UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

U.S. NUCLEAR REGULATORY COMMISSION
REGION II

AUGMENTED INSPECTION TEAM

REPORT NOS. 50-413/88-14 AND 50-414/88-14

Licensee: Duke Power Company
422 South Church Street
Charlotte, NC 28242

Docket Nos.: 50-413 and 50-414

License Nos.: NPF-35 and NPF-52

Facility Name: Catawba Units 1 and 2

Inspection Conducted: March 10-18, 1988

Team Members: B. R. Crowley, Reactor Engineer, RII
K. N. Jabbour, Catawba Project Manager, NRR
P. S. Lam, Chief, Reactor Systems Section, AEOD
M. S. Lesser, Resident Inspector, Catawba
W. T. Orders, Senior Resident Inspector, McGuire

Team Leader: T. A. Peebles — 4-13-88
T. A. Peebles, Chief — Date Signed
Projects Section 3A

8805020106 880420
PDR ADOCK 05000413
Q DCD

TABLE OF CONTENTS

REPORT DETAILS

I. INTRODUCTION - FORMATION AND INITIATION OF AIT

A. Background

Catawba Units 1 and 2 are four loop Westinghouse Pressurized Water Reactors rated at 1145 megawatts electric. They have ice condenser containments and are located about 25 miles south of Charlotte, North Carolina. Unit 1 was licensed January 17, 1985, and Unit 2 in May 25, 1986.

On March 9, 1988 at 10:15 PM, the licensee notified the NRC headquarters duty officer of the following event:

> Catawba Unit 2 reactor tripped from 21% power on low-low steam generator (S/G) level on "B" S/G. This occurred when the feedwater regulating valve on "B" S/G (2CF37) failed open (cause unknown and being investigated) when being placed in auto. This caused a feedwater swing which resulted in "C" and "D" S/G to be fed up giving a P14 signal (high-high S/G level) on the "D" S/G. On the P14 signal, a feedwater isolation occurred which resulted in all S/Gs levels decreasing and the "B" S/G reaching the low-low level giving a reactor trip signal. Both auxiliary feedwater pumps auto started but for an unknown reason the "A" auxiliary feedwater (CA) pump suction swapped over to the nuclear service water (RN) system.

B. Formation of AIT

On the morning of March 10, 1988, the Regional Administrator, after briefing by regional staff and consultation with senior NRC management, directed the dispatch of an AIT.

C. AIT and Charter

The charter for the AIT was prepared on March 10, 1988, and the AIT members began arriving at the Catawba site that morning. The licensee shutdown the other unit at 10:50 a.m. due to their concerns of CA operability. An entrance meeting and briefing by the site staff and plant manager was held with the AIT at 5:00 p.m.

A Confirmation of Action letter (CAL) was issued on March 11, 1988. This CAL documented the understanding between the licensee and NRC that Region II would be in agreement with investigation results prior to startup of either unit.

The charter for the AIT specified that the following tasks be completed.

1. Develop and validate a detailed sequence of events associated with the March 9, 1988 Reactor Trip and subsequent swapover of the suction to the Auxiliary Feedwater Pumps to the Nuclear Service Water System and subsequent degraded auxiliary feedwater flow.

2. Evaluate the significance of the event with regard to radiological consequences, safety system performance, safety significance, and plant proximity to safety limits as defined in the Technical Specifications.

3. Evaluate the accuracy, timeliness, and effectiveness with which information on this event was reported to the NRC.

4. For each equipment malfunction, to the extent practical, determine:

   a. Root cause;

   b. If the equipment was known to be deficient prior to the event;

   c. If equipment history would indicate that the equipment had either been historically unreliable or if maintenance or modifications had been recently performed;

   d. Any equipment vendor involvement prior to or after the event;

   e. Pre-event status of surveillance, testing and/or preventive maintenance; and

   f. The extent to which the equipment was covered by existing corrective action programs and the implication of the failures with respect to program effectiveness.

5. Evaluate the licensee's action taken to verify equipment operability on the operating unit.

6. Identify any human factors/procedural deficiencies related to the event.

7. Through operator and technician interviews, determine if any of the following played a significant role in the event: plant material condition; the quality of maintenance; or the responsiveness of engineering to identified problems.

8. Provide a Preliminary Notification upon initiation of the inspection and an update on the conclusion of the inspection.

9. Prepare a special inspection report documenting the results of the above activities within 30 days of the start of the inspection.

D. Persons Contacted

Licensee Employees at Exit Meeting

T. B. Owen, Manager, Catawba Nuclear Station (CNS)
C. L. Hartzell, Compliance Engineer, CNS
M. A. Cote, Licensing Specialist, CNS
C. E. Muse, Unit 2 Coordinator, CNS
R. F. Wardell, Technical Services Superintendent, CNS
W. R. McCollum, Station Services Superintendent, CNS
G. T. Smith, Maintenance Superintendent, CNS

Other Licensee Employees

E. Fritz
M. Carwile
J. Kammer
M. Anderson
J. Caldwell
Z. Taylor

Other licensee employees were contacted.

E. Design Descriptions

1. Nuclear Service Water System (FSAR Section 9.2.1)

The Nuclear Service Water System (RN) provides essential auxiliary support functions to Engineered Safety Features of the station. The system is designed to supply cooling water to various heat loads in both the safety and non-safety portions of each unit. Provisions are made to ensure a continuous flow of cooling water to those systems and components necessary for plant safety during normal operation and under accident conditions. Sufficient redundancy of piping and components is provided to ensure that cooling is maintained to essential loads at all times.

Functionally, the system consists of four sections which, when put together in series, serve to assure a supply of river water to various station heat loads and return the heated effluent back to its proper heat sink.

In order of flow, these are:

a. Source and intake section
b. RN Pumphouse section
c. Station heat exchanger section
d. Main discharge section

Source and Intake Section

Two bodies of water serve as the ultimate heat sink for the components cooled by the RN System. Lake Wylie is the normal source of nuclear service water. A single transport line conveys water from a Class 1 seismically designed intake structure at the bottom of the lake to both the A and B pits of the Nuclear Service Water Pumphouse serving the RN pumps in operation. Isolation of each line is assured by two valves in series and fitted with electric motor operators powered from separate power supplies.

Should Lake Wylie be lost due to a seismic event in excess of the design of Wylie Dam; the Standby Nuclear Service Water Pond (SNSWP), formed by the Class 1 seismically designed SNSWP Dam, contains sufficient water to bring the station safely to a cold shutdown condition following a single loss of coolant accident. The SNSWP has an intake structure designed to Class 1 seismic requirements, with two Class 1 seismic, redundant lines to transport water independently to each pit in the RN Pumphouse. Each line is secured by a single motor operated valve. Automatically upon loss of Lake Wylie the isolation valves are closed and the SNSWP valves are opened to both pit A and pit B.

RN Pumphouse Section

The RN Pumphouse is a Class 1 seismically designed structure that contains two separate pits from which two independent and redundant channels of RN pumps take suction. Each pit can be supplied from both the normal source and also the assured source of water. Either pit is capable of passing the flow needed for a simultaneous unit LOCA and unit cooldown. Flow spreaders in front of all the intake pipe entrances prevent vortices and flow irregularities while removable lattice screens protect the RN pumps from solid objects.

Pumps 1A and 2A take suction from pit A and discharge through RN strainers 1A and 2A respectively. The outlet piping of the 1A and 2A RN strainers then join back together to form the channel A Supply line to channel A components in both units.

RN pumps 1B and 2B are physically separated from RN pumps 1A and 2A by a concrete wall, and take suction from pit B, discharging through RN strainers 1B and 2B respectively. The outlet piping of strainers 1B and 2B join together to form the channel B supply line to channel B components in both units.

The supply and return headers are arranged and fitted with isolation valves such that a critical crack in either header can be isolated and will not jeopardize the safety functions of this system or flood out other safety related equipment. The operation of any two pumps on either or both supply lines is sufficient to supply all cooling water requirements for the two unit plant for unit startup, cooldown, refueling, or post-accident operation. However additional pumps are normally started for unit startup and cooldown and two pumps per unit operate during the hypothetical combined accident and loss of normal power if both diesel generators are in operation. In an accident the safety injection signal automatically starts both RN pumps in each unit, thus providing full redundancy.

Heat Exchanger Section

Nuclear Service Water supplied by the RN pumps is used in both units to supply essential and non-essential water needs or as an assured source of water for other safety-related systems.

Essential components are those necessary for safe shutdown of the unit, and must be redundant to meet single failure criteria. Nonessential components, are not necessary for safe shutdown of the unit, and are not redundant. Each unit has two trains of essential heat exchangers designated A and B, and one train of nonessential heat exchangers supplied from either A or B and isolated on Engineered Safety Features actuation.

The following components or services are supplied by each essential header of the RN System. Some components are normally in operation, some are automatically supplied upon ESF actuation, and others are used when needed.

a. RN Pump Motor Cooler
b. RN Strainer Backflush
c. RN Pump Bearing Lube Injection Water
d. RN Pump Motor Upper Bearing Oil Cooler
e. Diesel Generator Engine Jacket Water Cooler
f. Diesel Generator Building Essential Fire Water
g. Diesel Generator Engine Starting Air Aftercooler
h. Component Cooling Heat Exchanger
i. Assured Auxiliary Feedwater Supply
j. Assured Fuel Pool Makeup
k. Assured Component Cooling (KC) System Makeup
l. Containment Spray Heat Exchanger
m. The Control Room Area Chiller Condenser (Condensers A and B are shared between units, so they are fed by Unit 1 Essential Headers only).
n. Auxiliary Shutdown Panel Air Conditioning Unit.
o. Assured Containment Penetration Valve Injection Water (NW) System Makeup

From each essential RN header, a six inch branch line provides the backup water supply for Auxiliary Feedwater. This six inch line travels for approximately 250 feet before the first isolation valve. Just upstream of the isolation valve, a line branches off to supply approximately 10 GPM continuous flow to each auxiliary shutdown panel air conditioning unit condenser.

No provision is made for prevention of long-term corrosion in the RN System. Allowances for such corrosion were made by increasing the wall thickness of the pump pressure boundary, piping, and the heat exchanger shells and tubes in accordance with the applicable codes. Larger pipe sizes than necessary were used for pump adequacy considering scaling.

Asiatic clam control is achieved by a series of design features and operating procedures. Intake structures take suction elevated off the bottom of the lake and SNSWP and at a velocity well below that required by the Environmental Protection Agency for wildlife protection, so large clams are not drawn into the system. A bar screen with openings 4 in. x 4 in. keeps debris from entering the intake lines and a lattice screen with 1 in. x 1 in. openings separates the forebay of the RN Pumphouse from the RN pump suction bay, providing a second level of defense. The water discharging from each RN pump passes through an RN strainer with 1/32 inch openings to strain out dirt and sand particles that could clog control valves with cavitrol trim located throughout the RN System. These screens and strainers will prevent all but the smallest clam larvae from entering the RN piping.

