27
1/30/81
T.S.
24th JTB

(1)
R-1587

UCID- 18698, Vol. I

MASTER

SYSTEMATIC EVALUATION PROGRAM REVIEW OF
NRC SAFETY TOPIC VI-7.3 ASSOCIATED WITH THE
ELECTRICAL, INSTRUMENTATION AND CONTROL
PORTIONS OF THE ECCS ACTUATION SYSTEM FOR THE
DRESDEN II NUCLEAR POWER PLANT

Gerald St. Leger-Barter

November 1980

Lawrence
Livermore
Laboratory

This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the Laboratory.

This work was supported by the United States Nuclear Regulatory Commission under a Memorandum of Understanding with the United States Department of Energy.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

ABSTRACT

This report documents the technical evaluation and review of NRC Safety Topic VI-7.A.3, associated with the electrical, instrumentation, and control portions of the classification of the ECCS actuation system for the Dresden II nuclear power plant, using current licensing criteria.

DISCLAIMER

This book contains previous works in its entirety, as stated by an agency of the United States Government. Neither the United States Government, nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute an endorsement or recommendation by the United States Government or any agency thereof. The views and opinions of authors included herein do not necessarily state or reflect those of the United States Government or any agency thereof.

FOREWORD

This report is supplied as part of the Systematic Evaluation Program being conducted for the U.S. Nuclear Regulatory Commission by Lawrence Livermore National Laboratory. The work was performed under U.S. Department of Energy contract number DE-AC08-76NV01183.

Submitted for Review by RLB

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	1
2. CURRENT LICENSING CRITERIA	3
3. REVIEW GUIDELINES	5
4. SYSTEM DESCRIPTION	7
4.1 Core Spray Subsystem	7
4.2 Low Pressure Coolant Injection Subsystem	8
4.3 High Pressure Coolant Injection Subsystem	9
4.4 Automatic Pressure Relief Subsystem	10
5. EVALUATION AND CONCLUSIONS	13
5.1 Core Spray Subsystem	13
5.2 Low Pressure Coolant Injection Subsystem	14
5.3 High Pressure Coolant Injection (HPCI) Subsystem	15
5.4 Automatic Pressure Relief Subsystem	16
6. SUMMARY	21
REFERENCES	23
APPENDIX A NRC SAFETY TOPICS RELATED TO THIS REPORT	A-1

SYSTEMATIC EVALUATION PROGRAM REVIEW OF
NRC SAFETY TOPIC VI-7.A.3 ASSOCIATED
WITH THE ELECTRICAL, INSTRUMENTATION AND
CONTROL PORTIONS OF THE ECCS ACTUATION
SYSTEM FOR THE DRESDEN II NUCLEAR POWER PLANT

Gerald St. Leger-Barter
Lawrence Livermore National Laboratory

1. INTRODUCTION

This safety topic deals with the testability and operability of the emergency core cooling system (ECCS) actuation system. The ECCS test program should demonstrate a high degree of availability of the system to perform its design function. This report reviews the plant design to assure that all ECCS components, including the pumps and valves, are included in the component and system test, the frequency and scope of the periodic testing is identified, and the test program meets the requirements of the review criteria detailed in Section 2 of this report.

2. CURRENT LICENSING CRITERIA

GDC 37, entitled, "Testing of Emergency Core Cooling System," states in item 3 that:

The ECCS be designed to permit appropriate periodic pressure and functional testing to assure the operability of the system as a whole and, to verify under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.

Branch Technical Position ICSB 25, entitled, "Guidance for the Interpretation of GDC 37 for Testing and Operability of the Emergency Core Cooling System as a Whole," states that:

All ECCS pumps should be included in the system test.

Regulatory Guide 1.22, entitled, "Periodic Testing of the Protection System Actuation Functions," states in Section D.1.a that:

The periodic tests should duplicate as closely as practicable the performance that is required of the actuation devices in the event of an accident.

Regulatory Guide 1.22 also states in Section D.4 that:

Where actuated equipment is not tested during reactor operation, it should be shown that:

- a. There is no practicable system design that would permit operation of the actuated equipment without adversely affecting the safety or operability of the plant;
- b. The probability that the protection system will fail to initiate the operation of the actuated equipment is, and can be maintained, acceptably low without testing the actuated equipment during reactor operation, and
- c. The actuated equipment can be routinely tested when the reactor is shut down.

