REACTOR VESSEL INSTRUMENTATION SYSTEM

Chapter 3.1

OBJECTIVES

1. Identify the purpose of the Reactor Vessel Instrumentation system.
2. Describe the ranges and calibration conditions of the reactor vessel water level instrumentation.
3. List the reactor vessel water level and pressure initiation, trip and isolation functions.
4. Describe the other parameters monitored by the reactor vessel instrumentation system.

OBJECTIVES

5. Recognize the parameter setpoint and resultant action in tables 3.1-1 and 3.1-2.
6. Describe how the reactor vessel instrumentation system interrelates with the following systems
   a. Reactor Vessel System (Section 2.1)
   b. Reactor Core Isolation Cooling System (Section 2.7)
   c. Feedwater Control System (Section 3.2)
   d. Nuclear Steam Supply Shutoff System (Section 4.4)
   e. Recirculation Flow Control System (Section 7.2)
   f. Reactor Protection System (Section 7.3)
   g. Emergency Core Cooling System (Chapter 10)

PURPOSE

The Reactor Vessel Instrumentation System provides indication of;

- reactor vessel water level
- reactor vessel pressure
- reactor vessel temperature
- core flow rate
- core differential pressure
- vessel flange O ring leakage

These parameters are monitored to allow safe plant operation and to provide initiation, trip and isolation signals for various safety systems.

