U.S. NUCLEAR REGULATORY COMMISSION

REGION I

Meeting No. 50-293/M88-312

Docket No. 50-293

License No. DPR-35

Licensee: Boston Edison Company

Facility Name: Pilgrim Nuclear Power Station

Meeting Location: NRC Region I, King of Prussia, Pennsylvania

Meeting Date: August 31, 1988

Prepared by: cfa for L. Cheung — 9/6/88
L. Cheung, Sr. Reactor Engineer — date

Approved by: C. J. Anderson — 9/6/88
C. Anderson, Chief Plant Systems Section — date

Conference Summary:

A technical meeting was held on August 31, 1988, in the Region I office to discuss NRC's concerns regarding a Rosemount 1153 transmitter "Ringing" problem that had occured in two Region I plants, and to discuss Boston Edison's approach to resolve this issue for the Pilgrim station.

DETAILS

1.0 Conference Attendees

Boston Edison Company (BECO)

S. Dasgupta, Control Systems Division Manager
P. Hamilton, Compliance Division Manager
D. Richard, Control Systems Principal Engineer
R. Williams, Sr. System and Safety Analysis Engineer

United States Nuclear Regulatory Commission

J. Durr, Chief, Engineering Branch
C. Anderson, Chief, Plant Systems Section
N. Conicella, Operation Engineer
L. Cheung, Sr. Reactor Engineer

2.0 Background and Purpose of Meeting

Rosemount 1153 transmitter "Ringing" problems which caused reactor trips and inadvertent actuation of engineering safeguard systems were identified at Hope Creek and Nine Mile 2 during their startup periods. A letter was sent to the licensee from the NRC on January 29, 1988, identifying this as one of the six issues to be addressed for the Pilgrim Power Ascension Program. The licensee responded to all six issues in their February 29, 1988 letter to the NRC. Subsequently, a management meeting was held in the Region I office on April 8, 1988, to discuss the overall power ascension program. During that meeting, the licensee committed to submit a separate response to the NRC's concerns regarding "Ringing" problems associated with Rosemount 1153 transmitters.

The licensee submitted their response (BECO Letter No. 88-117) on August 4, 1988. This letter addressed the licensee's approach to resolve the NRC's concerns for the "Ringing" problem. Since several technical issues discussed in this letter were not clear to the NRC, a meeting was requested by the NRC to discuss these technical issues. This resulted in the current meeting being held on August 31, 1988.

3.0 Meeting Summary

The meeting was opened by J. Durr, Chief, Engineering Branch of NRC. P. Hamilton, Compliance Division Manager of BECO outlined the scope of BECO's presentation. The technical elements of BECO's approach to resolve the Rosemount 1153 transmitter "Ringing" problem were presented by R. Williams, Senior System and Safety Analysis Engineer of BECO.

The following summarizes the technical elements of the licensee's presentation:

a) The "Ringing" problems at Hope Creek and Nine Mile 2 were due to high frequency (3 to 20 Hz) harmonic type mechanical noise (pressure pulses).

b) This mechanical noise was probably caused by:
- Air in instrument lines from flexible hose or routing considerations (e.g., sloping, low points etc.)
- Long runs of small bore tubing
- Instrument tubing support (long unsupported spans)

c) The Rosemount 1153 transmitters used at Hope Creek and Nine Mile 2 were fast response type (60 milliseconds), therefore, these transmitters see this noise.

d) The Rosemount 1153 transmitters used at Pilgrim for reactor water level measurements contain filters which increase the response time to 350 to 500 milliseconds, thus filtering out the 3 to 20 Hz harmonic noise.

e) Pilgrims's instrument lines contain no flexible hose, are properly routed and supported, and consist of short instrument tube runs.

f) Other operating plants (Monticello, Hatch, Vermont Yankee, and Dresden) with similar instrument installation did not have inadvertent trips of this nature.

Other topics, such as the Plant Information Computer System (EPIC) and main steam flow measurements, were also discussed at the meeting. The licensee presentation is outlined in their handout which is provided as Attachment A to this report.

4.0 Conclusion

The NRC staff agreed with the licensee's conclusion that it is unlikely that the problem of Rosemount 1153 transmitters will cause unnecessary trips at the Pilgrim station.

