Non-Nuclear Instrumentation

Chapter 8.1
B&W Cross-Training Course
R-326C

HRTD
Human Resources
Training & Development

OBJECTIVES

1. Explain how the following signals are developed:
   (a) Loop - Tc, Th, ΔT, Tave
   (b) Unit - Tc, Th, ΔT, Tave, ΔTc
2. Explain how the automatic/manual selector switch determines which input signals will be used for the unit Tave signal.
3. State, as listed in Table 8.1-1, the functions provided in the integrated control system by the non-nuclear instrumentation inputs.
4. Explain why temperature compensation of the RCS flow signal is required.
5. Explain why pressurizer level is density compensated.
6. List the inputs and outputs for the pressurizer level control system.

OBJECTIVES

7. State the interlock provided by the pressurizer level signal and explain the purpose of the interlock.
8. List the inputs and outputs for the pressurizer pressure control system.

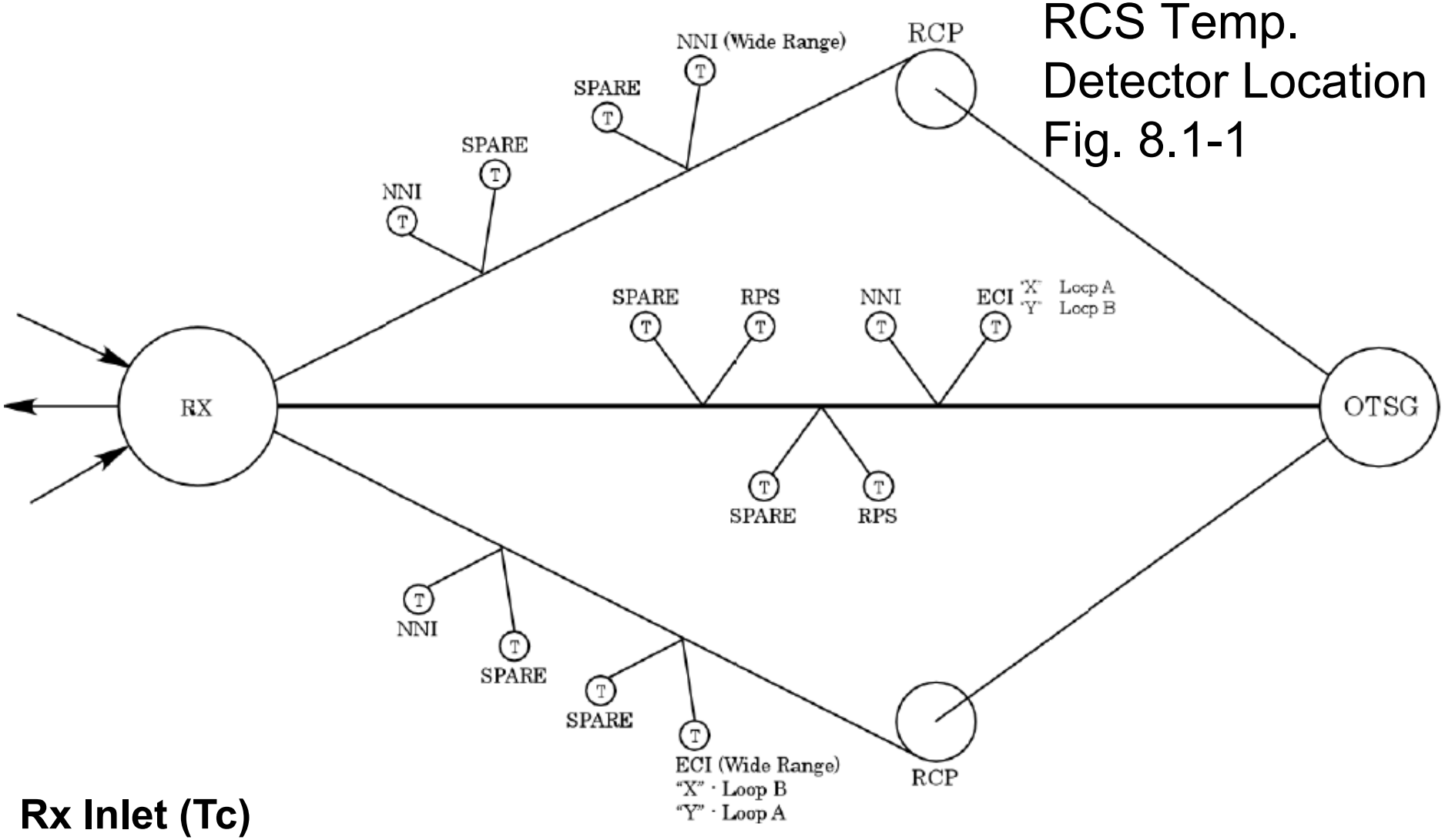
Non-Nuclear Instrumentation (NNI)

- Sensors, instruments & control systems for **normal** plant operation.
  - Not Class 1E.
  - Class 1E equipment is Essential Controls & Instrumentation (EC&I).
  - Usually separate sensors.
    - NNI & EC&I sometimes share sensors.
      - Signals separated by isolators.
    - RPS & ESFAS use own separate sensors.

NNI

- Provides input signals for:
  - ICS
  - Plant control systems
    - PZR pressure
    - PZR level
  - Indication & alarms
  - Plant computer
  - Some EC&I systems
    - Signals separated by isolators

RCS Temp. Detector Location Fig. 8.1-1

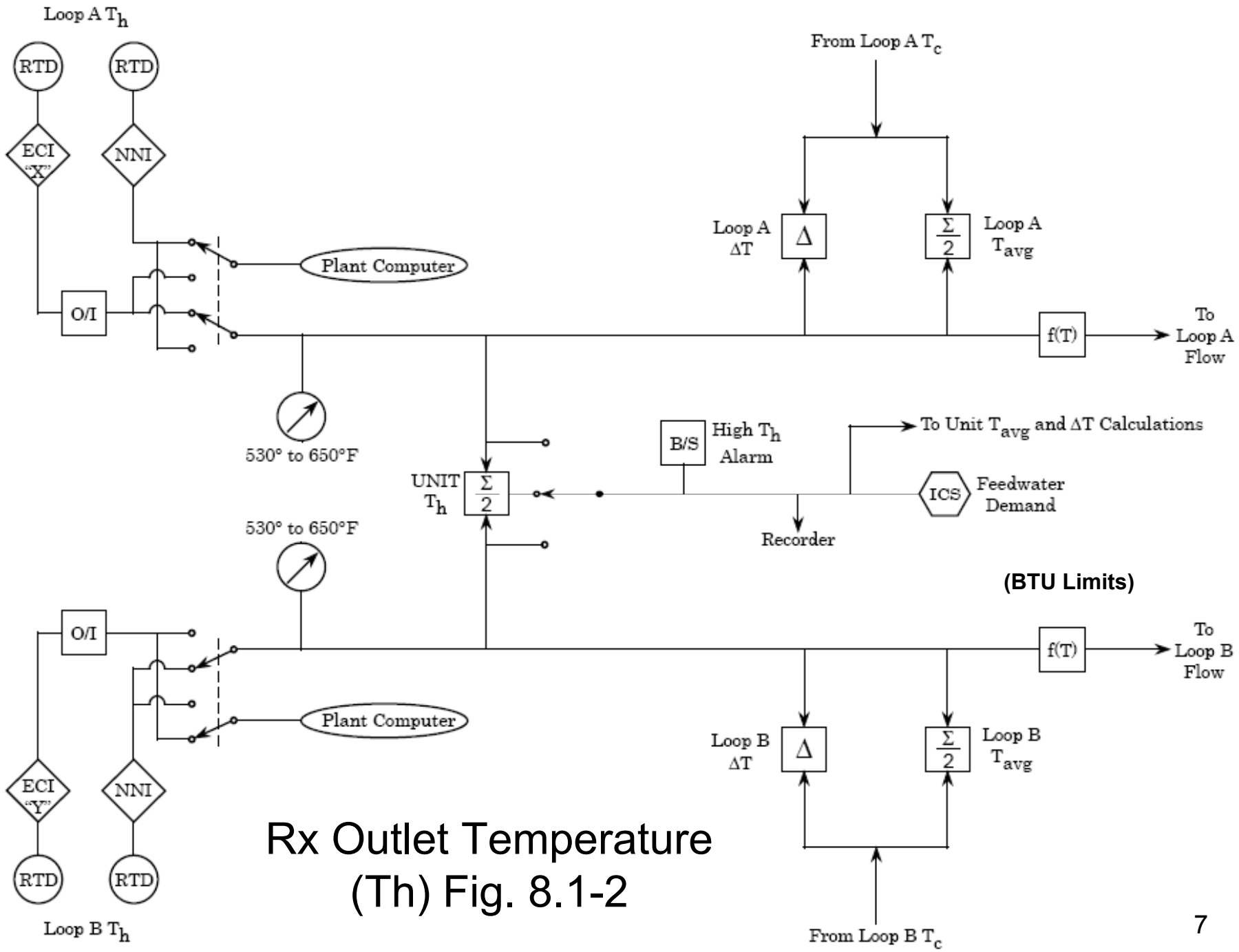


Rx Inlet (Tc)