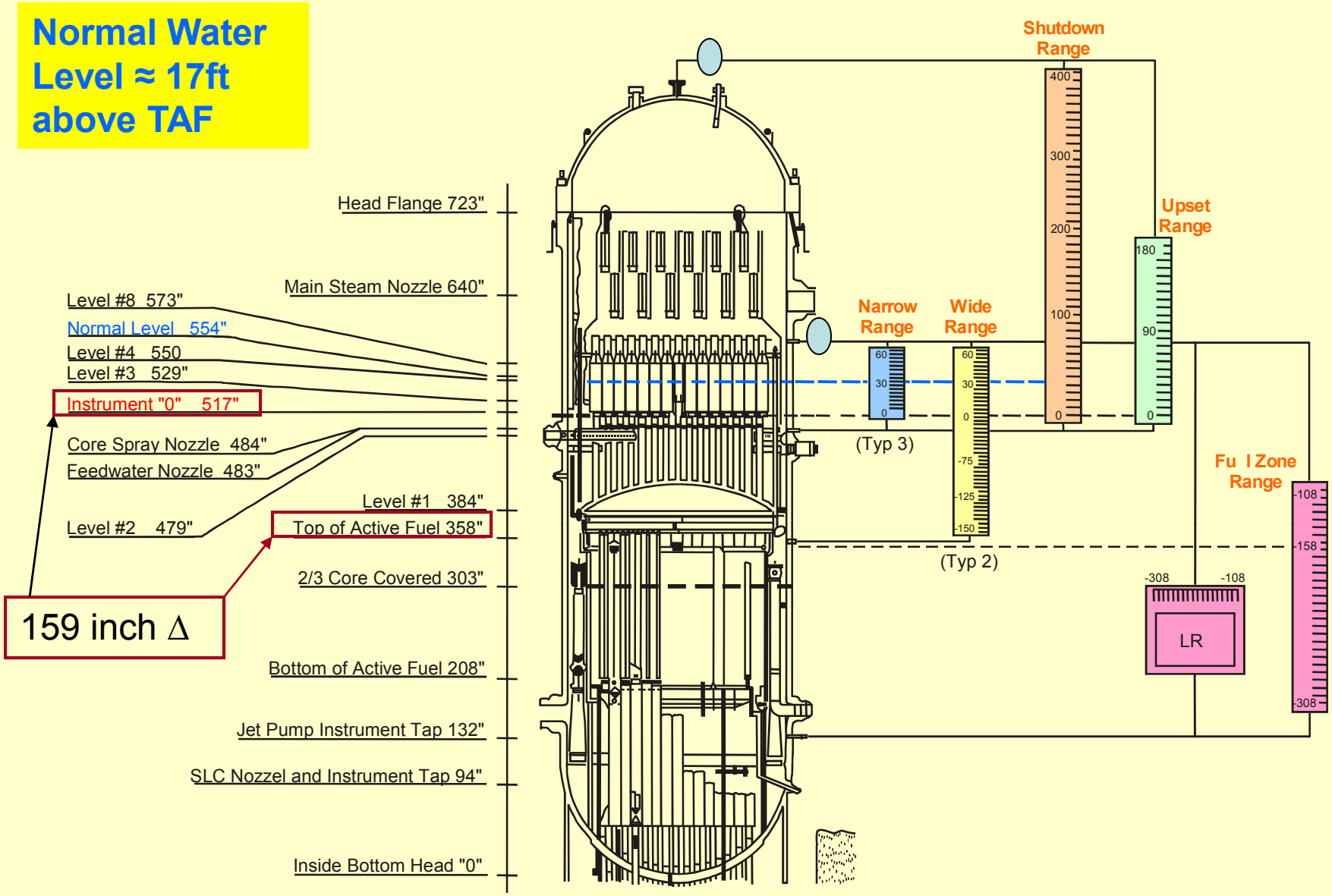


FIGURE 3.1-1 Vessel Level Instrumentation Ranges

Calibration Conditions

Level Instrument	Normal Operating Pressure	Normal Operating Temperature	Drywell Temperature
Narrow Range (0- 60 inches)	1,035 psig	540 °F	135 °F
Wide Range (-150 to 60 inches)	1,035 psig	540 °F	135 °F
Shutdown Range (0 to 400 inches)	0 psig	120 °F	80 °F
Upset Range (0 to 180 inches)	1,035 psig	540 °F	135 °F
Fuel Zone * (-108 to -308 inches)	0 psig	212 °F	212 °F

* No Jet Pump Flow

Reactor Vessel Level	Actions
Level 8 (+56.5")	Trip Main Turbine Trip Feed Pump Turbines Close RCIC Steam Supply Valve Close Trip HPCI Turbine
Level 7 (+40.5")	High Level Alarm
Level 5 (+37)	Normal Operating Level
Level 4 (+33.5")	Low Level Alarm Reactor Recirc Runback to 45 speed limiter (with concurrent loss of one cond. / cond. booster or feed pump)
Level 3 (+12.5)	Reactor Scram ADS Permissive signal for System Actuation Reactor Recirc Pump runback to 30% speed limiter RHR Isolation (Shutdown Cooling Mode) (NSSSS)

Level 2 (-38")	Initiate RCIC Initiate HPCI Trip Reactor Recirc Pumps (ATWS-RPT) Trip ARI Valves Isolate RWCU System Isolate Containment and Selected Reactor Plant System via NSSSS Initiate RBSVS
Level 1 (-132.5")	Initiate RHR (LPCI Mode) Initiate CS Start Diesel Generators Shut MSIVs ADS Actuation Logic Signal LOCA signal to Reactor Building Service Water System

Level Setpoint Basis

Level 8

- Turbines are tripped to protect them from carryover of moisture and subsequent blade damage.
- The tripping of RFP, RCIC and HPCI turbines prevents overfilling the reactor vessel.

Level 7

- High level alarm that warns operator moisture carryover will start to increase.

