NUCLEAR STEAM SUPPLY SHUTOFF SYSTEM

Chapter 4.4

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

Learning Objectives

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

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

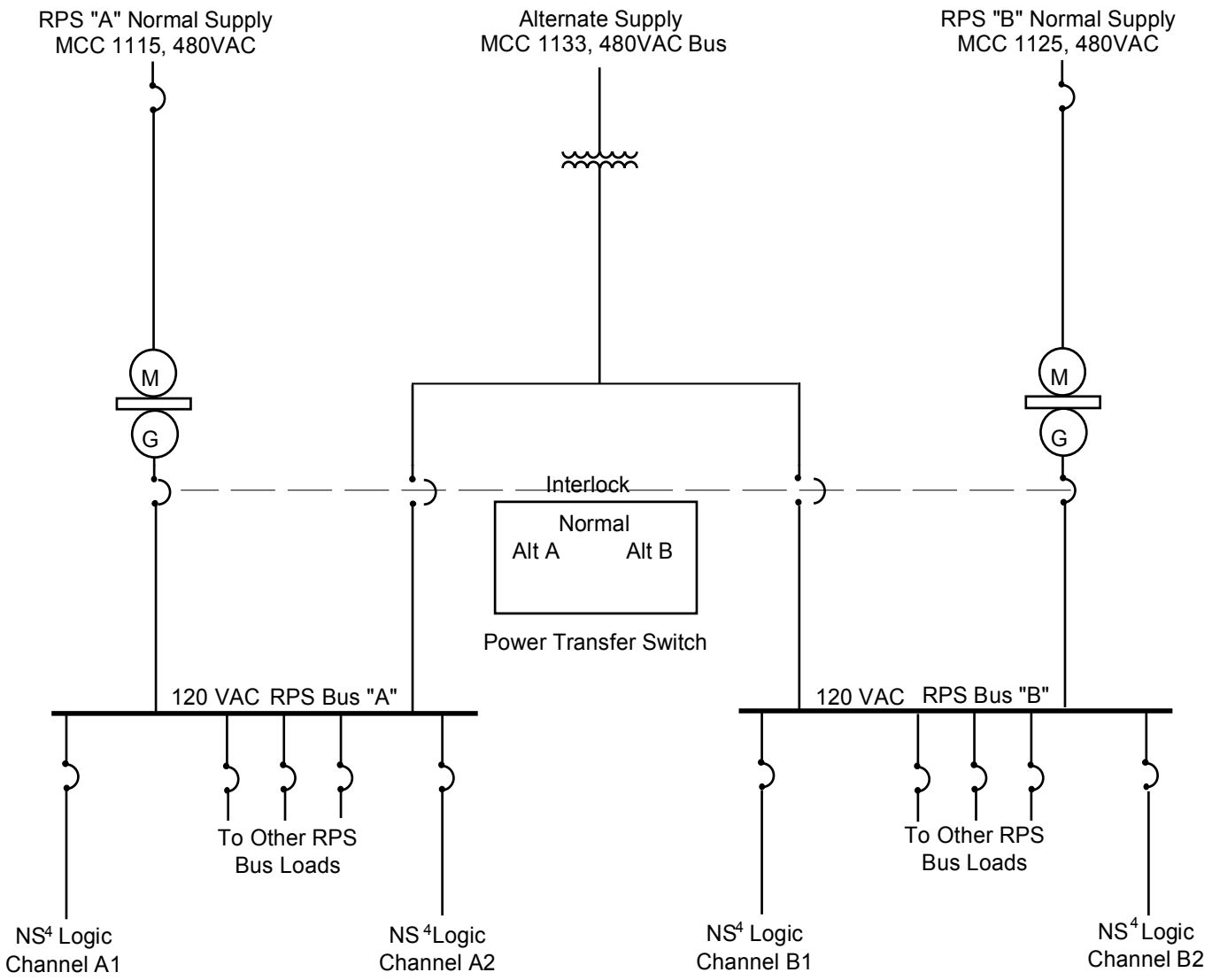
The sensors provide input to the NSSSS logic networks.

