COM-42-130
Revision 0
October 1982
64.4200.0502

MARK I PROGRAM SRV INHIBIT LOGIC MODIFICATIONS FOR QUAD CITIES UNITS 1 AND 2 AND DRESDEN UNITS 2 AND 3

Prepared for:
Commonwealth Edison Company

Prepared by:
NUTECH Engineers
San Jose, California

nutech ENGINEERS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In order to mitigate the consequences of subsequent actuations of the five safety relief valves (four Electromatic and one Target Rock) with elevated water legs present in the discharge piping, it was necessary to provide design modifications which would ensure that reopening of these valves would not take place during the elevated water leg residence time. Because of the high thrust loads on the discharge piping, it was not economically justified to provide a mechanical fix. Instead, an electrical fix was devised that accomplishes the task at a fraction of the cost of the mechanical fix.

The modification to the valves included two separate fixes:

1. Rearrangement of the relief valve opening setpoints into two separate groups so that subsequent challenges to the relief valves will be made to the lower setpoint group before the upper setpoint group is challenged.

2. Installation of a 10-second inhibit on the two valves in the low-set group to eliminate subsequent reopening of these valves when elevated water legs are present and an amber light to the low set valves' control switch in the control room to provide indication to the plant operator that the valve has an elevated water leg.

The electrical logic used to provide the inhibit is physically contained within the ADS panels for each unit at the Quad Cities Station. (Dresden's location has not yet been determined.)

The design package for Quad Cities Unit 1 has been issued, and the design packages for the other units are expected to be completed consistent with the outage schedules.

LIST OF TABLES

LIST OF FIGURES

1.0 BACKGROUND/NEED FOR MODIFICATION

The safety relief valve (SRV) inhibit logic modifications are required for the Mark I Containment program to eliminate potential high thrust loads on the SRV discharge line piping for Dresden Units 2 and 3 and Quad Cities Units 1 and 2. These potential high thrust loads would occur for a loss-of-coolant accident (LOCA) during subsequent actuation of SRVs before the water column in the SRV discharge line has time to return to normal height (approximately 13 feet about the quencher). Table 1-1 presents a summary of SRV load cases for the Mark I program. The load cases of interest are C3.1, C3.2, and C3.3 for subsequent SRV actuation. The limiting load case is C3.3, the steam phase of a small break accident (SBA), and of an intermediate break accident (IBA).

The SRV discharge line (SRVDL) piping is designed (by Sargent and Lundy) to handle thrust loads at normal water level in the SRVDL. Figure 1-1 presents the SRVDL reflood height transient after SRV closure for load cases C3.1 and C3.3, using the Dresden plant as an example. For load case C3.3, the reflood height is about 50 feet above the level of the SRVDL ramshead elevation. This is caused by the condensation of the steam in the SRVDL after valve closure, which results in a reduction in the pressure within the SRVDL. This then causes the water in the SRVDL to rise in order to equalize pressure between the wetwell and the drywell. During a LOCA, the pressure rises above normal in the wetwell, resulting in a driving force pushing the water into the SRVDL above the normal water level. The SRVDL clears in about 5.6 seconds for load case C3.3. The SRV inhibit logic is designed to delay the reopening of the two low set SRVs during this period. This eliminates high thrust load on the SRVDL. Even for load case C3.1, the peak reflood height is about 28 feet and the water level returns to normal in about three seconds.

In order to assess the impact of not incorporating the SRV modification, NUTECH performed a sensitivity study for Dresden Units 2 and 3 which presents thrust loads on the SRVDL for various initial water levels in the SRVDL for load case C3.1 (Figure 1-2). At normal water level in the SRVDL, the design load provided to Sargent & Lundy is 57 kips. At maximum reflood water weight for load case C3.1, the load is 177 kips (Figure 1-2). An even greater impact occurs for load case C3.3. The above results are similar for Quad Cities Units 1 and 2 except in one area. For Quad Cities Units 1 and 2, the duration of the high SRVDL water leg is 17 seconds (Reference 1) as compared to 5.6 seconds for Dresden Units 2 and 3. This is because the Quad Cities plant has a higher SRV reclose pressure (1082 psi versus 1070 psi) on the lowest set SRV. As part of the SRV modification, the Quad Cities SRV opening and closing setpoints will be made the same as Dresden's in order to reduce the water leg duration.

Hence, under the Mark I Containment program, the SRV logic is required to eliminate potential high loads on the SRVDL during subsequent SRV actuation for both Dresden Units 2 and 3 and Quad Cities Units 1 and 2.

1.1 Use of SRVDL Vacuum Breakers

The SRVDL vacuum breakers currently being installed or that will be installed in the Dresden and Quad Cities plants help reduce the elevated water columns in the

SRVDLs, but not enough. Figure 1-3 presents the results of a sensitivity study performed by NUTECH for Dresden Unit 3 showing the effect of larger vacuum breakers (6" vs 1") on the SRVDL water height. The results for Dresden Unit 2 and Quad Cities Units 1 and 2 are similar. The results of an 8" vacuum breaker are similar to those for a 6" vacuum breaker. Hence, the larger SRVDL vacuum breakers are helpful in reducing the water column height for subsequent SRV actuations, but do not eliminate the need for the SRV inhibit logic modifications.

TABLE 1-1

SRV LOAD CASES FOR MARK I PROGRAM

DESIGN INITIAL CONDITIONS	ANY ONE VALVE	ADS VALVES	MULTIPLE VALVES
A. FIRST SRV ACTUATION			
1. NORMAL OPERATING CONDITION	A1.1		A3.1
2. SBA/IBA	A1.2	A2.2	A3.2
3. DBA	A1.3		
B. LEAKING SRV			
1. NORMAL OPERATING CONDITION			B3.1
C. SUBSEQUENT SRV ACTUATION			
1. NORMAL OPERATING CONDITION			C3.1
2. SBA/IBA - AIR			C3.2
3. SBA/IBA - STEAM			C3.3