Level 5

- Normal control level for the feedwater system

Level Setpoint Basis

Level 4

- Steam carryunder begins affecting core flow rate due to Jet and Recirc. pump cavitation.
- Recirc. Runback with a loss of RFP, CBP or CP to lower thermal power to within capacity of a single RFP

Level 3

- Rx scram before water carryunder the dryer seal skirt
- Scram to keep water level above the top of active fuel to allow for:
  - Decay heat boil off
  - Steam Void collapse
  - Loss of feed flow

Level Setpoint Basis

Level 2

- Low enough that HPCI & RCIC should not initiate without a loss of FW on normal scram
- High enough to allow RCIC to recover vessel level before Level 1starts low pressure ECCS systems
- Recirc Pumps tripped to add negative reactivity and prevent pump cavitation.
- ARI initiated to insert negative reactivity
- Select isolations to stop any leaks from non safety systems
- RBSVS starts to clean air in RB in the event of a leak.

Level Setpoint Basis

Level 1

- High enough above TAF to allow low pressure ECCS to restore level before fuel damage
- EDG's start in case needed by LOOP
- MSIV's isolate to remove a potential leakage path.
- All non safety RBSWS loads isolate to preserve cooling water for the safety systems

Level Setpoint Basis

- - 213.5” Containment Spray Interlocks
  - Level below -213.5" LPCI automatically overrides containment spray and SP cooling.
  - Can be overridden by the operator at P601

Reactor Vessel Pressure	Actions
125 psig	RHR Isolation (Shutdown Cooling Mode)
310 psig	Auto close Recirculation Pump discharge valve, during LOCA
465 psig & 338 psig	Permissive for injection by CS and RHR, during LOCA
1025 psig	High pressure alarm
1043 psig	High pressure reactor scram
1120 psig	Trips Reactor Recirc Pumps (ATWS-RPT) Trip ARI Valves

Rx Pressure Setpoint Basis

1120 psig

- Recirc Pumps tripped & ARI initiated to shutdown the reactor (assumes failure to scram)

1043 psig

- High pressure scram
- With SRV ops ensures margin to the RCPB limits

1025 psig

- High pressure alarm warns pressure is above normal operating band.

Rx Pressure Setpoint Basis

466 & 338 psig

- CS and RHR injection valve opening pressure if initiation signal is present.
- Not opened before these pressures to protect low pressure system piping