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.
  - NSSSS 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
M
G
M
G
Interlock
Normal
Alt A
Alt B
Power Transfer Switch
120 VAC RPS Bus "A"
120 VAC RPS Bus "B"
To Other RPS
Bus Loads
To Other RPS
Bus Loads
NS4 Logic
Channel A1
NS4 Logic
Channel A2
NS4 Logic
Channel B1
NS4 Logic
Channel B2

Isolation Valves

Three classes of isolation valves.

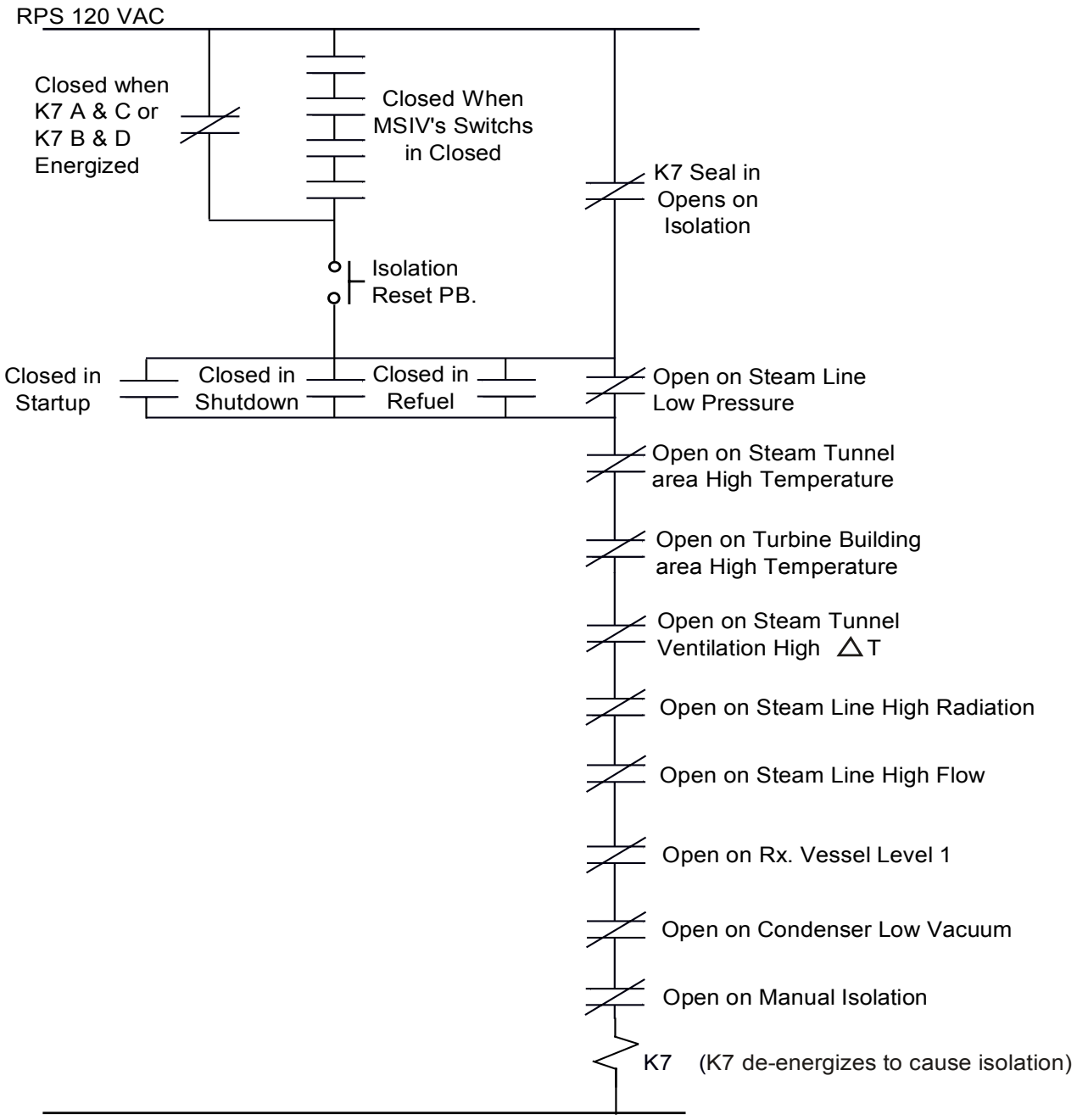
- Valve classes depend on the degree to which there process lines penetrate the reactor coolant boundary or primary containment.
- Regulatory requirements for each valve class are located in 10 CFR 50, App A, Criterions 55,56, and 57.