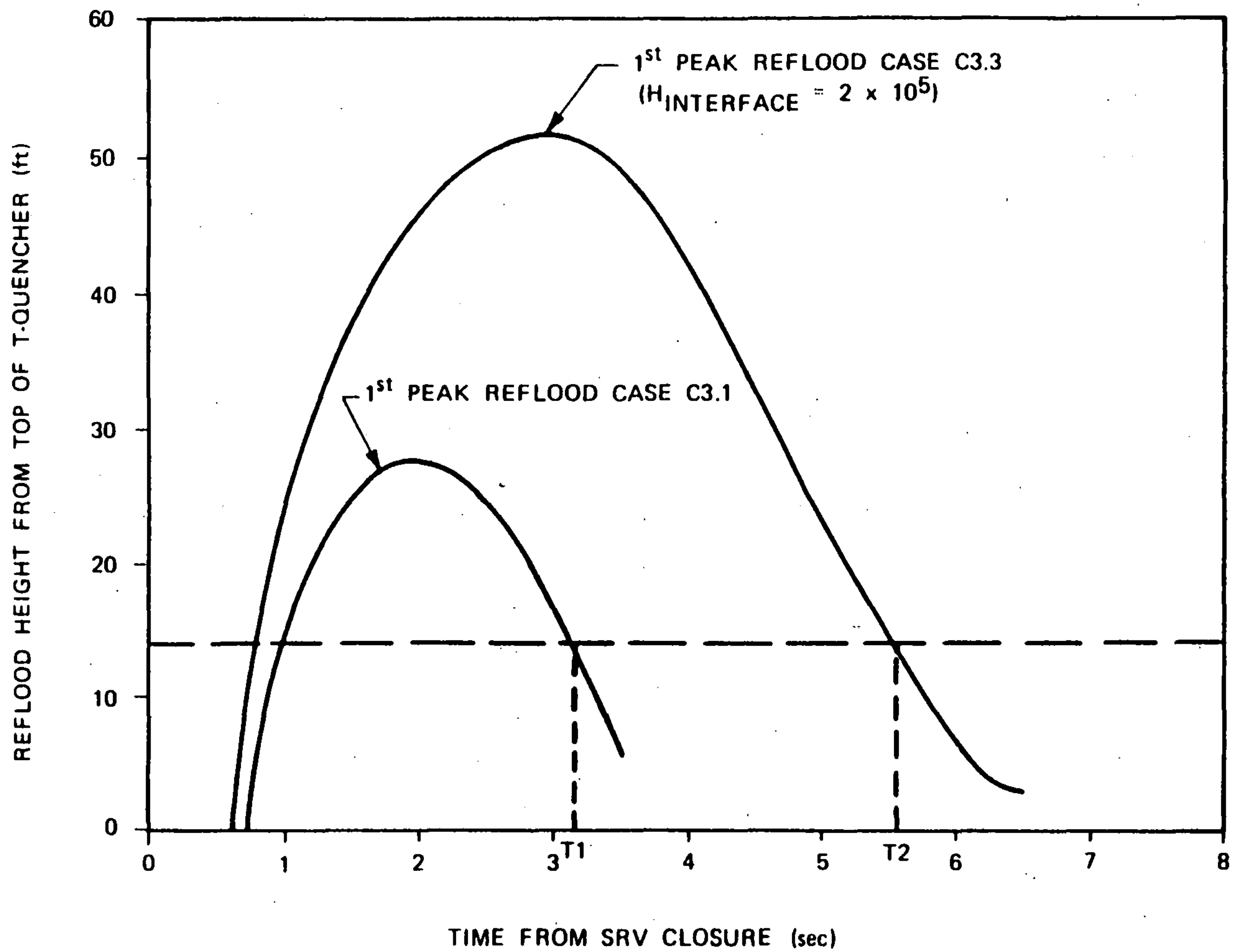

Figure 1-1
SRVDL REFLOOD HEIGHT VS TIME FROM SRV CLOSURE
LDR CASES C3.1 AND C3.3
(DRESDEN 2 & 3)

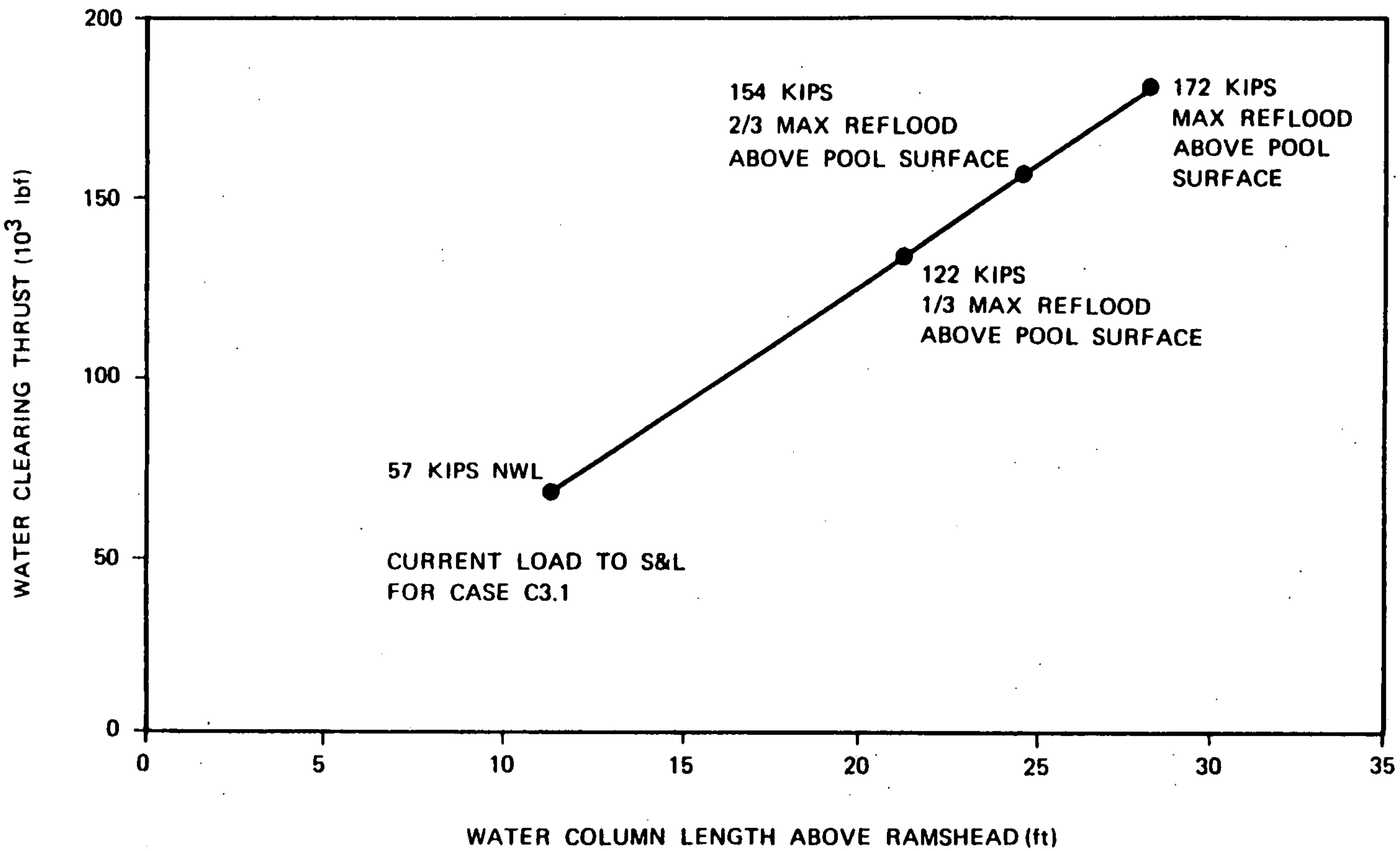

Figure 1-2
WATER CLEARING THRUST LOAD VERSUS WATER COLUMN HEIGHT FOR VARIOUS REFLOOD LEVELS IN THE SRVDL (DRESDEN UNIT 3, LINE E, LOAD CASE C3.1)

