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HIGH PRESSURE CORE SPRAY SYSTEM RISK-BASED INSPECTION GUIDE

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1. INTRODUCTION

1.1 Purpose

This HPCS System Risk-Based Inspection Guide (S-RIG) has been developed as an aid to NRC inspection activities at the BWR/5 and BWR/6 plants utilizing HPCS as a means of high pressure injection into the reactor vessel. The document presents a risk-based discussion of the HPCS role in accident mitigation and provides PRA-based HPCS failure modes. Most PRA-oriented inspection plans end here and require the inspector to rely on his experience and knowledge of plant-specific and BWR operating history.

The system RIG goes a step further, however, by using industry operating experience, including illustrative examples, to augment the basic PRA failure modes. The risk-based input and the operating experience are combined to develop a composite BWR HPCS failure ranking. This information may then be used to optimize NRC resources by allocating proactive inspection effort based on both risk and industry experience.

1.2 Scope

The High Pressure Core Spray (HPCS) system has been examined from a risk perspective. Following a brief generalized description of the HPCS system for background information (Section 2), common BWR accident sequences in which HPCS function is required are discussed in Section 3 both to review the system accident mitigation capability, and to identify system unavailability combinations that can greatly increase risk exposure. Section 4 describes the prioritization of the PRA-based HPCS failure modes for inspection purposes, and the results of a review of BWR operating experience are presented in Section 5 to illustrate these failure modes. This inspection guide also provides additional information in related areas such as

HPCS support systems, human errors, system interactions, and valve failures (Section 6). A summary and list of references are provided in Sections 7 and 8, respectively. Modified (based upon risk) HPCS system walkdown tables specific to the HPCS systems found in each individual plant are provided in Appendices A.1 through A.7. A proposed inspection plan for diesel generators at nuclear power plants is given in Appendix B as a guideline for inspections which encompass the HPCS diesel generator.

1.3 Application to Inspections

This inspection guide can be used as a reference for both routine inspections and for identifying the significance of component failures. The information presented in Section 5 can be used to prioritize day-to-day inspection activities and the illustrative HPCS failures can provide multiple inspection perspectives. The system RIG is also useful for NRC inspection activities in response to system failures. The accident sequence scenarios described in Section 3, in conjunction with the discussion of multiple system unavailability (Section 6), provide some insight into combinations of system outages that can greatly increase risk. Within the context of the HPCS system, the operating experience review provides examples of several failure mechanisms (together with the corrective actions implemented and potential areas for inspection) which are useful for the review of licensee response to a system failure. The system RIG can also be used for trending purposes. Table 5-1 provides a summary of the HPCS operating experience, in particular the industry wide distribution of HPCS failures. The summary section presents a compilation of the industry experience with HPCS up to mid-1990. Those HPCS failure modes which account for a larger fraction of the HPCS system failures are candidates for increased inspection activity. Since the plant specific failure distribution is expected to vary over time, the summary includes a mechanism to update and trend each individual plant's HPCS experience, in comparison to the more static industry experience.

2. GENERAL HPCS SYSTEM DESCRIPTION

The High Pressure Core Spray (HPCS) system is a single train, high pressure injection system used in BWR/5 and BWR/6 plants. It includes a single electric motor-driven pump, associated valves, piping, and instrumentation to provide cooling water to the reactor core. A simplified flow diagram is provided in Figure 2-1. The HPCS System, in conjunction with other ECCS, is designed to cool the reactor core sufficiently to prevent fuel cladding temperatures from exceeding 2200°F following any break in the nuclear system piping. The HPCS System is designed to pump water into the core over a wide range of pressures from SRV lift pressure (typically up to 50 psi, differential) to below 200 psid. For small breaks (less than one inch diameter), HPCS is capable of maintaining reactor water level above the top of the core, and preventing actuation of the Automatic Depressurization System (ADS). For large breaks up to and including the Design Basis Accident, HPCS plus either Division I ECCS (RHR A and LPCS) or Division II ECCS (RHR B and C) is capable of providing adequate core cooling.

HPCS also serves as a backup to the Reactor Core Isolation Cooling (RCIC) System to supply makeup water to the reactor vessel in the event of a reactor isolation.

The HPCS system takes suction from either of two sources: the Condensate Storage Tank (CST), or the suppression pool. The primary source of water for the HPCS System is the CST. The suction line taps into the CST via a locked open manual valve at a lower elevation than any other CST suction lines to ensure an adequate minimum reserve capacity for the HPCS system, as well as the RCIC system, which taps off of the HPCS suction line. The normally open HPCS CST suction line isolation valve F001,[1] and CST suction line check valve F002 are located downstream of the RCIC tap off.

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[1]Standard GE valve designations are utilized throughout this system description.

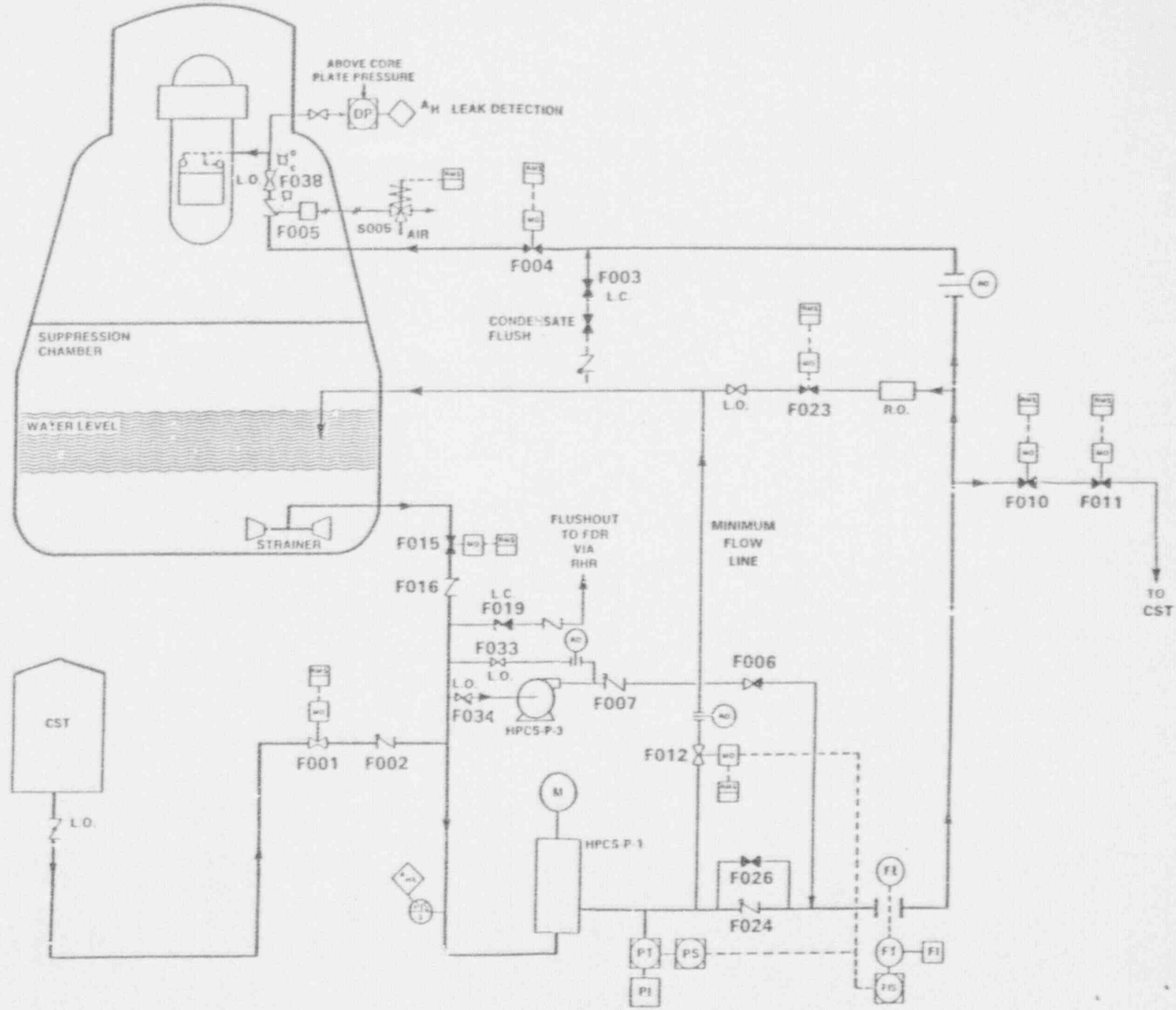

Figure 2-1 Simplified HPCS flow diagram

The alternate source of water to the HPCS system is the suppression pool. A stainless steel mesh strainer is provided at the source of the suppression pool suction pipe. This strainer is designed to maintain adequate NPSH for the HPCS pump with up to fifty percent of the strainer surface area plugged. The suppression pool suction flow passes through isolation valve F015 and a checkvalve F016 to the HPCS pump.

Upon system initiation the CST suction line isolation valve F001 will open, providing a source from the CST. Should a CST low level condition occur HPCS, suction will switch over to the suppression pool automatically after a brief (approximately two second) time delay. The time delay prevents inadvertent shifting due to the pressure transient when the HPCS pump starts. Once the suppression pool suction isolation valve F015 is fully open, the CST suction isolation valve F001 will close. Automatic switching of the suction source will also occur upon a high level condition in the suppression pool.

HPCS pump discharge flow to the reactor vessel passes through a normally shut injection isolation valve F004, located outside the containment, and a pneumatically testable check valve F005 and a locked open injection stop valve (F036 in BWR/6 or F038 in BWR/5), located inside the drywell. The piping enters the reactor vessel above the shroud and separates into two lines which curve around the inside of the vessel in opposite directions. The two lines turn downward 180° apart and penetrate the shroud just above the top of the core. The two semi-circular spargers contain nozzles which direct the flow to the top of the fuel bundles in the reactor core to remove decay heat following a postulated loss of coolant accident. The HPCS system will initiate automatically on either high drywell pressure or low reactor water level (level 2). In the event the HPCS system is in any mode other than standby when an automatic initiation signal is received, all valves will realign for the injection mode of operation. HPCS system injection into the reactor vessel is automatically terminated when a high reactor vessel level (level 8) is reached by automatic closure of the injection isolation valve (F004).

When reactor vessel level again drops to level 2 the injection valve automatically opens to commence injection into the reactor.

A minimum flow line is provided to assure that the minimum flow requirements for the HPCS pump are met to avoid impeller damage. The pump minimum flow line passes flow through restricting orifice D001 and minimum flow control valve F012 to the suppression pool. The flow control valve F012 position is controlled at most plants by signals from flow element FE-N007, and Pressure Transmitter PT-N051.

Two full flow test lines provide the capability to test the HPCS system while discharging to either the CST, through the CST test valves F010 and F011, or the suppression pool, through the test to suppression pool valve F023. A restricting orifice (D004, D005) is installed in each of these test lines to simulate the back pressure seen when pumping into the reactor vessel. Valve interlocks prevent establishing a test flow path from the suppression pool to the CST.

The HPCS system utilizes a "Keep Fill," "Jockey," or "Water Leg" pump to ensure that the piping between the injection valve F004 and the HPCS pump discharge check valve F024 is maintained full of water. This minimizes the occurrence of water hammer (due to the voiding of system piping) and minimizes the time it takes for the HPCS system to actually deliver water to the reactor vessel following initiation. Normal power for the HPCS system is provided from the Division 3 bus. In the event of a total loss of normal power, this bus is powered by the HPCS diesel generator. The HPCS system will deliver rated flow into the vessel within 27 seconds following receipt of an initiation signal.

Plant specific details for the HPCS system are provided in Appendix A and References 40-63.

3. ACCIDENT SEQUENCE DISCUSSION

The role of the HPCS system in the prevention of reactor core damage during abnormal plant conditions provides valuable information that can be applied to normal day-to-day inspection activities. If a plant has its own Probabilistic Risk Assessment (PRA), this information is readily available. Not only are plant specific design and operating nuances considered, but the accident sequences, systems, and component risk importances are generally quantified and prioritized.

Since most plants do not currently have PRAs, the application of risk insights is less straightforward. An ongoing PRA-based Team Inspection Methodology for the Risk Applications Branch of NRR has developed eight representative BWR accident sequences based on a review of the available PRAs [1]. Because of design and operational similarities, generic risk insights from these representative accidents can be applied to other BWRs for risk based inspections. This information can be used to allocate inspection resources commensurate with risk importance. In addition, if single or multiple systems are degraded or unavailable, this methodology can be used to designate those accident sequences that have become more critical due to the unavailability of a key system(s). This allows the inspector to focus on the remaining systems/components within a sequence to assure continued availability and minimize plant risk. Five of the eight representative sequences require the HPCS system to function for mitigation or as a potential initiator. These five sequences are discussed below.

3.1 Loss of High Pressure Injection and Failure to Depressurize

This sequence is initiated by a general transient (such as turbine trip with subsequent MSIV closure, MSIV closure and loss of condenser vacuum, loss of main feedwater, inadvertent SRV opening with MSIV closure, or a loss of offsite power), or a small break LOCA. The reactor successfully

scrams. The power conversion system, including the main condenser, is unavailable either as a direct result of the initiator or due to subsequent MSIV closure. The high pressure injection systems (HPCS/RCIC) fail to inject into the vessel. The major causes of HPCS/RCIC unavailability include hardware failures (primarily pump faults) and system outages for test or maintenance activities. The CRD hydraulic (CRDH) system can also be used as a source of high pressure injection (HPI), but the failure of the second CRD pump or unsuccessful flow control station valving prevents sufficient RPV injection. The operator attempts to manually depressurize the reactor pressure vessel (RPV), but a common cause failure of the safety relief valves (SRVs) defeats both manual and automatic depressurization of the reactor vessel. The failure to depressurize the vessel after HPI failure results in core damage due to a lack of vessel makeup.

3.2 Station Blackout (SBO) with Intermediate Term Failure of High Pressure Injection

This sequence is initiated by a loss of offsite power (LOOP). The division I and II emergency diesel generators (EDGs) are unavailable, primarily due to hardware faults. Maintenance unavailability is a secondary contributor. Support system malfunctions include EDG room or battery/switchgear room HVAC failures, service water pump, or EDG jacket cooler hardware failures.

The high pressure injection systems can provide inventory makeup until:

- the Division III (HPCS) diesel generator fails to continue to run
- the systems fail due to environmental conditions; i.e., loss of room cooling and ventilation, high lube oil temperatures, or high RCIC turbine exhaust pressure due to t. high suppression pool temperature and pressure, or

- the RCIC high area temperature logic isolates the system or long term exposure to high temperatures disables the turbine driven pump.

Plant procedures address means to maintain the HPCS diesel generator for as long as possible, to maintain DC power for as long as possible, to assure a continued source of water to the HPCS or RCIC, to ensure adequate lube oil cooling, and to provide contingency measures (such as supplying fire water via RHR system) if the SBO progresses until reactor pressure (decay heat) can no longer support RCIC. The plant procedures should be consistent with the BWR Owner's Group Emergency Procedure Guidelines.

3.3 Station Blackout with Short Term Failure of High Pressure Injection

This SBO sequence is similar to the previous sequence except the high pressure injection systems fail early. HPCS unavailability is dominated by pump failures and maintenance unavailability. The sources of emergency AC power, i.e., the emergency diesel generators (EDGs) including the HPCS diesel generator fail primarily due to hardware failures. Secondary contributors are: output breaker failures and EDG unavailability due to test or maintenance activities. Support system malfunctions, such as service water failures in the EDG jacket cooling water train, battery/switchgear room HVAC failures, or test and maintenance unavailability are significant contributors to the loss of all AC power.

Station battery failures (including common mode) are an important contributor to this sequence by definition, because the EDGs and high pressure injection systems are DC dependent. Core damage occurs shortly after the failure of all injection systems.

3.4 ATWS with Failure of RPV Water Level Control at High Pressure

This sequence is initiated by a transient with initial or subsequent MSIV closure and a failure of the reactor protection system. Attempts to manually scram are not successful, however the Standby Liquid Control System (SLCS) is initiated. By definition, the condenser and the feedwater system are unavailable. The BWR Owner's Group Emergency Procedure Guidelines (EPGs) recommend RPV water level reductions to control reactor power below 3% and the BWR representative sequence was based on that philosophy.

This sequence postulates a failure to ensure sufficient RPV makeup at high pressure to prevent cor damage. The high pressure injection (HPCS) system fails, primarily due to pump failure to start or testing and maintenance (T&M) unavailability. Injection or minflow valves, suction switchover, or loss of electrical power are other system failures. HPCS pump failure to start or run, pump unavailability due to testing and maintenance activities, and Service Water EDG jacket cooler inlet or return valve failures are the major system failures.

At this point in the sequence, once HPCS has failed, with ADS inhibited, the remaining high pressure injection systems cannot keep the core covered at ATWS power levels. The operator fails to manually depressurize in a timely fashion, and core damage ensues.

The continued operability of HPCS during an ATWS event is critical. Within the context of this accident sequence, (i.e., time available for success) the licensee capability to perform the logic bypasses should be evaluated periodically. With regard to HPCS system availability, the remaining sections will discuss system failures and availability evaluation.

3.5 Unisolated LOCA Outside Containment

An interfacing LOCA initiator is defined as the initial pressurization of a low pressure line which results in a pressure boundary failure, compounded by the failure to isolate the failed line. The failure is typically postulated [illegible] a low pressure portion of the low pressure core spray (LPCS) system, the LPCI, shutdown cooling and (to a lesser extent), the HPCS or RCIC pump suction, or the head spray line of RHR system.

The unisolated LOCA outside containment results in a rapid loss of the reactor coolant system (RCS) inventory, eliminating the suppression pool as a long term source of RPV injection. Piping failures in the reactor building can also result in unfavorable environmental conditions for the ECCS. Unless the unaffected ECCS systems or the condensate system are available, long term RPV injection is suspect and core damage is likely.

There have been several HPCI pump suction overpressurization events, primarily during surveillance testing of the normally closed motor-operated HPCI injection valve [4]. This is of particular concern for the discharge configuration with a testable air-operated check valve in addition to the normally closed MOV because of the valve's history of back leakage. There is the potential for a similar situation to develop in the HPCS system which also utilizes a normally closed motor-operated injection valve F004 in series with a testable air-operated check valve F005 in the injection line.

Several possible interfacing system LOCA precursors are included in Section 6, Other System Considerations.

3.6 Overall Assessment of HPCS Importance in the Prevention of Core Damage

As previously stated, the high pressure injection function (HPCS/RCIC/CRDH) is important in five of the eight representative BWR accident sequences. The various system failures and their importances in all eight sequences were prioritized by their contribution to overall core damage frequency (using a normalized Fussell-Vesely importance measure). The high pressure injection function, in aggregate, was in the high importance category. Other high risk important systems are Emergency AC Power and RPS. The HPCS system itself is of medium risk importance, because of the multiple systems that can successfully provide vessel makeup at high pressure. For comparison, other systems with a medium risk importance are: Standby Liquid Control, Automatic/Manual Depressurization, Service Water, and DC Power.

4. PRA-BASED HPCS FAILURE MODES

PRA models are often used for inspection purposes to prioritize systems, components, and human actions from a risk perspective. This enables the inspection effort to be apportioned based on a prioritization measure called risk importance. The HPCS failure modes for this system Risk-Based Inspection Guide (System RIG) were developed from a review of BWR plant specific RIGs [6-10] and the PRA-Based Team Inspection Methodology [1]. The component failure modes are presented in Table 4-1, grouped by risk significance. The potential human errors associated with HPCS system availability are discussed separately in Section 6.

PRAs are less helpful in the determination of specific failure modes or root causes and do not generally are not intended to provide detailed inspection guidance. This makes it necessary for an inspector to draw on his experience, plant operating history, Licensee Event Reports (LERs), NRC Bulletins, Information Notices and Generic Letters, INPO documents, vendor information and similar sources to conduct an inspection of the PRA-prioritized items. To accomplish this task, the next section presents the results of a HPCS operating experience review. The aforementioned sources of HPCS information are correlated by PRA failure mode to provide illustrative examples which help to focus inspection efforts.