It is understood that Asiatic clam larvae do not permanently attach to pipe walls and grow, but nest in stagnant places such as valved off pipes and idle heat exchangers and operating heat exchanger heads in front of the tube sheet. Performance monitoring programs to verify adequate flow, and visual inspection of the intake piping and inlet heat exchanger heads during maintenance provide early detection of any clam infestation of raw water systems.

2. Auxiliary Feedwater System (FSAR Section 10.4.9)

The Auxiliary Feedwater System (CA) assures sufficient feedwater supply to the steam generators (S/G), in the event of loss of the Condensate/Feedwater System, to remove energy stored in the core and primary coolant. The two units are provided with separate CA Systems.

The CA System is designed to start automatically in the event of loss of offsite electrical power, trip of both main feedwater pumps, safety injection signal, or low-low S/G water level; any of which may result in, coincide with, or be caused by a reactor trip. The CA System will supply sufficient feedwater to maintain the reactor at hot standby for two hours followed by cooldown of the Reactor Coolant System (NC) to the temperature at which the Residual Heat Removal System (ND) may be operated.

Three CA pumps are provided, powered from separate and diverse power sources. Two full capacity motor driven (MDCA) pumps are powered from two separate trains of emergency on-site electrical power, each normally supplying feedwater to two steam generators. One full capacity turbine driven (TDCA) pump, supplying feedwater to two steam generators, is driven from steam contained in either of the two steam generators. A minimum of 225,000 gallons feedwater supply is required for the design basis hot standby followed by normal cooldown to conditions at which the ND System may be operated.

Standards for nuclear safety related systems are met for the CA System except for the condensate quality feedwater sources.

The normal lineup is for train A MDCA pump 1(2)A to supply A and B steam generators, for train B MDCA pump 1(2)B to supply C and D steam generators and for the TDCA pump to supply B and C steam generators.

The MDCA pumps will automatically start and provide the minimum required feedwater flow within one minute following any of these conditions:

a) Two out of four low-low level alarms in any one of the four steam generators.
b) Loss of both main feedwater pumps.
c) Initiation of the safety injection signal.
d) Loss of station normal auxiliary electrical power.

The TDCA pump will automatically start and provide the minimum required feedwater flow within one minute following either of these conditions:

a) Two out of four low low level alarms in any two of the four steam generators.
b) Loss of station normal auxiliary electric power.

Driving steam for the TDCA pump is provided from either the steam generator B or C main steam lines upstream of the main steam lines containment isolation valves and is discharged to the atmosphere from the turbine.

3. Condensate Storage System (FSAR 9.2.6) (CS)

The Condensate Storage System provides a readily available source of deaerated condensate for makeup to the condenser and is the preferred source of auxiliary feedwater for makeup to the steam generators. It also serves to collect and store miscellaneous system drains.

Makeup to the Condensate Storage System is to the upper surge tank (UST) dome from the Makeup Demineralized Water System. The upper surge tank dome drains to the two upper surge tanks. Makeup to the condenser is supplied by gravity flow from the UST. The UST also provides sealing water for various equipment, and the supply for the auxiliary electric boiler feedwater pumps. Overflow from the UST is returned to the Condensate Storage Tank (CST) through a 27 foot loop seal which prevents the introduction of air into the upper surge tanks. Valve 1CM363 provides a means for filling and makeup to the loop seal. The CST receives the drains from various equipment and holds these drains until they are transferred to the UST dome by the two full capacity CST pumps. The CST operates at atmospheric pressure and is vented to the roof. The overflow line from the CST has a 3 foot loop seal to prevent steam from the hot drains discharging into the tank from entering the building.

The preferred source of clean water supply for the auxiliary feedwater pumps is provided by the main condenser hotwell (170,000 gallons) and the two UST (85,000 gallons total) on each unit and the shared Auxiliary Feedwater Condensate Storage Tank (CACST) (42,500 gallons). Relative pressure differentials considering normal vacuum in the hotwell and UST result in the supply to the CA pumps initially from the CACST then the UST. The hotwell may then be pumped to the UST or vacuum relieved and supplied directly to the CA pumps. The Condensate Storage System tanks are not safety related, since the assured source of water for the auxiliary feedwater pumps is provided from the Nuclear Service Water System.

Sufficient instrumentation is provided to monitor system performance. Alarms are provided in the control room for high and low UST level, high and low CST level, low hot well level and low CACST tank level.

All of the preferred sources of condensate quality water are normally aligned to the CA pump suctions. The condensate reserve for each unit is maintained among the following sources:

Source	Max. Capacity
a. Auxiliary Feedwater Condensate Storage Tank	42,500 gallons/station (Shared by both units)
b. Upper Surge Tanks	85,000 gallons/unit (two 42,500 gallon tanks per unit)
c. Condenser Hotwell	170,000 gallons/unit (Normal operating level)

II. DESCRIPTION OF EVENT

Overview of Event for Catawba Unit 2

1. Event Description

At 6:25 pm on March 9, 1988, Catawba Unit 2 was operating at 20% reactor power carrying load of 150 MWE and in the process of starting up from the unit's first refueling. An operator was transferring from the feedwater (CF) bypass valve to the main feedwater regulating valve (2CF37) on steam generator (S/G) B. As the valve (2CF37) was placed in automatic, it failed full open which caused the operating main feedwater pump speed to start oscillating thus resulting in a major swing in flow throughout the feed system. Another operator assumed manual control of the pump and attempted to bring it under control. The operator on the B main feedwater regulating valve assumed manual control and closed it down to prevent over feeding S/G B. Level in S/G's C and D meanwhile increased until two of four channels on S/G D reached High/High S/G level. This resulted in a main turbine trip, a feed water isolation, and a main feedwater pump trip.

Both motor driven auxiliary feedwater (MDCA) pumps auto started immediately upon loss of the main feedwater pump. An apparent CA pump low suction pressure resulted in the swap of the A train MDCA pump suction to the RN system which serves as the safety related assured source (valves 2RN 250A and 2CA 15A opened). Details concerning the swap to RN are delineated in Section III.A of this report. Level in S/G's A and B were meanwhile dropping and a reactor trip occurred due to Low/Low Level in S/G A. The turbine driven auxiliary feedwater (TDCA) pump was initiated when S/G B also reached Low/Low level which satisfied the logic of two of four S/G's at Low/Low level. The operators secured the TDCA pump approximately one minute after it auto started and manually throttled CA flow to stabilize S/G levels.

Approximately 13 minutes into the event, the control room operators reviewed the panels to determine any abnormal indications. It was at this time that one operator saw an annunciator illuminated which indicated that a CA suction swapover had occurred and another operator detected (on the control panel) that valve 2RN 250A was open. The operators immediately closed 2RN 250A, and verified suction flow path from the UST. It should be noted that neither operator detected that valve 2CA 15A had opened. (Valve 2RN 250A and valve 2RN 15A are in series and both must open for RN to be supplied to MDCA pump 2A.)

Approximately 20 minutes into the event, with auxiliary feedwater maintaining steam generator levels it was detected that the level in the B generator was starting to decrease slightly. The operator opened the CA flow control valve supplying the B S/G (2CA 56) but noticed that the valve when full open would pass only 100 gpm, instead of normal flow of 300 gpm. This was the first indication of flow degradation even though the operators at this time still had not detected that valve 2CA 15A had opened in response to the apparent low suction pressure signal.

At approximately 7:00 pm, some 35 minutes into the event, during shift turnover, the oncoming shift supervisor detected that valve 2CA 15A was open. It was not until this time that the on duty operating shift knew that 2CA 15A had repositioned. Furthermore, it was not until this time that the on duty Unit Supervisor and Shift Supervisor became aware that the unit had experienced a CA suction problem. This is indicative of a communications problem on the part of the on duty operations crew.

Auxiliary feedwater continued to supply the generators until about 8:45 pm when the operators were able to restart the main feedwater pump, and place the CA system in standby.

After it was detected that valve 2CA 15A had opened, actions were initiated to disassemble and inspect CA flow control valves 2CA 56 and 2CA 60, the valves which had passed RN water to S/G's A and B. By 10:30 am March 10, it was determined that the valves were clogged with clam shells.

By 11:50 a.m. March 10, it had also been concluded that continued safe operation of unit 1, which was at 100% reactor power, could not be assured due to the possibility of clam fouling of the CA system. At 12:50 p.m. the licensee began shutting unit 1 down to mode 4. At 4:45 p.m., unit 2 was taken into mode 4.

The licensee formulated a program of flushes and inspections to confirm that suspect RN lines supplying assured sources of cooling to safety related equipment were clear of fouling. Details of these programs are delineated in Section III.B of this report.

The licensee also initiated a test and inspection program to verify the correct operation of the instrumentation, logic and equipment associated with the CA suction swapover, as well as CA pump verification tests and CA system valve function. Details of the testing performed are described in Section III.A. of this report.

Subsequent to the completion of the aforementioned flushes, and inspections on March 11, 1988, unit 1 restarted after conferences with the AIT, the Region and NRR. Unit 2 was allowed to restart on March 18, 1988 after resolving the issues of fouling and CA suction swapover.

2. Detailed Sequence of Events

The sequence of events was developed from discussions with operations personnel, review of computer alarm typer data recorded during the event and review of plant logs and investigation packages.

March 9, 1988

6:25:00 PM	-	Unit operating at 21% power carrying load of 150 MWE.
6:25:37	-	Received Turbine Trip, Feedwater isolation and Feedwater Pump trip on High/High S/G level in the D S/G when main feedwater regulating valve 2CF37 failed open when placed in automatic.
6:25:37	-	Both MDCA pumps started on the loss of the running main feedpump.
6:25:44	-	Low CA pump suction pressure resulted in swap of suction to Nuclear Service Water, the assured source.
6:25:49	-	Levels in A and B S/G's decreasing; level in S/G A reaches low/low level in 2 of 4 channels resulting in reactor trip.
6:26:09	-	Level in B S/G reaches low/low level in 2 of 4 channels - results in autostart of TD CA pump.
6:27:20	-	TDCA pump secured.
-------	-	Operators throttle CA flow to S/G's to stabilize cooldown rate.
6:38:55	-	Operators isolate RN from CA pump suction by closing valve 2RN 250A.
6:45 approx.	-	It was noticed that CA flow to the A and B S/G's had degraded over time. Initial flow was normal (300 gpm/SG) but had decreased to approximately 100 gpm to the A S/G and 200 gpm to the B S/G. Operator notes that with valve 2CA 56 (CA flow control valve to the A S/G) full open, valve will pass only 100 gpm.
10:15 PM		Licensee notified NRC Duty Officer of Unit 2 Reactor Trip.

March 10, 1988

6:00 AM - 10:00 AM Licensee disassembles and inspects CA flow control valves 2CA56 and 2CA60 which supply the A & B S/G's. Upon disassembly, valves were found to be clogged with clam shells.

9:00 AM Licensee discusses event with Region II.

------- - Licensee evaluating cause of CA swap to RN.

11:50 AM - Licensee determines continued safe operation of Unit 1 can not be assured due to the possibility of clams fouling the CA system, should swapover to RN become necessary. Unit shutdown began.