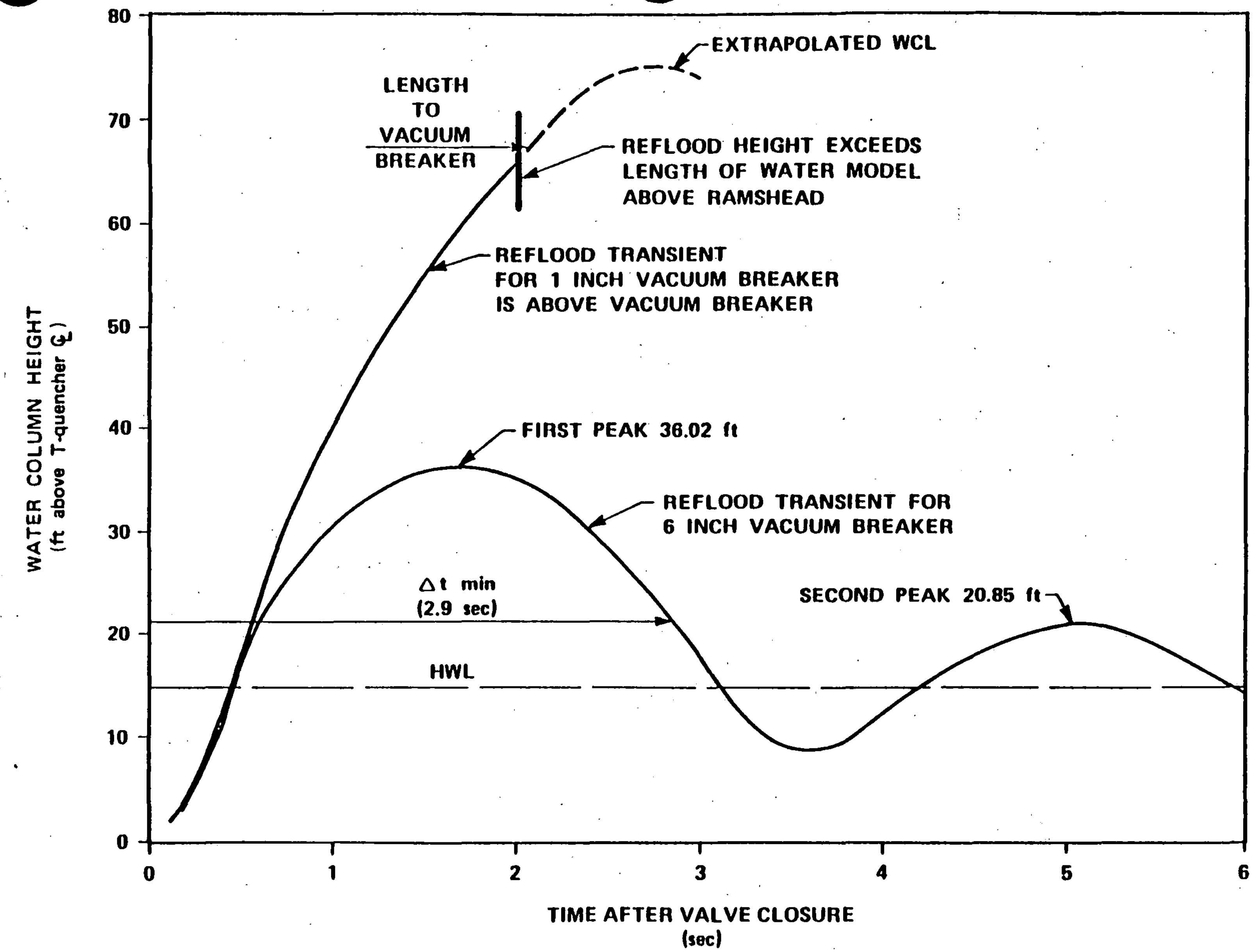

Figure 1-3

WATER COLUMN HEIGHT VERSUS TIME FOR ONE INCH AND SIX INCH SRVDL VACUUM BREAKER (DRESDEN UNIT 3, LOAD CASE C3.1)

1.2 Summary of SRV Modifications

The SRV modifications consist of the following:

1. Raise the opening setpoint and change the blowdown ΔP of the closing setpoint of the Target Rock SRV. Rearrange the opening and closing setpoints of the SRVs into two separate groups.

2. Incorporate a 10-second inhibit on reopening of two of the five SRVs (both electromatic) following an SRV demand.

3. Change the setpoints of both Dresden Units 2 and 3 and Quad Cities Units 1 and 2 to that given in the NUTECH design specification COM-42-014 (Reference 2).

Item 1 is necessary to prevent the mechanical opening of an SRV (i.e., the Target Rock valve). Item 2 is the chief feature of the modification which prevents reopening of the two low-set SRVs until the water leg in the SRVDL returns to normal. Item 3 is necessary to provide consistency between the Quad Cities and Dresden plants and to utilize identical logic for both.

1.3 Mark I Containment Program Basis for Structural and Mechanical Modifications

The Mark I structural and mechanical modifications which have been designed and/or installed on the Dresden and Quad Cities plants are based on the assumption that a normal column of water exist in the SRVDL for load cases C3.1 to C3.3. In December 1981, the final reports prepared by General Electric (References 1 and 3) demonstrated the need for SRV logic modifications to eliminate elevated water leg concerns. This has resulted in reduced plant modifications for the Mark I containment program. Because the SRV logic modifications are load mitigators (i.e., load cases C3.1 through C3.3), they are designated as "major" modifications under the Mark I containment program. minor

1.4 Mark I Containment Program Criteria for SRV Logic Modifications

The overall criteria for the SRV Logic modifications are defined in the NRC's Safety Evaluation Report, NUREG-0661 (Reference 4), which states in Appendix A, Section 2.13.7 that load cases for first and subsequent actuations for SBAs and IBAs must be considered. NUREG-0661 also states that subsequent actuations for a single SRV are determined by a plant-specific primary system analysis (as in References 1 and 3). The load definition report (LDR) describes the methodology for peforming SRVDL reflood transient analysis (Reference 5). NUTECH's approach for the SRV logic modifications meets the Mark I containment program criteria as defined in NUREG-0661 and in the LDR.

2.0 MODIFICATION OPTIONS AND PROJECT HISTORY

To provide a description of the modification being installed in the Dresden and Quad Cities plants, it is necessary to review both the modifications considered and the history of the design effort. It is also necessary to list the criteria which were used as guidance for determining the option to be used. These two factors together should provide the information necessary to show how the present design has evolved.

2.1 Criteria Used To Select Options

At the beginning of the project, various design criteria were established for design guidance. These criteria included:

1. Risk Reduction: Any changes made to the SRV/ADS logic of the plants should not degrade the reliability of the logic. This results in a need to meet the single failure criteria for the overall SRV logic modification and method to handle inadvertent operator errors.

2. Reasonable Cost/Reduced Outage Impact: All attempts should be made to minimize the cost of the modification without reducing overall system quality. A consideration of outage requirements for the modification should also be included.

3. Licensibility: The recommended modification should provide a high degree of confidence to obtain NRC approval.

4. Versatility: The modification should be compatible with existing plant physical configurations and logic.

2.2 Options Considered

There are several electrical modifications* which can be utilized to mitigate the consequences of any SRV opening during the time interval of an elevated water leg. The following five options were evaluated.

Option

A: Direct Indication Modification

B: Indirect Indication Modification

C: Combination Direct-Indirect (Hybrid) Modification

D: ADS Timer-Valve Actuation Modification

E: Use Probability Argument and Accept Loads

The direct indication modification was the first option considered for the project. It consisted of pressure taps on the SRV discharge piping which determined if the SRVs were open or closed. Upon receiving a valve close signal, the pressure instrumentation would initiate an inhibit on the ADS valves, thus preventing actuation with an elevated water leg. However, due to the amount of outage-related work and the cost of piping and containment isolation valves, the first option was dropped.

---

* For a detailed description and review of the five proposed options, see NUTECH letter COM-42-008 dated May 21, 1982, in Appendix D of this report.

Refinements to the first proposed modification, including a rearrangement of the valve set points into two groups and utilization of the direct-indirect valve position, resulted in the direct-indirect (hybrid) Option C. A full evaluation of Option C is presented in Appendix D of this report. A PRA study was also performed (see Reference 6), which indicated that Option C was the best. With this modification, the SRV's opening set points would be rearranged so that only two of the five SRVs would require an inhibit logic. The inhibit logic would utilize two semi-direct signals from the limit switches (originally, use of the acoustic monitors was proposed). on the valves and indirect signals from the electrical signal to open the valves. The use of the limit switches resulted from discussions held with CECo personnel from SNED, Dresden, and Quad Cities Stations on June 18, 1982 in the CECo offices. The limit switches could be utilized without having to perform significant work in the drywell or any work beyond the ADS logic panels.

After the schematic diagrams and design specification were issued for comments, Quad Cities Station personnel requested additional information and discussions on the logic. On October 4, 1982, Mr. Tom Tamlyn and Mr. Mike Tucker of CECo, and Mr. Pat Donnelly of NUTECH agreed to a refinement of the logic scheme. There were three reasons for changing the logic:

1. The number of relays per valve required for the inhibit function could be reduced from eight to four. In addition, since the limit switch indications were eliminated, the need for an auxiliary relay for the control room annunciators could be eliminated.

2. The need to use the limit switches with their questionable reliability was eliminated.

3. The need for a new logic panel for the relays was eliminated.

The new logic would include only the indirect signal for the inhibit logic. The design requirement that single failures of the inhibit logic shall not keep the affected SRVs from functioning normally was eliminated. It was recognized that some reliability in the SRV demand logic was lost and that single failures within a valve's demand logic could result in the loss of functionality of that valve. However, since the modification is on an individual valve basis, the degradation of the overal modification is minimal; this is because a valve mechanical failure could cause the same loss of function in that valve. Overall, the ADS function or SRV pressure relief function is essentially unaffected. Moreover, these disadvantages would be balanced by advantages identified above for the modification. As a result of the meeting, other design changes included having the manual initiation bypass the inhibit logic and the installation of an amber light in the control room on the manual control switch for each of the low-set valves. Section 3.0 of this report provides a complete description of the present logic scheme.

