UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 28, 1994

Docket No. 50-313

LICENSEE: Entergy Operations, Inc.

FACILITY: Arkansas Nuclear One, Unit 1

SUBJECT: MEETING SUMMARY - ERV MANUAL ACTUATION

On February 8, 1994 representatives of Entergy Operations, Inc. met with NRC staff to discuss Arkansas Nuclear One, Unit 1 operations that include procedures to manually open the electromatic relief valve (ERV) to mitigate the effects of pressure transients. Another name for the ERV is the power operated relief valve (PORV). The meeting was requested by NRC staff after the review of a plant transient revealed that plant Abnormal Operating Procedures include steps to mitigate pressure transients by manually opening the PORV to prevent a reactor trip. Intentional opening of the ERV appeared to conflict with the post-TMI action plan. The post-TMI action plan included various measures to reduce ERV use in an attempt to reduce the potential for repeating the TMI accident sequence. Slides used by the licensee to justify continued use of the ERV and to resolve the apparent conflict with the post-TMI action plan are included as Enclosure 1. A list of meeting participants is included as Enclosure 2.

The licensee presented a PRA based justification of why the ERV should be used to mitigate pressure transients rather than allowing the transient to progress to a reactor trip. The licensee analysis also concluded that manual use of the ERV in this manner did not conflict with the post-TMI action plan. To illustrate plant modifications related to the ERV system, the licensee showed a video tape that demonstrated a very prominent alarm that was activated whenever acoustic monitors detected flow in the ERV discharge line. The licensee presentation is outlined by the slides in Enclosure 1 and explained in more detail in a letter to the NRC dated April 16, 1994. While this issue is being resolved with the NRC, the licensee instituted temporary procedural changes restricting the manual use of the ERV.

The NRC received a copy of the licensee PRA that addressed manual use of the ERV. Following review of this PRA, NRC will contact Entergy and provide our views on manual use of the ERV. Although various Technical Specification

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requirements associated with the ERV system were discussed during the meeting, it was decided to address issues raised by Generic Letter 90-06 separately.

George Kalman

George Kalman, Project Manager
Project Directorate IV-1
Division of Reactor Projects - III/IV/V
Office of Nuclear Reactor Regulation

Enclosures:
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See next page

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ORIGINAL SIGNED BY:

George Kalman, Project Manager
Project Directorate IV-1
Division of Reactor Projects - III/IV/V
Office of Nuclear Reactor Regulation

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GKalman
PNoonan
JMitchell, EDO
NRC Participants

OFC	LA/PD4-1	PM/PD4-1	D/PD4-1
NAME	PNoonan	GKalman/bc	WBeckner
DATE	2/10/94	2/10/94	2/10/94
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cc:

Mr. Harry W. Keiser, Executive Vice
President & Chief Operating Officer
Entergy Operations, Inc.
P. O. Box 31995
Jackson, Mississippi 39286

Mr. Charles B. Brinkman, Manager
Washington Nuclear Operations
ABB Combustion Engineering
Nuclear Power
12300 Twinbrook Parkway, Suite 330
Rockville, Maryland 20852

Mr. Nicholas S. Reynolds
Winston & Strawn
1400 L Street, N.W.
Washington, D.C. 20005-3502

Mr. Robert B. Borsum
Licensing Representative
B&W Nuclear Technologies
1700 Rockville Pike, Suite 525
Rockville, Maryland 20852

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
P. O. Box 310
London, Arkansas 72847

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

Honorable C. Doug Luningham
County Judge of Pope County
Pope County Courthouse
Russellville, Arkansas 72801

Ms. Greta Dicus, Director
Division of Radiation Control
and Emergency Management
Arkansas Department of Health
4815 West Markham Street
Little Rock, Arkansas 72205-3867

Mr. Jerrold G. Dewease
Vice President, Operations Support
Entergy Operations, Inc.
P. O. Box 31995
Jackson, Mississippi 39286

Mr. Robert B. McGehee
Wise, Carter, Child & Caraway
P. O. Box 651
Jackson, Mississippi 39286

Admiral Kinnaird R. McKee, USN (Ret)
214 South Morris Street
Oxford, Maryland 21654

