Transient Analysis of Primary Feed Pump Trip for 700 MWe IPHWR

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TRANSIENT ANALYSIS OF PRIMARY FEED PUMP TRIP FOR 700 MWe INDIAN PRESSURIZED HEAVY WATER REACTOR

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ABSTRACT

700 MWe Indian Pressurized Heavy Water Reactor (IPHWR) is a horizontal channel type reactor with two loops of Primary Heat Transport (PHTS) system. Three (two operating and one stand by) main boiler feed water pumps (BFP) supply feed water to Steam Generators (SGs). In the event of one of the running BFP trip, standby comes on line on auto. The transient has been initiated by tripping one of the pumps.

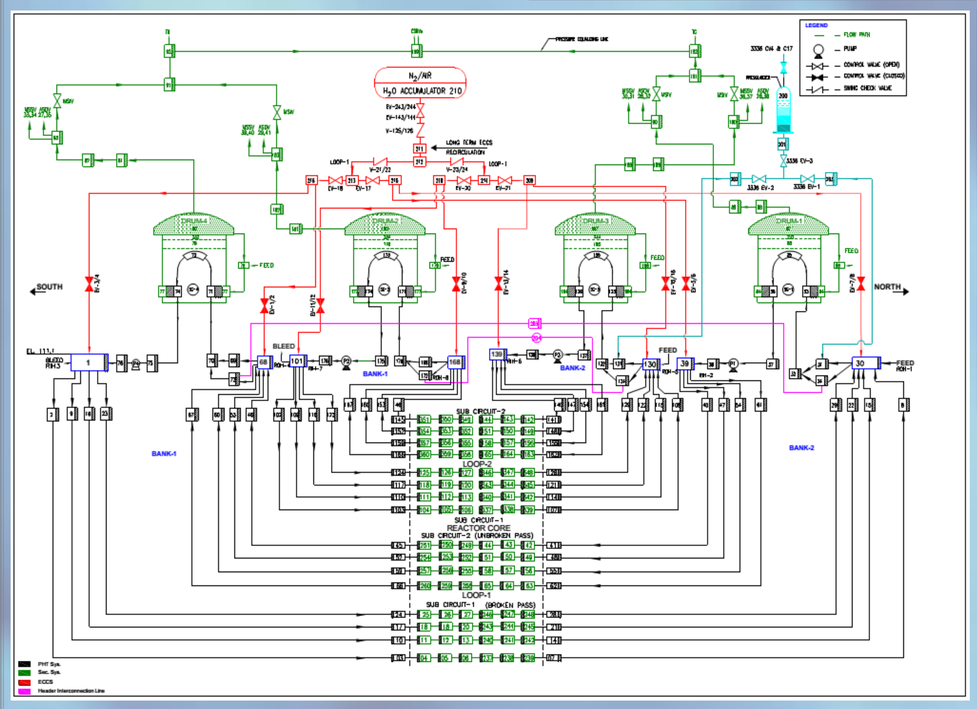
In this paper two cases are considered for analysis with postulated initiating event as follows:

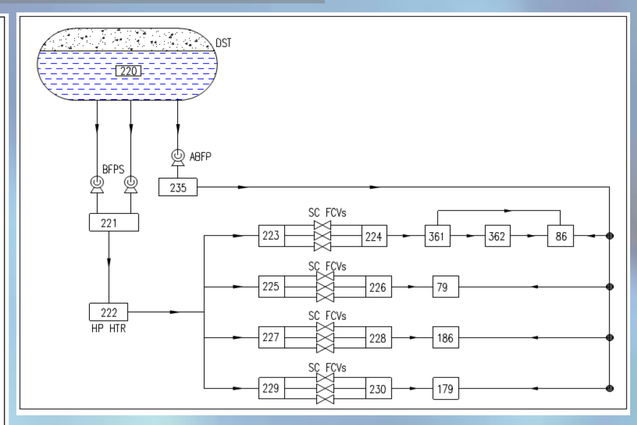
Case 1: BFP Trip and Standby BFP available on auto
Case 2: BFP Trip and Standby pump not available.

Transient analysis was performed using ATMIKA-T in-house developed 3-D neutron kinetics coupled thermal hydraulics computer code. This paper provides timeline of sequence of events which is important for operator's action to maneuver the event.

METHODOLGY/FORMULATION

NODALIZATION OF ATMIKA.T:





- **Thermal Hydraulic Model**
  - Fluid Dynamics Model
  - Drift Flux Model
  - Flow Stratification
  - Critical Discharge Model
  - Frictional Model for 1-Φ & 2-Φ region
  - Heat Conduction
  - Wall Heat Transfer Mode
  - Metal Water Reaction
  - Core Neutronics Model
- **Control System Model**
  - Reactor Regulating System
  - Steam Generator Pressure/Level Control (SGPC/SGLC)
  - PHT Pressure Control
  - Pressurizer Level Control
  - BCD Pressure/Level Control
  - Electro Hydraulic Turbine Control (EHTC)
  - Various Control related Interlocks
- **Component Model**
  - Pumps
  - Valves
  - Pressurizer
  - Accumulator
  - Fuel Pin
  - Pipe
  - Heat Exchanger