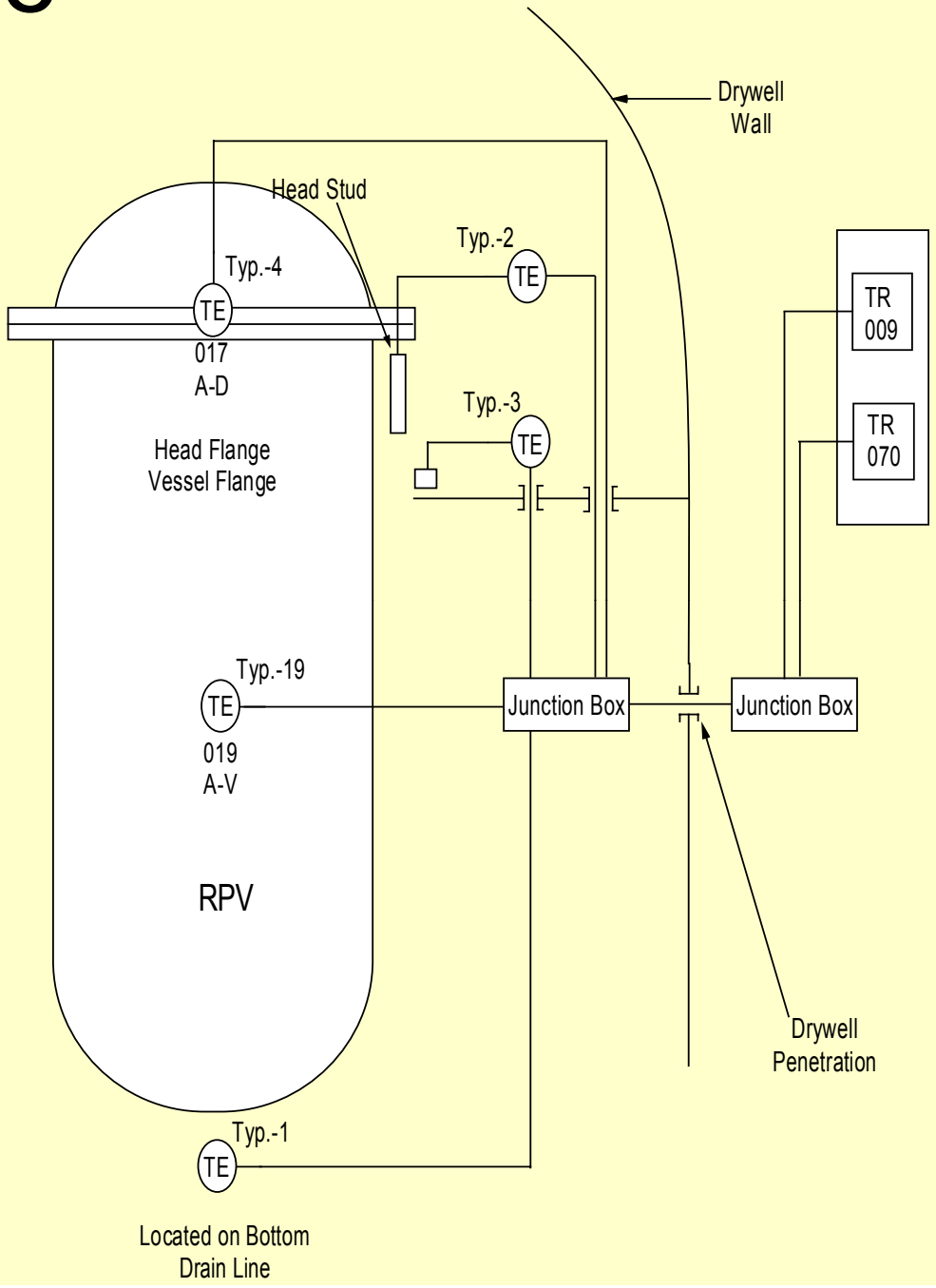
310 psig

- The Recirc. Pump discharge valves closure ensures flow directed to the vessel