Mr. Jerry W. Yelverton
Vice President, Operations ANO
Entergy Operations, Inc.
Route 3, Box 137G
Russellville, Arkansas 72801

ANO-1 ERV MEETING
February 8, 1994

Name	Organization
George Kalman	NRR
Jay Miller	ANO/Nuclear Safety Analysis
Dwight Mims	ANO/Licensing Director
Elinor G. Adensam	NRR
Jack Roe	NRR
James R. Houghton	AEOD
Jocelyn Mitchell	OEDO
Thomas Koshy	NRR
Stacey Rosenberg	NRR
Mark Caruso	NRR
Lois Lambros	NRR
Alan Cox	ANO/Engineering
Dale James	ANO/Licensing
Natalie Mosher	ANO/Licensing
Charles Zimmerman	ANO/Operations Manager
Jimmy D. Vandergraft	ANO/Plant Manager
Tom Alexion	NRR
Karen Head	ANO/Safety Analysis
William Beckner	NRR

ARKANSAS NUCLEAR ONE

Unit One

MANUAL PRE-TRIP ELECTROMATIC RELIEF VALVE USE

FEBRUARY 8, 1994

ENTERGY

AGENDA

February 8, 1994
10:30 a.m.

Introduction and Opening Remarks	**Jimmy Vandergrift** Plant Manager, ANO-1
Operating Philosophy ERV Reliability Plant/Operator Response Procedures/Training Controls/Indications	**Charlie Zimmerman** Operations Manager, ANO-1
Safety Assessment Risk Evaluation High Pressure Reactor Trip Pre-Trip Manual ERV Use	**Karen Head** Senior Engineer, Nuclear Engineering Design
Regulatory Guidance NUREG-0737 Requirements ANO-1 Evaluation Generic Letter 90-06	**Dale James** Supervisor, Licensing
Closing Remarks	**Jimmy Vandergrift**