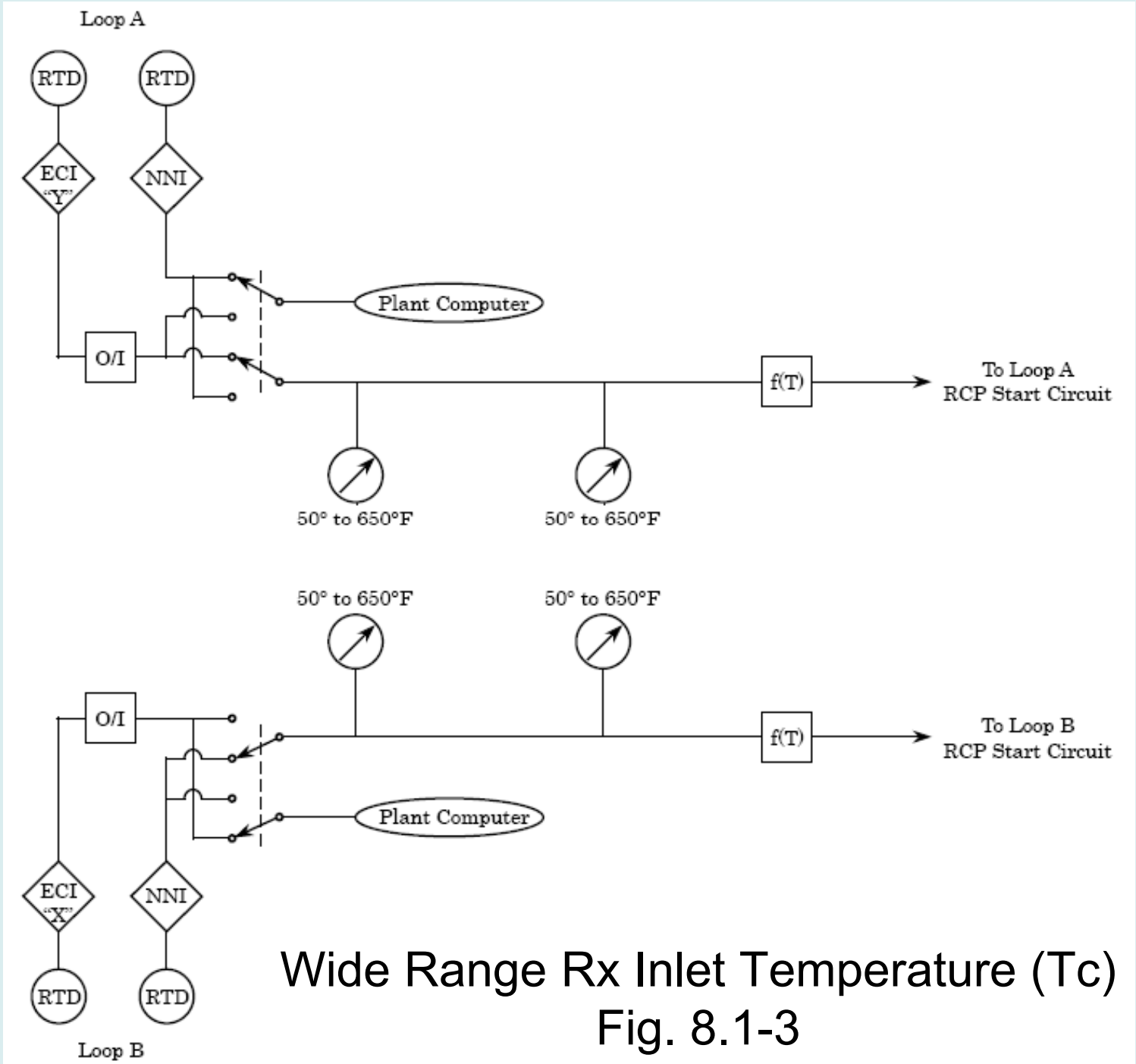
- **-2 dual element / cold leg**
- **-1 NR (530° F – 650° F)**
- **-1 WR (50° F – 650° F)**
- **-NNI in one loop & EC&I in other**
- **-2 spare**

Rx Outlet (Th) RTDs

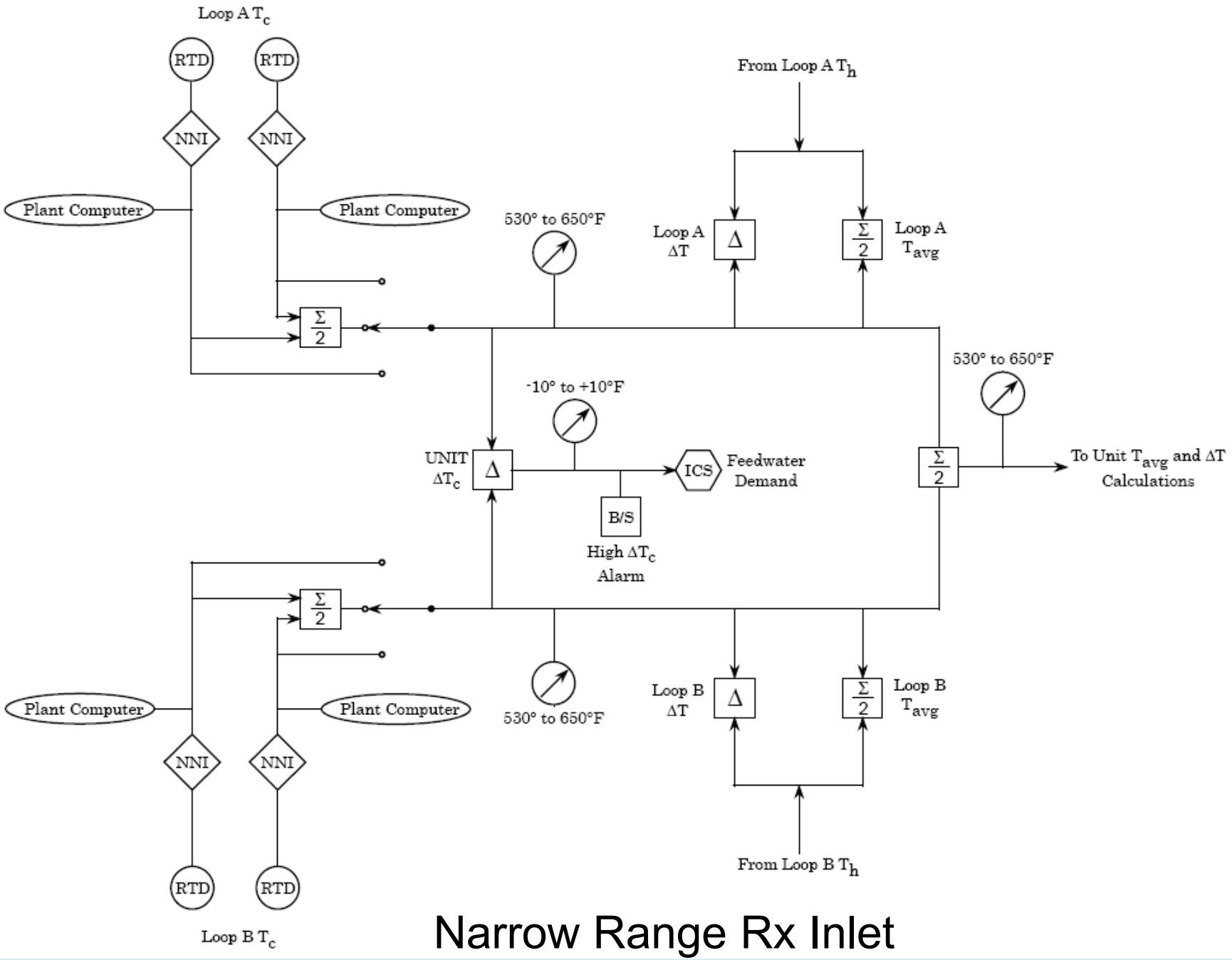
- **-3 dual element/hot leg**
- **-1 NNI, 1 EC&I, 2 RPS, 2 spare**
- **-530° F – 650° F**



