U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Anticipated Transient Without Scram (ATWS)

Chapter 4.7

HRTD

Human Resources

Training & Development

Objectives

1. Define the term "**A**nticipated **T**ransient **W**ithout **S**cram" (ATWS).

2. Describe the limiting (most severe) ATWS case for a pressurized water reactor (PWR).

3. List three parameters or components that affect a plant's sensitivity to an ATWS event.

Objectives (cont)

4. Describe the modification made to Westinghouse reactor trip breakers after the Salem ATWS.

5. State the functions of the ATWS mitigation system.

6. Delete

ATWS 10CFR50.62

- “an anticipated operational occurrence… followed by failure of the reactor trip portion of the protection system”

- An anticipated operational occurrence is defined as those conditions of normal operation that are expected to occur one or more times during the life of a nuclear unit (e.g., Rx Trip, Turb Trip, LOOP, Loss of FW, etc.)

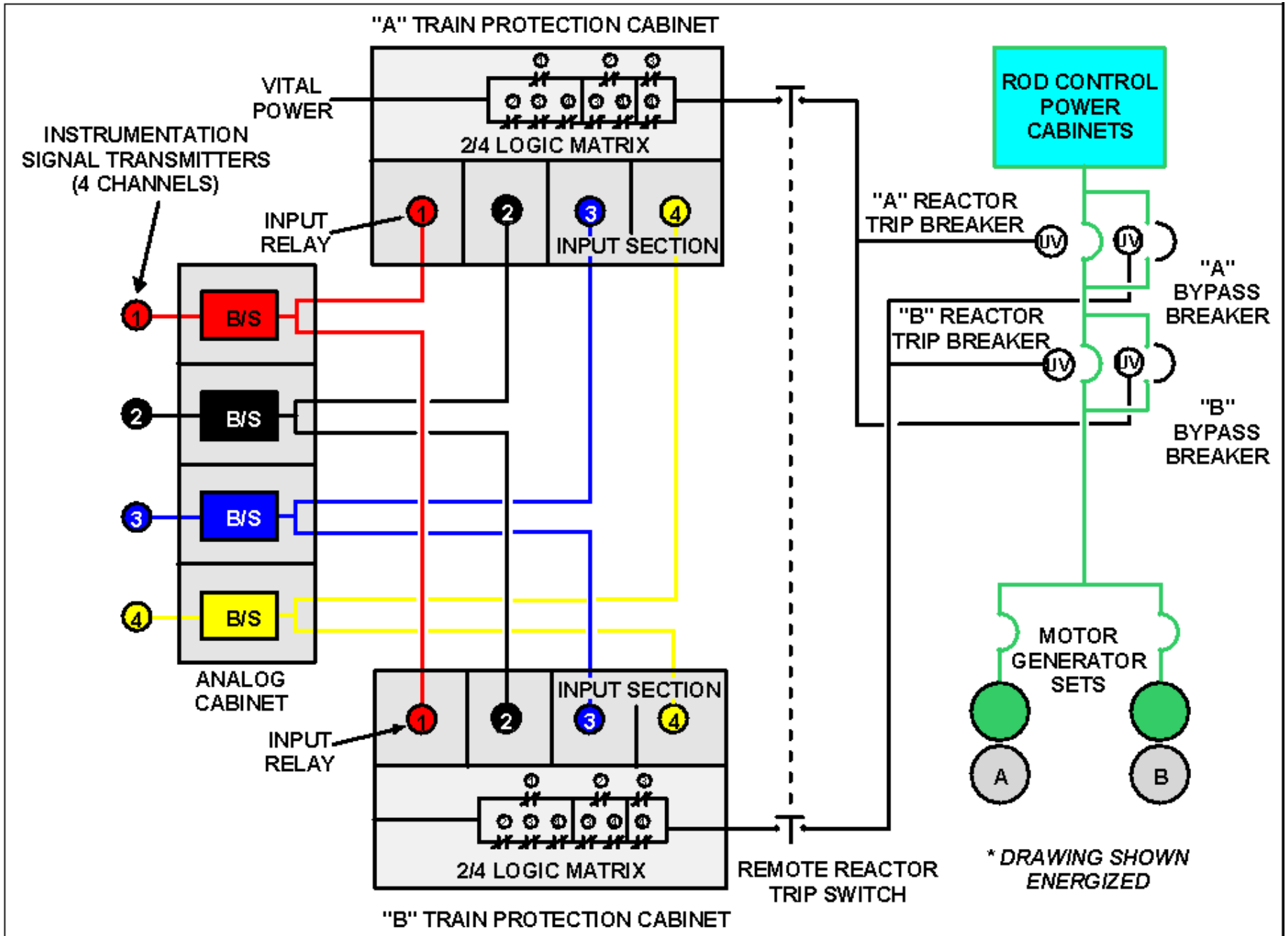


Fig 4.7-1 Solid State Protection

History

- 1968 Advisory Committee on Reactor Safety (ACRS) found that separation of control and protection systems to be adequate.
- 1969 ACRS: Evaluate likelihood of RPS common mode failures and analyze consequences of postulated ATWS events.
- 1980 NUREG 460 ATWS (USI A-9)
  - PRA to estimate benefit of modifications
- 1984 ATWS Rule 10CFR50.62

