FOR INFORMATION ONLY

QA Record

TVA 10697 (DNE-QA-6-86)

DNE CALCULATIONS

Title: Probabilistic Analysis Showing the Effects of Deleting the Residual Heat Removal (RHR) Autoclosure Interlock (ACI)				Plant/Unit: SQN/Units 1 and 2
Preparing Organization: NE/RPS	KEY NOUNS (Consult RIMS Descriptors List): Probability, RHR, ACI			
Branch/Project Identifiers: SQN-SQS2-0097	Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.			
	Rev	(for RIMS' use)	RIMS ACCESSION NUMBER	
	RO	891006D0012	B81 890929 004	
Applicable Design Document(s): N/A	R1	891207C0004 (23)	B04 '89 1205 302	
	R2		B04 '90 0221 300	
SAR Section(s): 5.5.7, 7.6.2 / UNID System(s): 74	R			

	Revision 0	R1	R2	R3	
ECN No. (or Indicate Not Applicable)	N/A	N/A	N/A		Safety-related? Yes (X) No ( )
Prepared	Gloria J. Dyer	[signature]	[signature]		Statement of Problem
Checked	Fredrick K. Hoyos	Fredrick K. Hoyos	Fredrick K. Hoyos		Perform a probabilistic analysis on SQN units 1 and 2 that: (1) shows the effects of deleting the RHR ACI function in order to reduce the likelihood of a loss of RHR cooling accident and (2) demonstrates the adequacy of the ACI deletion from both a core safety standpoint and a RHR system overpressurization standpoint.
Reviewed	Mary B. Townsend	[signature]	[signature]		
Approved	Richard J. McMahon	[signature]	[signature]		
Date	September 29, 1989	12/4/89	2/20/90		
USE FORM TVA 10534 IF MORE SPACE REQUIRED: List all pages added by this revision					
List all pages deleted by this revision					
List all pages changed by this revision		All	9, 17		

ABSTRACT [These calculations contain an unverified assumption(s) that must be verified later. Yes ( ) No (X)]

This calculation provides a probabilistic determination of the effect of deleting the RHR autoclosure interlock for SQN units 1 and 2.

This calculation compares the RHR systems of SQN units 1 and 2 and Salem 1 (the similar reference plant for WCAP 11736) and reviews the WCAP 11736 analyses as applicable to SQN for RHR overpressurization events and RHR system unavailability.

No significant differences were found that would invalidate the Salem WCAP 11736 analyses for applicability to SQN. The deletion of the SQN RHR autoclosure interlock was shown to have a net beneficial effect on decay heat removal and RHR overpressurization events.

(X) Microfilm and store calculations in RIMS Service Center
( ) Microfilm and return calculations to: Microfilm and destroy. ( )
Address:

cc: RIMS, ET SLE 26P-K

TVA

Title: Probabilistic Analysis Showing the Effects of Deleting the Residual Heat Removal (RHR) Autoclosure Interlock (ACI)

REVISION LOG

SQNSQS2-0097

Revision No.	DESCRIPTION OF REVISION	Date Approved
0	Initial issue.	9/29/89
1	Major rewrite: Expanded the calculation to include the comparison of the Sequoyah RHR system with Salem RHR system and a review of the probabilistic analysis used to determine the effect of deletion of the RHR autoclosure interlock.	12/4/89
2	Revised section 6.2.1.1 to provide additional information regarding power lockout of suction isolation valves and added references 13 and 14.	

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

SQN-SQS2-0097	R2
Calculation No.	Revision

Method of design verification (independent review) used (check method used):

1. Design Review ✓
2. Alternate Calculation ______
3. Qualification Test ______

Justification (explain below):

Method 1: In the design review method, justify the technical adequacy of the calculation and explain how the adequacy was verified (calculation is similar to another, based on accepted handbook methods, appropriate sensitivity studies included for confidence, etc.).

Method 2: In the alternate calculation method, identify the pages where the alternate calculation has been included in the calculation package and explain why this method is adequate.

Method 3: In the qualification test method, identify the QA documented source(s) where testing adequately demonstrates the adequacy of this calculation and explain.

This revision incorporates additional information regarding the RHR suction isolation valves (FCV-74-1 & FCV-74-2). Review of these valves indicates the valve motor operators may have sufficient torque to open against reactor pressure. Review of plant operating procedures indicates that formal procedures are in place which prevent the opening of these valves during reactor operations when RHR overpressurization could occur. Therefore, the open permissive interlock and the power lockout features prevent the opening of these valves, resulting in this type of transient being very unlikely and thus having no impact on this analysis. In conclusion, this calculation is based on credible references and makes conservative and appropriate assumptions where necessary and is therefore determined to be technically adequate.

William J. Morris Jr. (signature) — Design Verifier (Independent Reviewer)

2/20/90 — Date

CALCULATION CLASSIFICATION & CATEGORIZATION

CALCULATION INFORMATION:

PLANT/UNIT SQN / UNIT 1 & 2 IDENTIFIER SQN - SQS2 - 0097

RIMS NO. ____ ISSUE DATE ____

TITLE PROBABILISTIC ANALYSIS SHOWING THE EFFECTS OF DELETING THE RESIDUAL HEAT REMOVAL (RHR) AUTOCLOSURE INTERLOCK (ACI)

REVISION LEVEL 2

AFFECTED SYSTEM(S)

PLANT FEATURE	SYSTEM/COMPONENT DESCRIPTION
(✓) SAFETY SYSTEM	SYSTEM NO. 74 RHR
( ) PLANT ENVIRONMENT (EQ, ETC.)	
( ) NON-SAFETY SYSTEM	SYSTEM NO.
( ) APPENDIX R	
( ) CIVIL STRUCTURES	
(✓) INSTRUMENTATION (1.97, PAM, ETC.)	PS-68-68E, PS-68-66D PS-68-66E, PS-68-68D PCV-74-1, PCV-74-2
(✓) LICENSING	GENERIC LETTER 88-17
( ) OTHER	

CALCULATION CATEGORY ____

FINAL CLASSIFICATION

(✓) ESSENTIAL ( ) FILE ONLY

( ) DESIRABLE ( ) SUPERCEDED

SUBMITTED J. Stuart Clint DATE 2/15/90

REVIEWED William J. Mims Jr. DATE 2/15/90

APPROVED R. J. McMahon DATE 2/20/90

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

SQN-SQS2-0097 — R1

Calculation No. — Revision

Method of design verification (independent review) used (check method used):

1. Design Review X
2. Alternate Calculation ____
3. Qualification Test ____

Justification (explain below):

Method 1: In the design review method, justify the technical adequacy of the calculation and explain how the adequacy was verified (calculation is similar to another, based on accepted handbook methods, appropriate sensitivity studies included for confidence, etc.).

Method 2: In the alternate calculation method, identify the pages where the alternate calculation has been included in the calculation package and explain why this method is adequate.

Method 3: In the qualification test method, identify the QA documented source(s) where testing adequately demonstrates the adequacy of this calculation and explain.

This calculation provides a probabilistic evaluation (ACI) of the removal of the Residual Heat Removal (RHR) autoclosure interlock for Sequoyah Nuclear Plant, Units 1 & 2. The basis for the conclusion that this removal(s) would result in a net benefit to the plant ability to respond to overpressurization and/or heat removal depends on a comparison of the Salem Nuclear Plant Unit 1 and Sequoyah, Unit 1 & 2 configurations. This configuration comparison reviewed the primary/critical configurations necessary for the RHR and related systems to perform the required safety functions for a variety of scenarios. In conclusion, this calculation is based on credible references and makes conservative and appropriate assumptions where necessary and is therefore determined to be technically adequate.

William Z Mann Jr — 11/29/89

Design Verifier (Independent Reviewer) — Date

CALCULATION CLASSIFICATION

IDENTIFIER: SQN-SQS2-0097

PRELIMINARY CLASSIFICATION:

- [x] ESSENTIAL
- [ ] DESIRABLE
- [ ] FILE ONLY
- [ ] SUPERCEDED

CALCULATION CLASSIFICATION JUSTIFICATION:

SUBMITTER: THIS CALCULATION CAN BE USED AS JUSTIFICATION FOR MAKING TECHNICAL SPECIFICATION CHANGES AND FOR THE REMOVAL OF THE RHR AUTOCLOSURE INTERLOCK, A PLANT SAFETY FEATURE.

REVIEWER:

- [x] AGREE WITH CLASSIFICATION
- [ ] DISAGREE - COMMENTS REQUIRED

APPROVER:

- [x] AGREE WITH CLASSIFICATION
- [ ] DISAGREE - COMMENTS REQUIRED

Table of Contents

1.0 Purpose

This calculation is being prepared in response to programmed enhancement recommendation 3a and 5 of Generic letter 88-17 as requested by Sequoyah Engineering Project in QIR SQPSQN89330 (reference 1) to provide a probabilistic determination of the effect of deleting the RHR autoclosure interlock (ACI) on the Sequoyah Nuclear Plant (SQN). This analysis will evaluate the combined effects of ACI deletion on the RHR decay heat removal function and RHR system overpressurization protection.

2.0. BACKGROUND

The Nuclear Regulatory Commission issued Generic Letter 88-17 "Loss Of Decay Heat Removal" (reference 2) as a result of increasing concern over the loss of decay heat removal during nonpower operation and the consequences of such a loss. Generic Letter 88-17 requires a response which is to include:

1) A description of the actions taken to implement each of eight recommended expeditious actions identified in the attachment to the letter.
(2) A description of enhancements, specific plans, and a schedule for implementing each of the six programmed enhancement recommendations identified in the attachment to the letter.

Two of these programmed enhancement recommendations specifically mention the RHR autoclosure interlock.

1) Programmed enhancement recommendation No. 3a is,
"Assure that adequate operating, operable, and/or available equipment of high reliability is provided for cooling the RCS, [reactor cooling system], and for avoiding a loss of RCS cooling."

Generic Letter 88-17 goes further in the discussion of this recommendation by noting,
"Loss of DHR [decay heat removal] due to unplanned activation of the autoclosure interlock function is not consistent with provision of reliable equipment. You should investigate this feature if installed in your plant and should consider changes to obtain a reliable heat removal system consistent with other requirements."

2) Programmed enhancement recommendation 5 is,
"Technical specifications (TSs) that restrict or limit the safety benefit of the actions identified in this letter should be identified and appropriate changes should be submitted."

The discussion of this recommendation notes,

"Typical potential impacts include TSs that control ... the autoclosure interlock; ... ."

This calculation is a response to programmed enhancement recommendations 3a and 5 and will evaluate whether the proposed changes associated with the deletion of the SQN autoclosure interlock will enhance the reliability of the decay heat removal system consistent with other requirements, such as overpressurization protection.

3.0 METHODOLOGY

This analysis presents a "comparison and bounding" study between SQN and the reference plant modeled in WCAP 11736, "RESIDUAL HEAT REMOVAL SYSTEM AUTOCLOSURE INTERLOCK REMOVAL REPORT FOR THE WESTINGHOUSE OWNERS GROUP" (reference 3). Four reference Westinghouse plants were analyzed based on similar RHR system configurations and design characteristics. The reference plant with a similar RHR configuation to Sequoyah is Salem 1. WCAP 11736 presented a thorough probabilistic evaluation of the effects of deleting the RHR ACI and adding overpressurization alarms in the control room. The methodology used in the WCAP study was to model sequences involving RHR overpressurization and loss of RHR decay heat removal function both with and without the proposed RHR changes. The models were quantified and evaluated to determine the combined effect of the RHR changes on minimum core cooling.

This calculation notes the similarities and differences of the RHR system configuration, logic, control circuitry, and proposed changes associated with the deletion of the ACI between Sequoyah Nuclear Plant units 1 & 2 and Salem 1. These factors are evaluated to determine whether the Salem 1 analysis and conclusions are valid for Sequoyah 1 & 2. The analyses used in WCAP 11736 are then reviewed with applicable Sequoyah information included.

4.0. RESIDUAL HEAT REMOVAL SYSTEM FUNCTIONAL DESCRIPTION

The primary purpose of the RHR system is to remove decay heat energy from the reactor core and Reactor Coolant System (RCS) during plant cooldown and refueling operations. (references 4 & 5)

4.1. NORMAL FUNCTION

4.1.1. COOLDOWN

The initial phase of reactor cooldown is accomplished by transferring heat from the RCS to the Main Steam system through the use of the steam generators. When the reactor coolant temperature and pressure are reduced to approximately 350°F and 380 lb/in^{2}g respectively, approximately four hours after reactor shutdown, the second phase of cooldown starts with the RHR system being placed into operation.

During this phase of operation reactor coolant is withdrawn from RCS hot leg 4 through RHR suction isolation valves FCV-74-1 and FCV-74-2 to the RHR pumps. The reactor coolant is pumped through the RHR heat exchangers where the heat is transferred to the Component Cooling Water System and the reactor coolant is returned to the RCS through the cold legs. The rate of cooldown is controlled by regulating the reactor coolant flow through the RHR heat exchangers. As cooldown continues, the steam bubble in the pressurizer is collapsed and the RCS is operated in the water solid condition. At this stage, pressure control is accomplished by regulating the charging flow rate and the rate of letdown from the RHR system to the Chemical and Volume Control System (CVCS).

After the reactor coolant pressure is reduced to atmospheric pressure, the temperature is 140°F or lower, the reactor coolant reactivity level is reduced to an acceptable level, and the reactor coolant has been degassed, the RCS may be opened for refueling or maintenance.

4.1.2. REFUELING

The refueling cavity is flooded by closing RHR inlet isolation valves, FCV-74-1 and FCV-74-2, and opening the refueling water storage tank (RWST) isolation valve FCV-63-1. The water from the RWST is then pumped into the reactor vessel through the normal RHR system return lines and into the refueling cavity through the open reactor vessel. After the water level reaches normal refueling level, the RHR inlet isolation valves are opened, the refueling water storage tank supply valve (FCV-63-1) is closed, and normal RHR from the RCS hot leg is resumed.

Following refueling, the RHR pump(s) are used to drain the refueling cavity to the top of the reactor vessel flange by pumping water from the RCS hot leg 4 to the RWST.

4.1.3. REACTOR STARTUP

At initiation of plant startup, the RCS is in a water solid condition with the pressurizer heaters energized. The RHR system is operating in its normal decay heat removal configuration and is connected to the CVCS via the low pressure letdown line to control reactor pressure. As heatup commences, the RHR system operates in conjunction with the RCS to control temperature and pressure. At approximately 350°F, the RHR system is isolated from the RCS system by closing valves FCV-74-1 and FCV-74-2. The RCS pressure is then controlled by normal letdown and the pressurizer spray and pressurizer heaters.

4.2. SAFETY FUNCTION

4.2.1. EMERGENCY CORE COOLING SYSTEM

During normal power operation and hot standby, the RHR system is aligned for standby operation as part of ECCS (Reference 6). Following ECCS actuation in the injection mode, the residual heat removal pumps take suction from the RWST and deliver borated water to the RCS. These pumps begin to deliver water to the RCS only after the pressure has fallen below the pump shutoff head. When a low level signal is received from the RWST in conjunction with a "S" (safety injection) signal and a high containment sump level signal, the recirculation mode is entered with the RHR pump suction automatically realigned from the RWST to the containment sump. The RHR block valves (FCV-74-3 and FCV-74-21) are automatically closed coincident with the opening of the sump isolation valves (FCV-63-72 and FCV-63-73). In the recirculation mode the water from the sump is passed through the RHR heat exchangers and returned to the reactor vessel through the cold leg injection path. The RHR system can be aligned to provide suction to the high head centrifugal charging pumps of the CVCS or the safety injection pumps of the Safety Injection System (SIS) during the recirculation phase.

4.2.2. RHR CONTAINMENT SPRAY SYSTEM

The RHR system can be aligned as a containment spray system following a LOCA if conditions require it (reference 7). These conditions are: the containment pressure must exceed 9.5 psig; at least one hour has elapsed since the beginning of the accident; RHR suction is aligned to the containment sump; and at least one component cooling water pump and one safety injection pump are running. In this configuration, water is drawn from the containment sump by the RHR pumps, cooled by the RHR heat exchangers, sprayed through the RHR spray headers and drains back to the containment sump.

4.3. RHR OVERPRESSURIZATION PROTECTION

The RHR system is designed as a low pressure (600 psig) system that is isolated from the high pressure RCS by two high pressure motor operated isolation valves in series on the inlet line (FCV-74-1 and FCV-74-2) and two series check valves on each of the discharge lines into the RCS (reference 4).

The inlet line to the RHR system is equipped with a pressure relief valve (74-505) sized to relieve the combined flow of the charging pumps at the relief valve set pressure (reference 5). The discharge lines to the RCS are equipped with a pressure relief valve (63-627, 63-628, 63-637) to relieve the maximum possible back-leakage through the valves separating the RHR system from the RCS. These relief valves are part of the ECCS.

The inlet isolation valves, FCV-74-1 and FCV-74-2, are normally closed and are only opened for residual heat removal after reactor coolant system pressure is reduced to approximately 380 psig and the RWST suction valve (FCV-63-1) and containment sump isolation valve (FCV-63-72) are fully closed.

4.3.1. RHR Autoclosure Interlock

The RHR autoclosure interlock (ACI) was installed to prevent overpressurization of the RHR system which could lead to reactor coolant being discharged outside containment through a break in the low pressure system. The ACI will automatically close the RHR inlet isolation valves on RCS pressure greater than 700 psig. The RHR system is vulnerable to this type of overpressurization during startup or during cooldown while the reactor vessel is closed. A detailed description of the overpressurization transients is presented in Section 6.2 'Low Temperature Overpressurization Events.'

While the RHR ACI is designed to protect the RHR system, it is also a contributor to the unavailability of the RHR system due to the probability of its spurious actuation which would isolate the RHR system and could lead to a loss of decay heat removal transient. A detailed description of this contribution is presented in Section 6.3 'RHR Unavailability Analysis.'

4.3.2. Proposed Changes to the RHR Autoclosure Interlock

The proposed change described in the WCAP 11736 analysis and in SQ-DCR-3365 (reference 9) removes the autoclosure interlock feature from the RHR suction isolation valves, FCV-74-1 and FCV-74-2. With removal of the autoclosure interlock feature, these valves will not automatically close on increasing pressure greater than 700 psig. However as stated in the DCR-3365 and in WCAP 11736 Section 6.1, an alarm will be added, for each suction isolation valve, that actuates in the main control room given a "VALVE NOT FULLY CLOSED" signal in conjunction with a "RCS PRESSURE HIGH" signal. The intent of the alarms is to alert the operator that one or both of the suction isolation valves is not closed with RCS pressure greater than 700 psig. The alarm must meet the same design criteria as other safety-related function control room annunciation. Valve position indication to the alarm must be provided from the valve stem mounted limit switches and power must not be affected by power lockout to the valve. The proposed changes only affect the autoclosure interlock feature; and the valve open permissive circuit will not be affected.

In addition to changing the valves' interlock circuitry, the Sequoyah plant operating procedures governing reactor cooldown and startup must be modified to reflect the appropriate recognition and response to the new added alarms. The procedures should be revised to direct the operator to take the necessary action to close the open suction isolation valve(s) following alarm actuation, or if this is not possible, to take appropriate action to prevent RHR overpressurization.

The removal of the ACI will require changes in TVA's documentation of Sequoyah Nuclear Plant. A partial list of documents which will need revising includes the: Design Criteria, Final Safety Analysis Report, Technical Specifications, Surveillance Instructions, Maintenance Instructions, TVA Drawings and other sources. The design change process will identify the specific documents to be revised.

5.0. COMPARISON BETWEEN THE SEQUOYAH AND SALEM RHR SYSTEMS

5.1. System Configuration and Mechanical Components

Both Salem 1 and Sequoyah have similar vintage RHR systems consisting of two separate RHR trains of equal capacity, each independently capable of meeting the safety analysis design basis. Each train consists of one heat exchanger, one motor driven pump and associated piping, valves and instrumentation necessary for operational control. The inlet line to each train of the RHRS is connected to a common letdown line from the hot leg of reactor cooling loop (loop 4 for SQN and loop 1 for Salem), while return lines are connected to the cold legs of all four reactor cooling loops via the SIS accumulator discharge lines downstream of the cross-connect (for SQN-train A discharges to loops 2 and 3, train B discharges to loops 1 and 4. For Salem, train A discharges to loops 1 and 3, train B discharges to loops 2 and 4).

The RHR system for Salem 1 and Sequoyah are normally isolated from the RCS by two, series, MOVs, suction isolation valves in the single letdown line connecting the low pressure RHRS to the high pressure RCS. The RHRS discharge lines are isolated from the RCS by two check valves in series for each line. The RHRS suction isolation valves, the inlet line pressure relief valve, the return lines to the RCS cold legs downstream of the appropriate valves and the hot leg injection lines are located inside containment while the remainder of the system is located outside containment. Based on this evaluation, there are no significant differences between the system configuration and mechanical components of Salem 1 and Sequoyah.

5.2 Autoclosure Interlock Logic and Control Circuitry

Salem 1 and Sequoyah use similar designs to protect the RHR system from overpressurization. The first protective feature is the decreasing low pressure permissive interlock for opening the valves (below 380 psig); the second feature is the passive relief valve located on the RHR inlet piping within the containment which maintains the system pressure below the design pressure of the RHRS for most overpressure events, and the third protective feature for both plants is the RHR autoclosure interlock which closes both inlet isolation valves by the appropriate train (A for train A valve and B for train B valve) instrumentation that is set above the RHR design pressure. This control logic and control circuitry is typical for both SQN and Salem.

In addition to the above scheme, the SQN inlet isolation valves (FCV-74-1 and FCV-74-2) have the power administratively removed once the valves are closed (breaker locked in trip position). Since the SQN valves have backup controls, pressure switches sensing RCS pressure above 700 psig automatically close the valves in the backup control mode. In addition, the SQN valves have their local control switches disconnected to preclude inadvertent operation due to the effects of a LOCA (reference 10).

In summary, there are no significant differences between the design and configuration, mechanical and electrical, of the RHR overpressure protection features for Salem 1 and Sequoyah. Therefore,the use of the WCAP analysis performed for deletion of the RHR autoclosure interlock is reasonable for SQN.

6.0. ANALYSES

WCAP 11736 (reference 3) presents a thorough analysis of the RHR overpressurization events and system unavailability which would be affected by the deletion of the autoclosure interlock. The analyses sections of this calculation are a review of those analyses for Salem 1 with applicable Sequoyah information included. For further information on the analyses, the WCAP should be consulted.

6.1. Event V Analysis

An interfacing LOCA, referred to as Event V in Wash-1400, (reference 11) is a breach of the high pressure RCS boundary at an interface with a low pressure system, in this case the RHR system. This event has the potential to cause a non-isolatable LOCA outside containment. It is assumed to occur if the RHR suction inlet valves (FCV-74-1 and FCV-74-2) fail open when the reactor is at normal operating pressure (2250 psia). Since the RHR system is designed for a lower pressure (600 psig), the result is overpressurization of the RHR system with gross failure of the RHR boundary and an uncontrolled LOCA outside containment.

In the analysis performed in WCAP 11736 for Salem 1 several failure combinations are considered which would result in both inlet isolation valves being open. These failure modes are defined as : 1) rupture of the two series suction valves and 2) failure to have closed one suction valve or spurious opening of the valve and subsequent rupture of the other valve. Failure to close both inlet valves was not considered because the condition would become apparent as the RCS increased in pressure (see section 6.2.1.3) and corrective action would be taken thus precluding system overpressurization.

The general equation used to calculate the frequency of an Event V (F(VSEQ)) with the above failure modes is:

$$F(VSEQ) = X\,[(f_2)\,Q(V_1) + (f_1)\,Q(V_2) + (f_2)\,Q(V_1R)]$$

where

$F(VSEQ)$ = the frequency of an Event V sequence

X = the number of RHR suction lines (1 for Salem & Sequoyah)

(f_2) = failure rate per year of RCS valve due to rupture

(f_1) = failure rate per year of RHR valve due to rupture

$Q(V_1)$ = probability that the RHR valve is open

$Q(V_2)$ = probability that the RCS valve is open

$Q(V_1R)$ = probability of rupture of RHR valve

Fault trees were developed to determine the probability that one of the inlet isolation valves is open at power conditions ($Q(V_1)$ & $Q(V_2)$). These fault trees are shown in Appendix B of WCAP 11736 (reference 3)

Two fault trees were developed to determine the probability that the valves were open for this sequence. One with ACI in place and the second with the ACI removal changes made.

The scenarios examined in the fault tree for the case with the ACI are: 1) the operator fails to remove power to the valve by racking out the circuit breaker and subsequently the valve spuriously opens during power operation or 2a) the operator fails to close the valve during startup (or the operator attempts to close the valve but due to some component failure, the valve does not close) and 2b) the autoclosure interlock fails to perform its function and does not close the valve and the operator fails to detect that the valve is not closed during startup or power operation.

For the case with the autoclosure interlock removed, the scenarios developed in the fault trees are: 1) the operator fails to remove power to the valve by racking out the circuit breaker and subsequently the valve opens during power operation (note: this is identical to scenario 1 above) or 2a) the operator fails to close the valve during startup (or the operator attempts to open the valve but it does not close) (note: identical to scenario 2a above) and 2b) the operator fails to detect that the valve is not closed and then close it when the overpressure alarm is received (or the alarm fails to operate).

Essentially the difference between these two fault trees is scenario 2b where the autoclosure interlock is replaced by a control room alarm which must be detected by the operator(s) who, then, must close the inlet isolation valves. These fault trees are quantified and the probability of the suction valves being open during operation is 1.48 E-04 with the autoclosure interlock and 1.10 E-06 without the autoclosure interlock. The fault trees indicate that the alarm circuitry with the required operator action are less likely than the autoclosure interlock to fail to close the inlet suction valves.

These probabilities are substituted into the general equation for Event V and quantified for the frequency of occurrence with and without the autoclosure interlock. The frequencies are: 8.35 E-07/year with ACI and 5.77 E-07/year without ACI. The frequency of Event V decreases by approximately 31% as a result of removing the ACI.

6.2. Low Temperature Overpressurization Events

A number of events have occurred during startup or shutdown (low temperature events) which have the potential of overpressurizing the RHR system. The effect of these transients will be altered by the removal of the autoclosure interlock. WCAP 11736 examines these transients and analyzes the effect of ACI removal for Salem 1. Sequoyah 1 & 2 are expected to respond the same as Salem 1 due to the similarity in design of the two plants.

The overpressurization analysis uses event trees to model the mitigating actions (both manual and automatic) following the occurrence of low temperature overpressurization events.

Two general categories of low temperature overpressurization events have occurred in the industry and are analyzed: 1) events that affect the the balance between mass addition and mass letdown; and 2) events that affect the heat input/removal balance.

6.2.1. Heat Input Transients

6.2.1.1 Premature Opening of the RHR Suction Isolation Valves

If the suction isolation valves (FCV-74-1 & FCV-74-2) were opened prior to reducing the RCS pressure below the RHR design pressure, overpressurization of the RHR system could occur. However these valves are equipped with an open permissive interlock which prevents the opening of these valves above RHR design pressure and their electrical power is procedurely locked out during plant heatup from hot shutdown to hot standby (reference 13 & 14). The power to these valves is not restored until normal cooldown when placing RHR decay heat removal in service and RCS pressure is below 380 psig (reference 12). Because of these features, i.e., the open permissive interlock and the power lockout, this type of transient is not considered likely at Sequoyah and is not analyzed. R2

WCAP 11736 states that the motor operators on these valves at Salem 1 are sized such that the valve does not have sufficient torque to open against RCS pressure. TVA believes that the SQN valves have sufficient torque to open against full RCS pressure. However, the capability of the valves to open against RCS pressure has no impact on this analysis as the open permissive and power lockout would sufficiently preclude this transient.

6.2.1.2 Inadvertent Control Rod Withdrawal During Shutdown

The withdrawal of one or more banks of control rods during RHR operation would result in a power excursion in the reactor and would be terminated by automatic features of the Reactor Protection System. The RHR relief valve (74-505) would help mitigate the transient and the RHR system would not pressurize above 110% of the RHR design pressure or the ACI setpoint. The removal of the ACI would not have an impact on this transient, and, therefore, it was not analyzed.