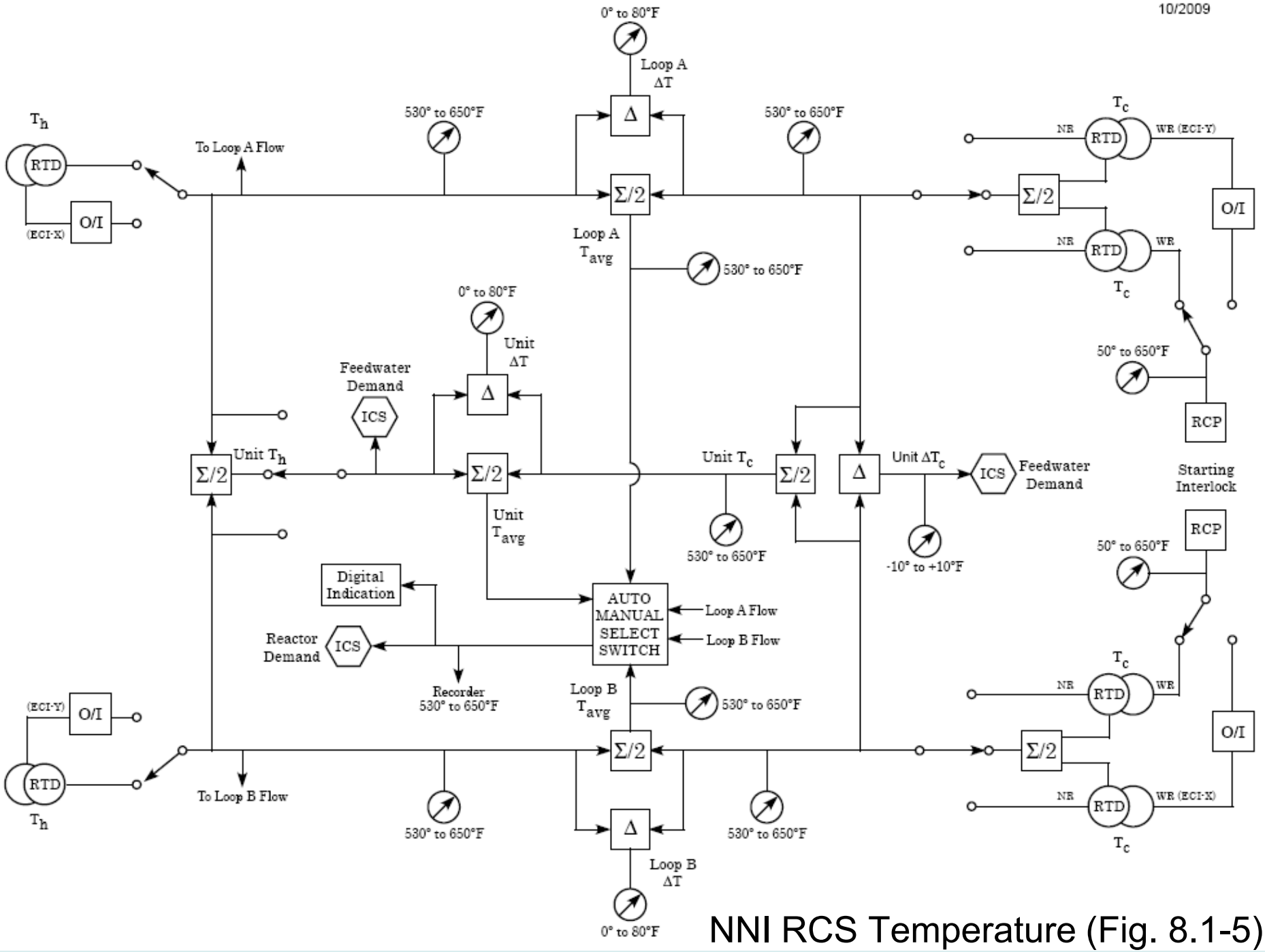
Rx Outlet Temperature (Th) Fig. 8.1-2



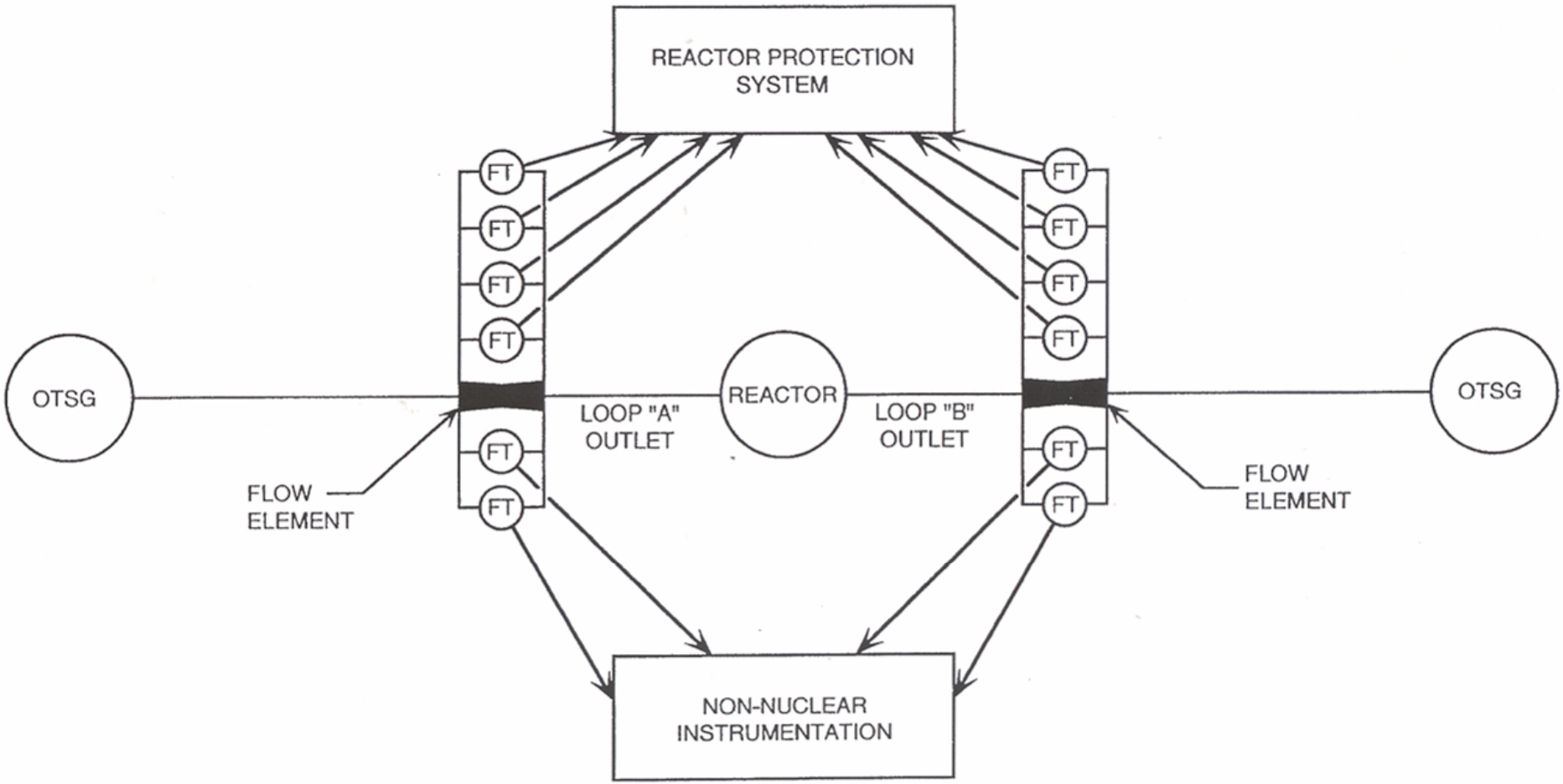
Wide Range Rx Inlet Temperature (Tc)
Fig. 8.1-3