History

- 1984 ATWS Rule -10CFR50.62

  Diverse Trip System: Not required for Westinghouse.

  ATWS mitigation system: Required to initiate AFW & Turbine trip under conditions indicative of ATWS.

History

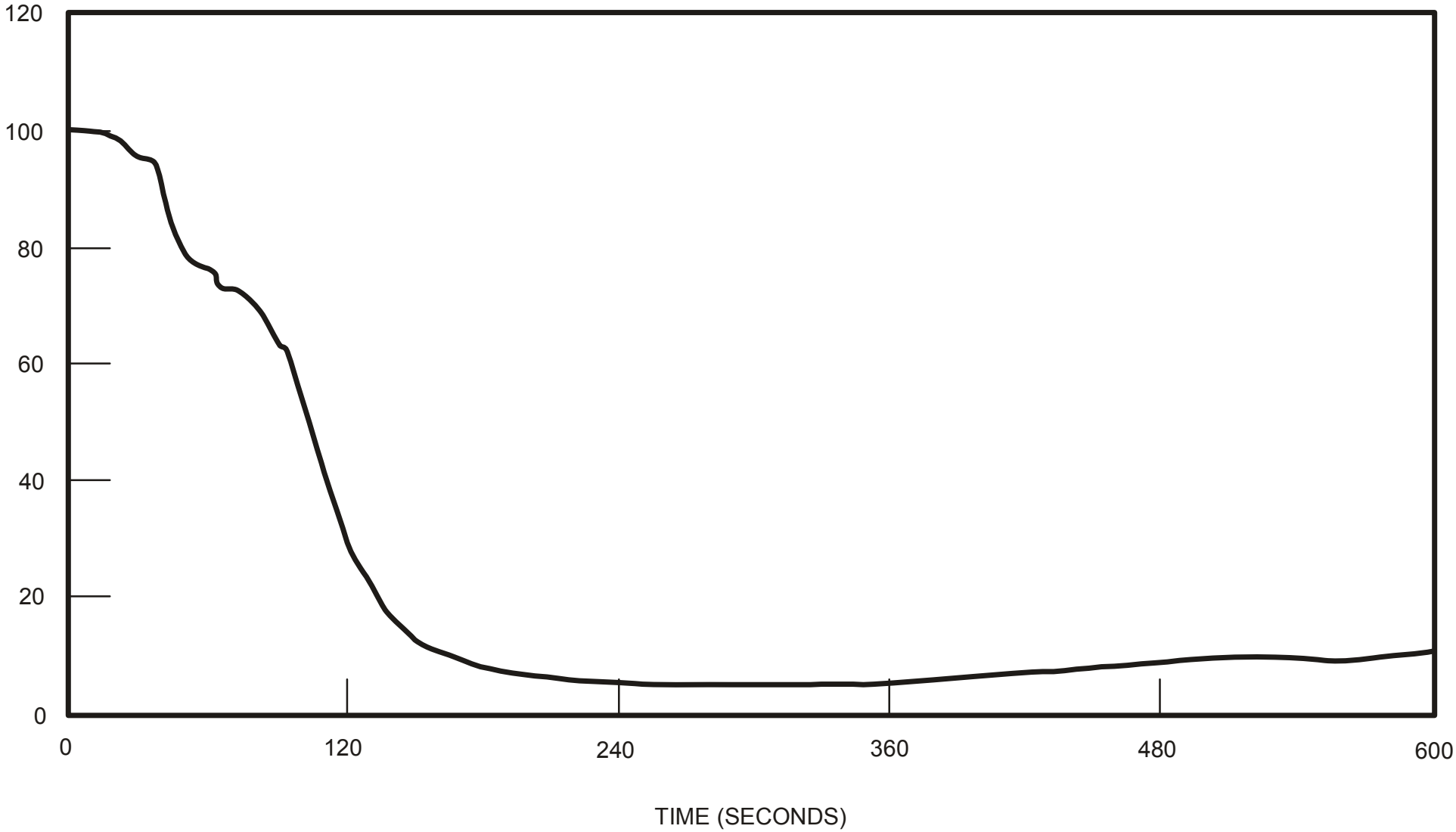
- Sept. 2003 NUREG-1780, Regulatory Effectiveness of the Anticipated Transient Without Scram Rule
  - Concluded that ATWS rule was effective in reducing risk and costs associated with implementation were reasonable.
  - Report also stated “uncertainties in the reactor protection system and mitigative capability may warrant further attention to ensure the expected levels of safety are maintained”