6.2.1.3 Failure to Isolate RHR System During Startup

During plant startup, the RCS is water solid and the pressurizer heaters are energized. The RHR suction isolation valves are open and the RHR pumps are discharging the excess reactor coolant to the CVCS. After the reactor coolant pumps are started, pressure is controlled by the RHR system until the pressurizer bubble is formed. Following bubble formation, the RHR system is isolated from the RCS by closing the suction isolation valves (reference 5).

If the RHR system is not isolated as directed in the procedures, as the RCS pressure increases above 450 psig, the RHR relief valve (74-505) would discharge into the pressurizer relief tank (PRT) slowing the increase in pressure and sounding an alarm on increasing tank level. This transient is not considered to be a credible event past this point and is not analyzed in this calculation or WCAP 11736. Note: if one of the suction relief valves were left open, this event would fall under the Event V analysis presented earlier.

6.2.1.4 Inadvertent Pressurizer Heater Actuation

If the pressurizer heaters are inadvertently energized during shutdown while the reactor is closed and the RHR system is operating, pressure will increase in the RCS and RHR system until the RHR relief valves open and discharge into the PRT, sounding an alarm. If the relief valves fail to open, the RHR system would overpressurize until the heaters are automatically shut off at 10% pressurizer volume.

This event would be slow developing and annunciators in the control room would alert the operator of PRT level increase and instrumentation would inform the operators of increasing reactor pressure. Due to the pace of this transient and indication in the control room, the operators should recognize this transient and mitigate it before the autoclosure interlock setpoint is reached. This transient has not happened at a Westinghouse plant and is not analyzed in this calculation or WCAP 11736.

6.2.1.5 Startup of an Inactive Reactor Coolant Pump

During the cooldown of the reactor, the reactor coolant pumps are stopped when the reactor coolant temperature is below 160°F and the RHR heat exchangers are used to continue lowering the coolant temperature. Since the flow through the steam generators stops when the reactor coolant pumps are stopped, the reactor coolant in the steam generators may remain at a temperature greater than the RCS temperature since there is little circulation through the steam generators. If a reactor coolant pump is started, the sudden heat input into the reactor coolant from the steam generators would cause a rapid increase in reactor coolant temperature.

Another transient caused by the startup of the reactor coolant pump would occur if a reactor coolant pump was stopped during heatup while the RHR system was in operation, but the charging and seal injection water continued in service. This water would collect in the vertical pipe loop below the reactor coolant pumps. When the inactive reactor coolant pump was started, this water would be injected into the reactor, expand as the density decreased and cause a pressure increase in the RCS and RHR systems. Depending on initial RCS pressure, this increase could overpressurize the RHR system. The startup of an inactive reactor coolant pump transients are considered in Section 6.2.1.7 " Heat Input Transient Analysis."

6.2.1.6 Loss of RHR Cooling Train

An increase in temperature and pressure would result due to loss of one of the two RHR cooling trains during the early stages of plant cooldown, when heat generation from the reactor core exceeds the heat removal capacity of the remaining train of the RHR system. During this phase of cooldown, the operators are closely monitoring the RCS parameters and would mitigate this transient before the RHR system exceeded design pressure. This transient is not analyzed further in this calculation or WCAP 11736.

6.2.1.7 Heat Input Transient Analysis

The heat input transient with the potential for the greatest overpressurization of the RHR system is the startup of an inactive reactor coolant pump with higher temperature coolant residing in the steam generator. WCAP 11736 references another Westinghouse analysis, WCAP 10529, which indicates that following startup of a reactor coolant pump, the peak pressure change of approximately 1500 psi would occur in roughly 90 seconds without relief valve actuation. Because the RHR suction inlet valves have a two minute closing time, the RHR system would be subjected to high pressure before the valves could close which could lead to an interfacing LOCA. The low temperature overpressurization system (LTOPS) is designed to prevent this type of RCS pressure surge by opening the pressurizer PORV. Both the RHR relief valve and the low temperature overpressurization system would have to fail in order for this event to occur and the probability of both these systems failing is small.

The next most severe heat input transients are loss of an RHR train, reactor coolant pump startup with injection of cold seal water, or actuation of the pressurizer heaters. These transients evolve quickly but would not raise the RCS pressure above 450 psig. The low temperature overpressurization system and RHR relief valve would be used to mitigate these transients. Since the RHR autoclosure interlock setpoint would not be reached, the ACI would not be involved in mitigating these transients.

Therefore, the removal of the RHR autoclosure interlock will not have an effect on these heat input transients. In the case of the reactor coolant pump startup, the low temperature overpressurization system works to limit the pressure surge or RHR system overpressurizes before the ACI has time to function. For the other heat input transients the RHR relief valve prevents the RHR pressure from reaching the ACI setpoint.

6.2.2. Mass Input Transients

6.2.2.1 Opening Of Accumulator Discharge Isolation Valve

Plant procedures require that the accumulator discharge valves be closed and de-energized during plant cooldown. If these valves were to open, water would be forced into the reactor coolant system causing a pressure transient in the RHR system. The peak pressure reached during this transient would be between the initial RCS pressure and the accumulator pressure (700 psig). An event tree was not constructed for this transient because the peak pressure would be below the ACI setpoint.

6.2.2.2 Letdown Isolation

During cold shutdown, a letdown path is established through the RHR system to control pressure in the RCS. If this letdown path is lost through: 1) closure of the letdown control valve, 2) isolation of the RHR/CVCS crossover, or 3) closure of the RHR inlet isolation valves, pressure control is lost and the pressure transient must be controlled by the RHR relief valve or the low temperature overpressurization system. If the inlet isolation valves close, the use of the RHR relief valve is lost. This transient is analyzed in Sections 6.2.2.4.1 and 6.2.2.4.2

6.2.2.3 Charging/Safety Injection Pump Actuation

When the reactor vessel is water solid during cold shutdown, the safety injection signal is blocked to prevent high pressure injection by the high head safety injection pumps or the charging pumps. The inadvertent actuation of one of these pumps when the RCS is water solid without an increase in letdown would result in a pressure transient. This transient is analyzed in Section 6.2.2.4.3

6.2.2.4 Mass Input Transient Analysis

Event trees were constructed in the WCAP analysis to determine the consequences of these mass input transients. The safety functions which were questioned for transient mitigation, i.e. the top events were: 1) mass input initiating event, 2) RHR isolated, 3) RHR relief valves lift, 4) low temperature overpressurization system works, 5a) RHR inlet isolation valves automatically close (present design), 5b) operator closes RHR inlet isolation valves (proposed ACI deletion changes), 6) operator stops safety injection or charging pump 7) operator opens a PORV, 8) RHR relief valve reseats, 9) pressurizer PORV reseats. The success criteria for each of these top events was determined and the failure probability was calculated. Consequence categories were determined for the initiating events, given that top event failure(s) did not prevent overpressurization of the RHR system.

6.2.2.4.1 Letdown Isolation Analysis--Loss of CVCS Letdown

For this event, it was assumed that one charging pump was operating at its maximum flow rate and only one RHR relief valve or one PORV must operate to mitigate this transient. The initiating event was loss of letdown by 1) closure of the letdown control valve or 2) isolation of the RHR/CVCS crossover path. Two event trees were constructed, with and without the proposed ACI deletion changes, and the trees quantified. The results showed that with the proposed ACI changes there was a slight decrease in the "MSCI" consequence category and that there is an increase in the "HOPV" category from 5.66E-15/shutdown year to 1.49E-11/shutdown year.

The "MSCI" category is isolation of the RHR system with the running charging pump not stopped; pressure control is performed by the low temperature overpressurization system having opened a PORV. There is a loss of coolant and the operator must take action to stop the running pump and then check that the PORV reseated completely.

The "HOPV" consequence category is a high overpressure with the RHR system open to the RCS. The running charging pump is not stopped and no relief valves have actuated. The RHR system integrity is lost and an interfacing LOCA has occurred. The operator must attempt to isolate the RHR system.

The "HOPV" is a severe consequence accident with reactor coolant being released outside containment, however the frequency of 1.49E-11/shutdown year is very remote and thus the overall increase in the frequency of an interfacing LOCA for this initiating event as a result of making the ACI deletion changes is not significant.

6.2.2.4.2 Letdown Isolation-- RHR Isolated Analysis

The initiating event for this transient is the inadvertent closure of the RHR inlet isolation valve(s). In this case, if the autoclosure interlock were removed, the initiator frequency would be reduced. WCAP 11736 assumes the frequency would be reduced by one half. The result of reducing the initiating event frequency decreases the challenges to the mitigating safety systems and reduces the frequencies of all the adverse consequence categories by a total of 5.89E-02/shutdown year which is a significant reduction.

6.2.2.4.3 Charging/Safety Injection Pump Actuation Analysis

In this event, it is assumed that one charging pump and one safety injection pump are started. The success criteria was determined to be two PORVs or one PORV and one RHR relief valve. The event tree was constructed and quantified for an RHR system with and without the ACI changes. There was a total increase in the frequencies of the adverse consequences for this event of 2.4E-10/shutdown year as a result of the ACI deletion changes. This increase, even though it includes the most severe consequence of an interfacing LOCA outside containment, does not represent a significant increase due to its low (2.4E-10/shutdown year) frequency.

6.2.3. Summary of Overpressurization Transients Analysis

The Overpressurization analysis considered the Event V sequence where the RHR inlet isolation valves fail open during power operation which allows high pressure reactor coolant to overpressurize the RHR system leading to an interfacing LOCA. The results of the Event V analysis indicate that making the ACI deletion change reduces the frequency of this event.

The overpressurization analysis also considered transients that occur during reactor cooldown and startup. These were divided into heat input and mass input transients. The deletion of the ACI was not considered to impact the heat input transients because they either happen so fast that the inlet valves can not close fast enough to mitigate the transient even if the ACI were installed, or the transient did not increase RCS pressure to the ACI setpoint.

The mass input transients were analyzed by constructing event trees to determine the change in frequency of the consequence categories for several mass input initiating events. There was a slight increase in some adverse consequence categories as a result of making the ACI deletion changes but this increase was probabilistically insignificant compared to the decrease caused by reducing the initiating event frequency of the spurious actuation of the RHR inlet isolation valves.

6.3 RHR Unavailability Analysis

The RHR system was analyzed to determine its unavailability due to the spurious closure of the inlet isolation valves (FCV-74-1 & FCV-74-2). Separate fault trees were developed in WCAP 11736 to determine the system unavailability for startup of the RHR system, for short term cooling (72 hours), and long term cooling (6 weeks). The short term and long term cooling fault trees were constructed both with and without the autoclosure of the inlet isolation valves to show the change in system unavailability due to removal of the autoclosure interlock.

6.3.1 Failure to Initiate RHR

A single fault tree was developed for this phase of RHR operation to identify those faults that could impact the startup and first two hours of operation of the RHR system. The autoclosure interlock does not play a role in RHR startup, rather the inlet valves' open permissive prevents the valve opening until RCS pressure is below 380 psig and this feature is not being modified by the proposed ACI changes.

The fault tree for Salem was developed from the Salem operating procedures. The Sequoyah procedures for RHR startup, SQN SOI-74.1, Section A (reference 12), are functionally similar to the Salem procedure described in the WCAP analysis and the fault trees are therefore applicable.

The dominant contributors to RHR startup were operator errors of failure to energize control boards for valves which had been de-energized for power operation and failure to open other valves required for RHR operation.

6.3.2 Failure of Short Term Cooling

Both pump trains of RHR are required for short term cooling due to the decay heat generation immediately following shutdown. Failure to supply cooling flow from two RHR pump trains into three of four RCS cold legs constitutes RHR system failure. Two fault trees were developed to determine the impact of the removal of the ACI.

The dominant failure contributor for loss of short term cooling for both fault trees (with and without ACI) was the failure of one of the two RHR pumps to run for 72 hours. For the Salem plant, the failure probability for short term cooling was reduced 13 percent with the deletion of the ACI. The reduction in RHR short term cooling unavailability for Sequoyah would be similar following deletion of the ACI.

6.3.3 Failure of Long Term Cooling

Long term cooling requires cooling flow injection into any two RCS cold legs from two of four RHR trains for 6 weeks. This fault tree primarily features spurious closing of various valves over the six week period and failure of the first pump with failure of the second pump to start and run.

The dominant failure contributor for Salem during long term cooling was RHR pump failure. For the fault tree with ACI present, the other top contributors involve the single failure of a component associated with the ACI such as the power supply, signal comparator or pressure transmitter which causes spurious closure of one of the RHR inlet isolation valves. The deletion of the ACI resulted in a 67 percent reduction in system unavailability for Salem. The Sequoyah long term cooling unavailability would be reduced by a similar amount following removal of the ACI.

7.0. CONCLUSION

This calculation examined the impact of the removal of the autoclosure interlock (ACI) feature on the inlet isolation valves (FCV-74-1 & FCV-74-2) of the RHR system for Sequoyah 1 & 2. This calculation referenced WCAP 11736 " Residual Heat Removal System Autoclosure Interlock Removal Report for the Westinghouse Owners Group" and is a review of that report and a comparison between the reference plant, Salem 1, and Sequoyah. The two plants have very similar RHR system configuration, control logic, and design for the autoclosure interlock feature. By virtue of this similarity, the analysis for Salem is considered valid for Sequoyah.

The overpressurization transients which have the potential for an uncontrolled loss of coolant outside containment were examined to determine the effect of ACI deletion. The Event V sequence, heat input and mass input events were analyzed. A reduction in event frequency (a net positive result) was the result of removing the ACI for these transients.

The RHR system unavailability to remove decay heat from the reactor core was calculated with fault trees constructed both with and without ACI. The analysis showed that the removal of the ACI resulted in an improvement in RHR availability.

Therefore, it is the conclusion of this calculation that making the design, Technical Specification, and procedure changes associated with the removal of the autoclosure interlock as outlined in this calculation and WCAP 11736 will reduce the frequency of an RHR overpressurization event and increase the RHR system availability at Sequoyah.

8.0 REFERENCES

1. Quality Information Request, QIR SQPSQN89330 R0, RIMS NO. B25'890828002.

2. NRC Generic Letter NO.88-17, " Loss of Decay Heat Removal", October 17,1988.

3. WCAP 11736, " Residual Heat Removal System Autoclosure Interlock Removal Report For The Westinghouse Owners Group", Volumes I & II, Rims No. B26 '88 0714 364 & B26 '88 0714 365.

4. Sequoyah Design Criteria, SQN-DC-V-27.6 R3, " Residual Heat Removal System".

5. Sequoyah FSAR Section 5.5.7 R6, "Residual Heat Removal System".

6. Sequoyah FSAR Section 6.3 R6, "Emergency Core Cooling System".

7. Sequoyah Emergency Instruction E-1 R7, "Loss of Reactor or Secondary Coolant, page 12.

8. Sequoyah FSAR Section 7.6.2 R6, "Residual Heat Removal Isolation Valves".

9. Sequoyah Design Change Request, SQ-DCR-3365.

10. TVA Sequoyah Drawings, 45N779-11 RV, 2-47W611-74-1 R0, 1,2-45N765-13 R0, 45W657-32 RG, 45N779-12 RY, 1-47W611-74-1 R0, 47W610-74-1 RN, 1,2-47W810-1 R6.

11. WASH 1400, NUREG 75/014, "Reactor Safety Study, An Assessment Of Accident Risks In U.S. Commercial Nuclear Power Plants", October 1975.

12. Sequoyah System Operating Instruction, SOI-74.1 R 51, "Residual Heat Removal System".

13. Sequoyah General Operating Instruction, GOI-1 Rev 85, "Plant Startup From Cold Shutdown to Hot Standby" R2

14. Sequoyah System Operating Instruction, SOI 63.1 Rev 59, "Safety Injection System"

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2

EVALUATION OF REMOVAL OF RESIDUAL HEAT

REMOVAL AUTOCLOSURE INTERLOCK

(B25 900310 010)

QA Record

B25 '90 0310 010

Westinghouse Electric Corporation
Energy Systems
Box 355
Pittsburgh Pennsylvania 15230-0355

Mr. P. G. Trudel
Project Engineer
Tennessee Valley Authority
PO Box 2000
Soddy Daisy, TN 37379

TVA-90-653
March 8, 1990
Contract #
85P62-965930

Tennessee Valley Authority
Sequoyah Nuclear Plant Unit 1
Residual Heat Removal Autoclosure Interlock
Removal Report

Dear Mr. Trudel:

Attached for your information and use is the subject report. An advance copy was hand carried on 3/8/90.

Please call us if there are questions.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

B. J. Garry, Manager
TVA Sequoyah Project
Customer Projects Department

cc: P. G. Davis
D. M. LaFever

RIMS, ET SLE 26P-K - w/attachments

TENNESSEE VALLEY AUTHORITY

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2

EVALUATION OF REMOVAL OF RESIDUAL HEAT REMOVAL AUTOCLOSURE INTERLOCK

March 1990

Prepared by:

N.B. Closky
Risk Management and Operations Improvement

Approved by:

K.J. Vavrek
Risk Management and Operations Improvement
Westinghouse Electric Corporation

TENNESSEE VALLEY AUTHORITY

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2

EVALUATION OF REMOVAL OF RESIDUAL HEAT REMOVAL AUTOCLOSURE INTERLOCK

SUMMARY

The purpose of this report is to document the qualitative evaluation of the deletion of the Residual Heat Removal System suction valves' autoclosure interlock (ACI) and the implementation of a control room alarm for the Tennessee Valley Authority (TVA) Sequoyah Nuclear Plant Units 1 and 2. The evaluation provides a comparison of the Sequoyah configuration with that in WCAP-11736-A, "Residual Heat Removal System Autoclosure Interlock Removal Report for the Westinghouse Owners Group," for Salem (the reference plant for Sequoyah).

WCAP-11736-A provides the analyses which justify deletion of the autoclosure interlock associated with the Residual Heat Removal System (RHRS) suction/isolation valves. A probabilistic analyses was used to demonstrate that deletion of the autoclosure interlock and the addition of a control room alarm results in a net safety benefit. The safety evaluation examined the effect of ACI removal on interfacing systems LOCA potential, RHRS availability, and low temperature overpressurization protection.

The estimated results for Sequoyah based on a comparison to Salem are shown below:

	With ACI	Without ACI	Percent Change*
Interfacing System LOCA			
F(VSEQ)	9.49E-07/year	5.77E-07/year	-39
RHRS Unavailability			
RHR Initiation	3.20E-02	3.20E-02	0
Short Term Cooling	1.63E-02	1.40E-02	-14
Long Term Cooling	4.00E-02	1.20E-02	-70
Overpressurization			**

* (-) - Reduction
(+) - Increase

** - Reduction in some categories and a small increase in other categories

Based on the comparative evaluation between Salem and Sequoyah with regard to the deletion of the autoclosure interlock, the three different areas examined indicate that the results and conclusions for Salem in WCAP-11736-A are not invalidated by the proposed change for Sequoyah. The deletion of the ACI and the inclusion of a control room alarm to warn the operator that one series suction/isolation valve is not fully closed or RHR pressure is above the alarm setpoint is acceptable for Sequoyah.

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2

EVALUATION OF REMOVAL OF RESIDUAL HEAT REMOVAL AUTOCLOSURE INTERLOCK

TENNESSEE VALLEY AUTHORITY

SEQUOYAH UNITS 1 AND 2

EVALUATION OF REMOVAL OF RESIDUAL HEAT REMOVAL AUTOCLOSURE INTERLOCK

1.0 INTRODUCTION AND PURPOSE

The purpose of this report is to document the qualitative evaluation of the deletion of the Residual Heat Removal System suction valves' autoclosure interlock (ACI) and the implementation of a control room alarm for the Tennessee Valley Authority (TVA) Sequoyah Nuclear Plant Units 1 and 2. The evaluation provides a comparison of the Sequoyah configuration with that proposed in WCAP-11736-A, "Residual Heat Removal System Autoclosure Interlock Removal Report for the Westinghouse Owners Group," (Reference 1).

WCAP-11736-A provides the analyses which justify deletion of the autoclosure interlock associated with the Residual Heat Removal System (RHRS) suction/isolation valves for four reference plants (Salem Unit 1, Callaway Unit 1, North Anna Unit 1 and Shearon Harris). A probabilistic analyses was used to demonstrate that deletion of the autoclosure interlock and the addition of a control room alarm to alert the operator if an RHRS suction/isolation valve is not fully closed when RCS pressure is above the alarm setpoint results in a net safety benefit. The probabilistic analysis examined the proposed change based on a safety evaluation of the effect of ACI removal on interfacing systems LOCA potential, RHRS availability, and low temperature overpressurization protection. WCAP-11736-A was submitted to the NRC and a safety evaluation and an acceptance for referencing the WCAP in plant specific submittals was provided in 1989 (Reference 1). The NRC acceptance states that "the licensee should do sufficient PRA and safety analyses to ensure that its plant will not show results that invalidate the conclusions of WCAP-11736-A."

This report provides an evaluation of the Sequoyah plant and TVA's proposed implementation of ACI deletion and installation of the alarm. The intent is to compare the Sequoyah proposed change to that in WCAP-11736-A and to determine if the change invalidates the conclusions in WCAP-11736-A. The determination is based on a qualitative comparison of the probabilistic analyses in WCAP-11736-A and a Sequoyah analyses.

2.0 COMPARISON BETWEEN SEQUOYAH AND SALEM

The Westinghouse Owners Group (WOG) plants participating in WCAP-11736-A were categorized into one of four groups based on similar RHR System configurations and design characteristics in order to minimize the work to be performed by other WOG plants. Sequoyah Units 1 and 2 were categorized in Group 1 in which the reference plant for the group was Salem Unit 1. Thus the Sequoyah plant RHR system configuration and autoclosure interlock circuit are compared to the Salem plant to determine what portions of the probabilistic analyses would be impacted.

2.1 RHR System Configuration

The Salem RHR system configuration is shown in Figure 1. The RHR system takes a suction from the RCS through two motor-operated valves in series. The suction line then splits into two trains of RHR, each containing a pump and heat exchanger. The trains each inject into two cold legs through a series of check valves.

The Sequoyah RHR system configuration is shown in Figure 2. The system configuration is essentially identical to the Salem configuration.

There are no component differences between the Sequoyah and Salem RHR system designs. Because the RHR system designs are identical, the RHR availability analysis which models the RHR system would require only component identification numbers (tag IDs) to be changed.

2.2 Present Autoclosure Interlock Circuitry

The Salem original autoclosure interlock circuitry and motor operated valve control circuitry are shown in Figure 3 logically and Figure 4 physically. When a RHR suction valve is open and RCS pressure is greater than the setpoint (measured by pressure transmitter PT-403 located in the RCS), the RHR suction valve would automatically close through relay 63Y/RCP.

The Sequoyah present motor operated valve circuitry is shown in Figure 5 logically and Figure 6 physically. When a RHR suction valve is open and RCS pressure is greater than the setpoint (measured by pressure transmitter PT-405 located in the RCS), the RHR suction valve would automatically close through relay PB405B. The same principal applies to the other suction valve with pressure transmitter PT-403.

