Nuclear Safety

Module 5

GUARANTEED SHUTDOWN STATE (GSS)

Slide 1

What is the GSS?

- Criticality impossible despite worst case failures
- Negative reactivity load sufficient to counteract
  - Fission product decay
  - Plutonium build-up
  - Temperature coefficients of reactivity
  - all reactivity mechanisms in most reactive state
  - dilution of moderator poison due to PT/CT rupture
- Condition guarantees to prevent net removal of negative reactivity

Slide 2

When is the GSS Required?

- RRS unable to control reactor power
- SDS impaired and cannot be returned to service within grace period
- ECI or Containment removed from service

Why is the GSS Required?

- to prevent a LORA when RRS or SDS impaired
- ensures CONTROL when normal and backup CONTROL, COOL, or CONTAIN methods are unavailable

Methods of Achieving the GSS

1) **Overpoisoned moderator**
2) **Moderator drained**
3) **Moderator Dumped (Pickering-A only)**

1) Overpoisoned Moderator GSS

- Gd added to moderator
- HTS depressurized to reduce risk of in-core LOCA diluting moderator poison
- All means of adding reactivity defeated:
  - moderator purification isolated
  - pH measured frequently and controlled <6 to prevent poison precipitation
  - D_2O makeup to Moderator system isolated

2) Moderator Drained GSS

- calandria drained
- makeup isolated
- HTS cold depressurized
  - Can't risk filling calandria with (unpoisoned) HT D_2O
- 'hole' in system below calandria level

3) Moderator Dumped
(Pickering-A only)

- **Condition guarantee prevents moderator pump-up**
  - **Cover gas compressors isolated**
  - **He pressure regulating valves open**
- **PHT loop interconnect valves closed**
  - **limits D_2O entering calandria/dump tank system to roughly half PHT inventory**
- **Total D_2O inventory in PHT storage tank plus moderator dump tank limited**
  - *prevents D_2O backing up into calandria in event of in-core LOCA*

Precautions While in GSS

- Positions of all guaranteed devices checked frequently (typically daily)
- Neutron flux monitored continuously
- At least one SDS kept poised (except in drained state at some stations)
- PHT system cold, depressurized

Additional Precautions

Overpoisoned GSS:

- moderator poison concentration and pH measured frequently to confirm within safe limits
- moderator circulated continuously

Moderator Dumped (Pickering-A only):

- PHT storage tank and moderator dump tank levels monitored to confirm total inventory within limits

Responsibilities of GSS Holder of Record

To ensure that:

1. condition guarantees are not violated
2. unit status is OK prior to surrendering GSS

The Operations Manager is the Holder of Record to ensure effective administrative control