A RISK-BASED REVIEW OF INSTRUMENT AIR SYSTEMS AT NUCLEAR POWER PLANTS

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Attachment 2 to Enclosure 2

A RISK-BASED REVIEW OF INSTRUMENT AIR SYSTEMS AT NUCLEAR POWER PLANTS

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Prepared for:

Operational Safety and Reliability Research (OSRR) Project
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EXECUTIVE SUMMARY

A principal objective of the work was to provide a systematic evaluation of IA systems at nuclear power plants. A second objective was to establish an information base that could be used to develop, among other things, a reliability program for air systems. The principal objective was achieved by reviewing published risk analyses (PRAs and the NRC Accident Sequence Precursor (ASP) program reports) for:

- IA-initiated accident sequences,
- IA interactions with frontline systems, and
- IA-related risk significant events.

PRA models were used for evaluating the sensitivity to risk (at both the core melt and consequence level) of initiating event frequencies and common-cause failures of air-operated valves (AOVs). The information base was used to calculate a loss-of-IA initiating event frequency of 9.2E-2 per year. These calculations were necessary because generic estimates for this initiating event frequency are not available. This initiating event frequency was used to requantify sequence frequencies in PRAs that explicitly considered loss-of-IA event trees and to estimate sequence frequencies in PRAs that did not explicitly consider loss-of-IA event sequences. The risks associated with common-cause failure of air-operated components were evaluated by estimating upper bound frequencies of sequences that include multiple failures of air-operated components.

Fourteen PRAs were checked for IA contributions to risk, eight were reviewed in detail and three (two PWRs and a BWR PRA) were chosen for detailed review and sensitivity analysis. The two PWR PRAs (Haddam Neck and Oconee-3) were chosen because IA-initiated sequences were important in the final risk calculations. The IA system did not figure prominently in any BWR PRA reviewed; the Browns Ferry PRA was chosen for sensitivity analysis.

The objective of reviewing IA-related events was achieved by collecting about 500 event descriptions from NUREG-1275 and Licensee Event

Reports (LERs). About 275 were considered to be relevant for review and categorization in order to study the causes and effects of IA problems. The problems are predominantly caused by contamination and human error during operations/maintenance activities. The effects are more often characterized as misfunctions rather than as malfunctions, i.e., the IA system often introduces a problem rather than fails to function.

Although a large number of events related to the IA system have been reported, there is neither such a plurality of events nor do the events place a typical plant in such grave danger of core damage and/or significant release of radioactivity that treatment of the IA system should be significantly revised. This study has yielded three generally applicable conclusions:

1) The IA system contribution to total core melt frequency is generally much lower than that of frontline safety systems, and is significantly lower at BWRs than at PWRs.

2) The total risk cannot be significantly reduced by IA system modifications or reliability improvements.

3) Most plants which had notable IA-related risk sequences needed modifications outside the IA system.

The generally small risk contribution, however, must be qualified by plant-specific operating and design weaknesses. There are specific designs and occasional events that can have a significant impact on plant risk. The following conditions have been observed to increase the risk impacts of the IA system:

- Unique or incorrect designs of fail-safe valve positions.

- Contamination problems in the air system that significantly increase the common-cause failure probabilities of air-operated components.

- Accumulator and associated check valve reliabilities, taking into account test frequency and adequacy.

- Dependencies on IA leading to failure of EDGs following loss of offsite power.

Recommendations that deal with preventing further occurrence of these and similar situations are provided.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A systematic review of IA-related events, system designs and risk impacts has been performed. Although a large number of events related to the IA system have been reported, there is neither such a plurality of events nor do the events place a typical plant in such grave danger of core damage and/or significant release of radioactivity that treatment of the IA system should be significantly revised. This study has yielded three principal conclusions:

1) The IA system contribution to total core melt frequency is generally much lower than that of frontline systems and is significantly lower at BWRs than at PWRs.

2) The risk contribution of the IA system cannot be significantly reduced by IA system modifications or reliability improvements.

3) The plants which had notable IA-related risk sequences needed modifications outside the IA system. (e.g., the condensate system at Oconee, and the HPI system at Haddam Neck)

Risk and reliability analyses that have systematically considered the IA system, its interactions with frontline systems, and the affect of loss of IA on the plant have, however, uncovered plant specific operating and design weaknesses that impact risk. The following conditions have been observed to increase the risk impacts of the IA system:

- Unique designs in fail-safe valve positions (e.g., Oconee).

- Contamination of the air system such that the common-cause failure probabilities of air-operated components are significantly increased (e.g., Turkey Point).