ATWS Principal Transients

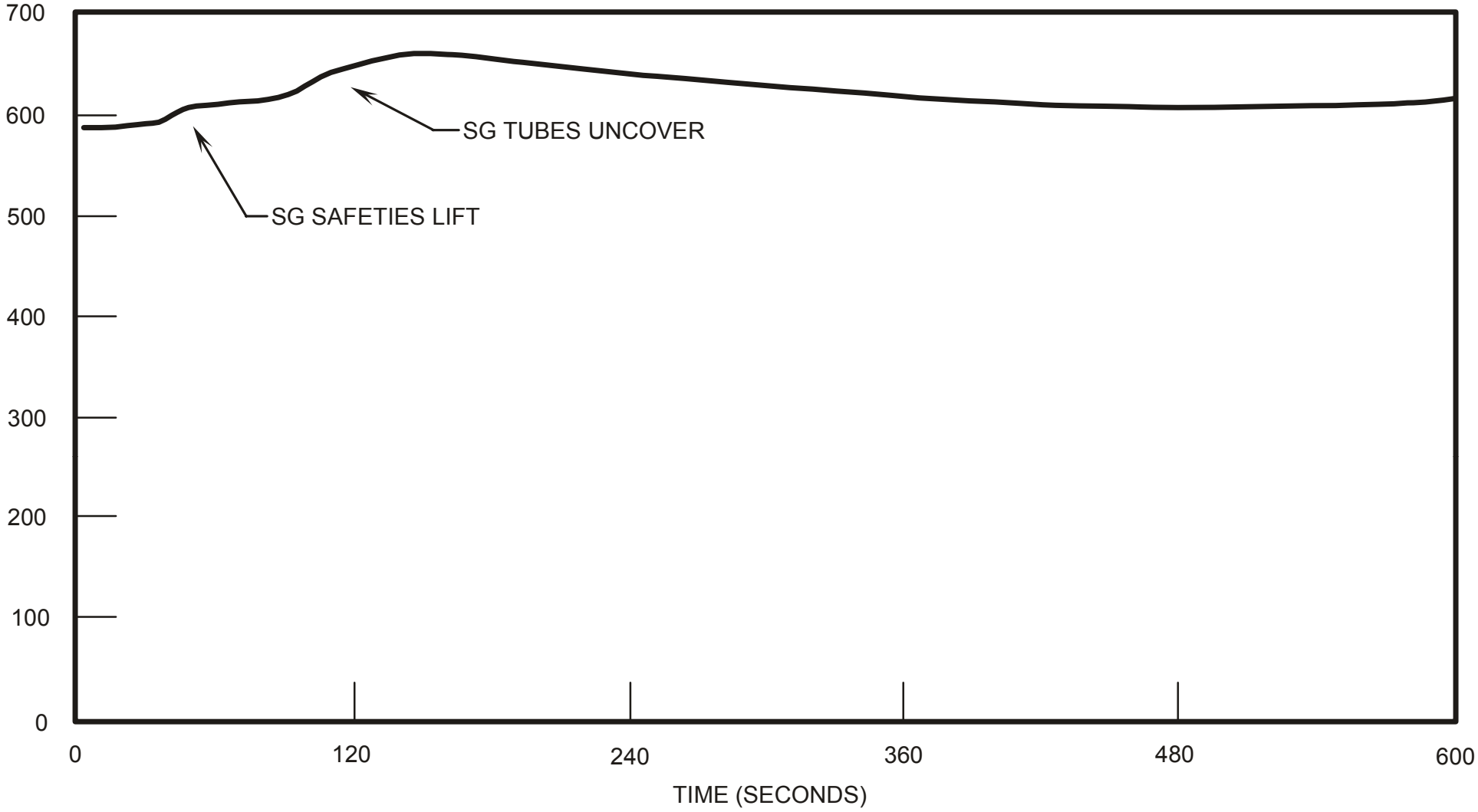
- Loss of Load/Turbine Trip
- Loss of Offsite Power
- Accidental RCS Depressurization
- Uncontrolled RCCA Bank Withdrawal
- Loss of Normal Feedwater (worst case)

