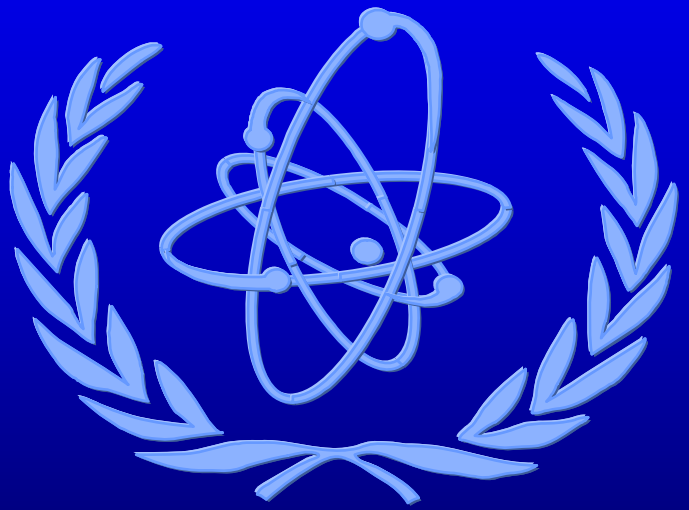
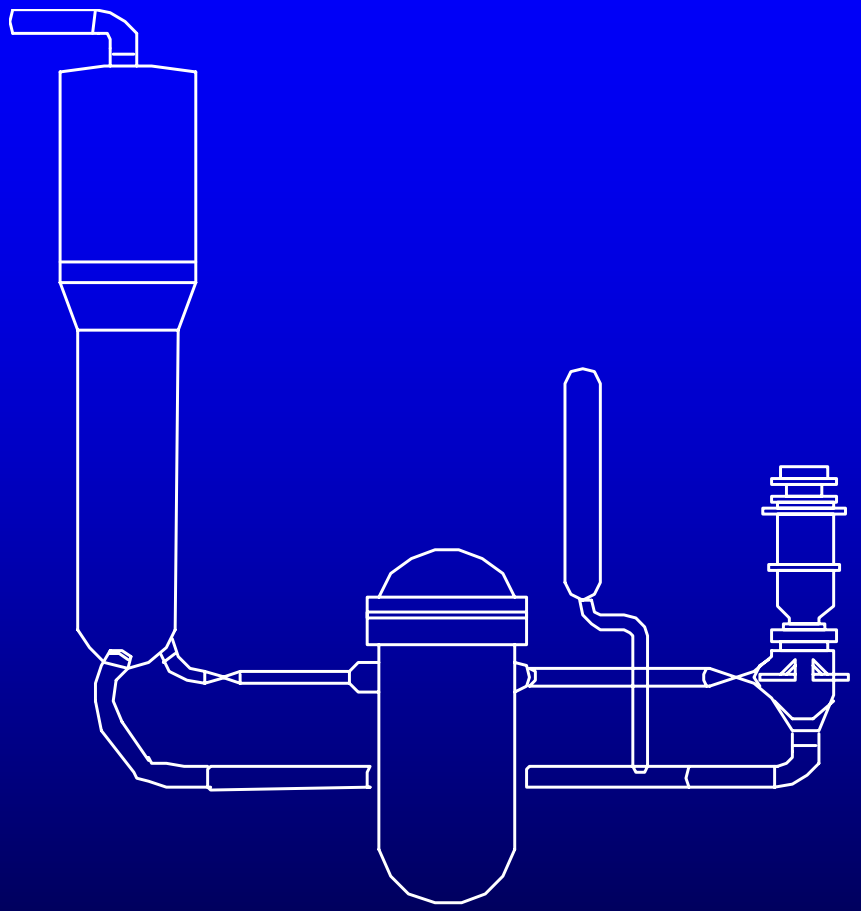
Exercise E2 Severe Accident Phenomena



Mechanisms for RCS Depressurization Before Vessel Failure

- Situation:
  - 3300MW_{th}, 3-loop PWR
  - Failure of all ac/dc power (station blackout)
  - Core Damage begins 6.5 hrs after loss of power with RCS at high pressure
- Question:
  - What physical mechanisms might cause reactor vessel pressure to decrease before lower head failure occurs?