Table 4-1 HPCS PRA-Based Failure Summary

COMPONENTS[2]

High Risk Importance[3]

Pump Fails to Start or Run
System Unavailable Due to Test or Maintenance Activities
HPCS Pump Injection Isolation Valve F004 Fails to Open

Medium Risk Importance[3]

CST/Suppression Pool Switchover Logic Fails
Suppression Pool Suction Valve F015 Fails to Open
Normally Open HPCS Manual Injection Line Stop Valve (F036 in BWR/6, F038 in BWR/5) is Plugged or Closed
Minimum Flow Valve F012 Fails to Open

Lower Risk Importance[3]

CST Suction Line Check Valve F002 Fails to Open
CST Suction Line Manual Valve is Plugged
Normally Open CST Pump Suction Valve F001 Fails Closed or is Plugged
Pump Discharge Check Valve F024 Fails to Open or Air Testable Check Valve F005 Fails to Open
Suppression Pool Suction Line Check Valve F016 Fails to Open
False Low Suction Pressure Alarm
System Actuation Logic Fails
Suction Strainer Fails to Pass Flow

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2 See Section 6 for a discussion of HPCS human errors.

3 The Fussell-Vesely Importance Measure is used to rank the system components. This measure combines the risk significance of a failure or unavailability with the likelihood that the failure/unavailability will occur.

5. OPERATING EXPERIENCE REVIEW

An HPCS system operating experience review was performed in order to compare actual industry operating experience with the PRA-derived failure modes for HPCS. At the seven BWR/5 and BWR/6 plants utilizing HPCS systems, seventy-five HPCS Licensee Event Report (LERs) were identified (through mid-1990) via the Sequence Coding Search System (SCSS). These were reviewed for applicability to the 15 PRA failure modes for HPCS; 23 LERs documented such HPCS faults or degradations. Table 5.1 presents a summary of the LERs categorized by failure mode. Fifteen LERs involved problems with the dedicated HPCS (Division 3) emergency diesel generator (EDG), five reported problems with the Division 3 AC bus, and one incident was associated with the Division 3 DC bus. In addition, twenty-four LERs reported problems such as: generic valve failures of HPCS valves, HPCS support systems, human error, simultaneous unavailability of multiple required ECCS systems, and potential LOCA situations. These events are described in more detail in Section 6. The remainder of the LERs documented occurrences such as successful system challenges, administrative deviations, and seismic or equipment qualification concerns.

The BWR/5 and BWR/6 plants which utilize the HPCS system have only been in operation since the early 1980s. There are only seven plants of this vintage, and several have only just begun operating. For these reasons, the operating experience accumulated by the nuclear industry for the HPCS system is very limited as compared to the HPCI system, and the quantity of HPCS-related LERs reported to date is not very large.

In order to enhance the comparison of the industry's HPCS LER operating experience with the PRA derived failure modes, the Nuclear Plant Reliability Data System (NPRDS) was also searched for HPCS-related events. NPRDS incidents which are related to or are potential precursors of the PRA-derived failure modes are highlighted in the following subsections (by definition, the most significant events are reported as LERs). By examining the NPRDS data, additional insights can be gained into

Table 5.1 Summary of Risk Significant LERs

Failure Description	Clinton	Grand Gulf	La Salle	NMP-2	Perry	River Bend	WNP-2	Total Risk Significant LERs	% of Total Risk Signif. LERs	Total Related or Precursor NPRDS Events [18]
Pump Fails to Start or Run		84-008	84-005 84-018					3	13	6
System Unavailable Due to Test & Maint.	87-069 88-027 89-039	82-097 88-008 88-020	82-044 84-018		88-027	86-054	89-044	11	46	6
Injection Valve F004 Fails to Open		85-050						1	4	5
CST/Suppression Pool Switchover Logic Fails		(Note 1)	82-044 (Note 2)					1	4	8
Suppression Pool Suction Valve F015 Fails to Open							89-030	1	4	0
Manual Injection Line Stop Valve is Plugged/Closed								0	0	0
Minimum Flow Valve F012 Fails to Open		88-020	88-005 89-017				89-043	4	17	15
CST Suction Check Valve F002 Fails to Open								0	0	0
CST Suction Manual Valve is Plugged/Closed			85-027					1	4	0
CST Suction Valve F001 Fails Closed								0	0	1
Pump Discharge Valves F024 or F005 Fail to Open								0	0	1
Suppression Pool Suction Check Valve F016 Fails to Open								0	0	0
False Low Suction Pressure Manual Trip								0	0	1
System Actuation Logic Fails			85-041 88-009					2	8	10
Suction Strainer Fails to Pass Flow								0	0	0
TOTAL								24	100	53

Notes:
1. Operators' misunderstanding of auto transfer logic led to unintentional disabling of auto transfer feature. See Section 5.4 and Reference [19].
2. Eight suppression pool high level LER events occurred at Units 1 & 2 between 11/17/84 and 1/22/85. See Section 5.4 for discussion of the potential effect on the auto transfer feature.

failure mechanisms or other problems which might impact risk-important components in the HPCS system. This supplements the information provided by the limited LER experience base available at this time and provides greater confidence that the most critical items have been identified.

Each of the fifteen PRA-based failure modes that has corresponding industry failures is discussed below. Selected LERs and NPRDS failure events identified during the operating experience review are summarized to illustrate typical failure mechanisms, applicable inspection methods, and potential corrective actions. Where applicable, other sources of background information are cited including NRC IE Bulletins, Information Notices, Inspection Reports, NUREGs, and AEOD Reports. Selected illustrative examples of corresponding industry failures are provided in Table 5.2 along with details of the root cause, method of detection, corrective action taken, and potential inspection areas that could identify and prevent similar problems. This information can help inspectors by providing valuable insight into the types of problems which their assigned plants may already be experiencing, or anticipating risk-significant problems which have developed in plants of similar design to their own.

5.1 HPCS Failure No. 1 - HPCS Pump Fails to Start or Run

The major contributor to HPCI system unavailability, both from a risk and operational viewpoint, is the failure of the electric motor driven pump to start or continue running. The problem areas which can lead to this failure mode can be grouped into four categories: 1) HPCS pump circuit breaker problems, 2) motor/pump instrumentation and control (I&C) problems, 3) motor and pump problems, and 4) loss of 4160V AC power to Division III. Table 5.2, Section 5.1 contains descriptions of five events associated with problems of circuit breakers and I&C.

Table 5.2 Illustrative Examples of Risk-Important HPCS Failures

PRA Derived Failure Mode	Description of Example Failure	Detection Method (Note 1)	Root Cause	Corrective Action	Potential Inspection Areas
5.1 Pump Fails to Start or Run	LaSalle 2- LER 374 84 005/DCS 8406120446 & LER 374 84 018/DCS 8409200021. During system inservice testing, pump circuit breaker failed to close.	IST	Breaker position switch (52LS), which enables breaker closing circuit when breaker is racked up into position, was 'ulty/not adjusted/not correctly installed.	Replaced breaker position switch (52LS). Analyzed failed switch. Inspected breaker position switches in all Division III 4160V switchgear.	Observe periodic HPCS inservice testing. Observe periodic breaker maintenance and inspection. Review post-maintenance testing program for electrical maintenance.
	Grand Gulf 1-LER 416 84 008/DCS 8403190059. While tagging out HPCS diesel for maintenance, control power to the HPCS pump was lost.	IST	Wrong breaker was opened due to incorrect information on electrical lineup for HPCS diesel operating instruction.	Corrected breaker positions. Corrected electrical lineup sheet.	Review equipment tagout procedures. Review licensed RO and technician training in tagout and return to service procedures and independent verification of safety related equipment positions.
	HPCS-NPRDS, 5/24/89 [18]. During surveillance testing, sparks observed shooting out from upper part of HPCS pump motor.	ST	To be determined from disassembly inspection.	Replaced motor. Disassemble motor to determine cause of failure.	Verify electrical maintenance/testing procedure in accordance with IEEE 112-1984. Observe HPCS inservice surveillance testing. Inspect for adverse environment: humidity, dirt/dust, water or debris falling from above motor, etc.
	HPCS-NPRDS, 9/1/87 [18]. During surveillance testing, operators received HPCS pump motor overcurrent alarm and HPCS pump control manual override alarm.	ST	High dropout contacts in "C" phase overcurrent relay for HPCS pump motor were suspected to have been sticking closed intermittently.	Replaced the relay.	Observe periodic maintenance/testing/inspection for protective relaying on safety related systems. Inspect for adverse environment at switchgear: dirt/dust, high humidity, temperature oil vapor, salt air, etc.

Note 1: Abbreviations for detection method are as follows:
IST - Inservice Testing or Inservice Inspection; ST - Surveillance Testing; SI - Special Inspection; ALRM - Audio or visual alarm or annunciator
RO - Routine Observation; OA - Operational abnormality; CM - Corrective maintenance; PM - Preventative maintenance

Table 5.2 Illustrative Examples of Risk-Important HPCS Failures(Cont'd)

PRA-Derived Failure Mode	Description of Example Failure	Detection Method (Note 1)	Root Cause	Corrective Action	Potential Inspection Areas
5.2 System Unavailable due to Test or Maintenance	Grand Gulf 1 - LER 416 82 091/DCS 8211090161 and LER 416 82 097/DCS 8211100436. Inadequate post-modification retesting following modification of a HPCS valve position indicator resulted in incorrect HPCS valve lineup during surveillance test and technical specification violation.	SI	Inadequate retesting after valve position indicator modification; failure to remove info tag warning operator not to rely on position indicator.	Revised retest control procedure. Removed information tag. Retested HPCS system.	Review modification procedure for safety-related equipment. Review procedures for verifying proper ECCS systems required by technical specification.
	LaSalle 2- LER 374 84 018/DCS 8409200021. During system inservice testing, pump circuit breaker failed to close.	IST	Breaker position switch (52LS), which enables breaker closing circuit when breaker is racked up into position, was not correctly installed.	Replaced breaker position switch (52LS). Analyzed failed switch. Inspect breaker position switches in all Division III 4160V switchgear.	Observe performance of electrical maintenance completion verification procedure. Review post-maintenance testing program for electrical maintenance.
	Perry 1- LER 440 88 027/DCS 8808030284. HPCS declared inop due to erroneous HPCS line break alarm.	ALRM	Leakage of water into transmitter for HPCS line break monitoring instrument. Source of water could not be determined.	Replaced transmitter. Sealed conduit to transmitter to prevent water intrusion.	Evaluate effectiveness of corrective action.
	River Bend 1- LER 458 86 054/DCS 8703120095. With unit at full power, an HPCS level 2 initiation instrument was declared inoperable, and its associated master trip unit was placed in the tripped condition per tech specs. This also made inoperable an HPCS level 8 slave trip unit also fed from that master trip unit. HPCS should then have been declared inoperable, but was not.	SI	Human error	Unknown	Review operator training on Rosemount analog trip system. Verify that procedures for placing inoperable master/slave trip units into tripped condition are adequate. Review operator training on ECCS and isolation instrumentation tech specs.
5.3 Injection Valve F004 Fails to Open	HPCS-NPRDS, 3/28/88 [18]. During surveillance test valve F004 motor operator tripped on thermal overload when stroking open.	ST	Motor operator limit switches were out of adjustment.	Adjusted limit switches, retested and returned to service.	Review PM program for safety-related valve operators. Verify analysis or trending of surveillance test results for safety-related valve operators.
	HPCS-NPRDS, 1/21/88 [18]. As found thrust load on valve stem exceeded rated level. Stem to disc coupling nut threads stretched and disc seating surface scored.	RD	Overtorquing stretched threads on stem to disc coupling nut.	Replaced coupling nut, valve stem, and valve disc. Retested and returned to service.	Review procedure for disassembly, inspection, and reassembly of safety-related valve operators.

Note 1: Abbreviations for detection method are as follows:
IST - Inservice Testing or Inservice Inspection; ST - Surveillance Testing; SI - Special Inspection; ALRM - Audio or visual alarm or annunciator
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Table 5.2 Illustrative Examples of Risk-Important HPCS Failures (Cont'd)

PRA-Derived Failure Mode	Description of Example Failure	Detection Method (Note 1)	Root Cause	Corrective Action	Potential Inspection Areas
5.e CST/Suppression Pool Switchover Logic Fails	G[illegible]d Gulf 1, 1985 (Note 2). SRVs weeping into suppression pool (SP) required routine pumping to radwaste to remain within tech specs. After SP high level alarm & auto transfer of HPCS suction from CST to SP, operators failed to follow Alarm Response Instruction (ARI) and manually transferred HPCS suction back to CST before SP high level signal had cleared. Logic for HPCS suction auto transfer from CST to SP did not automatically reset with SP high level signal still present; auto transfer function was therefore disabled by operators.	SI	Human error	Unknown.	Verify operator training on procedure adherence. Verify operator training on Alarm Response Instructions.
	LaSalle 1 - LER 373 88 044/DCS 8207130371. During calibration & functional surveillance test for suppression chamber high level monitoring instrument, the instrument rack root stop valve was found closed and seal wire was missing.	ST	Human error.	Instrument root valve was returned to its proper open position and seal wired.	Verify personnel training on significance of seal wired valves, locked valves, tag outs, information tags, and unauthorized equipment operation. Review post-maintenance verification of valve positions in I&C procedures.
	HPCS-NPRDS, 1/30/87 [18]. During surveillance testing, pump suction from CST valve F001 did not close when pump suction from suppression pool valve F015 opened.	ST	Contact on limit switch for valve F015 operator, which provides the auto close signal to F001 when F015 opens, was dirty.	Dirty contact on HPCS valve F015 operator limit switch was cleaned. Valve was retested and returned to service.	Review PM program for safety-related valve operators.
	HPCS-NPRDS, 5/18/90 [18]. Unit at full power, an operator observed that a suppression pool level transmitter had failed.	OA	Level transmitter output failed low due to suspected wearout of regulator (bubbler) not allowing air to pass sufficiently to transmitter.	Regulator was replaced and retested.	Observe [illegible]odic maintenance or inspection of suppression pool level instrumentation.

Notes:

1) Abbreviations for detection method are as follows:

IST - Inservice Testing or Inservice Inspection	ST - Surveillance Testing	SI - Special Inspection	ALRM - Audio or visual alarm or annunciator
RO - Routine Observation	OA - Operational abnormality	CM - Corrective maintenance	PM - Preventative maintenance

2) Source: NRC Inspection Report 50-416/85-28, Grand Gulf 1 [19].

Table 5.2 Illustrative Examples of Risk-Important HPCS Failures (Cont'd)

PRA-Derived Failure Mode	Description of Example Failure	Detection Methods (Note 1)	Root Cause	Corrective Action	Potential Inspection Areas
5.5 Suppression Pool Pump Suction Valve F015 Fails to Open	WNP2-LER 397 89 030/DCS 8909010232. HPCS suction valve from the suppression pool (F015) failed to open during surveillance testing.	ST	Failure of Limitorque motor operator for valve F015.	Valve was manually closed and verified closed by leak testing.	Verify adequacy of licensee PM program for valves. Inspect the valve for adverse environment or physical abnormalities.
5.6 Manual Injection Valve is Plugged/Closed	None.	-	-	-	Verify that valve is in locked open position.
5.7 Minimum Flow Valve F012 Fails to Open	LaSalle 2-LER 374 88 005/DCS 8810180014 and LER 374 89 017/DCS 8912200071. During surveillance testing flow switch FS-2E22-N006, which functions to provide minimum flow bypass for HPCS under low flow conditions, was found out of tolerance above the reject limit.	ST	Setpoint drift, no other abnormalities noted.	Replaced the flow switch. Disassembled and inspected old flow switch.	Observe performance of surveillance tests for the instrument. Verify licensee's response to IE Bulletin 88-02 on Static-O-Ring differential pressure switches [15].
	WNP2-LER 397 89 043/DCS 9001020250. During operability surveillance testing, the minimum flow valve F012 (HPCS-V-12) would not open properly to maintain minimum flow through the pump when system flow was secured.	ST	The test return valve to suppression pool F023 was open 10%, keeping system flow above the open setpoint for F012. Position indication for F023 showed it fully closed.	Manual block valve for the test return line (HPCS-V-64) was closed to isolate the bad valve F023 which could not be closed by hand or motor operator.	Verify adequacy of licensee PM program for valves.
5.8 CST Suction Check Valve F002 Fails to Open	None	-	-	-	Verify adequacy of licensee PM program for valves.
5.9 CST Suction Manual Valve is Plugged/ Closed	None	-	-	-	Verify that valve is in locked open position.
5.10 CST Suction Valve F001 Fails Closed	HPCS-NPRDS, 7/25/84[18]. CST suction valve F001 would not open with hand switch after valve was closed. Valve opened by hand OK	OA	Jumper in the open switch logic at the Limitorque operator which bypasses the torque switch and close limit switch was not installed.	Licensee replaced jumper; it was assumed that it was not installed originally. Incident occurred prior to commercial operation.	Verify design (drawings, FSAR) agree with physical conditions. Review configuration management program.

Note 1: Abbreviations for detection method are as follows:
IST - Inservice Testing or Inservice Inspection; ST - Surveillance Testing; SI - Special Inspection; ALRM - Audio or visual alarm or annunciator
RO - Routine Observation; OA - Operational abnormality; CM - Corrective maintenance; PM - Preventative maintenance

PRA-Derived Failure Mode	Description of Example Failure	Detection Methods (Note 1)	Root Cause	Corrective Action	Potential Inspection Areas
5.11 Pump Discharge Check Valves F024 or F005 Fail to Open	HPCS-NPRDS, 6/5/87[18]. During surveillance testing to cycle the testable check valve F005 with the plant shutdown for refueling, the valve would only stroke less than one quarter of its full stroke, and appeared to be binding.	ST	The jam nut and flange nut were installed too tightly, thereby preventing full movement of the valve.	Jam nut and flange nut were removed and reinstalled 1/8" from the lever arm. Valve was successfully stroked and leak tested.	Inspect testable check valve F005 for proper installation of flange nut and jam nut.
5.12 Suppression Pool Suction Check Valve F016 Fails to Open	None	-	-	-	-
5.13 False Low Suction Pressure Signal	None	-	-	-	-
5.14 System Actuation Logic Fails	LaSalle2-LER 374 85-041/DCS 8511060244. While troubleshooting a Div. III 125Vdc ground, HPCS low reactor water level initiation switch was malfunctioning.	CM	Taped insulation at the switch had worn through and short circuited to ground.	Repaired insulation at switch.	Observe calibration and functional surveillance testing.
	HPCS-NPRDS, 11/1/84[18]. High drywell pressure HPCS initiation pressure switch #1 setpoint found high out of specification.	ST	Instrument drift	Recalibrated and returned to service.	Verify calibration frequency is adequate based on calibration history of instrument.
	HPCS-NPRDS, 7/29/89[18]. With plant at low power, reactor vessel level for HPCS initiation at analog trip unit 1B21N673C was 15 inches higher than the other 3 redundant channels.	OA	Troubleshooting revealed very slow response from the Rosemount Model 1153DB5PC transmitter; loss of oil from sensing module suspected. Third failure of this component in past 3 months.	Replaced transmitter. Sent defective unit to Rosemount for disassembly and inspection.	Generic concern with loss of oil in Rosemount Model No. 1153 and 1154 transmitters. Observe surveillance testing of channels utilizing this type of transmitter.

Note 1: Abbreviations for detection method are as follows:
IST - Inservice Testing or Inservice Inspection; ST - Surveillance Testing; SI - Special Inspection; ALRM - Audio or visual alarm or annunciator; RO - Routine Observation; OA - Operational abnormality; CM - Corrective maintenance; PM - Preventative maintenance

No LERs were reported concerning the HPCS pump, however, experience on HPCI pumps has indicated that time depend... ...adation mechanisms such as fatigue, high stress, wear, and erosion can lead to pump failure. ...e most common pump failure mode was low injection flow [11]. Accordingly, HPCS pump surveillance testing and ASME XI in-service testing would be the most likely means of detecting HPCS pump problems.