3/4/90

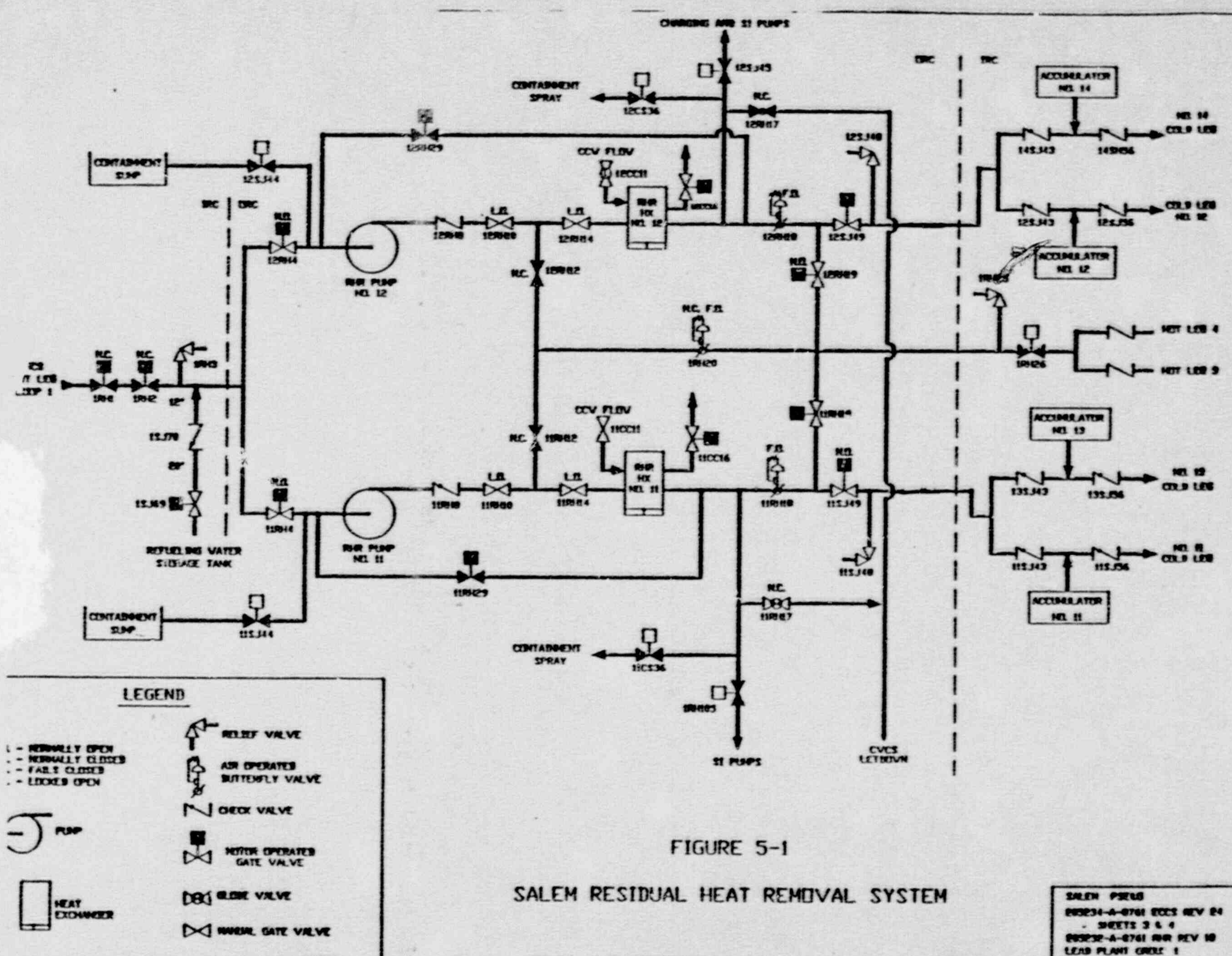


FIGURE 5-1

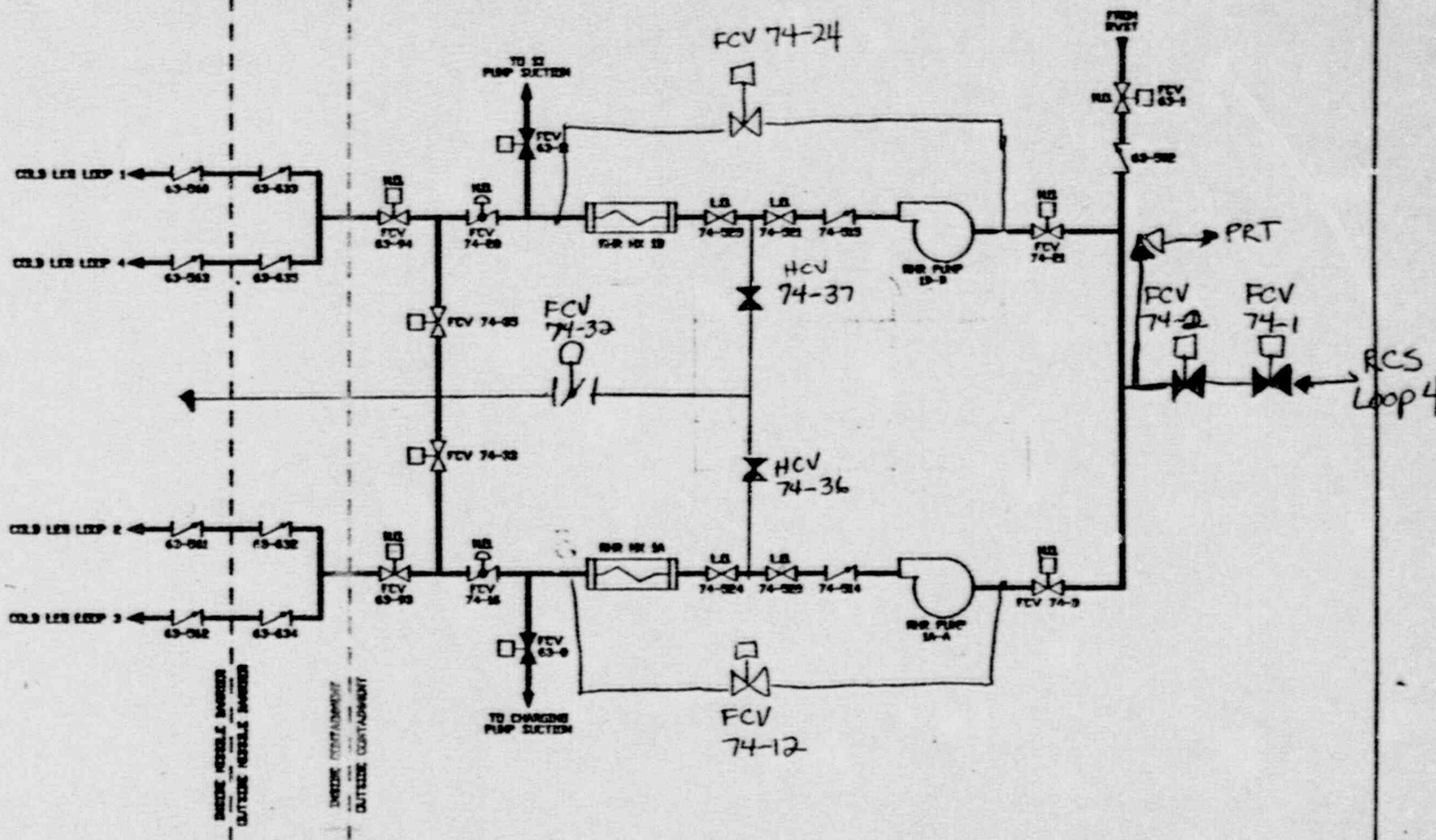
SALEM RESIDUAL HEAT REMOVAL SYSTEM

FIGURE 1

SALEM RHR SYSTEM CONFIGURATION

FIGURE 2

SEQUOYAH RHR SYSTEM CONFIGURATION



REF. DWG 47W810-1

FIGURE 3

SALEM RHR SUCTION VALVE LOGIC DIAGRAM

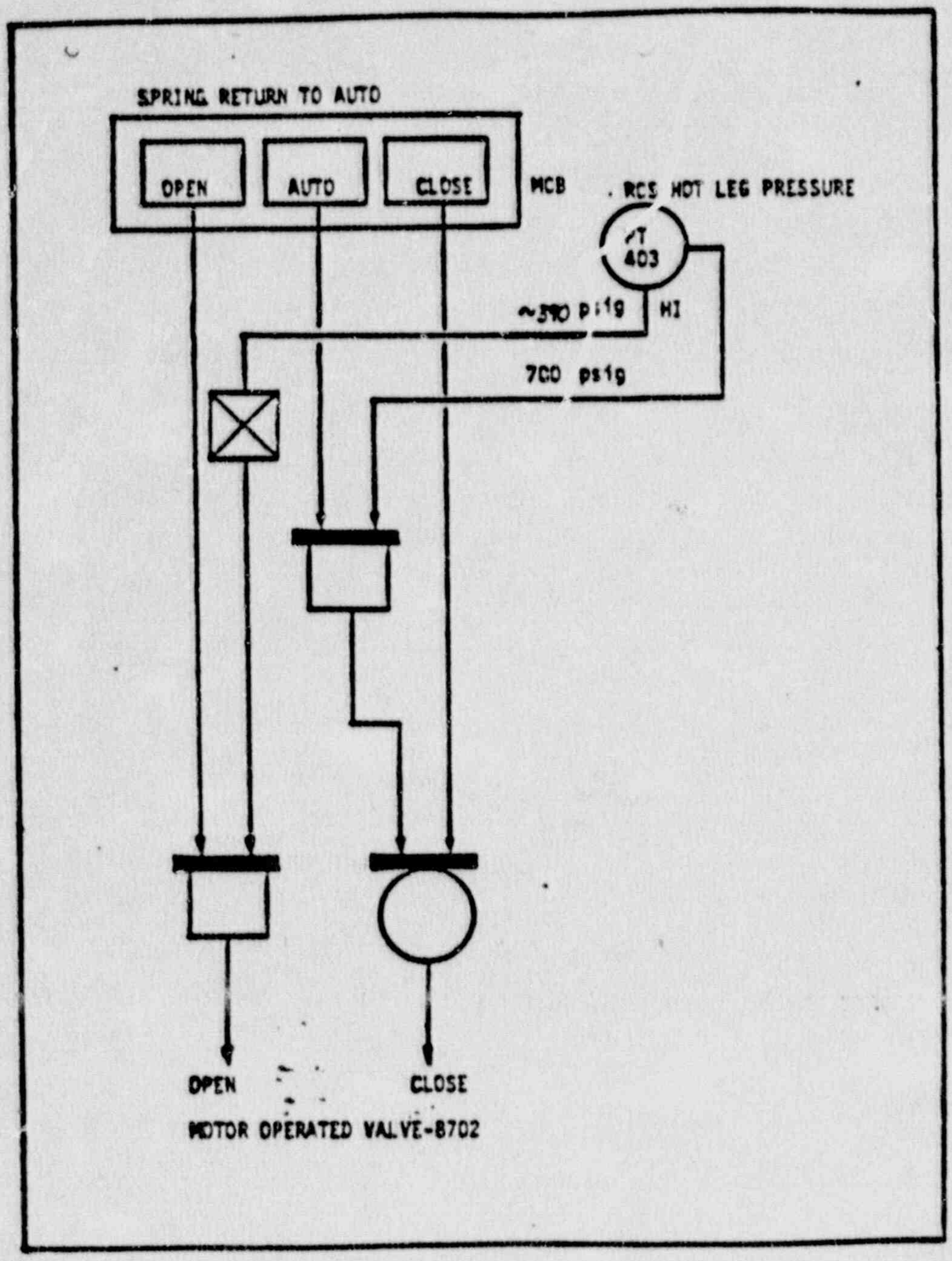


Figure 5-2. Salem Current Interlock-MOV-8702 (1RH-1)

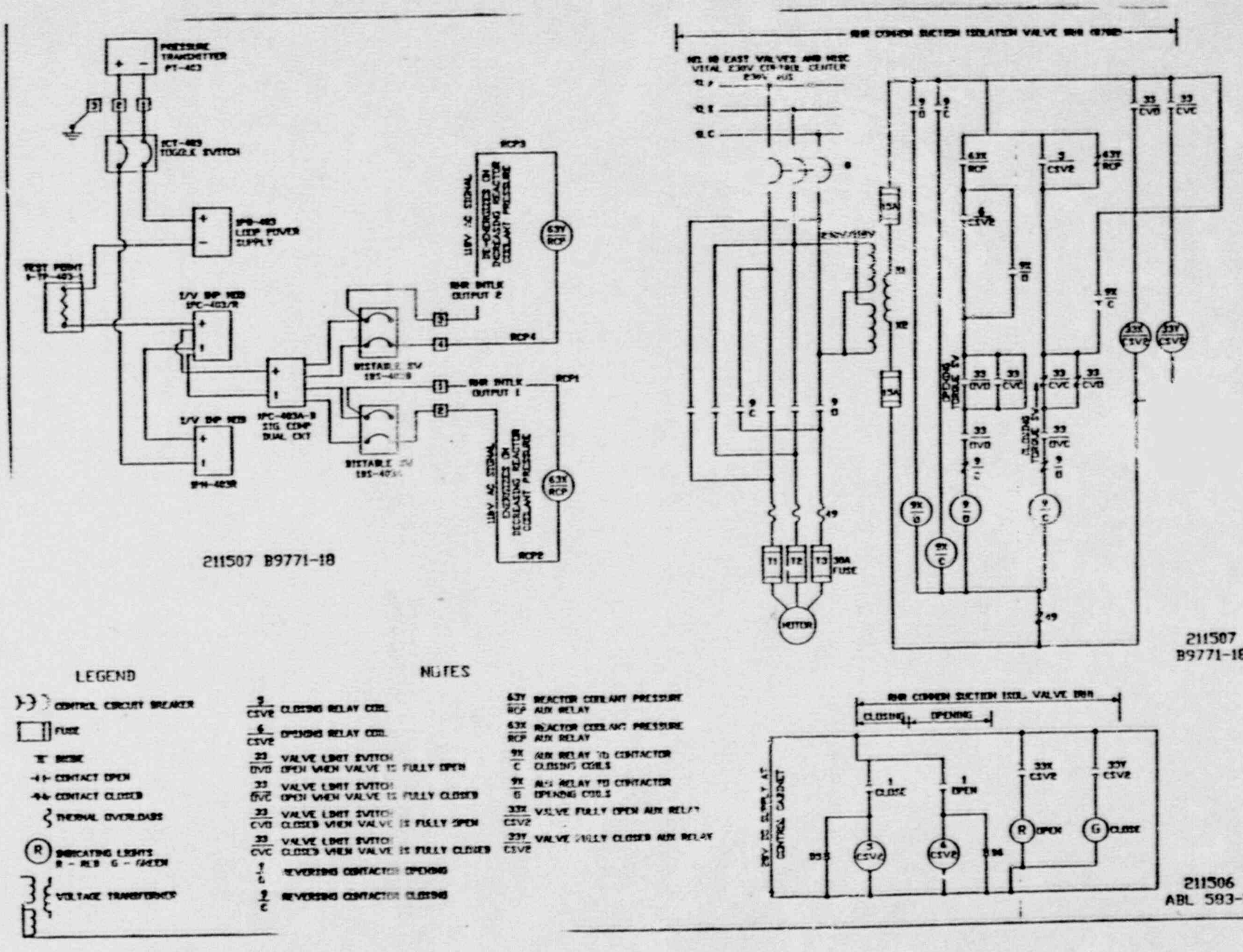
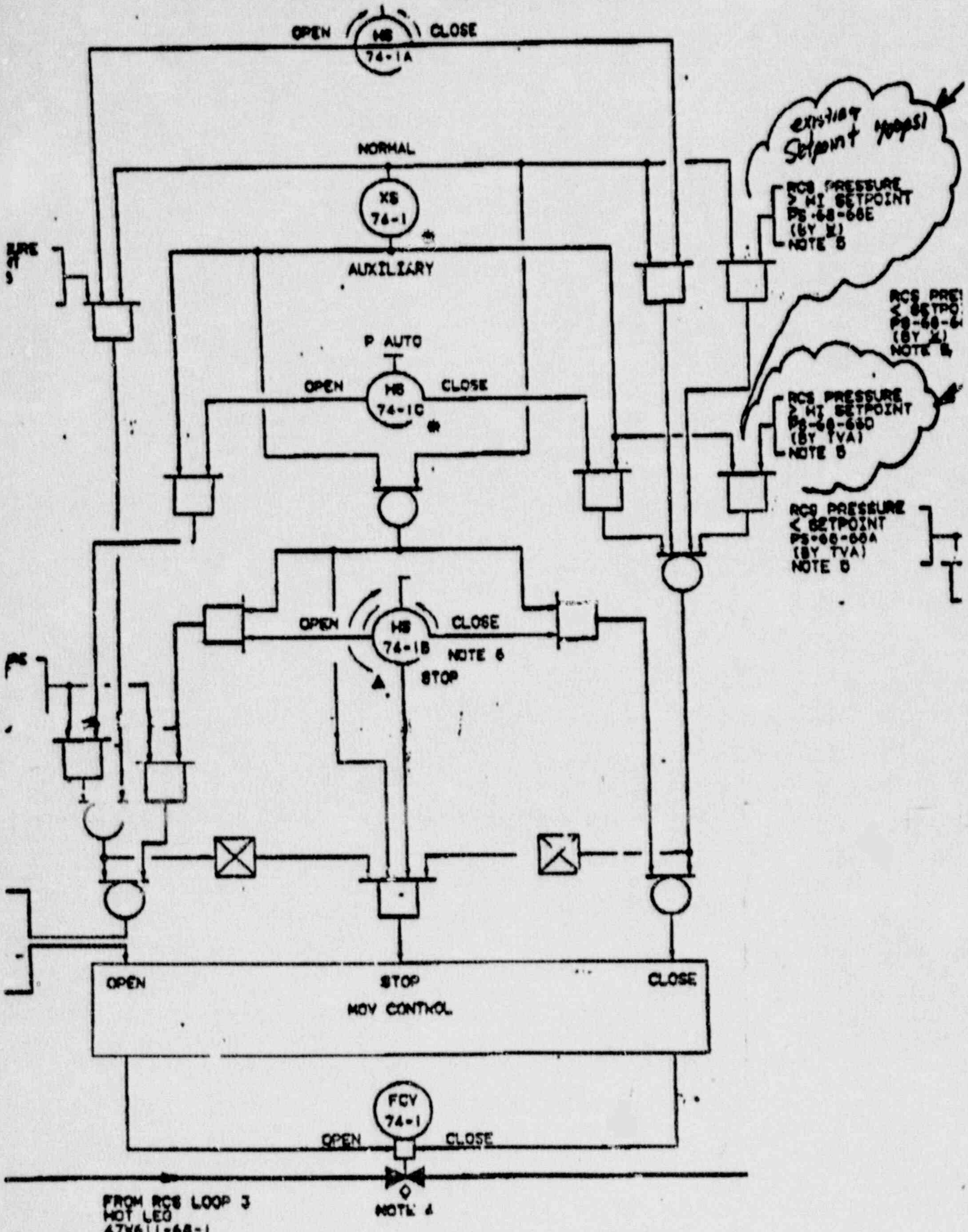


FIGURE 4
SALEM RHR SUCTION VALVE WIRING DIAGRAM

FIGURE 5

SEQUOYAH RHR SUCTION VALVE LOGIC DIAGRAM



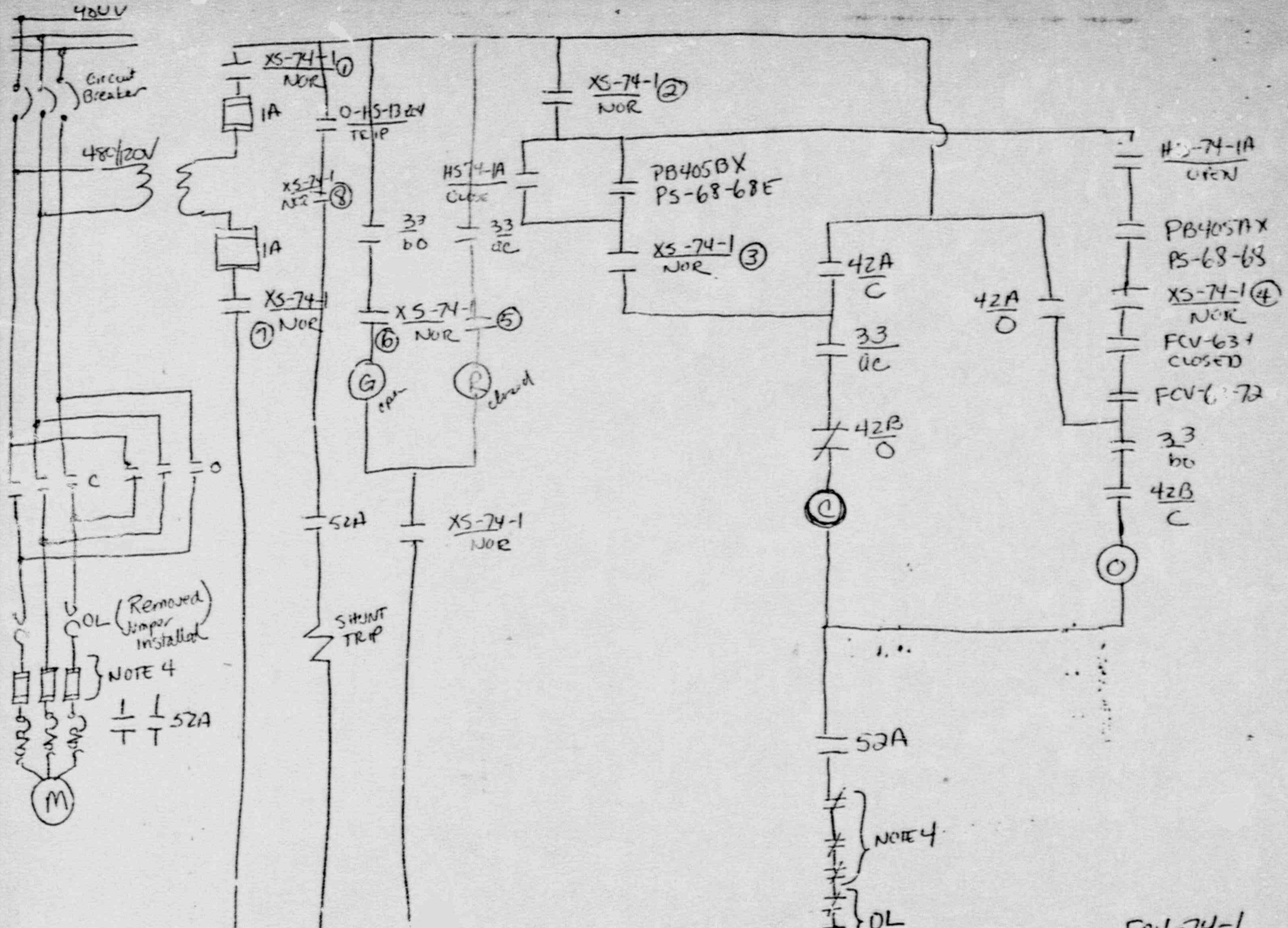
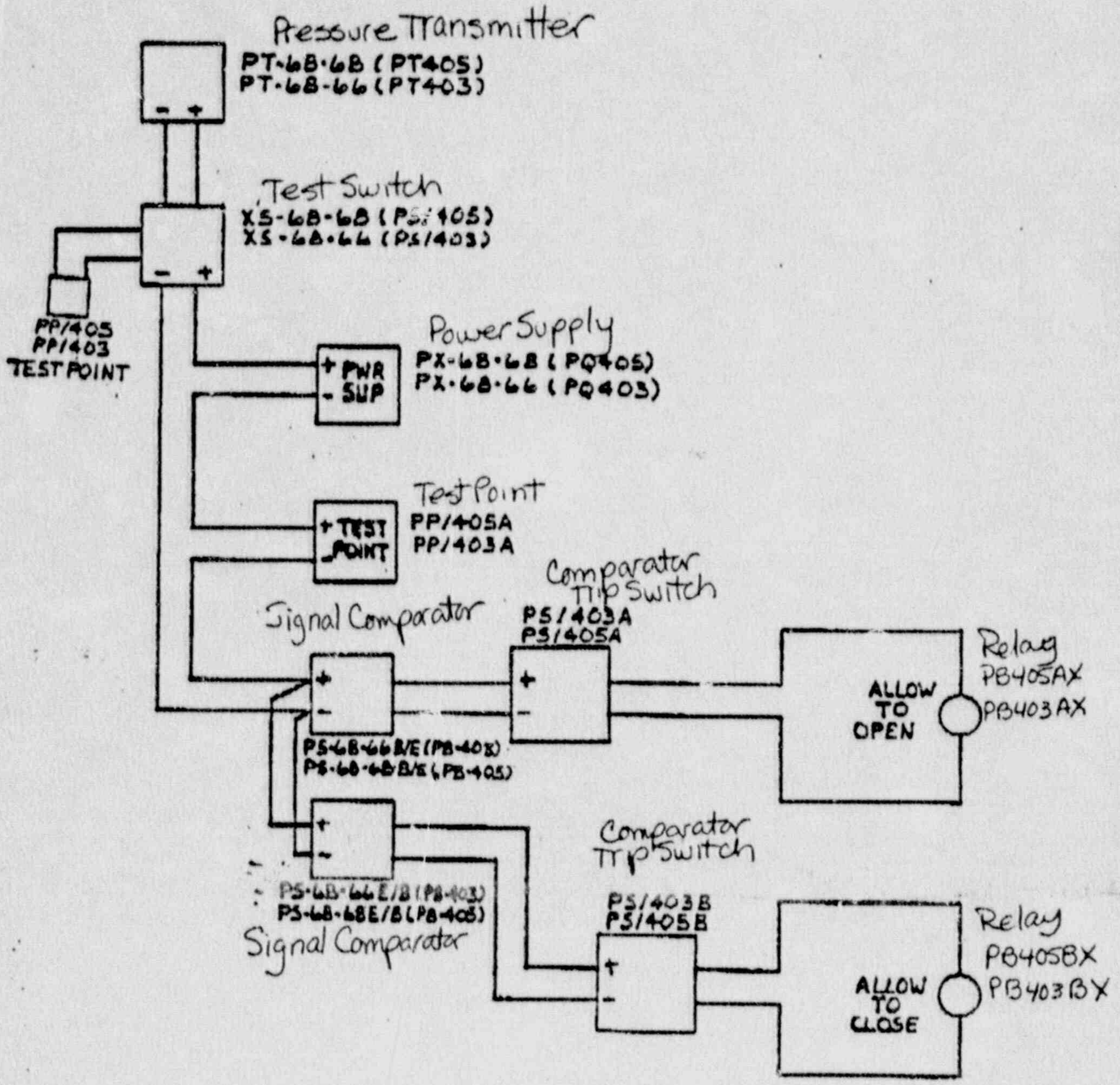


FIGURE 6

SEQUOYAH RHR SUCTION VALVE WIRING DIAGRAM

FIGURE 6 (cont.)
SEQUOYAH RHR SUCTION VALVE WIRING DIAGRAM



SEQUOYAH RHR SUCTION CONTROL CIRCUITRY
FCV-74-1 AND FCV-74-2

In order to compare the autoclosure interlock circuitry and the motor operated valve control circuitry, the two plants are compared in Table 1. In the analysis of the motor operated valves in the interfacing system LOCA evaluation, the RHRS availability evaluation and the low temperature overpressurization analysis, the components with an "NA" in Table 1 under Sequoyah would be deleted from the Salem analysis and those with an "NA" under Salem would be added to the Salem analysis to model the Sequoyah valve circuitry. For example, the I/V Input Modules would be deleted from the Salem fault trees because Sequoyah's circuitry does not have these modules. The Salem analysis would also have to be modified to include the shunt trip circuitry used in the Sequoyah design.

2.3 Sequoyah Proposed Circuitry Change

The elimination of the autoclosure interlock requires the addition of a control room alarm to alert the operator in the event that one of the RHR suction/isolation valves is open and RCS pressure is greater than a given setpoint. This is to ensure that a double isolation barrier exists between the high pressure RCS and the lower pressure RHR system during power operation.

WCAP-11736-A proposed that the deletion of the ACI and the alarm circuit be added using the logic shown in Figure 7 (shown for Salem) and implemented along the lines shown in Figure 8.

The Sequoyah proposed change is shown in Figure 9 logically and in Figure 10 mechanically. This change uses an "OR" logic rather than an "AND" logic as proposed in WCAP-11736-A. The Sequoyah change would provide a control room alarm if one suction valve was open and the other suction valve was closed or the alarm would annunciate when the RHR pressure measured above a given setpoint by either of two pressure switches. The Sequoyah proposed change serves the same function as the change proposed in WCAP-11736-A, i.e., to alert the operator of an improperly positioned RHR suction/isolation valve.

TABLE 1

COMPARISON OF SALEM AND SEQUOYAH SUCTION VALVE CIRCUITRY

COMPONENT DESCRIPTION	SALEM ID	SEQUOYAH ID
	8702 (1RH1)	8702 (FCV-74-1)
Pressure Interlock Circuitry		
Pressure Transmitter	PT-403	PT-405
Toggle Switch	1CT-403	XS-68-68 (PS405)
Loop Power Supply	1PQ-403	PX-68-68 (PQ405)
Test Point	1-TP-403-1	PP405
I/V Inp Mod	1PC-403/R	NA
I/V Inp Mod	1PM-403R	NA
Signal Comparator Dual Circuit	1PC-403A-B	PB-405
Bistable Switch (Close)	1BS-403B	PS-405A
Bistable Switch (Open)	1BS-403A	PS-405B
Motor Operated Valve Control Circuitry		
Common Components		
Circuit Breaker from MCC Bus	8	Circuit Breaker
Power Transformer	230/118V	480/120V
Control Circuit Fuses	2 15 AMP	2
Three Phase Close Contacts	9/C	C Phase A,B & C
Three Phase Open Contacts	9/O	O Phase A,B & C
Three Phase Fuses	T1,T2,T3	Phase A,B & C
Thermal Overload Contact	49	OL (2 in Series)
Power Supply Contacts	NA	XS-74-1/NOR1,2 &7
Blown Fuse Trip Contacts	NA	Note 4 (3 in Series)
Close Circuitry Components		
Pressure Transmitter Contacts (Close)	63Y/RCP	PB405BX
Closing Torque Switch	33/CVC	NA
Limit Switch (Torque Bypass)	33/CVO	NA
Limit Switch	33/OVC	33/ac
Interlock Contact (Close Circuit)	9/O	42b/o
Interlock Contact (9X/C Circuit)	9/C	NA
Handswitch Contact	5/CSV2	HS 74-1A/CLOSE
Handswitch Relay Coil	5/CSV2	NA
Control Room Switch Contact (Close)	1/CLOSE	NA
Diode in Handswitch Circuit	D5	NA
Lockin Relay Coil Contacts (Close)	9X/C	42a/c
Lockin Relay Coil (Close)	9X/C	NA
Power Supply Contacts	NA	XS-74-1/NOR 3

* NA - not used in circuitry for that plant

TABLE 1 (cont.)