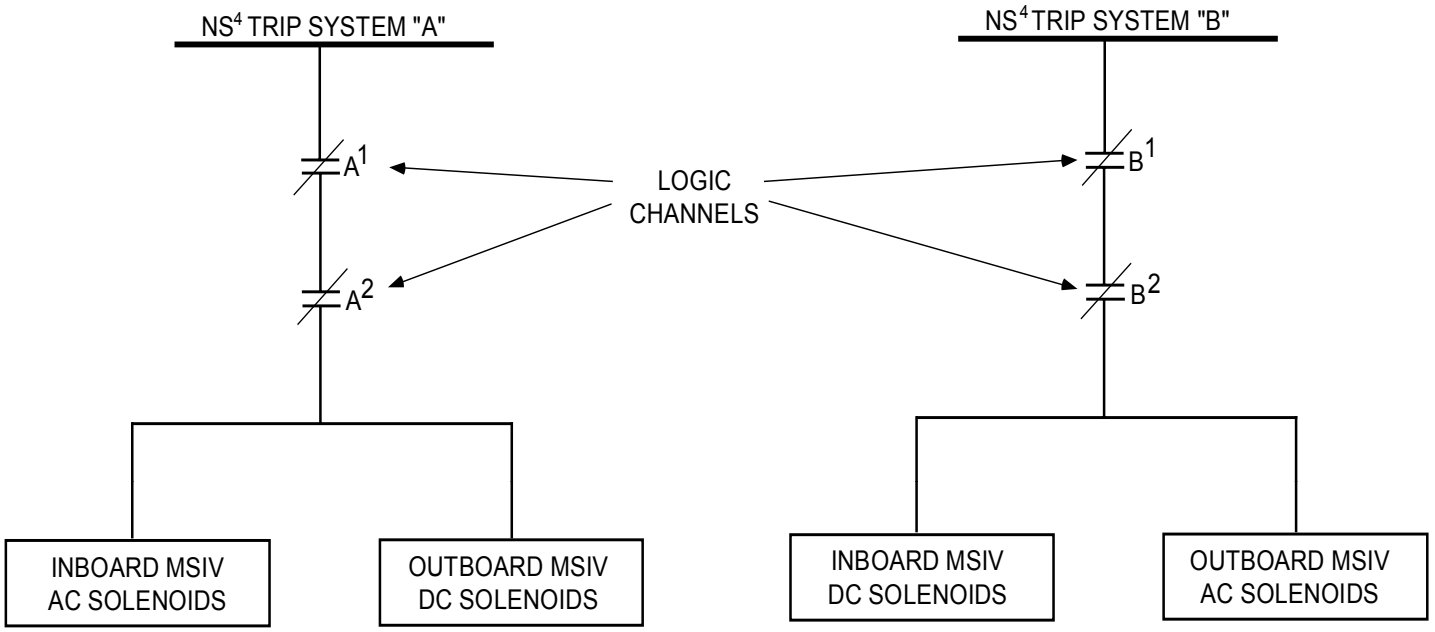
- **Class A valves** (Criterion 55) lines which penetrate the primary containment and communicate with the reactor vessel or coolant boundary.
- **Class B valves** (Criterion 56) lines which penetrate the primary containment and communicate with its atmosphere.
- **Class C valves** (Criterion 57) lines 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.