Operational Philosophy

Charlie Zimmerman

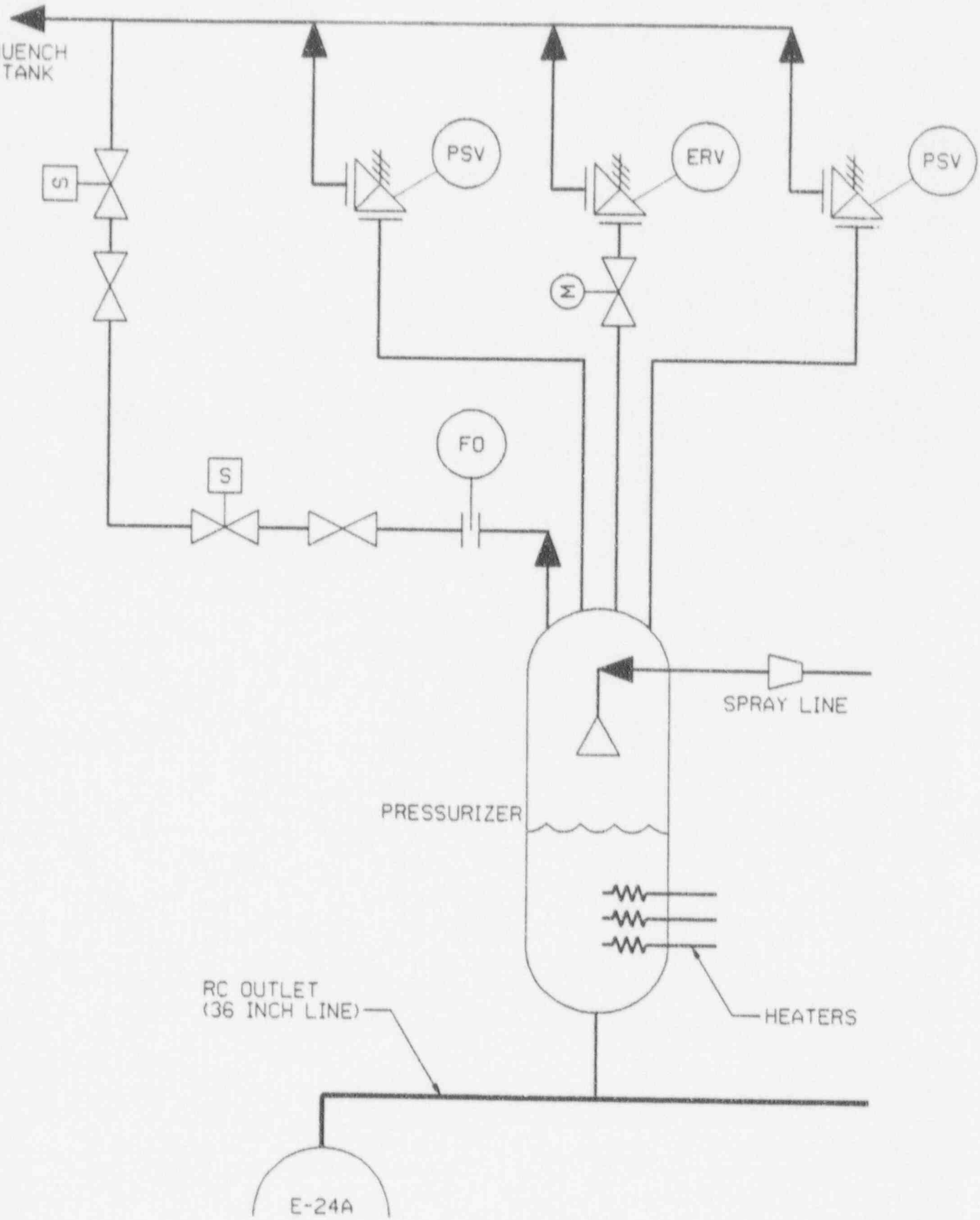
INTRODUCTION

- On June 13, 1993, 1 of 2 Operating Main Feedwater Pumps Tripped at 100% Power

- In accordance with Abnormal Operating Procedure Immediate Actions, operators manually opened the Pressurizer Electromatic Relief Valve (ERV) and avoided a reactor trip

- Plant was returned to full power later that day

- Manual Use of the ERV during power operation prompted interaction between ANO staff and NRC


QUENCH TANK
S
PSV
ERV
PSV
M
FO
S
SPRAY LINE
PRESSURIZER
RC OUTLET (36 INCH LINE)
HEATERS
E-24A

RELIABILITY

ERV

- ERV solenoid operated pilot valve and control circuit utilize Class 1E power sources
- The ERV is routinely operated during startup to establish steam bubble in the pressurizer
- IST program requires stroke test of the ERV during cold shutdown
- ANO-1 ERV has experienced no failures
- ANO experience has shown high ERV reliability

ERV Motor Operated Block Valve

- MOV design differential pressure of 2525 psig
- Powered from diesel-backed Class 1E bus
- MOV torque switch override capability
- ERV block valve is maintained within the GL 89-10 MOV program and is stroke tested quarterly per IST program

ERV SYSTEM

- ERV is treated as a system including

  - ERV itself
  - Block Valve
  - Position indication for the ERV and the block valve

- ANO-1 Technical Specifications require isolation of ERV flow path upon failure of any one of the three components

  - Tech Spec 3.1.1.7 requires inoperable vent path be maintained closed (ERV and associated block valve are treated as one pressurizer vent path)

  - Tech Spec Table 3.5.1-1 item 4 requires the ERV be isolated if the acoustic monitor is inoperable

  - Tech Spec Table 3.5.1-1 item 5 requires flow path isolation if ERV block valve position indication is inoperable

- The ERV will <u>not</u> be used for transient mitigation during power operation if the total ERV "system" is not operable

PLANT RESPONSE

- B&W plant close primary-to-secondary coupling results in immediate RCS temperature/pressure change for step changes in secondary heat removal

- Close coupling will challenge Reactor Protective System High Pressure Trip for large step heat removal reductions (such as Main Feedwater Pump trip)

- Integrated Control System (ICS) recognizes externally induced heat transfer mismatches and attempts to rebalance heat generation and heat removal

- Pressurizer spray valve automatically operates to reduce RCS pressure but is insufficient for some transients (i.e. MFP trip) Note: Changes have been made to the spray valve to optimize its pressure reducing capabilities by providing full open automatic capabilities