Standard Review Plan, section 7.3, Appendix A, entitled, "Use of IEEE Std 279 in the Review of the ESFAS and Instrumentation and Controls of Essential Auxiliary Supporting Systems," states in Section 11.b that:

Periodic testing should duplicate, as closely as practical, the integrated performance required from the ESFAS, ESF systems, and their essential auxiliary supporting systems. If such a "system level" test can be performed only during shutdown, the testing done during power operation must be reviewed in detail. Check that "overlapping" tests do, in fact, overlap from one test segment to another. For example, closing a circuit breaker with the manual breaker control switch may not be adequate to test the ability of the ESFAS to close the breaker.

3. REVIEW GUIDELINES

- (1) Verify that the test conditions come as close as possible to the actual performance required by ECCS during acciuent mitigation.
(GDC-37 item 3, ICSB-25, RG 1.22-D.1.a, SRP 7.3 - Appendix A-11.b.)
- (2) Verify that the system test covers from end to end (sensor through actuated device). If partial tests are performed, verify that the overlapping tests indeed overlap from one test segment to another.
(GDC-37 item 3, ICSB-25, SRP 7.3 - Appendix A-11.b, RG 1.22-D.2.)
- (3) Summarize the ECCS system surveillance testing interval as defined in the plant's technical specification.

Blank

4. SYSTEM DESCRIPTION

Means are needed to provide continuity of core cooling during those postulated accident conditions where it is assumed that mechanical failures occur in the primary system and coolant is partially or completely lost from the reactor vessel. Also normal auxiliary power is unavailable to drive the feedwater pumps or the loss of coolant occurs at a rate beyond the capability of the feedwater system. Under these circumstances core cooling is accomplished by means of the emergency core cooling system (ECCS). The ECCS consists of two independent core spray subsystems, the low pressure coolant injection (LPCI) subsystem, the high pressure coolant injection (HPCI) subsystem and the automatic pressure relief subsystem. Although these subsystems were each designed to specific design bases, the overall ECCS design bases are:

The ECCS is designed to prevent fuel cladding melting for any mechanical failure of the primary system, up to and including a break area equivalent to the largest primary system pipe.

The entire spectrum of line breaks, up to and including this maximum, is designed to be protected against by at least two independent cooling methods which are activated automatically.

No reliance is assumed to be placed on external sources of power.

4.1 CORE SPRAY SUBSYSTEM

The core spray subsystem consists of two independent spray systems each with its own pump, valves, and associated piping and instrumentation. The water source is common to both systems and can be from the suppression pool in the torus, or by appropriate valving, from the contaminated demineralized water storage tank. Initiation of the core spray subsystem occurs on signals indicating reactor low-low water level and reactor low pressure or high drywell pressure. Low-low water level

and high drywell pressure are each detected by four independent level and pressure switches connected in a form of one-of-two-twice logic array. These same signals also initiate starting of the diesel generator. Water injection can start when the admission valve is opened and when the reactor vessel pressure drops below pump discharge pressure (350 psig). The pumps are operated on the minimum flow bypass which discharges back to the suppression pool. During this period the pumps are running while the admission valves are closed. The minimum flow bypass valves close when the flow through the main flow lines exceeds a preset value. Rated flow is sprayed over the top of the core at 90 psig in the reactor vessel. Opening of the admission valves is accomplished only after the reactor pressure decays to approximately the design discharge pressure of the pump, at which time the permissive signal to open the valves is initiated by two pressure switches connected in a one out of two logic array. When the vessel pressure decreases to below the shutoff head of the core spray subsystem, core spray injection begins.

4.2 LOW PRESSURE COOLANT INJECTION SUBSYSTEM

The LPCI subsystem consists of two main subdivisions: one, the LPCI system and the other, the containment cooling system. The major equipment of the entire subsystem consists of two heat exchangers, four containment cooling service water pumps, four main system pumps, two drywell spray headers, a suppression chamber spray header, and associated valving, piping and instrumentation. The LPCI piping injects the water into the outlet headers of the main recirculation pumps. During LPCI subsystem operation, water is taken from the suppression pool and is pumped into the core region of the reactor vessel via one of the two recirculation loops. (There is also a connection on the contaminated demineralized condensate storage tank to make condensate available for use in functional testing of the system.) Full flow capacity for the LPCI subsystem is available by operating three of the four main system pumps providing redundancy of pump capacity.