COMPARISON OF SALEM AND SEQUOYAH SUCTION VALVE CIRCUITRY

COMPONENT DESCRIPTION	SALEM ID	SEQUOYAH ID
Open Circuitry Components		
Pressure Transmitter Contacts (Open)	63X/RCP	PB405AX
Opening Torque Switch	33/OVO	NA
Limit Switch (Torque Bypass)	33/CVC	NA
Limit Switch	33/OVO	33/bo
Interlock Contact (Open Circuit)	9/C	42b/c
Interlock Contact (9X/O Circuit)	9/O	NA
Handswitch Contact	6/CSV2	HS 74-1A/OPEN
Handswitch Relay Coil	6/CSV2	NA
Control Room Switch Contact (Close)	1/OPEN	NA
Diode in Handswitch Circuit	D6	NA
Lockin Relay Coil Contacts (Open)	9X/O	42a/o
Lockin Relay Coil (Open)	9X/O	NA
Power Supply Contacts	NA	XS-74-1/NOR 4
Status Light Indication		
Red Light (Open)	R	R
Red Light Contact	33X/CSV2	NA
Red Light Relay Coil	33X/CSV2	NA
Red Light Relay Coil Circuit Limit Sw	33/CVO	33/ac
Green Light (Close)	G	G
Green Light Contact	33Y/CSV2	NA
Green Light Relay Coil	33Y/CSV2	NA
Green Light Relay Coil Circuit Limit Sw	33/CVC	33/bc
Power Supply Contacts	NA	XS-74-1/NOR 5 & 6
Additional Components		
Shunt Trip Circuitry	NA	Shunt Trip
Shunt Trip Contact	NA	52 A
Trip Handswitch	NA	O-HS-13-204/Trip
Power Supply Contact	NA	XS-74-1/NOR 8

* NA - not used in circuitry for that plant

FIGURE 7

SALEM PROPOSED RHR SUCTION VALVE LOGIC DIAGRAM

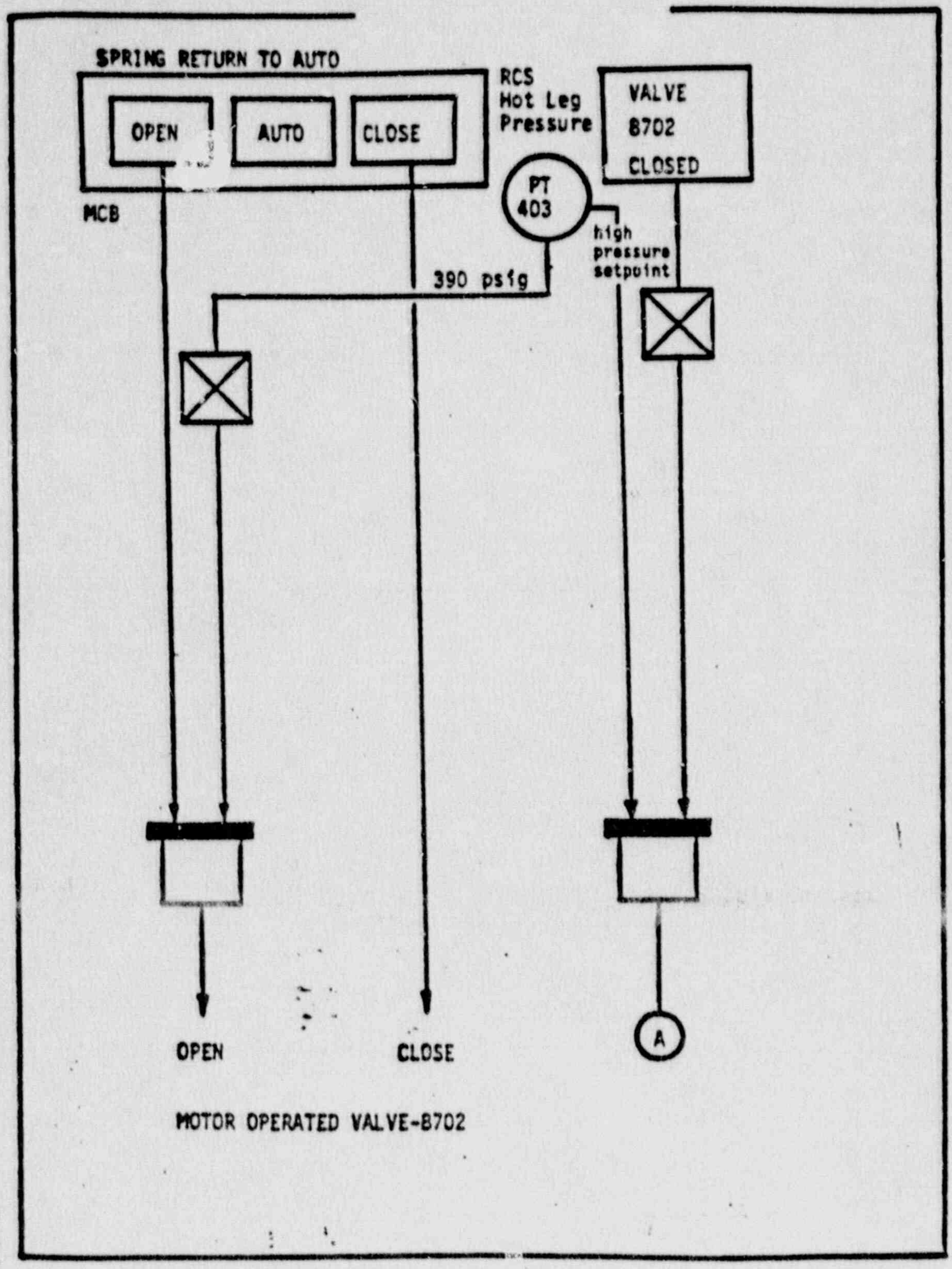
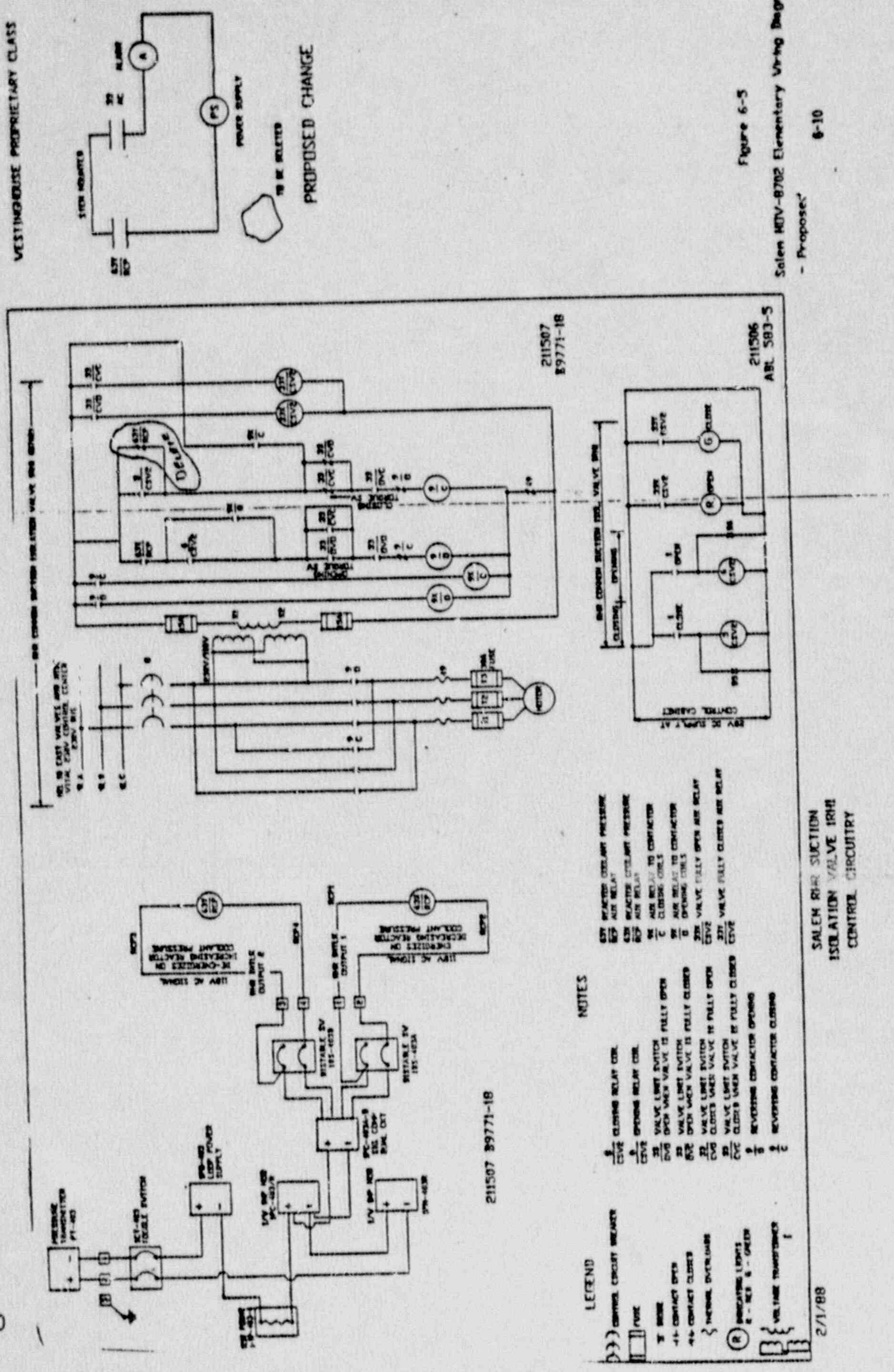


Figure 6-2. Salem Proposed Interlock-MOV-8702

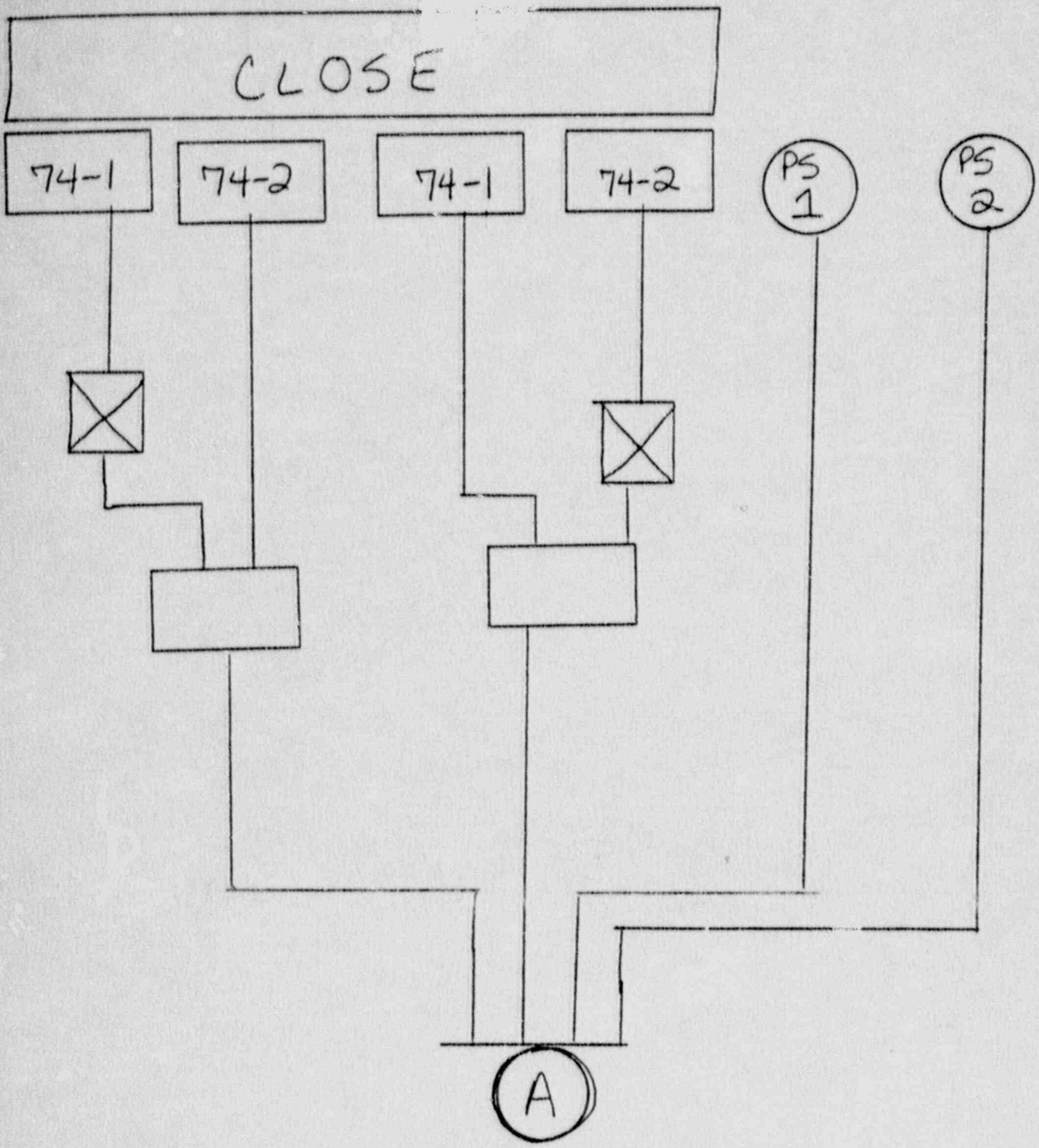
FIGURE 8
SALEM PROPOSED RHR SUCTION VALVE WIRING DIAGRAM



3/4/90

FIGURE 9

SEQUOYAH PROPOSED RHR SUCTION VALVE LOGIC DIAGRAM



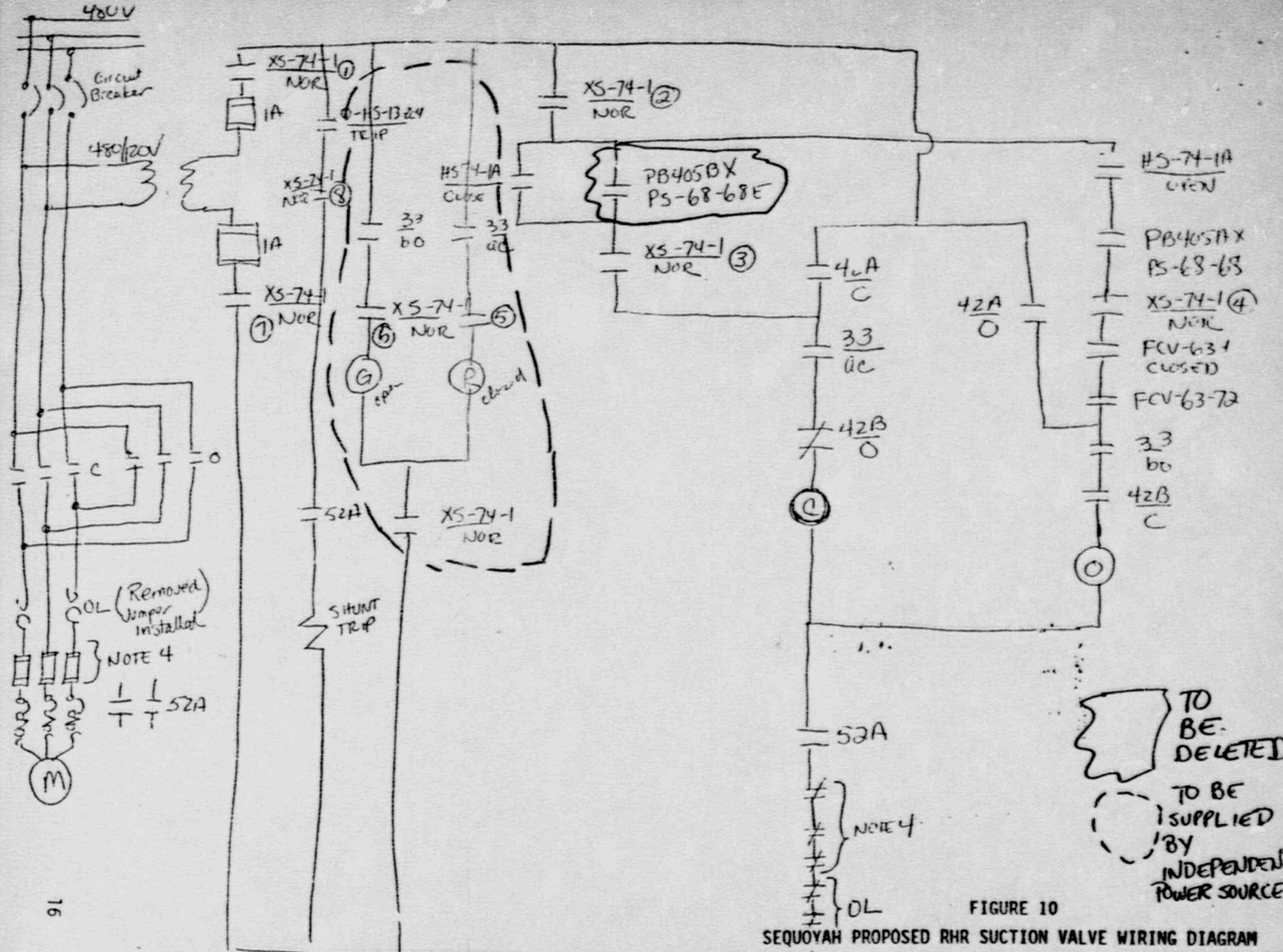
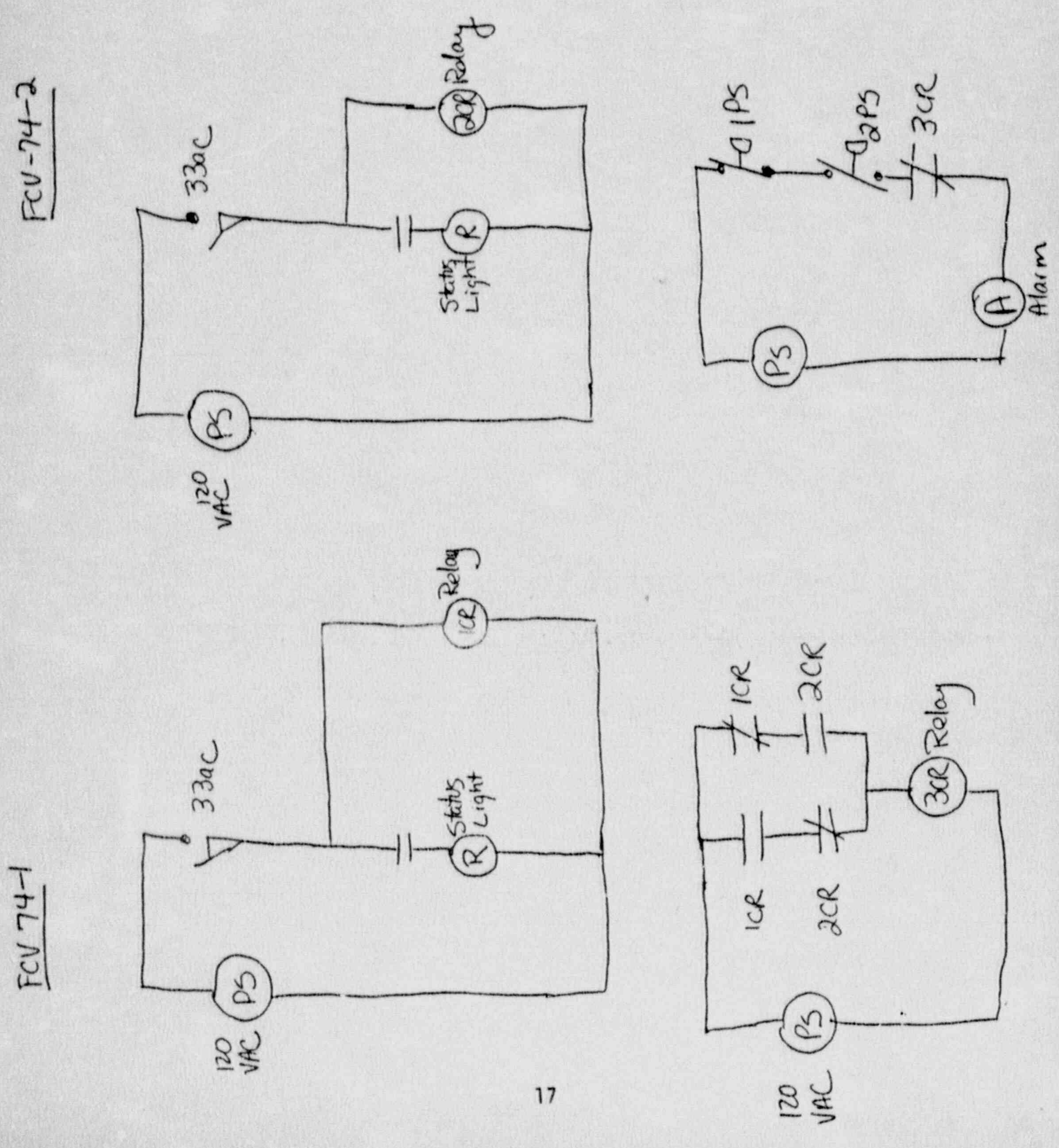


FIGURE 10

SEQUOYAH PROPOSED RHR SUCTION VALVE WIRING DIAGRAM

FIGURE 10 (cont.)

SEQUOYAH PROPOSED RHR SUCTION VALVE WIRING DIAGRAM



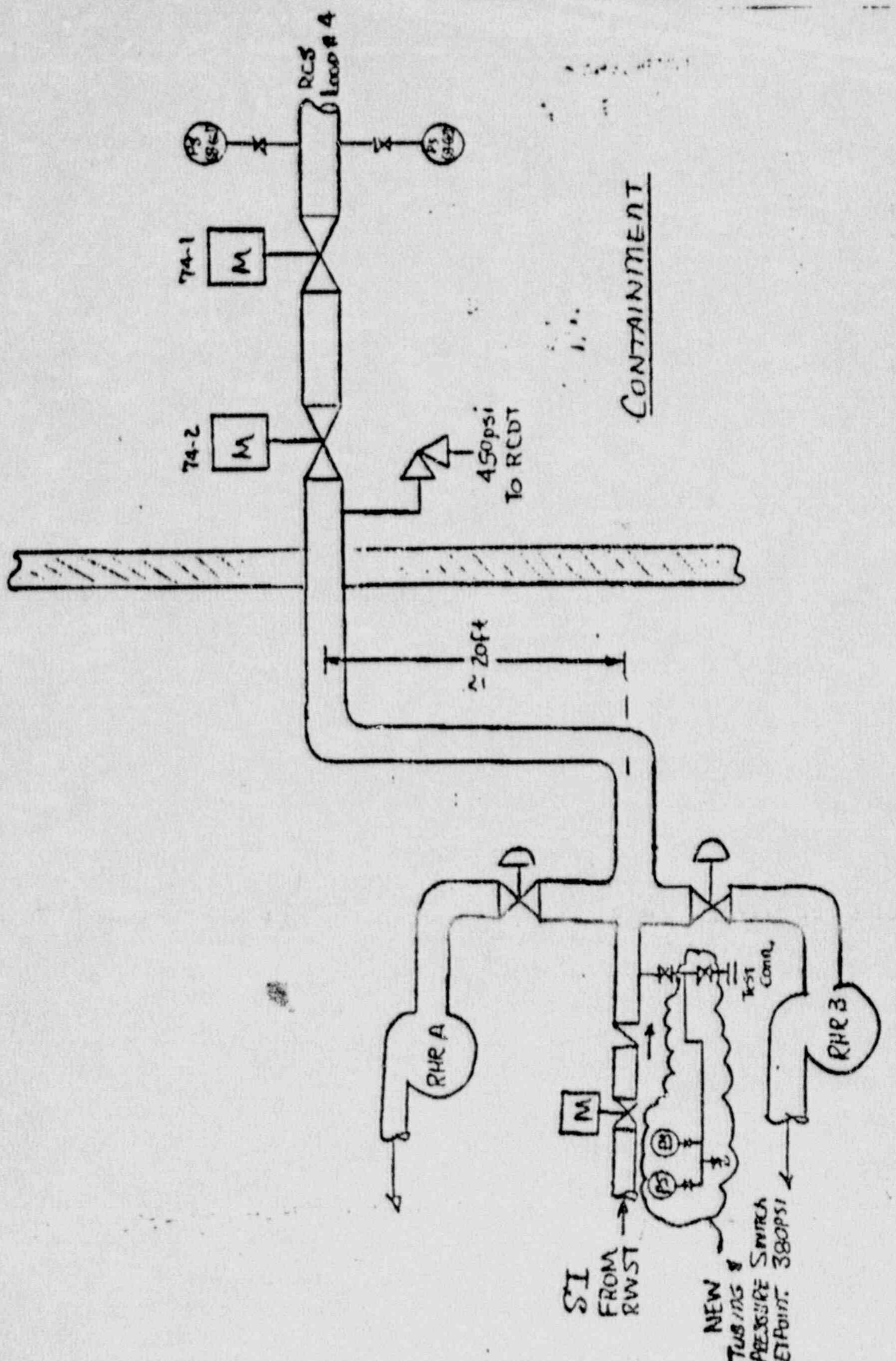
The Sequoyah change also has several unique characteristics with regard to implementation. First, the pressure switches used in the alarm circuit to alert the operator of high pressure are located in the RHR system downstream of the RHR suction valves (Figure 11). When RHR pressure is greater than 380 psig, the alarm would sound. The WCAP proposed change used the same pressure circuitry as used in the autoclosure interlock circuit which relied upon pressure transmitters located in the RCS.

The use of the pressure switches on the RHR system side would provide several benefits: 1) excessive leakage past the two suction valves would be detected, 2) the operator would be alerted to a low temperature overpressure event during shutdown or startup even before the RHR relief valve lifted at 450 psig and 3) the operator would be alerted that during startup, the RHR system was not isolated as required. The impact of this change on the probabilistic analyses would be factored into the low temperature overpressurization analysis in that the operator would be alerted and would have more time to respond to an overpressure event, providing additional protection of the RHR system.

A second implementation difference between the WCAP and the Sequoyah proposed change is that status light indication and the alarm would be powered from a separate power source and utilize the same limit switch (for valve position) as shown in Figure 10. When power is removed from the suction valve by racking out the circuit breaker, the status lights and the alarm would still be operational. Thus, the operator would have continuous indication of valve position by two different indicators (status light and alarm). This characteristic is factored into the interfacing system LOCA analyses in that the operator would be able to detect the improper valve position via the alarm even if the status light indication circuit failed or power was removed from the valve.

FIGURE 11

LOCATION OF PRESSURE SWITCHES FOR ALARM



3.0 IMPACT ON PROBABILISTIC ANALYSES

This section determines the impact of the Sequoyah configuration and proposed change on the probabilistic analyses conducted for Salem in WCAP-11736-A. The objective is to determine if the conclusions based on the Salem results are invalid based on calculations to estimate the Sequoyah results.

3.1 Interfacing System LOCA

WCAP-11736-A, Appendix B, performed calculations to determine the change in frequency of an interfacing system LOCA due to removal of the autoclosure interlock. In the analysis, several failure combinations were considered in which both suction valves would be in the "OPEN" position. These failure modes included: 1) rupture of the two series motor operated valves in the RHR suction line and 2) one suction valve failing open and subsequent rupture of the other valve. The scenarios examined for the suction valve failing open with the autoclosure interlock in place were: 1) the operator fails to remove power to the valve by racking out the circuit breaker and subsequently the valve spuriously opens during power operation or 2) the operator fails to close the valve during startup (or the operator attempts to close the valve but due to some component failure, the valve does not close) and the autoclosure interlock fails to perform its function and does not close the valve and an operator fails to detect that the valve is not closed during startup or power operation.

For the deletion of the autoclosure interlock and the addition of an alarm, the scenarios developed were: 1) the operator fails to remove power to the valve by racking out the circuit breaker and subsequently the valve spuriously opens during power operation or 2) the operator fails to close the valve during startup (or the operator attempts to close the valve but due to some component failure, the valve does not close) and the operator fails to detect that the valve is not closed via the presence of an alarm (or the alarm fails to operate).

Reviewing the dominant cutsets for Salem (Table B-3 in WCAP-11736-A) shows that the dominant failure modes are failures which occur during startup (i.e., the operator fails to close the valve and does not detect that the valve has not closed). Table 2 shows Table B-3 recreated with the cutsets applicable to Sequoyah marked on the right. The cutsets which are not applicable are based on the fact that the Sequoyah valve circuitry does not contain these components. Table 3 shows the additional cutsets that are applicable for the Sequoyah design because Sequoyah has additional components in its circuitry.

By subtracting out the cutsets which are not applicable to Sequoyah from the Salem mean failure probability and adding the probabilities associated with the additional cutsets shown in Table 3, an estimate of the mean probability of failure for Sequoyah with the ACI can be calculated by the following:

Sequoyah Probability = Salem Probability - (Probabilities for Non-Applicable Cutsets) + (Additional Cutsets)

= 1.48E-04 - 5.36E-05 + 1.19E-04
= 2.13E-04

Entering this probability into the equation for interfacing systems LOCA:

$$F(VSEQ) = (lambda)_2\ Q(V_1) + (lambda)_1\ Q(V_2) + (lambda)_2\ Q(V_{1R})$$

where $(lambda)_2$ = failure rate of valve closest to RCS
$(lambda)_1$ = failure rate of valve closest to RHRS
$Q(V_1)$ = probability that valve closest to RCS is open
$Q(V_2)$ = probability that valve closest to RHRS is open
$Q(V_{1R})$ = probability that valve closest to RHRS ruptures.

and utilizing the failure rates in WCAP-11736-A for $(lambda)_2$, $(lambda)_1$, and $Q(V_{1R})$ and the Sequoyah estimated probability for $Q(V_1)$ and $Q(V_2)$, yields:

F(VSEQ) = 1E-07/hr * (2.13E-04) + 1E-07/hr * (2.13E-04) + 1E-07/hr * (6.57E-04)

= 2.13E-11/hr + 2.13E-11/hr + 6.57E-11/hr

= 1.08E-10/hr * (8760 hrs/year)

= 9.49E-07/year

TABLE 2

TABLE B-3
SALEM DOMINANT CUTSETS
FOR $Q(V_1)$
PROBABILITY THAT MOV 1RH1 IS OPEN
WITH ACI CASE

MEAN PROBABILITY OF FAILURE = 1.48E-04

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
NO	1.	3.46E-05	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 ~~RELAY COIL 9X/C FAILS~~ OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	2.	3.46E-05	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 RELAY COIL 9/C FAILS OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	3.	1.15E-05	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 CONTACT ~~9/C~~ 42a/C FAILS TO TRANSFER (~~TO 9X/C COIL~~) OPERATOR FAILS TO DETECT OPEN MOV 1RH1
NO (No Lockin Circuit)	4.	1.15E-05	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 ~~CONTACT 9X/C FAILS TO CLOSE~~ OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	5.	1.15E-05	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 CONTACTOR FAILS TO CLOSE (9/C) PHASE C OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	6.	1.15E-05	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 CONTACTOR FAILS TO CLOSE (9/C) PHASE B OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	7.	1.15E-05	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 CONTACTOR FAILS TO CLOSE (9/C) PHASE A OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	8.	4.03E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 480/120 ~~230V/115V~~ TRANSFORMER FAILS OPERATOR FAILS TO DETECT OPEN MOV 1RH1
NO (No Torque Switch)	9.	2.30E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 ~~CLOSING TORQUE SWITCH FAILS OPEN (17)~~ OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	10.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 15 AMP FUSE #2 FAILS OPERATOR FAILS TO DETECT OPEN MOV 1RH1

TABLE 2 (cont.)