- Original design provided automatic opening of the ERV to reduce pressure prior to reaching high pressure trip setpoint allowing ICS time to restore heat balance

- Automatic operation of the ERV occurred without the operator "in the loop"

OPERATOR RESPONSE

- After 1980, ERV setpoint was raised above the high pressure trip setpoint eliminating automatic ERV actuation during power operation

- Setpoint change placed operator "in the loop" if ERV was used prior to a reactor trip

- Placing the operator "in the loop" ensures operator awareness of ERV status

- Manual operation of the ERV will

  - Reduce RCS pressure

  - Allow ICS time to rebalance heat transfer and avoid reactor trip

- Operator response to open the ERV must be prompt (RCS pressure can approach 2300 psi in 30-40 seconds)

PROCEDURES/TRAINING

- Abnormal operating procedures for selected events contain immediate actions to utilize the ERV to reduce RCS pressure if necessary

  - Main Turbine Trip <43% Power
  - Load Rejection
  - Loss of Main Feedwater (partial)

- Immediate actions are memorized actions

- Operator actions for a failed open ERV are also proceduralized immediate actions and include isolating the ERV and tripping the reactor if unisolable

- Operators are well trained on abnormal operating procedure immediate actions involving use of ERV

  - Regular simulator scenarios challenge the operators with Main Feedwater Pump trips