The system pumps are activated on either a signal of reactor low-low water level and reactor low pressure or a signal of high drywell pressure similar to that received by the core spray pumps. The initiation signal also trips the recirculation pumps and supplies a start signal to the diesel

generator which will provide power for the pump prime mover if normal auxiliary power has failed. The check and admission valves in the high pressure part of the system operate on reactor low pressure signal similar to that of the valving on the core spray subsystem, thereby establishing a flow path. There is a minimum flow bypass line (not so named or referred to as the FSAR) through valves 1501-13A (and B). When flow through the LPCI lines to the recirculation pump outlet lines exceeds a preset value of the flow switch, the bypass valves 1501-13A (and/or B) close. Instrumentation is provided to sense the water level in the reactor shroud, which causes necessary valves to close or open (as needed) to establish the full LPCI flow. Instrumentation also determines whether there is a recirculation line break and appropriate valving is selected to inject LPCI flow into the recirculation leg which retains piping integrity. Since the LPCI flow passes through heat exchangers, heat may be rejected from the containment by starting the containment cooling service water pumps to cool the heat exchangers when sufficient electrical power is available. The containment cooling function can be performed with the residual heat removal system after the core is flooded.

4.3 HIGH PRESSURE COOLANT INJECTION SUBSYSTEM

The HPCI subsystem is provided to ensure that adequate core cooling takes place for all break sizes which do not result in rapid depressurization of the pressure vessel. The system meets this requirement without reliance on an external power source for the injection system.

The HPCI subsystem consists of a single steam turbine driving a multi-stage high pressure pump and a gear driven single stage booster pump, valves, high pressure piping, water sources, and instrumentation. The turbine is driven with steam from the reactor vessel. Exhaust steam from the turbine is discharged to the suppression pool. Suction for the HPCI pump is taken from the suppression pool. Suction for the HPCI pump can also be taken from the condensate storage tank by remote manual operation. The water is pumped into the reactor vessel through the feedwater sparger and water leaving the vessel through a line break drains by gravity back to the suppression pool.

Operation of the system is dependent upon reactor water level signals. Either low water level or high primary containment pressure signals start the system, and high water level will stop it. A minimum flow bypass system directing flow back to the suppression chamber via valve 2301-14 is provided for pump protection. The auto-open permissive for this valve is only valid when it is not fully closed. This valve closes when HPCI flow into the main feedwater leg is above the preset value for the flow switch FSL 2-2354. The level and pressure switch for starting (i.e., opening valve 2301-3 to provide steam to the HPCI turbine) are in a one-of-two-twice logic array similar to that of the reactor protection system. The high water level switches for stopping HPCI flow operate in two-of-two logic. The high water level switches stop the HPCI flow by tripping the HPCI turbine but should the drywell pressure be high or the low water level mark be reached again the HPCI turbine trip is reset. The system will automatically maintain reactor water level between low level and high level if the break size is within the capacity of the pump and the reactor is not depressurized below 165 psia.

To inject water at a high pressure, three major active components must operate. A motor-operated valve must open to admit steam to the turbine driving the pump, a motor-operated valve must open to admit the discharge flow from the pump into the reactor feedwater line, and the turbine driven pump itself must operate.

4.4 AUTOMATIC PRESSURE RELIEF SUBSYSTEM

The automatic pressure relief subsystem is provided for backup of the HPCI subsystem and performs the function of vessel depressurization for all small breaks. When the automatic pressure relief subsystem is actuated, the critical flow of steam through the relief valves results in a maximum energy removal rate with a corresponding minimum mass loss. Since the automatic pressure relief subsystem does not provide coolant make up to the reactor, its function is considered only in conjunction with the LPCI or core spray subsystems as a backup to the HPCI.

There are two power sources for this subsystem with automatic switchover for reliability: one is the 125-volt main bus No. 2; the other is reserve bus No. 2 (normally supplied from Unit III's dc system) to power the solenoid valves. There are five valves in this system, of which one is a Target Rock solenoid-operated air-assisted valve and the other four are directly solenoid-operated electromatic valves. There are two actuation chains to operate the automatic pressure relief subsystem for the EECs: one on main bus No. 2, and the other supplied by power with the same switchover arrangement as the solenoid valve operators. Either actuation chain will operate the valves and three basic functions must be completed for the chain to be complete. Each function is entered into the chain twice from separate sensors. Automatic actuation requires coincident reactor low-low water level and high drywell pressure with one set maintained for a period of about 2 minutes and the other set without a time delay. This is required in conjunction with LPCI and/or core spray pump operation sensed by two of the LPCI and/or core spray pressure switch relay logic functions. The time delay is in series with the blowdown activation signal to allow the coolant injection systems to achieve proper operation before actuation of the relief valves.