12:30 PM Licensee notified NRC Duty Officer of the shutdown of both units.

12:53 PM Licensee notified NRC Duty Officer of Unusual Event declared on Unit 1 as a safety system (CA) was degraded at power and shutdown of both units was commencing.

11:15 PM Unusual event terminated. Unit 1 in mode 4.

March 11, 1988

------- - Licensee initiates program to flush stagnant portions of RN piping which serve as back up supply to safety systems. Flushing program includes radiography and boroscopic examinations to confirm flush adequacy.

------ - Licensee initiates testing on both units CA to RN swap logic and equipment to determine if calibrated, operable and cause for swap on Unit 2.

- CAL Issued

11:00 PM - All testing and flushing complete on Unit 1, unit receives NRC concurrence for restart.

------- - Unit 2 flushing and testing continuing.

March 13, 1988

9:18 PM - Unit 1 enters Mode 2

March 12-18, 1988

------- - Flushes, inspections and tests continue.

March 18 - Unit 2 allowed to restart commensurate with CAL. Licensee agreed to utilize compensatory measures relative to CACST valve 2CA 6.

III. EQUIPMENT STATUS AND EVALUATION

A. Auxiliary Feedwater Suction Swapover to Nuclear Service Water System

This section discusses the Catawba Unit 2 CA suction swapover from the normal sources to the safety-related assured source of RN. To cover the March 9, 1988, event in detail the following sections are included:

1. Control logic
2. Equipment as found
3. Conclusion

1. Control Logic for CS/RN Swapover

As the CA System serves a vital safety related function during all postulated occurrences, two trains supplied by a safety grade, seismically designed water source must be assured at the pump suctions to assure pump operability and function. The Standby Nuclear Service Water Pond, with a maximum capacity of 2.74×10^8 gallons total for the station, serves as the ultimate long-term safety related source of water for the CA System. To maintain steam generator water chemistry, especially for events which require fast response recovery such as; blackout, loss of normal feedwater, or main steam system malfunction, the CA pumps are normally aligned to condensate quality water. The sources of condensate quality water exist as non-seismic grade sources in the Turbine Building. To prevent inadvertent injection of out of chemistry nuclear service water to the steam generators a reliable means of detecting loss of condensate source and automatic transfer of the pump suctions to the nuclear service water source is employed. Such detection and transfer controls are automatic since minimum CA System flow must be established within one minute from the initiating event. The automatic detection and transfer controls will detect and transfer the pump suctions to nuclear service water upon detection of any of the listed postulated failures of the non-seismic condensate supplies:

(a) Depletion of all condensate sources.
(b) Loss of source due to pipe break.
(c) Partial or complete loss of source due to air leakage into the system from a pipe crack, or failure to isolate a depleted source.
(d) Partial loss of source due to steam void formation in the suction piping caused by excessive friction loss associated with a high flow rate, failure or spurious operation of a valve causing partial closure, or bending or partial obstruction in the pipe.

The detection scheme incorporates three trains of three differential pressure switches located in the Auxiliary Building in a vertical leg of the common condensate supply pipe to all three CA pumps. Two trains of pressure switches serve the two safety-grade RN trains, and the remaining train of pressure switches serves the condenser circulating (RC) system supply. RC provides a backup to RN for further CA suction supply. One of three pressure switches activating gives a low pressure alarm in the control room. Upon two out of three indications of low suction pressure from any train, the transfer logic will be activated for that train. The instrumentation and controls for the RN trains meet the standards for nuclear safety related systems, including requirements for redundancy and separation. If the station normal auxiliary electrical power is available during the initiating occurrence, a maximum 30,000 gallons additional condensate supply is available from the condensate storage tank. If the two makeup demineralizers are available, a maximum condensate supply of 950 GPM is available for the short term or 475 GPM for an indefinite period. Additional condensate may also be provided from condensate sources associated with the other unit, if these sources are available, operable, and a loss of normal station auxiliary electrical power has not occurred.

The logic for the automatic swapover of the CA system to take suction from the nuclear service water (RN) system is based upon the following conditions:

1. CA pump running
2. Loss of condensate source (i.e. 2 out of 3 low suction pressures at pressure switches)
3. The Technical Specifications assume an overall time for swapover to occur of 15 seconds with 10 seconds allowed for valve movement.

Applied to the above logic is a time delay (3-5 seconds) for the low suction pressure. The purpose of the time delay relay is to allow for a momentary low suction pressure during a pump start transient.

The automatic switchover to RN takes place only if the CA system has been initiated by a CA auto start signal and the CA pump suction pressure is low as sensed by 2/3 pressure switches. Low pressure in one of three A or B train pressure switches will alarm the Operator Aid Computer (OAC). Either train A or B RN suction sources can align to the turbine driven CA pump if all of the following has occurred within the proscribed sequence:

(1) The TDCA pump has received an auto start signal.

(2) The pump turbine steam supply valve SA2 or SA5 has opened.

(3) The pump turbine trip and throttle valve is open.

(4) A 3-5 second time delay times out prior to providing the run indication to the swapover logic of TDCA pump. This time delay relay is in addition to the 3-5 second time delay intended to prevent swapover on a pump start transient.

(5) Two out of three low suction pressure indications from the train A or B pressure switches and their 3-5 second time delay relay has timed out.

CA pump suction following swapover to RN is through the following paths:

Train A is from the 24 inch A train RN header to the 6 inch RN line through valve RN 250A then either through valve CA 15A to the A train MDCA pump or through valve CA 116A to the TDCA pump.

Train B is from the 24 inch B train RN header to the 6 inch RN line through valve RN 310B then either through valve CA 18B to the B train MDCA pump or through valve CA 85B to the TDCA pump.

The following section lists all the as found setpoints for trains 1A, 1B, 2A, and 2B.

2. Equipment as found

(a) Pressure Switches

(1) Unit 1 A Train

Required setting: 10.5±.15 psig

Pressure Switch	As Found Setpoint
1CAPS 5220	10.8 psig
1CAPS 5221	10.44 psig
1CAPS 5222	9.92 psig

Technical Specification (TS) trip setpoint ≥ 10.5 psig

TS Allowable Value ≥ 9.5 psig

(2) Unit 1 B Train

Required setting: 6.0±.15 psig

Pressure Switch	As Found Setpoint
1CAPS 5230	5.95 psig
1CAPS 5231	5.90 psig
1CAPS 5232	6.10 psig

TS trip setpoint 6.2 ≥ psig

TS Allowable Value ≥ 5.2 psig

(3) Unit 2 A Train

Required setting: 10.5±.15 psig

Pressure Switch	As Found Setpoint
2CAPS 5220	11.0 psig
2CAPS 5221	11.2 psig
2CAPS 5222	10.6 psig

TS trip setpoint ≥ 10.5 psig

TS Allowable Value ≥ 9.5 psig

(4) Unit 2 B Train

Pressure Switch	As Found Setpoint
2CAPS 5230	6.85 psig
2CAPS 5231	6.05 psig
2CAPS 5232	6.05 psig

TS trip setpoint ≥ 6.0 psig

TS Allowable Valve ≥ 5.0 psig

It was noted that the licensee interprets the Trip Setpoint, as specified in Table 3.3-4 of TS, as a nominal value and allows a band of ±.15 psig. The TS indicates that the trip setpoint is a minimum value as opposed to a nominal value, although TS basis discusses it as a nominal value. The licensee's interpretation appears to be consistent with the Westinghouse setpoint methodology. This was confirmed with R. Giardina of NRR, OTSB.

(b) Time Delay

The Unit 1 A Train time delay was found to be 4.27 seconds and for Unit 1 B Train it was 4.39 seconds. The Unit 2 A Train time delay was found to be 4.15 seconds and for Unit 2 B Train it was 4.7 seconds. These values were found acceptable because they conform to the manufacturer's recommendations of being in the range of 3-5 seconds.

(c) Pressure Switch Root Valves

Pressure switches 2CAPS 5220, 5221, 5222 have common impulse lines and are isolated by one root valve. Pressure switches 2CAPS 5230, 5231, 5232 have common impulse lines and are isolated by one root valve. The root valves on Unit 2 A and 2 B Trains were found to be partially blocked by magnetite. The blockage may have contributed to the fact that the alarm in the control room had a 51 second duration before it cleared.

(d) Valve 2CA6

Valve 2CA6 is the supply of condensate grade water to the CA pump from the CACST and is powered from the emergency bus. The valve is normally open and for 3 days after the event the licensee believed the valve had been open. However, after completing their interviews of the operators, the licensee determined that 2CA6 had been closed at the start of the event.

The same valve on Unit 1 had been closed at various times over the past year to prevent drainage of the CACST through the CA system. The CACST is a common tank to both units and was receiving makeup from Unit 1 at the time. The licensee had been attempting to identify the causes for CACST level decreases. The losses of CACST level were not fully understood by the licensee but were believed to be a result of check valve backleakage to the hotwell or a design feature.

The operations staff had decided to close 2CA6 on Unit 2 to prevent migration of water between Units 1 and 2 and to prevent draining the CACST. The CACST normally supplies the highest head and thus shutting 2CA6 apparently removed this added margin and contributed to the low suction pressure event.

(e) Swapover Valves

All of the major Unit 2 train A and B Swapover valves had been periodically stroke tested and were tested and found operable following the event.

3. Suction Swapover Event Analysis

Normally all three CA pumps are aligned to non-safety grade, condensate quality sources. The safety-related RN supply is not normally aligned to the CA pump suction, but is automatically aligned when low suction pressure is detected.

The following evaluation of the March 9, 1988 sequence of events is based on analysis of strip charts, computer alarm printouts, calibration of components and interviews of personnel. This is the AIT evaluation which is consistent with that of the licensee's evaluation.

Both MDCA pumps 2A and 2B started after the main feedwater pump trip. The OAC received a low pressure alarm from both the train A and train B pressure switches. Valves 2RN250A and 2CA15A opened, aligning the RN train A suction source with MDCA pump 2A. MDCA pump 2B was still aligned to the normal suction source. MDCA pump 2A was operating while taking suction from its assured RN source, and simultaneously pump 2B was operating while taking suction from the normal non-safety grade sources. About 32 seconds after the MDCA pumps started, valves SA2 and SA5 opened, and the TDCA pump began to ramp up to 3650 rpm and pump auxiliary feedwater to steam generators B and C. The pump had received a CA pump start signal on detection of low low level in two of four steam generators. Nineteen seconds after valves SA2 and SA5 opened, the low suction condition in train A and B cleared.

Based on the actuation sequence of the CA pump suction pressure switches, it appears that when the CA pumps started, the suction pressure dropped below the actuation pressure of the decreasing setpoint on at least two of the train A pressure switches, (2CAPS5220, 5221, and 5222) and below the decreasing setpoint of one of the train B switches, (2CAPS5230, 5231, and 5232). No information is available that indicates condenser circulating water (RC) pressure switches (2CAPS5240, 5241, and 5242) actuated.