3.0 FINAL MODIFIED DESIGN

The final modified option incorporated the basic design of a rearrangement of the set points and the installation of the inhibit logic on the two SRV valves which have opening set points lower than the other three SRVs. The modification is to be physically installed in the Quad Cities ADS Logic Panels, and the same will be done at Dresden if there is sufficient space.

The design for a SRV inhibit logic modification incorporated a rearrangement of SRV opening set points. Set points were chosen so no overlap of SRV opening points between the two lower set valves and the three higher set valves would occur. Included in the determination of the set points was the set point drift and the Target Rock valve mechanical safety function. The rearrangement is as follows:

why 1050

SRV	Maximum Opening Set Point Limit	Nom.Open. Set Point	Max.Close. Set Point	Nom.Close. Set Point
A*	1135 psig	1125 psig	1090 psig	1080 psig
B**	1115 psig	1105 psig	1052 psig	1043 psig
C**	1115 psig	1105 psig	1052 psig	1043 psig
D	1135 psig	1125 psig	1090 psig	1080 psig
E	1135 psig	1125 psig	1090 psig	1080 psig

The SRV set points transmitted to General Electric to perform the load case analysis represent the most conservative configuration of set points, and are consistent with the SRV set points identified above.

* Target Rock Valve
** Low-Set Valve

nutech ENGINEERS

The other modification included a 10-second inhibit on the reopening function of the two low-set SRVs (B&C) to preclude the possibility of actuation during the elevated water leg period. This inhibit is contained within the ADS logic of each of the low set SRVs with individual logic on each valve. The individual logic on each valve precludes the possibility of failing more than one valve with a single failure in the inhibit logic. A signal to open the valve activates the inhibit logic, and when the valve is required to close, the inhibit prevents reopening of the low-set SRVs for 10 seconds following the closure signal (Figure 3-1). The manual opening logic of the low-set SRVs bypasses the inhibit logic. However, an amber light is installed in the control room to indicate when the inhibit logic is timing to warn the operator that elevated water legs in these valves' discharge lines are present. Since manual initiation activates the inhibit logic, reopening of the valves from a pressure signal or ADS signal following closure will not reopen the valves until after the time delay signal has ended.

Figures 3-1 and 3-2 present the final SRV logic for Quad Cities Unit 1, Valves 203-3B and 203-3C. The logic for both valves is identical. The logic for Quad Cities Unit 2 and Dresden Units 2 and 3 would also be identical (subject to approval by the Dresden Station staff).