The fourth category affecting failure of the HPCS pump to start and run is loss of 4160V AC power to the Division III bus. The causes of loss of AC power are quite diverse and are outside the scope of this inspection guide. The special case of the HPCS (Division III) diesel generator is discussed briefly in Section 6.2.

5.2 <u>HPCS Failure No. 2 - System Unavailable Due to Test or Maintenance Activities</u>

In addition to component failures, the system may not be functional due to testing or maintenance (T&M) activities. In a single train system like HPCS, test and maintenance activities on one component usually disable the entire system. It is important to keep the time spent in HPCS T&M activity as low as possible because of its direct contribution to system unavailability. This unavailability is defined as the number of hours that the system is unavailable due to T&M activities divided by the number of hours the system is required to be operable.

The development of a plant specific system unavailability model and subsequent tracking of unavailability trends is strongly recommended, since the variation in system unavailability from plant to plant (even between seemingly similar plant designs operated by the same utility) can be significant (see Reference [64] for an example of trending safety system function via risk-based performance indicators). As a related example, while conducting an inspection of the Limerick Generating Station, Unit 1 [13], Region I inspectors determined the HPCI Cycle 1 T&M unavailability was 6.4E-2 compared with a

PPA assumption of 1.0E-2 using previous Peach Bottom experience Based on the inspector's finding, the licensee began the development of a methodology for tracking a measure of the system total unavailabilities and for evaluating, on an ongoing basis, the effects of increased unavailability on total core damage frequency (CDF).

The root sources of excessive HPCS T&M unavailability were examined as part of this operating experience review. The 11 HPCS LER examples of test or maintenance errors were divided into three categories: 1) inadequate maintenance or post-maintenance testing (6 occurrences), 2) human error that inadvertently or incorrectly disables the HPCS system (2 events), and 3) system inadvertently disabled during testing activity (3 occurrences).

In eight of the LER events (73%) associated with T&M activities, the affected plants were operating at power. The detection of the problems was by means of special reviews or inspections 45% of the time, and by operational abnormalities or incidental observation 27% of the time. A similar distribution of detection means and system status at the time of the occurrence was noted for six NPRDS events in the T&M area.

In summary, the T&M component of system unavailability must be continuously monitored by the inspector to assure it is as low as possible. The licensee should be administratively limiting the number of times that the HPCS system is in test or maintenance during operation. System restoration should be vigorously pursued; HPCS should not be down for days, if it can reasonably be repaired in hours. Whenever it is feasible, portions of the system should be tested during outages. In addition, HPCS unavailability can also be minimized by adequate root cause analysis and effective corrective action to prevent the recurrence of system outages due to the same types of failures, and thorough, efficient work planning to avoid unnecessary removals from service or inadvertent system isolations during calibration or surveillances.

5.3 HPCS Failure No. 3 - Injection Valve F004 Fails to Open

The HPCS injection valve F004 is a normally closed, AC motor operated valve. It opens automatically upon system initiation. It closes whenever reactor vessel water level rises above the level 8 setpoint. The failure of this valve to open disables HPCS injection into the reactor vessel.

One LER (416 85 050/DCS 8604070413) reported the failure of the injection valve (F004) to open automatically when required at Grand Gulf. A reactor scram had occurred when vessel level dropped to level 3 following the trip of all condensate and feedwater pumps. Operators manually initiated HPCI and RCIC to restore level. The HPCS injection valve failed to open automatically because of a failed Agastat model CR 0095 relay base; however, the operators opened the valve with the control room handswitch. There were four related occurrences reported on NPRDS [18], 2 of which are contained in Table 5.2, Section 5.3.

Selected illustrative valve failures that have occurred in high pressure injection systems, including root cause and corrective actions, are presented in Section 6.5.

5.4 HPCS Failure No. 4 - CST/Suppression Pool Switchover Logic Fails

In the standby mode, the HPCS pump is normally aligned to take suction from the condensate storage tank (CST). Upon receipt of a low CST level signal, or a high suppression pool level signal, the suppression pool suction valve F015 automatically opens with subsequent closure of the CST suction valve F001. System operation then continues with the HPCS pump suction from the suppression pool.

As indicated in Table 5.2, Section 5.4, failures of suppression pool level instrumentation and suppression pool high water level occurrences indicate that this area should continue to be monitored by NRC inspectors.

5.5 HPCS Failure No. 5 - Suppression Pool Suction Valve F015 Fails to Open

The HPCS pump suppression pool suction valve is a normally closed, motor operated valve which is in series with the HPCS pump suppression pool suction check valve F016 in the alternate suction line to the HPCS pump. The HPCS pump is normally aligned to the CST via the CST suction valve F001. Upon receipt of a low CST level signal or a high suppression pool level signal, the CST suction valve F001 automatically closes and the suppression pool suction valve F015 automatically opens. The importance of this HPCS failure mode has been diminished by the current emergency procedure guidelines which emphasize the continued use of outside injection sources. This requires operator action to bypass the HPCS suppression pool switchover logic to prevent the opening of the suppression pool suction valve F015. This is especially true for the decay heat removal (non ATWS) sequences where it is likely that the CST makeup can be maintained. There has been only one LER noted in the industry survey for HPCS which involved the failure of the suppression pool suction valve F015 to open.

5.6 HPCS Failure No. 6 - Manual Injection Valve is Plugged/Closed

The Injection Stop Valve (F038 in BWR/5 or F036 in BWR/6) is a locked open manual valve in the HPCS injection line located within the drywell. If the valve were to become plugged or somehow closed mistakenly, HPCS injection could not take place.

There were no LERs or NPRDS events noted for this failure category in the HPCS industry survey. Since it is located inside the drywell, the valve is not readily accessible to verify its locked open position. Position indicator lights are provided on the main control room reactor core cooling panel P601.

5.7 HPCS Failure No. 7 - Minimum Flow Valve F012 Fails to Open

The minimum flow bypass line is provided for pump protection. The bypass valve F012 automatically opens on a low flow signal when the pump discharge pressure is greater than a set level which indicates that the pump is running. When the bypass is open, flow is directed to the suppression pool. The valve automatically closes on a high flow signal. With regard to system operation and testing in the minimum flow mode, the licensee response to IE Bulletin 88-04 [16] should be reviewed to determine if the design of the minimum flow bypass line is adequate.

There were four LERs related to failure of the minimum flow valve F012 to open. Two of them, were associated with the flow switches. IE Information Notice 86-47 and IE Bulletin 86-02 [15] describe erratic performance problems in Series 102 and 103 differential pressure switches manufactured by SOR, Incorporated, formerly known as the Static "O" Ring Pressure Switch Company.

There were 15 events noted on the NPRDS related to failure of the minimum flow valve to open. Three involved the motor operator; these included a burned out motor, improperly crimped lugs at the valve motor operator, and improperly adjusted limit switches which caused the valve shear drive key to break. Two were caused by air in the sensing lines to the HPCS high flow trip instrument. The remainder were due to excessive instrument setpoint drift on HPCS pump discharge pressure instrumentation (4) and HPCS pump flow instrumentation (6) which control the minimum flow valve.

5.8 HPCS Failure No. 8 - CST Suction Check Valve F002 Fails to Open

There have been no LERs and no NPRDS events found in the HPCS operating experience survey reporting a failure of the CST suction check valve F002 to open.

5.9 HPCS Failure No. 9 - CST Suction Manual Valve is Plugged/Closed

There have been no incidents noted in the HPCS operating experience survey in which the normally locked open CST suction manual valve was plugged or improperly closed.

5.10 HPCS Failure No. 10 - CST Suction Valve F001 Fails Closed

The CST suction valve F001 is a normally open, motor operated valve in the HPCS pump suction line from the CST, downstream from the RCIC tap off. The primary source of water for the HPCS system is usually the CST (LaSalle is an exception); upon system initiation F001 opens automatically provided the HPCS pump suction from suppression pool valve F015 is not fully open. F001 will close when F015 is fully open, and is prevented from opening when F015 is fully open.

There were no LERs in the HPCS survey dealing with the CST suction valve F001 failing closed. There was one related NPRDS incident [18] in which the valve would not open with the handswitch, but could be manually.

5.11 HPCS Failure No. 11 - Pump Discharge Check Valves (F024 or F005) Fail to Open

There are two check valves in the HPCS injection line between the HPCS pump and the reactor vessel. The first, pump discharge check valve F024, is a conventional check valve and is located just downstream of the HPCS pump. The other is the air operated testable check valve F005 located within the drywell in the injection line downstream from the HPCS injection valve F004 and upstream from the normally locked open HPCI injection manual stop valve.

In the event of a rupture just outside the drywell, the air testable check valve F005 would act to limit primary coolant loss. To enable verification of valve operability, a pneumatic actuator is attached to the valve disc pivot arm. The air actuator cannot prohibit disc opening. By energizing a

solenoid controlled air supply to the actuator, the valve can be forced to lift off its seat. A light on the HPCS portion of the control room panel P601 verifies the operability of the stem.

There were no incidents of failure of either check valve F005 or F024 to open reported on LERs. There was one incident reported to the NPRDS in which the testable check valve F005 was binding during surveillance testing. Less than one quarter of the valve's full stroke could be attained.

5.12 HPCS Failure No. 12 - Suppression Pool Suction Check Valve F016 Fails to Open

There were no reported failures of the suppression pool suction check valve F016 to open found in either the LER data base or NPRDS.

5.13 HPCS Failure No. 13 - False Low Suction Pressure Trip

HPCS pump suction pressure is monitored in the main control room by a high/low pressure alarm and with a local pressure indicator. There are no automatic actions associated with these instruments. Note that the HPCS design minimizes inadvertent or false low suction pressure trips as compared to HPCI in which the turbine/pump trip is automatic. HPCS design inserts an additional step; i.e., operator incorrectly evaluates the alarm and trips HPCS pump. There were no LERs in this category.

5.14 HPCS Failure No. 14 - System Actuation Logic Fails

Startup and operation of the HPCS system is automatically initiated upon detection of either low-low reactor vessel water level in the reactor vessel or high drywell pressure. The HPCS system can also be manually initiated by arming and then depressing the manual initiation switch in the control room.

There were two LERs which described failures of HPCS low level initiation instrumentation, and ten incidents related to failure of actuation logic instrumentation and controls identified in the NPRDS [18].

Five of the failures described in NPRDS were associated with the level transmitter which initiates HPCI upon low reactor water level. These occurred between February 1988 and March 1990 and involved Rosemount transmitters. There is a generic concern associated with Rosemount transmitters due to sensing element oil leakages that affect instrument accuracy. In February 1989, Rosemount issued a Part 21 notification concerning the loss of oil problem in sensing cells of some of their Model No. 1153 and 1154 transmitters.

5.15 HPCS Failure No. 15 - Suction Strainer Fails to Pass Flow

A suction strainer is located within the suppression pool at the source of the HPCS suppression pool suction line. The strainer is located off the bottom of the suppression pool to reduce the possibility of clogging by sediments which inevitably collect on the suppression pool bottom. The strainer mesh is designed to prevent passage of particles which are large enough to cause clogging of the HPCS sparger nozzles, and the strainer area is oversized so that even with 50% of its surface blocked, the minimum required net positive suction head will be provided to the HPCS pump.

There were no reports of failure of the HPCS suction strainer to pass flow in either the LER search or the NPRDS data base.

5.16 Comparison of Operating Experience to PRA-Based Ranking

As discussed earlier in this section, the total industry operating experience accumulated thus far is still somewhat limited because the plants have not been operating that long. Nevertheless, the PRA-based prioritization of HPCS failures correlates well with the actual industry failure experience. Two

salient exceptions within the LER data base are HPCS Failure No. 7 - minimum flow valve F012 fails to open, and HPCS Failure No. 14 - system actuation logic fails. These were designated as "medium" and "low" risk importance respectively in the PRA-based ranking developed in Section 4. The NPRDS data corroborated the larger number of problems associated with HPCS Failures Nos 7 and 14 in the LER data. As more HPCS operating experience is gained, the operating experience review will be updated to reflect the long term trends.

6. OTHER SYSTEM CONSIDERATIONS

In addition to the failures and problems specific to or originating within the HPCS system as discussed in Section 5, there are other factors which can inhibit the successful functioning of HPCS. Among these are human errors of an operational nature affecting HPCS, failures in systems which support the operation of HPCS, interactions with systems that can impact upon HPCS function, and generic valve failures. These topics are discussed in the following sections.

6.1 Human Error

The potential for human error pervades every aspect of nuclear power plant operation. Any task that requires human intervention such as maintenance, calibration, surveillance and, of course, operation has the potential for human error. In Probabilistic Risk Assessments, operator errors are included both in fault trees (system failure diagrams) and in the event trees to account for human interactions. As such, human error events are usually actions that can fail a complete system or components required to preserve system function. Typical PRA-based HPCS human errors are:

1. Failure to manually start the high pressure injection system if automatic actuation fails.

2. Failure of the operator to transfer pump suction from the CST to the suppression pool after a pump trip on low suction pressure due to CST unavailability.

3. Failure to provide makeup to the CST during an ATWS event.

4. Failure to transfer pump suction from the suppression pool to the CST during an event with a high suppression pool temperature. There are two cases when this must be performed, one during an ATWS event and one during a non-ATWS event with the failure of suppression pool cooling.

5. Operator recovery from initial failure of HPCS.

6. Miscalibration of HPCS sensor(s) disables system actuation, high RPV level isolation or results in false isolation signals.

7. Failure to reset the HPCS system for operation after testing or maintenance.

With the exception of the last two entries, these human errors are either: (a) conditional, that is, they must be considered within the context of an HPCS failure or isolation (errors 1 and 2), or (b) event specific (items 3, 4 or 5). These requirements make direct observation unlikely. The potential for these human errors can be evaluated indirectly by a review of the licensee procedures, operator training program, and observation of operator performance at a simulator

The last two human errors can occur during normal operation and are therefore more inspectable. Resident Inspectors routinely examine surveillance, calibration and maintenance practices and procedures, and perform ECCS control room and plant lineup verifications. HPCS operability is confirmed by checking the pump suction and discharge lineups, and the control function settings (hand/auto station in automatic).

There is a second source of human error that is not readily discernible in most risk assessments because it is not considered as a separate failure. It is the human contribution to component unavailability. The component failure estimates are developed from plant specific experience, if enough data exists, or from other, more generic, data sources. In either case, the unavailability estimate of a standby component is based on the number of failures per total demands. This estimate inherently includes all failures caused by human error. Based on the operating experience review, it is estimated that nearly

half of the HPCS LER failures have a human error contribution. The more unusual human errors have been included with the illustrative examples of Section 5.

As previously indicated, the examination of licensee practices and procedures, as well as the application of industry experience, can help reduce that portion of the HPCS unavailability that is due to human error. In the reactive mode, a thorough root cause analysis and suitable corrective measures can prevent similar occurrences in the future.

6.2 HPCS Support Systems

The high pressure core spray system is dependent on other systems (support systems) for successful operation. These systems include.

AC Power: For HPCS injection pump, keep fill pump, and valve movement. Loss of off-site power requires HPCS (Division III) Diesel Generator and its support systems: fuel oil, jacket cooling water, lube oil, starting air, DC control power, room cooling

DC Power: For system control (125V DC)

Condensate Storage (CST) and Transfer System: Primary source for injection and system flushing.

Suppression Pool: Alternate source for injection and discharge reservoir for minimum flow and test pathways.

Room Cooling: For HPCS pump room cooling to support long-term operations. This function requires service water (for cooling) and AC power for the fan motor.

HPCS Actuation: RPV level and primary containment pressure instrumentation for system initiation and shutdown.

The Condensate Storage Tank (CST) and Suppression Pool, as the primary and alternate sources for HPCS injection, are an integral part of system functional success. A sufficient volume of water is maintai ·d in them as required by Technical Specifications to assure an adequate supply for emergency core cooling systems such as HPCS and RCIC. In accident sequences requiring extended use of HPCS, the condensate transfer system or other means of replenishing the CST water volume such as fire water pumps can be more important.

The compressed air or nitrcgen system is often considered an HPCS support system since it provides compressed air to the pneumatic actuator of the testable check valve F005. It is not required for successful operatic . of the HPCS system, however, since it supports a test function to verify valve operability.

6.2.1 HPCS Diesel Generator (DG) and Division III AC Power

AC power is critical to the success of HPCS operation which utilizes a single 4160V AC motor-driven pump and 480V AC motor-operated valves. HPCS is a Division III electrical system which is usually supplied via normal off-site AC power. This source is backed up by the Division III HPCS diesel generator.

Inspection of the off-site power system and the Di ision III (HPCS) diesel generator lie outside the scope of this inspection guide. Many detailed studies have been performed specifically for these components, particularly in the area of reliability/availability of emergency diesel generators at nuclear power stations, and include guidelines for on-site inspections [22]. Inspectors should consult these documents for inspections concentrating on off-site power systems and emergency diesel generators. A proposed inspection plan for diesel generators at nuclear power plants is provided in Appendix B [22] as a guideline for those inspectors who wish to investigate aspects of the 'CS diesel generator in more detail.

6.2.2 Division III DC Power

The Division III HPCS DC Distribution System is an independent 125 volt DC system consisting of a battery, one or more static battery chargers (one preferred and one back-up), and a DC panel-board. The HPCS DC Distribution system supplies HPCS Equipment and is physically separated from Division I and II to provide the utmost reliability. Figure 6-1 illustrates this configuration.

During normal operation, all load current required by the system is supplied by the charger with the battery fully charged and on float. The battery will only supply current to the HPCS DC Bus when larger loads are started. On loss of all AC power to the chargers, the battery is sized to provide power to all HPCS DC loads for at least 2 hours.

AC power outages should only be of short duration as the chargers are fed from the Division III AC Bus and will be re-energized when the HPCS-diesel starts and re-energizes the Division III AC Bus.

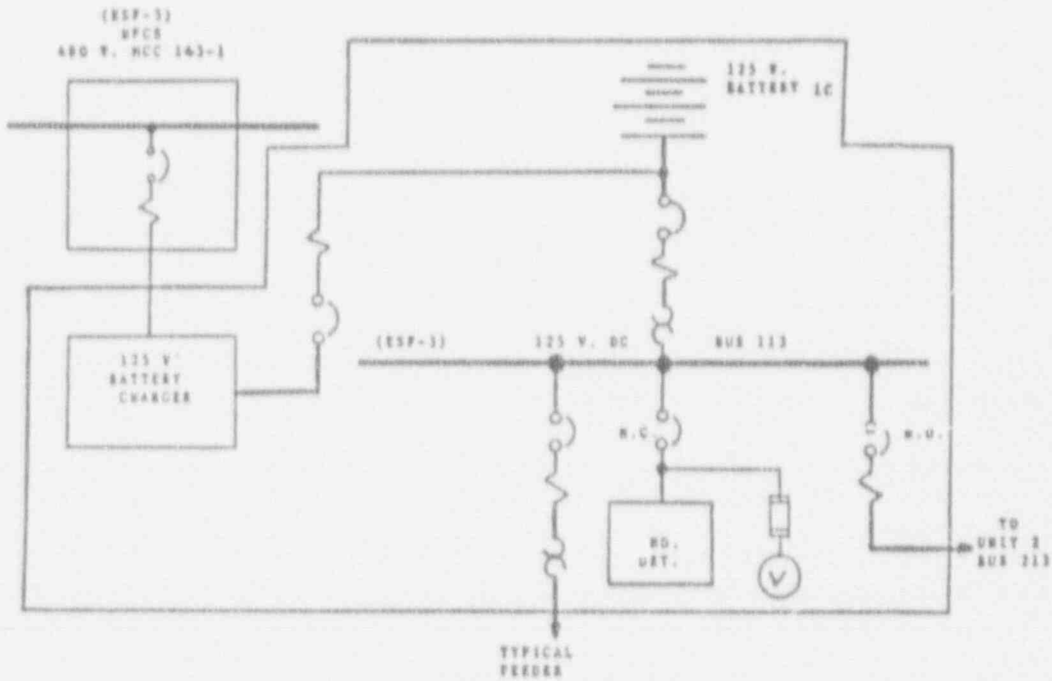

Figure 6-1. LaSalle County Station, Unit 1, 125V DC ESF Division III.