The pressure appears to have stayed below the reset pressure of the two train A switches for at least four seconds, and initiated swapover to RN as a source for MDCA pump 2A. After about 51 seconds, the pressure apparently rose above the reset point of the train B switch and all the train A switches.

As two of the three train A pressure switches had actuated and a partial train A swapover to RN occurred, it was questioned why valve 2CA116A did not open during the March 9 event and allow RN to supply the TDCA pump. After the initial swapover occurred, one of the pressure switches could have reset between five and thirty-two seconds into the event, aided by the pressure increase from the RN supply, and prevented valve 2CA116A from opening. The limit switch indicating valve 2CA116A closed on the computer was not functioning, so no positive indication of valve position was available. However, since: 1) the TDCA pump auto start signal occurred approximately 32 seconds after the MDCA pump auto start signal; 2) a time delay occurs in opening 2SA2 or 2SA5; and 3) a 3-5 second time delay relay times out before the low suction pressure 3-5 second time delay relay starts the 2/3 low suction pressure logic; the logic could have partially cleared at some point in this sequence and demand for 2CA116A to open was never actuated.

The licensee initially suspected that valve 2CA116A had partially opened because chemistry results of the 2C S/G indicated high levels of cation conductivity. Several days later it was determined that these samples were in error. The sample line from C S/G became clogged after the trip and the chemistry technicians were actually sampling A or B S/G. The chemistry of steam generators C and D was found to be actually within specification indicating that valve 2CA116A did not open. Further inspections were conducted on valve 2CA116A; it passed a stroke test following the event and it was disassembled and inspected and no problems were found. Also, the TDCA pump seal water supply from its discharge was inspected and found clean.

The swapover of the train A pump to RN system indicates that at least two of the train A pressure switches actuated. No swapover occurred on train B which indicates that apparently only one of the train B switches actuated. This hypothesis is also supported by calibration checks done on the pressure switches, which showed that the three pressure switches with the highest actuation pressures were two train A's and one train B. A logic check on both trains was performed, and no problems were identified.

The electrical system performed as expected. When more than one of the train A switches sensed pressure below decreasing setpoint and the timer timed out, swapover to RN occurred. The computer alarm listings indicate that after 51 seconds, all switches in both train A and train B had reset. Because both trains indicated low pressure, it does not appear that an electrical failure was responsible for the swapover. The wiring of the switches was checked to ensure that there was no crossover between trains. Calibration checks of the train A and B pressure switches were performed. Pressure switches are tubed from separate manifolds. A failure of a single root valve, manifold, or pressure switch could not prevent actuation of a separate train. Although the train B root valve was found to be partially clogged, that condition would not affect the operation of train A. Barton 580 series pressure switches, the type used for the CA system swapover logic, have a deadband of ± 10%. It is impossible to predict the exact reset pressure of a given switch within the deadband, and the reset sequence of a group of switches might not be the same as the actuation sequence.

Therefore, it was concluded that all of the logic for the swapover of TDCA pump suction was not made up, which was proper as was confirmed by several means as noted above. However, whether a low pressure condition actually occurred and if it did why train B was not actuated was not yet known.

An investigation of the hydraulic system was performed to determine if a low pressure condition actually occurred. Plant personnel verified that the isolation valves from the hotwell and upper surge tank were open, however, the CA condensate storage tank isolation valve 2CA6 was closed. Normally UST level is maintained greater than 80%; however, during the event the water level in the upper surge tank was believed to have been approximately 55-65%. This was not known until a few days after the event. The tank level per recorder had stuck at the 90% level and the tank makeup had been isolated that day for maintenance. Under these conditions, when MDCA pumps 2A and 2B started, the steady state pressure at the instrument taps was calculated to be 12 to 20 psi higher than the low pressure set points. Explanations for extremely low suction pressure would be loss of the normal suction sources due to inadvertent isolation, check valve failure, or depletion of suction sources. A failure of the common supply suction check valve CA129 or the upper surge tank supply check valve CA3 resulting in flow blockage, would be the most probable occurrence. Valve 2CA1, the hotwell check valve, might have had excessive leakage, short circuiting the supply from the upper surge tank, subsequently limiting flow to the CA pumps and causing a low pressure condition. However, effects of rising hotwell level were not observed.

After the incident occurred, and the check valve failure investigation begun, the common suction supply check valve CA129 and the upper surge tank check valve CA3 were inspected; the discs were observed to swing freely with no apparent obstructions or misalignment. The hotwell supply check valve 2CA1 was inspected and had virtually no leakage. 2CA3 was also inspected and no problems were observed.
At this point the licensee could not explain why or if an actual low pressure condition occurred. A dynamic test was developed to prove operability of the system and obtain more data to explain the event.

4. Dynamic Testing

In order to obtain transient data on CA pump suction pressure during CA pump starts, the CA suction header was instrumented at 5 different points with temporary 0-50 ± 0.125 psig pressure transmitters and visicorders. TT/2/A/9200/14, CA System Autostart Transient Test, was written and approved to measure and record suction header pressure during various CA pump starts. An attempt would be made to recreate conditions necessary for swapover to RN supply on an extended low suction pressure greater than the 3-5 second time delay. In this test, the pumps would be manually started. The logic for manual starts of the pumps requires that if an actual low suction pressure existed longer than the time delay, the pumps would automatically trip and swapover to RN would not occur. (Swapover to RN occurs with an autostart signal and extended low suction pressure.)

The pressure switches were recalibrated to be within their required settings prior to dynamic testing.

The following conditions were considered in determining test prerequisites:

a. All 3 CA pumps starting simultaneously would create the lowest possible transient suction pressure.

b. A 34 second time delay in starting the TDCA pump would simulate starting conditions under certain actual demands.

c. Upper Surge Tank (UST) level would be maintained at 60-80% level, as level was estimated to have been at 65% during the March 9 event.

d. Starting the pumps with 2CA 6 open and again with 2CA6 shut would show system response with and without the additional suction head of the CA CST available.

The test therefore would include 4 manual starts in the following manner:

(1) Simultaneous start of all 3 CA pumps with 2CA6 open.

(2) Simultaneous start of all 3 CA pumps with 2CA6 shut.

(3) Simultaneous start of both MDCA pumps, TDCA pump start 34 seconds later, with 2CA6 open.

(4) Simultaneous start of both MDCA pumps, TDCA pump start 34 seconds later, with 2CA6 shut.

The test was run on March 17 with the unit in Mode 3 and the following results were observed:

The transients exhibited a characteristic suction pressure dip of 25-30 psig just after pump start as expected, lasting 3-4 seconds. (Refer to graph 1.) In each case where 2CA6 was open, the CA suction pressure never dipped below the low suction pressure setpoints. When 2CA6 was shut, available NPSH was less and pressure was observed to drop below the low pressure setpoints. This caused control room annunciators to momentarily alarm, but not longer than the 3-5 second time delay and the CA pump trip did not occur. In all cases steady state suction pressure was acceptable.

After the 4 starts with UST level at about 60%, and 2CA6 shut, vacuum on the main feed pump (CF) condenser was inadvertently lost and the running CF pump tripped. This caused a CA autostart. Both MDCA pumps started, a swapover to RN occurred on train A and raw water was again injected into steam generators A and B. During this event the MDCA pumps were thought to have started in a staggered manner 1/2 - 1 second apart, which was suspected to have extended the pump start transient past the time delay on train A and caused swapover. UST level also appeared to be a more significant parameter than originally believed. Since the TDCA pump did not start during this event, it was concluded that it played no role in the swapover scenario.

Evaluation of the results of the initial dynamic testing and the inadvertant CA start led to the conclusion that the March 9 low pressure scenario was real and therefore could be duplicated. A further test program was defined and additional instrumentation installed.

Three (3) starts of the MDCA pumps, staggered by 2 seconds, were then conducted with 2CA6 shut. UST level varied from 65-90%. No CA pump trips were observed. On graph 2 one notes that the transient is indeed extended to about 6 seconds; however, the pressure did not dip below the setpoints. The licensee suspected this stagger time to be too long to cause swapover and did 3 more starts with pump starts staggered at 1/2 - 1 second. In each of these last 3 starts the train A MDCA pump tripped, indicative of an extended low pressure sensed on train A. The transient is shown on graph 3. The sequence of starting pump A or B first did not matter.

UST level was dropped to 55% and the running CF pump was tripped to initiate an autostart of the CA pumps. A swapover to RN occurred on train A only. The time difference between pump starts was measured and concluded to be negligible.

5. Dynamic Testing Conclusions

As a result of the testing the following conclusions were reached:

a. With 2CA6 shut and UST level between 55-60%, starting the MDCA pumps simultaneously or slightly staggered would cause a swapover to RN on "A" train only because of 3 reasons.

   (1) The suction pressure transient dipped lower and lasted longer than expected.

   (2) The pressure transient as sensed by "A" train instruments typically lasted 0.3 to 0.4 seconds longer than "B" train due to the location of the instruments and the length of impulse lines.

   (3) The time delay relay on "A" train (4.15 seconds) was shorter than "B" train (4.70 seconds).

b. With UST above 90% and 2CA6 shut or with 2CA6 open, enough NPSH was available during the transient to prevent swapover.

6. <u>Conclusions</u>

Partial swapover of CA to RN on train A occurred because of the following reasons:

1. 2CA6 was shut by operations to eliminate water migration between Units 1 and 2 and to prevent loss of CACST level.

2. UST level had dropped to 55-65% level without knowledge of the operators since the pen recorder had stuck at 90%.

3. Two pressure switches of Train A suction and one on Train B were slightly high out of tolerance.

4. The time delay relay on Train A was shorter than on Train B and the transient was sensed by Train A for a slightly longer time; therefore, swapover only occurred on Train A.

5. The logic for swapover was made up for the MDCA pump and not for the TDCA pump.

7. Corrective Actions for Short Term

The licensee has committed to operating with valve 1CA6 and 2CA6 open until evaluations determine an operating envelope for proper autostarts of the CA pumps.

B. Investigation of Clam Fouling of RN Supply

1. History of Licensee Program For RN Fouling

a. On September 3, 1980, Arkansas Nuclear One experienced low service water flow through the containment cooling units due to Asiatic clams in the system. As a result, NRC issued IE Bulletin 81-03 on April 10, 1981. The Bulletin requested, in part, that holders of construction permits (Catawba at time of Bulletin) determine if Asiatic clams were present in the vicinity of the station, determine whether infestations were present in potentially affected systems, components, or systems affected, and outline corrective and preventative actions. The licensee responded in July 1981 and March and September 1983. The following summarizes the responses:

(1) 1981 Response Summary

- The Asiatic clam has been present in the Duke service area since the mid 1960s. In 1978 Duke formed an ad hoc committee to deal with clam related problems at all Duke generating facilities.

- At Catawba, clams are a potential problem in two systems that have safety-related implications, the Nuclear Service Water (RN) system and the Fire Protection Systems (RF and RY).

- The Catawba RN system includes provisions to prevent the introduction of clams into the system from the lake via the RN intake structure by filtering the water discharged from each RN pump through a strainer with 1/32 inch openings. Provisions have also been made to allow backflushing the redundant heat exchanger trains and piping to remove any clams in safety-related RN components and piping.