- Accumulator and associated check valve reliabilities, taking into account test frequency and adequacy.

- EDG dependencies on IA during an actual LOOP.

With the exception of contamination induced problems, the risk impacts are not caused by poor IA-system performance. The conditions were found during analysis of the IA system, but any risk reduction will come from improvements to the frontline systems. Thus, the IA system acts as a lightning rod in the w:/ the analysis can be used to uncover design problems with frontline systems.

IA-caused trip frequency is estimated to be 9.2E-2/yr., which is about 1% of all trips. Even if the IA system is not recovered, the ability of most plants to achieve a safe shutdown condition is not significantly impaired. This ability is ensured by fail-safe positions for AOVs, (especially if no shift is necessary to achieve this position), redundant systems not dependent on IA, and safety-grade accumulators for selected components. The trips come from a wide variety of causes, and since they are infrequent events, it is unlikely that an IA system design, performance, or reliability improvement program could be well enough focused to substantially reduce the trip frequency.

Generally, the IA system does not have a major impact on plant risk. However, specific designs and occassional events involving IA have been shown to have a significant impact on plant risk. The following actions can ensure that IA system contributions to plant risk remain low:

1) Plant management should ensure that appropriate standards of design quality (moisture, particulate size, etc.), design intent (compressor capacity, back-up sources of air, etc.) and operational performance (minimize maintenance-related and other human errors) are maintained.

2) The IA system should be included in risk-based reviews of plant systems (e.g., PRAs) and when risk sequences are quantified analysts should use an estimate of the frequency of loss of IA that reflects the generic frequency and nature of problems in the system.

3) Plants should locate and correct any EDG/IA interactions in which non-safety grade portions of IA can cause EDGs to fail during a LOOP. Included in this review should be elimination of diesel room cooling dependence on IA systems that are off-line during a LOOP.

4) Plants should ensure that the design and functionality of accumulators is consistent with safety analyses.

REFERENCES

1. Ornstein, H.L., "Operating Experience Feedback Report - Air System Problems," NUREG-1275, Volume 1, December, 1987.

2. Lofgren, E.V., et al., "A Reliability Program for Emergency Diesel Generators at Nuclear Power Plants", NUREG/CR-5078.

3. "Licensed Operating Reactors Status Summary Report," NUREG-0020 (commonly known as Grey books), various dates.

4. Mackowiak, D.P., et al., "Development of Transient Initiating Event Frequencies for Use in Probabilistic Risk Assessments (Draft)", NUREG/CR-3862, EG&G Idaho, Inc., Idaho Falls, Idaho, June 1984.

5. "Data Summaries of Licensee Event Reports of Valves at U.S. Commercial Nuclear Power Plants", NUREG/CR-1363.

6. Strip, D.R., "Estimates of the Financial Consequences of Nuclear Power Reactor Accidents", NUREG/CR-2723, SAND82-1110, September, 1982.

7. Atefi, B. et al., "Review of the Risk Based Evaluation of Integrated Safety Assessment Program Issues for Haddam Neck Plant", SAIC-87/3004, Contract No. NRC-03-82-096.

Enclosure 3 to the Minutes of CRGR Meeting No. 141
Proposed Draft Rule to Require College Degrees for SROs

TOPIC

B. Morris (RES) and J. Telford (RES) presented for CRGR review a proposed amendment to 10 CFR Part 55.31 that would require each senior reactor operator to hold a bachelor's degree from an accredited college or university. (This topic was considered previously by the Committee at Meeting No. 48.) Copies of the briefing slides used by the staff to guide their presentation and the discussions of this issue at this meeting are enclosed (see attachment to this enclosure).

BACKGROUND

The package submitted by the staff for review by CRGR in this matter was transmitted by memorandum dated June 17, 1988, E. S. Beckjord to E. L. Jordan; that package included the following documents:

1. Draft Commission Paper (undated) entitled "Proposed Revision of 10 CFR Part 55 to Require Degrees for Senior Reactor Operators," and attachments as follows:

   a. Enclosure A - Advance Notice of Proposed Rulemaking (FRN 19561) dated May 30, 1986

   b. Enclosure B - ACRS Letter dated August 12, 1988, "ACRS Comments on the Advance Notice of Proposed Rulemaking: Degree Requirements for Senior Operators"

   c. Enclosure C - Memorandum dated June 24, 1987, S. J. Chilk to V. Stello, Jr., "SECY-87-101 - Issues and Proposed Options Concerning Degree Requirement for Senior Operators

   d. Enclosure D - Draft Notice of Proposed Rulemaking (undated), "Degree Requirement for Senior Reactor Operators at Nuclear Power Plants"

   e. Enclosure E - Regulatory Analysis (undated) for Degree Requirement for Senior Reactor Operators

