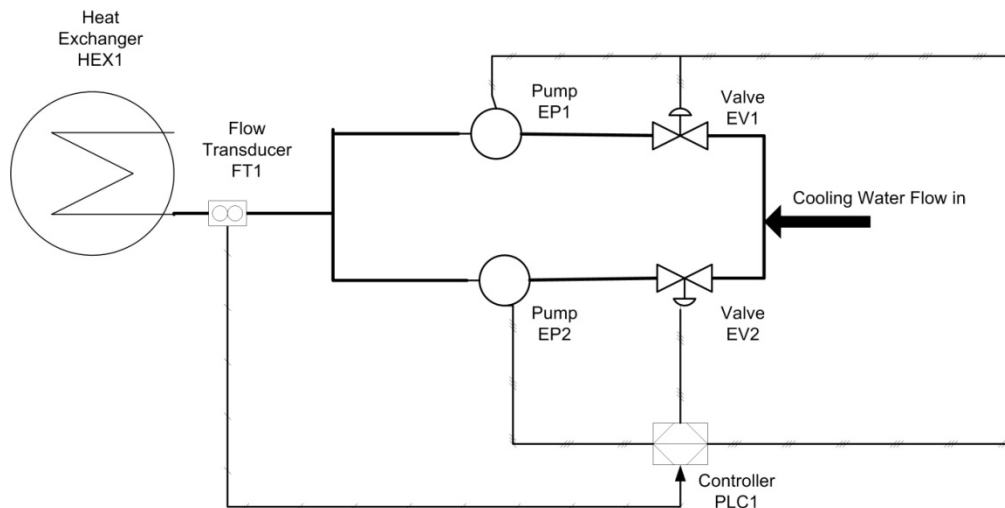


Reliability of Technical Systems
Tutorial #5 (FTA Cont)
Due: October 26th, 2010



The cooling system shown above is responsible to continuously cool a subsequent reactor. During normal operating situations, the cooling water is pumped into the heat exchanger HEX1 through an electric pump EP1 and regulated by an electric valve EV1. Flow transducer FT1 monitors the flow rate of the water flowing into the HEX1. If the FT1 detects the drop of the flow rate, then the operating situation is assumed to become unstable. In this case, the controller PLC1 will first close the EV1 and shut down the EP1, then open the EV2 and start the EP2. After that, cooling water will be pumped into the HEX1 through the EP2 and the EV2. This will provide enough time for maintenance personnel to identify the cause(s) of this abnormal operation situation and make further actions.

1. Your task is to help the maintenance personnel to draw a failure tree considering "No cooling" as the top event. You may assume that

- all the pumps and valves are equipped with backup electric power supply.
- the controller PLC1 is capable to control all the electric valves and pumps (EV1, EV2, EP1, EP2).
- water backflow issues can be neglected.

2. Your next task is to develop a reliability block diagram according to the previously developed failure tree and identify all possible minimum cuts.

3. Your last task is to calculate the possibility of the top event "No Cooling". You may use the table below as the reference. Try to use both diagrams (failure tree and reliability block diagram) and check whether or not those results vary,

Probability of failure	Probability of failure
PLC: 9.999E-5	Transducer: 5E-5
Electric Valve: 4.182E-3	Electric Pump: 7.937E-3
Power supply: 1E-4	Backup power supply: 1E-3
Heat exchanger: 9.999E-5	