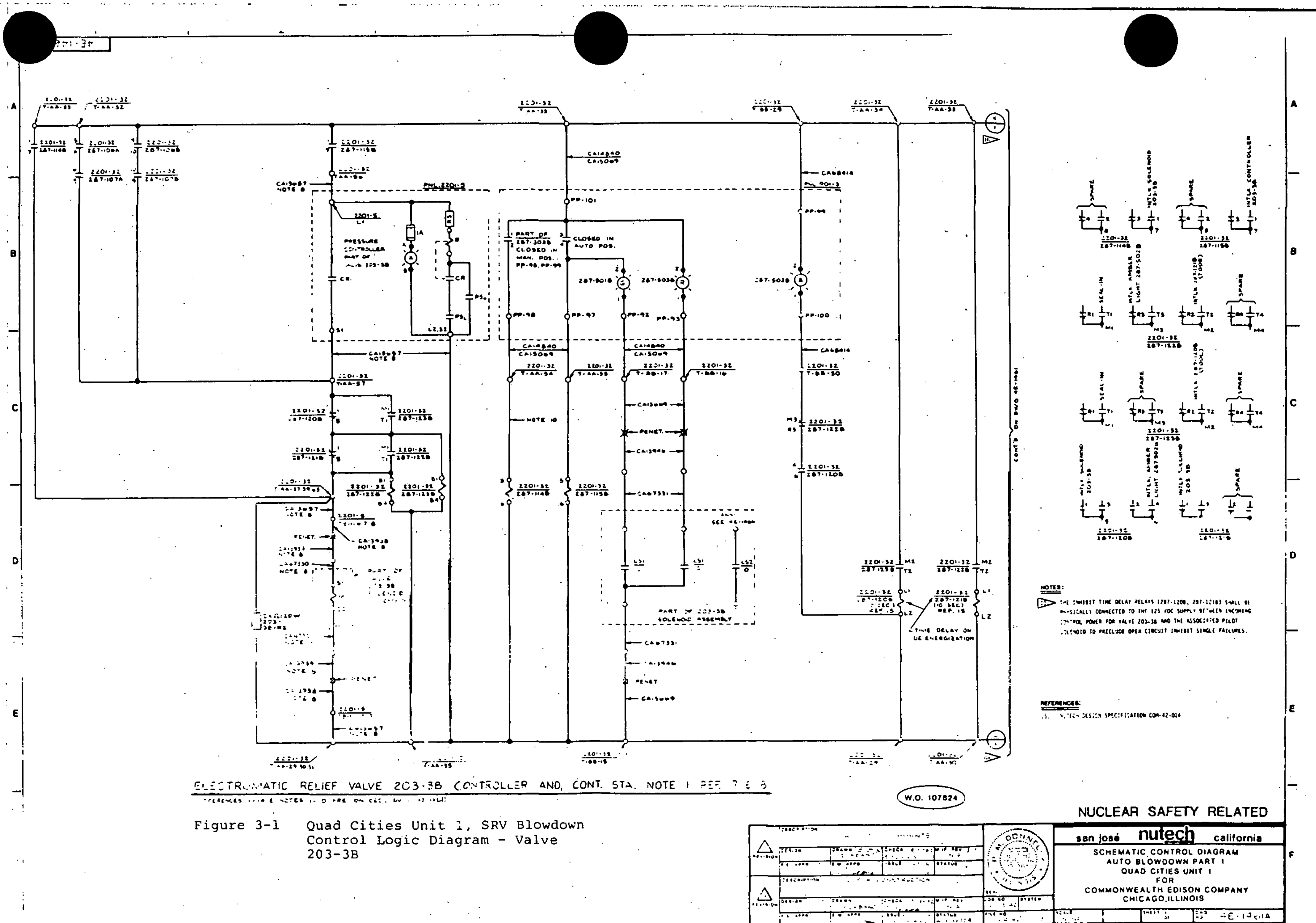

Figure 3-1 Quad Cities Unit 1, SRV Blowdown Control Logic Diagram - Valve 203-3B

COM-42-130

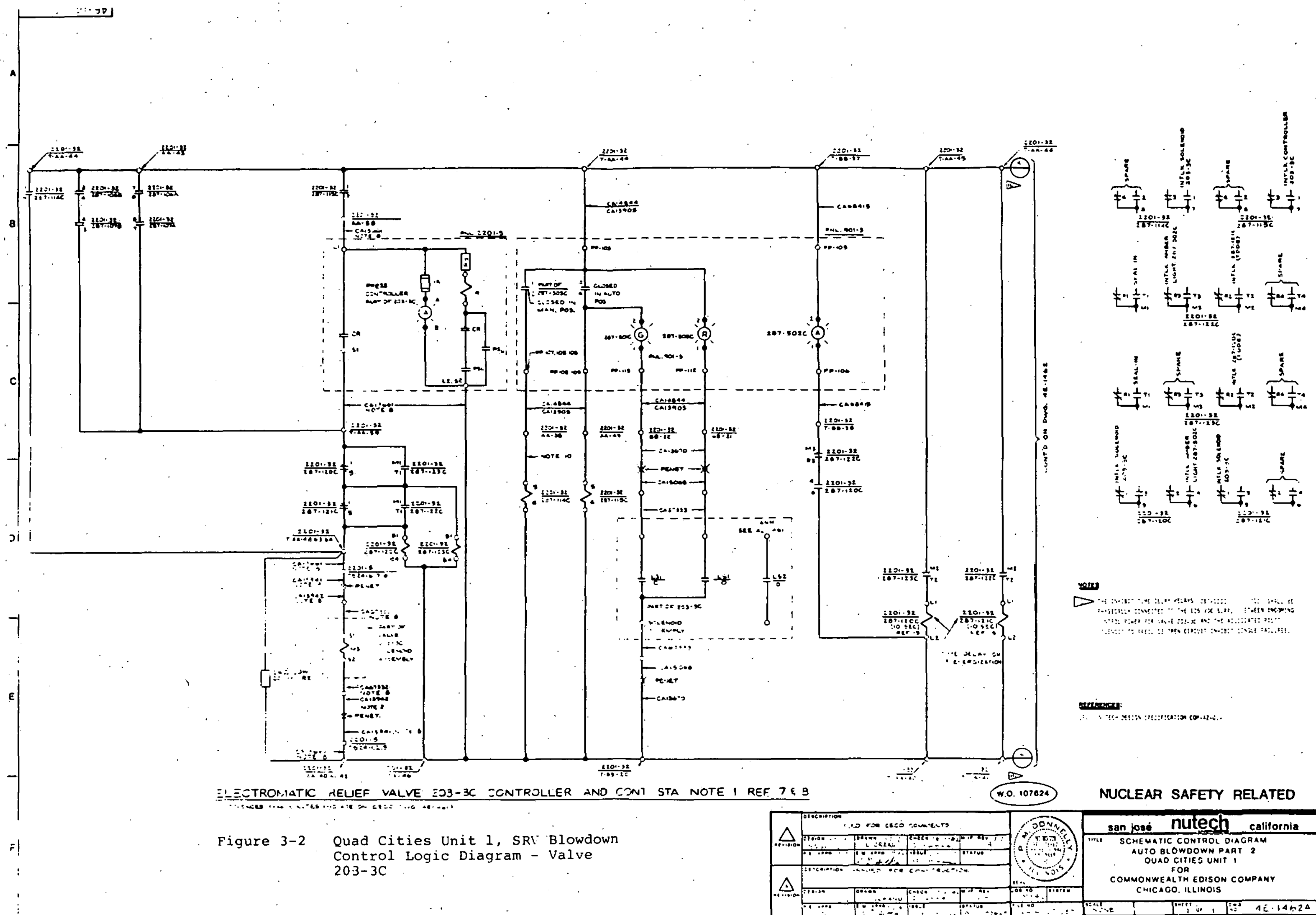

Figure 3-2 Quad Cities Unit 1, SRV Blowdown Control Logic Diagram - Valve 203-3C

COM-42-130

4.0 Status of Modification Drawings/Documents

The following design drawings have been issued for construction for Quad Cities Unit 1:

Drawing Number	Revision	Title
4E-1461A	A	Schematic Control Diagram, Auto Blowdown, Part 1 - Quad Cities Unit 1 for Commonwealth Edison Company Chicago, IL
4E-1462A	A	Schematic Control Diagram, Auto Blowdown, Part 2 - Quad Cities Unit 1 for Commonwealth Edison Company Chicago, IL
4E-1077	BK	Elect. Instal. - Reactor Bldg. - El. 595'-0"-West-Unit 1
4E-1077-CS	D	Category I - Conduit Support Schedule
4E-1079	AW	Elect. Instal. - Reactor Bldg. - EL. 623'-0"-West-Unit 1
4E-1461	Y	Schematic Control Diagram, Auto Blowdown, Part 1 - Unit 1

Drawing Number	Revision	Title
	(Continued)	
4E-1462	V	Schematic Control Diagram, Auto Blowdown, Part 2 - Unit 1
4E-1691C	T	Front Elevation M.C.B. PNL 901-3
4E-1696	T	Wiring Diagram - M.C.B. PNL 901-3
4E-1701	AN	Wiring Diagram - M.C.B. PNL 901-3
4E-1769A	P	Wiring Diagram - Inst. Rack 2201-5 Sec. A - Reactor Instrumentation & Protection
4E-1769C	H	Wiring Diagram - Instr. Rack 2201-5 Sec. C - Auto Blowdown Sys.
4E-1789E	K	Wiring Diagram, Auto Blowdown, Relay Panel 2201-32
4E-1904B	AA	Cable Tabulation - Cables 13650 to 13699
4E-6506A	C	Cable Tabulation - Cables 68400 to 68499

The drawing release schedule for similar drawings for the remaining units is as follows:

Dresden Unit 2	1/7/83
Dresden Unit 3	3/15/83
Quad Cities Unit 2	1/7/83

This schedule is based on assuming that there will be no major changes in logic for Dresden Units 2 and 3.

The following design specificaton which covers Quad Cities Units 1 and 2 and Dresden Units 2 and 3 has been issued.

Specification	Revision	Title
COM-42-014	0	Design Specification, SRV Blowdown Control Logic, Dresden Units 2 & 3 and Quad Cities Units 1 & 2, for Commonwealth Edison Company Chicago, IL

The final design report will be issued by March 1983, or after the issuance of the design drawing package for each unit.

5.0 OVERALL SCHEDULE FOR MODIFICATION INSTALLATION

Since the SRV logic modification is designated as major, it should be installed by the following NRC "Major Modification" dates:

Dresden Unit 2: Cycle 9 (3/83)

Dresden Unit 3: 12/30/82

Quad Cities Unit 1: Cycle 7 (12/82)

Quad Cities Unit 2: Cycle 7 (9/83)

The current plan is to install the SRV logic modifications in Quad Cities Unit 1 during the current outage. For Dresden Unit 3, the modifications have been delayed for one outage based on considerations listed in Reference 6.

6.0 REFERENCES

1. "Evaluation of Mark I SRV Load Cases C3.2 and C3.3 for Quad Cities Nuclear Power Station Units 1 and 2," General Electric Company, NEDC-24379, December 1981.

2. "Design Specification, SRV Blowdown Control Logic," Dresden Units 2 & 3 and Quad Cities Units 1 & 2, NUTECH, COM-42-014, Revision 0, October 1982.

3. "Evaluation of Mark I SRV Load Cases C3.2 and C3.3 for Dresden Nuclear Power Station Units 2 and 3," General Electric Company, NEDC-24378, December 1981.

4. "Mark I Containment Long-Term Program," Safety Evaluation Report, USNRC, NUREG-0661, July 1980.

5. "Mark I Containment Program Load Definition Report," General Electric Company, NEDO-21888, Revision 2, November 1981.

6. "Probabilistic Assessment of SRV Delay Concepts", NUTECH, COM-42-013, July 1982.

APPENDIX A

PRA RESULTS FOR

DRESDEN UNIT 3

A PRA study was performed by NUTECH (Reference 6) in order to justify delaying the modifications to Dresden Unit 3 for an additional outage beyond the NRC major modification date of December 1982.

Table A-1 presents the results of the study for the Dresden plant, where probability is defined as the risk for torus damage per plant year. For example, the mean probability for the current system (i.e., no modification) is 2.5 x 10^{-5} for load case C3.1. This indicates that the risk of not incorporating the modification to Dresden 3 is small enough to justify a delay of one outage; however, the risk is high enough that NRC acceptance of not modifying the SRV logic is unlikely.

although C_x 3.3 was worstcase

Utilizing Option C reduces the risk of potential damage to the torus by a factor of about 500 (i.e., to 1 x 10^{-10}). Based on the revisions made to Option 3 at the meeting with NUTECH and CECo (Mr. Tamlyn and Mr. Tucker), the risk reduction factor will be reduced somewhat. However, the conclusions are the same. NUTECH will issue an addendum to Reference 6 to justify the revisions made.

Table A-2 presents similar results for the Quad Cities plant.