Blank

5.0 EVALUATION AND CONCLUSIONS

5.1 CORE SPRAY SUBSYSTEM

The core spray subsystems are designed so that each component of the system can be tested periodically. The instrumentation for initiation is tested and calibrated on a three-month cycle using test lines. A logic system functional test and a simulated automatic actuation test is completed at each refueling outage.

The pumps and valves of the system are subject to preoperational tests and periodic (quarterly) tests during operation using test lines. Once each quarter it is to be verified that each pump delivers at least 4500 gpm against a system head corresponding to a reactor vessel pressure of 90 psig. The condensate storage tank water is used for initial flushing and periodic testing of the system.

A test line capable of full system flow is connected from a point near the outside isolation valve back to the suppression chamber. Flow can be diverted into this line to test operability of the pumps and control system during reactor operation.

Each core spray subsystem may be tested individually during reactor operation. The pumps, admission valves and testable check isolation valves may all be tested independently. In the event that a reactor low-low water level and reactor low pressure signals occur or a high drywell pressure actuation signal occurs during a loop test, the loop not under test will start automatically. The loop being tested will return automatically to the operational mode and will then restart automatically.

The power sources for the core spray subsystems are located on separate emergency buses that have provisions to protect them from adverse environments. Power for these emergency buses can be supplied from the diesel generators if offsite power is not available. With core spray pump 1401-2A on

bus 23-1 it implies that it is supplied by the auxiliary transformer 21 fed from the main generator. Assuming the core spray is required coincidentally with a scram and a turbine trip, this bus would have to be supplied by the diesel generator. The other core spray pump is powered by bus 24-1 fed through transformer 22. Transformer 22 being fed from the switchyard.

The test frequencies for the components of the core spray subsystem are shown in Table 5.1.

Based on the information available it is concluded that the core spray subsystem of the ECCS meets the current licensing criteria listed in section 2 of this report.

5.2 LOW PRESSURE COOLANT INJECTION SUBSYSTEM

The LPCI/containment cooling systems are designed so that each component of the system can be tested and inspected periodically to demonstrate availability of the system. The LPCI subsystem is initiated by the same parameters as the core spray subsystem and the instrumentation is calibrated on a three-month cycle. A logic system functional test and simulated automatic actuation test is completed at each refueling outage.

The pumps and valves of the system are subject to preoperational tests and periodic (quarterly) tests during operation. A design flow functional test of the LPCI pumps will be performed once each quarter during normal plant operation by taking suction from the suppression pool and discharging through the test lines back to the suppression pool. The discharge valves to the reactor recirculation loops remain closed during this test and reactor operation is undisturbed. An operational test of these discharge valves will be performed by shutting the downstream valve after it has been satisfactorily tested and then operating the discharge valve. The discharge valves to the containment spray headers are checked in a similar manner by operating the upstream and downstream valves individually. Control system design provides automatic return from test to operating mode if LPCI initiation is required during testing. The initiating conditions for the LPCI also start the diesel

generators so that ac power is available if offsite power is not available. The LPCI pumps are split, two each on bus 23-1 and two each on bus 24-1 with the same arrangement for power source selection as the core spray pump subsystem (i.e., immediate start with offsite auxiliary power and time delayed start if diesel generator power only is available). The containment and pressure suppression pool cooling subsystem's pumps are the same ones used for the LPCI; the valve sequencing determines the cooling mode. The valving to containment spray from the LPCI pumps is accomplished at operator's discretion. A reactor low water level inside the shroud interlock is provided to prevent LPCI flow from being diverted to the containment spray system unless the core is flooded. A key lock switch permits this interlock to be overridden only if containment pressure (1 of 2 taken twice) is still above 1 psi. The test frequencies for logic functional testing and the components of the low pressure coolant injection/containment spray subsystem are shown in Table 5.1. The calibration interval for the instrumentation is shown in the Technical Specifications Table 4.2.1.

Based on the information available it is concluded that the low pressure coolant injection subsystem of the ECCS meets the current licensing criteria listed in section 2 of the report.