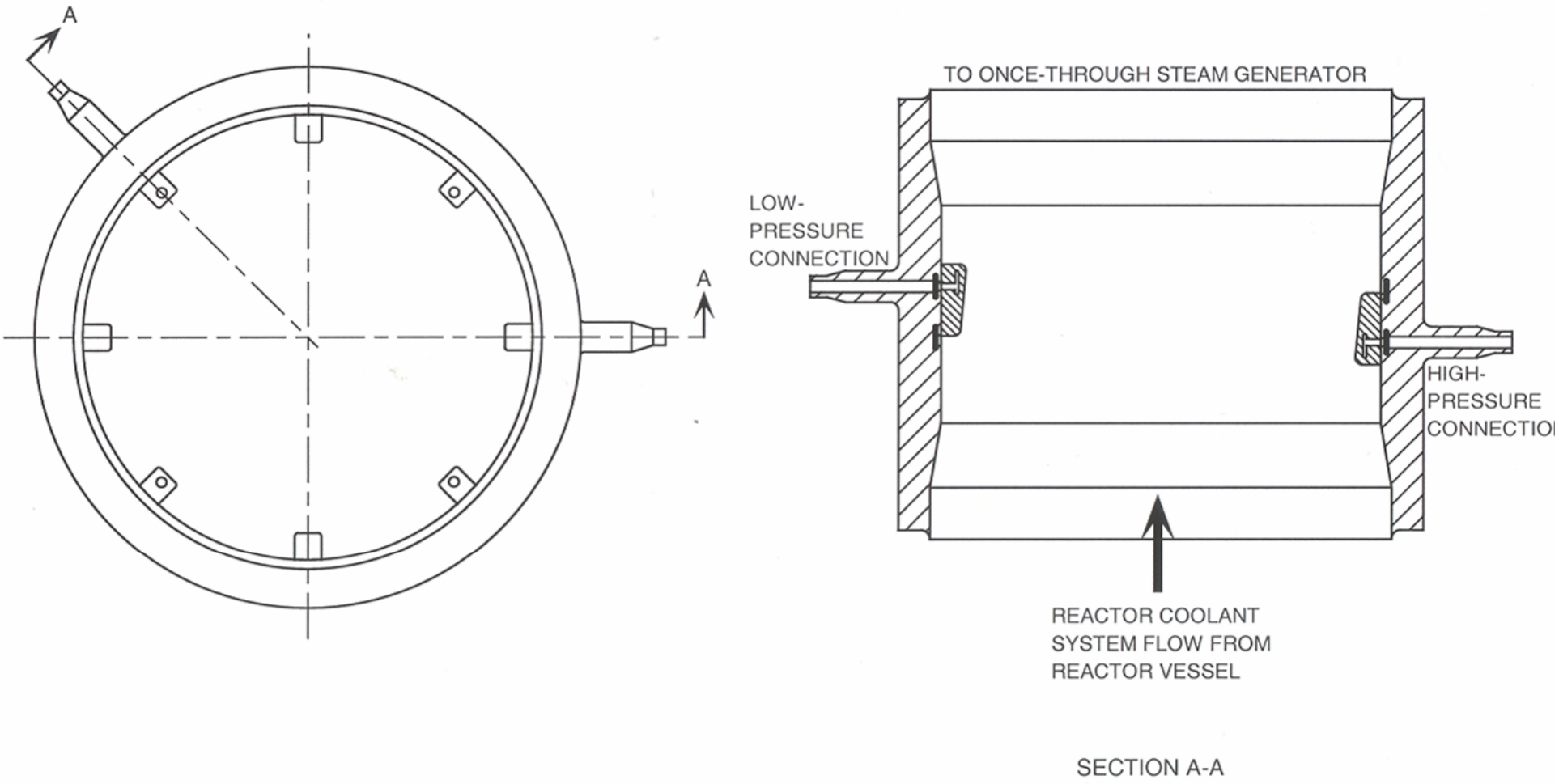
Narrow Range Rx Inlet Temperature (Tc) Fig. 8.1-4



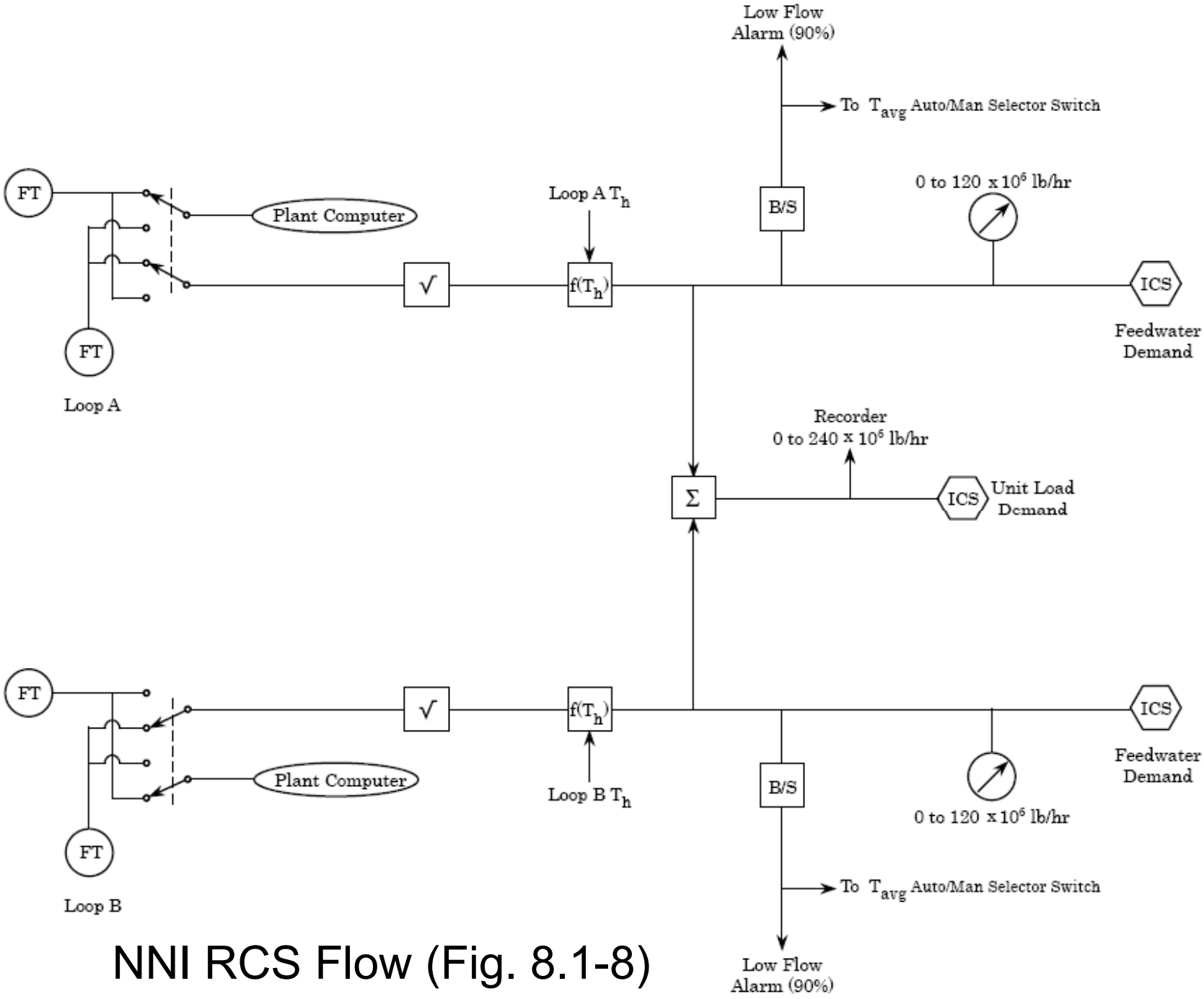
NNI RCS Temperature (Fig. 8.1-5)



RCS Flow Detector Location
(Fig. 8.1-6)