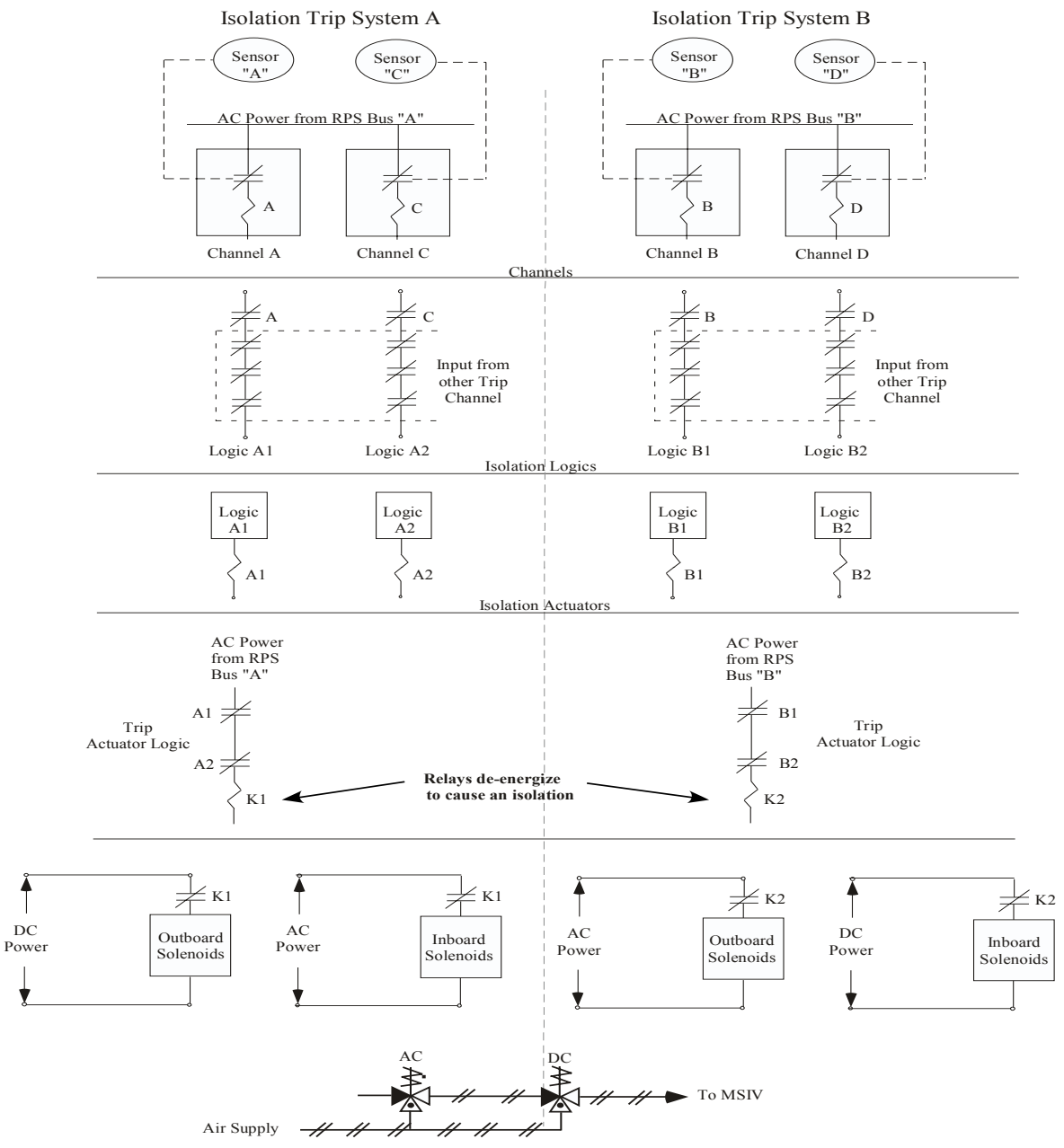
System Isolations

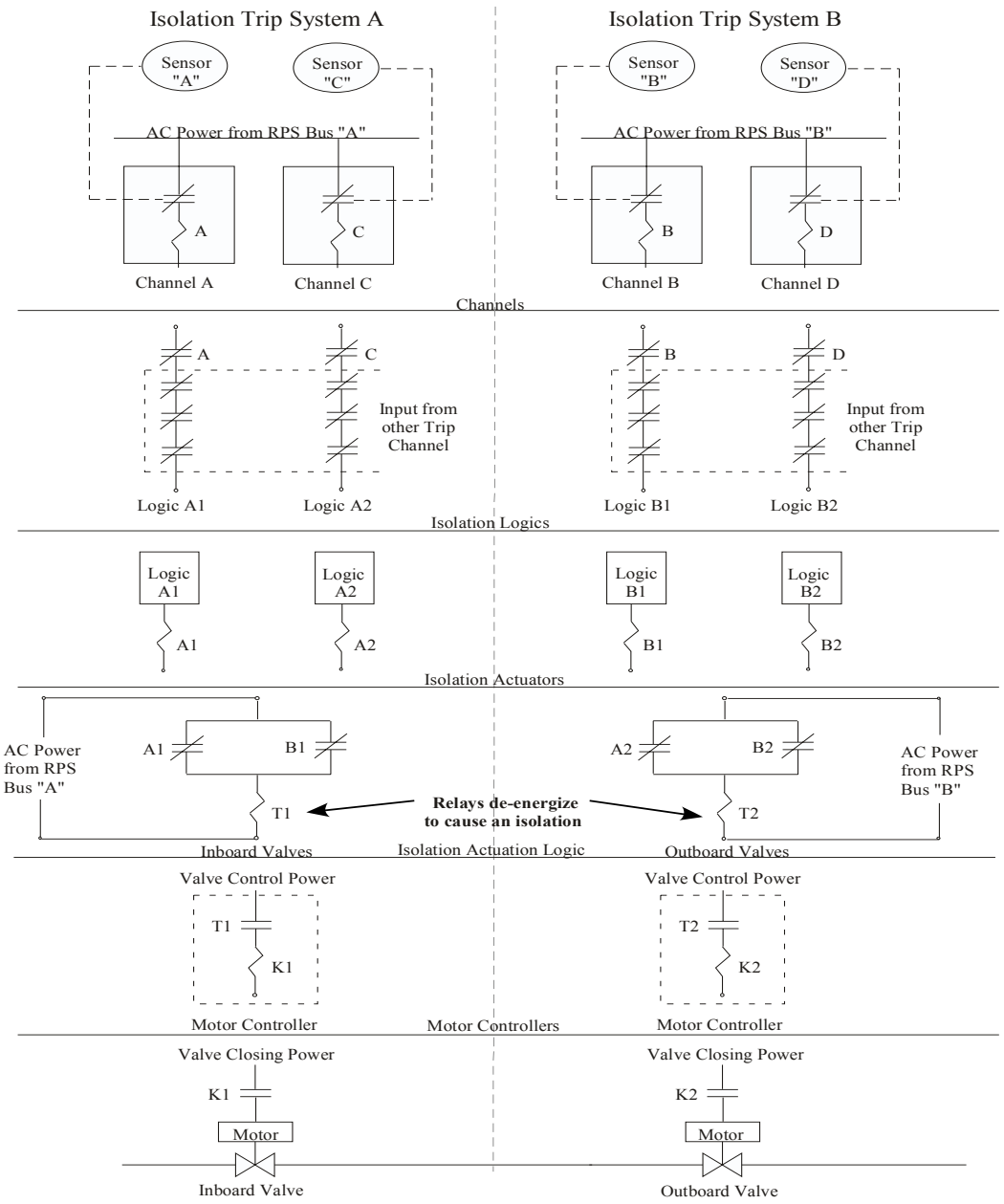
- **Main Steam System - Main steam lines (Grp 1) and main steam line drains (Grp 14).**
  a. Rx Vessel Level 1 (-132.5”)
  b. Low Steam Line pressure (835 psig) Bypass MS not in RUN
  c. High Steam Line Radiation (3 X Normal background)
  d. High Steam Line Flow (134%)
  e. Low Condenser Vacuum (8.5” 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)