5.3 HIGH PRESSURE COOLANT INJECTION (HPCI) SUBSYSTEM

The HPCI subsystem is designed so that each component of the system can be tested on a periodic basis. The instrumentation for initiation is calibrated on a three-month cycle.

A logic system functional test and simulated automatic actuation test is accomplished at each refueling outage.

The plant Technical Specifications call for surveillance testing once per quarter to verify that the HPCI pump delivers at least 5000 gpm against a system head corresponding to a reactor vessel pressure of 1150 psig to 150 psig. A test of the system up to the isolation valve can be conducted with steam from the reactor vessel. The steam admission valve is opened, driving the turbine-pump unit at its rated output. The valves from the suppression

chamber and to the feedwater line remain closed and water is pumped from the condensate storage tank, through the system, and returned to the condensate storage tank by way of the test line. To assure proper operation of the valves and strainers when pumping from the suppression chamber, the turbine-pump unit is run at a reduced rate by throttling at the turbine and pumping from the suppression chamber and returning the flow back to the suppression chamber by way of the minimum bypass line. In the event that an accident signal occurs while the HPCI subsystem is being tested, the subsystem is automatically restored to the automatic startup status and will begin operation. The HPCI subsystem is designed to operate without external power for the pump prime mover and uses station battery for valve operation.

The test frequencies for the components of the HPCI subsystem are shown in Tabl 5.1

Based on the information available it is concluded that the HPCI subsystem of the ECCS meets the current licensing criteria listed in section 2 of this report.

5.4 AUTOMATIC PRESSURE RELIEF SUBSYSTEM

Pressure relief of the reactor vessel may be accomplished manually by the operator or without operator action by the automatic pressure relief circuitry, either as overpressure relief or as part of the ECCS. A manual actuation test of each valve is required on an interval determined by observed failure rates. Proper operation is to be verified by observation of other steam flow parameters. Individual sensors for the automatic pressure relief subsystem are tested and calibrated singly without initiating the valves safety function. The plant Technical Specifications indicate a three-month calibration cycle. These specifications also require that a logic system functional test and simulated automatic actuation test are accomplished during each operating cycle. With the system powered from the 125-volt dc station battery system it is not sensitive to onsite/offsite ac power sources. The referenced drawings do not indicate operating air reserve accumulators for the

Target Rock valve but this is only one of the five APRS valves. The four electromatic valves are 125-volt dc operated which are supplied either by the station 125 volt battery or via either charger. There are two battery chargers which are on busses which can be supplied by either diesel generator (2 or 2/3).

The test frequencies for the components of the automatic pressure relief subsystem are shown in Table 5.1.

Based on the available information it is concluded that the automatic pressure relief subsystem of the ECCS meets the current licensing criteria listed in section 2 of this report.

TABLE 5.1

SURVEILLANCE REQUIREMENTS *

CORE AND CONTAINMENT COOLING SYSTEM

Applicability:

The operational readiness of the following subsystems shall be demonstrated in accordance with the Inservice Testing Program for Pumps and Valves defined in Section 1.0 (F.F.) of Dresden II Plant Technical Specifications. Additional requirements for each subsystem are listed below.

Objective

To verify the operability of the core and containment cooling subsystems.

Specification:

A. Surveillance of Core Spray Subsystem

1. Once each quarter, it shall be verified that each pump delivers at least 4500 gpm against a system head corresponding to a reactor vessel pressure of 90 psig.
2. A simulated Automatic Actuation Test shall be completed each refueling outage.
3. The Core Spray header Δp instrumentation shall be checked as follows:

check	once/day
calibrate	once/3 months
test	once/3 months
4. A Logic System Functional Test shall be completed each refueling outage.

B. Surveillance of LPCI/Containment Cooling Subsystems

1. Once each quarter, it shall be verified that three LPCI pumps deliver at least 14,500 gpm against a system head corresponding to a reactor vessel pressure of 20 psig.
2. A simulated Automatic Actuation Test shall be completed each refueling outage.
3. A Logic System Functional Test shall be completed each refueling outage.

* Extracted from the Dresden II Plant Technical Specifications, section 4.5

Table 5.1 cont.

