

Regulatory Performance Meeting

Failure of Atmospheric Dump Valve  
Quick-Open Override Relay

Presented by:

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# Background

- On January 23, 2004, Calvert Cliffs Unit Two Reactor Tripped on a loss of # 22 Steam Generator Feed Pump
  - The Atmospheric Dump Valves (ADVs) and Turbine Bypass Valves (TBVs) remained open after the  $T_{ave}$  setpoint for clearing the “Quick Open” was reached.
    - A prolonged overcooling of the Reactor Coolant System
    - Engineered Safety Feature actuations (SGIS and SIAS)
    - A Loss of Normal Heat Removal
- The “Quick Open” K7 Relay in the Reactor Regulating System (RRS) failed to operate properly.
  - The relay output contacts failed to reposition when the K7 relay was de-energized at the  $T_{ave}$  setpoint
  - Internal inspection subsequently found the K7 relay contacts burned and welded
  - The relay contact was underrated for the application.

# Root Cause Analysis (IR200400047)

- A multi-discipline Root Cause Analysis Team specifically addressed the failure of the K7 Relay
  - Five root cause teams were formed to ensure thorough analysis of the initiating event and contributors
- Causal Analysis techniques
  - Equipment (Kepner-Tregoe Problem Analysis)
  - Human Performance (Barrier Analysis, Why Staircase, Problem Analysis, and Potential Cause Analysis)

# Causes and Contributors

- K7 relay contacts underrated for application
  - Original design error by vendor ( > 30 years )
  - Vendor K7 circuit modification in 1992 resulted in increased contact current (missed opportunity, exacerbated error)
  - Design and design verification performed by vendor

Note: Owner's acceptance review of modification performed although not required in 1992; however, would not be expected to detect this design error
- Contributing Factors that may have prevented the event
  - Inadequate use of Operating Experience (Millstone OE)
  - Inadequate internal communications (K1 Relay)

# Extent of Condition/Cause

- Reviewed control relays for Reactor Regulating, Reactor Protection, Engineered Safety Features, and Auxiliary Feedwater Systems
- Reviewed other “important” (e.g. LONHR) relays using the CCNPP PRA
- Performed OE searches for adverse trends
  - Inadequate contact rating
  - Vendor design errors

No other underrated contacts or adverse trends were identified

# Immediate Compensatory Measures

- Replaced K7 relays on both Units
- Reviewed relay design adequacy in the below systems
  - Reactor Regulating
  - Reactor Protection
  - Engineered Safety Features Actuation
  - Auxiliary Feedwater Actuation
- Reviewed Field Assistance Reports to ensure recommended actions were acted upon and Issue Reports written when appropriate
- Reviewed 2003 Operating Experience (OE) for proper analysis of all related issues contained within the OE

# Corrective and Preventive Actions

(All actions are complete unless otherwise noted)