- Chlorinated filtered water is used to provide normal makeup and maintain pressure in the fire protection system. The main fire pumps on the intake structure are equipped with basket strainers on the pump suction which prevent mature clams from being pumped into the system. Periodic operational testing of the main fire pumps will detect any blockage of the pump suction screens and verify acceptable pump performance.

- Periodic performance monitoring programs to verify adequate flow, and visual inspection of the intake piping and inlet heat exchanger heads during maintenance will provide early detection of any clam infestation of raw water systems.

(2) 1983 Response Summary

- Clams are a potential problem in the Nuclear Service Water (RN) and fire protection (RF and RY) systems.

- Following turnover of the RN system to the Nuclear Production Department, the system will be functionally tested to verify capability to supply required cooling flows in accordance with plant safety analysis. Subsequently two heat exchangers in the RN system will be monitored on a quarterly basis by setting reproducible flow through the heat exchanger and recording the inlet and outlet pressures. The differential pressure will be checked to determine if significant fouling has occurred. The heat exchangers will be a component cooling water heat exchanger and the Diesel Generator Starting Air After Cooler.

- Preventative actions now being taken consist of preventive maintenance inspection of system components and backflushing of raw water system piping. The frequency of these inspections and backflushes is now determined by what is discovered when components are examined. System performance monitoring will also be used to determine frequency of preventative maintenance once the plant is operational.

- The October 17, 1983, final report on the Corbicula infestation recommends that flushing of RN lines, especially low flow lines, be accomplished twice a year.

b. Presently, Catawba has in place several programs and practices designed to verify adequate Nuclear Service Water (RN) flow to various systems and components. This includes the following activities:

- The RN system is periodically flow balanced to verify the required RN flow rates are maintained to the appropriate equipment.

- Essential heat exchangers serviced by the RN system are systematically tested to verify their heat transfer capability, or are cleaned periodically, based on differential pressure indications, to prevent fouling. During cleaning, these heat exchangers and/or any other raw water system piping are examined for the presence of clams or unusual fouling conditions.

- The inspections of the RN system dead leg piping for clams has consisted of spot radiographic (RT) inspection. In April 1987, questions concerning accumulation of clams in the RN system dead legs resulted in spot RT inspection of three low spots in each unit's RN to CA lines. In addition, in March 1988, prior to the Unit 2 CA swapover to the RN system, two low spots in the Unit 1 RN to CA dead leg piping were RT inspected. None of the RT inspections revealed any clams.

2. Flushes and Inspection of Nuclear Service Water (RN) and Associated Systems

As a result of the Unit 2 Auxiliary Feedwater (CA) System Swapover from Condensate (CS) to RN system water and the subsequent introduction of raw water and clams into the CA system, the licensee initiated a program of flushes and/or inspection of dead legs between the RN system and various safety-related systems. Since RN water was introduced into Train "A" of the Unit 2 CA system, the flushes for Unit 2 included flushing CS water through Train "A" CA flow control valves to steam generators "A" and "B". The following summarizes the results of the flushes/inspections and the NRC's inspection activities:

a. Flushes/Inspections

(1) RN to CA

There is approximately 250 feet of six inch RN pipe connecting each train of CA piping to the main RN Header. This 250 feet of RN pipe as well as the connecting CA piping contains stagnant RN water. Each train of both Units 1 and 2 was flushed at approximately 1500 gpm for greater than 30 minutes until relatively clear. The flush path was from the RN header through the stagnant RN and CA piping to the Condenser Circulating Water (RC) system. The results were as follows:

- Unit 1 - Visual of flush samples taken at drain valve 1CA176 revealed some small clams (< 1/2 inch diameter) in train "B" and small clam fragments in both trains "A" and "B"

- Unit 2 - Procedure and sampling identical to Unit 1: results similar to Unit 1

After flushing, Unit 2 Train "A" and "B" stagnant RN piping was spot RT inspected for the presence of clams. Each train received five spot RTs (17 inches for each spot). The five areas included the two low spots in each train. No clams were found.

In addition to the flushing and RT inspections, check valve CA172 was disassembled on both Units 1 and 2 and the CA piping on either side of the valve inspected for clams with a boroscope ("Videoprobe"). Results were as follows:

- Unit 1 - Piping for about three feet on either side of valve 1CA172 was inspected. Water contained some silt and was fairly cloudy. No clams were detected.

- Unit 2 - On the downstream side of valve 2CA172, piping was inspected to valves 2CA116A and 2CA15A. On the upstream side of the valve, piping was inspected to valve 2RN 250A. The water was fairly clear and the pipe walls appeared clean. No clams were detected.

Historically, the only flush these lines have received has been during the quarterly Inservice Test (IST) of check valves CA171 and CA172. These check valves are partially stroked each quarter in accordance with PT/1(2)/A/4200/08F, CA Pump Suction Check Valve Partial Stroke Test. This test requires that isolation valves RN250A and RN310B be opened and a small flow be established through the check valves and out CA183 and CA184 test drain valves to a sump. Therefore, only minor flushing occurs and RN water is introduced to the CA system dead legs.

During evaluation of the event the following Unit 2 valves were disassembled for inspection of the valves and/or inspection of the piping:

2CA1
2CA3
2CA129
2CA172
2CA116A
2CA175
2CA173
2CA174
2CA48
2CA52
2CAPS 5230
2CA56
2CA60

No significant problems were identified except for valves 2CA56 and 2CA60 which are described below.

(2) Condensate to CA

After flushing RN to CA piping, the dead legs in the CA piping were flushed with condensate water to remove residual RN water from CA lines (both Units 1 and 2). The flow paths were as follows:

- CA129 - CA11A - CA12 - CA15A -CA116A - CA175 to RC

- CA129 - CA9B - CA9B - CA18B - CA85B - CA175 to RC

- CA129 - CA171 - CA85B - CA175 to RC

These flushes were accomplished before the boroscope inspection described in paragraph (1) above.

(3) RN to Component Cooling (KC)

RN supplies emergency makeup water to the KC system. The RN piping between the supply header and the RN/KC isolation valve is a short section containing stagnant RN water. The licensee concluded that clam infestation was likely in these pipes. RT inspection was performed at suspect locations (low spots) on both trains of both units. In addition, A and B trains on Unit 2 and B train on Unit 1 were flushed. The flush path was from the RN system through temporary drains on disassembled valves KC 498 and KC495 to the basement sump. A minimum pressure of 50 psig was considered adequate to remove any debris.

The results of the flushes and RT inspections were as follows:

- Unit 1 - Train A: RT inspected, no clams, not flushed.

  - Train B: RT inspected before and after flush. No clams before or after flush. Good flow during flushing.

- Unit 2 - Train A: Vertical connection to RN. RT before flush revealed several small clams. During flush, debris could be heard moving in pipe - assumed to be clams. RT after flush revealed no clams. Flow was good.

  - Train B: Horizontal connection to RN. RT before flush revealed an object that appears to be a clam. The object is still visible by RT after flushing. Flow was good.

(4) RN to Containment Penetration Valve Injection Water (NW)

RN is the safety related source of water for the NW system. These stagnant RN lines were flushed through their normally closed isolation valves to confirm whether clam infestation could degrade their ability to operate. Flow rates were acceptable with a clean water discharge. Also, all in-line valves in trains 1B and 2B (NW61B and RN493) were successfully stroked and checked for shutoff capability.

(5) RN to Spent Fuel Pool Cooling (KF)

RN supplies emergency makeup water to the KF system. RN lines to the spent fuel pool are not restricted by valves with limited flow or components with narrow passages. Each train has an unobstructed path to the spent fuel pool. Therefore, flushing of the stagnant lines was not considered a high priority or re-start issue. However, the licensee planned to flush these stagnant lines shortly after re-start of the plants. Radiographs taken later did reveal the presence of some clams and a flush procedure is being developed.

(6) Condensate through CA to Steam Generator (S/G) (Unit 2, Generator A and B)

During the initial event (swapover to RN), flow through CA train A degraded to approximately 100 gpm to S/G A and 200 gpm to S/G B versus a design flow rate of approximately 300 gpm per S/G. After plant shutdown, flow control valves 2CA 56 and 2CA60 were disassembled and found to be clogged with clam fragments. Approximately 1 1/2 pints of clam fragments were found in each valve. The valves are Design ET Fisher Controls valves with anti-cavitation cages which have 1/8 inch to 1/4 inch diameter flow holes. The clam fragments easily clogged the small holes. TDCA Pump Flow Control Valves (2CA48 and 2CA52) were disassembled and inspected. No clams were found. Later investigations revealed that only A Train motor driven CA pump swapped over to RN.

Due to RN water and clams being introduced into A Train MDCA pump suction and discharge piping, it was necessary to assure that these lines were free of clams and clam fragments that would degrade flow. The lines had seen approximately 20 minutes of degraded flow from condensate after switch back from RN to condensate. After the flow control valves (2CA 56 and 2CA 60) were disassembled and cleaned, the A train MDCA pump suction and discharge were flushed approximately 10 minutes to each S/G using condensate water. The flow path was from condensate through the CA pump to the S/Gs. The flow rate was approximately 700 gpm, or about twice the design flow rate. Therefore, the suction piping saw 700 gpm for approximately 20 minutes. There was no degradation of flow. The valves (2CA 56 and 2CA 60) were disassembled and inspected for clams a second time. A few small fragments were found in each valve. Further investigation indicated that, based on the location of the small fragments and the method used to clean the valves, the fragments most likely had not been removed during the first cleaning. The licensee declared the lines clean and reassembled the valves.

In addition to the above flushes, piping downstream of CA pump 2A was inspected for clams at valves 2CA 27, 2CA 28, and 2CA 29. No clams were found.

Additional flushing occurred during flow balancing the CA system. Train "A" was operated a minimum of 20 minutes at approximately 600 gpm through the pump and 300 gpm to each S/G. No flow degradation occurred.

After all flushes had been completed, the CA system again swapped over to the RN system during dynamic testing (see paragraph III.A.4) in mode 3. After switching back to Condensate Water, flow control valves 2CA56 and 2CA60 reacted properly and therefore no further inspection was required.

b. NRC Inspection Activities

The NRC AIT members reviewed/observed the following relative to the activities detailed in paragraph a. above:

(1) The team reviewed flush paths, completed procedures and results of the flushes described above. The procedure review specifically included the following procedures:

TT/1/A/9200/13 - RN to KC Assured Source Piping Flush

TT/2/A/9200/12 - RN to CA Piping Flush

TT/2/A/9200/18 - RN to KC Assured Source Piping Flush

TT/2/A/9200/12 - RN to CA Piping Flush

The RN to NW flushes were documented on a memorandum to file dated March 12, 1988. The team questioned whether a memorandum was adequate documentation for this work. The licensee pointed out that no plant conditions were changed and that valve manipulations for the flushes were documented under their Removal and Restoration (R&R) procedures. The team verified by visual observations that systems were restored to their correct alignment after flushing.