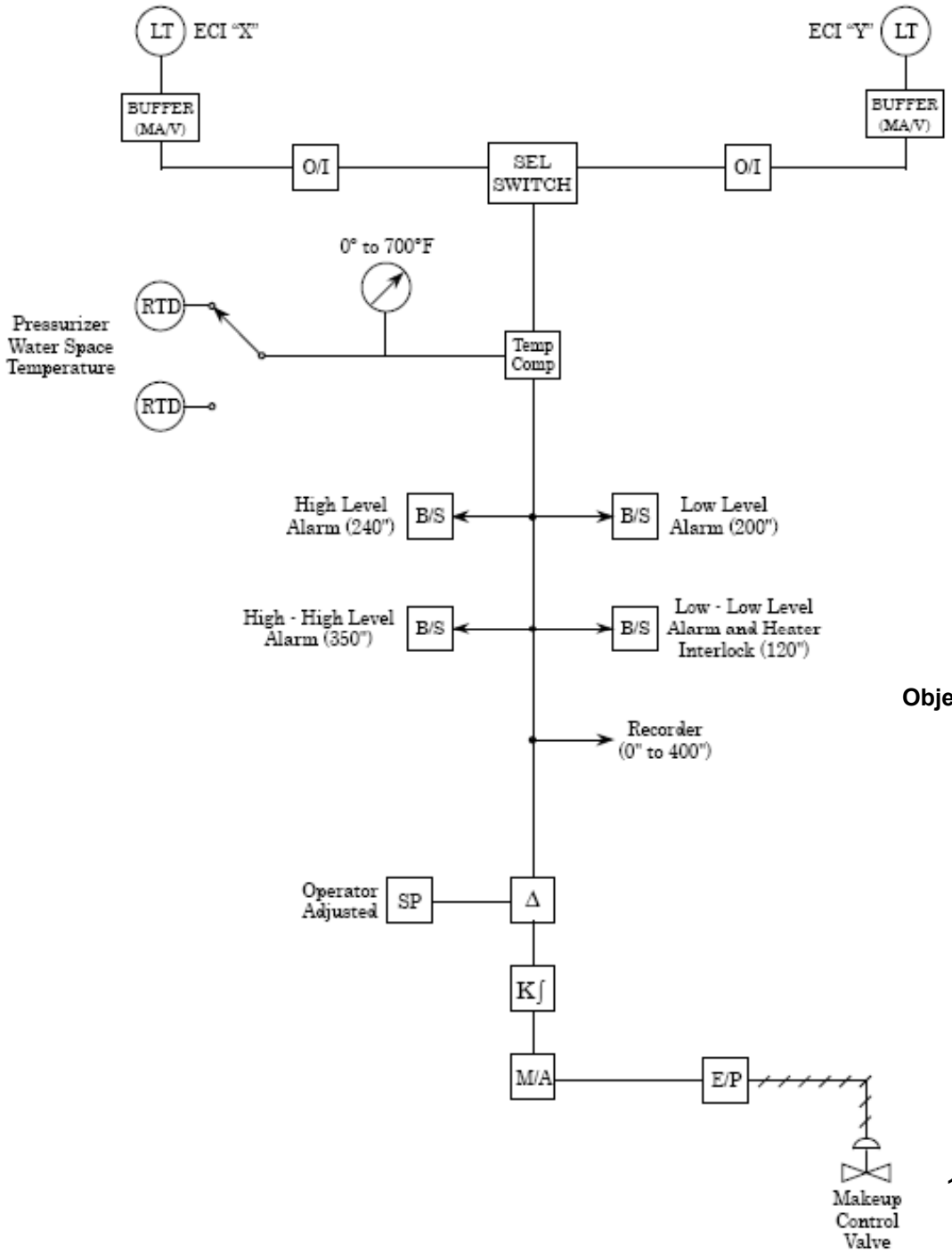


Reactor Coolant Flow Tube
Fig. 8.1-7



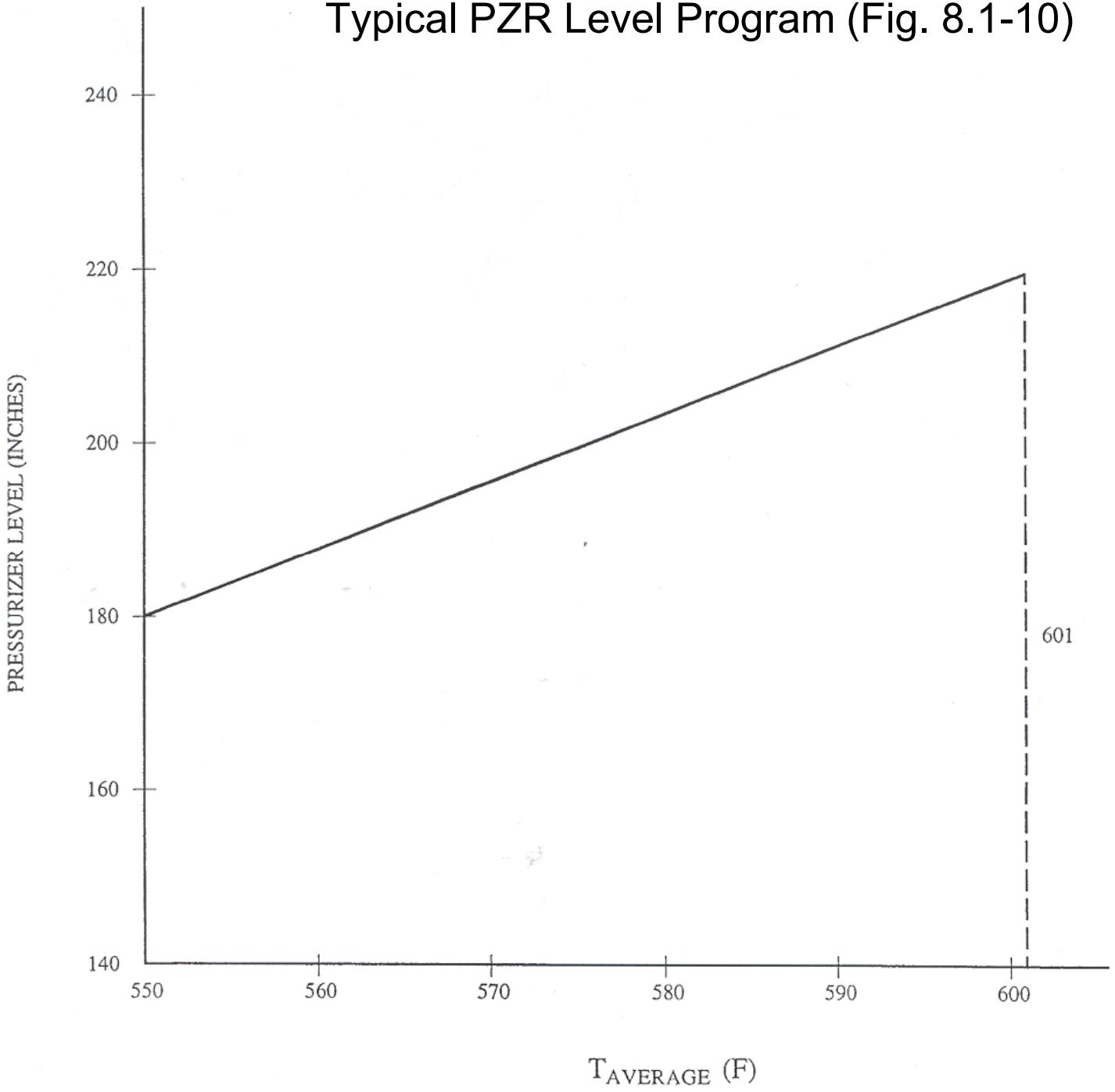
NNI RCS Flow (Fig. 8.1-8)

PZR Level Control (Fig. 8.1-9)