Attachment A

Rosemount 1153 Transmitter "Ringing" Issue

(Monitoring at Pilgrim Station)

Presentation to the NRC
August 31, 1988

Trips at Newer BWR's Alert Industry To Rosemount Transmitter Sensitivity Problems

- Hope Creek and Nine Mile 2 Reported Inadvertent SCRAMS Resulting from Reactor Water Level Signal Noise
- Industry was Notified of the Problem by GE
- GE Issued RICSIL 12 With Supplement and SIL 463
  - RICSIL 12 With Supplement - Provided Information Based on GE Investigations
  - SIL 463 - Provided Discussion, Recommended Actions, and Root Cause Analysis Guidelines
- Boston Edison Documented Problem (PCAQ NED 87-142, NED 87-187)

Hope Creek has Experienced Inadvertent Trips Involving Rosemount 1153 Transmitters

- Turbine Stop-valve Closure caused Pressure Transient
- This Resulted in Inadvertent Trips From the Reactor Water Level system
- Trips Were Caused by the above Amplified Pressure Transients Being Detected by the Fast (60 millisecond) Response Time 1153 Transmitters
- Corrective Action was to Add Filter Capacitors to Slow the Response Times of the 1153 Transmitters to Under 300 ms

Nine Mile Point 2 Has Experienced Inadvertent Trips Involving Rosemount 1153 Transmitters

- Inadvertent Trips Occurred During Startup Testing
- Process Perturbations Caused Pressure Transients
- Flex Hose Instigated or Amplified Pressure Transients in the Reactor Water Level Instrument Sensing Lines
- Instrument Line Slopes Contributed to Pressure Transients
- Trips Were Caused by the above Amplified Pressure Transients Being Detected by the Fast (60 millisecond) Response Time 1153 Transmitters
- Corrective Action was to Add Filter Capacitors to Slow the Response Time of the 1153 Transmitters to 300 ms

BECo Acts to Identify and Resolve Issue

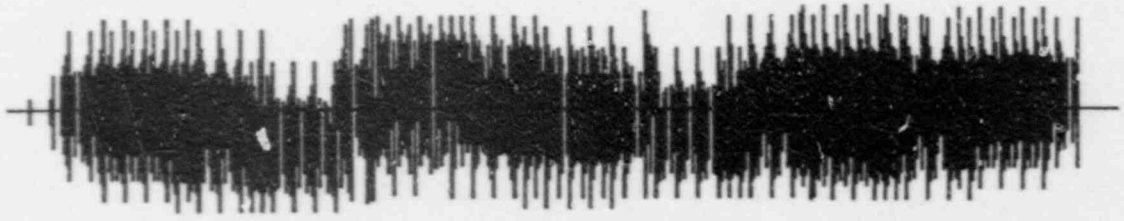
- BECo Surveyed 10 BWR's for Problems
  - Nine Mile Point 1&2
  - Perry 1&2
  - Clinton
  - Quad Cities
  - Dresden
  - Grand Gulf
  - Limerick
  - Monticello
  - Fitzpatrick
  - Hope Creek
- Evaluated Pilgrim's Succeptibility

Sensitivity Linked to Combination Of Process Noise and Instrument Line Characteristics

- Only Rosemount 1153 DB5 Transmitters with Fast Response Times (less than 60 milliseconds) are Sensitive to Process Noise
  - Noise (Ringing) Frequency Between 3 & 20 Hz
- Noise Effects can be Aggravated by:
  - Air in Instrument Lines From Flexible Hose or Improper Routing (e.g., sloping, low points etc.)
  - Long Runs of Small Bore Tubing
  - Improper Instrument Tubing Support (unsupported spans too long)
- Inadvertent Trips Have Resulted From Combination of Noise, Transmitter Sensitivity, and Instrument Line Anomalies.

Random Noise is A System Response to Process Variables

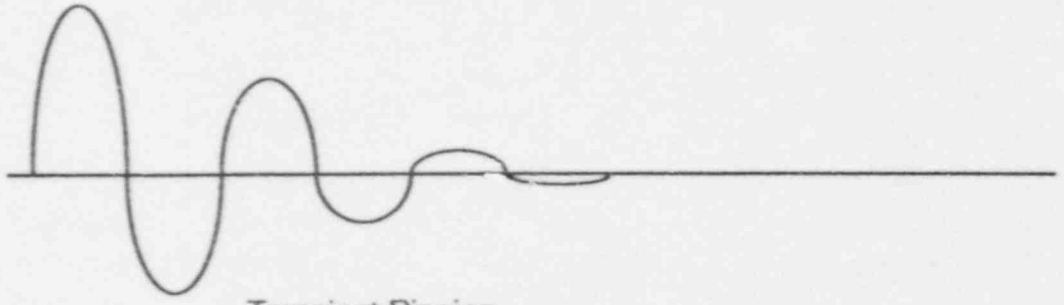
- Process Noise
  - Random Noise is Inherent in All Dynamic Systems
  - This Noise is Independent of any Resonance in the System