Table A-1

SUMMARY OF PROBABILISTIC ASSESSMENT
FOR DRESDEN NUCLEAR POWER STATION

	MEAN PROBABILITY	UPPER 95% PROBABILITY	MEAN RISK REDUCTION
CURRENT SYSTEM			
Load Case C3.1	2.5×10^{-5}	6.4×10^{-5}	-
Load Case C3.2/C3.3	7×10^{-8}	3×10^{-7}	-
OPTION C			
Load Case C3.1	4.9×10^{-8}	1.4×10^{-7}	500
Load Case C3.2/C3.3	1×10^{-10}	5×10^{-10}	500

Table A-2

SUMMARY OF PROBABILISTIC ASSESSMENT
FOR QUAD CITIES NUCLEAR POWER STATION

	MEAN PROBABILITY	UPPER 95% PROBABILITY	MEAN RISK REDUCTION
CURRENT SYSTEM			
Load Case C3.1	2.3×10^{-4}	6.1×10^{-4}	-
Load Case C3.2/C3.3	5.3×10^{-7}	1.1×10^{-7}	-
OPTION C			
Load Case C3.1	4.5×10^{-7}	1.2×10^{-6}	500
Load Case C3.2/C3.3	1.6×10^{-9}	4.2×10^{-9}	500

APPENDIX B

RESPONSE TO JIM ABEL'S QUESTIONS

nutech ENGINEERS
6835 VIA DEL ORO • SAN JOSE, CALIFORNIA 95119 • PHONE (408) 629-9800 • TELEX 352062

July 2, 1982
COM-42-011

Mr. R. H. Mirochna
Station Nuclear Engineering Department
Commonwealth Edison Company
Post Office Box 767
Chicago, Illinois 60690

Subject: Responses to Mr. J. S. Abel's Questions Regarding the Dresden/Quad Cities SRV Inhibit Logic Modifications

Reference 1: Safety Analysis Report for Dresden 2&3, Volume 1, Docket 50237-20, Rev. 3/22/68 (Figure 6.2.35)

Dear Mr. Mirochna:

As discussed in our project status meeting on June 17, 1982, we are submitting responses to Mr. J. S. Abel's questions on the proposed modifications to the Dresden/Quad Cities SRV inhibit logic. They are:

Question No. 1: Why does the Target Rock SRV set point have to be changed?

Response: The Target Rock SRV can be opened either electrically or mechanically. Since it is not possible to inhibit the Target Rock SRV from opening mechanically, NUTECH recommends that the set points of the Target Rock SRV are changed so that subsequent actuations will not occur. The opening set point of the Target Rock SRV will be changed from 1115 psig to 1135 psig. Concurrently, the opening set point of one of the electromatic SRV's will be set at 1115 psig (i.e., the lowest opening set point). This will ensure that the modified SRV Inhibit Logic will function without concern for opening the Target Rock valve mechanically.

Question No. 2: What effect will the new SRV logic have on the Appendix K (of 10CFR50.46) ECCS calculated peak clad temperatures?

Response:

The proposed SRV inhibit logic could potentially inhibit 2 of the 5 ADS valves for an additional 10 seconds, assuming that the two SRV's with lowest set point closed on pressure relief function just prior to the ADS demand. For conservatism, GE usually assumes the loss of one ADS valve for calculating blowdown capacity. Therefore, an ADS delay of 5 seconds is bounding. Utilizing an adiabatic heat-up rate of approximately 3°F/sec for the limiting fuel rod in a small break LOCA, the impact on calculated Peak Clad Temperature (PCT) is approximately 15°F. The impact is estimated to be negligible for large break LOCA's.

Since the PCT for small break LOCA's is of the order of 1750°F (Reference 1), a 15°F increase will not result in violation of the Appendix K (of 10CFR50.46) ECCS PCT limit of 2200°F.

There is also a more subtle effect; depending on the specific break size and plant conditions, the ADS demand could conceivably occur at any reactor pressure in the deadband region of the ADS valve with the lowest set point when operating in the pressure relief mode (30 to 45 psi). This is due to the fact that ADS demand is driven by reactor water level and not reactor pressure. The initial ADS blowdown rate is approximately 6 psi/second, which results in a "deadband error" of about 5 seconds. Therefore, if the ADS function commenced at the top of the deadband region (about 1115 psi) as opposed to the bottom of the deadband region (1085 psi), an additional delay of 5 seconds in core recovery would result. Furthermore, the only way in which the additional delay caused by the proposed design change, could happen, is if the SRV's closed just at the bottom of the deadband region. Thus, the effect of the proposed design change is no greater than that already permitted by existing "deadband error."

<u>Question No. 3</u>: Instead of inhibiting the SRV's for a specified time period following the closure of the SRV's, why not install a logic that would close any ADS valve 15 seconds prior to the timing out of the 2 minute ADS time delay?

<u>Response</u>: To implement this modification, a global inhibit on all the valves or either individual inhibits on each of the valves is required. The global modification, which would require less material/hardware, would be subject to a single failure which could inhibit all SRV's from opening. The addition of the logic to each SRV would require a large amount of hardware (i.e., timers, relays, cables) and at least two direct indications of SRV position. The modification to each valve (i.e., closing ADS valve 15 seconds prior to a 2 minute ADS time delay) represents a larger effort and would have a greater monetary impact on Commonwealth Edison than the NUTECH proposed modification of SRV inhibit on 2 of the 5 valves. Hence, NUTECH believes that the proposed modification is more cost effective; it is also consistent with the post TMI philosophy of maintaining safety systems operable.

<u>Question No. 4</u>: If the Acoustic Monitoring System is used, what impact does a leaky SRV have on system operability?

<u>Response</u>: The SRV inhibit logic modification will now utilize the limit switches on the SRV's for direct indication. The Acoustic Monitoring System will not be used. This decision was made at a June 18, 1982 meeting between Quad Cities and Dresden Station personnel, CECo-SNED and NUTECH.

If you have any comments or additional questions, please contact Craig Sawyer or myself.

Very truly yours,

Ajoy K. Moonka

For H. W. Massie
Project Manager

HWM/vh

cc: E. R. Zebus
C. D. Sawyer
File 64.4200.0004

APPENDIX C
SETPOINT CHANGES AND SPECIAL REQUIREMENTS FOR TARGET ROCK VALVE

Each of the ADS's for the Dresden 2 and 3 Units and the Quad Cities 1 and 2 Units has five valves. Four of the valves are Electromatic valves, and the other is a Target Rock valve. The Target Rock valve has special significance to this project, since it can be opened either electrically or mechanically. In order to provide protection from elevated water legs in the Target Rock valve discharge line, special design considerations are required.

The changes to the Target Rock valve included a change in the opening set point and an enlargement of the blowdown window (for the Quad Cities Units). The opening set point upper limit was raised to 1145 psig to significantly reduce the possibility of more than one actuation of the Target Rock valve. The blowdown window was also increased to a ΔP of 45 psi for the Quad Cities valves. The electrical set points can be recalibrated in a matter of minutes at the pressure controller. With these modifications made, subsequent challenges to the Target Rock valves will not occur for the load cases C3.1 through C3.3.

APPENDIX D

NUTECH LETTER ON

SRV INHIBIT LOGIC SYSTEM -

EVALUATION OF OPTIONS

nutech 6835 VIA DEL ORO • SAN JOSE, CALIFORNIA 95119 • PHONE (408) 629-9800 • TELEX 352062

May 21, 1982
COM-42-008

Mr. E. R. Zebus, Project Engineer
Station Nuclear Engineering Department
Commonwealth Edison Company
P. O. Box 767
Chicago, Illinois 60690

Subject: SRV Inhibit Logic System - Evaluation of Options - Dresden Units 2&3, Quad Cities Units 1&2

Reference: NUTECH letter number COM-42-004 from G. R. Edwards to E. R. Zebus, dated April 15, 1982

Dear Mr. Zebus:

As requested by Mr. R. H. Mirochna, NUTECH performed an evaluation of a range of options to inhibit subsequent safety relief valve (SRV) operation during periods of high water leg in the SRV discharge lines. This evaluation is presented in the attachment.

The recommended option is Option C, a SRV inhibit logic which utilizes your plant's existing acoustic monitors for direct indication of the SRV position. To make the logic single failure proof, a second signal from the SRV solenoids will be utilized. In addition, the Target Rock opening and closing setpoints should be raised to 1135 psig and 1090 psig, respectively, to reduce the possibility of opening on the mechanical setpoint. Concurrently, one of the electromatic SRV's opening and closing setpoints should be lowered to 1115 psig and 1070 psig, respectively.