ATWS Loss of FW Worst Case

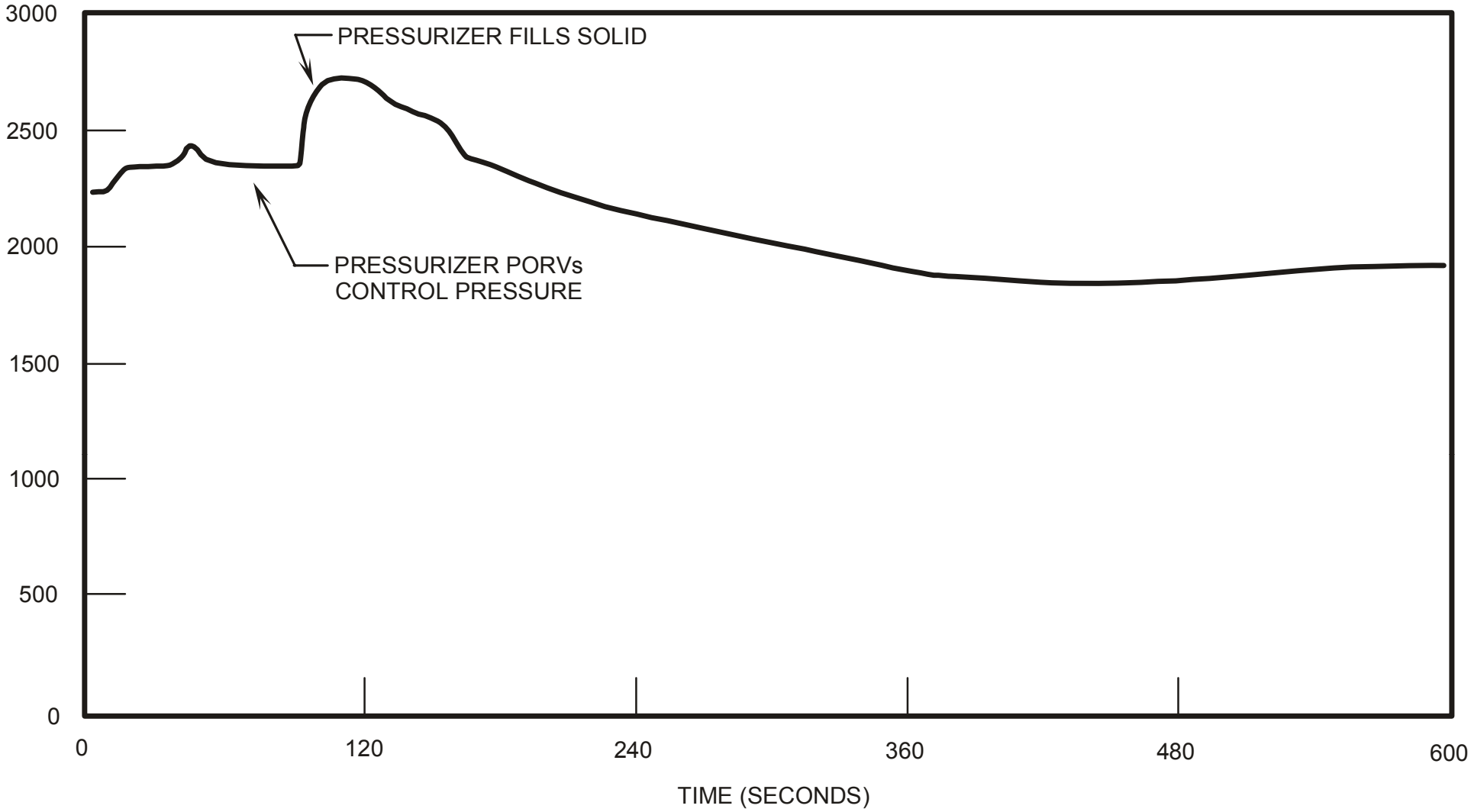
- The loss of FW/Loss of Heat Sink without trip causes increase in RCS Temperature. Temp increase raises SG Press. Safeties open, SG's Dry out. AFW can't keep up.
- Coolant Expansion due to temp increase causes a large in-surge to the Pressurizer.
- The In-Surge compressed the PZR bubble increasing RCS pressure >3000 psia
- Concern failure of RCS boundary/ECCS interface connections.