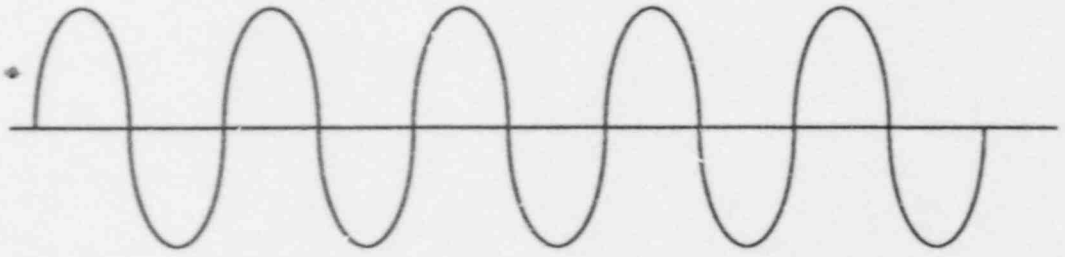
Random Process Noise

Ringing Is a Characteristic Response to a Stimulus

- Every System Has a Characteristic Resonant Frequency at Which it will Vibrate in Response to an Appropriate Stimulus
- The Stimulus can be Transient or Continuous in Nature Resulting in Transient or Continuous Ringing



Transient Ringing



Continuous Ringing

The Rosemount Transmitter Does Not Ring

- The Rosemount 1153 Transmitters are Inherently Overdamped and cannot Ring
- The Rosemount Transmitter output can Only Reflect the System Variable it is Monitoring
- System Ringing will be Reproduced by the Rosemount output if the Transmitter has a Fast Enough Response Time
- Therefore a Fast Response Time Transmitter may give the Appearance of Ringing When it is Not

Pilgrim Has Two Applications Which Require Review for Transmitter Sensitivity

- Two Applications of Seven Identified in SIL 463 use Rosemount 1153 Transmitters
  - Reactor Water Level
  - Main Steam Line Flow
- 1153 Transmitters not Used at Pilgrim for Many Process Variables Exhibiting Problems at Other Plants
- Other Pilgrim Applications use Different Sensing Instruments With Good Performance History
- Other Pilgrim 1153 Transmitter Applications are not Noise Problems and/or do not Cause Trips

BECo Concludes Rosemount 1153 Transmitter Response Time Problems as Improbable at Pilgrim

Reactor Water Level

- Transmitters are Slower Acting (350 to 500 millisec.)
- No Flexible Hose
- Short Instrument Tube Runs
- Lines Properly Routed and Supported

BECo Concludes Rosemount 1153 Transmitter Response Time Problems are Improbable at Pilgrim

Main Steam Line

- Large Margin Between Normal Operation (100 psid) & Trip Set Point (121 psid)
- Industry Noise Lower Than Margin by Factor of 10
- No Flex Hose; Lines are Short & Properly Supported and Sloped
- Industry Has Not Experienced Inadvertent Actuations From Main Steam Line Ringing

Pilgrim is Similar to Plants Having No Inadvertent Trips Due to Fast 1153 Transmitter Response Time

- These Plants have no long Tubing Runs
- Do not use flexible Hose
- Do not use Fast Response Time Transmitters For Water Level Applications
  - Monticello
  - Hatch
  - Vermont Yankee
  - Dresden

Pilgrim Takes Conservative Measure to Monitor for Ringing Sensitivity

- Monitor All 56 Rosemount 1153 Transmitter Outputs
- Monitor With Transient Recording in EPIC
- Design Complete, Construction Scheduled for October 1988 Completion
- Tie-ins are Expected to be Complete in October, Work Can Continue During Plant Operation with Final Test and Turnover During Power Ascension
- Monitoring Expected to Confirm Evaluation
  - Detects Sensitivity to Noise
  - Trends Noise Information
  - Provides Root Cause Information

10/14/88

Monitoring the Rosemount 1153 Transmitters is Not a Safety Issue

- The Likelyhood of an inadvertent trip at Pilgrim due to Fast Response time instruments is very low.
- Proper Plant Safety Responses to Situations Requiring RPS / ECCS FunctionsWill Not Be Prevented if Monitoring is Not Available.
- Events at Other Plants Did Not Result in Adverse Safety Consequences.
- Industry Experience for Plants of PNPS Design has Shown no Inadvertent Trips From Rosemount Transmitter Sensitivity