TABLE B-3 (CONT.)

SALEM DOMINANT CUTSETS

FOR $Q(V_1)$

PROBABILITY THAT MOV 1RH1 IS OPEN

WITH ACI CASE

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	11.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 15 AMP FUSE # 1 FAILS OPERATOR FAILS TO DETECT OPEN MOV 1RH1
NO (Removed)	12.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 THERMAL OVERLOAD FAILS PHASE C OPERATOR FAILS TO DETECT OPEN MOV 1RH1
NO (Removed)	13.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 THERMAL OVERLOAD FAILS PHASE B OPERATOR FAILS TO DETECT OPEN MOV 1RH1
NO (Removed)	14.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 THERMAL OVERLOAD FAILS PHASE A OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	15.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 30 AMP FUSE PHASE C FAILS OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	16.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 30 AMP FUSE PHASE B FAILS OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	17.	1.73E-06	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 30 AMP FUSE PHASE A FAILS OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	18.	2.30E-07 42b/0	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 CONTACT 9/O SPURIOUSLY OPENS OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	19.	2.30E-07 52A	SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 THERMAL OVERLOAD CONTACT FAILS OPEN (49) OPERATOR FAILS TO DETECT OPEN MOV 1RH1
YES	20.	1.38E-07	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 MECHANICAL FAILURE OF MOV 1RH1 OPERATOR FAILS TO DETECT OPEN MOV 1RH1

5.36E-05 TOTAL PROBABILITY OF NON-APPLICABLE CUTSETS

TABLE 3

ADDITIONAL SEQUOYAH CUTSETS

INTERFACING SYSTEMS LOCA

WITH ACI

	CUTSET * PROBABILITY	CUTSET DESCRIPTION	COMPONENT ** PROBABILITY
1.	8.32E-05	LIMIT SWITCH 33/AC SPURIOUSLY OPENS	8.66E-05
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN MOV	0.98
2.	3.46E-05	SHUNT TRIP CAUSES MOTOR CB TO OPEN	3.6E-05
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN MOV	0.98
3.	2.30E-07	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (1)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN MOV	0.98
4.	2.30E-07	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (7)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN MOV	0.98
5.	2.30E-07	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (2)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN MOV	0.98
6.	2.30E-07	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (3)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN MOV	0.98
7.	1.15E-07	CB TO MOTOR SPURIOUSLY OPENS	1.2E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN MOV	0.98
	1.19E-04	TOTAL FROM ADDITIONAL CUTSETS	

* Cutset probability determined by multiplying component probabilities.
For example:
Cutset # 1 probability = 8.60E-05 * 0.98 * 0.98 = 8.32E-05

** Component failure rate obtained from Table 7-1 of WCAP-11736-A.
Component probability determined by multiplying failure rate by 12 hours.
For example:
Limit Switch = 7.22E-06/hour * 12 hours = 8.66E-05
Shunt trip coil = 3.00E-06/hour * 12 hours = 3.6E-05
Contacts Spurious Operation = 2.00E-08/hour * 12 hours = 2.40E-07
Circuit Breaker Spurious Operation = 1.00E-08/hour * 12 hours = 1.2E-07

By utilizing the same approach for the deletion of the autoclosure interlock and the inclusion of a control room alarm, the frequency for interfacing system LOCA is calculated. Table 4 shows Table B-4 recreated with the cutsets applicable to Sequoyah marked on the right. Table 5 shows the additional cutsets that are applicable for the Sequoyah design.

By subtracting out the cutsets which are not applicable to Sequoyah from the Salem mean failure probability and adding the probabilities associated with the additional cutsets shown in Table 5, an estimate of the mean probability of failure for Sequoyah without the ACI can be calculated by the following:

Sequoyah Probability = Salem Probability - (Probabilities for Non-Applicable Cutsets) + (Additional Cutsets)

= 1.10E-06 - 2.88E-07 + 1.17E-07
= 9.29E-07

Entering this probability into the equation for interfacing systems LOCA:

$$F(VSEQ) = (lambda)_2\ Q(V_1) + (lambda)_1\ Q(V_2) + (lambda)_2\ Q(V_{1R})$$

= 1E-07/hr * (9.29E-07) + 1E-07/hr * (9.29E-07) + 1E-07/hr * (6.57E-04)

= 9.29E-14/hr + 9.29E-14/hr + 6.57E-11/hr

= 6.59E-11/hr * (8760 hrs/year)

= 5.77E-07/year

TABLE 4

TABLE B-4
SALEM DOMINANT CUTSETS
FOR $Q(V_1)$
PROBABILITY THAT MOV 1RH1 IS OPEN
ACI DELETION CASE

MEAN PROBABILITY OF FAILURE = 1.10E-06

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	1.	3.13E-07	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 OPERATOR FAILS TO DETECT VIA ANNUCIATOR
YES	2.	1.02E-07	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 VALVE ~~STEM MOUNT~~ ALARM LIMIT SWITCH FAILS TO OPERATE
YES	3.	8.18E-08	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 POWER SUPPLY TO ANNUCIATOR FAILS
YES	4.	8.18E-08	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 ~~118 V A~~C POWER SUPPLY FAILS TO LIMIT SWITCH
NO	5.	8.18E-08 *	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 LOOP POWER SUPPLY 1-PQ-403 FAILS
YES	6.	6.00E-08	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 ANNUCIATOR FAILS TO OPERATE
NO	7.	4.23E-08 *	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 RELAY COIL 63Y/RCP FAILS
NO	8.	4.09E-08 *	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 SIGNAL COMPARATOR DUAL CIRCUIT FAILS 1PC403AB
NO	9.	3.95E-08 *	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 PRESSURE TRANSMITTER PT-403 FAILS
NO	10.	2.33E-08 *	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 BISTABLE SWITCH 1BS-403B FAILS

* ANNUNCIATOR CIRCUIT ONLY DEPENDENT ON VALVE POSITION

TABLE 4 (cont.)

TABLE B-4 (CONT.)
SALEM DOMINANT CUTSETS
FOR $Q(V_1)$
PROBABILITY THAT MOV 1RH1 IS OPEN
ACI DELETION CASE

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
NO	11.	1.81E-08 NO 28VDC	28 V DC POWER SUPPLY FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 OPERATOR FAILS TO DETECT VIA ANNUCIATOR
YES	12.	1.41E-08	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 RELAY COIL CONTACT ~~63Y/RCP~~ RHRD FAILS
NO	13.	9.38E-09 NO LOCKIN RELAY COIL	RELAY COIL ~~DX/C~~ FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 OPERATOR FAILS TO DETECT VIA ANNUCIATOR
YES	14.	9.38E-09	RELAY COIL 9/C FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 OPERATOR FAILS TO DETECT VIA ANNUCIATOR
NO	15.	9.38E-09	RELAY COIL 5/CSV2 FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 OPERATOR FAILS TO DETECT VIA ANNUCIATOR
NO	16.	5.91E-09 NO 28VDC	28 V DC POWER SUPPLY FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 VALVE ~~STEM MOUNT~~ LIMIT SWITCH FAILS TO OPERATE
NO	17.	4.75E-09 NO 28VDC	28 V DC POWER SUPPLY FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 POWER SUPPLY TO ANNUCIATOR FAILS
NO	18.	4.75E-09 NO 28VDC	28 V DC POWER SUPPLY FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 118 V AC POWER SUPPLY FAILS
NO	19.	4.75E-09 NO 28VDC	28 V DC POWER SUPPLY FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 LOOP POWER SUPPLY 1-PQ-403 FAILS
NO	20.	3.48E-09 NO 28VDC	28 V DC POWER SUPPLY FAILS SECOND OPERATOR FAILS TO DETECT OPEN MOV 1RH1 ANNUNCIATOR FAILS TO OPERATE

2.88E-07 TOTAL PROBABILITY OF NON APPLICABLE CUTSETS

TABLE 5

ADDITIONAL SEQUOYAH CUTSETS

INTERFACING SYSTEMS LOCA

WITHOUT ACI

	CUTSET * PROBABILITY	CUTSET DESCRIPTION	COMPONENT ** PROBABILITY
1.	4.23E-08	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP	1.20E-03
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		RELAY COIL 1CR FAILS TO OPERATE	3.60E-05
2.	4.23E-08	OPERATOR FAILS TO CLOSE VALVE DURING STARTUP	1.20E-03
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		RELAY COIL 3CR FAILS TO OPERATE	3.60E-05
3.	2.26E-08	LIMIT SWITCH 33/AC SPURIOUSLY OPENS	8.66E-05
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN VIA ANNUNCIAT	2.66E-04
4.	9.38E-09	SHUNT TRIP CAUSES MOTOR CB TO OPEN	3.6E-05
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN VIA ANNUNCIAT	2.66E-04
5.	6.26E-11	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (1)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN VIA ANNUNCIAT	2.66E-04
6.	6.26E-11	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (7)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN VIA ANNUNCIAT	2.66E-04
7.	6.26E-11	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (2)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN VIA ANNUNCIAT	2.66E-04
8.	6.26E-11	XS-74-1/NOR CONTACTS SPURIOUSLY OPEN (3)	2.4E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN VIA ANNUNCIAT	2.66E-04
9.	3.13E-11	CB TO MOTOR SPURIOUSLY OPENS	1.2E-07
		SECOND OPERATOR FAILS TO DETECT OPEN MOV	0.98
		OPERATOR FAILS TO DETECT OPEN VIA ANNUNCIAT	2.66E-04
	1.17E-07	TOTAL FROM ADDITIONAL CUTSETS	

* Cutset probability determined by multiplying component probabilities. For example:

Cutset # 1 probability = 1.20E-03 * 0.98 * 3.60E-05 = 4.23E-08

** Component failure rates obtained from Table 7-1 of WCAP-11736-A and Salem analysis in Appendix B. Component probability determined by multiplying failure rate by 12 hours.

When comparing the results with and without the autoclosure interlock, as shown below:

	With Autoclosure Interlock	Without Autoclosure Interlock
F(VSEQ)	9.49E-07/year	5.77E-07/year

the frequency of an interfacing system LOCA decreases by approximately 39 percent. The main contributor to the frequencies in each case is a double rupture of the suction valves (frequency of 5.75E-07/year in both cases). The deletion of the ACI has no impact on the rupture of a suction valve.

3.2 RHR Availability

The availability of the RHR system to remove decay heat during cold shutdown was considered in three phases in the WOG analyses. First the RHR system must be placed in service and go through a warm-up period in order to minimize the thermal shock to the system. Secondly, during the initial phase of cooldown, the decay heat load is high. For this phase, two trains of RHR (two pumps and two heat exchangers) are assumed to be required for 72 hours. The final phase of cooldown is long term decay heat removal. The decay heat load is low and only one train of RHR (one pump and one heat exchanger) is assumed to be required to be in operation. Six weeks was assumed to be the time period for this phase.

Each of these phases is evaluated for the Sequoyah plant.

<u>Failure to Initiate RHR</u>

This phase models the operator actions and component operation required to initiate the RHR system before aligning the system to RCS cooling and the actions required to align the system to the RCS to provide decay heat removal. The Salem model developed in Appendix C of WCAP-11736-A details the steps of the procedure for initiating RHR operation. It is assumed that the Sequoyah RHR initiation procedure is similar in the steps for aligning the RHR system.

Because the deletion of the autoclosure interlock has no impact on the failure probability for RHR initiation (because the autoclosure interlock has no function with regard to valve opening), the failure probability for Sequoyah would not be impacted and thus does not require an evaluation.

Failure of Short Term Cooling

This phase models a cooldown in which both RHR trains are required to be in operation to provide adequate cooling. The short term cooling phase primarily features spurious closing of various valves and failure of the RHR pumps to run for 72 hours. Spurious closure of the RHR suction valves due to failures in the autoclosure interlock circuitry are explicitly modeled.

Reviewing the dominant cutsets for Salem (Table C-5 in WCAP-11736-A) shows that the dominant failure modes for the short term cooling phase with the autoclosure interlock. Table 6 shows Table C-5 recreated with the cutsets applicable to Sequoyah marked on the right. Table 7 shows the additional cutsets that are applicable for the Sequoyah design.

By subtracting out the cutsets which are not applicable to Sequoyah from the Salem mean failure probability (Table 6) and adding the probabilities associated with the additional cutsets shown in Table 7, an estimate of the mean probability of failure for Sequoyah with the ACI can be calculated by the following:

Sequoyah Probability = Salem Probability - (Probabilities for Non-Applicable Cutsets) + (Additional Cutsets)

= 1.60E-02 - 5.76E-05 + 3.46E-04
= 1.63E-02

By utilizing the same approach for the deletion of the autoclosure interlock and the inclusion of a control room alarm, the failure probability for short term cooling is calculated. Table 8 shows Table C-6 recreated with the cutsets applicable to Sequoyah marked on the right. There are no additional cutsets that are applicable for the Sequoyah design (the Sequoyah RHR system configuration is identical to Salem and there are no additional control circuitry failures in Sequoyah that are not modeled in Salem).

TABLE 6

TABLE C-5

SALEM
DOMINANT CONTRIBUTORS
LOSS OF SHORT TERM COOLING
WITH AUTOCLOSURE INTERLOCK

MEAN PROBABILITY OF FAILURE = 1.60E-02

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	1.	7.20E-03	RHR PUMP NO. 12 FAILS TO RUN FOR 72 HOURS
YES	2.	7.20E-03	RHR PUMP NO. 11 FAILS TO RUN FOR 72 HOURS
YES	3.	4.18E-04	LOOP POWER SUPPLY FAILS HIGH PQ-405
YES	4.	4.18E-04	LOOP POWER SUPPLY FAILS HIGH PQ-403
YES	5.	2.09E-04	SIGNAL COMPARATOR FAILS PB-403
YES	6.	2.09E-04	SIGNAL COMPARATOR FAILS PB-405
YES	7.	2.02E-04	PRESSURE TRANSMITTER FAILS PT-403
YES	8.	2.02E-04	PRESSURE TRANSMITTER FAILS PT-405
NO	9.	1.44E-05	I/V MODULE FAILS 2-PC-405R
NO	10.	1.44E-05	I/V MODULE FAILS 2-PM-405R
NO	11.	1.44E-05	I/V MODULE FAILS 1-PC-405R
NO	12.	1.44E-05	I/V MODULE FAILS 1-PM-405R
YES	13.	1.44E-05	PUMP DISCHARGE CHECK VALVE ~~12RH8~~ FAILS TO OPEN 74-515
YES	14.	1.44E-05	PUMP SUCTION VALVE ~~12RH4~~ SPURIOUSLY CLOSES (MOV) FCV-74-21
YES	15.	1.44E-05	RHR HEAT EXCH. 12 FAILS TO REMOVE HEAT (CCW VALVE SPURIOUS CLOSE)
YES	16.	1.44E-05	PUMP DISCHARGE CHECK VALVE ~~11RH8~~ FAILS TO OPEN 74-514
YES	17.	1.44E-05	PUMP SUCTION VALVE ~~11RH4~~ SPURIOUSLY CLOSES (MOV) FCV-74-3
YES	18.	1.44E-05	RHR HEAT EXCH. 11 FAILS TO REMOVE HEAT (CCW VALVE SPURIOUS CLOSE)
YES	19.	1.44E-05	CROSSTIE VALVE 11RH19 (MOV) SPURIOUSLY CLOSES FCV-74-33
YES	20.	1.44E-05	CROSSTIE VALVE 12RH19 (MOV) SPURIOUSLY CLOSES FCV-74-35

5.76E-05 TOTAL PROBABILITY OF NON-APPLICABE CUTSETS

TABLE 7

ADDITIONAL SEQUOYAH CUTSETS

SHORT TERM COOLING

WITH ACI

	CUTSET * PROBABILITY	CUTSET DESCRIPTION	COMPONENT ** PROBABILITY
1.	1.73E-04	BISTABLE SWITCH PS/403B FAILS HIGH	1.73E-04
2.	1.73E-04	BISTABLE SWITCH PS/405B FAILS HIGH	1.73E-04
	3.46E-04	TOTAL FROM ADDITIONAL CUTSETS	

* Cutset probability determined by multiplying component probabilities.

** Component failure rates obtained from Table 7-1 of WCAP-11736-A and Salem analysis in Appendix C. Component probability determined by multiplying failure rate by 72 hours.
For example:
Bistable Switch = 2.40E-06/hour * 72 hours = 1.73E-04

TABLE 8

TABLE C-6

SALEM
DOMINANT CONTRIBUTORS
LOSS OF SHORT TERM COOLING
WITHOUT AUTOCLOSURE INTERLOCK

MEAN PROBABILITY OF FAILURE = 1.40E-02

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION	
YES	1.	7.20E-03	RHR PUMP NO. 12 FAILS TO RUN FOR 72 HOURS	
YES	2.	7.20E-03	RHR PUMP NO. 11 FAILS TO RUN FOR 72 HOURS	
YES	3.	1.44E-03	PUMP DISCHARGE CHECK VALVE ~~12RH8~~ FAILS TO OPEN	74-515
YES	4.	1.44E-05	PUMP SUCTION VALVE ~~12RH4~~ SPURIOUSLY CLOSES (MOV)	FCV-74-21
YES	5.	1.44E-05	RHR HEAT EXCH. 12 FAILS TO REMOVE HEAT (CCW VALVE SPURIOUS CLOSE)	
YES	6.	1.44E-05	PUMP DISCHARGE CHECK VALVE ~~11RH8~~ FAILS TO OPEN	74-514
YES	7.	1.44E-05	PUMP SUCTION VALVE ~~11RH4~~ SPURIOUSLY CLOSES (MOV)	FCV-74-3
YES	8.	1.44E-05	RHR HEAT EXCH. 11 FAILS TO REMOVE HEAT (CCW VALVE SPURIOUS CLOSE)	
YES	9.	1.44E-05	CROSSTIE VALVE ~~11RH19~~ (MOV) SPURIOUSLY CLOSES	FCV-74-33
YES	10.	1.44E-05	CRO~~T~~SS TIES VALVE ~~12RH19~~ (MOV) SPURIOUSLY CLOSES	FCV-74-35
YES	11.	1.44E-06	LOCKIN CIRCUITRY FAILURE CONTACT 9/C SHORTS CLOSED	42A/C (74-1
NO	12.	1.44E-06	CLOSE RELAY COIL CONTACT 5/CSV1 FAILS	
YES	13.	1.44E-06	CLOSE CONTACT ~~1/CLOSE~~ SHORTS	HS-74-1A/CLOSE
YES	14.	1.44E-06	LOCKIN CIRCUITRY FAILURE CONTACT ~~9/C~~ SHORTS CLOSED	42A/C (74-2
NO	15.	1.44E-06	CLOSE RELAY COIL CONTACT 5/CSV1 FAILS	
YES	16.	1.44E-06	CLOSE CONTACT ~~1/CLOSE~~ SHORTS	HS-74-2A/CLOSE
YES	17.	2.07E-10	RHR DISCHARGE VALVE ~~12SJ49~~ SPURIOUSLY CLOSES (MOV) RHR DISCHARGE VALVE ~~11SJ49~~ SPURIOUSLY CLOSES	FCV-63-94 FCV-63-93
YES	18.	2.07E-10	CHECK VALVE ~~12SJ56~~ FAILS TO OPEN RHR DISCHARGE VALVE ~~11SJ49~~ SPURIOUSLY CLOSES	63-563 FCV-63-93

TABLE 8 (cont.)

TABLE C-6 (Cont)

SALEM
DOMINANT CONTRIBUTORS
LOSS OF SHORT TERM COOLING
WITHOUT AUTOCLOSURE INTERLOCK

MEAN PROBABILITY OF FAILURE = 1.40E-02

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	19.	2.07E-10	CHECK VALVE 12SJ43 63-635 FAILS TO OPEN RHR DISCHARGE VALVE 11SJ49 FCV-63-93 SPURIOUSLY CLOSES
YES	20.	2.07E-10	CHECK VALVE 14SJ43 63-560 FAILS TO OPEN RHR DISCHARGE VALVE 11SJ49 FCV-63-93 SPURIOUSLY CLOSES

2.88E-06 TOTAL PROBABILITY OF NON-APPLICABLE CUTSETS

An estimate of the mean probability of failure for Sequoyah without the ACI can be calculated by the following:

Sequoyah Probability = Salem Probability - (Probabilities for Non-Applicable Cutsets) + (Additional Cutsets)

= 1.40E-02 - 2.88E-06 + 0
= 1.40E-02

Failure of Long Term Cooling

Only one RHR pump and one heat exchanger are required for six weeks in the long term cooling phase to provide adequate cooling. The long term cooling analysis shows spurious closing of various valves over the six week period along with failure of one RHR pump to continue running and upon failure of the running pump, failure of the second RHR pump to start, run or be unavailable due to test or maintenance.

The failure of both pumps to run for six weeks is the dominant contributor to the system unavailability in the long term cooling phase. With the ACI present, the other failure modes involve the single failure of a component associated with the ACI such as the power supply, signal comparator, bistable switch, or pressure transmitter which causes spurious closure of one of the RHR suction valves.

Reviewing the dominant cutsets for Salem (Table C-7 in WCAP-11736-A) shows that the dominant failure modes for the long term cooling phase with the autoclosure interlock. Table 9 shows Table C-7 recreated with the cutsets applicable to Sequoyah marked on the right. Table 10 shows the additional cutsets that are applicable for the Sequoyah design.

By subtracting out the cutsets which are not applicable to Sequoyah from the Salem mean failure probability (Table 9) and adding the probabilities associated with the additional cutsets shown in Table 10, an estimate of the mean probability of failure for Sequoyah with the ACI can be calculated by the following:

TABLE 9

TABLE C-7

SALEM
DOMINANT CONTRIBUTORS
LOSS OF LONG TERM COOLING
WITH AUTOCLOSURE INTERLOCK

MEAN PROBABILITY OF FAILURE = 3.60E-02

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	1.	1.02E-02	PUMP NO. 12 FAILS TO RUN FOR SIX WEEKS PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	2.	5.85E-03	LOOP POWER SUPPLY FAILS HIGH (1RH1) FCV-74-1
YES	3.	5.85E-03	LOOP POWER SUPPLY FAILS HIGH (1RH2) FCV-74-2
YES	4.	2.92E-03	SIGNAL COMPARATOR FAILS (1RH1) FCV-74-1
YES	5.	2.92E-03	SIGNAL COMPARATOR FAILS (1RH2) FCV-74-2
YES	6.	2.82E-03	PRESSURE TRANSMITTER FAILS (1RH1) FCV-74-1
YES	7.	2.82E-03	PRESSURE TRANSMITTER FAILS (1RH2) FCV-74-2
YES	8.	1.02E-03	PUMP NO. 12 FAILS TO START ON DEMAND PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	9.	2.81E-04	PUMP NO. 12 UNAVAILABLE DUE TO TEST PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	10.	2.02E-04	RHR DISCHARGE VALVE 11SJ49 SPURIOUSLY CLOSES FCV-63-93
YES	11.	2.02E-04	RHR DISCHARGE VALVE 12SJ49 SPURIOUSLY CLOSES (MOV) FCV-63-94
NO	12.	2.02E-4	I/V MODULE FAILS (1RH1) (PC)
NO	13.	2.02E-04	I/V MODULE FAILS (1RH2) (PC)
NO	14.	2.02E-04	I/V MODULE FAILS (1RH1) (PM)
NO	15.	2.02E-04	I/V MODULE FAILS (1RH2) (PM)
YES	16.	1.59E-04	PUMP NO. 12 UNAVAILABLE DUE TO MAINTENANCE PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	17.	2.04E-05	PUMP SUCTION VALVE 12RH4 SPURIOUSLY CLOSES FCV-74-21 PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS

TABLE 9 (cont.)

TABLE C-7 (Cont)

SALEM
DOMINANT CONTRIBUTORS
LOSS OF LONG TERM COOLING
WITH AUTOCLOSURE INTERLOCK

MEAN PROBABILITY OF FAILURE = 3.60E-02

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	18.	2.04E-05	PUMP DISCHARGE CHECK VALVE ~~12RH8~~ 74-515 FAILS TO OPEN PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	19.	2.04E-05	HEAT EXCH. 12 FAILS TO REMOVE HEAT (CCW VALVE SPURIOUS CLOSE) PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	20.	2.04E-05	PUMP NO. 12 FAILS TO RUN FOR SIX WEEKS PUMP SUCTION VALVE ~~11RH4~~ FCV-74-3 SPURIOUSLY CLOSES
		8.08E-04	TOTAL PROBABILITY OF NON APPLICABLE CUTSETS

TABLE 10

ADDITIONAL SEQUOYAH CUTSETS

LONG TERM COOLING

WITH ACI

	CUTSET * PROBABILITY	CUTSET DESCRIPTION	COMPONENT ** PROBABILITY
1.	2.42E-03	BISTABLE SWITCH PS/403B FAILS HIGH	2.42E-03
2.	2.42E-03	BISTABLE SWITCH PS/405B FAILS HIGH	2.42E-03
	4.84E-03	TOTAL FROM ADDITIONAL CUTSETS	

* Cutset probability determined by multiplying component probabilities.

** Component failure rates obtained from Table 7-1 of WCAP-11736-A and Salem analysis in Appendix C. Component probability determined by multiplying failure rate by 1008 hours.
For example:
Bistable Switch = 2.40E-06/hour * 1008 hours = 2.42E-03

Sequoyah Probability = Salem Probability - (Probabilities for Non-Applicable Cutsets) + (Additional Cutsets)

= 3.60E-02 - 8.08E-04 + 4.84E-03
= 4.00E-02

By utilizing the same approach for the deletion of the autoclosure interlock and the inclusion of a control room alarm, the failure probability for short term cooling is calculated. Table 11 shows Table C-8 recreated with the cutsets applicable to Sequoyah marked on the right. There are no additional cutsets that are applicable for the Sequoyah design (the Sequoyah RHR system configuration is identical to Salem and there are no additional control circuitry failures in Sequoyah that are not modeled in Salem).

An estimate of the mean probability of failure for Sequoyah without the ACI can be calculated by the following:

Sequoyah Probability = Salem Probability - (Probabilities for Non-Applicable Cutsets) + (Additional Cutsets)

= 1.20E-02 - 4.04E-05 + 0
= 1.20E-02

Results of RHR Availability

The results with and without the autoclosure interlock are shown below:

	With ACI	Without ACI	Percent Change
RHR Initiation	3.20E-02	3.20E-02	0
Short Term Cooling	1.63E-02	1.40E-02	-14
Long Term Cooling	4.00E-02	1.20E-02	-70

P. 4

The simple designation "a" or "b" is used in all cases where there is no need to adjust the contacts to change position at any particular point in the travel of the main device or where the part of the travel where the contacts change position is of no significance in the control or operating scheme. Hence the "a" and "b" designations usually are sufficient for circuit breaker auxiliary switches.

D4.1. Auxiliary Switches with Defined Operating Positions. When it is desired to have the auxiliary, position, or limit switch designation indicate at what point of travel the contacts change position, as is sometimes necessary in the case of valves and for other main devices, then an additional letter (or a percentage figure, if required) is added (as a suffix to the "a" or "b" designation) for the purpose.

