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Revision 1 Abstract

Since the initial publication of NP-7243, "Investigation of Response Time Testing Requirements", the US nuclear utility industry has been pursuing elimination of RTT requirements through preparation of generic licensing topical reports by the BWR and Westinghouse Owner's Groups. These topical reports rely extensively upon NP-7243 for an assessment of pressure sensor failure modes and their detectability. Through these activities, certain technical inaccuracies and clarifications have been identified in NP-7243 regarding Camille-Bauer Tobar pressure transmitter (Ref. 19) and Weed/Foxboro pressure transmitters (Ref. 20). NP-7243 has been revised to address these issues as follows:

- The conclusion in Section 4 indicating that Tobar/Veritrak models 32PA1, 32DP1, and 32PG1 have failure modes likely to affect sensor response time without concurrently affecting calibration of these sensors is inconsistent with the results of the FMEA analyses documented in Section 3 and has been deleted. The recommendation in Section 4 suggesting continued hydraulic response time testing for these transmitters has also been deleted.

- The conclusion in Section 4 regarding the susceptibility of Rosemount, Statham, and Foxboro N-E13 transmitters to show loss of fill oil from the sensor has been modified. This modification more clearly emphasizes that this failure mechanism had only been observed in Rosemount transmitters, while no such observations had been made for Statham or Foxboro N-E13 transmitters.

- The recommendation in Section 4.0 suggesting periodic power interrupt testing for Foxboro N-E13 transmitter models has been deleted in consideration of the lack of observed oil-loss induced failures for these transmitter types (Ref. 20).

In addition, it should be noted that the FMEA analyses presented in this report have been significantly supplemented by ongoing EPRI research in the area of condition monitoring as documented in EPRI Report TR-103436, "Instrument Calibration Monitoring Program" (Ref. 21). The results of these activities include assessment of the credibility of identified failure modes and a determination of their detectability via calibrations, channel comparisons, and trending analysis.

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- Electronic white noise analysis RTT may not detect response time degradation due to loss of fill fluid prior to the loss, causing the sensor to exceed response time limits at its setpoints.

- The FMEAs identified two failure modes having the potential to affect response time without concurrently affecting sensor output. These failure modes, slow sensor fill fluid leak during pressurized operation and variable damping potentiometer misadjustment, cannot be detected by calibration and drift monitoring methods.

- The FMEAs also identified two manufacturing/handling defects having the potential to affect response time: low sensor fill fluid from the manufacturing process and crimped capillaries from the manufacturing process or improper handling by the manufacturer or in the field during maintenance or plant modifications.

- Sensor failure modes associated with all Barton transmitters, models 763 and 764, and switch model 288/289, SOR switches, and Foxboro (Weed), models N-E11GH, N-E11DM, N-E11GM were not found to affect sensor response time without significantly affecting calibration.

- ~~Tobar/Veritrak models 32PA1, 32PD1, and 32PG1 FMEA failure modes were found to be likely to affect sensor response time without affecting calibration. The potential effects of slow loss of fill fluid indicate a need for testing to determine specific failure effects.~~

- Rosemount, Statham, and Foxboro ~~E13s~~ ***N-E13 transmitters*** use fill fluid as part of the sensing process. ~~These transmitters are subject to~~ Slow loss of fill fluid ***was identified as a potential*** failure modes that ~~can~~ ***could*** affect response time over part of their operating range. ~~These~~ ***This*** failure modes ***has been observed to cause*** ~~may or may not introduce~~ detectable changes in sensor output ***in the case of Rosemount pressure transmitters***. These effects ***have not been observed*** ~~have yet to be demonstrated~~ for Statham and Foxboro E13 transmitters.

- Periodic drift monitoring can be used as a method for detecting loss of fill fluid before response time is affected for Rosemount transmitters using the criteria in the Rosemount Technical Bulletins.

- At the present time, hydraulic RTT is the most effective method for response time testing Statham transmitters.

- The power interrupt test is a viable method of RTT for force-balance transmitters.

- Variable damping potentiometers can affect response time through improper adjustment during calibration.

- Hydraulic ramp and step, and electronic white noise analysis RTT methods can detect variable damping misadjustments that increase response time. Drift monitoring cannot be used for this purpose.

RTT RECOMMENDATIONS FOR PRESSURE, LEVEL, AND FLOW SENSOR WITH TECHNICAL SPECIFICATION RESPONSE TIME REQUIREMENTS.

The following information provides a summary of recommendations for modifying the current RTT program for pressure and differential pressure sensors. These recommendations are based on improving sensor failure detection, minimizing the potential for human error resulting in Licensee Event Reports (LERs), reducing personnel exposure, and reducing potential impact on plant availability.

- Perform a hydraulic RTT prior to installation of a new transmitter/switch or following refurbishment of the transmitter/switch (e.g., sensor cell or variable damping components) to determine an initial sensor-specific response time value. The power interrupt test is an alternate method to use on force-balance transmitters.

- For transmitters and switches that use capillary tubes, RTT should be performed after initial installation and after any maintenance of modification activity that could damage the capillary tubes.

- Perform periodic drift monitoring on all Rosemount pressure and differential pressure transmitters, models 1151, 152, 1153 and 1154. Guidance on drift monitoring can be found in EPRI NP-7121 (17) and Rosemount Technical Bulletins. Drift monitoring intervals should be based on utility response to NRC Bulletin No. 90-01 (18).

- Utilities having Statham pressure and differential pressure transmitters, models PD-3200 and PG-3000, should continue to perform hydraulic RTT until criteria are developed relating sensor output to loss of fill fluid and potential response time degradation.

- ~~Utilities having Tobar pressure and differential pressure transmitters, models 32PA1, 32PD1, and 32PG1, should continue to perform hydraulic RTT until criteria are developed relating sensor output to loss of fill fluid, electronic component drift, and potential response time degradation.~~

- ~~Perform power interrupt tests on all Foxboro (Weed) force balance transmitters, models N-E13DH and N-E13DM, at an interval to be determined by the utility.~~

- If variable damping is used, implement a method to assure that the potentiometer is at the required setting and cannot be inadvertently changed. This approach should eliminate the need for RTT to detect a variable damping failure mode. Otherwise, RTT the transmitter by hydraulic or electronic white noise analysis methods, at a minimum, following each transmitter calibration.

(this page replace original report page R-2)

15. Rosemount Technical Bulletin 1, Rosemount, Inc., May 10, 1989

16. Rosemount Technical Bulletin 4, Rosemount, Inc., December 22, 1989

17. Technical Guidance for Incipient Failure Detection of Rosemount Pressure Transmitters, Palo Alto, CA, Electric Power Research Institute, in process, NP-7121

18. U.S. Nuclear Regulatory Commission, "Loss of Fill-Oil in Transmitters Manufactured by Rosemount", Washington, D.C., March 9, 1990, NRC Bulletin 90-01

19. *Camille Bauer Letter, J.H. Murphy to EPRI, November 19, 1992*

20. *Weed Letter, "EPRI Report NP-7243", S. Qualls to J. Taylor, June 3, 1993*

21. *EPRI Report TR-103436, "Instrument Calibration Monitoring Program (ICMP)", Volume 1 - "ICMP: Basis for Methodology", Volume 2 - "ICMP: Failure Modes and Effects Analysis", December 1993*