Learning Objectives

1. Identify the NSSSS system's purpose.

2. Recognize the purpose, function, and operation of the following NSSSS system major components:
   a. Sensors
   b. Trip circuits
   c. Power Supplies
   d. Isolation valves
   e. Isolation groups

3. Recognize the purpose of each of the group isolation signals.
Learning Objectives

4. List the NSSSS system setpoints which effect the MSIV (Group 1) isolations;

5. Identify the following for the MSIV Isolations;
   a. When the isolation signal can be bypassed
   b. How the isolation signal can be reset
   c. How the system can be manually isolated
6. Describe how the NSSSSS system interrelates with the following systems:
   a. Main Steam System
   b. Reactor Water Cleanup System
   c. Recirculation System
   d. Residual Heat Removal System
   e. Reactor Protection System
   f. Primary Containment System
   g. Secondary Containment System
   h. Reactor Core Isolation Cooling System
   i. High Pressure Coolant Injection System
   j. Radwaste System
   k. Post Accident Sampling System
   l. Service and Instrument Air
   m. Reactor Building Closed Loop Cooling System
Purpose

The purpose of the Nuclear Steam Supply Shutoff System (NSSSS) is to isolate systems connected to:

- the primary coolant,
- the primary containment
- the secondary containment

• These are isolated during accident conditions to prevent the release of radioactive materials to the environment in excess of 10 CFR 100 limits.
Components

The NSSSS system uses sensors from other plant systems to develop isolation signals

These sensors measure:

- Reactor water level,
- Main steam line radiation
- Various system flow rates or differential flow rates
- Various system pressures
- Various area and process radiation signals
- Various area temperatures or differential temperatures
- Drywell pressure
- Standby Liquid Control system initiation
- RWCU non regenerative heat exchanger inlet temperature

The sensors provide input to the NSSSS logic networks.
Trip Circuits

• Trip circuits are arrangements of sensors and processors that evaluate plant parameters.
  – The trip circuits produce trip outputs when the logic is satisfied.
  – NSSSSS logic uses two separate and independent trip circuits.

• Two trip circuit logic arrangements are used;
  – One of two take twice for the MSIV logic
  – Two of Two taken once (inboard / outboard) for all other isolation logic

• The trip circuits must maintain electrical and physical separation from each other.

• Trip circuits are powered such that a loss of power causes trip circuit actuation.
Power Supplies

• NSSSS is supplied power by the RPS buses.
  – RPS MG sets provided 120 VAC power.
  – RPS A and B buses provide separation of power to the NSSSS trip circuits.
  – The trip logic for each isolation group de-energizes to initiate an isolation.
RPS "A" Normal Supply
MCC 1115, 480VAC

Alternate Supply
MCC 1133, 480VAC Bus

RPS "B" Normal Supply
MCC 1125, 480VAC

Power Transfer Switch

120 VAC RPS Bus "A"
To Other RPS Bus Loads
NS Logic Channel A1

120 VAC RPS Bus "B"
To Other RPS Bus Loads
NS Logic Channel B1

Interlock
Normal
Alt A  Alt B

Power Transfer Switch

120 VAC RPS Bus "B"
To Other RPS Bus Loads
NS Logic Channel B2
Isolation Valves

Three classes of isolation valves.

- Valve classes depend on the degree to which there process lines penetrate the reactor coolant boundary or primary containment.
- Regulatory requirements for each valve class are located in 10 CFR 50, App A, Criteria 55, 56, and 57.

• **Class A valves** (Criterion 55) lines which penetrate the primary containment and communicate with the reactor vessel or coolant boundary.

• **Class B valves** (Criterion 56) lines which penetrate the primary containment and communicate with its atmosphere.

• **Class C valves** (Criterion 57) lines that penetrate the primary containment, but do not communicate with the:
  - reactor vessel
  - reactor coolant boundary
  - and are not open to the primary containment.