With this option, NUTECH recommends that a more detailed probabilistic risk assessment (one man-month study) be performed. We believe this additional effort is required to do a better job of defending the proposed fix to the NRC. It also will put the role of the operator in a better perspective, include load cases C3.1 and C3.2, and provide a final confirmation of the risk reduction associated with the NUTECH recommended option.

In the reference letter, NUTECH emphasized the need for the use of direct indication of SRV position to obtain NRC acceptance of the proposed fix. We proposed a pressure switch sensing system from a belief that the acoustic monitors are not likely to be qualifiable. However, this issue (NUREG-0578 item) will be settled one way or another outside of the Mark I program and our proposed fix could tap into any required upgrade of your SRV acoustic monitoring system. To this end, NUTECH has stopped work on direct indication logic based upon using pressure switches. Also, the purchase of the manual valves, excess flow check valves, and pressure switches should be discontinued.

The total cost of the recommended SRV inhibit logic fix (see Attachment) has been reduced from about $1.8 million to about $0.7 million. Of the total cost, NUTECH's engineering costs have been reduced from about $764K to about $350K.

If you have any questions regarding this letter and its attachment, please call Craig Sawyer or me.

Very truly yours,

H. W. Massie

H. W. Massie
Project Manager

cc: R. H. Mirochna (w/attachments)
File 64.4200.0004

EVALUATION OF OPTIONS

FOR A

SRV INHIBIT LOGIC SYSTEM

QUAD CITIES UNITS 1 & 2 AND DRESDEN UNITS 2 & 3

1.0 INTRODUCTION

This report contains evaluations of a range of options that inhibit the safety relief valves (SRV's) from opening during a subsequent SRV actuation until after the water column (leg) in the SRV discharge line clears. Without exercising one of these options, a potential exists of having high loads on the SRV discharge line due to the high water leg in load cases C3.1, C3.2 and C3.3. This could result in damage to the torus if the high loads cause rupture of the SRV discharge line in the wetspace. NUTECH recommends SRV inhibit logic based on direct indication in order to eliminate this concern. It is worth noting that earlier analyses performed by NUTECH for load case C3.3, the limiting case, has eliminated the need for SRV low-low set logic; provided, however, that the blowdown window on the lowest set valves be increased to approximately 50 psi. (Currently, Quad Cities is at approximately 30 psi.)

Earlier, NUTECH also performed a simplified probabilistic study for Dresden Unit 3 which justified the delay of SRV logic plant modifications until the next scheduled outage (Reference 1). The probabilistic analysis performed evaluated the "relative" risk involved of not performing the plant modifications as opposed to an "absolute" risk (e.g., uncertainties were not evaluated). Hence, NUTECH has reviewed a range of plant modifications with the goal of reducing Commonwealth Edison's "relative" risk at a reasonable cost.

The recommended option is a SRV inhibit logic which utilizes the existing acoustic monitors for direct indication of SRV position. For single failure protection, an electronic signal from the valve solenoids (i.e. indirect indication) is used. This option represents a relatively lower cost approach with a reasonable chance for NRC acceptance. Also, NUTECH proposes to perform a one-month probabilistic study to better quantify the "relative" risks associated with the recommended option and to use this study for justification to the NRC.

2.0 DISCUSSION OF PROBABILISTIC ASSESSMENT OF SRV LOGIC MODIFICATION

2.1 Evaluation of Previous Work

The probabilistic analysis was specifically limited to the SRV load case C3.3 and was directed at justifying delaying modifications at Dresden 3 (Reference 1). The effect of normal operating conditions such as anticipated transients with subsequent SRV actuation (load case C3.1) was not quantified. Given the present ADS design, this approach assessed the relative risk of the SRV load case C3.3 with respect to the small and intermediate break accidents. The conclusion showed that the SRV load case C3.3 events degraded the plant's ability to mitigate small and intermediate breaks in a relative sense. Therefore, NUTECH concluded that some logic modification was necessary. Furthermore, the actual numerical values are low for several reasons:

- Load Cases C3.1 and C3.2 were not included.
- The effect of operator error was not considered.
- The effect of operator normal actions, as specified in the emergency procedures, was not considered.
- Uncertainties were not quantified.
- A fault tree analysis of the recommended design was not performed.

In the course of this study, the intent was not to portray the output as relating to absolute plant risk. Thus it is incorrect to conclude that no design action is appropriate in view of the calculated low values.

The probabilistic analysis can be used to assess the the relative risk of the various options being considered.

2.2 Probabilistic Risk Analysis (PRA) for Evaluation of Options

At present, the decision-making process is largely judgmental and does not quantitatively address all the relevant aspects such as risk reduction with the option in place, cost, and availability. A probabilistic approach based on event tree/fault tree analysis should be performed to provide the final confirmation of the selected option.

The PRA study will include the additional elements described in the comprehensive study (Section 2.1). It is estimated that the effort will require approximately one-man month, and the final report will be available in one month.

Five major alternatives are being considered with respect to SRV logic modification as described in Section 3.0.

3.0 REVIEW OF OPTIONS

There are several options which can be utilized to mitigate the consequences of any SRV opening during the time interval of an elevated water leg. The following five options were evaluated:

- Direct Indication System
- Indirect Indication System
- Combination Direct - Indirect (Hybrid) System
- ADS Timer-Valve Actuation System
- Use Probability Argument and Accept Loads

For each option, a description, list of advantages and disadvantages, and a comparative scoping cost of the system is presented. Also, alternatives within some of the options, as appropriate, are briefly discussed.

OPTION A - Direct Indication System

The direct indication system is based upon the criterion that to prevent the reopening of the SRV during the elevated water leg period, an absolute indication of the valve position is necessary. The most direct indication of valve position is to tap into the SRV discharge piping, sensing either a pressure increase or flow indication. The direct indication signal is transmitted to timers which inhibit SRV valve actuation during the elevated water leg period.

The inhibit logic is based on a one out of two twice logic with redundant signals taken from the SRV discharge line. The logic also requires redundant signals to prevent single failure. A total of eight relays are required for the redundant logic along with the associated wiring to connect the relays. This logic system is installed in spare panel space either in the ADS panel or in a panel near the ADS panels in the Auxiliary Electric Equipment Room. Lastly, each valve logic operates independently from the other valves' logic.

There are several advantages of this system over other designs.

- o The system is single failure proof with no single failure able to inhibit valve opening during non-elevated water leg periods.
- o The system provides more accurate (i.e. direct) information on valve position.
- o The system can be used for SRV position indication, should the acoustic monitors fail the qualification tests.
- o The system is licensable, since it meets all the NRC requirements for a safety system with very low risk of changes needed.
- o The system would be compatible with a future need for a low-low set scheme, should the NRC impose this requirement on the utilities.

The disadvantages of the system include:

- o The total cost is highest for this option.
- o The material lead time for the valves and switches and the time necessary to have the modification installed could be a schedular problem for Quad Cities Unit 1.
- o The system requires outage time to install piping or flow switches.

The cost for this option for all 4 units is approximately $1.8 million, including engineering, hardware and installation costs. This option had a very detailed cost breakdown as presented in Reference 2. The cost for the other options are more scoping costs.

As an alternative within this option, a non-redundant system could be used. This would reduce materials and construction costs with only minimal savings in engineering costs. However, this is not recommended since the inhibit system would not be single failure proof.

<u>OPTION B - Indirect Indication System</u>

The indirect indication option for the SRV inhibit function utilizes a signal from the existing logic at the solenoids of the electromagnetic SRVs. Since the Target Rock valve could be opened mechanically, it would be preferable to obtain a signal from the acoustic monitors. Also, the Target Rock valve setpoints are such that the valve is likely to open first; its setpoints should be modified. The Target Rock valve setpoints for opening and closing would be raised to 1135 psig and 1090 psig, respectively; this is identical to one of the electromagnetic SRVs. Concurrently, this electromagnetic SRV setpoint would be lowered to that of the original Target Rock valve setpoints for opening and closing: 1115 psig and 1070 psig, respectively. The indirect signal would be utilized in the same way as the direct signal, but the physical fix would be much reduced in both time and cost.