CONCLUSIONS/RECOMMENDATIONS

As a result of their review of this matter, including the discussions with the staff at this meeting, the Committee concluded that the information provided in the review package does not adequately demonstrate either that the proposed rule amendment is required for adequate safety, or that it would provide in a cost beneficial manner a substantial improvement in safety. Therefore, the Committee recommended that the proposed amendment not go forward at this time. Instead, the Committee recommended that the staff develop additional information (for example, from foreign experience in countries that now require degrees for operators) to better support an argument of safety need or substantial and cost beneficial safety improvement in connection with this proposal.

PRESENTATION TO CRGR

ON RES RULEMAKING:

DEGREE REQUIREMENT FOR SENIOR OPERATORS

BY:

BILL M. MORRIS, DIRECTOR

DIVISION OF REGULATORY APPLICATIONS

JOHN L. TELFORD, LEADER

RULEMAKING SECTION

MORTON R. FLEISHMAN

RESPONSIBLE FOR RULEMAKING

JULY 14, 1988

Attachment to Enclosure 3

OUTLINE

PRESENTATION

- BACKGROUND
- PROPOSED RULEMAKING
- COMPARISON OF SO REQUIREMENTS
- ADVANTAGES OF DEGREE RULE
- POSSIBLE NEGATIVE IMPACTS
- COST

BACKGROUND

°	ADVANCE NOTICE OF PROPOSED RULEMAKING (ANPRM)	MAY 31, 1986
°	COMMENT PERIOD ON ANPRM ENDED	SEPTEMBER 29, 1986
°	SECY-87-101: ISSUES AND PROPOSED OPTIONS CONCERNING DEGREE REQUIREMENT FOR SENIOR OPERATOR	APRIL 16, 1987
°	STAFF REQUIREMENTS MEMO	JUNE 24, 1987
°	ACRS COMMENTS	
°	CHAIRMAN ZECH'S AND COMMISSIONER BERNTHAL'S RESPONSE	AUGUST 28, 1987; SEPTEMBER 1, 1987
°	OFFICE CONCURRENCE ON PROPOSED RULE	JUNE 17, 1988

PROPOSED RULEMAKING

- EFFECTIVE FOUR YEARS AFTER THE DATE OF RULE (CUT-OFF DATE):

- BACHELOR'S DEGREE IN ENGINEERING, ENGINEERING TECHNOLOGY, OR PHYSICAL SCIENCES REQUIRED FOR SOs.

  - OTHER BACHELOR'S DEGREES ACCEPTED ON CASE-BY-CASE BASIS.

- TWO YEARS OF NUCLEAR PLANT EXPERIENCE IS REQUIRED:

  - AT LEAST SIX MONTHS AT THE PLANT FOR WHICH LICENSE IS SOUGHT.

  - AT LEAST ONE YEAR AS A LICENSED RO AT GREATER THAN TWENTY PERCENT POWER.

  - EXCEPTIONS ALLOWED FOR APPLICANTS FROM PLANTS THAT CANNOT ACHIEVE TWENTY PERCENT POWER.

- EXISTING SOs (ON CUT-OFF DATE) WOULD BE GRANDFATHERED.

COMPARISON OF SO REQUIREMENTS

	CURRENT	PROPOSED
EDUCATION:	H.S. DIPLOMA OR EQUIVALENT	BACHELOR'S DEGREE
EXPERIENCE without degree	FOUR YEARS RESPONSIBLE POWER PLANT EXPERIENCE INCLUDING TWO YEARS NUCLEAR PLANT EXPERIENCE SIX MONTHS AT THE SPECIFIC PLANT FOR WHICH LICENSE IS SOUGHT RO LICENSE FOR ONE YEAR	MUST HAVE SO LICENSE ON CUT-OFF DATE
with degree	TWO YEARS RESPONSIBLE NUCLEAR POWER PLANT EXPERIENCE SIX MONTHS AT THE SPECIFIC PLANT FOR WHICH LICENSE IS SOUGHT (NOT COUNTING TRAINING TIME)	TWO YEARS RESPONSIBLE NUCLEAR POWER PLANT EXPERIENCE INCLUDING ONE YEAR AS RO AT GREATER THAN 20% POWER SIX MONTHS AT THE SPECIFIC PLANT FOR WHICH LICENSE IS SOUGHT (NOT COUNTING TRAINING TIME)