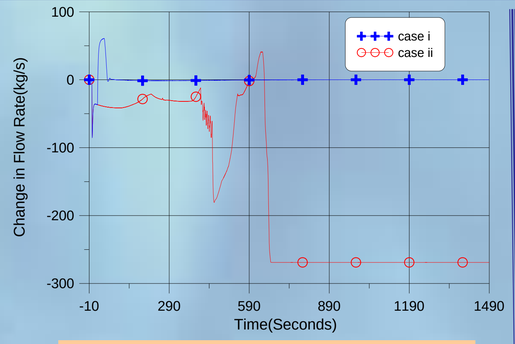
PRIMARY FOCUS/OBJECTIVES OF THE STUDY:

The objective of this paper is to analyse/study plant dynamics during trip of Primary feed pump trip during availability and non availability of stand by feed pump of 700 MWe IPHWR and bring out the sequence of events which is important for deciding operator's action to maneuver the event.

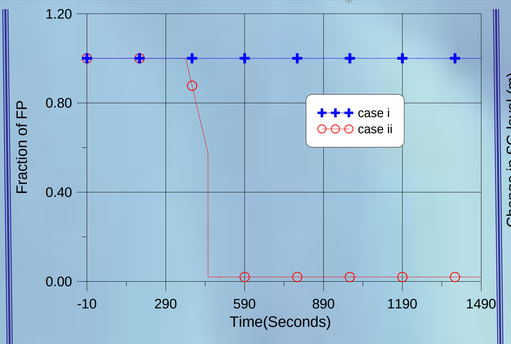
Sequences of events in case 1 and case 2:

- Feed Flow reduces.
- SGs Pressure Rises due to reduction in sub-cooled water
- SGs level starts falling. If standby comes, it recovers and reactor stabilizes at 100% FP.
- If Stand by fails to start then
- Reactor set back on SG low level
- Reactor trips on SG level very very low
- Turbine Trips

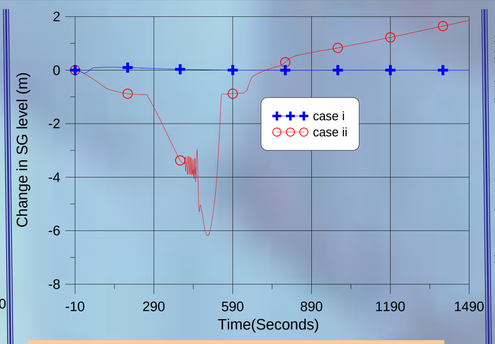
RESULTS



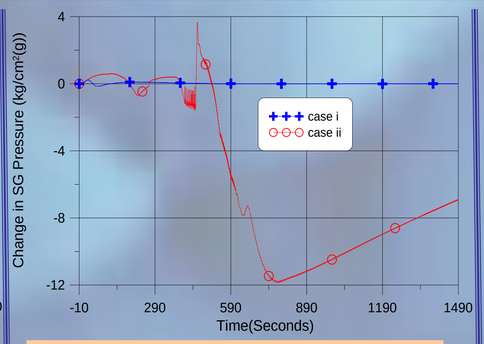
CHANGE IN FEED FLOW WRT THE NOMINAL FLOW



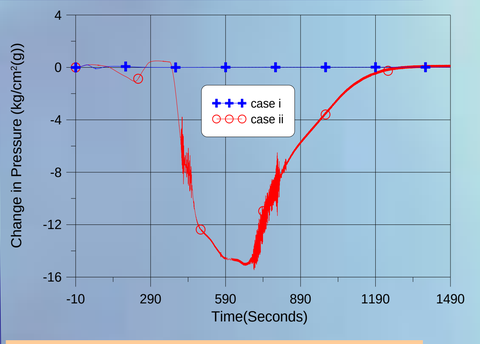
REACTOR POWER



SG LEVEL VARIATION WRT INITIAL LEVEL



SG PRESSURE VARIATION WRT THE SET POINT



PHTS PRESSURE VARIATION WRT THE SET POINT

Event	Case 1 calculated timeline (s)	Case 2 calculated timeline (s)
Feed Flow reduces	0	0
Stand By comes after	14	-
Reactor set back on SG level low	-	365
Reactor Trips on SG level very very low	-	450

TIME LINE OF EVENTS

CONCLUSION

- In case 1, If the standby pump comes after 14 sec, the SG level recovers with a slight dip in level (does not reach the low level alarm setting). The feed flow rises and settles down to normal value. Subsequently all the parameters converge to steady state value. Reactor continues to operate at 100% FP.
- In case 2 without the availability of standby BFP, feed flow rate drops. Steam Generator pressure rises slightly due to reduction in sub cooled feed flow and SG level starts to decrease. Reactor setback starts as SG level goes below setback setting at around 6 min. SG level continues to fall and reactor trips on SG Level very very low at around 7.5 min. Thereafter, core decay heat removal continues initially by PCPs coast down and subsequently by thermosyphoning on primary side.
- **For both the cases, automatic actions are sufficient to safely ride over the postulated transient.**

Key References/ Acknowledgment

[1] Rammohan H.P., and Bajaj S. S., 1996. "ATMIKA-A System Thermal-Hydraulic Computer Code Model Description"., Internal Report, NPCIL, Mumbai, India, 1996.

"*Advanced Sensors and Modeling Techniques for Nuclear Reactor Safety,December 15-19, 2018, IIT Bombay, Mumbai, India*"