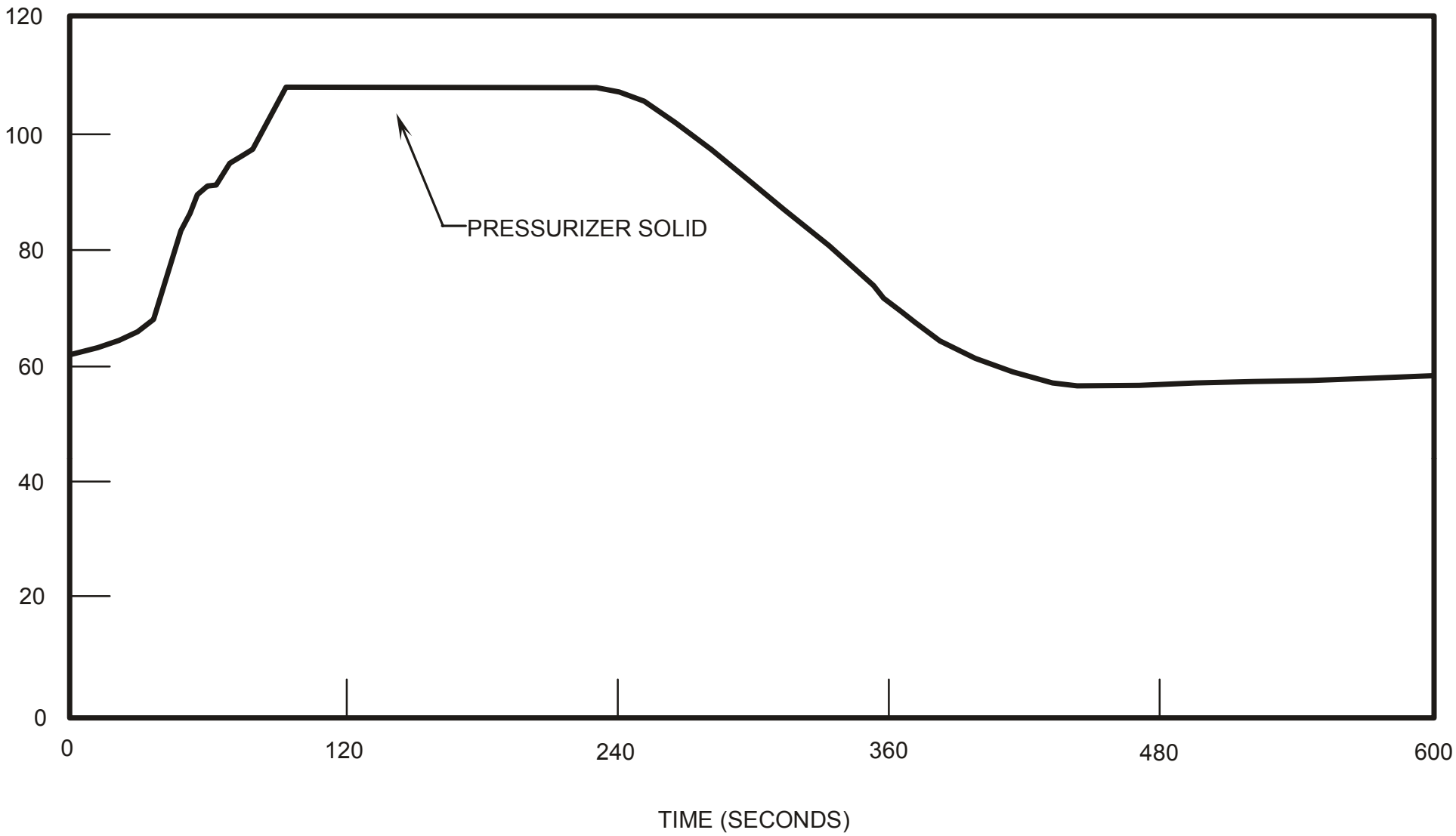
Loss of FW ATWS–Nuclear Pwr



Loss of FW ATWS – Tave



Loss of FW ATWS–PZR Pressure



Loss of FW ATWS–PZR Level

Severity of Peak Pressure

- Value of MTC - Determines how much neg reactivity is added with the temp increase – worst BOL
- Pressurizer Volume -Time to reach solid
- Pressurizer Safety Valve Capacity - Affects ultimate pressure reached when solid
- Secondary Inventory – determines time to S/G dry-out
- Turbine Trip- preserves secondary inventory

