooled liquid
7			Subcooled liquid
8			Subcooled liquid
a		7.75	Saturated liquid
b	T_a + 14.4	15.5	Subcooled liquid

2) Validation of the working parameter of the nuclear reactor using nuclear reactor simulator

Normal Operation and Load Reduction

This is a test of the reactor control system for load reduction. The user can enter a load demand different from the panel indicated and the reactor will respond to reach the desired load with a ramp rate RAMP in percent per minute.

Please click at ”M” for manual control for **Reactor/Power Demand** in the upper right reactor control panel and enter the new (40 %) power demand. As the results, the reactor will drop it power output from the original 100 % to 80 % at a rate of 10 %/min.

The observed parameters are as follow:

a) *Power Turbine Load, Power Core Thermal, Temperature RCS Average,*

b) *Flow SG A Steam, Flow SG A Feedwater, Level SG A Narrow Range, Pressure SG A*

c) *Temperature RCS Average, Level Pressurizer, Flow Letdown, Flow Charging*

d) *Pressure RCS, Power Pressurizer Heater, Flow Pressurizer Spray*

e) *Reactivity Rod, Reactivity Mod Temperature, Reactivity Fuel (Doppler)*

Please use a transient plots to get the response of the observed parameters to the load reduction.

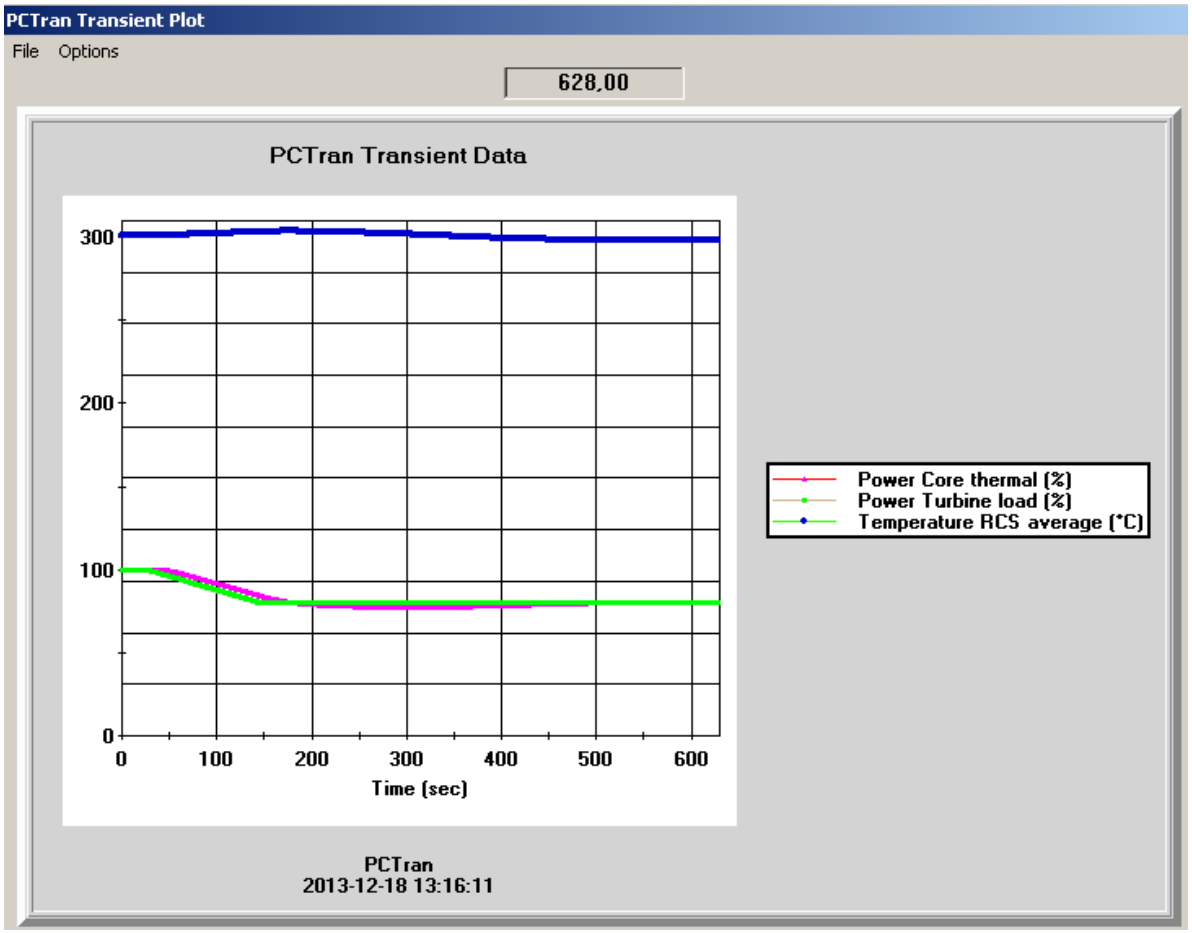

Figure 2. Changes of the power core thermal and power turbine load during normal operation of the nuclear power plant