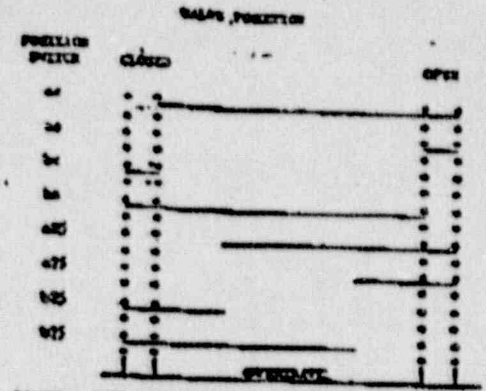
For a valve, the method of designating such position switches is shown in the diagram and legend in figure 1. There are thus two points to consider in visualizing or describing the operation of these position switches. The first is whether the contact is an "a" or "b" as indicated by the first letter. The second is where the contact changes position, either at or near:

(1) The closed position of the valve (c)

(2) The open position of the valve (o), or

(3) A specified percentage such as 25 percent of the full open position, as for example 25.

When applied to devices other than valves, gates, circuit breakers, and switches for which the letters "o" and "c" are used for "open" and "closed," respectively, it will be necessary to use other applicable letters. For example, for such devices as a clutch, turning gear, rheostat, electrode, and adjusting device, the letters "d," "e," "h," "l," "u," and "d" meaning "disengaged," "engaged," "high," "low," "up," and "down," respectively, are applicable. Also, other appropriate suffix letters may be used for special "a" or "b" position switches, when these are considered more appropriate and if their meaning is clearly indicated. For example, in the case of an early opening auxiliary switch on a power circuit breaker, adjusted to open when the breaker is tripped before the main contacts part, it may be thus described and then designated as an "ae" auxiliary switch.



LEGEND: SOLID LINE INDICATES SWITCH CONTACT CLOSED

Each of the eight valve positions can be described as follows:

ac - "a" contact which changes position at or near the closed position of the valve, i.e., open only when valve is fully closed

ao - "a" contact which changes position at or near the open position of the valve, i.e., closed only when valve is fully open

bc - "b" contact which changes position at or near the closed position of the valve, i.e., closed only when valve is fully closed

bo - "b" contact which changes position at or near the open position of the valve, i.e., open only when valve is fully open

a25 - "a" contact which changes position when valve is 25 percent open, i.e., closed only when valve is open 25 percent or more

a75 - "a" contact which changes position when valve is 75 percent open, i.e., closed only when valve is open 75 percent or more

b25 - "b" contact which changes position when valve is 25 percent open, i.e., closed only when valve is open less than 25 percent

b75 - "b" contact which changes position when valve is 75 percent open, i.e., closed only when valve is open less than 75 percent

FIGURE 1

VALVE

D4.2. Auxiliary Switches for Devices Without a Standard Reference Position. In designating position switches for such a special device as, for example, a fuel transfer device, which has no standard reference or nonoperated position and may be placed in either extreme or any intermediate position for normal operation, "a" and "b" designations are still applicable. However, a percentage figure of one of the "full open" or "on" positions should always be used, and for the sake of consistency, this percentage should always be in terms of the position which is 50 percent or more of "full open" or "on," as shown in figure 2.

Adopted from ASA and NEMA Standards.

This Drawing Supersedes Drawings: 30A553, 30A554, and 30A555.

ELECTRICAL STANDARDS

DEVICE NUMBERS AND FUNCTIONS SHEET 8

DESIGN AND DRAFTING STANDARDS
TENNESSEE VALLEY AUTHORITY

KNOXVILLE 6-16-65 C E D 30A574-8R0

GILBERT/COMMONWEALTH
SQN SITE
FAX - (615)-843-7443

DATE 2-22-90

TO: Nancy Closky
LOCATION: Westinghouse
TELEPHONE #: 412-374-5946

FROM: Stephen Barkofski / T.D. Patel
LOCATION: SEQUOYAH
TELEPHONE #: 615-843-6475 / 7417

Nancy if you need additional information please call me or TD Patel

[signature]

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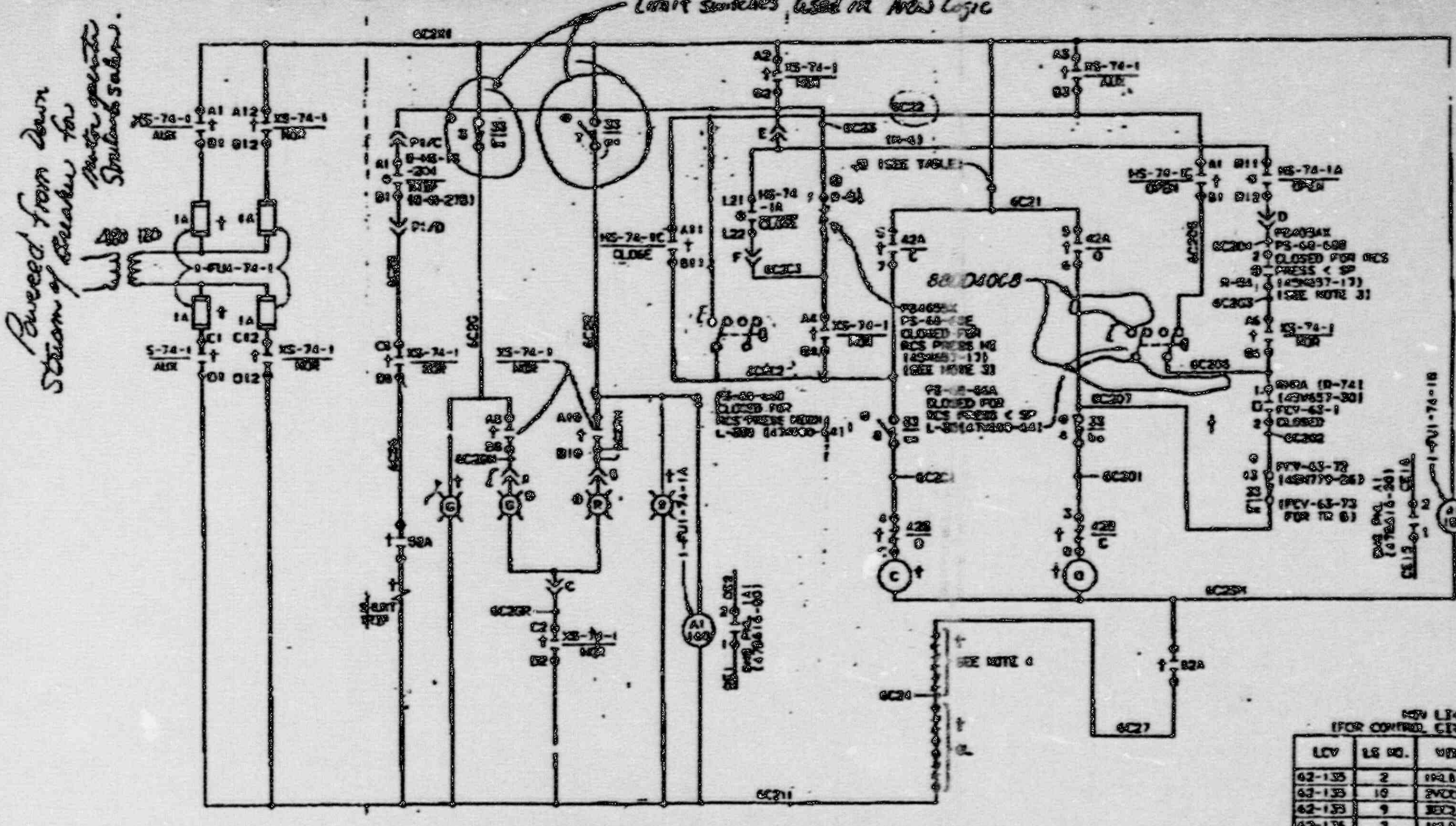


MOTOR OPERATED VALVE FCV-74-1

(SCHEMATIC SHOWN TYPICAL FOR THREE LISTED)

88D04008

SUPPLY	WIRE PREFIX				PRESSURE SWITCH	FUSE UNIT'S

MOV LIS
(FOR CONTROL CIRC

LCV	LS NO.	VIRE
62-135	2	[illegible]
62-135	10	[illegible]
62-135	9	[illegible]
62-136	2	[illegible]
62-136	10	[illegible]
62-136	9	[illegible]

FEB-22-'90 THU 17:18 ID:G/C-WHSE-TLK-15 TEL NO:615-843-7443 #975 P03

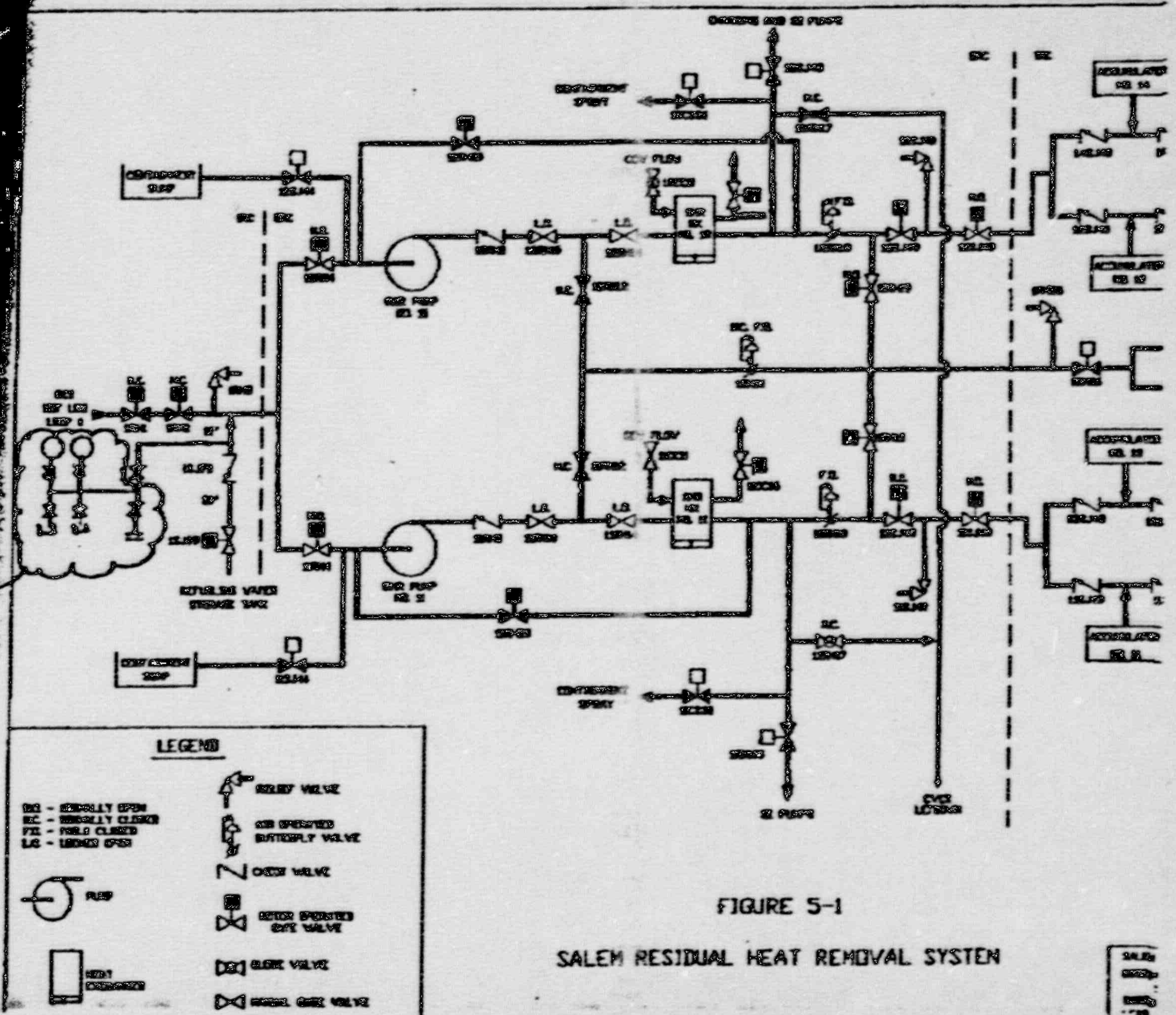
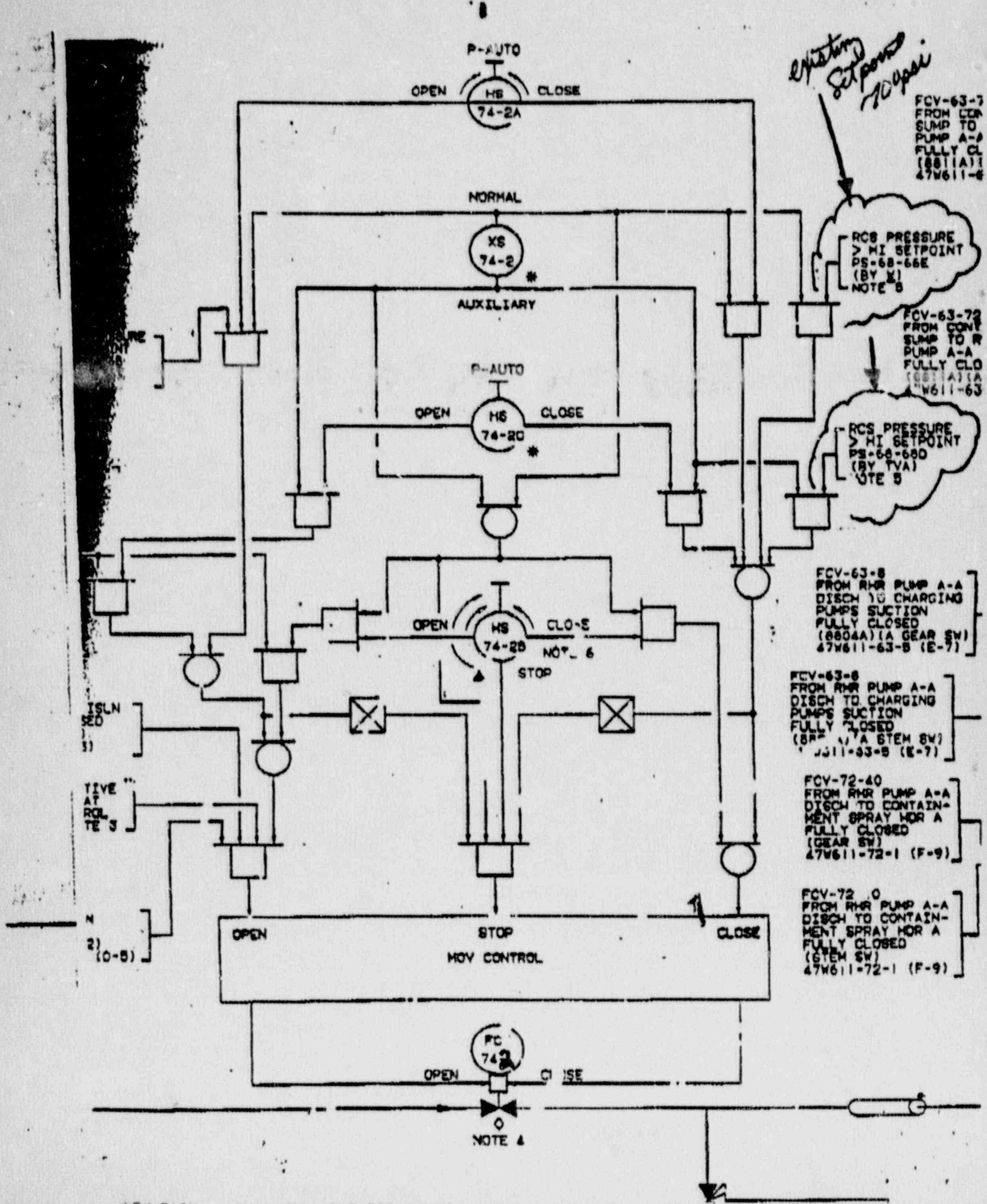
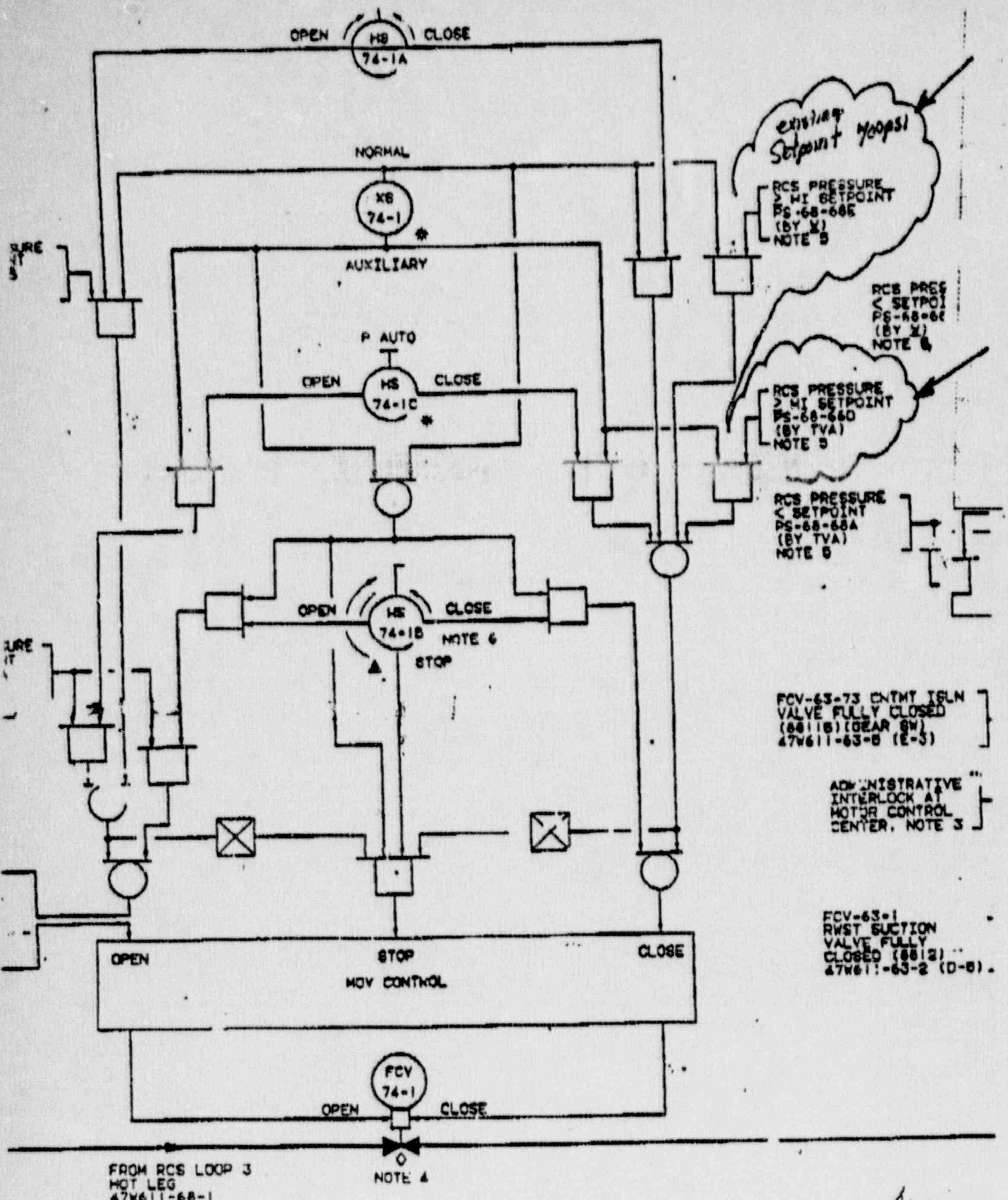


FIGURE 5-1

SALEM RESIDUAL HEAT REMOVAL SYSTEM



P-AUTO
OPEN
HS 74-2A
CLOSE
existing setpoint 70 psi
FCV-63-7
FROM CON
SUMP TO
PUMP A-A
FULLY CL
NORMAL
XS 74-2
AUXILIARY
RCS PRESSURE > HI SETPOINT PS-68-66E (BY X) NOTE 5
FCV-63-72
FROM CONT
SUMP TO R
PUMP A-A
FULLY CLO
P-AUTO
OPEN
HS 74-20
CLOSE
RCS PRESSURE > HI SETPOINT PS-68-66D (BY TVA) NOTE 5
FCV-63-8 FROM RHR PUMP A-A DISCH TO CHARGING PUMPS SUCTION FULLY CLOSED (8804A)(A GEAR SW) 47W611-63-5 (E-7)
OPEN
HS 74-20
CLOSE
NOTE 6
STOP
FCV-63-8 FROM RHR PUMP A-A DISCH TO CHARGING PUMPS SUCTION FULLY CLOSED
FCV-72-40 FROM RHR PUMP A-A DISCH TO CONTAINMENT SPRAY HDR A FULLY CLOSED (GEAR SW) 47W611-72-1 (F-9)
FCV-72 0 FROM RHR PUMP A-A DISCH TO CONTAINMENT SPRAY HDR A FULLY CLOSED (STEM SW) 47W611-72-1 (F-9)
ISLN
SED
TIVE
AT
ROL
TE 3
N
2)
(0-5)
OPEN
STOP
CLOSE
MOV CONTROL
FC 742
OPEN
CLOSE
NOTE 4



FEB-22-'90 THU 17:19 ID:G/C-WHSE-TLR-15 TEL NO:615-843-7443 #975 P05

GILBERT/COMMONWEALTH
SQN SITE
FAX - (615)-843-7443

DATE 2-22-90

TO: Nancy Closky
LOCATION: Westinghouse
TELEPHONE #: 412-374-5946

FROM: Stephen Barkofski / T.D. Patel
LOCATION: SEQUOYAH
TELEPHONE #: 615-843-6475 / 7417

Nancy if you need additional information please call me or TD Patel

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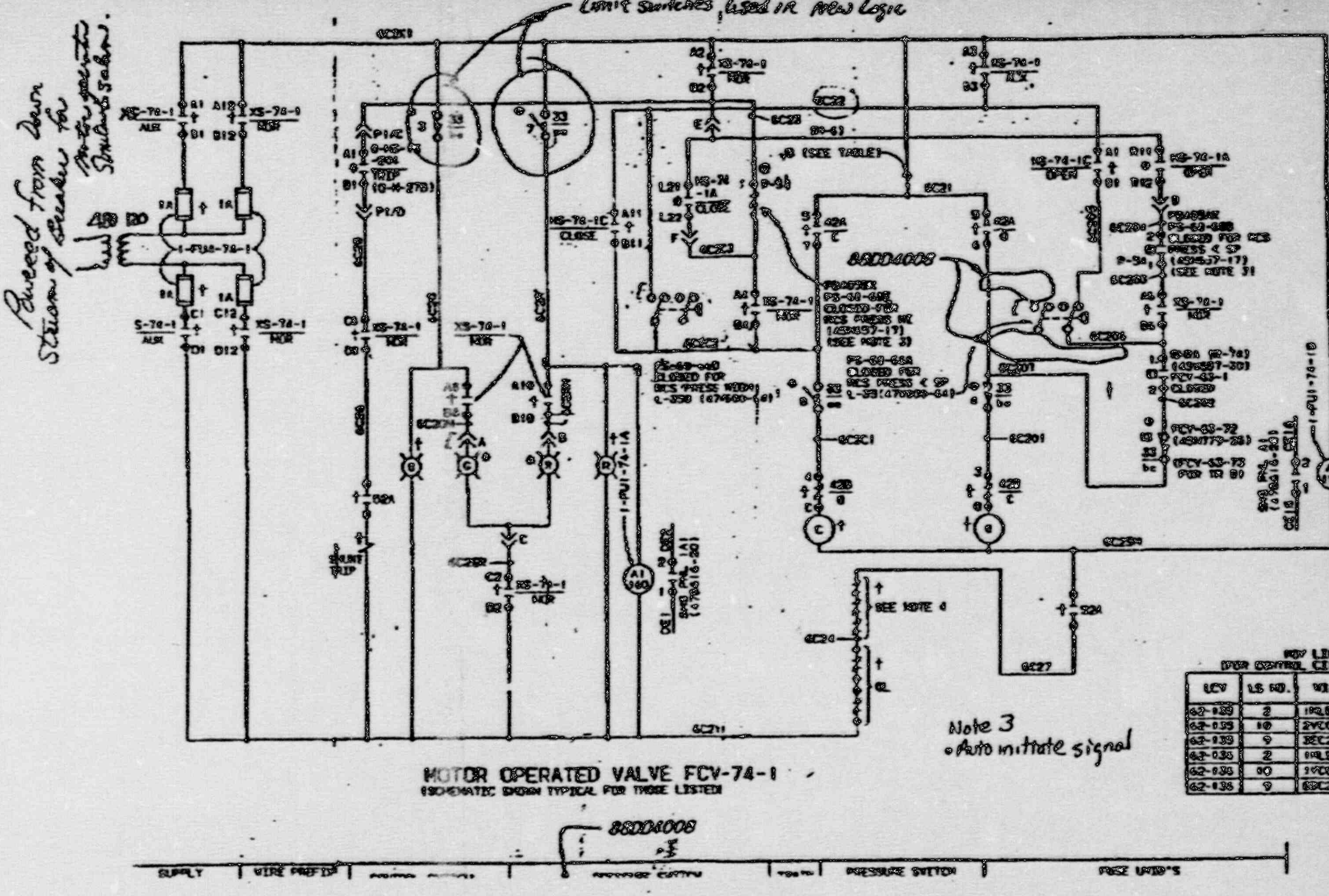


MOTOR OPERATED VALVE FCV-74-1
(SCHEMATIC SHOWN TYPICAL FOR THOSE LISTED)

MOV LIMI(T)
(FOR CONTROL CIRC)