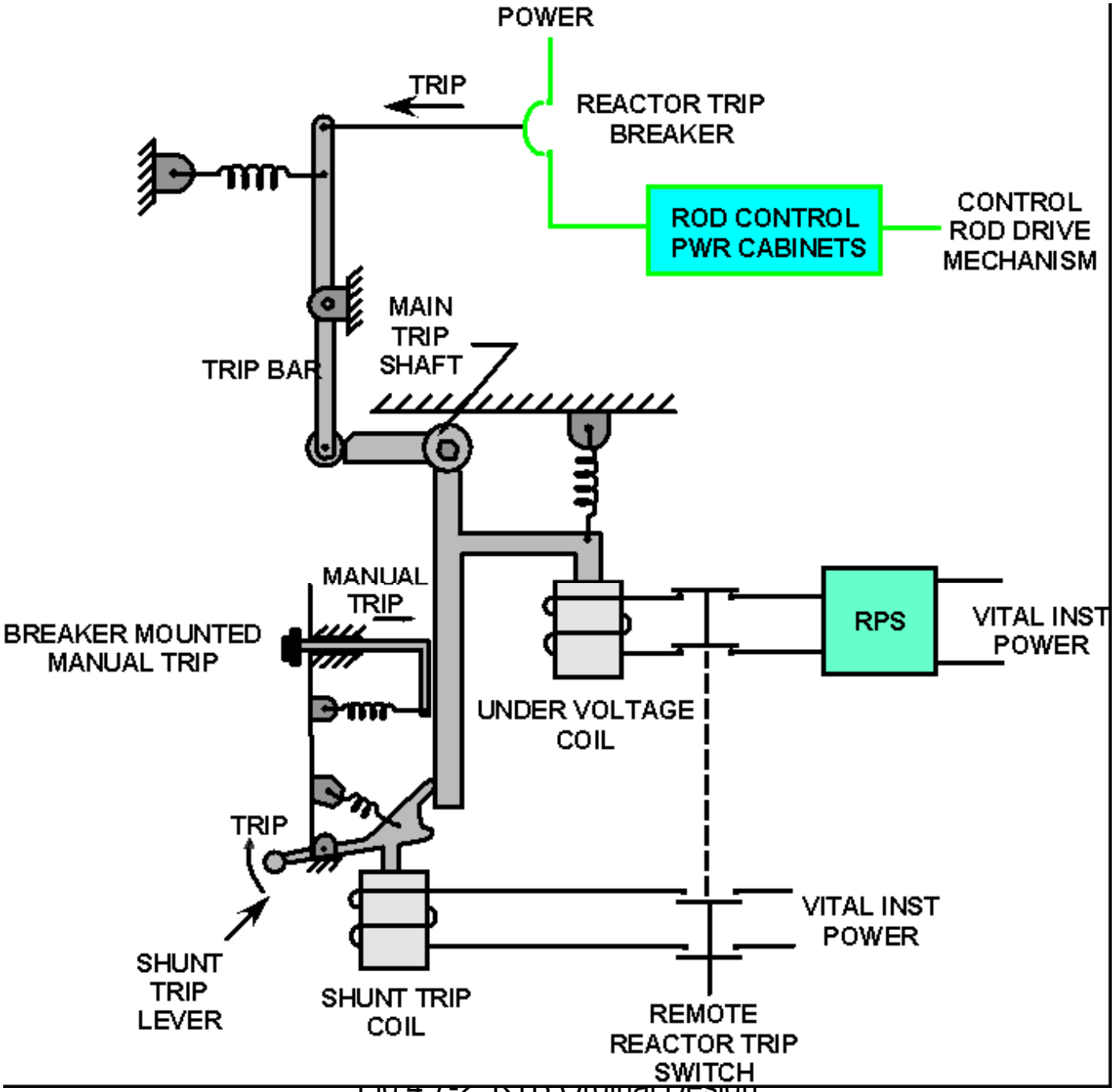


Fig 4.7-2 RTB Original Design

Salem ATWS Events (1983)

2/22/83

- 20% pwr with 1 MFP I/S & 1 MFP min speed.
- During transfer from offsite pwr to Main Gen control power to MFP is lost, SG levels drop.
- SG levels decrease to trip setpoint but trip does not occur. Operator manually trips 3.5 seconds later. Operators think they tripped Rx prior to level setpoint being reached.

Salem ATWS Events (1983)

2/25/83

- Plant recovers from 2/22 trip and starts up.
- During low power operation there is difficulty controlling SG levels. One SG drops to the Low Low Level setpoint.
- Once again trip does not occur but alarm indication tells operators that trip setpoint has been reached.
- Operators manually trip plant 23 seconds after auto trip signal generated.

Salem ATWS Events (1983)

- Investigation determined problem with Rx Trip Breakers.
- UV coils operated properly but mechanical interference in mechanisms prevents breakers from opening.
- Similar problems found at McGuire in 1987. NRC Bulletin 88-01 issued as result.