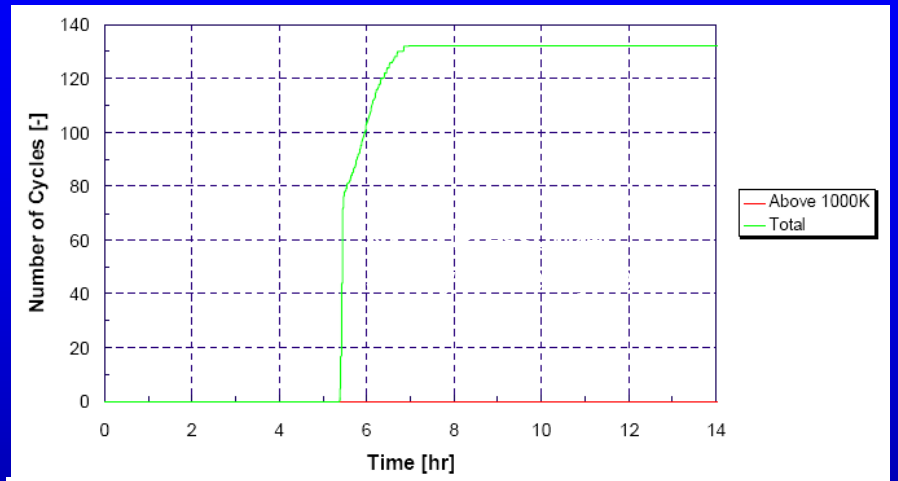


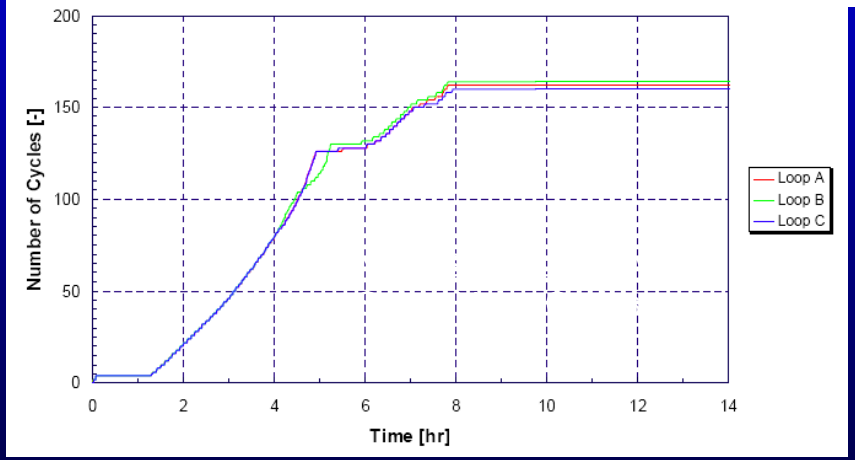
Mechanisms for RCS Depressurization

Answers

Mechanisms for RCS Depressurization

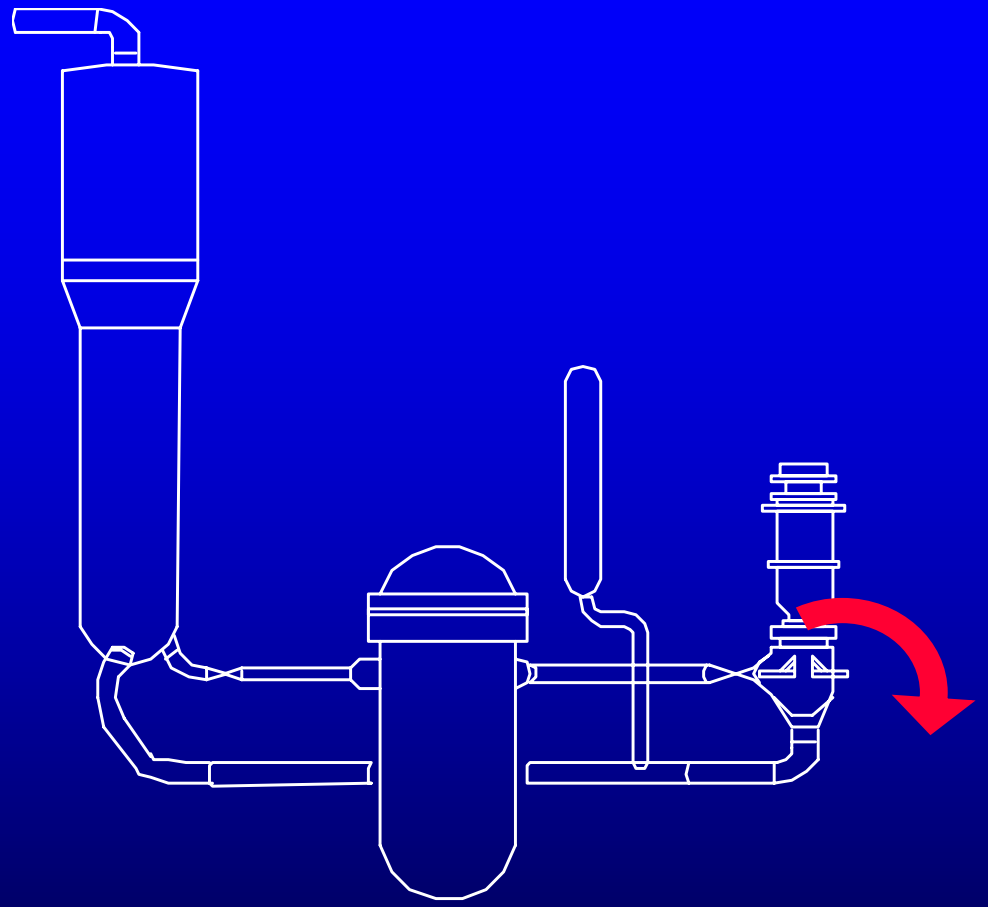
- Safety Valves Stick Open
  - Primary and secondary safety valves cycle many times without manual control
  - Typical failure rate (stick-open) on demand is ~0.01
  - Failure rate would increase significantly during core damage
    - Pressurizer effluent temperatures could approach 900K