  - Proficiency is routinely demonstrated during simulator evaluations

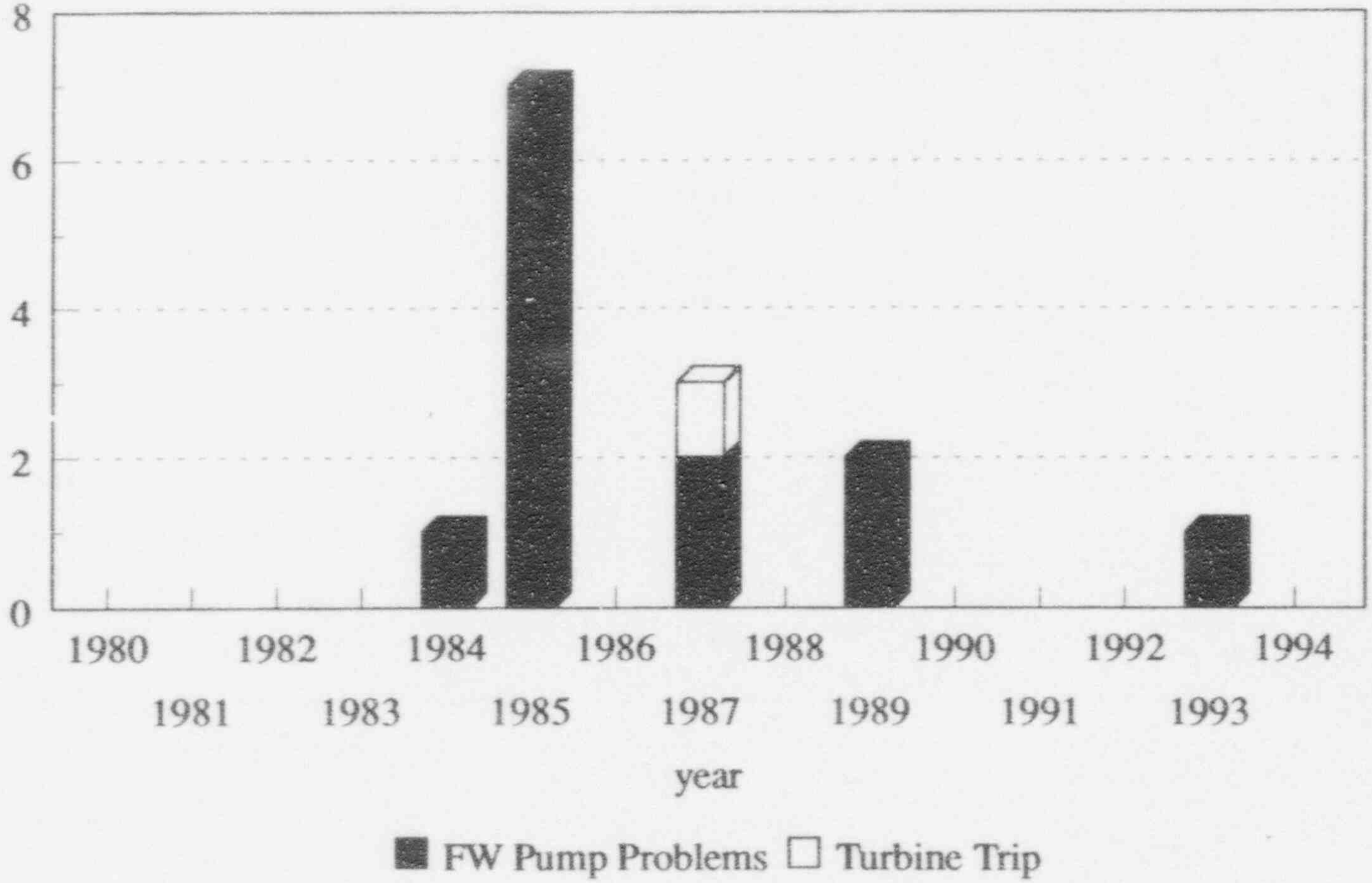
POST TMI IMPROVEMENTS

- Improvements in Emergency Operating Procedures
  - Follow-up checks of ERV status
  - Coping strategies for failed open ERV flow path
- Instrumentation improvements provide enhanced ERV status indications for the operator

TRANSIENT INITIATORS

- ANO is committed to reducing plant transient initiators and ANO's performance history depicts the success of this philosophy
- Since 1980 there have been approximately 14 events at ANO in which the ERV was used during power operation
- 13 of these events have been due to main feedwater problems
- Main feedwater pump trips have been the most frequent transient initiators leading to ERV challenges
- Transient reduction efforts have significantly reduced transients <u>and</u> ERV usage
- Only one main feedwater pump trip since 1989

ERV Transient History



SUMMARY

- Entergy's goal is to be a Safe, Reliable, Cost Effective producer of electricity

- Manual use of the ERV to prevent unnecessary reactor trips is an acceptably safe action consistent with this goal by

  - Demonstrated reliability of the ERV and its block valve

  - Improved indications of the ERV status

  - Improved abnormal and emergency operating procedures

  - Operator training and demonstrated proficiency

- Entergy is committed to continuing efforts to reduce transient initiators which will result in reducing those transients that challenge use of the ERV and this represents the most effective overall means of achieving the goal

Safety Assessment

Karen Head

SAFETY ASSESSMENT PHILOSOPHY

- Design Basis

- Safety Analysis

- Licensing Basis

- Risk Evaluation

RISK EVALUATION METHODOLOGY

- Assess Overall Plant Safety

- Manually Using ERV Pre-Trip verses Experiencing a High Pressure Reactor Trip

- Determine Relative Risk

RISK EVALUATION BASIS

High Pressure Reactor Trip Sequence

Main Feedwater Pump Trip	➔	Pressure Increases until Reactor Trips on High Pressure (Turbine Trips)	➔	Loss of all Feedwater (MFW, AFW, EFW)	➔	Loss of Injection (High and/or Low Pressure)	➔	Core Damage Frequency

Pre-Trip Manual ERV Use Sequence

Main Feedwater Pump Trip	➔	ERV Sticks Open during Manual Cycling	➔	Block Valve remains Open (Operator or Valve Failure)	➔	Loss of Injection (High and/or Low Pressure)	➔	Core Damage Frequency

CALCULATION INTENT

- Provide a representative evaluation of the relative risk from a probabilistic standpoint

- Base assumptions for ANO experience include

  - Design Basis

  - Modifications/Indications

  - ERV Reliability

  - Operations Philosophy

  - Operator Training/Capability

HIGH PRESSURE TRIP SEQUENCE

Event Frequency

- Assume 1 Overpressurization Event per Fuel Cycle 1/1.5 rx.-yr. (Note: There has been 1 event in the last 4 years at ANO-1)

Core Damage Frequency (CDF) Calculation

$$\frac{\text{Overpressurization Event Frequency}}{\text{ANO-1 IPE Reactor Trip Frequency}} = \frac{\text{CDF for Overpress Event Reactor Trips}}{\text{CDF for all Reactor Trips (ANO-1 IPE Value)}}$$

$$\frac{1/1.5 \text{ rx.-yr.}}{3.9/\text{rx.-yr.}} = \frac{\text{CDF}}{5.42 \text{ E-6/rx.-yr.}}$$

CDF = 9.3 E-7/rx.-yr.