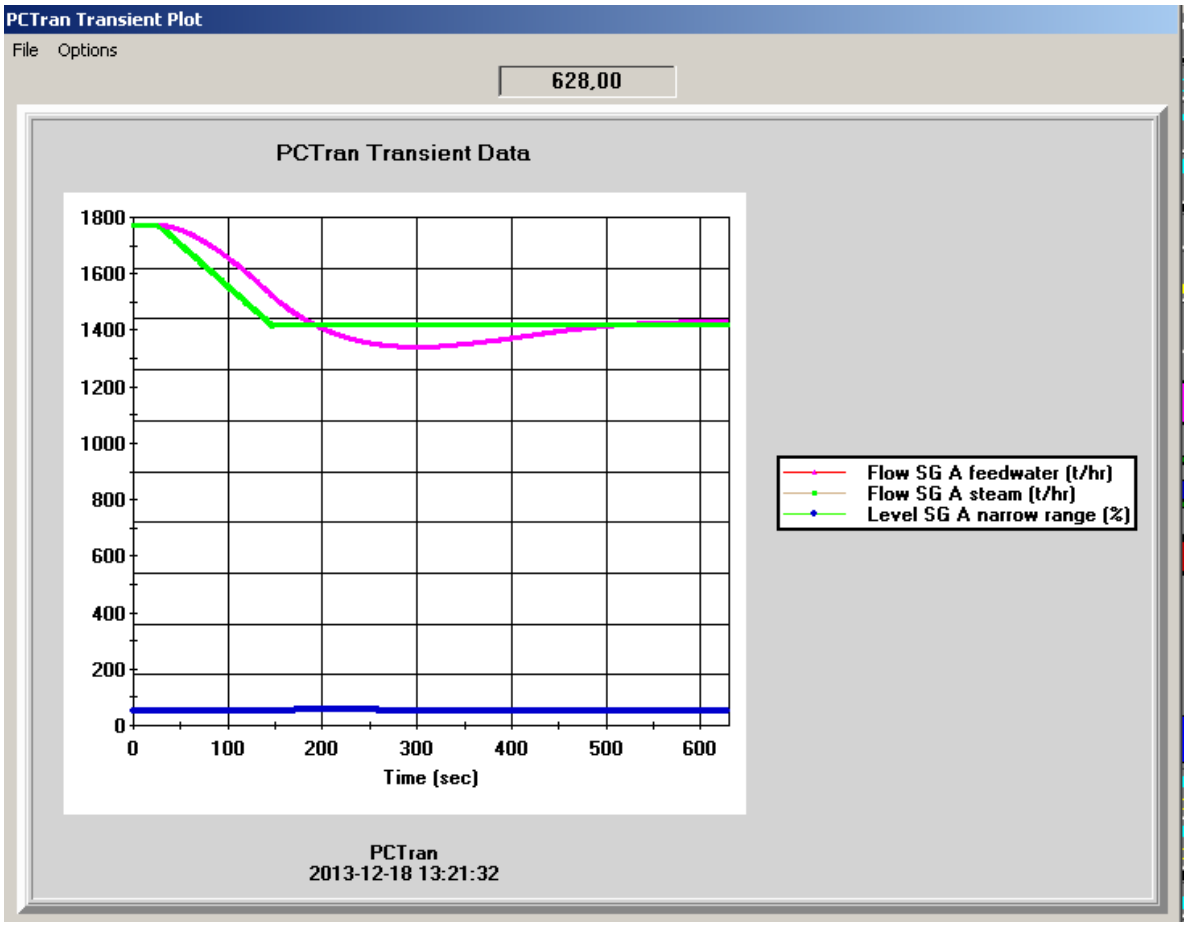

Figure 3. Changes of the power flow SG feedwater and flow SG steam during normal operation of the nuclear power plant