Monitoring of Rosemount 1153 Transmitters is Not a Re-start Issue

- Design Review Concludes Low Likelyhood of Getting Inadvertent ATS Trip / Initiation Signal
- Design Weaknesses Found at Other Plants Do not Exist at Pilgrim
- Pilgrim Reactor Water Level Instruments Have Larger Time Constant Than Those Triggering Trips at Other Plants
- Pilgrim Main Steam Line Flow Transmitter Setpoints are Well Above Normal Output Providing a Large Margin
- Industry Experience for Plants of PNPS Design has Shown no Inadvertent Trips From Rosemount Transmitter Sensitivity
- Monitoring Capability is Scheduled to be Available Before Completion of Power Ascension
- Plant Response to an Inadvertent ATS Signal is within Design Basis

Other Reported Rosemount 1153 Transmitter Problems are not Restart Issues

- Transmitter Lock-up
  - Caused by Metallic Filings in the Dielectric Silicon Oil
  - Failures are Random and Easily Detected By Daily Surveillances
  - Initiation Logic Requires 2 out of 2 Failures - Improbable With Daily Surveillances

- Transmitter Drift
  - Drift Caused by Oil Leaking From Diaphragm
  - Failures are Random and Easily Detected By Daily Surveillances
  - Initiation Logic Requires 2 out of 2 Failures - Improbable With Daily Surveillances

Rosemount 1153 Transmitter 'Ringing' Safety Concerns

Q. Why are Rosemount transmitter problems not a safety concern?

A. Problems will result in premature (conservative) safety system initiation.

The following is a discussion of the three separate problems which have been identified.

TRANSMITTER RESPONSE TIME - When an underdamped system is exposed to a pulse or step transient, its output signal will overshoot the final steady state signal level and oscillate at the instrument's resonant frequency at a decaying amplitude.

ASSESSMENT OF RISKS:

- Fast response time could cause inadvertent trips / initiations of RPS and ECCS systems. This would be caused by process ringing, noise or transients in the system. This is not a safety problem, as the safety systems will have performed their safety functions; however, challenges to these systems should be avoided because of the potential to degrade system reliability. Rosemount transmitters are inherently not susceptible to ringing as they are underdamped and will not overshoot or ring. However, if the system being monitored rings in response to a process transient, a monitoring transmitter with a sufficiently fast response time will produce an output which mirrors the system ringing response.

- The Rosemount transmitters installed at PNPS for reactor water level are typically slower than that required to respond to the noise characterized by GE in SIL 463. If the noise in PNPS systems have the same characteristics as has been documented at other BWR's, the installed transmitters will not be affected and no inadvertent trips / initiations will occur.

- A large transient in the water level system could alternately initiate and trip the HPCI system. This was observed at Hope Creek during their turbine trip event but resulted in no loss of function to the HPCI system. This is attributable to the short duration of this transient (less than 3 seconds) which would prevent the system from actuating.

- Noise in the main steam line may cause premature actuation of the high flow group 1 PCIS actuation and the resulting SCRAM. The main steam line system at PNPS were designed to accommodate full flow in three of the four steam lines. Consequently, the high flow setpoints are set at approximately 25 psid higher than the normal signal level. Therefore in order for noise to trip these instruments, it must have a magnitude of approximately 25 psid. This magnitude of noise is physically unrealistic and well beyond the range of nose observed in the industry

  (Note that a high speed data acquisition system would be required to determine the nature of process noise at PNPS.)

TRANSMITTER LOCK-UP -Transmitters have failed due to metallic filings in the dielectric silicone oil. This causes the transmitter output to shift and remain offscale hi or lo and not responding to the transmitter input.

ASSESSMENT OF RISKS:

This failure mode is random in nature and easily detectable by daily surveillances which would result in the immediate replacement of the faulty transmitter. This is not a safety issue as the initiation logic requires at least two instruments to provide signals. The probability of two instruments failing in the same direction within a 24 hour surveillance period is vanishingly small and has never been observed in the industry.

TRANSMITTER DRIFT DUE TO LEAKAGE - The transmitters have silicone oil filling their diaphragms. The oil has been observed to leak from the diaphragms resulting in transmitter drift and sluggish response.

ASSESSMENT OF RISKS:

- The failure mode does not occur immediately but takes a length of operation before it is exhibited. It is easy to detect by performing daily surveillances which would result in the immediate replacement of the faulty transmitter. This is not a safety issue because the initiation logic requires at least two instruments to provide signals. The probability of two instruments exhibiting this failure mode within a 24 hour surveillance period is vanishingly small and has never been observed in the industry.