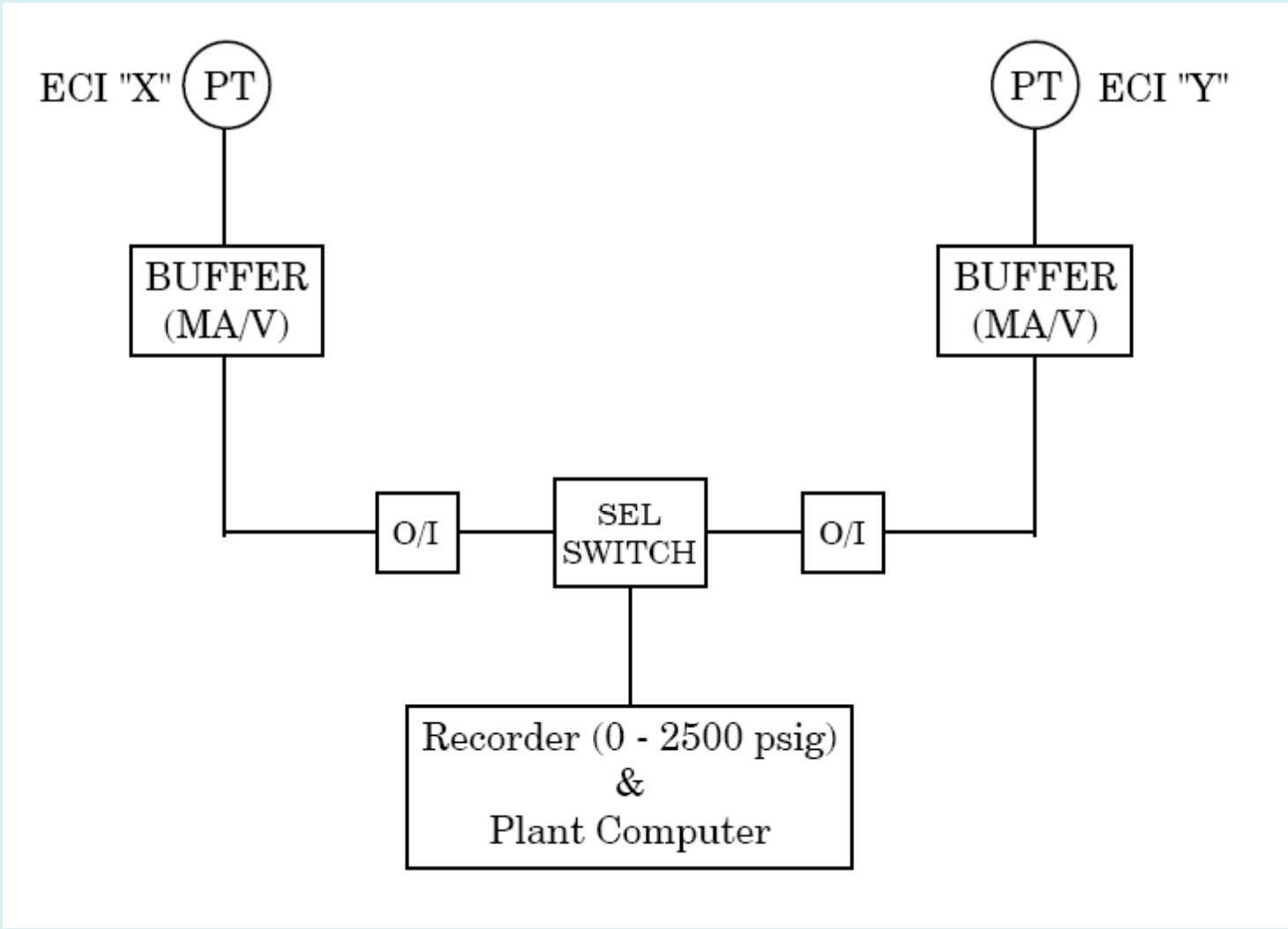


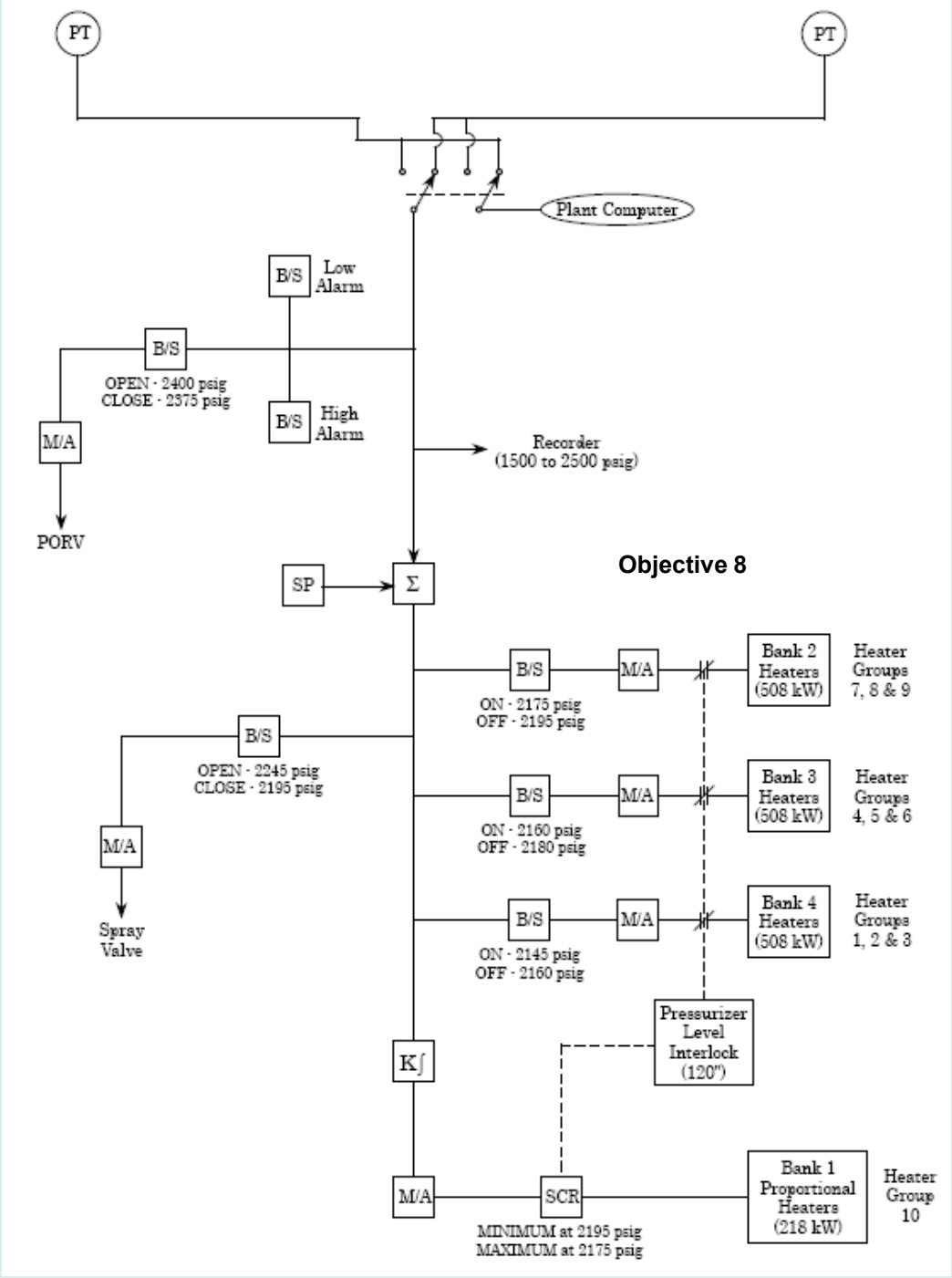
Objective 6

Typical PZR Level Program (Fig. 8.1-10)



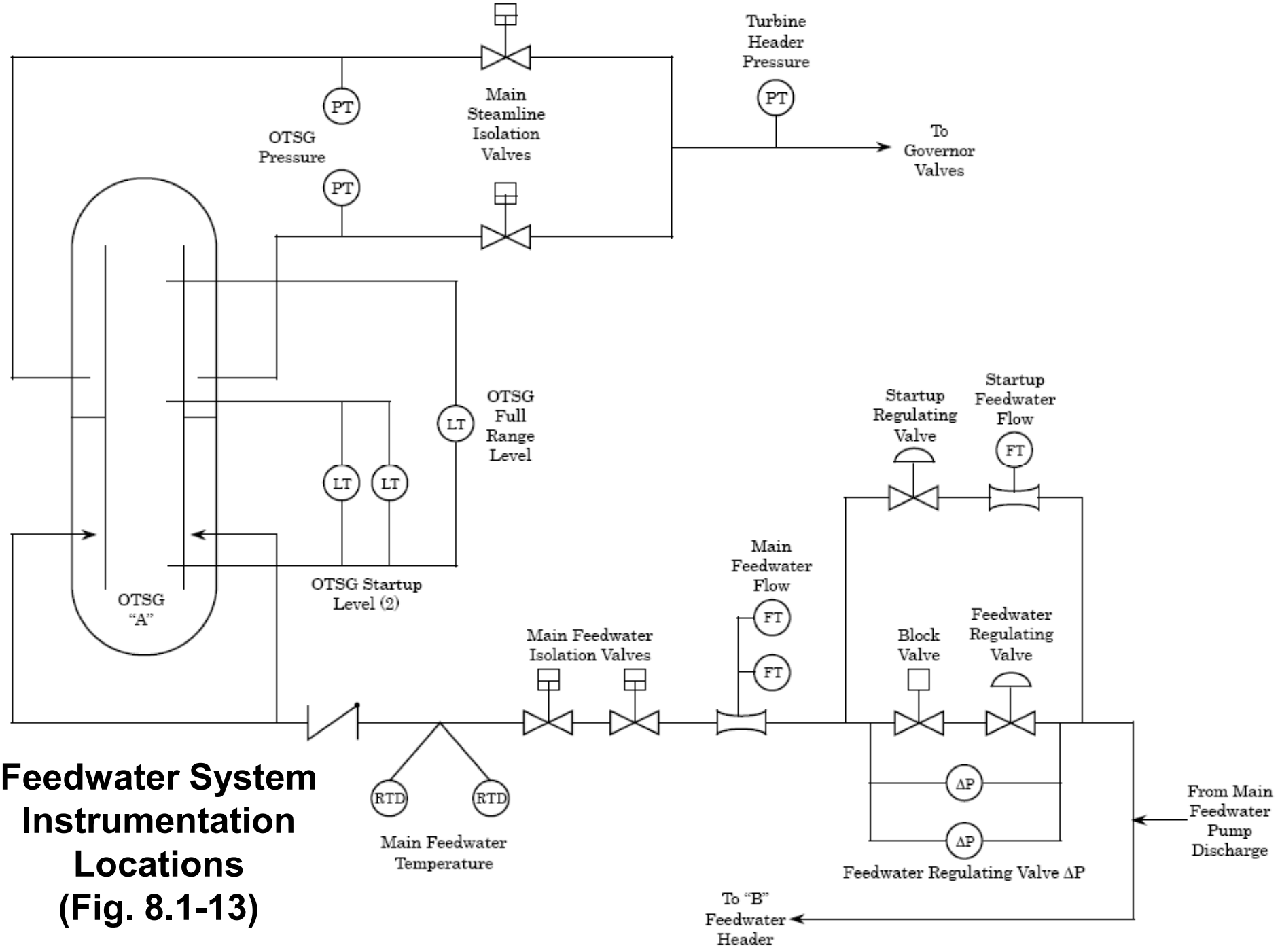
Wide Range PZR Pressure (Fig. 8.1-11)