(2) For the RN to KC flushes, valves KC495 and KC498 were disassembled. The valve work was covered by Work Requests 5289MNT, 5290MNT, 5291MNT and 5292MNT. The team reviewed the completed Work

Requests including associated documentation to insure that valves and systems were returned to required conditions.

(3) Video tape recordings of the boroscope inspections performed of CA piping through valve CA172 were reviewed.

(4) The two trains of Unit 2 stagnant piping (250 feet/train) between the RN header and the CA system were walked-down to insure that low spots were identified for RT inspection. RT film for these sections of pipe were reviewed.

(5) RT film associated with the KC flushes were reviewed.

(6) Valve lineup and preparations for Train 1B RN to KC flush was observed.

(7) Operability evaluations (PIRs 1-C88-0108 and 2-C88-0107) relative to flushes were reviewed.

3. Evaluation of Short Term Corrective Actions

(a) Effectiveness of Short Term Actions

The licensee's short-term corrective actions to eliminate clams and clam shells from the CA system lines and the RN system lines by flushing these lines with relatively high volumeteric flows while obtaining confirmatory indications that clams and clam shells are absent from these lines was judged adequate for the restart of Catawba Units 1 and 2 based on fundamental fluid dynamics considerations and confirmations by visual and radiographic examinations. However, long term corrective actions are also required to assure the effective control of clams in the RN system lines as the present configuration of the RN/CA system interfaces are conducive for clams growth and infestation. A brief discussion of these considerations is given below.

(b) Flushing of CA System Lines

The CA system lines were flushed with a flow rate of approximately 700 gpm. This corresponds to an average flow velocity of 17 ft/sec to 31 ft/sec in the 4-inch and 3-inch diameter lines, respectively. The CA pump discharge line rises from the CA pump elevation to the steam generator level. The Reynolds numbers associated with these flow velocities are of the order of $4x10^5$ to $8x10^5$, well into the turbulent flow regime. Empirical velocity profiles indicate that, within a distance of a few hundredths of an inch from the interior wall of the pipe, the flow velocity is already close to 60% of the average velocity. Based on empirical data and drag and lift coefficients, this range of flow velocities is estimated to create sufficient drag and lift forces on the clams and clam shells in the CA system discharge lines to flush them out of the lines.

As to the 10-inch diameter suction line to the CA pump, it runs vertically down from the RN line. The average velocity in the line is of the order of 3 ft/sec for a flow rate of 700 gpm. The flow is still sufficiently turbulent so that the drag and lift forces on the clams and clam shells are estimated to be sufficient to flush them out of the line.

The above discussions indicated that the short-term corrective action of flushing the CA lines with a 700 gpm flow is judged adequate for the removal of clams and clam shells from the lines. This judgement, is confirmed by the observation that the number of clam shells and shell debris collected at the CA flow control valve was practically none after flushing.

(c) Flushing of RN lines

The RN lines were repeatedly flushed with a flow rate of 1500 gpm. This corresponds to an average velocity of approximately 17 ft/sec in the 6-inch diameter RN lines. The Reynolds number associated with this velocity is about $8x10^5$, well into the turbulent flow regime. As indicated earlier, for turbulent flow inside a pipe, at this Reynolds number, the velocity at a distance of a few hundredths of an inch from the interior wall of the pipe is already close to 60% of the average velocity. Therefore, the turbulent flow is estimated to create sufficient drag and lift forces on the clams and clam shells to flush them out of the NSW lines. This conclusion is supported by two confirmatory indications: (1) the results of visual inspections of selected portions of the RN lines indicating the absence of clams and clam shells, and (2) the results of radiographic examinations of selected portions of the RN lines including all the low points indicating the absence of clams and clam shells.

4. Long Term Corrective Actions

The presence of Corbicula sp. organism or shells in the local environment of Catawba Station (Lake Wylie) was well recognized by the licensee. In response to NRC IE Bulletin 81-03, "Flow Blockage of Cooling Water to Safety System Components by Corbicula SP. (Asiatic clam) and Mytilus SP. (Mussell)," actions were taken by the licensee to address clam-related problems. These actions included provisions in the FSAR section 9.2.1.6 to prevent the introduction of clams into the RN system from the lake by filtering the water discharged from each RN pump through a strainer with 1/32 inch openings; provision to allow backflushing the redundant heat exchanger trains and piping to remove clams from safety-related components; provisions of flow elements in the RN system to allow verification of adequate service water flow to safety-related heat exchangers during performance monitoring programs; and the visual inspection of the intake piping and inlet heat exchanger heads during maintenance for the early detection of clams.

These actions collectively have been effective in controlling clam-related problems associated with the component cooling water heat exchangers and diesel generator cooling. However, due to the relatively stagnant conditions in the 250 feet of 6-inch diameter segments of the RN to CA system lines, additional corrective actions are required to assure that clams will not grow in these lines.

The 250 feet of 6-inch diameter piping from the RN system to the CA system is not entirely stagnant, but has a flow of about 10 gpm, and is likely to have temperatures above 65°F. These conditions provide a favorable environment for the breeding and growth of the Coribicula sp. There are several options for the control of the breeding and growth of the species:

Option 1: Chlorination

Shock chlorination to control mature clams requires a high concentration of free residual chlorine of 10 to 40 ppm for a duration of about 54 hours to ensure a 90% mortality. To control shelled larvae of about 200 microns in size, chlorine residual of 0.3 to 0.4 ppm is required for a duration of about 100 hours to ensure a 100% mortality. Since clams grow about 1/4 to 1/2 inch per year depending on the environmental conditions, to control the size of clams in the system to less than 1/8 inch would require at least a quarterly treatment. The effectiveness of the treatment can be enhanced by performing it during peak clam spawning periods, and the use of clam traps and mechanical cleaning, if feasible, during outages. Chlorination is generally acceptable only in closed systems.

Option 2: Heat Treatment

Corbicula sp. is more vulnerable to heat than to chlorine treatment. A 2-minute exposure to 120° water would lead to a 99% mortality of mature clams and larvae. Another nuclear power plant licensee has observed a 100% mortality rate when their service water system was flushed with 170°F water from the auxiliary boiler for about 30 minutes. The backflushing of a system with sufficiently hot water will achieve the dual objectives of ensuring a 100% mortality of mature clams as well as larvae, and the removal of clam shells from the system

Option 3: System Modifications

Potential system modifications may involve the removal of the 10 gpm flow through the relatively stagnant RN line by re-routing the 2 inch line to another location; relocating the CA/RN interface valve or adding another isolation valve upstream of the relatively stagnant RN line; or provide means for backflushing the relatively stagnant RN line. These system modifications aim at developing an un-inhabitable condition for clams or allowing the line to be chlorinated, heat treated, or backflushed.

Option 4: Other biocides or Chemical Treatments

On a longer term, other biocides or chemical treatments may be developed to inhibit and control clam growth as well as meeting existing state environmental restrictions. Currently there are many questions about the feasibility of developing an effective program, and its testing and verification. Therefore this option appears to be suitable only for a much longer term application.

IV. REGULATORY REQUIREMENTS

A. Catawba Technical Specification 3.7.1.2 requires that three independent steam generator auxiliary feedwater pumps and associated flow paths be operable with:

- Two motor-driven auxiliary feedwater pumps, each capable of being powered from separate emergency busses, and

- One steam turbine-driven auxiliary feedwater pump capable of being powered from an operable steam supply system when the unit is in modes 1, 2, or 3.

With one auxiliary feedwater pump inoperable, it is required to be restored to operable status within 72 hours or be in at least hot standby within the next 6 hours and in hot shutdown within the following 6 hours.

With two auxiliary feedwater pumps inoperable the unit must be in at least hot standby within 6 hours and in hot shutdown within the following 6 hours.

It is further required that each auxiliary feedwater pump be demonstrated operable at least once per 31 days on a staggered test basis by:

- Verifying that each motor-driven pump develops a total dynamic head of greater than or equal to 3470 feet at a flow of greater than or equal to 400 gpm,
- Verifying that the steam turbine-driven pump develops a total dynamic head of greater than or equal to 3550 feet at a flow of greater than or equal to 400 gpm when the secondary steam supply pressure is greater than 600 psig and the auxiliary feedwater pump turbine is operating at less than or equal to 3800 rpm and,
- Verifying that each non-automatic valve in the flow path that is not locked, sealed, or otherwise secured in position is in its correct position.

It is further required that at least once per 18 months that the valve in the suction line of each auxiliary feedwater pump from the Nuclear Service Water System be tested to verify that it automatically actuates to its full open position within less than or equal to 15 seconds on a loss-of-suction test signal.

The conditions of the plant which may have been contrary to the above requirements are:

1. On March 9, 1988, with the unit operating at 20% power, three independent steam generator auxiliary feedwater pumps and associated flow paths were not operable in that;
   - During an actual turbine trip/feedwater isolation transient and resulting auxiliary feedwater (CA) initiation, the train A discharge flow control valves, 2CA 56 and 2CA 60, became clogged with Asiatic clam shells and did not properly function after MDCA pump 2A suction realigned to the nuclear service water assured source.

B. 10 CFR Appendix B, Criterion XI, requires that a test program be established to assure that all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service is identified and performed in accordance with written tests procedures which incorporate the requirements and acceptance limits contained in applicable design documents. The test program shall include, as appropriate, proof tests prior to installation, pre-operational tests, and operational tests during nuclear power plant operation, of structures, systems, and components. Test results shall be documented and evaluated to assure that test requirements have been satisfied.

The surveillance program recommended in response to NRC Bulletin 81-03 stated that flushing of RN lines, especially low flow lines, twice a year was appropriate. This was documented in a memo dated October 17, 1983, from J. J. Hall to R. W. Quellette and was presented to the AIT as the final report referred to in the early 1983 Bulletin responses that was to be available by November 1983. In lieu of flushing, the licensee performed RT of selected pipes for clam infestation.

This flushing was not being accomplished. Also, the radiographic inspections that were made were inadequate in that they did not show clams and clams were present.

V. CONCLUSIONS

A. Reportability Review

The inspector reviewed the telephone reporting of the event to the NRC. The licensee appropriately reported the Unit 2 Reactor Trip as required. Later that evening, the licensee recognized the possible significant degradation of the CA system. Although the licensee communicated the additional information effectively to NRC: Region II the following morning, it would have been appropriate to initiate a followup phone call to NRC on the previous backshift in order to allow a more timely assessment by the NRC of the event. The licensee indicated that personnel would be sensitized to make followup calls when additional significant information is discovered relative to events and that more procedure guidance would be developed in this regard.

The next day, the licensee properly reported the shutdown of both units and the Unusual Event caused by the degraded systems during shutdown.

B. Auxiliary Feedwater Suction Swapover to RN

1. CA to RN swapover occurred, during the March 9, 1988 event, to the A train MDCA pump due to a momentary low pressure condition caused by the suction lineup being different than on previous CA pump auto-starts. The CACST was isolated and the UST level was lower than normal.