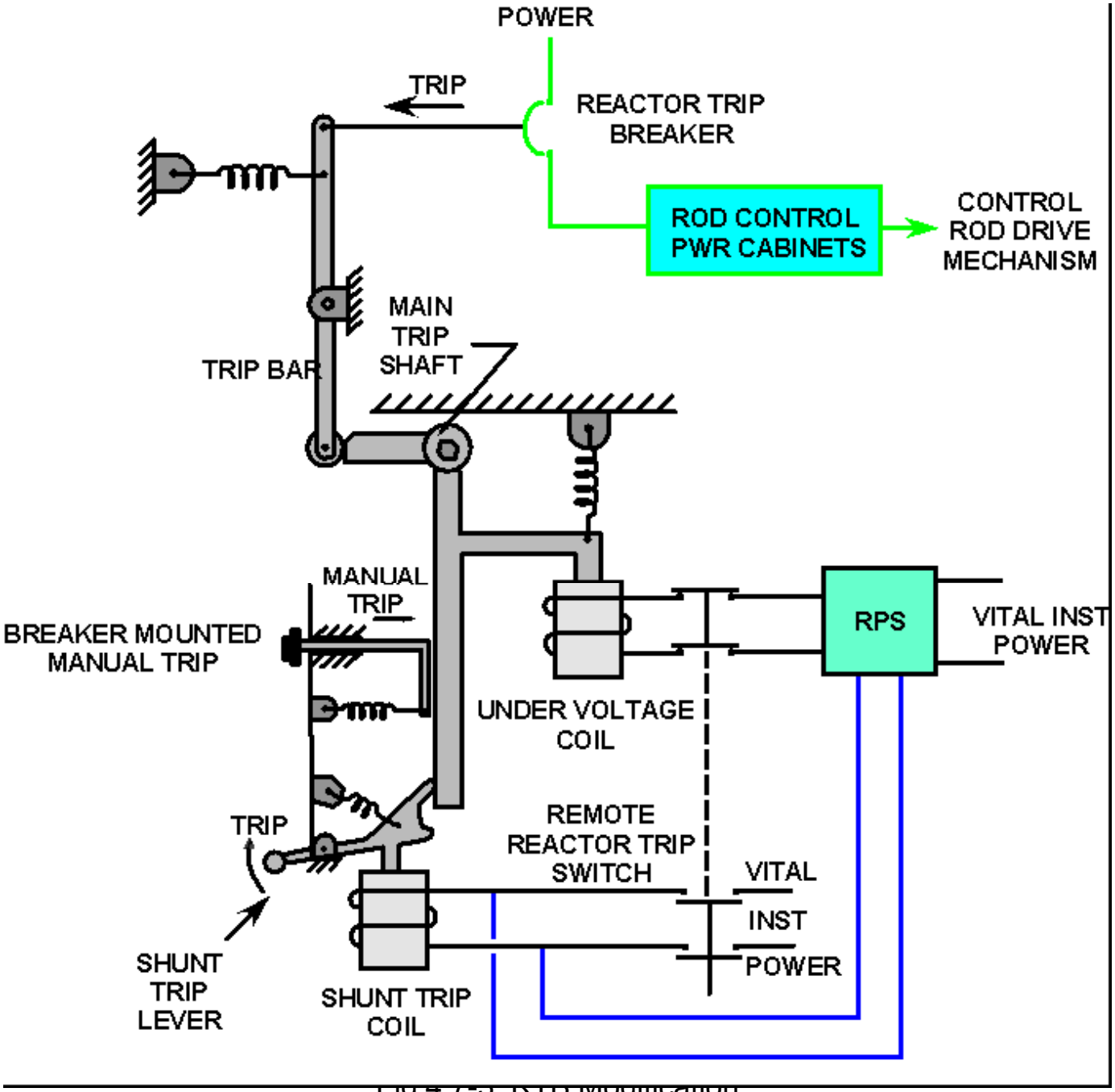


Fig 4.7-3 RTB Modification

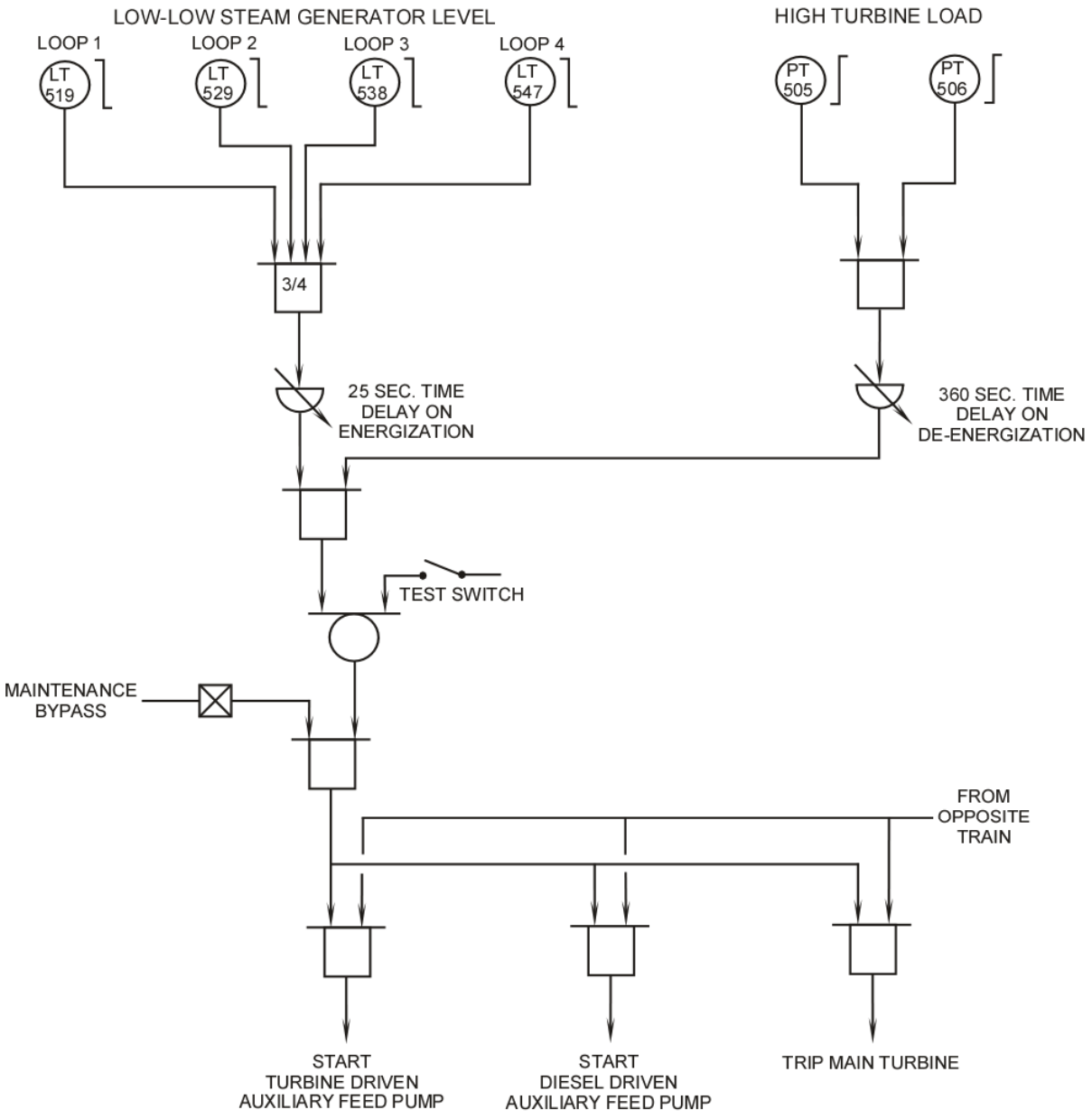


Fig 4.7-4 Trojan AMSAC Pg 4.7-7

Table 1 Categories of Initiating Events for Callaway Nuclear Generating Station, Unit 1 [1, 3]

Row	Approximate Frequency	Event Type	Initiating Event Likelihood (IEL)		
I	1 per 1-10 yr	Transients With PCS Available (Reactor Trip) (TRANS), Transients With Loss of PCS (TPCS)	1	2	3
II	1 per 10^{-1} - 10^{2} yr	Loss of Offsite Power (LOOP), Loss of (Normal) Service Water System (LSWS) [4]	2	3	4
III	1 per 10^{2} - 10^{3} yr	Steam Generator Tube Rupture (SGTR), Stuck-Open PORV (SORV), Small LOCA Including RCP Seal Failures (SLOCA), Main Steam Line Break Outside Containment (MSLB), Loss of Instrument Air (LIA), Loss of Vital DC Bus (LBDC)	3	4	5
IV	1 per 10^{3} - 10^{4} yr	Medium LOCA (MLOCA), LOOP and Loss of Vital 4.16 kV AC Bus (LEAC)	4	5	6
V	1 per 10^{4} - 10^{5} yr	Large LOCA (LLOCA), Loss of Component Cooling Water (LCCW)	5	6	7
VI	less than 1 per 10^{5} yr	Anticipated Transients Without Scram (ATWS) [2], Interfacing System LOCA (ISLOCA)	6	7	8
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

Turbine trip