6.2.3 Room Cooling and Ventilation

The effect that the loss of room cooling would have upon continued operation of the HPCS system is not as straightforward as the previously discussed support systems. Since HPCS and all its auxiliaries and support systems are powered from the same bus, power to the HPCS buses would imply power to the cooling units and fans. Loss of an individual cooler or fan while HPCS injection continued would be confined to individual equipment failures or feeder faults. The licensee should have evaluated the effects of temperature on long-term operation of HPCS upon loss of room cooling and have procedural provisions instituted as required to assure long-term HPCS operability.

6.2.4 System Actuation Instrumentation

The reactor pressure vessel level and high drywell pressure instrumentation required to actuate multiple ECCS functions via the Rosemount 510DU/710DU Trip/Calibration System is shared by HPCS. Consequently, the operating experience review specifically for HPCS revealed only a few incidents involving actuation instrumentation, and these have been discussed previously in Section 5.14.

In summary, support system problems can sometimes impact HPCI operation in a less than straightforward manner. In the context of specific accident sequences these support systems may be more prone to failure. The inspector should verify licensee awareness of these interaction relations and confirm that compensating measures are adequate.

6.3 HPCS Systems Interactions

Systems interactions refer to failures or problems arising in other plant systems unrelated to HPCS that can result in the disabling of HPCS. There were no specific examples of this in the HPCS operating experience review. However, an operating experience review covering 1980 to mid-1989 for HPCI, a system which has accumulated a much more extensive amount of operating time than HPCS, did have some system interaction incidents that are applicable to HPCS. All of these were fire protection system malfunctions that disabled HPCI.

There was one event at River Bend (LER 458 86 054/DCS 8703120095) involving HPCS and the analog trip system which highlights an area with the potential for adverse system interactions. In that case, a level 2 HPCS initiation instrument was declared inoperable, and its master trip unit was placed into the tripped condition per Technical Specifications. It was not until later on that the operators realized that the same master trip unit controlled an HPCS level 8 slave trip unit, which therefore made the level 8 slave unit inoperable as well. HPCS should then have been declared inoperable as well. Licensee procedures and training should demonstrate an awareness that the analog trip system master trip units can affect multiple systems and functions via slave trip units, and that incidents involving loss of power, restoration of power, and system power fuse replacement for the analog trip system cabinet potentially can impact several unrelated systems at the same time.

6.4 Simultaneous Unavailability of Multiple Systems

Multiple system unavailability is of concern because of the increased risk associated with continued operation and the increased common-cause potential it may imply [65]. Although Technical Specification 3.0.3 tends to limit the risk exposure somewhat, the licensee should avoid planned multiple system outages, if possible. The operating experience review of HPCS LERs identified seven incidents involving simultaneous unavailability of multiple ECCS systems.

Within the context of the accident sequences discussed previously (Section 3), certain combinations of system unavailability result in a much greater risk of core damage. Among the seven LERs mentioned above, one of the incidents at Clinton (LER 461 89 041/DCS 9001250005) reported the simultaneous unavailability of HPCS and RCIC. During this period, the probability of core damage is greatly increased for accident sequences that require HPCS and RCIC for mitigation. This would include all the sequences described in the Accident Sequence Descriptions except "Unisolated LOCA Outside Containment."

Most of these LER examples of multiple system unavailability were initiated by one or more random failures, and often following licensee decisions to remove a system from service for mainte-

nance or surveillance when another critical system is not operable. Five of the seven LERs also involved some type of human error, attributable to inexperience, unfamiliarity with Technical Specifications, and procedural inadequacies. Nevertheless, plant configurations involving simultaneous multiple system inoperability, particularly the configurations mentioned, should be avoided unless absolutely necessary since habitual entry into Technical Specification 3.0.3 greatly increases the risk of core damage.

6.5 Valve Failures in High Pressure Injection Systems

Many of the valve failures encountered in the HPCS or HPCI Systems whether they involve the pump discharge valve, the minimum flow valve, the turbine steam admission valve, etc. can be considered generic, i.e., not related to a specific application. Table 6-1 presents a summary of generic valve failures gleaned from the operating experience reviews for HPCS and HPCI. A failure description, root cause and corrective action is provided for information and potential inspection applications.

It is worth noting that a recent study entitled "Aging Study of Boiling Water Reactor High Pressure Injection Systems" [Reference 11] reported that valves and valve operators made up more than 25% of all HPCI failures and nearly 29% of HPCS failures in the LER database. In the NPRDS database, the study found that valve and valve operators made up over 44% of HPCI failures and more than 27% of HPCS failures (see Figure 6-2).

References [24-30] provide additional information on generic valve failures.

6.6 LOCA Outside Containment

Unlike the HPCS failures of Section 5 which describe the unavailability of the system for core damage mitigation, events have occurred where the high pressure injection system is a potential initiator of a LOCA outside containment. There were two LER incidents involving the HPCI system, in which inadvertent pressurizations of the system low pressure piping occurred. Due to the similarities of the discharge portions of the HPCS system and the HPCI system, the potential of this type of mishap also exists for HPCS.

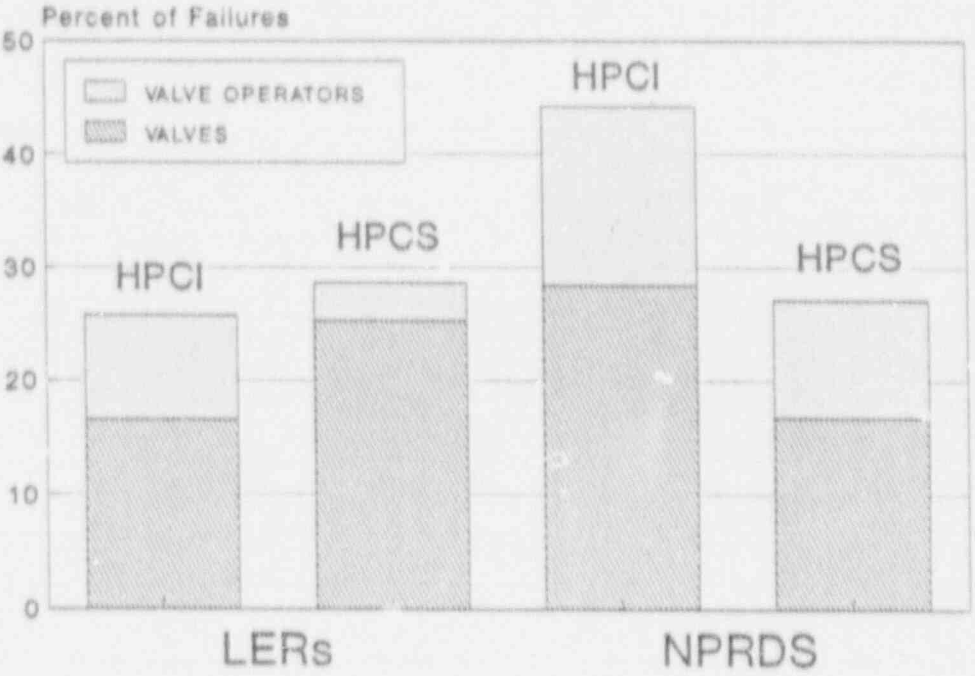

Figure 6-2. Percent of valve and valve operator failures reported to LER and NPRDS databases [11]

One event was attributed to the slow closure of pump discharge lift check valve (F005), while the second HPCI overpressurization event was due to the two pump discharge MOVs (F006 and F007) being left partially open. In addition, the upstream check valve (F005) was not properly seated. A similar RCIC overpressurization occurred on April 12, 1989 and is the subject of Inspection Report 50-293 89-80 [31].

Table 6-1. Summary of Generic Valve Failures - HPCI/HPCS

Category	Failure Description	Root Cause	Corr. Meas.	Comments
Valve Operators - Motor & Star'er	HPCI, LER 324 87 001/DCS 8705130141, Brunswick 2 - Pump discharge valve Failed To Open after scram.	Failure attributed to possible heat related breakdown of valve motor internals.	Valve motor replaced.	Note 1
	HPCI, LER 298 85 011/DCS 8511260500, Cooper - Min flow valve inoperable due to damaged motor starter disconnect switch.	Switch damage resulted from over-travel of the operating handle due to poor switch design.	Switch replaced, similar switches inspected. Possible redesign or replacement considered.	
Valve Operators - Torque Switch	HPCI, LER 293 89 013/DCS 8905090006, Pilgrim - Turbine steam admission valve Failed To Open. Valve operator motor windings failed.	Torque switch adjustment screws loose which affected the torque setting and damaged the valve.	Valve repaired, screws correctly torqued. Other safety related valves inspected, torque switch limiter plates installed and procedures revised.	
	HPCS, NPRDS [18], 8/3/89 - Test valve to suppression pool stopped at 25% open during surveillance test with plant at 100% power.	Dirty contacts on the torque switch.	Contacts were cleaned and valve tested.	
Valve Operators - Limit Switch	HPCS, NPRDS [18], 3/28/88 - Injection valve motor operator tripped on thermal overload when going to open.	Limit switches were out of adjustment.	Adjusted rotor such that limit switch opens to stop valve between 60 - 100% of travel in open position to prevent overload in backseat position.	
	HPCS, NPRDS [18], 7/17/86 - Test return valve to the CST would not return to full open position as indicated on both local and remote indicators with plant at 80% power.	Open limit switch was tripping prior to the torque switches during opening of valve. Position indicators were giving false reading when valve was closed.	Limit switches were adjusted to allow the torque switches to fully open the valve. Valve position indicators were adjusted.	
Valve Operators - Internals	HPCS, NPRDS [18], 2/10/89 - Suppression pool suction valve would not operate via the motor. Motor ran but valve wouldn't move.	Worn shaft clutch gear assembly fell apart due to missing split spacer which acts as a seat for shaft set screws. Spacer was not installed during manufacturing.	Replaced entire clutch assembly and worn shaft. Revised procedures to inspect assembly and re-stake set screws if required. Verified operability of all Limitorque motor operators of similar design.	Licensee notified the manufacturer, Limitorque, of possible QC deficiencies (10 CFR Part 21 Report)

Note 1: It is unclear if the corrective action addressed the root cause.

Table 6-1. Summary of Generic Valve Failures - HPCI/HPCS (Cont'd)

Category	Failure Description	Root Cause	Corr. Meas.	Comments
	HPCS, NPRDS [18], 4/22/87 - Test bypass to suppression pool valve would not stay torqued into its seat when closed electrically during normal operation.	Valve operator gearing and bearings were worn out. Attributed to normal wear.	Replaced valve operator housing, lower bearing cup, worm gear, worm bearing, and housing cap screw.	
Valve Operator to Valve Connection	HPCI, LER 259 87 027/DCS 8808150227, Browns Ferry 1 - Suppression pool suction line manual valve stem separated from the disk.	Valve disk and shaft connected by a key which is held in place by a cover secured by four bolts. Three bolts failed due to tensile overload.	Valve repaired, similar valves inspected. Valves were scheduled for inspection and testing during the next refueling outage.	Associated Control Equipment Inc. hand control valve.
	HPCS, NPRDS [18], 7/1/89 - Test return valve to the CST had an oil leak at the mating surface between the motor and motor operator.	Gasket between motor and motor operator had deteriorated due to unknown causes.	Replaced gaskets between motor and clutch housing.	
	HPCI, LER 254 87 004/DCS 8703310497 Quad Cities 1 - CST suction valve failed to fully close during testing.	Slight disc/body misalignment occurred over time due to horizontal valve mounting. Increased resistance caused torque switch to stop closure.	Open limit switch adjusted so valve did not open quite as far.	
Seat/Disk Leaks	HPCS, NPRDS [18], 4/6/88 - Licensee unable to establish pressure boundary during leak rate testing of discharge to suppression pool valve.	Valve seat was dirty and the flexitalic gasket was split as a result of aging and cyclic fatigue.	Valve internals were cleaned, gasket was replaced and valve retested.	
	HPCS, NPRDS [18], 10/21/87 - During HPCS system venting and filling while unit was in a refueling outage, the minimum flow valve was leaking by when the valve was closed.	Valve seat and disc had stress cracks as a result of incorrect torque switch settings which increased stem thrust higher than necessary to seat the valve.	Valve seat and disc cleaned; disc reinstalled 180° rotated from original position and "blue checked". LLRT successfully performed. Torque switches adjusted to lower equivalent stem thrust to 10000 to 13000 rounds.	
Packing Leaks	HPCS, NPRDS [18], 6/5/87 - Licensee health physicist found packing leak from suction valve from CST was causing a spread of contamination.	Worn packing.	Valve was replaced during next refueling outage, leak tested, and stroke time tested.	

Table 6-1. Summary of Generic Valve Failures - HPCI/HPCS (Cont'd)

Category	Failure Description	Root Cause	Corr. Meas.	Comments
	HPCS, NPRDS [18], 5/1/89 - Injection stop valve was found leaking during normal operator rounds.	Old and worn packing.	Packing in the valve was replaced.	
Mechanical Damage/Binding	HPCS, NPRDS [18], 1/28/86 - Injection valve was binding in the intermediate position causing circuit breaker to trip.	Valve stem needed lubrication.	Lubricated valve stem with Molykote GN.	
	HPCS, NPRDS [18], 1/28/86 - Broken valve yoke was discovered on the second test return valve to the CST (1E22F011).	Valve stem anti-rotation clamp set screw had loosen and allowed the clamp to slide below the key. This allowed stem to rotate and drive stem keys into the clamp resulting in an unequal load being applied to the valve yoke. After an unknown number of cycles in this configuration, the valve yoke cracked at its base.	Valve 1E22F011 was repaired. Design change initiated to install "L"-shaped stem keys on both test return to CST valves 1E22F011 and 1E22F010.	Prior to this incident, the licensee staked the set screws for the antirotation clamp on these valves because of similar problems at other nuclear power plants.
	HPCS, NPRDS [18], 1/21/88 - As found thrust load on the valve stem of the discharge isolation valve exceeded rated levels.	Stem to disc coupling nut threads were stretched due to undetermined root cause. Disc scored due to normal wear.	Replaced coupling unit, valve stem, and valve disc. Retested valve satisfactorily.	Note 1
Differential Pressure Across The Valve	HPCI, LER 265 85 023/DCS 8601300019, Quad Cities 2 - Containment Isolation Valve failed to open (FTO) after packing replaced.	Large differential pressure created a high torque condition. Bypass limit switch was set under zero delta P and opened prematurely.	Open MCC contactor closed, valve stroked to verify operability.	Note 1
	HPCS, LER 373 83 066/DCS 8307220193 and LER 373 83 067/DCS 8307220201, LaSalle 1 - Testable check valve 1E22-F005 failed to close due to failure of its bypass valve 1E22-F354 to close preventing a differential closing force to seat the valve.	Insufficient spring tension of the actuator assembly for the bypass valve 1E22-F354 to close the valve.	Spring tension to the rack and gear assembly was increased. Inservice test (IST) procedure was revised.	Valves made by W-K-M Division of ACF Ind.

More recently, (October 31, 1989) Dresden 2 declared HPCI inoperable due to elevated piping temperatures in the pump discharge line. The 260°F temperature was caused by feedwater back leakage through the closed injection valves. Discharge piping supports were damaged, attributable to water-hammer caused by steam void collapse upon system initiation. In addition to the potential for piping damage, steam binding of the pumps is also a consideration. Information Notice 89-36 [32] provides additional information on elevated ECCS piping temperature.

In general, the high pressure injection systems LOCA outside containment initiator is a very small contributor to total core damage. The examples presented above are potential areas of inspection to assure that plant design or operation does not increase the potential for this initiator.

7. SUMMARY

This System Risk-Based Inspection Guide was developed as an aid to BWR HPCS system inspections. The document presents a risk-based discussion of the HPCS role in accident mitigation and provides PRA-based HPCS failure modes (Sections 3 and 4). Most PRA oriented inspection plans end here and require the inspector to rely on his experience and knowledge of plant specific and BWR operating history.

The system RIG uses industry operating experience, including illustrative examples, to augment the basic PRA failure modes. The risk-based input and the operating experience have been combined in Table 7-1 to develop a composite BWR HPCS failure ranking. This information can be used to optimize NRC resources by allocating and focusing proactive inspection effort based on risk and industry experience. In conjunction, the more important or unusual component faults are summarized in Section 5 and provide potential areas of NRC oversight both for routine inspections and the "post mortems" conducted after significant failures.

A summary of the risk-important operating experience failure events is presented in Table 7-1 as a composite of the applicable LERs and NPRDS failures at all of the BWR/5 and BWR6 plants (Clinton, Grand Gulf, LaSalle Unit 1, LaSalle Unit 2, Nine Mile Point 2, Perry, River Bend, and WNP 2). Although individual plant specific experience is limited, the composite identification of HPCS failures in Table 7-1 serves as a guide to inspectors and a standard against which the performance of individual plants may be compared. Those components at a specific plant exhibiting a higher proportion of failures than the industry experience are candidates for more extensive inspection activity.

As the HPCS plants mature, operational experience is accumulated by the plant staffs and plant procedures are refined, thereby decreasing the number of inadvertent HPCS incidents attributable to surveillance and calibration activities. Conversely, as the equipment gets older, aging related faults are expected to become a contributor to a plant's HPCS failure statistics [11]. Inspectors should thus be

Table 7-1. HPCS System RIG Summary

Failure Description	All BWR/5 & BWR/6 Plants			Plant Specific Summary[4]		Comments
	% of Total LER Failure Contribution[1]	% of Total NPRDS Failure Contribution[2]	Failure Ranking[3]	Number of LER Failures	% of LER Failure Contribution	
Pump Fails to Start or Run	13.0	11.3	1			5
System Unavailable Due to Test & Maintenance	47.8	11.3	2			
Injection Valve F004 Fails to Open	0	9.4	3			
CST/Suppression Pool Switchover Logic Fails	4.3	15.1	4			
Suppression Pool Suction Valve F015 Fails to Open	4.3	0	5			8
Minimum Flow Valve F012 Fails to Open	17.5	28.3	6			6
Manual Injection Line Stop Valve is Plugged/Closed	0	0	7			
CST Suction Check Valve F002 Fails to Open	0	0	8			
CST Suction Manual Valve is Plugged/Closed	4.3	0	9			
CST Suction Valve F001 Fails Closed	0	1.9	10			
Pump Discharge Valves F024 or F005 Fail to Open	0	1.9	11			
System Actuation Logic Fails	8.8	18.9	12			6, 7
Suppression Pool Suction Check Valve F016 Fails to Open	0	0	13			8
False Low Suction Pressure Manual Trip	0	1.9	14			
Suction Strainer Fails to Pass Flow	0	0	15			
TOTAL	100%	100%	---			

Table 7-1 Notes

1. Failure contribution is expressed as a percentage of all significant HPCS LER failures as developed by the Operating Experience Review. Current up through mid-1990.

2. Failure contribution is expressed as a percentage of all significant related or precursor HPCS failures on NPRDS. Current up through 10/1/90.

3. Failure ranking is a subjective prioritization based on PRA and operational input, recovery potential, current accident management philosophy and conditional failures, as applicable.

4. The plant specific summary is to be completed by the inspector initially using the LERs provided in Table 5-1, and updated periodically with any additional LER events that may have occurred in the various categories. Categories with significantly higher failure contribution percentages than the industry experience are candidates for enhanced inspection attention.

5. Loss of offsite power and failure of the Division III (HPCS) diesel generator to start and run or loss of the Division III bus would also result in failure of the HPCS pump to start and run. However, these events are beyond the scope of the operating experience review for this inspection guide.

6. Failure importance was upgraded from the PRA-based ranking of Table 4-1.

7. The actuation logic arrangement (one out-of-two twice) diminishes the importance of a single instrument to reliable system operation. At least two low RPV level or two high drywell pressure sensors must fail. As shown in Section 5, unavailability is more dependent on control power.

8. The latest BWROG Emergency Procedure Guidelines deemphasize the suppression pool as an injection source.

aware of the effects of time-dependent factors such as these upon the HPCS failure categories at each individual plant.