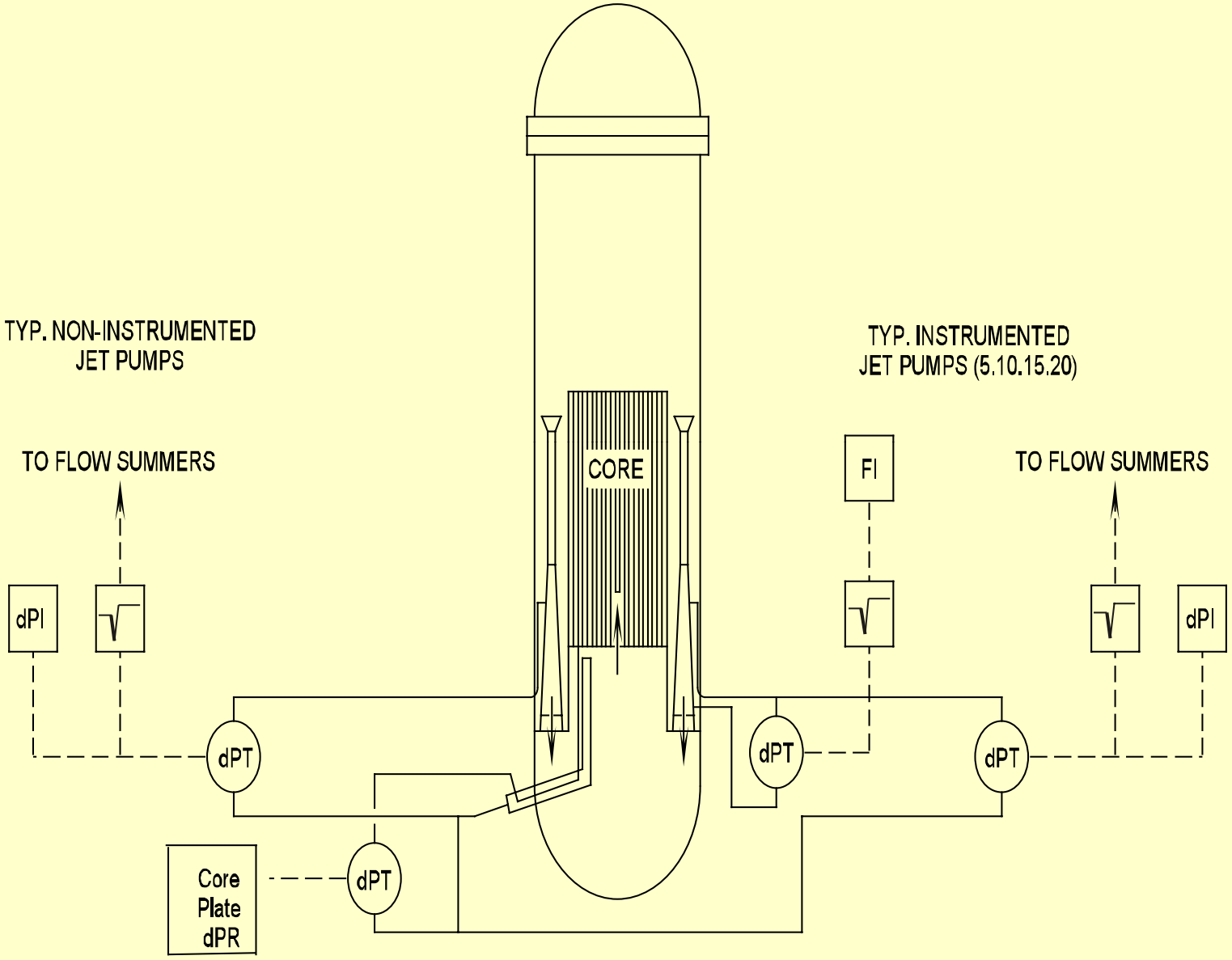
125 psig

- RHR SDC lines are isolated until this pressure to protect the low pressure piping.