**Class A, B and C valves are closed upon receipt of a trip signal.**
System Isolations

• Main Steam System - Main steam lines (Grp 1) and main steam line drains (Grp 14).
  a. Rx Vessel Level 1 (-132.5")
  b. Low Steam Line pressure (835 psig) Bypass MS not in RUN
  c. High Steam Line Radiation (3 X Normal background)
  d. High Steam Line Flow (134%)
  e. Low Condenser Vacuum (8.5” Hg) Bypassed MS not in RUN, Bypass sw. in Bypass, TSVs closed
  g. High Steam Tunnel area Temp.(155°F)
  h. High Steam Tunnel Δ Temp. (55°F)
  i. High Turbine Bldg area Temp (155°F)
Logic shown in the operating condition NSSSS is de-energized to cause the isolation
Isolation Trip System A

AC Power from RPS Bus "A"

Sensor "A"

Channel A

Logic A1

Logic A2

A1

A2

Isolation Actuators

AC Power from RPS Bus "B"

Relays de-energize to cause an isolation

Inboard Valves

Isolation Actuation Logic

Valve Control Power

Motor Controller

Valve Closing Power

Motor

Inboard Valve

Outboard Valves

Valve Control Power

Motor Controllers

Valve Closing Power

Motor

Outboard Valve

Isolation Trip System B

AC Power from RPS Bus "B"

Sensor "B"

Channel B

Logic B1

Logic B2

B1

B2

Isolation Actuators

AC Power from RPS Bus "A"

Relays de-energize to cause an isolation

Inboard Valves

Isolation Actuation Logic

Valve Control Power

Motor Controller

Valve Closing Power

Motor

Inboard Valve

Outboard Valves

Valve Control Power

Motor Controllers

Valve Closing Power

Motor

Outboard Valve
NS\textsuperscript{4} INBOARD VALVE

120VAC RPS BUS "A"

Contacts open to cause isolation

To Motor Controllers

NS\textsuperscript{4} OUTBOARD VALVE

120VAC RPS BUS "B"

Contacts open to cause isolation

To Motor Controllers

MANUAL ISOLATION PUSHBUTTON

120VAC RPS BUS "B"

Relays de-energize to cause isolation
System Isolations

Residual Heat Removal System - LPCI injection valves, head spray line to reactor, and Shutdown Cooling (SDC) suction isolation valves (Grp 5).
- Rx Vessel Level 3
- High Rx Pressure

Primary Containment Radiation Monitoring System, Core Spray Test return valve, Instrument Air to the SP and RHR System Containment spray test line return to suppression pool. (Grp 2).
- Rx Vessel Level 1
- High DW pressure
System Isolations

Reactor Recirculation System - Reactor water sample line (Grp 10).
  – Rx Vessel Level 1
  – High Main Steam Line Radiation

The reactor water sample line is isolated to remove a potential source of RPV leakage and prevent high radiation in habitable spaces

Reactor Water Cleanup System - Inboard and outboard suction isolation valves (Grps 3 & 4).
  – Rx Vessel Level 2
  – High system Δ flow
  – High HX / Pump area Temp.
  – SLC System Initiation (Outboard valve only)
  – High NRHX outlet temp. (Outboard valve only)
System Isolations

- Reactor Core Isolation Cooling System - Inboard and outboard steam supply isolation valves (Grps 6 & 15) and exhaust line vacuum breaker isolation (Grp 12).
  - RCIC Team line High Flow
  - RCIC Steam Supply Low Pressure
  - RCIC High Area Temperature
  - RCIC Exhaust Diaphragm High Pressure
  - High DW pressure coincident with low RCIC Steam Supply Pressure**

**Only closes the RCIC exhaust line vacuum breaker
• High Pressure Coolant Injection System - Inboard and outboard steam supply isolation valves (Grps. 7 & 16), HPCI pump suction from the suppression pool (Grp. 16), and HPCI exhaust line vacuum breaker isolation (Grp. 13).
  – HPCI Team line High Flow
  – HPCI Steam Supply Low Pressure
  – HPCI High Area Temperature
  – HPCI Exhaust Diaphragm High Pressure
  – High DW pressure coincident with low HPCI Steam Supply Pressure**