MANUAL PRE-TRIP ERV USE SEQUENCE

Event Frequency

- Assume 1 Overpressurization Event per Fuel Cycle (1/1.5 rx.-yr.)

Failure Probabilities

- ERV = 2.0 E-2 (Utilized conservative value with respect to ANO-1 IPE and operating experience)

- Block Valve = 1.63 E-2 (Incorporated operator failure to close the valve which is considered conservative)

Small Break LOCA Frequency

SBLOCA Freq. = (Event Freq) x (ERV Fail Prob) x (Block Valve Fail Prob)
SBLOCA Frequency = (1/1.5 rx.-yr.)(2.0 E-2)(1.63 E-2) = 2.17 E-4/rx.-yr.

Core Damage Frequency

$$\frac{\text{SBLOCA Freq. due to ERV Pre-Trip Manual Use}}{\text{ANO-1 IPE SBLOCA Frequency}} = \frac{\text{CDF for ERV Pre-Trip Manual Use}}{\text{CDF for SBLOCAs (ANO-1 IPE Value)}}$$

$$\frac{2.17\ \text{E-4/rx.-yr.}}{5.0\ \text{E-3/rx.-yr.}} = \frac{\text{CDF}}{1.49\ \text{E-5/rx.-yr.}}$$

CDF = 6.5 E-7/rx.-yr.

CORE DAMAGE FREQUENCY COMPARISON

- High Pressure Reactor Trip CDF = 9.3 E-7/rx.-yr.

- Manual Pre-Trip ERV Use CDF = 6.5 E-7/rx.-yr.

- These values indicate that the risk is essentially the same

CONCLUSION

- Potential for a SBLOCA or subsequent core damage as a result of the pre-trip manual ERV use is not significantly increased

- Risk associated with a high pressur reactor trip is essentially equivalent to pre-trip manuaı ERV use risk

- From a safety standpoint, pre-trip manual use of the ERV to avert a reactor trip is acceptable

Regulatory Guidance

Dale James

REGULATORY GUIDANCE
ERV and Block Valves

Pre-TMI

- ERV automatic actuation setpoint established to control RCS pressure to avoid reactor trips on minor plant upsets and anticipated events and the ERV also reduced potential challenges to the safety valves

- The ERV served no safety-related function other than pressure boundary isolation

Post-TMI

- ERV automatic operation curtailed to only that of reducing potential challenges to the safety valves

- Enhancements implemented to address deficiencies identified as a result of the TMI accident

IE BULLETIN 79-05B

- "Following detailed analysis, describe the modifications to design an procedures which will be implemented to assure the reduction of the likelihood of automatic actuation of the pressurizer PORV during anticipated transients"

- ANO-1 response

  - Increased the relief setpoint of the ERV from 2255 psig to 2450 psig

  - Decreased the high RCS reactor trip setpoint from 2355 psig to 2300 psig

NUREG-0737

II.D.1	Performance Testing of Relief and Safety Valves
II.D.3	Direct Indication of Relief and Safety Valve Position
II.G.1	Emergency Power to Pressurizer Equipment
II.K.2.10	Safety-Grade Anticipatory Trips
II.K.2.20	Small-Break LOCA Which Repressurizes the RCS to the PORV Setpoint
II K.3.1	Installation and Testing of Automatic PORV Isolation System

II.K.3.2 Overall Safety Effect of PORV Isolation System

- Submit report of actions taken to decrease probability of a SBLOCA caused by a stuck open PORV

- Modifications to reduce the likelihood of a stuck open PORV are sufficient if they reduce the probability of a SBLOCA caused by stuck open PORV such that it is not a significant contributor to the probability of a SBLOCA due to all causes

- B&W Studies

  - Considered the revised PORV setpoint and anticipatory trips

  - Showed the probability of a SBLOCA due to a stuck open PORV not to be a significant contributor to the overall probability of a SBLOCA