The HPCS failure statistics for each plant may be tabulated in the appropriate columns of Table 7-1 and can be periodically updated as the plant matures. This report includes all HPCS LERS and NPRDS failures through mid-19[illegible]. Subsequent LERs can be correlated with the PRA failure categories, used to update the plant specific HPCS failure contribution, and compared with the more static industry HPCS failure totals. The industry operating experience statistics are developed from the eight BWR/5 and BWR/6 listed previously and are therefore expected to exhibit less fluctuation with time than a single plant. This information can be trended to provide guidance as to where additional inspection focus is warranted as the plant matures.

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APPENDIX A

Plant-Specific System Information

Appendices A1 through A7 provide simplified HPCS system flow diagrams for each of the BWR plants utilizing this system. These diagrams provide plant-specific information and nomenclature to supplement the generic HPCS system description provided in Section 2. In addition, each of the Appendices A1 through A7 provides a plant-specific walkdown checklist which has been modified to include the most risk-significant valves and components as determined in the RIG. This is intended to help the inspector to optimize his efforts by concentrating on the most risk-significant components.

APPENDIX A1

Clinton Power Station HPCS System Details

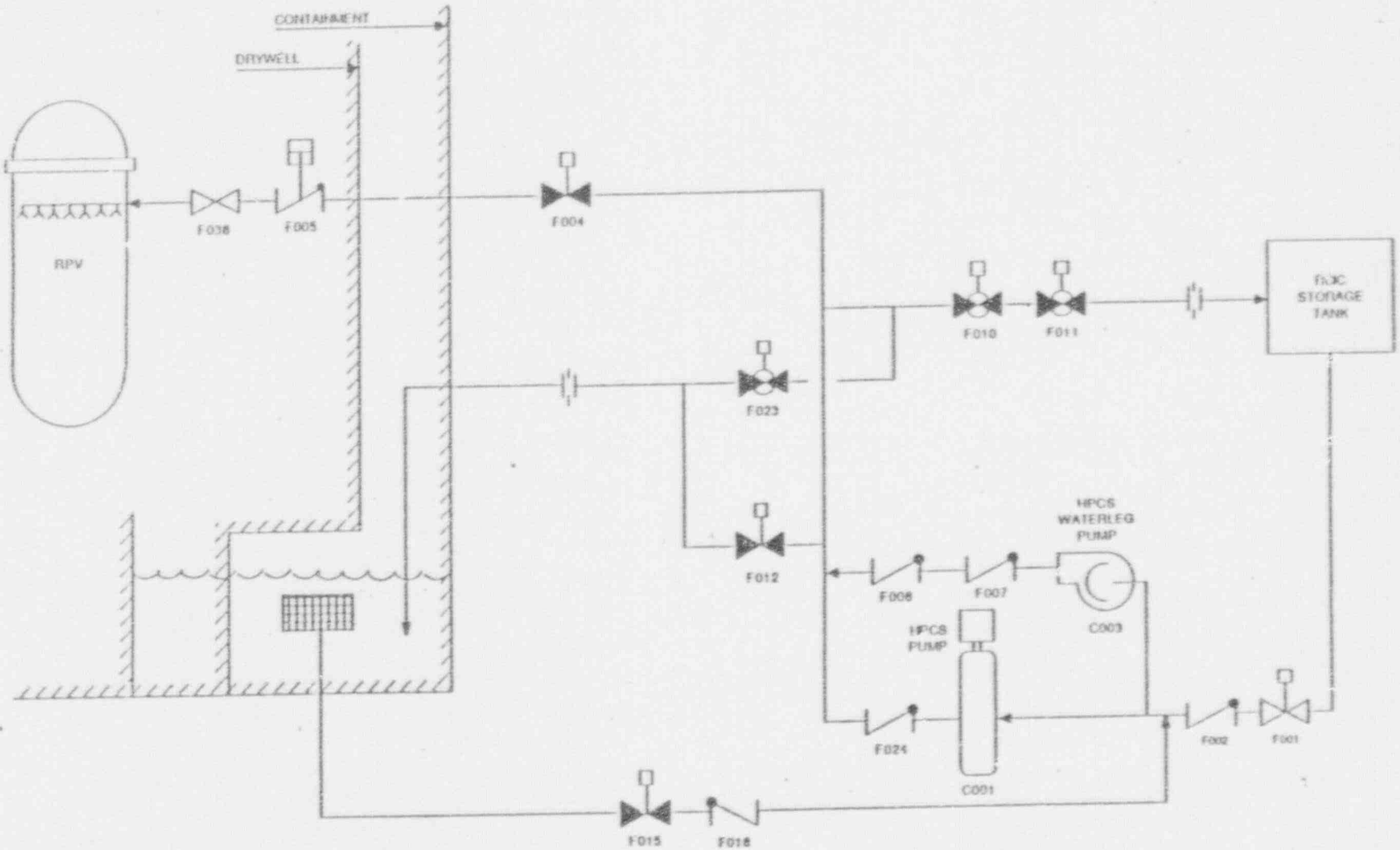

Figure A.1-1 Simplified HPCS Flow Diagram - Clinton Power Station

Table A.1-1 Modified HPCS System Walkdown - Clinton Power Station

I.   Electrical Lineup

Breaker ID No./Description	Location	Required Position	Actual Position
1E22-C001 HPCS Pump	4160VAC Bus 1C1 CUB 104	Racked In	
1E22-C003 HPCS Water Leg Pump	AB MCC 1C CUB 2C	On	
1E22-F001 Storage Tank Suction Valve	AB MCC 1C CUB 2D	On	
1E22-F010 First Test Valve to RCIC Storage Tank	AB MCC 1C CUB 3D	On	
1E22-F011 Second Test Valve to RCIC Storage Tank	AB MCC 1 CUB 3E	On	
1E22-F012 Min. Flow to Supp. Pool Valve	AB MCC 1C CUB 4B	On	
1E22-F015 Supp. Pool Pump Suction Valve	AB MCC 1C CUB 4C	On	
1E22-F023 HPCS Test Valve to Supp. Pool	AB MCC 1C CUB 4D	On	
1E22-F004 HPCS to Containment Outboard Isol. Valve	AB MCC 1C CUB 2E	On	
HPCS Area 120VAC	AB MCC 1C CUB 3A(R)	On	
125 VDC MCC 1C Supply from Division 3 125 VDC Battery	125 VDC MCC 1C (CB-6)	On	
Division 3 125 VDC Bus Supply from 125 VDC MCC 1C	125 VDC MCC 1C (CB-8)	On	
4.16 KV Switchgear Bus 1C1 Breaker Control Power	125 VDC (CB-11)	On	
Control Room Panel 1H13-P601	125 VDC (CB-17)	On	
NSPS Div. 3 Logic, Test, and Xmtr Power Supply 1H13-P663	NSPS Power Distr. Panel C (C71-P001C) (CB-7)	On	
Logic, Test, and Xmtr Power Supply 1H13-P664	NSPS Power Distr. Panel D (C71-P001B) (CB-17)	On	
ECCS HPCS Pump Room Supply Fan A (1VY08CA)	AB MCC 1C1 (1AP78E)	On	
ECCS HPCS Pump Room Supply Fan B (1VY08CB)	AB MCC 1C1 (1AP78E)	On	

Table A.1-1 Modified HPCS System Walkdown - Clinton Power Station (Cont'd.)

II. Valve Lineup

Valve ID No.	Description	Location	Required Position	Action Position
MOV 1E22-F015	HPCS Suppression Pool Suction	Control Room Panel 1H13-P601 (HP Cub)	Closed	
MOV E22-F012	HPCS Pump Minimum Flow to Suppr. Pool	Control Room Panel 1H13-P601 (HP Cub)	Closed	
MOV 1E22-F004	HPCS to Containment Outboard Isolation	Control Room Panel 1H13-P601 (Fuel Bldg., 755')	Closed	
MOV 1E22-F023	HPCS Test to Suppression Pool	Control Room Panel 1H13-P601 (HP Cub)	Closed	
MOV 1E22-F010	HPCS First Test Valve RCIC Storage Tank	Control Room Panel 1H13-P601 (HP Cub)	Closed	
MOV 1E22-F011	HPCS Second Test Valve RCIC Storage Tank	Control Room Panel 1H13-P601 (HP Cub)	Closed	
AOV 1E22-F005	HPCS Testable Check	Control Room Panel 1H13-P601 (Drywell, 775')	Closed	
MOV 1E22-F001	HPCS Storage Tank Suction	Control Room Panel 1H13-P601 (HP Cub)	Open	
1E22-F034	HPCS Water Leg Pump Suction Isolation	Fuel Bldg., 712'	Locked Open	
1E22-F006	HPCS Water Leg Pump Discharge Stop Check	Fuel Bldg., 712'	Locked Open	
1E22-F323	HPCS Pump Suction Pressure Instrument Root	Fuel Bldg., 712'	Open	
1E22-F325	HPCS Pump Discharge Pressure Instrument Root	Fuel Bldg., 712'	Open	
1E22-F324A	HPCS Pump Flow High Side Instrument Root for FT-1E22-N005 & N056	Fuel Bldg., 712'	Open	
1E22-F324B	HPCS Pump Flow Low Side Instrument Root for FT-1E22-N005 & N056	Fuel Bldg., 712'	Open	
1E22-F314	HPCS Suction Isolation from Suppr. Pool	Fuel Bldg., 712'	Locked Open	
1E22-F329	Suppression Pool Level Instrument Root	Fuel Bldg., 737'	Open	
1E22-F331	Suppression Pool Level Instrument Root	Fuel Bldg., 712'	Open	

Table A.1-1 Modified HPCS System Walkdown - Clinton Power Station (Cont'd.)

Valve ID No.	Description	Location	Required Position	Action Position
1E22-F381B	Suppression Pool Level Instrument Test Conn.	Fuel Bldg., 712'	Locked Closed	
1E22-F318A	Suppression Pool Level Instrument Test Conn.	Fuel Bldg., 712'	Closed	
1E22-F380	HPCS Line Break Detection Inst. Root	Rx. Bldg., Containment	Open	
1E22-F005	HPCS Flushing Water Supply	Fuel Bldg., 755'	Locked Closed	
1E22-F036	HPCS Manual Injection Line Stop	Rx. Bldg., Drywell 770'	Locked Open	
1E22-F318	HPCS Suction from RCIC Storage Tank	RCIC Storage Tank Room	Locked Open	
1E22-F336	RCIC Storage Tank Level Instrument Root	Fuel Bldg., 737'	Open	
1E22-F337	RCIC Storage Tank Level Instrument Root	Fuel Bldg., 737'	Open	
1E22-F335	RCIC Storage Tank Level Instrument Standpipe Vent	Fuel Bldg., 737'	Closed	
1E22-F342	RCIC Storage Tank Level Instrument Standpipe Vent	Fuel Bldg., 737'	Closed	

Table A.1-1 Modified HPCS System Walkdown - Clinton Power Station (Cont'd.)

III. HPCS Diesel Generator

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants."

APPENDIX A2

LaSalle County Station Units 1 & 2 HPCS System Details

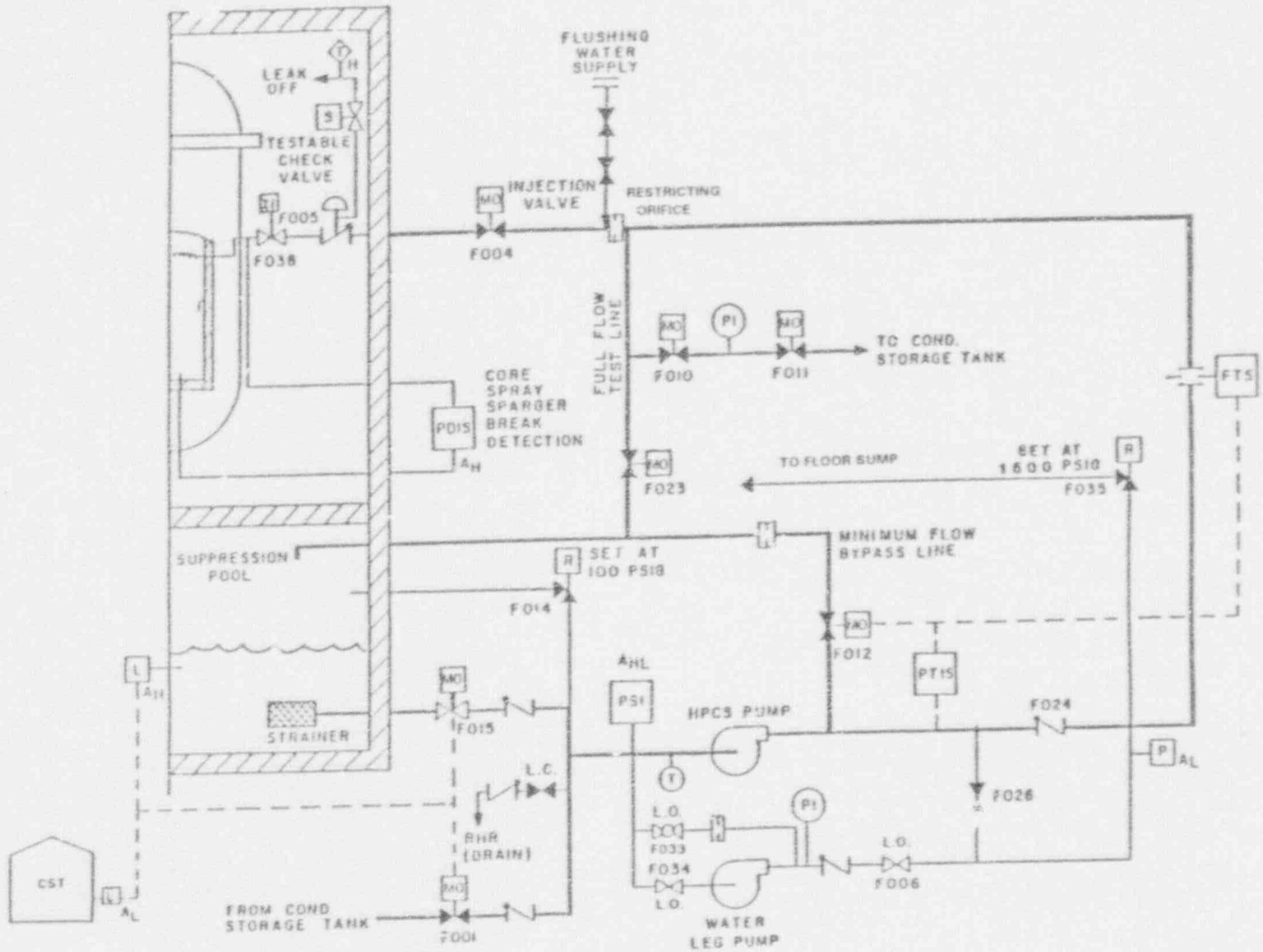

Figure A.2-1 Simplified HPCS Flow Diagram - LaSalle 1/2

NOTE: Suppression pool is the preferred HPCS source at LaSalle due to biological corrosion problem discussed in Section 5.9.

Table A.2-1 Modified HPCS System Walkdown - LaSalle Country Station Unit 1

I. Electrical Lineup

Breaker ID No./Description	Location	Required Position	Actual Position
1E22-C001 HPCS Pump	Bus 143 CUB 004	Racked In	
1E22-S003 HPCS Transformer to MCC 143-1	Bus 143 CUB 005	Racked In	
1E22-C003 Standby Water Leg Pump	MCC-143-1 CUB 2C	On	
1E22-F001 Cond. Storage Tank Suction Pump Valve	MCC-143-1 CUB 2D	On	
1E22-F010 Full Flow Test Upstream Stop to CST	MCC-143-1 CUB 2E	On	
1E22-F011 Full Flow Test Downstream Stop to CST	MCC-143-1 CUB 3A	On	
1E22-F012 Supp. Pool Min. Flow Bypass Stop	MCC-143-1 CUB 3B	On	
1E22-F015 Supp. Pool Pump Suction Valve	MCC-143-1 CUB 3C	On	
1E22-F023 Full Flow Test Stop to Supp. Pool	MCC-143-1 CUB 3D	On	
1VY02C HPCS Pump Room Ventilation Area Cooler Supply Fan	MCC-143-1 CUB 6B	On	
1E22-F004 HPCS Injection Discharge Stop	MCC-143-1 CUB 7C	On	
HPCS Instrument Power	MCC-143-1 CUB 2A	On	
Bus 113 Supply from U-1 Battery	125 VDC Bus 113 (CB-6)	On	
Bus 113 Alternate Supply from U-2 Battery	125 VDC Bus 113 (CB-7)	Off	
Switchgear 143 Breaker Control Power	125 VDC Bus 113 (CB-11)	On	
Panel 1H13-P625 HPCS Relay Logic and Pump Motor Control	125 VDC Bus 113 (CB-16)	On	
Control Room Panel 1H13-P601 Valve Position Ind.	125 VDC Bus 113 (CB-17)	On	

Table A.2-1 Modified HPCS System Walkdown - LaSalle Country Station Unit 1 (Cont'd)

II. Valve Lineup

Valve ID No.	Description	Location	Required Position	Actual Position
MO 1E22-F015	HPCS Pump Suction from Suppression Pool	Control Room Panel 1H13-P601 (EL 673' Rx. Bldg. South of Supp. Pool)	Open (Note 1)	
MO 1E22-F012	HPCS Pump Minimum Flow Stop	Control Room Panel 1H13-P601 (EL 673' Rx. Bldg. South of Supp. Pool)	Closed	
MO 1E22-F004	HPCS Injection Stop	Control Room Panel 1H13-P601 (EL 761' Rx. Bldg. Above & to the Side of CRD Filters)	Closed	
MO 1E22-F023	HPCS Test Discharge to Suppression Pool	Control Room Panel 1H13-P601 (EL 694'-6" Rx. Bldg. South of Supp. Pool)	Closed	
MO 1E22-F010	HPCS Test Discharge to CST Upstream Stop	Control Room Panel 1H13-P601 (EL 694'-6" Rx. Bldg. South of Supp. Pool)	Closed	
MO 1E22-F011	HPCS Test Discharge to CST Downstream Stop	Control Room Panel 1H13-P601 (EL 694'-6" Rx. Bldg. South of Supp. Pool)	Closed	
AO 1E22-F005	HPCS Testable Check	Control Room Panel 1H13-P601	Closed	
MO 1E22-F001	HPCS Pump Suction from CST	Control Room Panel 1H13-P601 (EL 673' Rx. Bldg. South of Supp. Pool)	Closed (Note 1)	
1E22-F034	HPCS Water Leg Pump Suction Stop	HPCS Room 673' Level	Open	
1W22-F006	HPCS Water Leg Pump Discharge Stop	HPCS Room 673' Level	Open	

NOTE: 1. Suppression pool is the preferred HPCS source at LaSalle due to the biological corrosion problem discussed in Section 5.9.