LCV	LS NO.	WIRE
62-139	2	1PLB1
62-139	10	2VCCX
62-139	9	3EC2/
62-136	2	1PLB3
62-136	10	1VCCX
62-136	9	3EC2/

FEB-26-'90 MON 17:02 ID:G/C-WHSE-TLR-15 TEL NO:615-843-7443 #000 P03

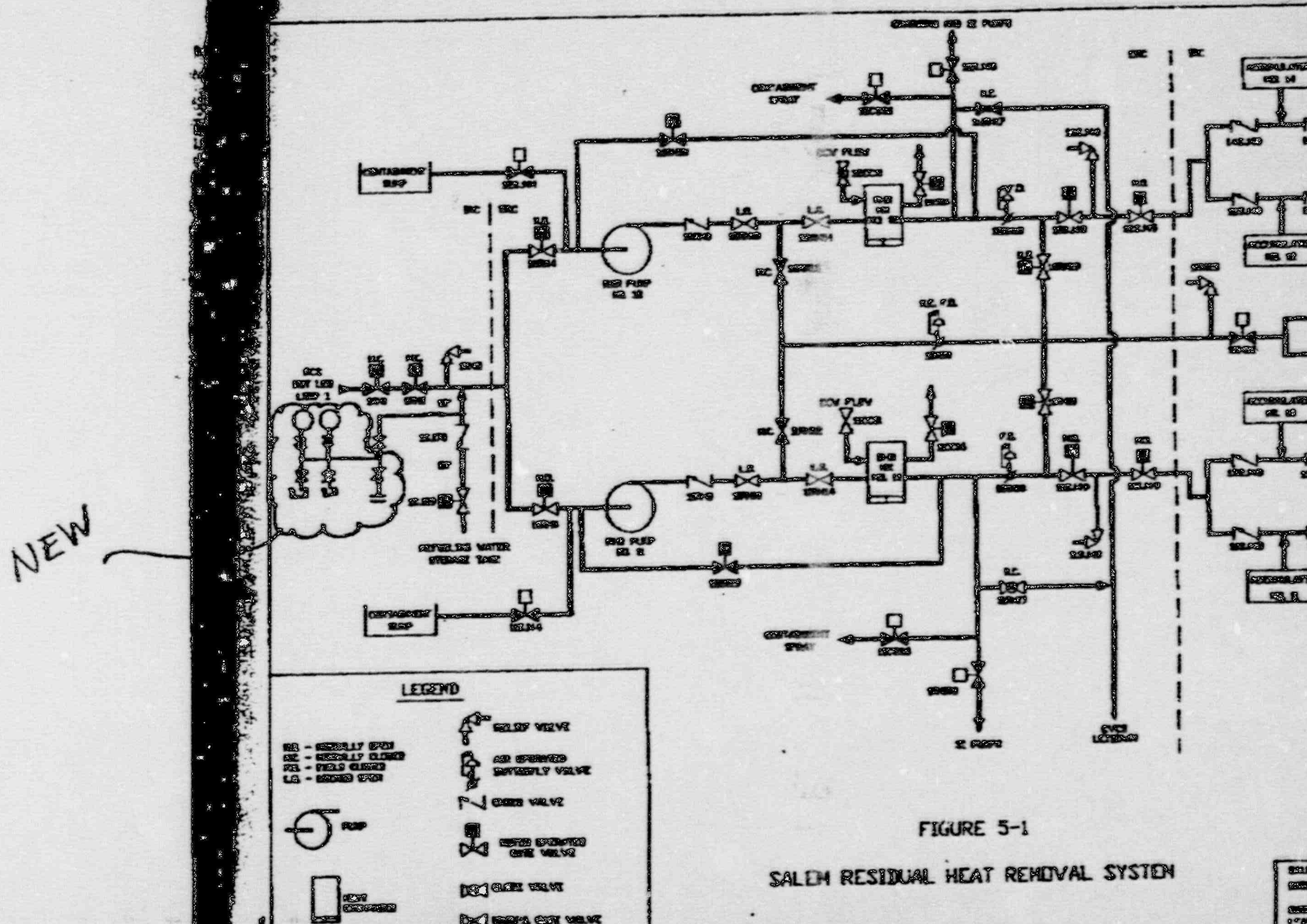
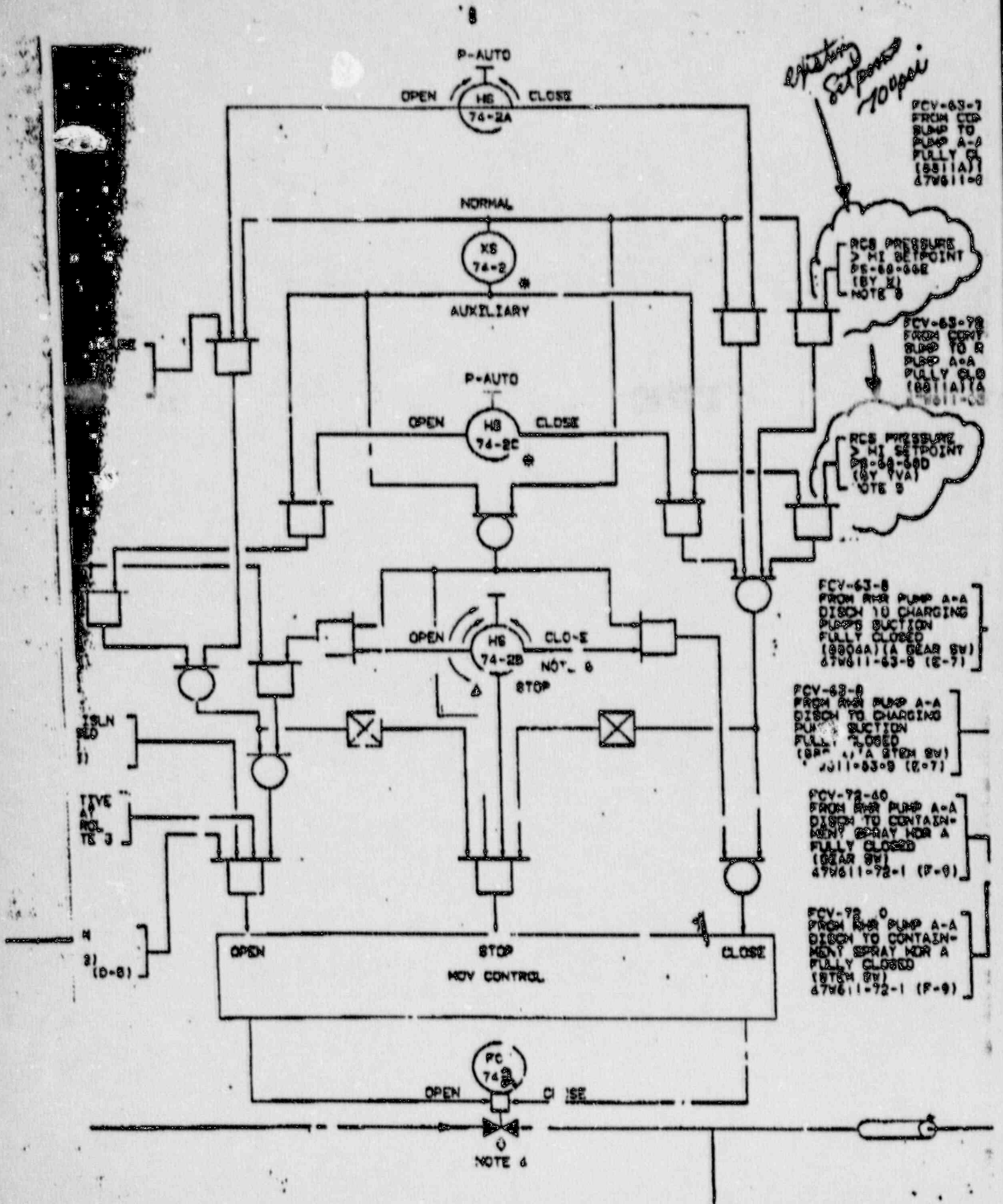
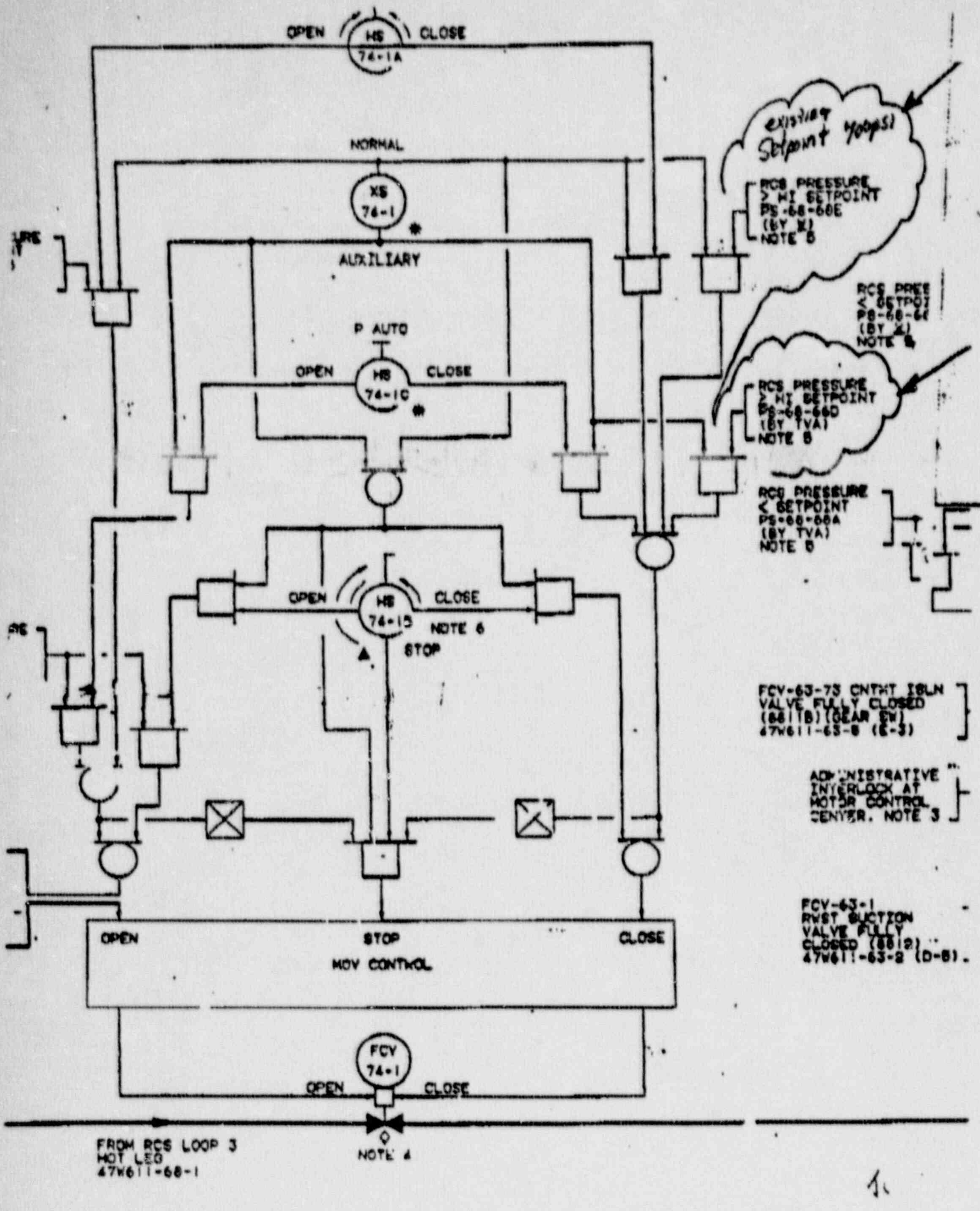


FIGURE 5-1

SALEM RESIDUAL HEAT REMOVAL SYSTEM


P-AUTO
OPEN
HS 74-2A
CLOSE
NORMAL
XS 74-2
AUXILIARY
HS 74-2C
HS 74-2B
STOP
OPEN
STOP
CLOSE
MOV CONTROL
NOTE 4
RCS PRESSURE > HI SETPOINT
FCV-63-8 FROM RHR PUMP A-A DISCH TO CHARGING PUMPS SUCTION FULLY CLOSED
FCV-63-9 FROM RHR PUMP A-A DISCH TO CHARGING
FCV-72-40 FROM RHR PUMP A-A DISCH TO CONTAINMENT SPRAY HDR A FULLY CLOSED (GEAR SW)
FROM RHR PUMP A-A DISCH TO CONTAINMENT SPRAY HDR A FULLY CLOSED (STEM SW)



OPEN
HS 74-1A
CLOSE
existing Setpoint 400psi
NORMAL
XS 74-1
AUXILIARY
RCS PRESSURE > HI SETPOINT PS-68-66E (BY X) NOTE 5
P AUTO
OPEN
HS 74-1C
CLOSE
RCS PRESSURE > HI SETPOINT PS-68-66D (BY TVA) NOTE 5
RCS PRESSURE < SETPOINT PS-68-66A (BY TVA) NOTE 5
OPEN
HS 74-15
CLOSE
NOTE 6
STOP
FCV-63-73 CNTMT ISLN VALVE FULLY CLOSED (BB1TB)(GEAR SW) 47W611-63-8 (E-3)
ADMINISTRATIVE INTERLOCK AT MOTOR CONTROL CENTER. NOTE 3
FCV-63-1 RWST SUCTION VALVE FULLY CLOSED (BB12) 47W611-63-2 (D-8)
OPEN
STOP
CLOSE
MOV CONTROL
FCV 74-1
OPEN
CLOSE
FROM RCS LOOP 3 HOT LEG 47W611-68-1
NOTE 4

GILBERT/COMMONWEALTH
SQN SITE
FAX - (615)-843-7443

DATE 2-28-90

TO: Nancy Closky

LOCATION: Westinghouse

TELEPHONE #: 412-374-5916 (FAX # 412-374-5744 or 5730)

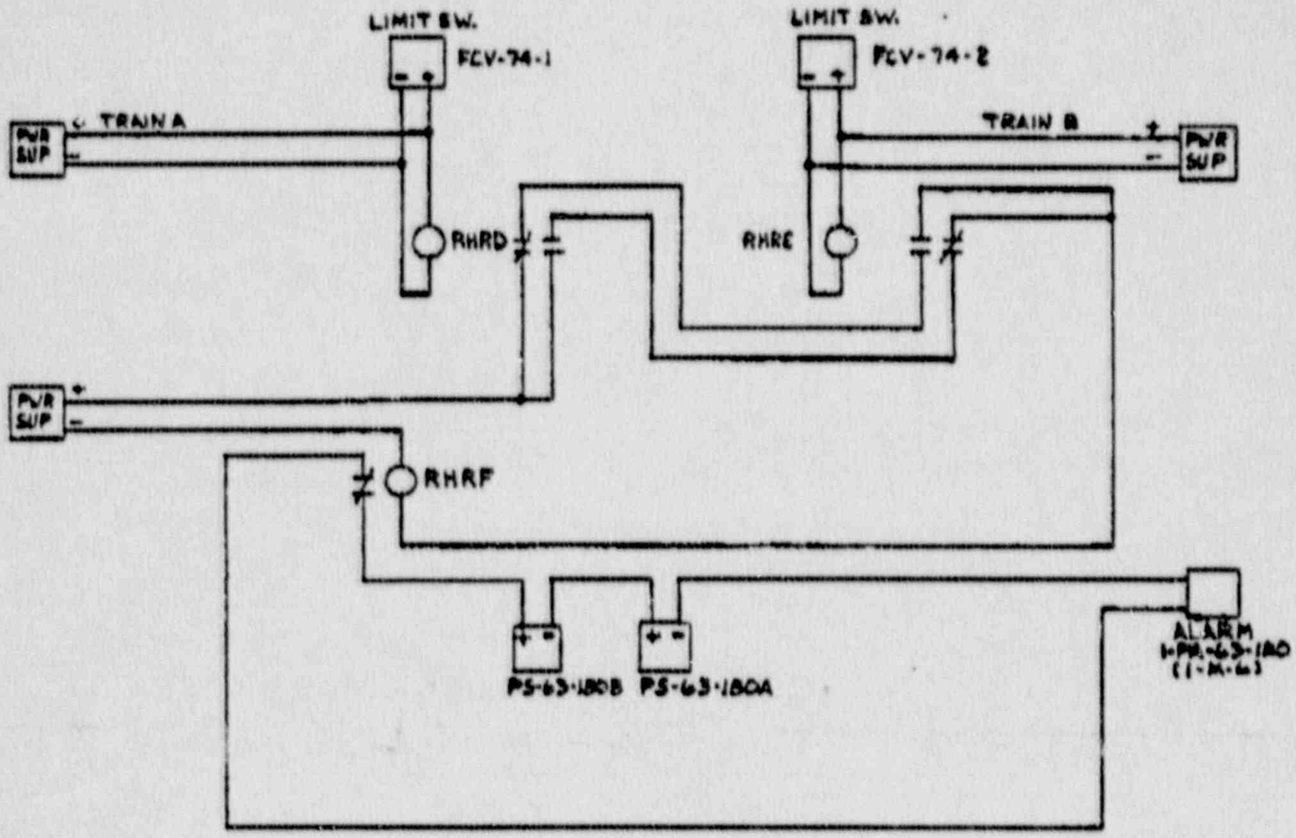
FROM: Stephen Boeksiki

LOCATION: Trailer #14

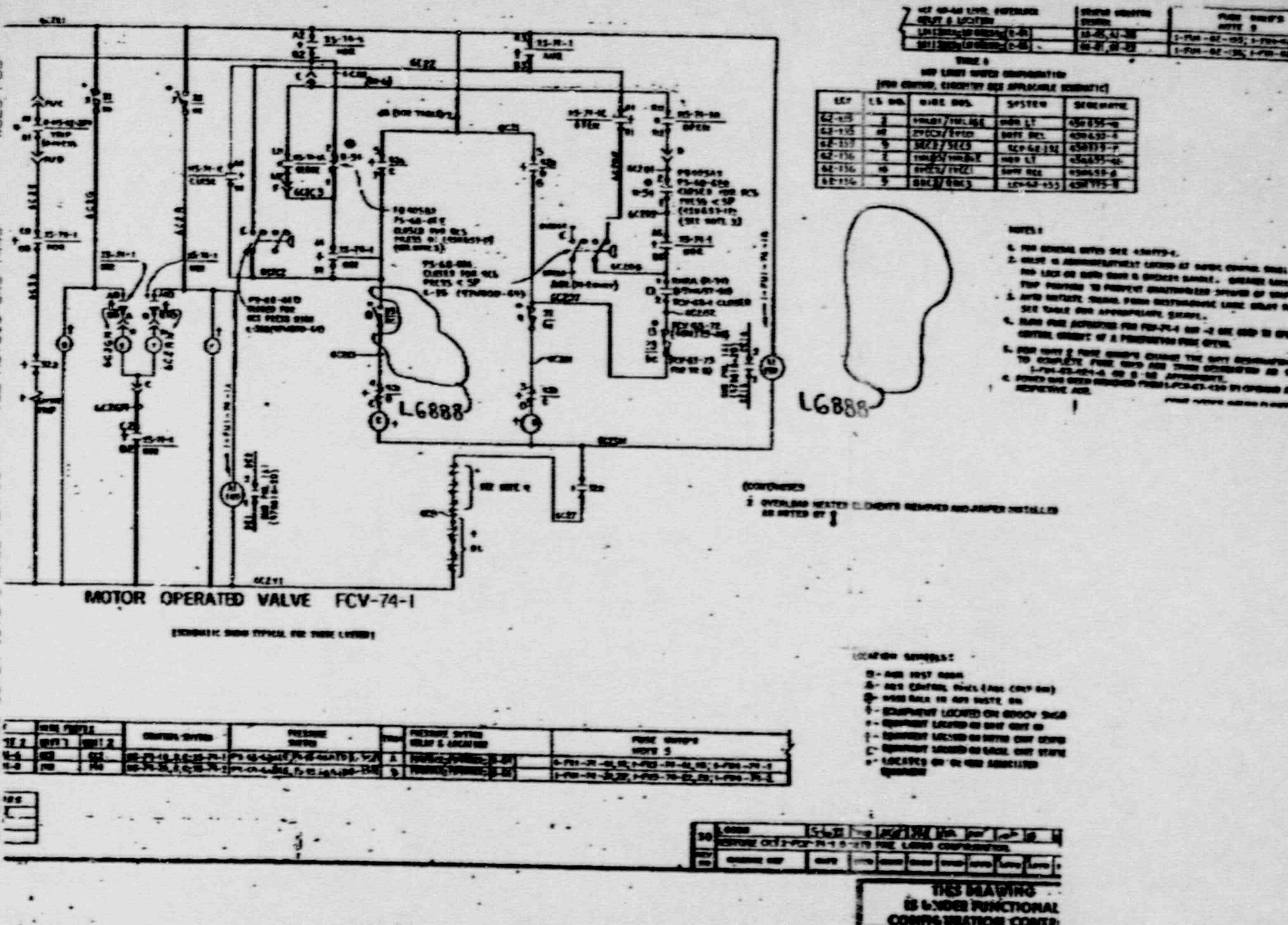
TELEPHONE #: 615-843-6475

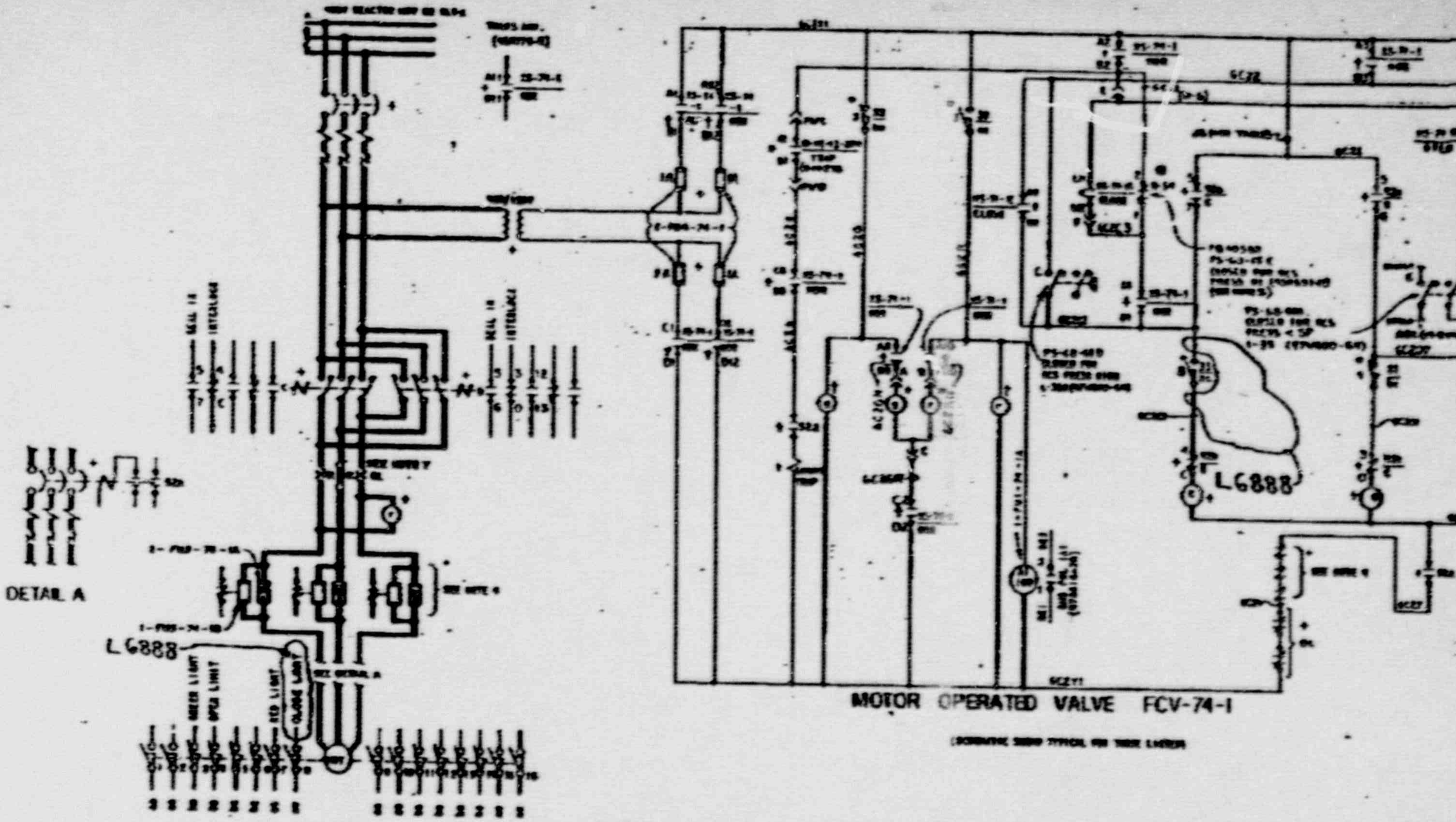
TOTAL NO. OF PAGES: COVER SHEET + 4

Gilbert/Commonwealth ENGINEERS/CONSULTANTS	SUBJECT		IDENTIFIER		PAGE OF PAGES
	REV. 0	1	2	3	
	MICROFILMED				
	ORIGINATOR				
	DATE				



SEQUOYAH RHR SUCTION/ISOLATION VALVE ALARM CIRCUITRY FCV-74-1 AND FCV-74-2


L6888
L6888
MOTOR OPERATED VALVE FCV-74-1
THIS DRAWING
IS UNDER FUNCTIONAL
CONFIGURATION CONTR



TVA VALVE NO.	W VALVE NO.	STATOR STARTER STATED	VALVE NOMENCLATURE		SUPPLY UNIT 1	SUPPLY UNIT 2	UNIT 1	UNIT 2	CONTROL SWITCH	PRESSURE SWITCH	TRAIN	PRESSURE SWITCH RELAY & LOCATION	
FCV-74-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	A	[illegible]	[illegible]
FCV-74-2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	B	[illegible]	[illegible]

CONT RELAY	SHUNT TRIP BKR LOC UNIT 1	SHUNT TRIP BKR LOC UNIT 2	SHUNT TRIP CONT SWITCH	SHUNT TRIP KB CONNECTIONS UNIT 1	SHUNT TRIP KB CONNECTIONS UNIT 2	PROOF ID (SEE TABLE) UNIT 1	PROOF ID (SEE TABLE) UNIT 2
[illegible]	9C	9C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7B	7B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUBJECT		IDENTIFIER		PAGE
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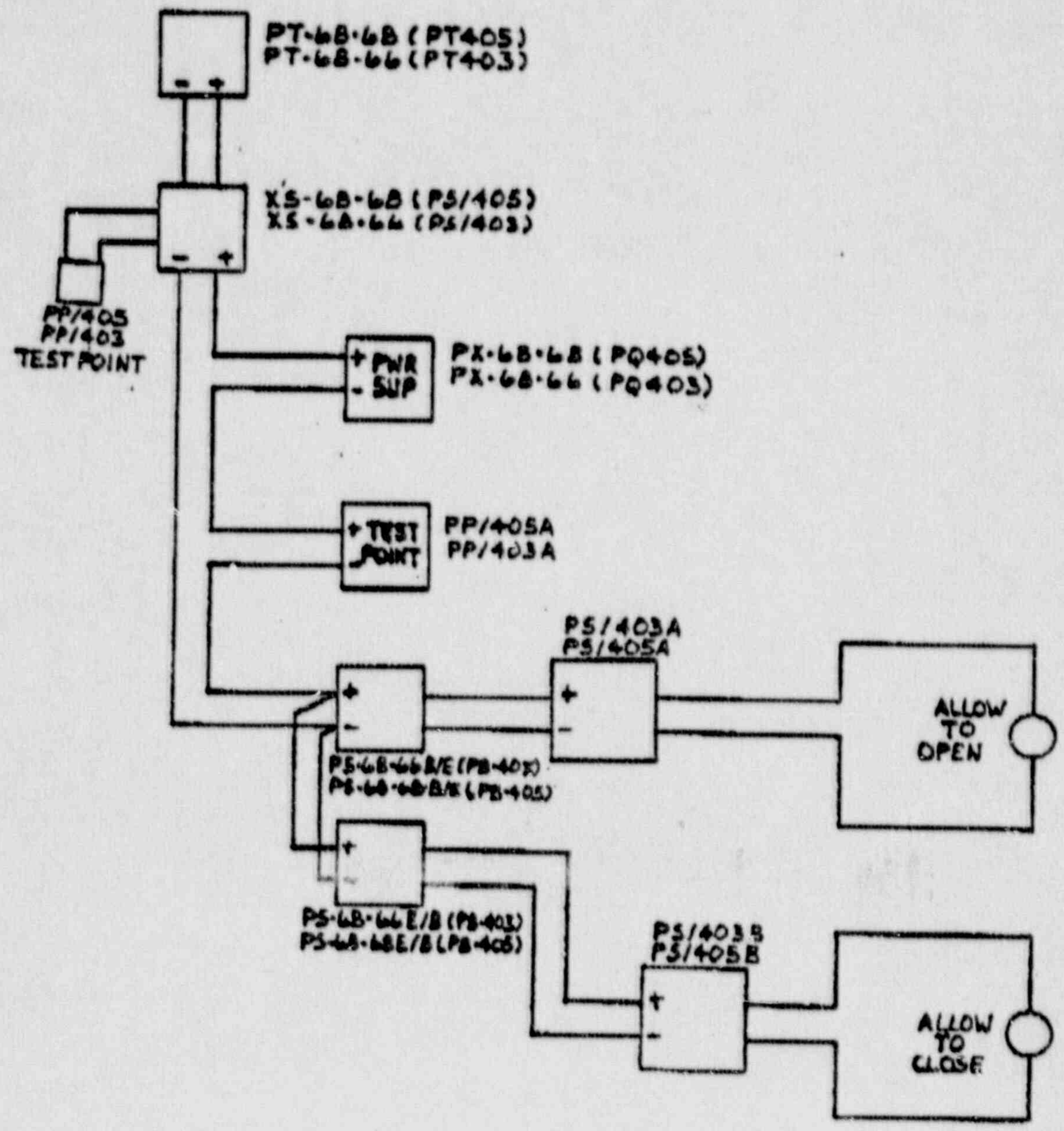

SEQUOYAH RHR SUCTION CONTROL CIRCUITRY
FCV-74-1 AND FCV-74-2

TABLE 11

TABLE C-8

SALEM
DOMINANT CONTRIBUTORS
LOSS OF LONG TERM COOLING
WITHOUT AUTOCLOSURE INTERLOCK

MEAN PROBABILITY OF FAILURE = 1.20E-02

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	1.	1.02E-02	PUMP NO. 12 FAILS TO RUN FOR SIX WEEKS PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	2.	1.02E-03	PUMP NO. 12 FAILS TO START ON DEMAND PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	3.	2.81E-04	PUMP NO. 12 UNAVAILABLE DUE TO TEST PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	4.	2.02E-04	RHR DISCHARGE VALVE ~~11SJ49~~ SPURIOUSLY CLOSES FCV-63-93
YES	5.	2.02E-04	RHR DISCHARGE VALVE ~~12SJ49~~ SPURIOUSLY CLOSES (MOV) FCV-63-94
YES	6.	1.59E-04	PUMP NO. 12 UNAVAILABLE DUE TO MAINTENANCE PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	7.	2.04E-05	PUMP SUCTION VALVE ~~12RH4~~ SPURIOUSLY CLOSES FCV-74-21 PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	8.	2.04E-05	PUMP DISCHARGE CHECK VALVE ~~12RH8~~ FAILS TO OPEN 74-515 PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	9.	2.04E-05	HEAT EXCH. 12 FAILS TO REMOVE HEAT (CCW VALVE SPURIOUS CLOSE) PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	10.	2.04E-05	PUMP NO. 12 FAILS TO RUN FOR SIX WEEKS PUMP SUCTION VALVE ~~11RH4~~ SPURIOUSLY CLOSES FCV-74-3
YES	11.	2.04E-05	PUMP NO. 12 FAILS TO RUN FOR SIX WEEKS HEAT EXCH. 11 FAILS TO REMOVE HEAT (CCW VALVE SPURIOUS CLOSE)
YES	12.	2.04E-05	CROSSTIE VALVE ~~11RH19~~ SPURIOUSLY CLOSES FCV-74-33 PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	13.	2.04E-05	CROSSTIE VALVE ~~12RH19~~ SPURIOUSLY CLOSES FCV-74-35 PUMP NO. 11 FAILS TO RUN FOR SIX WEEKS
YES	14.	2.04E-05	CROSSTIE VALVE ~~11RH19~~ SPURIOUSLY CLOSES FCV-74-33 PUMP NO. 12 FAILS TO RUN FOR SIX WEEKS

TABLE 11 (cont.)