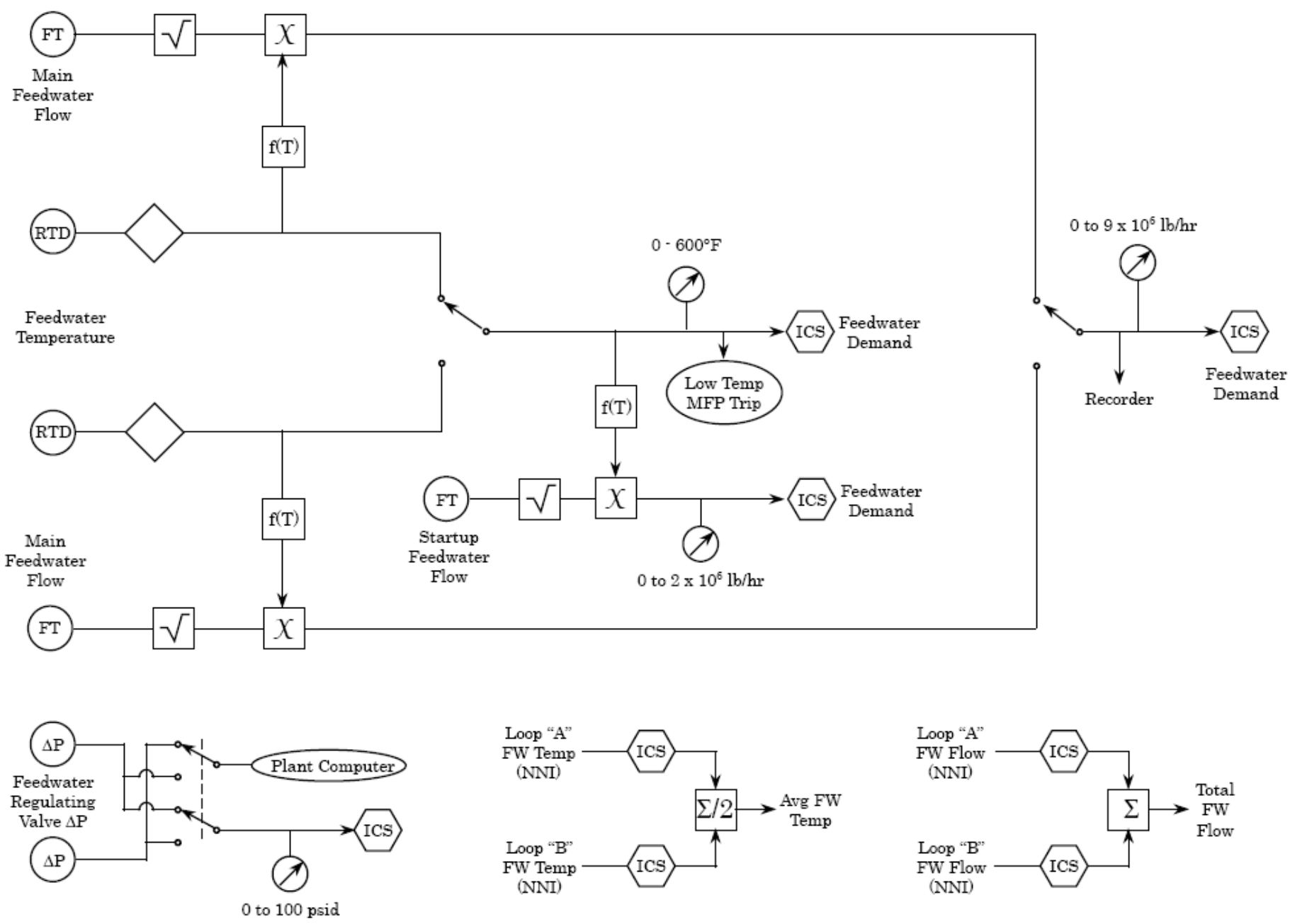




Narrow Range
PZR Pressure
Fig. 8.1-12

Feedwater System Instrumentation Locations (Fig. 8.1-13)





Feedwater Instrumentation Fig. 8.1-14

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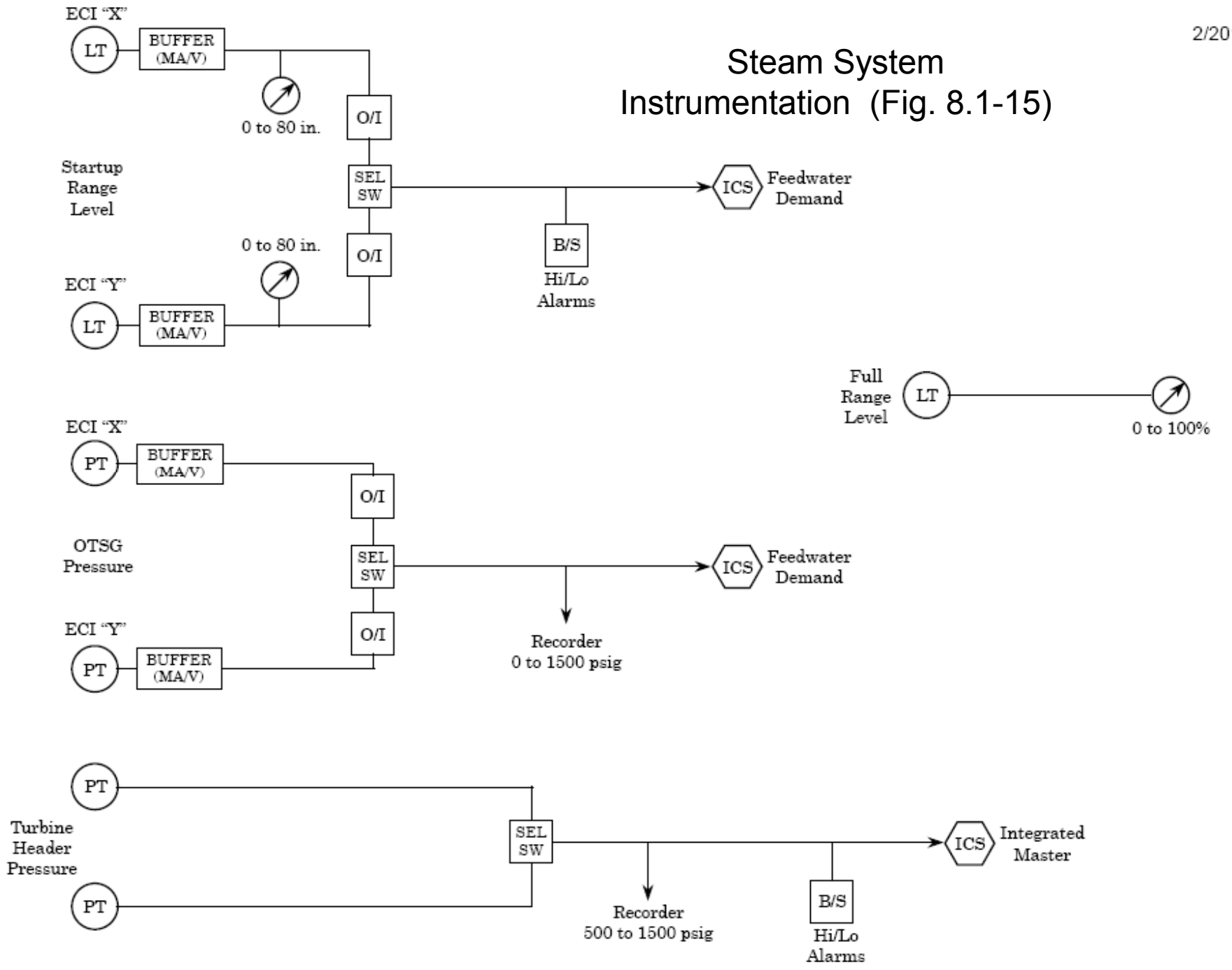
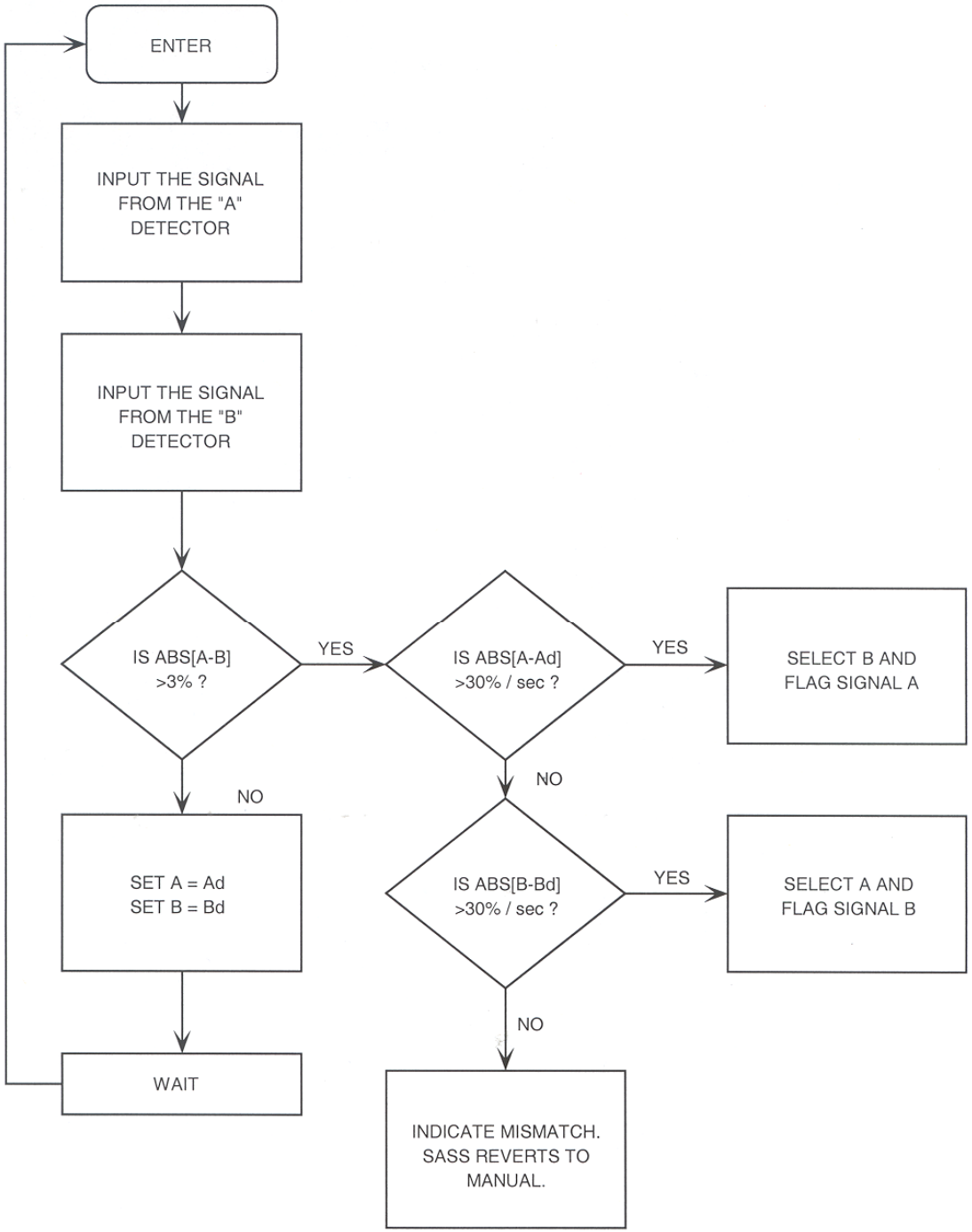
Steam System Instrumentation (Fig. 8.1-15)