Table A.2-1 Modified HPCS System Walkdown - LaSalle Country Station Unit 1 (Cont'd)

Valve ID No.	Description	Location	Required Position	Actual Position
1E22-F343	HPCS Pump Suction Pressure Instrument Root for PS-1E22-N003 & R001	HPCS Room 673' Level	Open	
1E22-F332	HPCS Pump Discharge Pressure Instrument Root for PS-1E22-N012A,B & PT-1E22-N004	HPCS Room 673' Level	Open	
1E22-F344	HPCS Pump Discharge Pressure Instrument Root for PIS-1E22-N013	HPCS Room 673' Level	Open	
1E22-F330	HPCS Pump Flow High Side Instrument Root for FT-1E22-N005 & N006	HPCS 673' Level South of Supp. Pool	Open	
1E22-F331	HPCS Pump Flow Low Side Instrument Root for FT-1E22-N005 & N006	HPCS 673' Level South of Supp. Pool	Open	
1E22-F328	Suppression Pool Water Level Instrument Root for LSH-1E22-N002A & N002B	SW Rx. Bldg. 695' Level	Open	
1E22-F329	Suppression Pool Water Level Instrument Root for LSH-1E22-N002A & N002B	SW Rx. Bldg. 695' Level	Open	
1E22-F388	Instrument Test Stop for LSH-1E22-N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway against Supp. Pool	Locked Closed	
1E22-F389	Instrument Test Stop for LSH-1E22-N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway Against Supp. Pool	Closed	
1E22-F390	Instrument Test Stop for LSH-1E22-N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway against Supp. Pool	Locked Closed	
1E22-F391	Instrument Test Stop for LSH-1E22 N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway against Supp. Pool	Closed	

Table A.2-1 Modified HPCS System Walkdown - LaSalle Country Station Unit 1 (Cont'd)

Valve ID No.	Description	Location	Required Position	Actual Position
1E22-F303	HPCS to Rx. Vessel d/p Inst. Root for PDIS-1E22-N009	S.W. Rx. Bldg. 710' Level by Drywell 15' Overhead 315°	Open	
1B21-F347	Differential Press re Indicator PDIS-1E22-N009	S.W. Rx. Bldg. 710' Level by Drywell 15' Overhead 315°	Open	
1E22-F003	Flushing Water to HPCS Injection Line Stop Inboard	S.E. Rx. Bldg. 761' Level	Closed	
1E22-F038	HPCS Manual Injection Line Stop	Containment-South 783'	Locked Open	
1E22-F302	HPCS Suction from CST	NE Side of CST	Locked Open	
1CY033B	CST Instrument Root (LS-E22-N001B)	TB 710' S.W. Corner	Open	
1CY033C	CST Instrument Root (LS-E22-N001A)	TB 710' S.W. Corner	Open	
1CY034B	CST Instrument Root (LS-E22-N001B)	TB 710' S.W. Corner	Open	
1CY034C	CST Instrument Root (LS-E22-N001A)	TB 710' S.W. Corner	Open	

Table A.2-1 Modified HPCS System Walkdown - LaSalle Country Station Unit 1 (Cont'd)

III. HPCS DIESEL GENERATOR 1B

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants."

Table A.2-2 Modified HPCS System Walkdown - LaSalle Country Station Unit 2

I. Electrical Lineup

Breaker ID No./Description	Location	Required Position	Actual Position
2E22-C001 HPCS Pump	Bus 243 CUB 004	Racked In	
2E22-S003 HPCS Transformer	Bus 243 CUB 005	Racked In	
2E22-F015 Suppression Pool Pump Suction Valve	MCC 243-1 CUB 3C	On	
2E22-F001 Cond. Storage Tank Suction Pump Valve	MCC 243-1 CUB 2D	On	
2E22-F004 HPCS Injection Discharge Stop	MCC 243-1 CUB 7C	On	
2E22-F010 Full Flow Test Upstream Stop to CST	MCC 243-1 CUB 2E	On	
2E22-F011 Full Flow Test Downstream Stop to CST	MCC 243-1 CUB 3A	On	
2E22-F012 Suppression Pool Min. Flow Bypass Stop	MCC 243-1 CUB 3B	On	
2E22-F023 Full Flow Test Stop to Suppression Pool	MCC 243-1 CUB 3D	On	
2E22-C003 Standby Water Leg Pump	MCC 243-1 CUB 2C	On	
2VY02C HPCS Pump Room Ventilation Area Cooler Supply Fan	MCC 243-1 CUB 6B	On	
Bus 213 Supply from U-2 Battery	125 VDC Bus 213 (CB-6)	On	
Bus 213 Alternate Supply from U-1 Battery	125 VDC Bus 213 (CB-7)	Off	
Switchgear 243 Breaker Control	125 VDC Bus 213 (CB-11)	On	
Panel 1H13-P625 HPCS Relay Logic and Pump Motor Control	125 VDC Bus 213 (CB-16)	On	
Control Room Panel 2H13-P601 Valve Position Ind.	125 VDC Bus 213 (CB-17)	On	
480 VAC Power Supply to 125 VDC Battery Charger	MCC 243-1 CUB 2B	On	

Table A.2-2 Modified HPCS System Walkdown - LaSalle County Station Unit 2 (Cont'd)

II. Valve Lineup

Valve ID No.	Description	Location	Required Position	Actual Position
MO 2E22-F015	HPCS Pump Suction from Suppression Pool	Control Room Panel 2H13-P601 (EL 673' Rx. Bldg. South of Supp. Pool)	Open (Note 1)	
MO 2E22-F012	HPCS Pump Minimum Flow Stop	Control Room Panel 2H13-P601 (EL 673' HPCS Pump Room Pump Discharge)	Closed	
MO 2E22-F004	HPCS Injection Stop	Control Room Panel 2H13-P601 (EL 761' Rx Bldg. Above & to the Side of CRD Filters)	Closed	
MO 2E22-F023	HPCS Test Discharge to Suppressio Pool	Control Room Panel 2H13-P601 (EL 694'-6" Rx. Bldg. South of Supp. Pool)	Closed	
MO 2E22-F010	HPCS Test Discharge to CST Upstream Stop	Control Room Panel 2H13-P601 (EL 694'-6" Rx. Bldg. South of Supp. Pool)	Closed	
MO 2E22-F011	HPCS Test Discharge to CST Downstream Stop	Control Room Panel 2H13-P601 (EL 694'-6" Rx. Bldg. South of Supp. Pool)	Closed	
AO 2E22-F005	HPCS Testable Check	Control Room Panel 2H13-P601	Closed	
MO 2E22-F001	HPCS Pump Suction from CST	Control Room Panel 2H13-P601 (EL 673' Rx. Bldg. South of Supp. Pool)	Closed (Note 1)	
2E22-F003	Flushing Water to HPCS Injection Line Stop Inboard	S.E. Rx. Bldg. 761' Level by CRD Hydraulics	Closed	
2CY044	CST Supply to HPCS Flushing Stop	RB 761' S.E. Between HCU's and RD Hydraulics	Closed	
2E22-F038	HPCS Manual Injection Line Stop	Containment-South 783' 235° 7' over head	Locked Open	
2E22-F303	HPCS to Rx. Vessel d/p Inst. Root for PDIS-2E22-N509	S.W. Rx. Bldg. 710' above DWEDS Pump Room	Open	
2B21-F347	Differential Pressure Indicator PDIS-2E22-N009	S.W. Rx. Bldg. 710' above DWEDS Pump Room	Open	

NOTE: 1. Suppression pool is the preferred HPCS source at LaSalle due to the biological corrosion problem discusses in Section 5.9.

Table A.2-2 Modified HPCS System Walkdown - LaSalle County Station Unit 2 (Cont'd)

Valve ID No.	Description	Location	Required Position	Actual Position
2E22-F328	Suppression Pool Water Level Instrument Root for LSH-2E22-N002A & N002B	S.W. Rx. Bldg. 695' Level Against S. Pool	Open	
2E22-F329	Suppression Pool Water Level Instrument Root for LSH-2E22-N002A & N002B	S.W. Rx. Bldg. 695' Level	Open	
2E22-F388	Instrument Test Stop for LSH-2E22-N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway against Supp. Pool	Locked Closed	
2E22-F389	Instrument Test Stop for LSH-2E22 N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway against Supp. Pool	Closed	
2E22-F390	Instrument Test Stop for LSH-2E22-N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway against Supp. Pool	Locked Closed	
2E22-F391	Instrument Test Stop for LSH-2E22-N002A & N002B	S.W. Rx. Bldg. 695' Level in Raceway against Supp. Pool	Closed	
2E22-F006	HPCS Water Leg Pump Discharge Stop	HPCS Room 673' Level	Open	
2E22-F034	HPCS Water Leg Pump Suction Stop	HPCS Room 673' Level	Open	
2E22-F343	HPCS Pump Suction Pressure Instrument Root for PS-2E22-N003 & R001	HPCS Room 673' Level Suction Side	Open	
2E22-F330	HPCS Pump Flow High Side Instrument Root for FT-2E22-N005 & N006	HPCS 673' Level South of Supp. Pool South Side of Station in Raceway	Open	
2E22-F331	HPCS Pump Flow Low Side Instrument Root for FT-2E22-N005 & N006	HPCS 673' Level South of Supp. Pool South Side of Station in Raceway	Open	
2E22-F332	HPCS Pump Discharge Pressure Instrument Root for PS-2E22-N012A, B & PT-2E22-N004	HPCS Room 673' Level Discharge Side	Open	
2E22-F341	HPCS Pump Discharge Pressure Instrument Root for PIS 2E22-N013	HPCS Room 673' Level	Open	
2E22-F302	HPCS Suction from CST	SE Side of CST	Locked Open	

Table A.2-2 Modified HPCS System Walkdown - LaSalle County Station Unit 2 (Cont'd)

Valve ID No.	Description	Location	Required Position	Actual Position
2CY033B	CST Instrument Root (LS-E22-N001B)	TB 710' S.W. Corner	Open	
2CY033C	CST Instrument Root (LS-E22-N001A)	TB 710' S.W. Corner	Open	
2CY034B	CST Instrument Root (LS-E22-N001B)	TB 710' S.W. Corner	Open	
2CY034C	CST Instrument Root (LS-E22-N001A)	TB 710' S.W. Corner	Open	

Table A.2-2 Modified HPCS System Walkdown - LaSalle County Station Unit 2 (Cont'd)

III. HPCS DIESEL GENERATOR 2B

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plant".

APPENDIX A3

Nine Mile Point - Unit 2 HPCS System Details

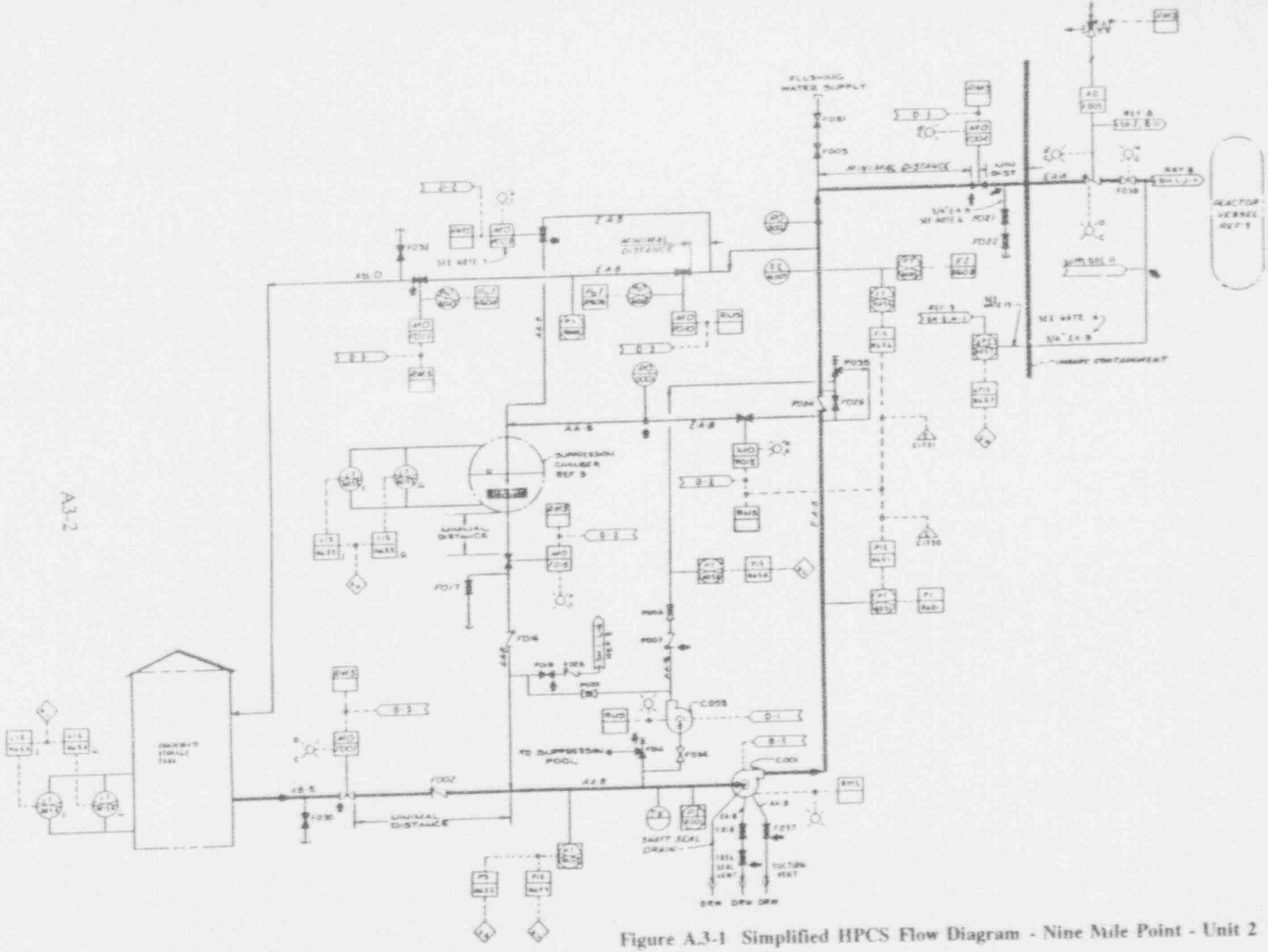

Figure A.3-1 Simplified HPCS Flow Diagram - Nine Mile Point - Unit 2

Table A.3-1 Modified HPCS System Walkdown - Nine Mile Point - Unit 2

I. Electrical Lineup

Breaker ID No./Description (Note 1)	Location	Required Position	Actual Position
2CSH*P1 (C001) HPCS Pump 1	2ENS*SWG102 BKR 4/2	Racked In	
2CSH*P2 (C003) HPCS Water Leg Pump 2	2EHS*MCC201 CUB 5A	On	
2CSH*MOV101 (F001) HPCS Pump Suction from CST	2EHS*MCC201 CUB 3A	On	
2CSH*MOV105 (F012) HPCS Min Flow Bypass	2EHS*MCC201 CUB 3B	On	
2CSH*MOV107 (F004) HPCS Pump 1 Injection	2EHS*MCC201 CUB 2C	On	
2CSH*MOV111 (F023) HPCS Test Return to Supp. Pool	2EHS*MCC201 CUB 10D	On	
2CSH*MOV110 (F010) HPCS Test Return to CST	2EHS*MCC201 CUB 6B	Off (Note 2)	
2CSH*MOV112 (F011) HPCS Test Return to CST	2EHS*MCC201 CUB 7B	On	
2CSH*MOV118 (F015) HPCS Pump Suction from Supp. Pool	2EHS*MCC201 CUB 3C	On	
2CSHN10 Relay Logic	2CES*IPNL414 BKR 16	On	
2CSHN11 Relay Logic	2SCV*PNL200P BKR 17	On	
2CSHN12 Valve Position Indication	2CES*IPNL414 BKR 17	On	
2CSHN13 Valve/Relay Logic	2SCV*PNL200P BKR 16	On	

NOTES: 1. Standard GE component numbers given in parenthesis.
2. Assures compliance with 10 CFR 50 Appendix R requirements.

Table A.3-1 Modified HPCS System Walkdown - Nine Mile Point - Unit 2 (Cont'd)

II. Valve Lineup

Valve ID No. (Note 1)	Description	Location	Required Position	Actual Position
2CSH*HCV120 (F038)	Injection Manual Vlv	Control Room Panel P601 (Rx. Bldg.)	Locked Open	
2CSH*MOV112 (F011)	Test Return to Condensate Tk	Control Room Panel P601 (Rx. Bldg.)	Shut	
2CSH*AOV108 (F005)	Injection Testable Check Vlv	Control Room Panel P601 (Rx. Bldg.)	Shut	
2CSH*MOV110 (F010)	Test Return to Condensate Tk	Control Room Panel P601 (Rx. Bldg.)	Shut (Note 2)	
2CSH*MOV107 (F004)	Pump 1 Injection Vlv	Control Room Panel P601 (Rx. Bldg.)	Shut	
2CSH*MOV111 (F023)	Test Return to Suppression Pool	Control Room Panel P601 (Rx. Bldg.)	Shut	
2CSH*MOV101 (F001)	Pump Suct from Cnds Tk	Control Room Panel P601 (Rx. Bldg.)	Open	
2CSH*MOV105 (F012)	Minimum Flow Bypass Vlv	Control Room Panel P601 (Rx. Bldg.)	Shut	
2CSH*MOV118 (F015)	Pump Suct from Suppression Pool	Control Room Panel P601 (Rx. Bldg.)	Shut	
2CSH-V37	2CNS-TK1B Outlet	CST 1B	Locked Open	
2CSH*V107	*LT3A Inst Root Isolation	CST 1B	Open	
2CSH*V108	*LT3B Inst Root Isolation	CST 1B	Open	
2CSH*V59	PI Suction Check Valve	HPCS Room	Installed	
2CSH*[illegible]	*P2 Suction Isol	HPCS Room	Open	
2CSH*V17	*P2 Discharge Check	HPCS Room	Installed	
2CSH*V55	*P2 Discharge Check	HPCS Room	Installed	
2CSH*V15	*P2 Discharge Isol	HPCS Room	Open	
2CSH*V96	*P2 Recirc Line Throttle		Locked Throttled (Note 3)	

NOTES: 1. Standard GE component number given in parenthesis.
2. Assures compliance with 10 CFR 50 Appendix R requirments.
3. With *P2 running, licensee throttles 2CSH*V54 and 2CSH*V96 as required to clear annunciators 601719 and 601720 while maintaining HPCS system pressure > 65 psig.

Table A.3-1 Modified HPCS System Walkdown - Nine Mile Point - Unit 2 (Cont'd)

Valve ID No. (Note 1)	Description	Location	Required Position	Actual Position
2CSH*V54	*P2 Recirc Line Throttle		Locked Throttled (Note 3)	
2CSH*V18	*PT102, PI103 Isol		Open	
2CSH*V27	*PT105, PI128 Isol		Open	
2CSH*V9	*P1 Discharge Check		Installed	
2CSH*V25	*FT104, 105 Isol		Open	
2CSH*V26	*FT104, 105 Isol		Open	
2CSH*V23	*PI115 Inst Root Isol		Open	
2CSH*V52	Suction Piping Drain to Radwaste Isol		Shut	
2CSH*V16 (F016)	Supp Pool Suction Piping Check		Installed	
2CSH*V57	*LS143 Inst Root Isol		Open	
2CSH*V56	*LS143 Inst Drain		Shut	
2CSH*V94	*LS143 Inst Drain		Shut and Capped	
2CSH*V58	*LS143 Inst Vent		Shut	
2CSH*V93	*LS143 Inst Vent		Shut and Capped	
2CSH*V31	Condensate Makeup Isolation		Locked Shut	
2C[illegible]30	Condensate Makeup Isolation		L[illegible] Shut	
2CSH*V45	*PDT109 Inst Root Isol		Open	
2CSH*V36	LT123, 124 Isol		Open	
2CSH*V99	LT Test Connection		Shut	
2CSH*V100	LT Test Connection		Shut and Capped	
2CSH*V79	LT124 Vent		Shut and Capped	
2CSH*V80	LT123 Vent		Shut and Capped	

NOTES: 1. Standard GE component [illegible] given in parenthesis.
2. Assures compliance with 10 C[illegible] 50 Appendix R requirement
3. With *P2 running, licensee throttles 2CSH*V54 and 2CSH*V96 as required to clear annunciators 601719 and 601720 while maintaining HPCS system pressure > 65 psig.

Table A.3-1 Modified HPCS System Walkdown - Nine Mile Point - Unit 2 (Cont'd)

Valve ID No. (Note 1)	Description	Location	Required Position	Actual Position
2CSH*V82	LT124 Isolation		Open	
2CSH*V76	LT123 Isolation		Open	
2CSH*V77	LT123 Isolation		Open	
2CSH*V75	LT124 Isolation		Open	
2CSH*V78	LT124 Drain		Shut and Capped	
2CSH*V81	LT123 Drain		Shut and Capped	
2CSH*V101	LT Test Conn		Shut	
2CSH*V102	LT Test Conn		Shut and Plugged	
2CSH*V35	*LT123, 124 Isol		Open	

NOTE: 1. Standard GE component number given in parenthesis.