2. A more timely debriefing of the operators involved would have expedited the event evaluation.

3. There were no precursors to the event which would have provided early warning and no equipment problems were repetitive or were ignored.

4. Short term corrective action is adequate.

C. Auxiliary Feedwater Degradation of Flow

1. The CA flow degradation was due to clam particles clogging the flow control valves. The clam particles were induced when the CA suction swapped to RN supply. The clams in the RN supply were there due to inadequate surveillance of the stagnant lines.

2. Some surveillance for clams in the stagnant lines was conducted by radiography but was inadequate as clams were found in the lines after radiography.

3. The licensee took appropriate and timely corrective actions by evaluating similar conditions on the other units. Catawba Unit 1 was shutdown and the stagnant lines flushed and inspected. Stagnant lines at McGuire Units 1 and 2 were inspected by boroscoping and they were found clean.

4. Flushing of stagnant lines at Catawba was recommended but not accomplished.

5. The short term corrective actions are adequate.

VI. EXIT

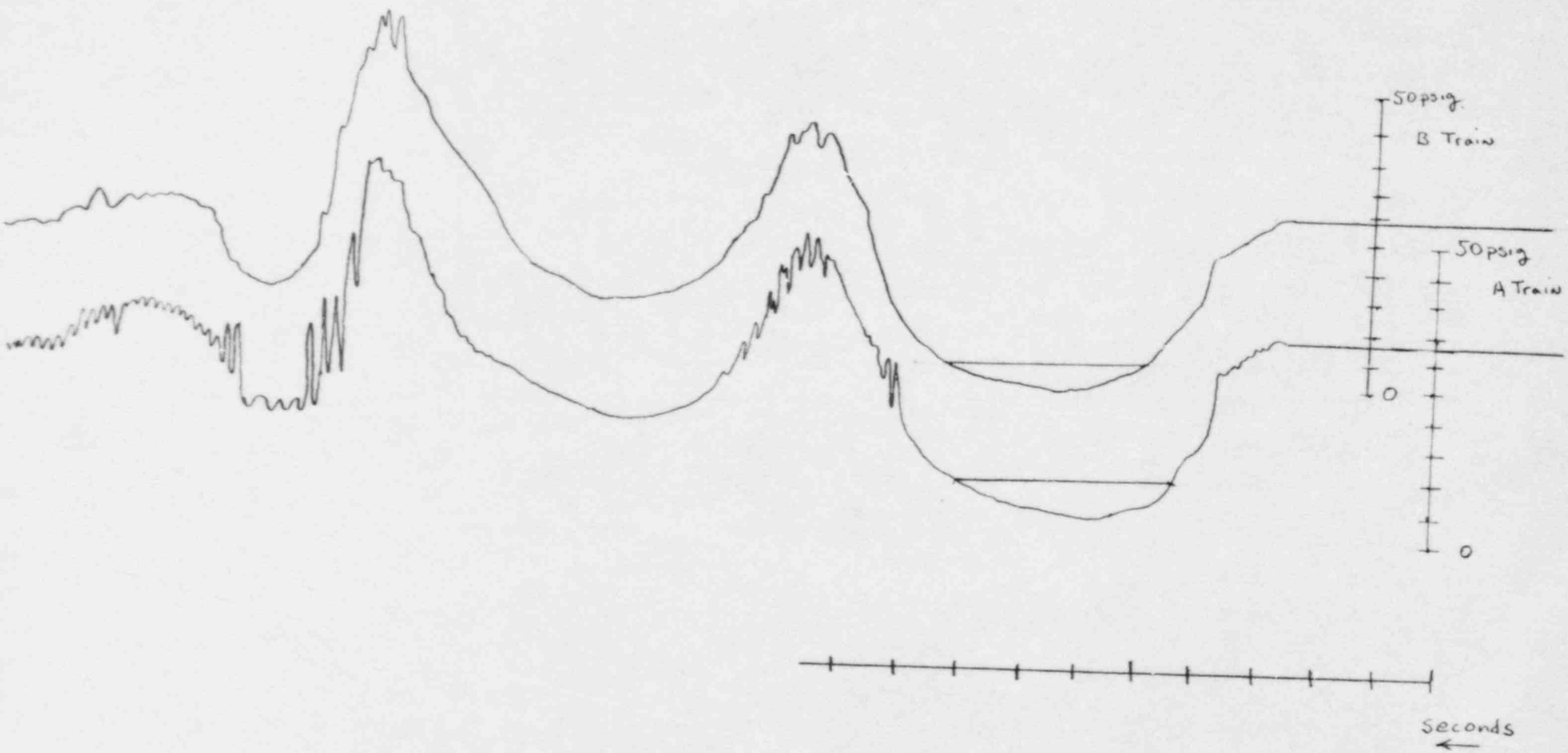
The inspection scope and findings were summarized on March 18, 1988, with those persons indicated in section I.V. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee, but areas of concern will be addressed at the forthcoming enforcement conference.

The licensee did not identify as proprietary any of the material provided to or reviewed by the inspectors during this inspection.