  - Concluded automatic closure of the block valve was not required

  - Did not consider pre-trip manual operator action

II.K.3.7 Evaluation of PORV Opening Probability During Overpressure Transient

- Licensee (B&W plants only) should document that the PORV will open in less than 5% of all anticipated overpressure transients using the revised setpoints and anticipatory trips

- In conjunction with the analysis performed to address item II.K.3.2, B&W's analysis concluded that the ERV will automatically open in less than 5% of all anticipated overpressure transients

NUREG 0737 SUMMARY

- Primary intent was to ensure a stuck open ERV would not significantly increase the probability of a SBLOCA

- Numerous modifications were implemented at ANO-1

  - Enhance the operator's ability to detect and isolate a stuck open ERV

  - Reduce the probability of automatic ERV opening

- B&W studies concluded the probability of a SBLOCA due to a stuck open ERV was not a significant contributor to the overall probability of a SBLOCA due to all other reasons

EVALUATION OF MANUAL PRE-TRIP ERV USE FOR ANO-1

- 50.59 review associated with procedure changes for pre-trip manual ERV operation concluded no unreviewed safety question existed

- Subsequent detailed PRA evaluation validates the pre-trip manual use of the ERV is safe

- Pre-trip manual use of the ERV does not invalidate any previous conclusion reached in the analysis performed to address NUREG-0737

- Pre-trip manual use of the ERV is in compliance with ANO-1's licensing basis

GENERIC LETTER 90-06

Issued June 25, 1990 to resolve Generic Issue 70, "Power-Operated Relief Valve and Block Valve Reliability," and Generic Issue 94, "Additional Low-Temperature Overpressure Protection for Light-Water Reactors"

Generic Issue 70 - Staff evaluated the role of the PORV to perform certain Safety-Related functions

- Mitigation of a design-basis steam generator tube rupture accident

- Low-temperature overpressurization protection of the reactor vessel during startup and shutdown

- Plant cooldown in compliance with Branch Technical Position RSB 5-1 to SRP 5.4.7 "Residual Heat Removal RHR system"

- Other Safety-Related functions

Generic Issue 94 - Not Applicable to B&W Plants

GENERIC LETTER 90-06
(continued)

ANO Response submitted December 21, 1990

- ANO-1 design does not rely on the ERV for design basis accident mitigation

- ERV and Block Valve are currently classified as "Q" and are included in ANO's Section XI IST program

- Block Valve is also in the MOV Program

- Technical Specification changes are not necessary as the ERV serves no safety-related function

Staff Review of ANO response November 24, 1992

- Identified feed and bleed cooling as "other function" which PORV is needed to facilitate

GENERIC LETTER 90-06

(continued)

B&W Generic Response submitted January 18, 1993

- NRC position is that most of the safety enhancement for the proposed backfit is derived from increases in feed and bleed capability

- TS shutdown requirement for an inoperable ERV is inappropriate because B&W plants with high head HPI pumps have the ability to provide feed and bleed cooling through the pressurizer safety valves without the ERV

- PRA for B&W plants shows that with a significant increase (75%) in PORV reliability only a minimal (3%) decrease in an already acceptable core damage frequency (1 E-5/rx.-yr.) is derived

- Inclusion of the ERV in Technical Specifications is inconsistent with NRC Policy Statement

- Manual pre-trip use of the ERV is not a design basis requirement but an enhancement to safety and therefore, does not support additional TS requirements

REGULATORY BASIS CONCLUSIONS

- ANO believes the intent of the NUREG 0737 items related to ERV operation were limited to the evaluation of the automatic actuation of the ERV

- ANO's detailed evaluation has shown compliance with the acceptance criteria of NUREG 0737 item II.K.3.2 considering pre-trip manual use of the ERV

- In accordance with post TMI requirements, changes were implemented to

  - Reduce automatic challenges to the ERV

  - Improve the ERV and block valve reliability

  - Enhance the operator's ability to detect a stuck open ERV

- The manual use of the ERV is an enhancement to safety but not required to mitigate the consequences of a design basis accident; therefore, the requirements of GL 90-06 are not applicable