NOTES: 1. Standard GE component number given in parenthesis.
2. Assures compliance with 10 CFR 50 Appendix R requirments.
3. With *P2 running, licensee throttles 2CSH*V54 and 2CSH*V96 as required to cle[illegible] annunciators 601719 and 601720 while maintaining HPCS system pressure > 65 [illegible]

Table A.3-1 Modified HPCS System Walkdown - Nine Mile Point - Unit 2 (Cont'd)

III. HPCS DIESEL GENERATOR

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants".

APPENDIX A4

Perry Nuclear Power Plant HPCS System Details

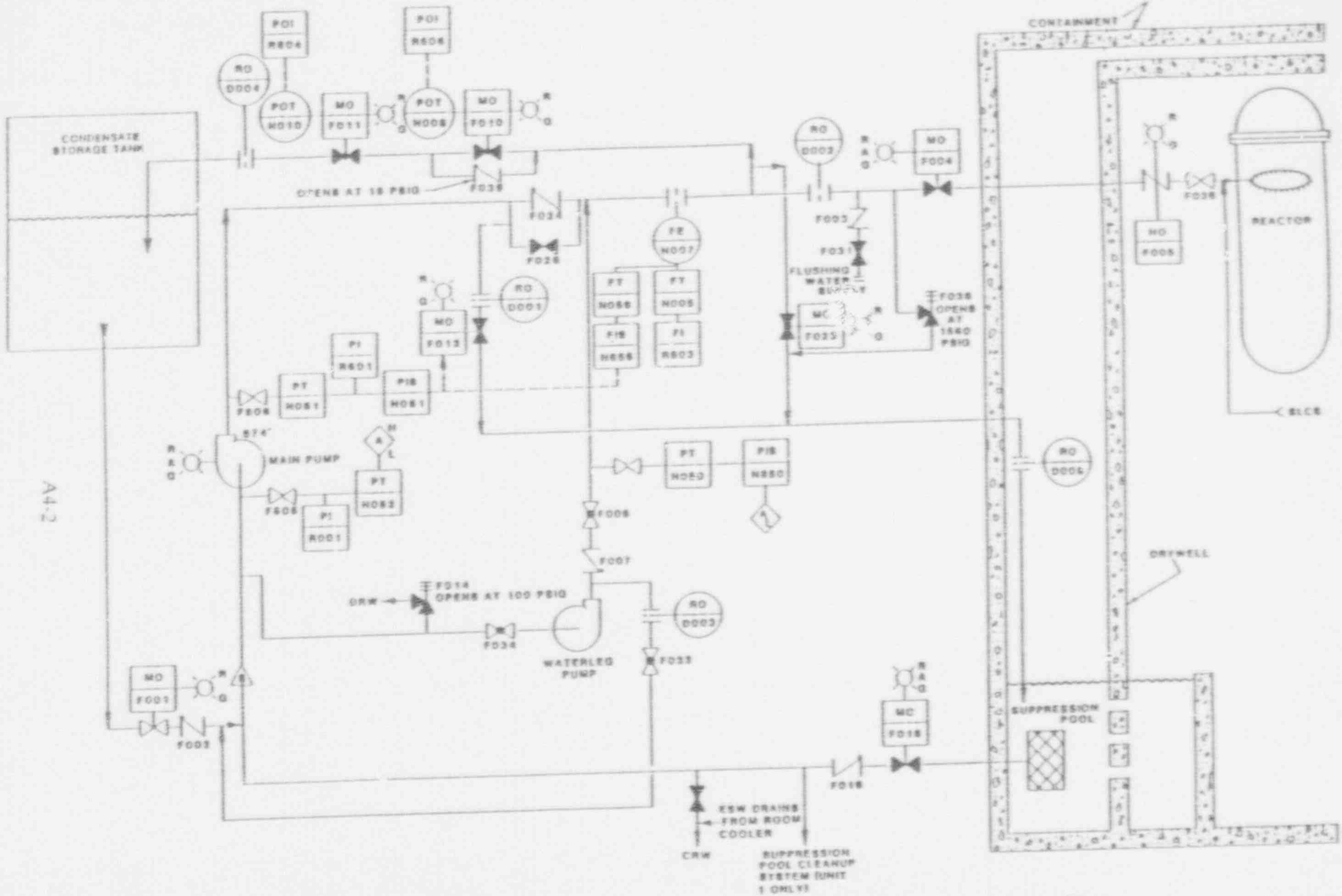

Figure A.4-1 Simplified HPCS Flow Diagram - Perry Nuclear Power Plant

Table A.4-1 Modified HPCS System Walkdown - Perry Nuclear Power Plant

I. Electrical Lineup

Breaker ID No./Description	Location	Required Position	Actual Position
1E22-C001 HPCS Pump	Bus EH13 BKR EH1304	Racked In	
1E22-S003 HPCS Transformer EHR-1-E to MCC ER-1-E1	Bus EH13 BKR EH1305	Racked In	
1E22-C003 Standby Water Leg Pump	MCC EF1E-1 Disconnect Switch C	Closed	
1E22-F001 Cond. Storage Tank Suction Pump Valve	MCC EF1E-1 Disconnect Switch D	Closed	
1E22-F010 Full Flow Test Upstream Stop to CST	MCC EF1E-1 Disconnect Switch G	Closed	
1E22-F011 Full Flow Test Downstream Stop to CST	MCC EF1E-1 Disconnect Switch H	Closed	
1E22-F012 Supp. Pool Min. Flow Bypass Stop	MCC EF1E-1 Disconnect Switch J	Closed	
1E22-F015 Supp. Pool Pump Suction Valve	MCC EF1E-1 Disconnect Switch K	Closed	
1E22-F023 Full Flow Test Stop to Supp. Pool	MCC EF1E-1 Disconnect Switch L	Closed	
HPCS Pump Room Ventilation Area Cooler Supply Fan	MCC EF1E-1 Disconnect Switch R	Closed	
1E22-F004 HPCS Injection Discharge Stop	MCC EF1E-1 Disconnect Switch F	Closed	
HPCS Instrument Power	MCC 143-1 CUB 2A	On	
125 VDC BUS Ed-1-C Supply from U-1 Battery	125 VDC Bus 113 (CB-6)	On	
Switchgear Bus EH-13 Breaker Control Power	125 VDC Distr. Panel (CB-11)	On	
Panel 1H13-P625 HPCS Relay Logic and Pump Motor Control	125 VDC Distr. Par (CB-16)	On	
Control Room Panel 1H13-P601	125 VDC Distr. Panel (CB-17)	On	

Table A.4-1 Modified HPCS System Walkdown - Perry Nuclear Power Plant (Cont'd)

II. Valve Lineup

Valve ID No.	Description	Location	Required Position	Actual Position
MO 1E22-F015	HPCS Pump Suction from Suppression Pool	Control Room Panel 1H13-P601 Rx. Bldg.	Closed	
MO 1E22-F012	HPCS Pump Minimum Flow Stop	Control Room Panel 1H13-P601 Rx. Bldg.	Closed	
MO-1E22-F004	HPCS Injection Stop	Control Room Panel 1H13-P601 Rx. Bldg.	Closed	
MO 1E22-F023	HPCS Test Discharge to Suppression Pool	Control Room Panel 1H13-P601 Rx. Bldg.	Closed	
MO 1E22-F010	HPCS Test Discharge to CST Upstream Stop	Control Room Panel 1H13-P601 Rx. Bldg.	Closed	
MO 1E22-F011	HPCS Test Discharge to CST Downstream Stop	Control Room Panel 1H13-P601 Rx. Bldg.	Closed	
AO 1E22-F005	HPCS Testable Check	Control Room Panel 1H13-P601	Closed	
MO 1E22-F001	HPCS Pump Suction from CST	Control Room Panel 1H13-P601 Rx. Bldg.	Open	
1E22-F034	HPCS Water Leg Pump Suction Stop	HPCS Room 673' Level	Open	
1E22-F006	HPCS Water Leg Pump Discharge Stop	HPCS Room 673' Level	Open	
1E22-F505	HPCS Pump Suction Pressure Instrument Root for PT-1E22-052 & PI-1E22-R001	HPCS Room	Open	
1E22-F506	HPCS Pump Discharge Pressure Instrument Root for PT-1E22-051 & PIS-1E22-N651	HPCS Room	Open	
1E22-F512A	HPCS Pump Flow High Side Instrument Root for FT-1E22-N005 & N056	HPCS 673' Level South of Supp. Pool	Open	
1E22-F512B	HPCS Pump Flow Low Side Instrument Root for FT-1E22-N005 & N056	HPCS 673' Level South of Supp. Pool	Open	
1E22-F	Suppression Pool Water Level Instrument Root for LIS-1E22-N655C & 655G	Rx. Bldg.	Open	
1E22-F	Suppression Pool Water Level Instrument Root for LIS-1E22-N655C 655G	Rx. Bldg.	Open	

Table A.4-1 Modified HPCS System Walkdown - Perry Nuclear Power Plant (Cont'd)

Valve ID No.	Description	Location	Required Position	Actual Position
1E22-F	Instrument Test Stop for LIS-1E22-N655C & N655G	Rx. Bldg.	Locked Closed	
1E22-F	Instrument Test Stop for LIS-2E22-N655C & N655G	Rx. Bldg.	Closed	
1E22-F	Instrument Test Stop for LIS-2E22-N655C & N655G	Rx. Bldg.	Closed	
1E22-F	Instrument Test Stop for LIS-1E22-N655C & N655G	Rx. Bldg.	Closed	
1E22-F	HPCS to Rx Vessel d/p Inst. Root for PDIS-1E22-N009	Rx. Bldg.	Open	
1E21-F	Differential Pressure Indicator PDIS-1E22-N009	Rx. Bldg.	Open	
1E22-F003	Flushing Water to HPCS Injection Line Stop Inboard	Rx. Bldg.	Closed	
1E22-F036	HPCS Manual Injection Line Stop	Rx. Bldg., Primary Containment	Locked Open	
1E22-F	HPCS Suction from CST	CST	Locked Open	
	CST Level Transmitter Instrument Root Valves	CST	Open	

Table A.4-1 Modified HPCS System Walkdown - Perry Nuclear Power Plant (Cont'd)

III. HPCS DIESEL GENERATOR EIC

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants".

APPENDIX A5

River Bend Station - Unit 1 HPCS System Details

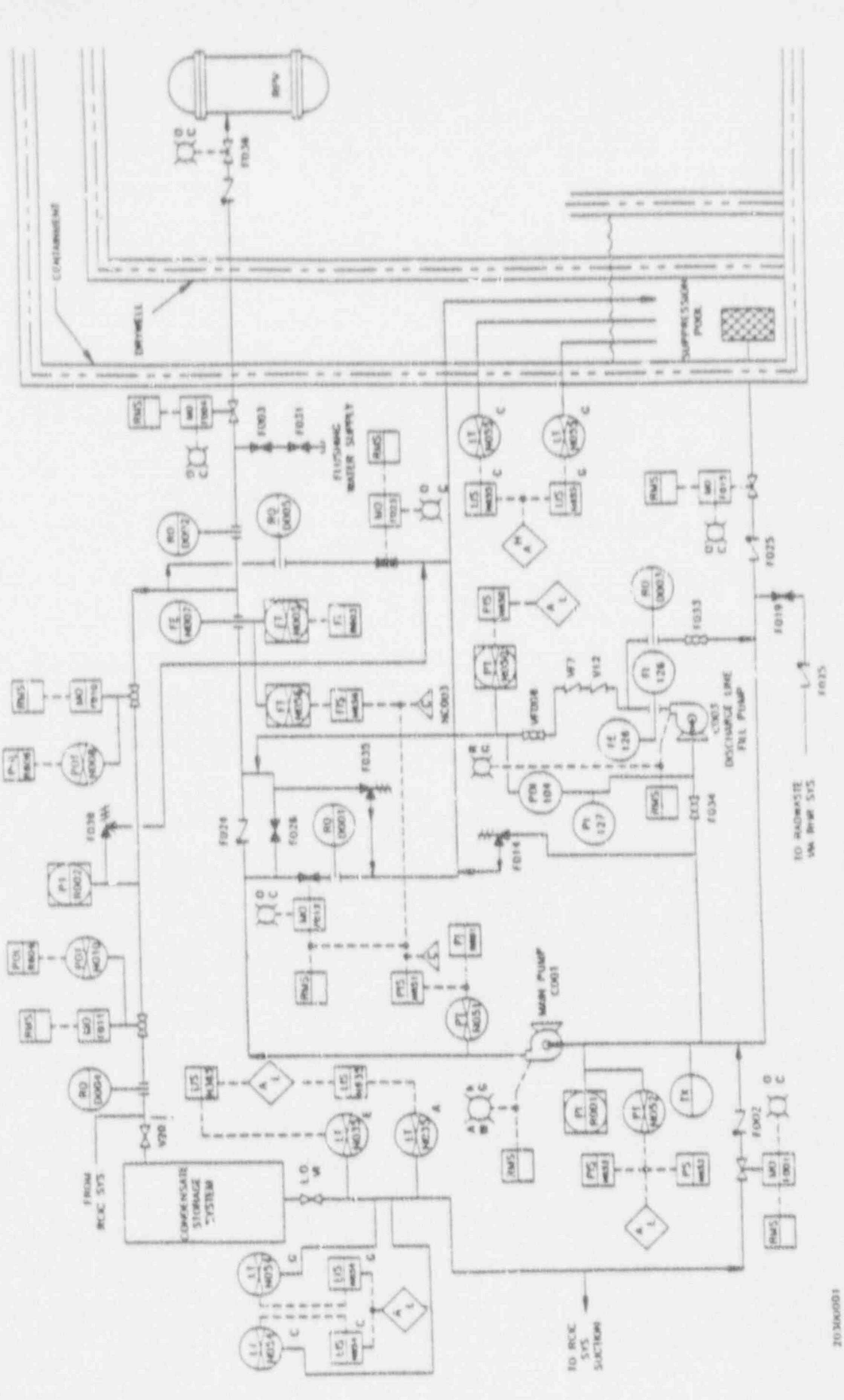

Figure A.5-1 Simplified HPCS Flow Diagram - River Bend Station Unit 1

Table A.5-1 Modified HPCS System Walkdown - River Bend Station - Unit 1

I. Electrical Lineup

Breaker or Switch ID No./Description	Location	Required Position	Actual Position
1E22-PC001 HPCS Motor Feed	SWGR E22*S004 BKR 02	Racked In Open (Note 1)	
1E22-PC003 Subsystem Fill Pump	MCC E22*S002 BKR 2C	On	
1E22-MOVF001 Cond. Storage Tank Pump Suction Valve	MCC E22*S002 BKR 2D	On	
1E22-MOVF010 Cond. Storage Tank Test Bypass Valve	MCC E22*S002 BKR 3D	On	
1E22-MOVF011 Cond. Storage Tank Test Bypass Valve	MCC E22*S002 BKR 3E	On	
1E22-MOVF004 HPCS Pump Discharge Valve	MCC E22*S002 BKR 2E	On	
1E22-MOVF023 Suppression Pool Test Bypass Valve	MCC E22*S002 BKR 4D	On	
1E22-MOVF015 Suppression Pool Pump Suction Valve	MCC E22*S002 BKR 4C	On	
1E22-MOVF012 Suppression Pool Min Flow Bypass Vlv	MCC E22*S002 BKR 4B	On	
1E22*PC003 HPCS Line Fill Pump	1H13-P601	Neutral After Stop	
1E22*PC001 HPCS Pump supply BKR 1E22-ACB02	1H13-P601	Neutral After Trip	

NOTE: 1. Check fuses installed, charging motor switch on, and charging springs indicate charged.

Table A.5-1 Modified HPCS System Walkdown - River Bend Station - Unit 1 (Cont'd)

II. Valve Lineup

Valve ID No.	Description	Location	Required Position	Actual Position
1E22-F015	HPCS Pump Suppression Pool Suction Valve	1H13-P601	Auto After Close	
1E22-F001	HPCS Pump CST Suction Valve	1H13-P601	Auto After Open	
1E22-F012	HPCS Min Flow Valve to Suppression Pool	1H13-P601	Auto After Close	
1E22-F023	HPCS Test Return to Suppression Pool	1H13-P601	Auto After Close	
1E22-F010	HPCS Test Bypass to CST	1H13-P601	Auto After Close	
1E22-F011	HPCS Test Return Valve to CST	1H13-P601	Auto After Close	
1E22-F004	HPCS Injection Isolation Valve	1H13-P601	Auto After Close	
1E22*AOVF005	HPCS Testable Check Valve	1H13-P601	Closed	
1CSH*V1	HPCS and RCIC CST Suction Isolation Valve	Auxiliary Building, EL 74'	Locked Open	
1CSH*V3	[1E22-PTN052 & PIR001] Root Valve	Auxiliary Building, EL 74'	Open	
1CSH*V6	[1E22-PTN051] Root Valve HPCS Pump Disch. Press.	Auxiliary Building, EL 74'	Open	
1E22*VF034	HPCS Fill Pump Suction Valve	Auxiliary Building, EL 84'	Open	
1E22*VF006	HPCS Fill Pump Discharge Valve	Auxiliary Building, EL 84'	Open	
1CSH*V24 1CSH*V22	[1E22-FEN007] Root Valves HPCS Flow	Auxiliary Building, EL 95'	Sealed Open	
1E22*VF003	HPCS Disch Line Flushing Water Supply	Auxiliary Building, EL 146'	Closed	
1E22*MOVF004	HPCS Injection to Rx	Auxiliary Building, EL 146'	Closed	
1CSH*V28	[1E31-PDTN081] Leak Detection Isolation Valve	Containment, EL 127' AZ 286	Open	
1E22*VF036	HPCS Disch to Rx, Manual Isolation Valve	Drywell, EL 146' AZ 270	Locked Open	
1CSH*V17 1CSH*V16	[1E51-LTN035A] Root Valves CST Level	Fuel Building Piping Tunnel	Open	

Table A.5-1 Modified HPCS System Walkdown - River Bend Station - Unit 1 (Cont'd)

Valve ID No.	Description	Location	Required Position	Actual Position
1CSH*V18 1CSH*V19	[1E22-LTN054C] Root Valves CST Level	Fuel Building Piping Tunnel	Open	

Table A.5-1 Modified HPCS System Walkdown - River Bend Station - Unit 1 (Cont'd)

III. HPCS DIESEL GENERATOR IC

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants."