Smart Automatic Signal Selection System (SASS)

- Industry events have shown that the majority of plant transients caused by the ICS were caused by input signal failures.
- The SASS auctions the ICS input signals, which reduces transients caused by input failures.
- SASS not installed on TTC B&W Sim.



Smart Analog Signal Select (SASS) System
Fig. 8.1-16

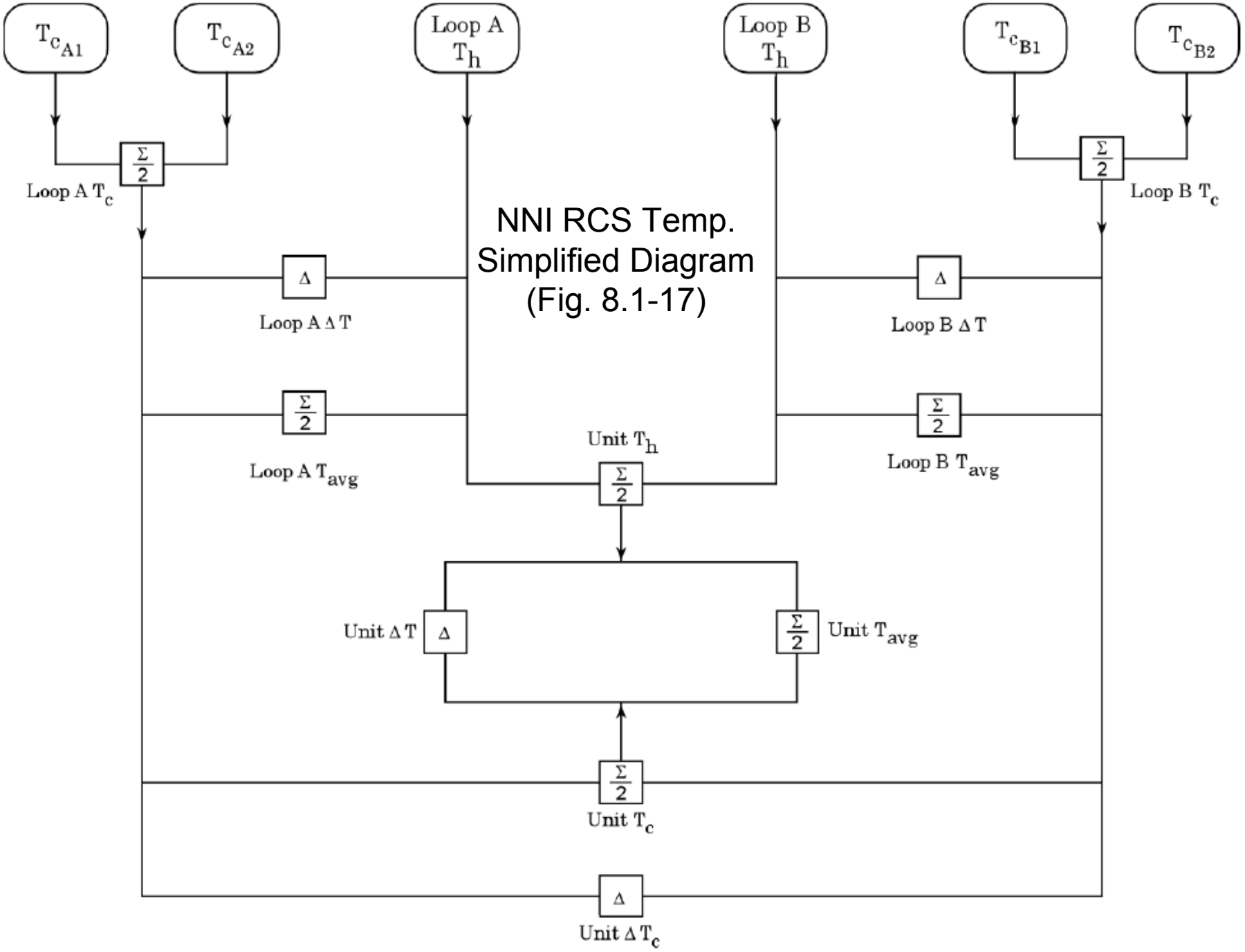

$T_{c_{A1}}$
$T_{c_{A2}}$
Loop A T_h
Loop B T_h
$T_{c_{B1}}$
$T_{c_{B2}}$
$\frac{\Sigma}{2}$
Loop A T_c
Loop B T_c
NNI RCS Temp.
Simplified Diagram
(Fig. 8.1-17)
Δ
Loop A ΔT
Loop B ΔT
Loop A T_{avg}
Unit T_h
Loop B T_{avg}
Unit ΔT
Unit T_{avg}
Unit T_c
Unit ΔT_c

TABLE 8.1-1 NON-NUCLEAR INSTRUMENTATION INPUTS TO INTEGRATED CONTROL SYSTEM

NNI Signal	ICS Subassembly	Function
Unit T_h	Feedwater Demand	Calculation of BTU Limits
Unit Delta T_c	Feedwater Demand	Calculation of feedwater flow ratio for OTSGs
Unit T_{ave}	Reactor Demand	Modify reactor demand signal for regulating rod movement
Loop A RCS Flow	Feedwater Demand	Calculation of BTU limits and feedwater flow rationing
Loop B RCS Flow	Feedwater Demand	Calculation of BTU limits and feedwater flow rationing
Total RCS Flow	Unit Load Demand	Initiation of runback signals
Loop Main Feedwater Flow	Feedwater Demand	Compared to feedwater demand to develop error signal
Loop Startup Feedwater Flow	Feedwater Demand	Control position of startup regulating valve
Loop Main Feedwater Temperature	Feedwater Demand	Calculation of BTU limits
Main Feedwater Valve ΔP	Feedwater Demand	Control main feedwater pump speed
OTSG Startup Level	Feedwater Demand	Low-level limit control
Turbine Header Pressure	Integrated Master	Turbine load control and steam dump valve control
OTSG Pressure	Feedwater Demand	Calculation of BTU Limits
Average FW Temperature	Feedwater Demand	Modify feedwater demand signal

Table 8.1-1