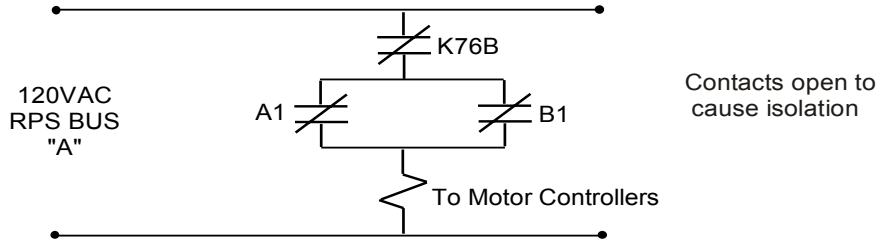

RPS 120 VAC
Closed when
K7 A & C or
K7 B & D
Energized
Closed When
MSIV's Switchs
in Closed
K7 Seal in
Opens on
Isolation
Isolation
Reset PB.
Closed in
Startup
Closed in
Shutdown
Closed in
Refuel
Open on Steam Line
Low Pressure
Open on Steam Tunnel
area High Temperature
Open on Turbine Building
area High Temperature
Open on Steam Tunnel
Ventilation High △T
Open on Steam Line High Radiation
Open on Steam Line High Flow
Open on Rx. Vessel Level 1
Open on Condenser Low Vacuum
Open on Manual Isolation
K7 (K7 de-energizes to cause isolation)



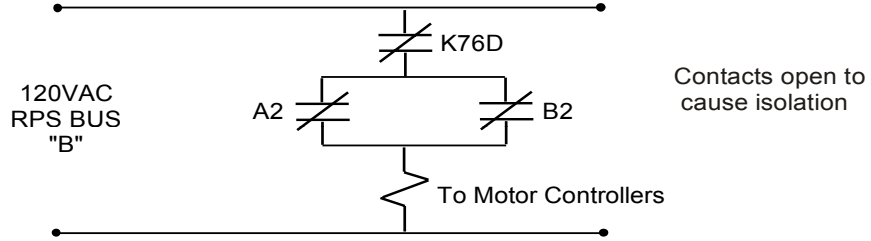
Logic shown in the operating condition NSSSS is de-energized to cause the isolation


Isolation Trip System A
Isolation Trip System B
Sensor "A"
Sensor "C"
Sensor "B"
Sensor "D"
AC Power from RPS Bus "A"
AC Power from RPS Bus "B"
A
C
B
D
Channel A
Channel C
Channel B
Channel D
Channels
Input from other Trip Channel
Logic A1
Logic A2
Logic B1
Logic B2
Isolation Logics
Isolation Actuators
AC Power from RPS Bus "A"
AC Power from RPS Bus "B"
Trip Actuator Logic
A1
A2
B1
B2
K1
K2
Relays de-energize to cause an isolation
DC Power
AC Power
Outboard Solenoids
Inboard Solenoids
AC
DC
To MSIV
Air Supply

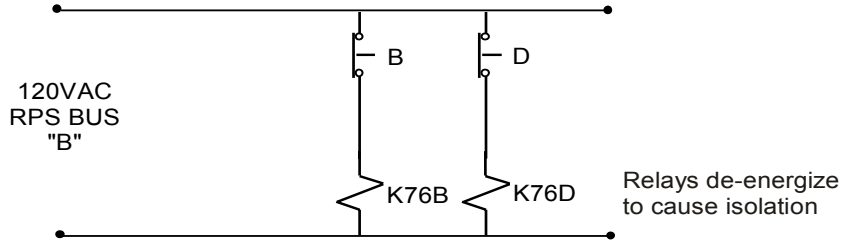

Isolation Trip System A
Isolation Trip System B
Sensor "A"
Sensor "C"
Sensor "B"
Sensor "D"
AC Power from RPS Bus "A"
AC Power from RPS Bus "B"
A
C
B
D
Channel A
Channel C
Channel B
Channel D
Channels
Input from other Trip Channel
Logic A1
Logic A2
Logic B1
Logic B2
Isolation Logics
A1
A2
B1
B2
Isolation Actuators
AC Power from RPS Bus "A"
AC Power from RPS Bus "B"
T1
T2
Relays de-energize to cause an isolation
Inboard Valves
Isolation Actuation Logic
Outboard Valves
Valve Control Power
K1
K2
Motor Controller
Motor Controllers
Valve Closing Power
Motor
Inboard Valve
Outboard Valve