APPENDIX A6

Washington Nuclear Plant No. 2 HPCS System Details

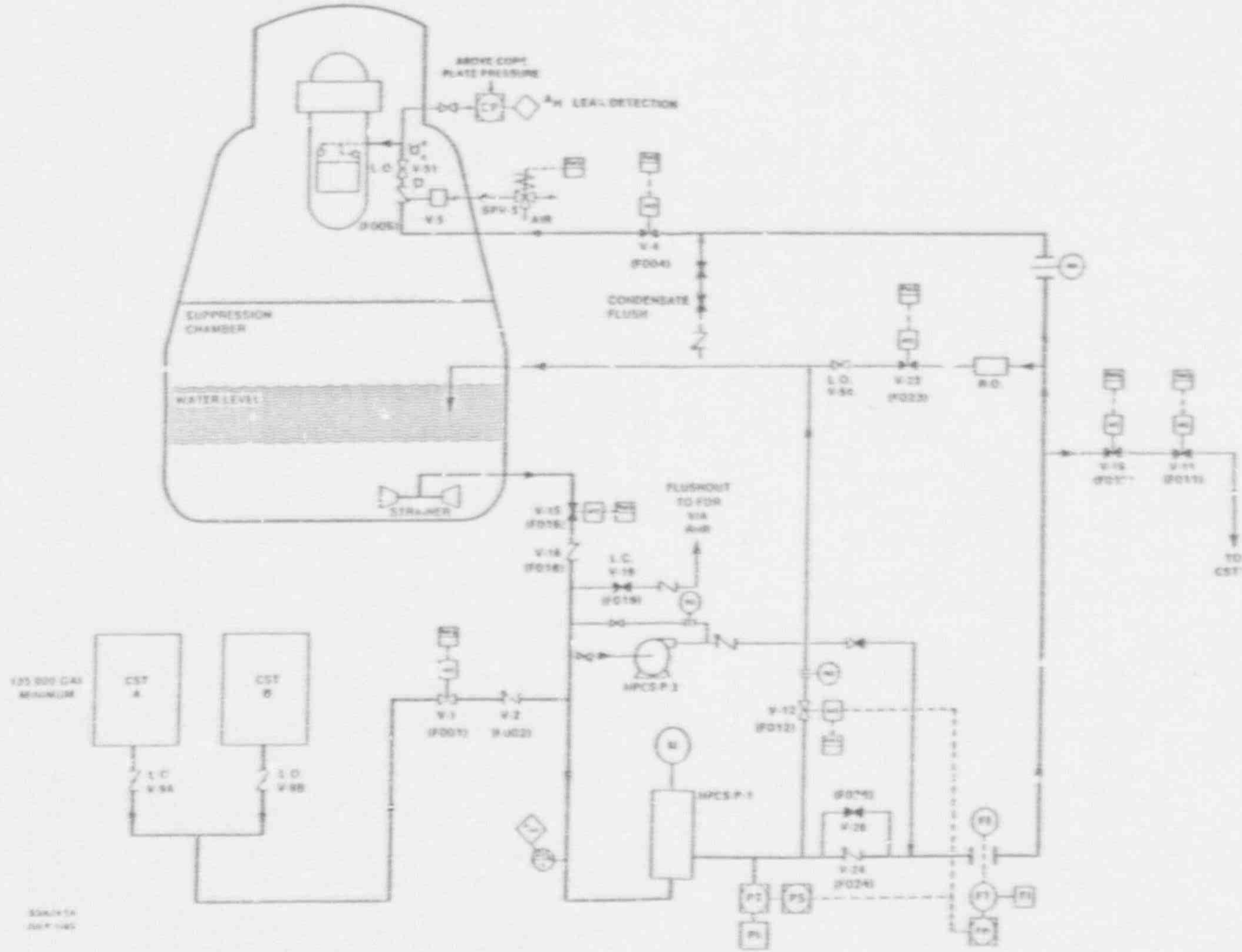

Figure A.6-1 Simplified HPCS Flow Diagram - WNP 2

Table A.6-1 Modified HPCS System Walkdown - Washington Nuclear Plant No. 2

I. Electrical Lineup

Breaker ID No./Description	Location (Note 1)	R ired Position (Note 2)	Actual Position
HPCS-P-1 High Pressure Core Spray Pump	SM-4	Racked In	
HPCS-P-3 HPCS Water Leg Pump	MC-4A CUB 1C	Closed	
HPCS-V-1 HPCS Suction from CST	MC-4A CUB 2D	Closed	
HPCS-V-4 HPCS Injection Valve	MC-4A CUB 5B	Closed	
HPCS-V-10 HPCS Inboard Return to CST	MC-4A CUB 2E	Closed	
HPCS-V-11 HPCS Outboard Return to CST	MC-4A CUB 3A	Closed	
HPCS-V-12 HPCS Minimum Flow	MC-4A CUB 3B	Closed	
HPCS-V-15 HPCS Suppression Pool Suct.on	MC-4A CUB 3C	Closed	
HPCS-V-23 HPCS Test Valve	MC-4A CUB 3D	Closed	
HPCS-V-5, HPCS-V-51	PP-4A Ckt 9	Closed	
HPCS-V-5	PP-4A Ckt 11	Closed	
PT-4 (E22-N004-Pump Disch. Press.) PT-5 (E22-N005-System Flow)	PP-4A Ckt 8	Closed	
HPCS Logic	125 VDC Ckt D-7 HPCS Dist	Closed	
HPCS-V-10, HPCS-V-11 Position Indication	125 VDC Ckt D-9 HPCS Dist	Closed	

NOTES: 1. Electrical equipment physically located in DG Room.
2. Licensee personnel are instructed that if these breakers are open, not to close them until directed by the Control Room Operator, and to see filling and venting instructions.

Table A.6-1 Modified HPCS System Walkdown - Washington Nuclear Plant No. 2 (Cont'd)

II. VALVE LINEUP

Valve ID No. (Note 1)	Description	Location: Bldg - Elev.	Required Position	Actual Position
HPCS-V-1 (F001)	Suction from CST MOV	RB-422	Open (Note 2)	
HPCS-V-701	Root Valve for PIS-3 (E22-N009) Suction Pressure	RB-422	Open	
HPCS-V-80	HPCS-P-1 Seal Drain	RB-422	Open (Note 2)	
HPCS-V-81	HPCS-P-1 Seal Drain	RB-422	Open (Note 2)	
HPCS-V-12 (F012)	HPCS-P-1 Minimum Flow MOV	RB-422	Closed	
HPCS-V-53	Minimum Flow Line Isolation	RB-422	Locked Open (Note 2)	
HPCS-V-34 (F034)	HPCS-P-3 Suction Isolation	RB-422	Open	
HPCS-V-77 (F033)	HPCS-P-3 Minimum Flow	RB-422	Open	
HPCS-V-6 (F006)	HPCS-P-3 Stop Check	RB-422	Open	
HPCS-V-708	Root Valve for PIS-13 (water leg pump discharge press.)	RB-422	Open (Note 2)	
HPCS-V-709 & V-710	Root Valves for FT-5 (E22-N005), FIS-6 (E22-N006), & FI-603 (E22-R603)	RB-444	Open (Note 2)	
HPCS-V-15 (F015)	Suppression Pool Suction MOV	RB-444	Closed	
HPCS-V-19 (F019)	HPCS Suction Tie to RHR	RB-444	Locked Closed	
HPCS-V-10 (F010)	HPCS-P-1 Test to CST MOV	RB-444	Closed	
HPCS-V-11 (F011)	HPCS-P-1 Test to CST MOV	RB-444	Closed	
HPCS-V-23 (F023)	HPCS-P-1 Test to Suppression Pool MOV	RB-444	Closed	
HPCS-PI-VX-732	HPCS-DPIS-9 (45°)	RB-536	Open	
HPCS-V-5 (F005)	Testable Check Valve	DW-547	Closed	

NOTES:
1. Standard GE component numbers given in parentheses.
2. Licensee requires independent verification of this valve position by its personnel.
3. Valve capped.

Table A.6-1 Modified HPCS System Walkdown - Washington Nuclear Plant No. 2 (Cont'd)

Valve ID No. (Note 1)	Description	Location: Bldg.-Elev.	Required Position	Actual Position
HPCS-V-76	Future SLC Connection Isolation	DW-547	Closed (Note 2) (Note 3)	
HPCS-V-37	Test Connection Isolation Valve (551', 236°)	DW-547	Closed (Note 2)	
HPCS-V-38	Test Connection Isolation Valve (551', 236°)	DW-547	Closed (Note 2)	
HPCS-V-51 (F038)	Injection Line Isolation Valve (551', 240°)	DW-547	Locked Open	
HPCS-V-3 (F003)	Condensation Flushing Supply Isolation	RB-522	Locked Closed	
HPCS-V-4 (F004)	Injection Line MOV	RB-522	Closed	
COND-V-9A	HPCS Suction from CST Isolation Valve	CST Area	Locked Open (Note 2)	
COND-V-9B	HPCS Suction from CST Isolation Valve	CST Area	Locked Open (Note 2)	

NOTES: 1. Standard GE component numbers given in parentheses.
2. Licensee requires independent verification of this valve position by its personnel.
3. Valve capped.

Table A.6-1 Modified HPCS System Walkdown - Washington Nuclear Plant No. 2 (Cont'd)

III. HPCS DIESEL GENERATOR

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants."

APPENDIX A.7

Grand Gulf Nuclear Station - Unit 1 HPCS System Details

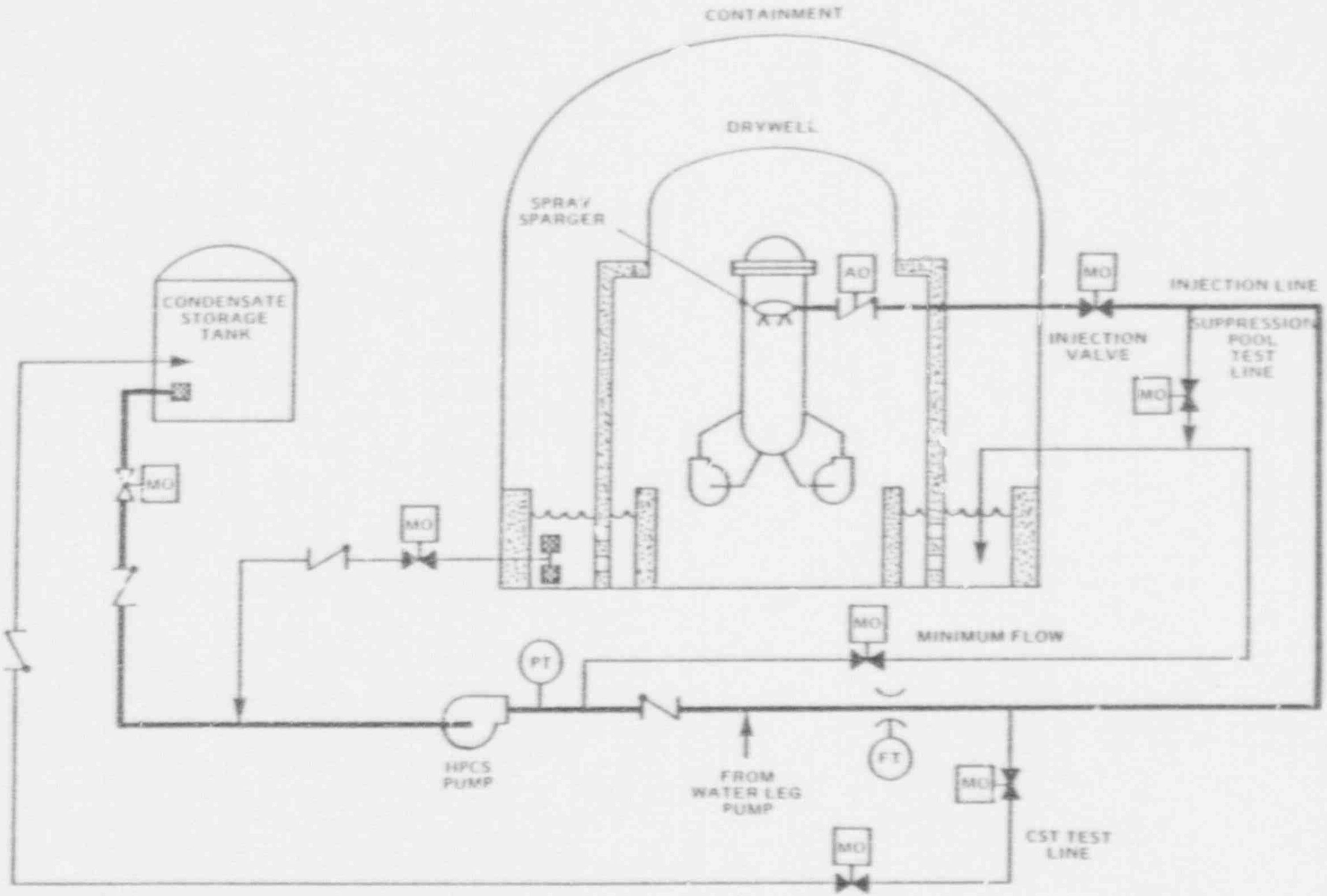

Figure A.7-1 Simplified HPCS Flow Diagram - Grand Gulf

Table A.7-1 Modified HPCS System Walkdown - Grand Gulf Nuclear Station Unit 1

I. Electrical Lineup

Breaker ID No./Description	Location	Required Position	Actual Position
C001 HPCS Pump Motor	BUS 17AC BKR 152-1702	Racked In (Note 1)	
C003 HPCS Standby Water Leg (Jockey) Pump	MCC 17B01 BKR 52-170105	Closed (Note 2)	
F001 HPCS Pump Suction from CST	MCC 17B01 BKR 52-170106	Closed	
F004 HPCS Injection Shutoff Valve	MCC 17B01 BKR 52-170101	Closed	
F010 HPCS Inboard Test Return to CST	MCC 17B01 BKR 52-170107	Closed	
F011 HPCS Outboard Test Return to CST	MCC 17B01 BKR 52-170108	Closed	
F012 HPCS Min Flow to Supp. Pool	MCC 17B01 BKR 52-170109	Closed	
F015 HPCS Pump Suction from Supp Pool	MCC 17B01 BKR 52-170110	Closed	
F023 HPCS Test Return to Supp. Pool	MCC 17B01 BKR 52-170111	Closed	
1T51-B001C HPCS Pump Room Cooler Fan	MCC 17B01 BKR 52-170117	Closed	
C001 HPCS Pump Motor Space Heater	PNL 17P11 BKR 52-1P71122	Closed	
Panel 1H13-P601 Valve Position Indication	PNL 1H22-P118 72-11C15	Closed	
Panel 1H13-P677	PNL 1H22-P118 72-11C17	Closed	
Panel 1H13-P625/HPCS Logic/Control Voltage	PNL 1H22-P118 72 11C18	Closed	
Ground Transformer/Bus Relaying and Voltmeter	PNL 1H22-P118 72-11C19	Closed	

NOTES: 1. 152-1702 will be racked in during the fill and vent instructions.
2. 52-170105 the HPCS Jockey Pump breaker will be closed during the fill and vent instructions.

Table A.7-1 Modified HPCS System Walkdown - Grand Gulf Nuclear Station Unit 1 (Cont'd)

II. Valve Lineup

Valve ID No.	Description	Location	Required Position	Actual Position
F001	HPCS Pump Suction from CST	1H13-P601 HS-M600 (S-1)	Auto Open	
F012	HPCS Min. Flow to Supp. Pool	1H13-P601 HS-M605 (S-12)	Auto Closed	
F015	HPCS Pump Suction from Supp. Pool	1H13-P601 HS-M609 (S-15)	Auto Closed	
F023	HPCS Test Return to Supp. Pool	1H13-P601 HS-M606 (S-23)	Auto Closed	
F004	HPCS Injection Shutoff Valve	1H13-P601 HS-M601 (S-4)	Auto Closed	
F010	HPCS Inboard Test Return to CST	1H13-P601 HS-M607 (S-10)	Auto Closed	
F011	HPCS Outboard Test Return to CST	1H13-P601 HS-M608 (S-11)	Auto Closed	
F005	HPCS Testable Check Valve	1H13-P601 HS-M602 (S-5)	Closed	
1P11 F021	CST Supply to HPCS/RCIC	CST Dike Area	Locked Open	
F034	HPCS Jockey Pump Suction	Area 8 Elev 93'	Locked Open	
F006	HPCS Jockey Pump Discharge Stop Check	Area 8 Elev 93'	Handwheel Open	
F219	Supp. Pool Suct. Line Test Connection Shutoff	Area 8 Elev 93'	Closed	
F017	Supp. Pool Suct Line Test Connection Isolation	Area 8 Elev 93'	Capped & Closed	
F019	HPCS Flush to Liq. Radwaste Surge Tank	Area 8 Elev 93'	Locked Closed	
F039	Stop Check Around F010	Area 8 Elev 93'	Handwheel Open	
FX050	PP N404	Area 8 Elev 93'	Capped Closed	
FX002	PT N050, Jockey Pump Press.	Area 8 Elev 93'	Open	
FX003 & FX004	Root Valves for E22-FT N005 & FT N056 (HPCS Pump Disch.)	Area 8 Elev 93'	Open	
FX005	PT N051, Pump Discharge Press.	Area 8 Elev 93'	Open	
FX006	PI R001	Area 8 Elev 93'	Open	
FX007	PI R002	Area 8 Elev 93'	Open	

Table A.7-1 Modified HPCS System Walkdown - Grand Gulf Nuclear Station Unit 1 (Cont'd)

Valve ID No.	Description	Location	Required Position	Actual Position
FX020	PP N401	Area 8 Elev 93'	Closed	
FX022	PP N403	Area 8 Elev 93'	Closed	
FX019	PP N400	Area 8 Elev 93'	Closed	
F031	Flushing Wtr Supply Shutoff	Area 8 Elev 119'	Locked Closed	
F003	Flushing Wtr Supply Isolation	Area 8 Elev 119'	Locked Closed	
FX038	L[illegible] N054C & G, CST Level	Area 7 Elev. 119'	Open	
B21-FX066	[illegible]T-N081 (Above Core [illegible]ate Tap) HPCS Leak Detection	Area 11 Elev 147'	Open	
E31 FX025	PDT N081, HPCS Leak Detect.	Area 11 Elev 147'	Open	
F036	HPCS Injection to Rx Isolation	Area 11 Elev 147'	Locked Open	

Table A.7-1 Modified HPCS System Walkdown - Grand Gulf Nuclear Station Unit 1 (Cont'd)

III. HPCS DIESEL GENERATOR C

Refer to Table B-1, "Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants."

APPENDIX B

Proposed Inspection Plan for Diesel Generators

Table B-1 Proposed Inspection Plan for Diesel Generators at Nuclear Power Plants

A. Objectives

To review and evaluate Diesel Generator design, operation, and maintenance at NPPs to ensure that the DGs will be available when needed to power safety systems

B. Details

1. The inspection of the following items should focus on DG auxiliary systems as follows: Fuel Injection System, Turbocharger, Starting System, Speed/Load Control, Jacket Water, Cooling Water, Lube Oil, Fuel Oil, Control and Monitoring Systems, and Generator.

2. Using the LER, 50.55e, and Part 21 systems computer printout, select 3 recent failures (within 2 years) for followup at the NPP. When at the plant select an additional 2 failures from the internal systems. Evaluate the licensee's response to these failures for proper failure analysis, corrective action, notification of vendor, Part 21 evaluation and documentation.

3. Maintenance: Refer to IE I.P.s 62700 and 62702, as they apply to DG maintenance. Additionally, does the NPP have, and have they implemented the DG vendors' maintenance recommendations (especially those recommendations unique to nuclear service DGs such as Colt's described in NSAC-79)? Are maintenance personnel specially trained on DGs? Is failure information fed back into maintenance program?

4. Design Change Control: Select two DG modifications and verify proper implementation. Utilizing information from DG vendor inspection on modifications recommended, verify the NPP is receiving all pertinent information in this area from the vendor. (Reference IE I.P. 37700).

5. Spare Parts and Procurement: Review how spare parts and services are purchased and parts stored, both from DG vendor and direct from sub-vendor. Verify adequate Part 21 and QA, particularly when vendors are only supplying commercial grade parts and services (e.g., Woodward Governor and Stewart and Stevenson). Verify ASME code specified where appropriate. Tour spare parts storage area. (Reference IE I.P. 38701 and 38702).

6. Training: Ensure appropriate DG specific training given to maintenance, operations, QA, and management personnel. Are there adequate documents to describe DG operation onsite (both main engine and auxiliary system)? (Reference IE I.P. 41700).

7. Observe DGs in operation. Ensure they run smoothly and are operated per procedure. Look for abnormal vibration and leaks (air, fuel oil, or lube oil). Check that readings are within specified limits. Are limits per DG vendor recommendations? Are recommendations clearly specified? Is air quality in DG room satisfactory without excessive dust? Are control cabinets properly gasketed? Are instruments calibrated? Is trending of operating data performed to detect degradation early?

8. Is NPF receiving all appropriate service information from vendor: design, maintenance, operational, etc? This is specially important for General Motors DG owner (verify they receive "Power Pointers" from GM).

9. Review site practices to limit DG cold fast starts.

10. Reliability records and calculations: Check logs, procedures, and calculations versus Reg. Guide 1.108 criteria.

11. Ensure that pertinent studies on DG performance have been reviewed and recommendations implemented as appropriate (e.g. NUREG/CR-0660 and NSAC-79).

12. Torquing: Ensure plant has adequate specifications for all torquing. Ensure it is documented and done with calibrated equipment. Observe re-torquing if in progress.

<u>Source</u>

[22] J.C. Higgins and M. Subudhi, "A Review of Emergency Diesel Generator Performance at Nuclear Power Plants," NUREG/CR-4440, Brookhaven National Laboratory, November 1985.