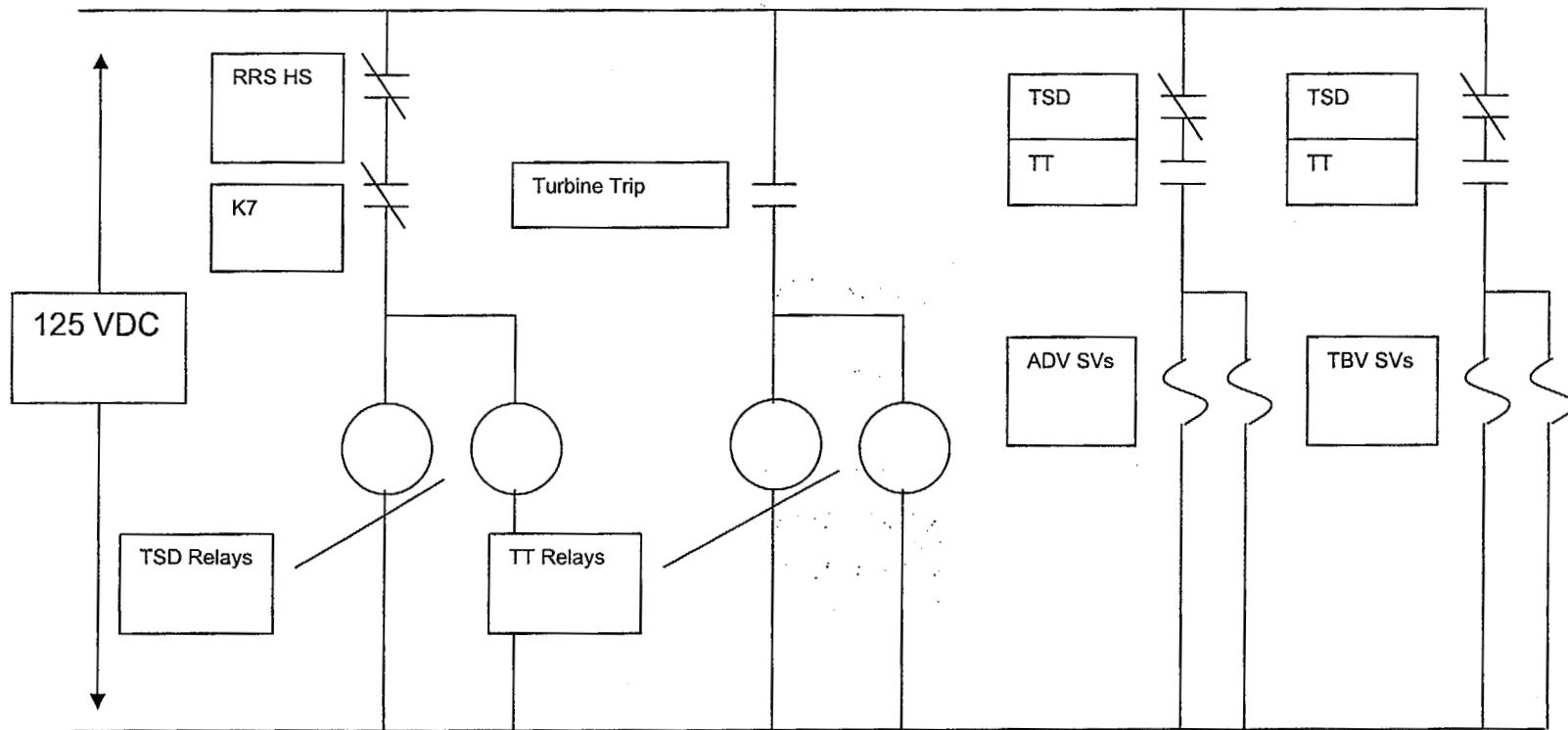
- Corrective Actions
  - Engineering issued to replace the K7 relay with one suitable for quick open circuit application
  - Modify the K7 relay installation to remove the effects of the underrated contacts
    - Unit One modified and Unit Two will be modified spring 2005 refueling outage
- Preventive Actions
  - Replace all K7 relays in both units with new Allied Control relays of the original design when received from the vendor.
  - Provided written expectations and training for OE review scope, focusing on addressing all issues related to a given event
    - Includes improved coordination of multiple system OE review.
  - Provided written expectations and training for Field Assistance Reports including Issue Reports for quality issues

# Additional Actions

- Common Cause Analysis for 2004 LONHR Events
- Single Point Vulnerability (SPV) analysis with focus on Loss of Normal Heat Removal (LONHR)
- Preventive Maintenance (PM) template for control relays
  - PM changes per the PM template on PRA Significant and SPV relays
- Develop a “Graduated Risk Review Process” for external vendor engineering products to further reduce human performance errors associated with vendor provided engineering products
- Human Performance Tools in Engineering



# Simplified sketch of the Reactor Regulating System Interface to the Quick Open Circuit



K7 contacts shown with RCS temperature greater than 557° F. Below 557° F, the K7 relay is de-energized and the K-7 ADV/TBV contacts are open.

For simplification, only one channel of RRS is shown.