TABLE C-8 (Cont)

SALEM
DOMINANT CONTRIBUTORS
LOSS OF LONG TERM COOLING
WITHOUT AUTOCLOSURE INTERLOCK

MEAN PROBABILITY OF FAILURE = 1.20E-02

APPLICABLE TO SQN		PROBABILITY	CUTSET DESCRIPTION
YES	15.	2.04E-05	CROSSTIE VALVE ~~12RH19~~ FCV-74-35 SPURIOUSLY CLOSES PUMP NO. 12 FAILS TO RUN FOR SIX WEEKS
YES	16.	2.02E-05	LOCKIN CIRCUITRY FAILURE CONTACT ~~9/C~~ 42A/C SHORTS CLOSED (~~1RH1~~)(74-1)
NO	17.	2.02E-05	CLOSE RELAY COIL CONTACT 5/CSV1 FAILS (1RH1)
YES	18.	2.02E-05	CLOSE CONTACT ~~1/CLOSE~~ SHORTS (1RH1) HS-74-1A/CLOSE
YES	19.	2.02E-05	LOCKIN CIRCUITRY FAILURE CONTACT ~~9/C~~ 42A/C SHORTS CLOSED (~~1RH2~~)(74-2)
NO	20.	2.02E-05	CLOSE RELAY COIL CONTACT 5/CSV1 FAILS (1RH2)

4.04E-05 TOTAL PROBABILITY OF NON-APPLICABLE CUTSETS

3.3 Low Temperature Overpressurization

The effect of an overpressure transient at cold shutdown conditions will be altered by removal of the autoclosure interlock. With removal of the interlock, the RHRS may also be subject to overpressure. However, the RHRS relief valve will be available to mitigate the transient. These two trade-offs are examined by performing an analysis to model the mitigating actions (both automatic and manual) following the occurrence of low temperature overpressure events. These mitigating actions affect the severity of the overpressurization events and reduce the possibility of damage to the plant.

The results of the overpressurization analysis in WCAP-11736-A showed that removal of the ACI feature has no effect on the heat input transients examined and results in a slight increase (on the order of 1E-10) in the frequency of occurrence for some categories of the mass input transients with a decrease in others. The results for Salem are shown in Tables 12, 13 and 14 for the charging/safety injection case and the letdown isolation/RHR operable and RHR isolated cases.

The event tree node that is impacted by the autoclosure interlock is the node RSV (RHR suction valves close on overpressure via autoclosure interlock) and OD (RHR suction valves close on overpressure via operator action given alarm). The Salem analysis assumed that on an overpressure event, only one of two RHR suction valves must close. The fault trees developed for these nodes examined the failure modes which would have both valves failing to close.

For the case with the autoclosure interlock, the additional failure modes that would be included for Sequoyah for a suction valve failing to close (previously identified in the interfacing system LOCA analysis) involved components located in the control circuit for the valves and not the autoclosure interlock circuit (i.e., the shunt trip circuit, the additional circuit breaker to the valve motor and the power supply contacts XS-74-1/NOR). These components would also be included in the valve failing to close in the case without the autoclosure interlock. Thus, the analysis for Salem would not be significantly altered for Sequoyah for this event tree node and the Salem analysis is applicable for Sequoyah.

TABLE 12
TABLE D-9

SALEM
CHARGING/SAFETY INJECTION ACTUATION
RESULTS

CONSEQUENCE CATEGORY	FREQUENCY WITH ACI	FREQUENCY WITHOUT ACI	FREQUENCY CHANGE
SUCCESS	8.91E-02	8.91E-02	-
LSFO	2.47E-03	2.47E-03	-
LSCI	0	0	-
LSCO	0	0	-
LLFO	4.30E-06	4.30E-06	-
LLCO	3.00E-02	3.00E-02	-
LLCI	3.30E-03	3.30E-03	-
LSFI	3.95E-13	9.38E-12	+9E-12
LLFI	4.82E-07	4.82E-07	-
MSFO	2.63E-12	8.34E-11	+8.1E-11
MLFO	0	0	-
MSFI	7.74E-05	7.74E-05	-
MLFI	0	0	-
MSCO	4.54E-12	1.44E-10	+1.4E-10
MSCI	5.56E-05	5.56E-05	-
MLCO	0	0	-
MLCI	0	0	-
MOPI	1.45E-05	1.45E-05	-
HOPI	1.96E-05	1.96E-05	-
HOPV	5.10E-15	1.34E-11	+1.3E-11
TOTAL	1.25E-01	1.25E-01	

TABLE 13
TABLE D-10

SALEM
LETDOWN ISOLATION RHR OPERABLE
RESULTS

CONSEQUENCE CATEGORY	FREQUENCY WITH ACI	FREQUENCY WITHOUT ACI	FREQUENCY CHANGE
SUCCESS	8.89E-02	8.89E-02	-
LSFO	2.75E-03	2.75E-03	-
LSCI	0	0	-
LSCO	3.34E-02	3.34E-02	-
LLFO	1.43E-09	1.43E-09	-
LLCO	9.89E-06	9.89E-06	-
LLCI	0	0	-
LSFI	4.81E-13	4.81E-13	-
LLFI	0	0	-
MSFO	0	0	-
MLFO	0	0	-
MSFI	0	0	-
MLFI	0	0	-
MSCO	0	0	-
MSCI	5.38E-09	5.37E-09	-1E-11
MLCO	0	0	-
MLCI	0	0	-
MOPI	4.84E-09	4.84E-09	-
HOPI	3.02E-09	3.02E-09	-
HOPV	5.66E-15	1.49E-11	+1.5E-11
TOTAL	1.25E-01	1.25E-01	

TABLE 14

TABLE D-11

SALEM
LETDOWN ISOLATION RHR ISOLATED
RESULTS

CONSEQUENCE CATEGORY	FREQUENCY WITH ACI	FREQUENCY WITHOUT ACI	FREQUENCY CHANGE
SUCCESS	3.26E-01	1.63E-01	-1.63E-01
LSFO	0	0	-
LSCI	1.40E-03	6.99E-04	-7E-04
LSCO	0	0	-
LLFO	0	0	-
LLCO	0	0	-
LLCI	1.17E-01	5.85E-02	-5.8E-02
LSFI	1.02E-07	5.07E-08	-5.1E-08
LLFI	1.70E-05	8.48E-06	-8.5E-06
MSFO	0	0	-
MLFO	0	0	-
MSFI	0	0	-
MLFI	0	0	-
MSCO	0	0	-
MSCI	0	0	-
MLCO	0	0	-
MLCI	0	0	-
MOPI	0	0	-
HOPI	3.73E-04	1.86E-04	-1.9E-04
HOPV	0	0	-
TOTAL	4.45E-01	2.22E-01	

In addition, because the pressure switch setpoint on the alarm to be included for Sequoyah is lower than the RHR relief valve setpoint, the operator would have more time in which to diagnose an overpressure event, isolate the RHR system before the overpressure transient caused the RHR relief valve to lift or the RHR system to be overpressurized. This results in an additional benefit for the calculation of the operator error probability used in the case without the autoclosure interlock.

Therefore, the results from the Salem overpressure analysis are applicable to Sequoyah. The conclusion to be drawn from the overpressurization analysis is that removal of the autoclosure interlock has little impact on the consequences of low temperature overpressure events. Furthermore, it should be understood that the autoclosure interlock was not installed to mitigate overpressure transients. The RHR suction valves are slow-acting and the ACI will not protect the RHR system from a fast-acting overpressure transient. The major impact with respect to overpressure concerns is that removal of the autoclosure interlock will significantly reduce the number of letdown isolation transients and the challenges to the operator.

4.0 CONCLUSIONS

Based on the comparative evaluation between Salem and Sequoyah with regard to the deletion of the autoclosure interlock, the three different areas examined indicate that the results and conclusions for Salem in WCAP-11736-A are not invalidated by the proposed change for Sequoyah. The deletion of the ACI and the inclusion of a control room alarm to warn the operator that a series suction/isolation valve is not fully closed or when RCS (or RHR) pressure is above the alarm setpoint is acceptable for Sequoyah.

The results of the different areas of evaluation for Sequoyah are shown below:

	With ACI	Without ACI	Percent Change*
Interfacing System LOCA			
F(VSEQ)	9.49E-07/year	5.77E-07/year	-39
RHRS Unavailability			
RHR Initiation	3.20E-02	3.20E-02	0
Short Term Cooling	1.63E-02	1.40E-02	-14
Long Term Cooling	4.00E-02	1.20E-02	-70
Overpressurization			**

* (-) - Reduction
(+) - Increase

** - Reduction in some categories and a small increase in other categories

Based on the comparative evaluation between Salem and Sequoyah with regard to the deletion of the autoclosure interlock, the three different areas examined indicate that the results and conclusions for Salem in WCAP-11736-A are not invalidated by the proposed change for Sequoyah. The deletion of the ACI and the inclusion of a control room alarm to warn the operator that one series suction/isolation valve is not fully closed or RHR pressure is above the alarm setpoint is acceptable for Sequoyah.

5.0 REFERENCES

1. WCAP-11736-A, "Residual Heat Removal System Autoclosure Interlock Removal Report for the Westinghouse Owners Group," Revision 0.0, October 1989.

APPENDIX A

INFORMATION RECEIVED FROM SEQUOYAH FOR ANALYSES

02/22/1990 11:54 NTB 615 843 5216 P.01

TENNESSEE VALLEY AUTHORITY

Mechanical/Nuclear Engineering Groups
Sequoyah Nuclear Plant
P.O. Box 2000
Soddy-Daisy, Tennessee 37379

Do not write in this space	
Date Sent:	2/22
Verified?	Yes ✓ No

2:30 Sturdis' Office Naomi Earl Gr

FAX Transmittal Sheet

To: LV Tomasic

Address: MEC-E-409

Telephone: 412-374-4715

FAX No. 412-374-5744 Verification No. ____________

From: DM Lafever

Address: DSC-C20 SQN

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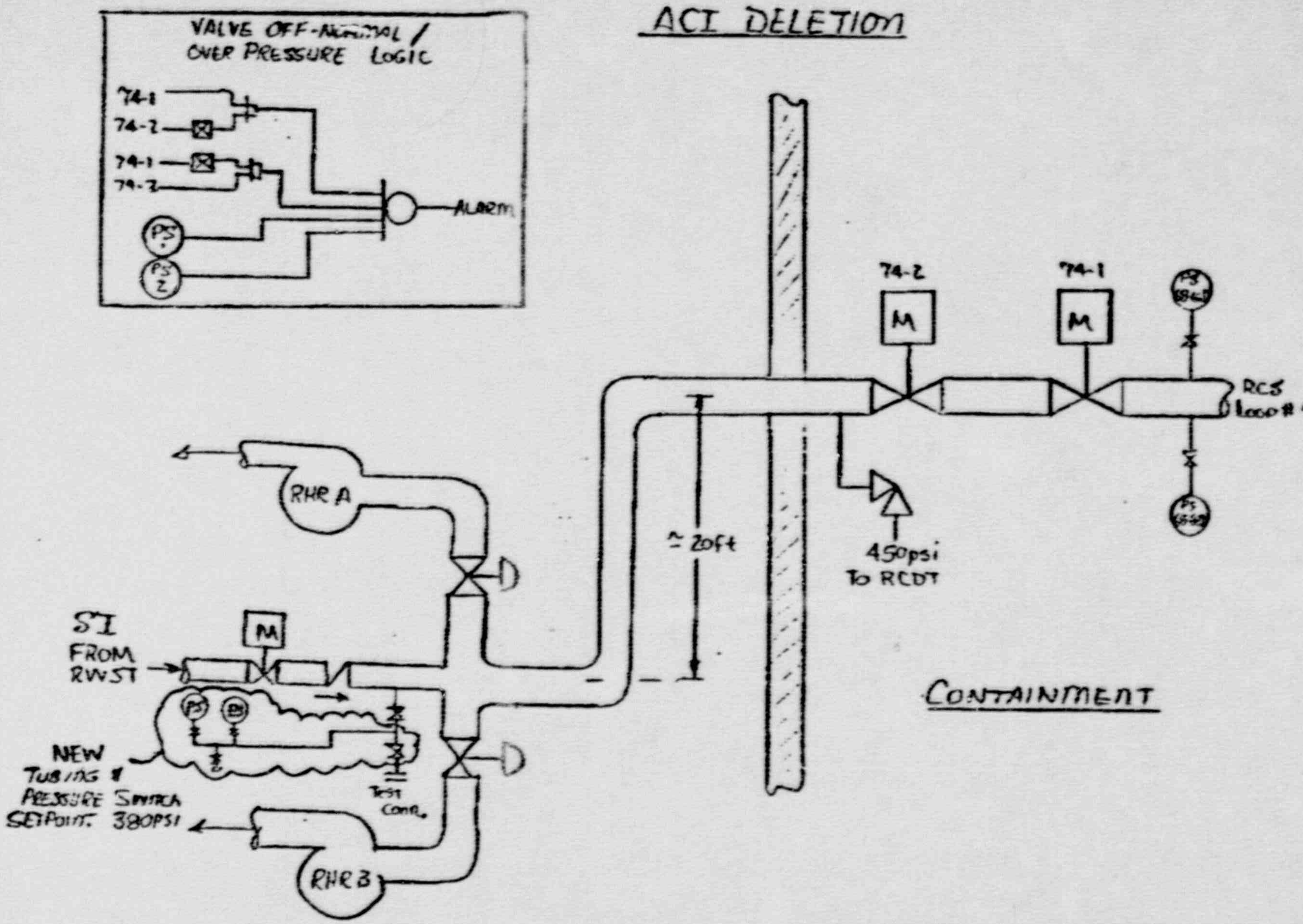
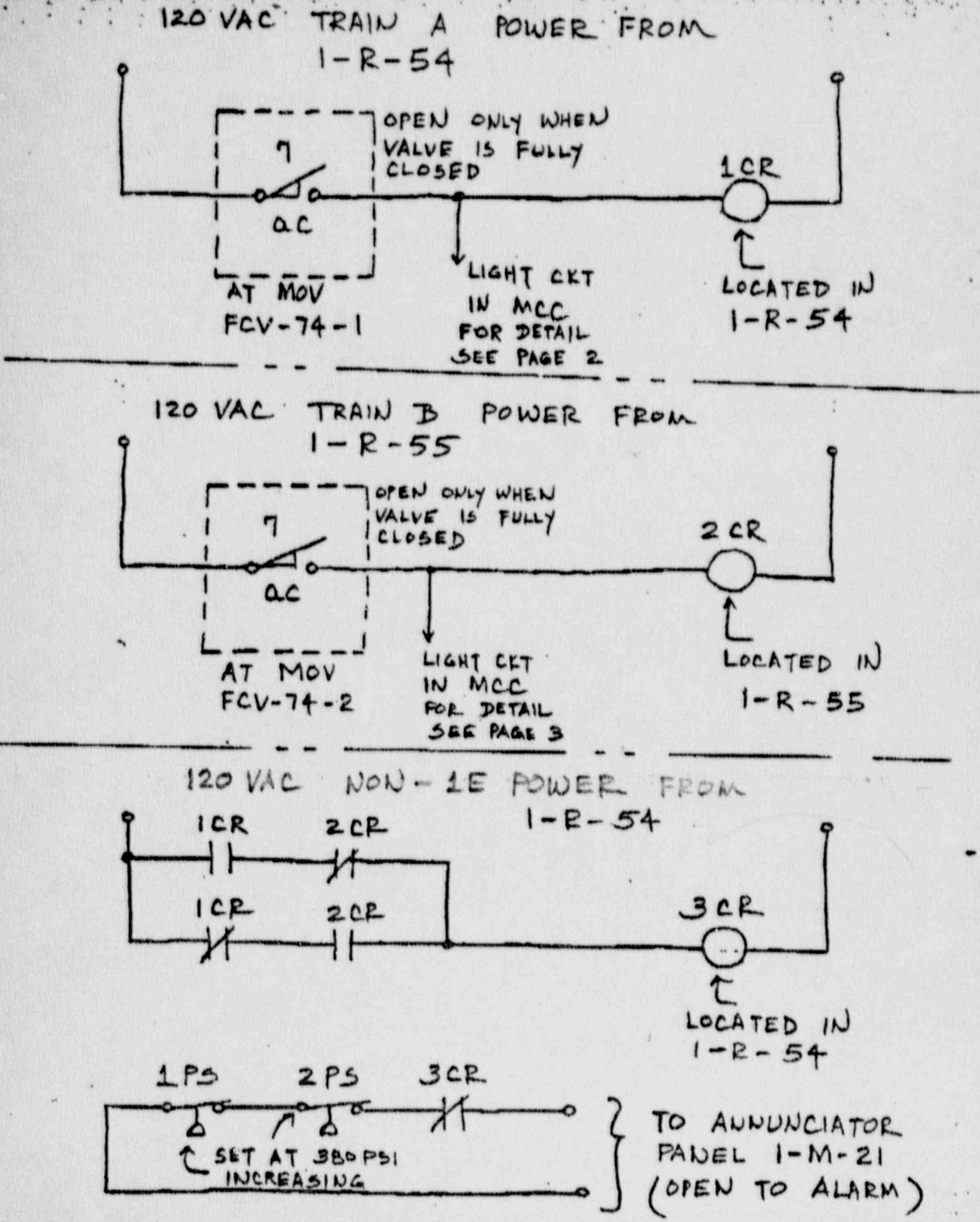
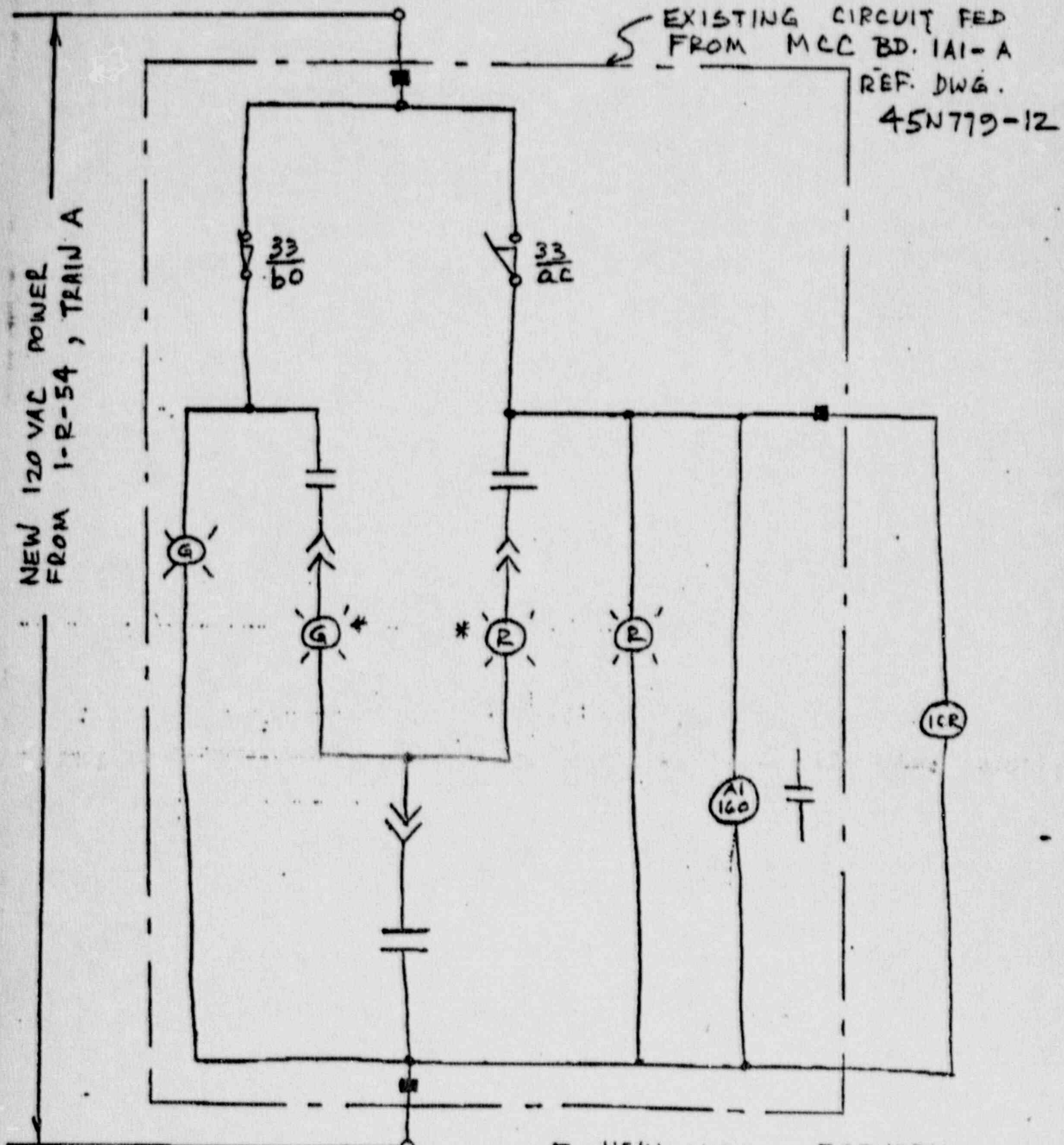
NUMBER OF PAGES (including this page): 6

VA 11030 (WM-7-75)

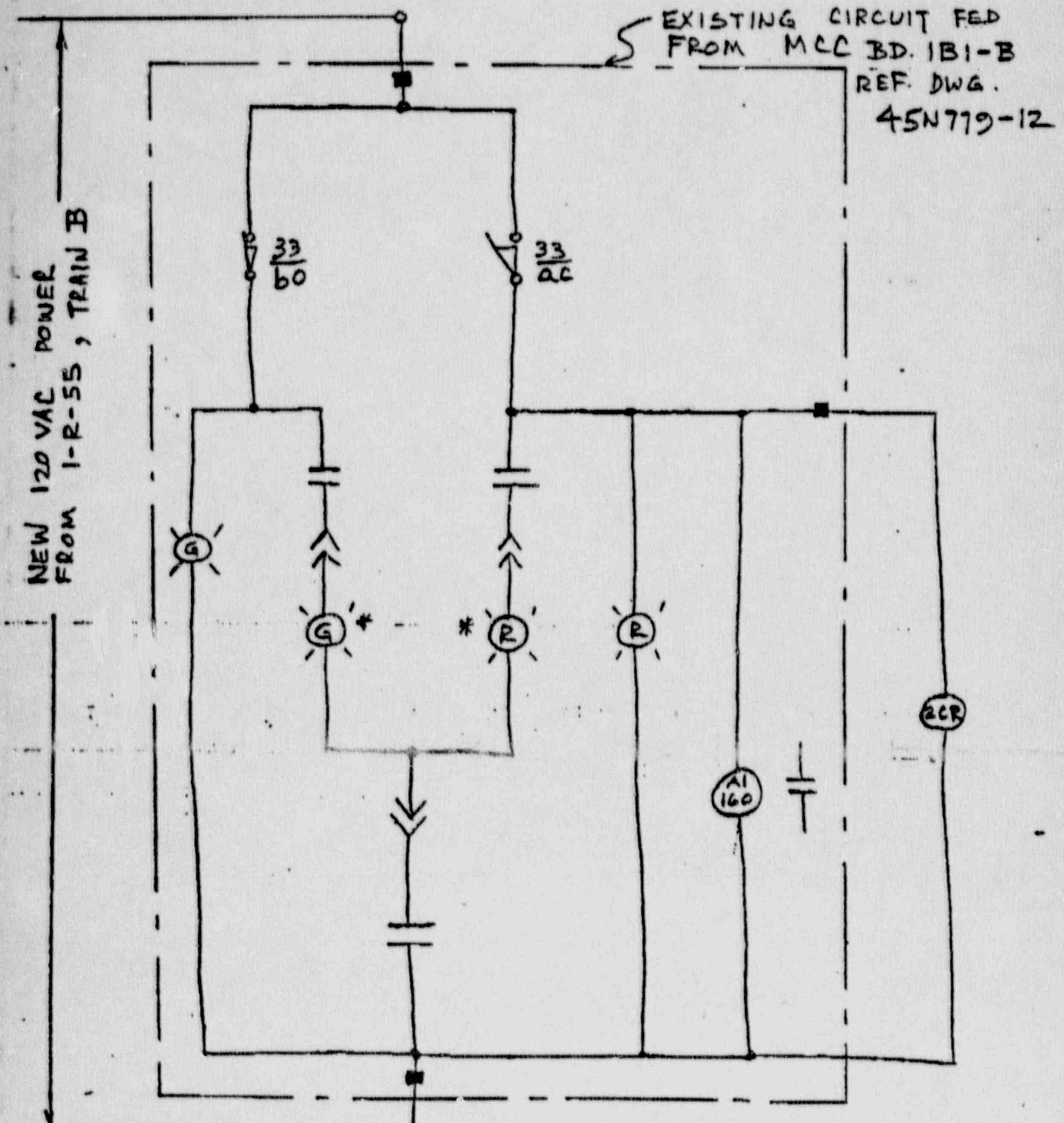
ACI DELETION




120 VAC TRAIN A POWER FROM 1-R-54
OPEN ONLY WHEN VALVE IS FULLY CLOSED
7
ac
1CR
AT MOV FCV-74-1
LIGHT CKT IN MCC FOR DETAIL SEE PAGE 2
LOCATED IN 1-R-54
120 VAC TRAIN B POWER FROM 1-R-55
OPEN ONLY WHEN VALVE IS FULLY CLOSED
7
ac
2CR
AT MOV FCV-74-2
LIGHT CKT IN MCC FOR DETAIL SEE PAGE 3
LOCATED IN 1-R-55
120 VAC NON-1E POWER FROM 1-R-54
1CR
2CR
1CR
2CR
3CR
LOCATED IN 1-R-54
1PS
2PS
3CR
SET AT 380 PSI INCREASING
TO ANNUNCIATOR PANEL 1-M-21 (OPEN TO ALARM)



■ NEW WIRES BETWEEN MCC 1A1-A & RACK 1-R-54



■ NEW WIRES BETWEEN MCC 1B1-B & RACK 1-R-55