4. During each five year period, an air test shall be performed on the drywell spray nozzles and nozzels.
 5. Once each quarter, it shall be verified that each containment cooling water pump can be deliver at least 3500 gpm against a pressure of 180 psig.
- C. Surveillance of the HPCI Subsystem.
1. Once per quarter, it shall be verified that the HPCI pump delivers at least 5000 gpm against a system head corresponding to a reactor vessel pressure of 1150 psig to 150 psig.
 2. A Simulated Automatic Actuation Test shall be completed each refueling outage.
 3. A Logic System Functional Test shall be completed each refueling outage.
- D. Surveillance of the Automatic Pressure Relief Subsystem
1. During each operating cycle the following shall be performed:
 - (a) A simulated automatic initiation which opens all pilot valves.
 - (b) A logic system functional test shall be performed each refueling outage.
 - (c) A visual inspection of the target rock and relief valve line restraints in the torus to verify structural integrity for continued operation.
 2. After March 1, 1979, the following test program shall be performed:
 - (a) With the reactor at ≥ 100 psig in the Steam Dome each relief valve shall be manually opened. Relief valve opening shall be verified by a compensating turbine bypass valve or control valve closure.
 - (b) The initial required test interval shall be determined by the number of remotely operated relief valves found inoperable from March 1, 1978 to March 1, 1979.
 - (c) The initial valve tests shall be completed by the earlier of the completion of the next refueling outage occurring after March 1, 1979 or the time period defined by March 1, 1979 plus the initial test interval determined above.

6.0 SUMMARY

The Dresden Station Unit II nuclear power plant ECCS testing complies with the current licensing criteria listed in section 2 of this report.

It was noted that there were no direct references to explicit testing or observation of the valving for the minimum flow bypass lines for the core spray, low pressure coolant injection, and the high pressure coolant injection subsystem pumps. The minimum flow bypass line valves for the core spray, LPCI, and HPCI subsystems are normally open. Test procedures indicate that operators shall verify the valves changing state during tests.

REFERENCES

1. Code of Federal Regulations, Title 10, Part 50 (10 CFR 50) Appendix A, (General Design Criteria 37), 1979.
2. U.S. Nuclear Regulatory Commission, Branch Technical Position ICSB 25, "Guidance for Interpretation of GDC 37 for Testing Operability of the Emergency Core Cooling System as a Whole."
3. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.22, "Periodic Testing of the Protection System Actuation Functions."
4. U.S. Nuclear Regulatory Commission, Standard Review Plan, Section 7.3, Appendix A, "Use of IEEE-Std-279 in the Review of the ESFAS and Instrumentation and Controls of Essential Auxiliary Supporting Systems."
5. Commonwealth Edison Company, Dresden Station Unit II Final Safety Analysis Report.
6. Commonwealth Edison Company, Dresden Station Unit II Technical Specifications.
7. Dresden II Mechanical Drawing, M-27, April 1977, Core Spray Piping.
8. Dresden II Mechanical Drawing M-29, September 1977, LPCI Piping.
9. Dresden II Mechanical Drawing M-51, June 1977, HPCI Piping.
10. Dresden II Mechanical Drawing M-12, August 1977, Main Steam Piping.
11. Dresden II Electrical Drawing 12 E 2429, September 1976, Relaying for Core Spray Pumps.
12. Dresden II Electrical Drawing 12 E 2430, February 1977, Core Spray Systems 1 and 2.

13. Dresden II Electrical Drawing 12 E 2436, September 1976, LPCI/Containment Cooling Pumps Switch Gear Control.
14. Dresden II Electrical Drawing 12 E 2437, September 1976, LPCI/Containment Cooling System 1.
15. Dresden II Electrical Drawing 12 E 2438, September 1976, LPCI/Containment Cooling System 2.
16. Dresden II Electrical Drawing 12 E 2527, September 1976, HPCI Sensors and Auxiliary Relays.
17. Dresden II Electrical Drawing 12 E 2528, December 1976, HPCI Valves and Turbine Auxiliaries.
18. Dresden II Electrical Drawing 12 E 2529, December 1976, HPCI Valves.
19. Dresden II Electrical Drawing 12 E 2461, September 1976, Auto Blowdown Control.
20. Dresden II Electrical Drawing 12 E 2462, September 1976, Auto Blowdown Control.

APPENDIX A

1. Topic VI-3, "Containment Pressure and Heat Removal Capability."
2. Topic VI-4, "Containment Isolation System."
3. Topic VI-7, "Emergency Core Cooling System".
4. Topic VI-7.C, "ECCS Single Failure Criterion and Requirements for Locking Out Power to Valves Including Independence of Interlocks on ECCS Valves."
5. Topic VI-9, "Main Steam Isolation."
6. Topic VI-10, "Selected ESF Aspects".