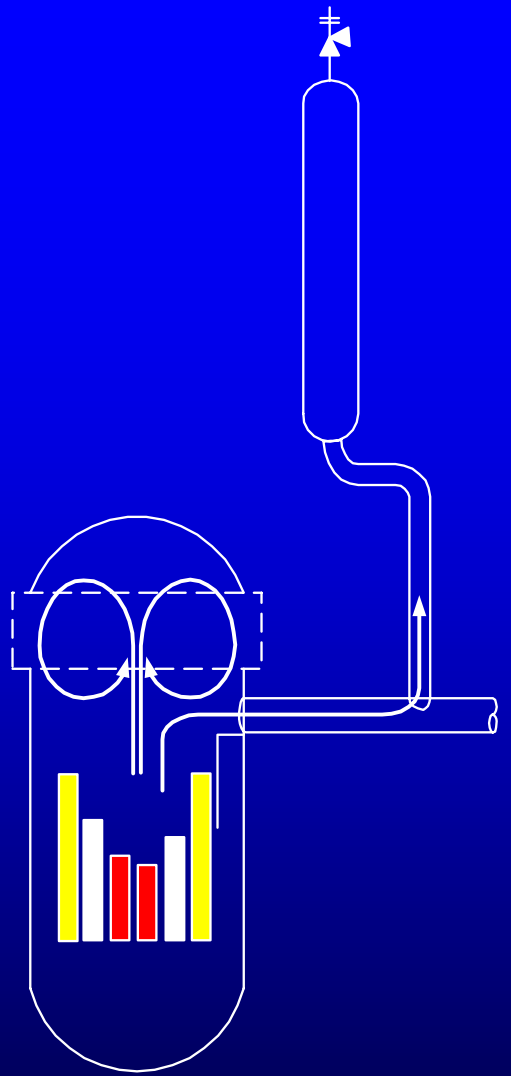
RCS Depressurization (2)

- Reactor Coolant Pump Seal Degradation and Increased Leakage
  - Failure of component cooling water (CCW) allows seals to overheat
  - High void fraction in pump at maximum RCS pressure causes seals to fail
  - Increased leak area reduces RCS pressure after onset of core damage.



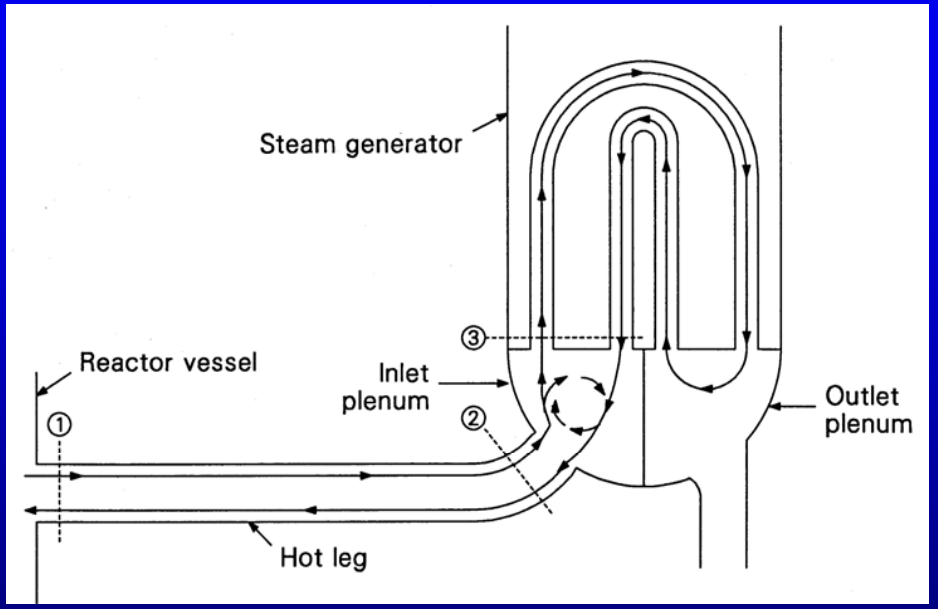
RCS Depressurization (3)

- Creep rupture of RCS pressure boundary
  - Natural circulation of core exit gases during fuel melting transports energy to RCS structures
  - Hot leg nozzle and pressurizer surge line are vulnerable locations
  - Increase in structure temperatures, combined with high pressure can lead to significant creep and failure.



RCS Depressurization (4)

- **Steam Generator Tube Rupture**
  - **Counter-current natural circulation through hot leg enhances transport of hot gases and fission products to steam generator tubes**
    - Heating of thin (weakened) tubes can lead to tube rupture



Ref: NUREG/CR-5214, Bayless et al.