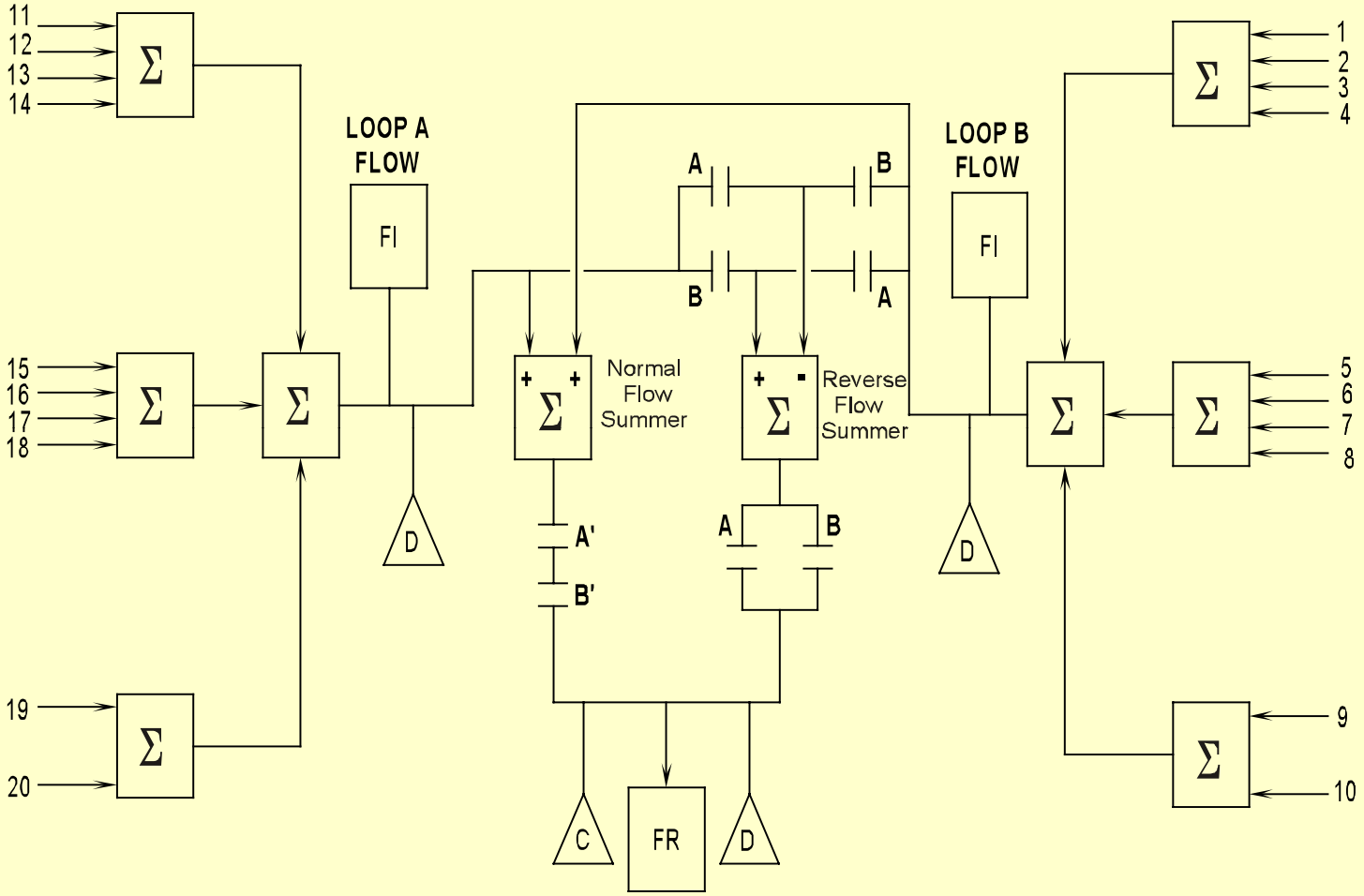
Temperature Monitoring



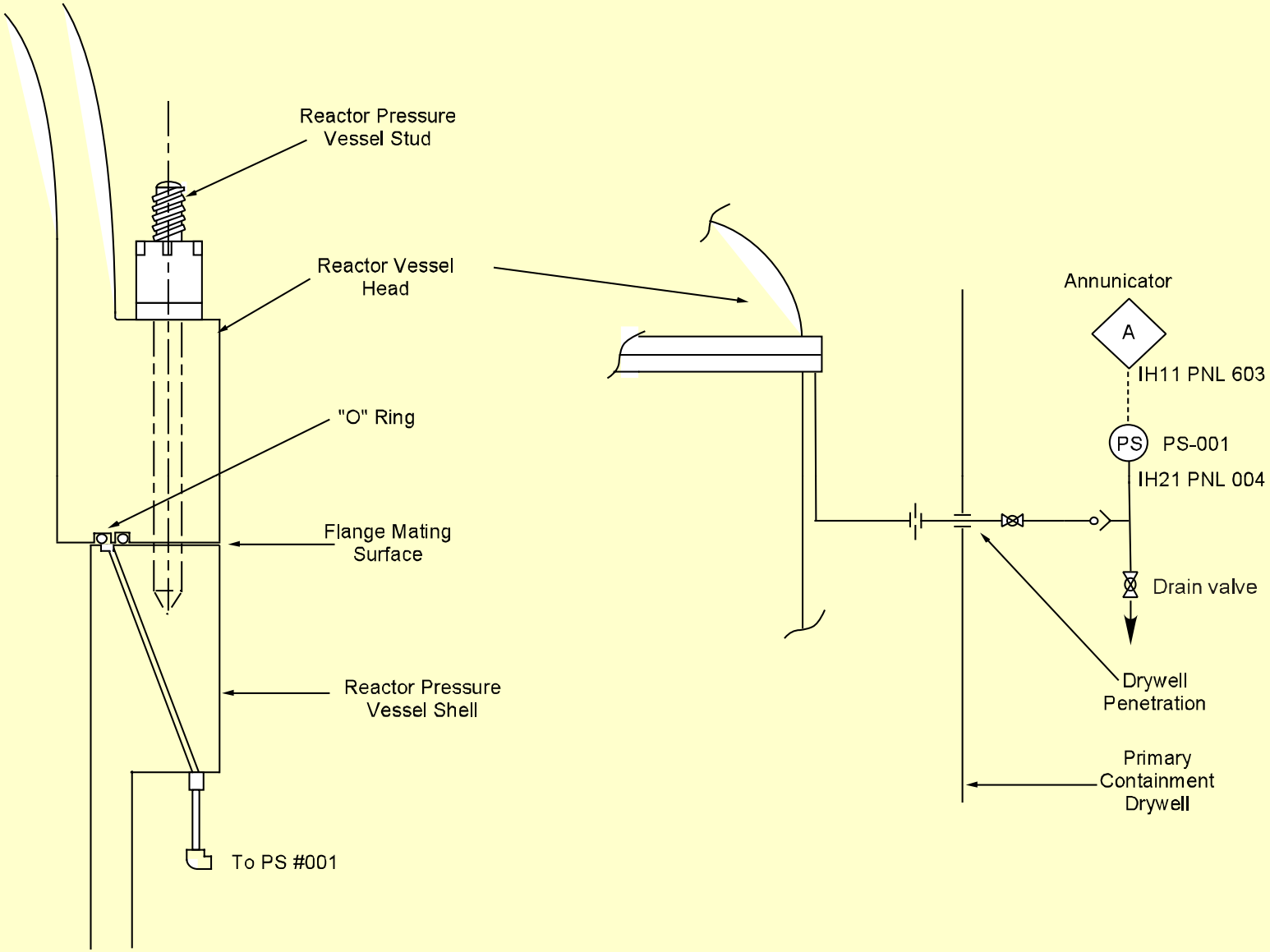
Core Plate and Jet Pump Flow Measurement



Core Flow Summing Network



A - SHUT IF PUMP A OFF AND PUMP B ON
B - SHUT IF PUMP B OFF AND PUMP A ON
A' - SHUT IF PUMP A ON OR PUMP B OFF
B' - SHUT IF PUMP A OFF OR PUMP B ON



Vessel Head Leak Detection

System Interfaces

Reactor Vessel System (Section 2.1)

- The Reactor Vessel System is the sensing point for the various Reactor Vessel Instrumentation System sensors.

Reactor Core Isolation Cooling System (Section 2.7)

- The RCIC System receives initiation and trip signals from the Reactor Vessel Instrumentation System

Feedwater Control System (Section 3.2)

- The Feedwater Control System receives vessel level signals for control and display from the Reactor Vessel Instrumentation System.

System Interfaces

Nuclear Steam Supply Shutoff System (Section 4.4)

- The NSSS receives vessel level and pressure isolation signals from the Reactor Vessel Instrumentation System.

Recirculation Flow Control System (Section 7.2)

- The RFC System receives level and pressure signals for runbacks and ATWS Recirculation Pump trips from the Reactor Vessel Instrumentation System.

Reactor Protection System (Section 7.3)

- The RPS system receives level and pressure trip signals for Reactor Scram and ATWS ARI functions from the Reactor Vessel Instrumentation System.

Emergency Core Cooling System (Chapter 10)

- The Emergency Core Cooling Systems (ADS, CS, HPCI and LPCI) receive initiation signals from the Reactor Vessel Instrumentation System.

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