NS[4] INBOARD VALVE



NS[4] OUTBOARD VALVE



MANUAL ISOLATION
PUSHBUTTON

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**

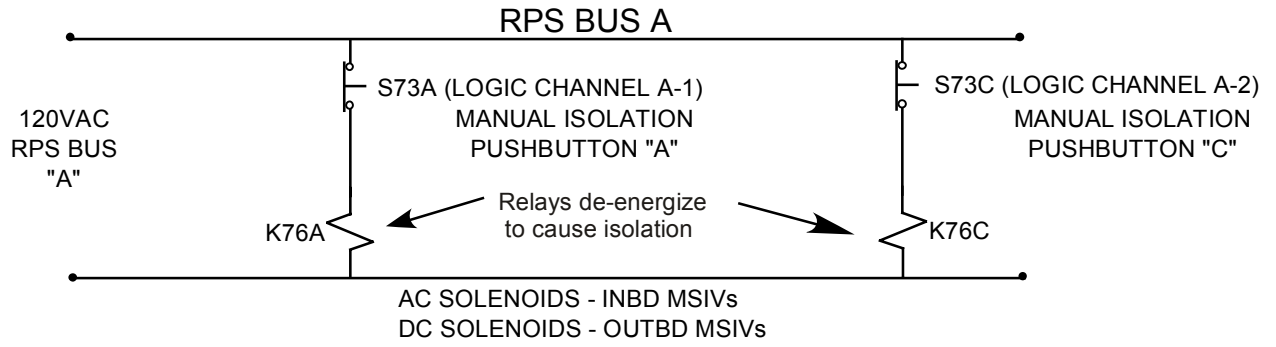
**Only closes the HPCI exhaust line vacuum breaker

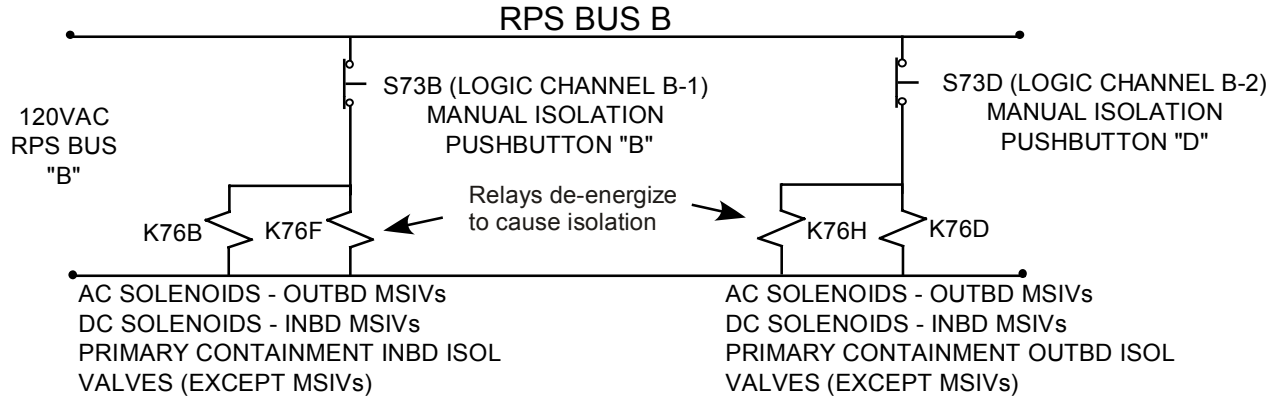
System Isolations

- 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
PUSHBUTTON "A"
S73C (LOGIC CHANNEL A-2)
MANUAL ISOLATION
PUSHBUTTON "C"
Relays de-energize
to cause isolation
K76A
K76C
AC SOLENOIDS - INBD MSIVs
DC SOLENOIDS - OUTBD MSIVs


RPS BUS B
120VAC
RPS BUS
"B"
S73B (LOGIC CHANNEL B-1)
MANUAL ISOLATION
PUSHBUTTON "B"
S73D (LOGIC CHANNEL B-2)
MANUAL ISOLATION
PUSHBUTTON "D"
Relays de-energize
to cause isolation
K76B
K76F
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 NSSSS 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 NSSSS logic and trip System**

OBJECTIVE REVIEW

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.

OBJECTIVE REVIEW

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

OBJECTIVE REVIEW

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