ADVANTAGES OF DEGREE RULE

- ESTABLISHES CAREER PATH TO UPPER MANAGEMENT POSITIONS
- ENHANCES THE PROFESSIONALISM OF SO POSITION
- ENHANCES THE ENGINEERING EXPERTISE ON SHIFT
- ENHANCES THE ACCIDENT MANAGEMENT EXPERTISE ON SHIFT
- GREATER OPERATOR EXPERIENCE IN PLANT MANAGEMENT

POSSIBLE NEGATIVE IMPACTS

- GREATER TURNOVER OF SOs

- LOW MORALE OF ROs

- LESS OVERALL EXPERIENCE ON SHIFT

COST

- COST ESTIMATES FOR ON-SITE TRAINING PROGRAM VARIED FROM $250K TO $480K PER YEAR

- CURRENT PROGRAM AT GRAND GULF:

  - ACTUAL COST OF $250K YEAR

  - SIXTY PEOPLE IN PROGRAM

  - AMERICAN TECHNICAL INSTITUTE RUNS PROGRAM

  - PROGRAM IS ACCREDITED

BACKUP

- SUMMARY OF PUBLIC COMMENTS
- SECY-87-101 OPTIONS
- COMMISSION DECISION
- ACRS COMMENTS
- RESPONSES OF CHAIRMAN ZECH AND COMMISSIONER BERNTHAL
- CHAIRMAN ZECH'S LETTER
- COMMISSIONER BERNTHAL'S LETTER
- ADVANCE NOTICE OF PROPOSED RULEMAKING
- POTENTIAL NEGATIVE IMPACTS

SUMMARY OF PUBLIC COMMENTS

195 OPPOSE: (97.5%)	- NOT NECESSARY - EXPERIENCE MORE IMPORTANT - NEGATIVE IMPACT ON SAFETY - TURN OVER - BLOCK CAREER PATH
5 FAVOR: (2.5%)	- SAFETY BENEFIT - PUBLIC CONFIDENCE

SECY-87 101 OPTIONS

- DEGREE RULE OF ANPRM/CONCURRENT POLICY STATEMENT
- RULE ON DEGREED SENIOR MANAGER (SECY-84-106)
- AMEND POLICY STATEMENT ON ENGINEERING EXPERTISE ON SHIFT

COMMISSION DECISION

	OPTION	VOTE
1.	SEPARATE TRAINING AND EDUCATION ISSUES	5
2.	DEGREE RULE AND CONCURRENT POLICY STATEMENT (FOUR YEARS AFTER EFFECTIVE DATE)	3
	ASSOCIATE DEGREE ALL OPERATORS/BACCALAUREATE ALL SHIFT SUPERVISORS (FIVE YEARS AFTER EFFECTIVE DATE)	1
	DISAPPROVE	1

ACRS COMMENTS

° MEETINGS WITH NRC STAFF: JUNE 24, 1987

JULY 9-11, 1987

JULY 15, 1987

AUGUST 6-8, 1987

° MEMO TO CHAIRMAN, AUGUST 12, 1987, HIGHLIGHTS:

- STRONGLY SUPPORT CONCEPT OF ENGINEERING EXPERTISE ON SHIFT.
- ENDORSES COMBINING STA FUNCTION WITH ONE OF SO POSITIONS.
- BELIEVES THAT THERE IS NO TECHNICAL RATIONALE FOR REQUIRING A DEGREE FOR SOs.
- PROPOSED RULE SHOULD BE RECONSIDERED BECAUSE OF CONCERN ABOUT ADVERSE EFFECTS.

RESPONSES OF

CHAIRMAN ZECH AND COMMISSIONER BERNTHAL

CHAIRMAN ZECH:

"THE ACRS HAS ADVANCED NO AGRUMENT THAT WOULD COMPEL ME TO CHANGE MY POSITION ON THIS MATTER."

"I FIRMLY BELIEVE THAT SUCH A PROGRAM...WILL RESULT IN A SUBSTANTIAL INCREASE IN PUBLIC SAFETY."

COMMISSIONER BERNTHAL:

"...THE ARGUMENTS IN SUPPORT OF PROVIDING A CONDUIT FOR EXPERIENCED OPERATORS INTO UPPER MANAGEMENT, AS WELL AS THOSE FOR ENHANCING PROFESSIONAL REGARD FOR THE ROLE OF SENIOR OPERATOR SHOULD BE FULLY ARTICULATED."