The advantages of using an indirect signal are as follows:

- It does not require mechanical components (piping, valves, instrumentation) as the direct indication requires.
- Fix is not outage related, although specific tasks may require de-energizing certain equipment.
- Cost to install this fix is much less than the cost of a direct system.

The disadvantages of the indirect system are as follows:

- There is a fair degree of risk in using an indirect signal in that the NRC may not license it.
- An additional fix and subsequent additional costs to the Target Rock Valves would be necessary, since they can open on a mechanical set point.
- The source of these signals in the inhibit logic is not diverse.

The total cost for this option for all 4 units is approximately $700,000 including engineering, hardware and installation costs.

As in Option A, a non-redundant logic scheme is not recommended.

<u>OPTION C - Combined Direct-Indirect (Hybrid) System</u>

This option combines the positive features of both direct and indirect SRV indication. The existing plants' acoustic monitors (one exists per SRV) are utilized to provide direct indication of SRV position. In order to make the logic signal failure proof, the second signal is obtained from the SRV solenoids. This in effect results in a reduncant and diverse logic without having SRV discharge piping penetrations and hence is non-outage related.

Since the Target Rock valve can be opened mechanically, the setpoint realignment discussed in Option B, is recommended; this will reduce the overall relative risk of this option and will be verified in the recommended probabilistic study.

The advantages of the system are as follows:

- o Does not require the mechanical components (piping, valves, instrumentation) the direct indication system requires.

- o System utilizes diverse signals for redundancy feature.

- o Fix is not outage related, although specific tasks may require de-energizing certain equipment.

- o System licensibility is increased due to diverse signals without using the pressure switch scheme.

- o Cost is comparable to indirect indication system and is less than the direct indication system.

- o System is compatible with changes in the Acoustic Monitoring System or with need to add a low-low set logic.

- o System equipment procurement schedule and installation schedule for Quad Cities Unit 1 is compatible with planned outage in fall.

The disadvantages of the system are:

- o Additional fix to Target Rock Valve setpoints would be necessary along with realignment of another SRV.

- o Additional cable runs will be necessary due to diverse signals.

The total cost for this option for all 4 units is approximately $700,000 including engineering, hardware and installation costs.

<u>OPTION D - ADS Timer-Valve Actuation System</u>

The objective of this option is to mitigate the elevated water leg problem by keeping open any SRV that opens during the delay period, beyond the two minute ADS delay. In this way, except for operator intervention, there can be no SRVs closed concurrent with elevated water legs, since the SRVs would be open when the ADS actuation signal is transmitted to the SRV valves.

The advantages of the system are:

- o Does not require the mechanical components (piping, valves, instrumentation).
- o Cost is slightly less than options B and C.
- o Fix is not outage related.

The disadvantages of the system are:

- o The signal is a non-redundant signal.
- o No margin against operator action exists.
- o The system still requires an indication of the SRV position which is the basis of Options A - C.

OPTION E - Use Probability Argument and Accept Loads

The discussion of Section 2.0 indicates NUTECH's concerns in attempting to justify no design action. A more complete Probabilistic Risk Assessment (PRA) will provide the necessary perspective here.

It is felt that the use of PRA in this case is to provide a final and confirmatory assessment of the other design options.

4.0 NUTECH Recommendation

Table 1 presents a summary of the options evaluated in Section 3.0 of this report. NUTECH believes that Option C is the most cost effective option with a reasonable level of risk. A PRA study is recommended as a final confirmation of this selection as well as for defense of this option to the NRC.

Four criteria were used in the selection process:

- o Risk Reduction: Any changes made to the SRV/ADS logic of the plants should not degrade the reliability of the logic; this results in a need to meet single failures and to handle inadvertent operator errors.
- o Reasonable Cost/Reduced Outage Impact: An attempt was made to reduce the cost of the modification without reducing overall system quality.

- Licensibility: The recommended system should have a high degree of confidence that the NRC will approve the system.

- Versatility: The recommended system should be convertible should the acoustic monitors not pass qualification requirements or low-low set logic is eventually required.

Table 1. OPTIONS FOR SRV INHIBIT LOGIC

(Quad Cities Units 1&2 and Dresden Units 2&3)

Option	Rough Hardware & Engineering Cost	Key Advantages	Key Disadvantages/Risk
Option A Direst Indication System	$ 1.8M	1. Easy to license 2. Able to use as backup to acoustic monitors 3. Accurate indication of SRV position	1. Highest cost 2. Probable schedular problem on Quad Cities 1 3. Requires outage time 4. Medium risk
Option B Indirect Indication System	$ 0.7M	1. No mechanical components required 2. Non-outage related fix 3. Lower Cost	1. NRC may not accept indirect indication 2. Signals are not diverse 3. High Risk
Option C Combined Direct-Indirect (Hybrid) System	$ 0.7M	1. Non-outage related fix 2. Utilizes existing plants' acoustic monitors 3. No mechanical components required 4. Has diverse signals for licensing requirements 5. Lower cost	1. Additional cable for diverse signals 2. Change Target Rock valve setpoints 3. Medium risk
Option D ADS Timer Valve Actuation System	$ 0.6M	1. Non-outage related fix 2. No mechanical components required 3. Lower cost	1. Signal is non-redundant 2. No margin for operator error 3. Potential reliability problem 4. Medium to high risk
Option E Use Probability argument and Accept Loads	$ 0.1M	1. Lowest costs	1. Difficult to license 2. Potential for high loads on SRV DL eventually resulting in torus damage 3. High risk

5.0 References

1) NUTECH Letter number COM-42-001, from W. S. Benedict to E. R. Zebus "Probabilistic Analysis of Mark I SRV Load Case C3.3 - Dresden Unit 3," dated March 29, 1982.

2) NUTECH Letter number COM-42-004, from G. R. Edwards to E. R. Zebus, "Changes in Scope of Work, SRV/ADS Logic Modification, Mark I Containment Program, Dresden Units 2&3; Quad Cities Units 1&2," dated April 15, 1982.

bcc: BJW, CDS, PMD, AKM,
CHF, TJM, GDS, PMD

rte: GRE/WGG/HWM/File

5.0 References

1) NUTECH Letter number COM-42-001, from W. S. Benedict to E. R. Zebus "Probabilistic Analysis of Mark I SRV Load Case C3.3 - Dresden Unit 3," dated March 29, 1982.

2) NUTECH Letter number COM-42-004, from G. R. Edwards to E. R. Zebus, "Changes in Scope of Work, SRV/ADS Logic Modification, Mark I Containment Program, Dresden Units 2&3; Quad Cities Units 1&2," dated April 15, 1982.

bcc: BJW, CDS, PMD, AKM,
CHF, TJM, GDS, PMD

rte: GRE/WGG/HWM/File

Corporate Office
NUTECH, Inc.
6835 Via del Oro
San Jose, CA 95119
Phone: (408) 629-9800
Telex: 352062

Operating Subsidiaries:
NUTECH Engineers, Inc.
6835 Via del Oro
San Jose, CA 95119
P (408) 629-9800
T 2062

NUTECH Engineers Bethesda
7910 Woodmont Avenue
Bethesda, MD 20014
Phone: (301) 652-1610

NUTECH Engineers Chicago
303 East Wacker Drive
Chicago, IL 60601
Phone (312) 565-2900

NUTECH Engineers Minneapolis
331 Second Ave., South
Minneapolis, Minnesota 55401
Phone (612) 339-1100

NUTECH Testing Services
2344B Walsh Ave
Santa Clara, CA 95051
Phone: (408) 727-1476

NUTECH International, Inc.
145 Martinvale Lane
San Jose, CA 95519
P (408) 224-3500
T 52062

NUTECH International Seoul
Korea Paint Building Room 401
174-1 Nonhun-Dong Gangnam-Ku
Seoul 134, Korea
Phone: 555-5887
Telex: K23560