**Only closes the HPCI exhaust line vacuum breaker
System Isolations

• Post Accident Sampling System (Grp 17) - Reactor water sample and primary containment atmosphere sample supply and return lines.
  – Rx Vessel Level 3
  – High DW Pressure

• Primary Containment Inerting System and Primary Containment Vent & Purge System (Grp 9).
  – Rx Vessel Level 2
  – High DW Pressure
  – High Refuel Floor Radiation
  – Low Reactor Building Δ Press.
System Isolations

- Drywell Floor & Equipment Drainage System, Traversing Incore Probe (TIP) System. (Grp 11)
  - Rx Vessel Level 2
  - High Drywell Pressure

- Reactor Building Closed Cooling Water to and from the DW coolers. (Grp 8)
  - High DW pressure
  - Rx Vessel Level 1
  - Low RBCLCW Expansion Tank Level
RPS BUS A

120VAC RPS BUS "A"

S73A (LOGIC CHANNEL A-1) MANUAL ISOLATION PUSHPUTTON "A"

Relays de-energize to cause isolation

K76A

S73C (LOGIC CHANNEL A-2) MANUAL ISOLATION PUSHPUTTON "C"

K76C

AC SOLENOIDS - INBD MSIVs
DC SOLENOIDS - OUTBD MSIVs

RPS BUS B

120VAC RPS BUS "B"

S73B (LOGIC CHANNEL B-1) MANUAL ISOLATION PUSHPUTTON "B"

Relays de-energize to cause isolation

K76B

K76F

S73D (LOGIC CHANNEL B-2) MANUAL ISOLATION PUSHPUTTON "D"

K76H

K76D

AC SOLENOIDS - OUTBD MSIVs
DC SOLENOIDS - INBD MSIVs
PRIMARY CONTAINMENT INBD ISOL VALVES (EXCEPT MSIVs)
AC SOLENOIDS - OUTBD MSIVs
DC SOLENOIDS - INBD MSIVs
PRIMARY CONTAINMENT OUTBD ISOL VALVES (EXCEPT MSIVs)
Isolation Reset

• Group 1 (MSIV’s)
  – the initiating signal must be cleared
  – all MSIV control switches must be in the CLOSE position
  – both A and B reset pushbuttons must be depressed

• Group 2 to 17
  – the initiating signals must have cleared
  – Pushbutton A resets the logic for all inboard isolation valves.
  – Pushbutton B is used to reset the outboard isolation valves.

• Once an isolation is initiated, valves will continue to close, even if the condition that caused the isolation is restored to normal.
System Interrelations

• The NSSSSS system provides isolation signals to the:
  a. Main Steam System
  b. Reactor Water Cleanup System
  c. Recirculation System
  d. Residual Heat Removal System
  e. Primary Containment System Inerting
  g. Secondary Containment
  h. Reactor Core Isolation Cooling System
  i. High Pressure Coolant Injection System
  j. The Reactor Building Closed Cooling Water System
  k. Post Accident Sampling System
  l. The Instrument air system
  m. The Suppression Pool Cleanup System

• RPS provides the power for the NSSSSS logic and trip System
1. Identify the NSSSS system's purpose.
2. Recognize the purpose, function, and operation of the following NSSSSS system major components:
   a. Sensors
   b. Trip circuits
   c. Power Supplies
   d. Isolation valves
   e. Isolation groups
3. Recognize the purpose of each of the group isolation signals.
OBJECTIVE REVIEW

4. List the NSSSSS system setpoints which effect the MSIV (Group 1) isolations;

5. Identify the following for the MSIV Isolations;
   a. When the isolation signal can be bypassed
   b. How the isolation signal can be reset
   c. How the system can be manually isolated
6. Describe how the NSSSS system interrelates with the following systems:
   a. Main Steam System
   b. Reactor Water Cleanup System
   c. Recirculation System
   d. Residual Heat Removal System
   e. Reactor Protection System
   f. Primary Containment System
   g. Secondary Containment System
   h. Reactor Core Isolation Cooling System
   i. High Pressure Coolant Injection System
   j. Radwaste System
   k. Post Accident Sampling System
   l. Service and Instrument Air
   m. Reactor Building Closed Loop Cooling System