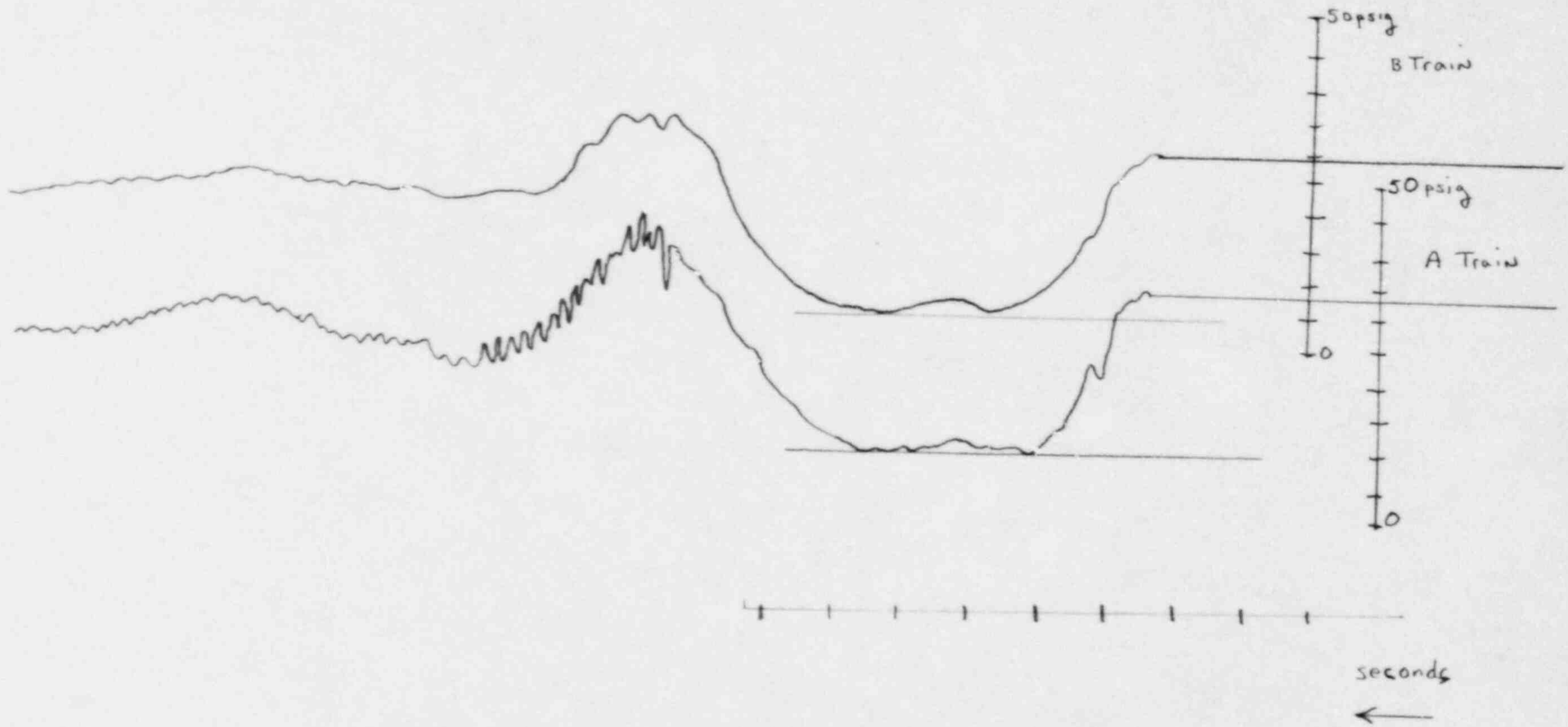
ATTACHMENT 1

GRAPH 1

3 CA PUMPS - 2CA6 SHUT - NO PUMP TRIP

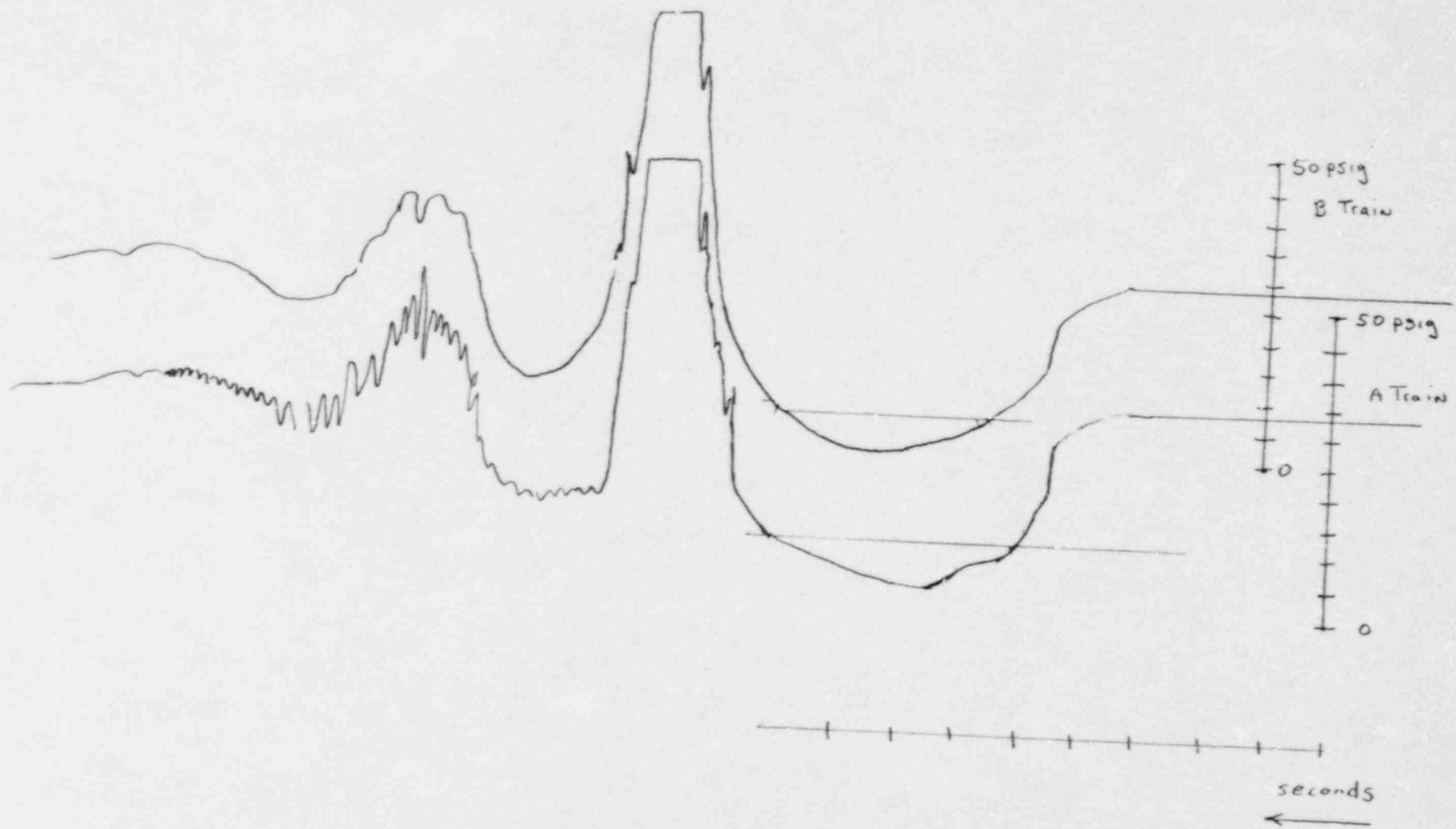


GRAPH 2
2 SECOND STAGGERED START OF MDCA PUMPS - 2CA6 SHUT-UST 60%
NO PUMP TRIP



GRAPH 3

1 SECOND STAGGERED START OF MDCA PUMPS-2CA6 SHUT-UST 60%-A-MDCA PUMP TRIP



DETAIL FIGURE 1

Designs ED, EAD, ET, EAT

Installation

1. Before installing an **easy-e** body, inspect it for any shipment damage and for any foreign material that may have collected during crating and shipment.

2. Blow out all pipelines to remove pipe scale, welding slag, and other foreign materials.

3. Install the valve so that flow through the body will be in the direction indicated by the flow direction arrow on the body.

4. Install the valve using accepted piping practices. For flanged bodies, use a suitable gasket between the body and pipeline flanges. Before installing welding-end bodies having composition seats, remove the trim to avoid damage to elastomer parts from heat generated by welding.

5. Control valves with an **easy-e** body can be installed in any position, but the normal method is with the actuator vertical above the body.

6. If continuous operation is required during maintenance and inspection, install a conventional three-valve bypass around the body.

7. Iron **easy-e** valve bodies are rated at 125 and 250 lb. ANSI; steel and alloy steel bodies are rated at 150, 300 and 600 lb. ANSI. Do not install the valve in a system where the working pressures exceed those specified in the standards.

Maintenance

WARNING

To avoid personal injury and damage to the process system, isolate the control valve from the system and release all pressure from the body and actuator before disassembling.

Disassembly

Part names used in the following steps refer to figure 2 except where indicated.

1. After the actuator is disconnected and taken off the body, remove the nuts (key 16, figure 7) or cap screws from the bonnet flange.

2. Lift off the bonnet along with th[illegible] plug and stem

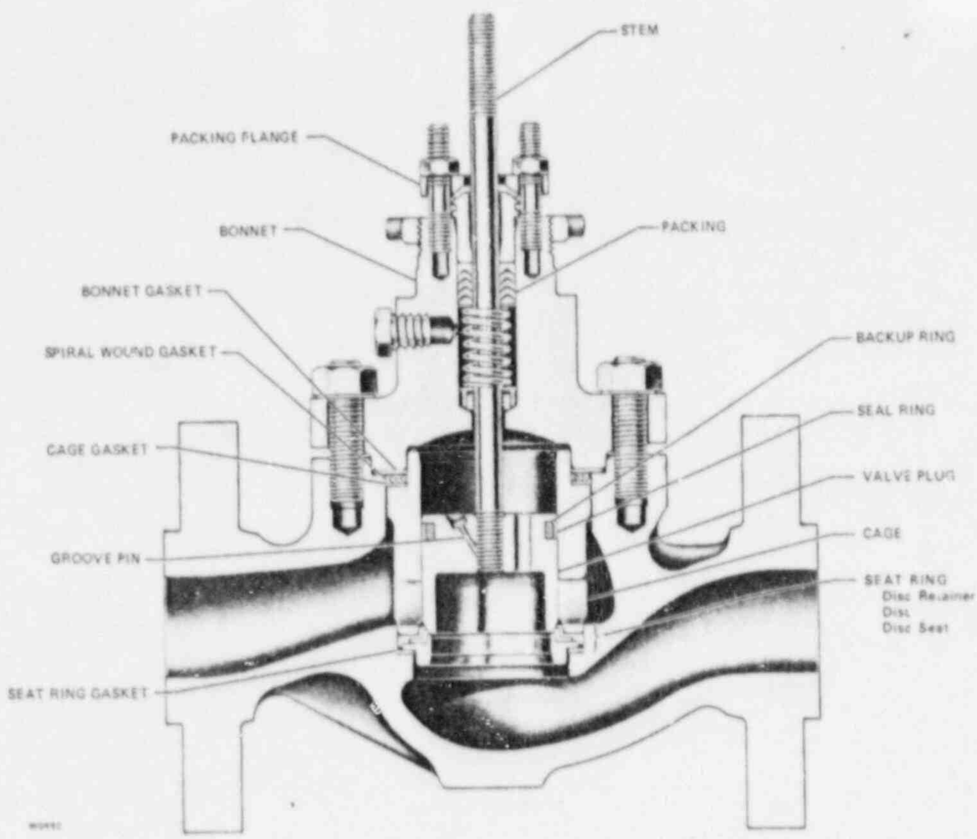


Figure 2. Sectional View of Design ET Valve Body with Full Size Trim

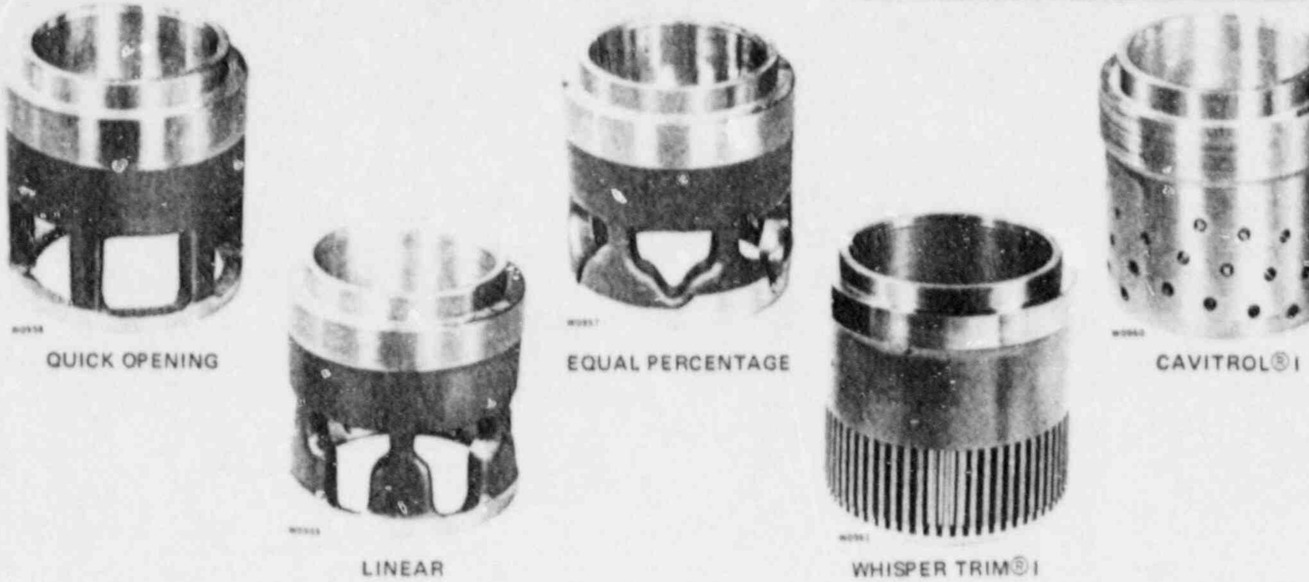


Figure 3. Cages for easy-e *Bodies*

3. Loosen the packing flange nuts (key 5, figure 12) and separate the valve plug and stem from the bonnet. If the stem needs replacing, drive out the groove pin and unscrew the stem. If the valve plug needs replacing, always replace the entire valve plug and stem assembly.

CAUTION

Never use an old stem with a new valve plug. The use of an old stem requires drilling a new groove pin hole through the stem, thereby weakening the stem.

4. The internal parts of the bonnet can be disassembled, if desired. For packing replacement, instructions are given in the section "Replacing Packing." For bellows seal replacement, follow the section entitled "Replacing Bellows Seal."

CAUTION

The exposed portion of the cage provides a guiding surface that must not be damaged during disassembly or maintenance. If the cage is stuck in the body, use a rubber mallet to strike the exposed portion at several points around the circumference.

5. Lift out the cage and gaskets. For restricted trim (figure 8), also remove the cage adaptor (key 4) and seat ring adaptor (key 5).

6. Lift out the seat ring and its gasket. For composition seats, lift out the disc retainer, disc seat and disc.

Reassembly

Part names used in the following steps are shown in figure 2 except where indicated.

1. Clean all gasketed surfaces and use all new gaskets for reassembly.

2. For restricted trim (figure 8), replace the seat ring adaptor gasket (key 14) and adaptor.

3. Install the seat ring gasket and replace the seat ring. If a composition seat is used, assemble it by inserting the disc into the disc retainer and slip this assembly over the disc seat.

4. Install the cage on top of the seat ring. Be sure that the cage slips onto the seat ring properly. Any rotational orientation of the cage with repect to the body is acceptable.

5. For full size trim, place cage gasket, spiral wound gasket, and bonnet gasket on the shoulder of the cage.

6. For restricted trim, place the cage gasket, spiral wound gasket, and another cage gasket on the sholder of the cage. For 2" x 1" angle and 1-1/2" x 1" globe bodies, a body adaptor gasket (key 20, figure 11) is required between the cage adaptor and body. Insert the cage adaptor and place the bonnet gasket on the adaptor.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

3/23/88

Docket Nos. 50-413, 50-414
License Nos. NPF-35, NPF-52

Duke Power Company
ATTN: Mr. H. B. Tucker, Vice President
Nuclear Production Department
422 South Church Street
Charlotte, NC 28242

Gentlemen:

SUBJECT: CONFIRMATION OF CONCURRENCE - STARTUP OF UNIT 2 - DOCKET NO. 50-414

This letter is to confirm our concurrence with your intention to restart Unit 2 following completion of your short term corrective actions relative to the Catawba Unit 2 trip on March 9, 1988 and subsequent swap-over of the auxiliary feedwater pumps suction supply and degraded auxiliary feedwater system flow. We had earlier confirmed with you our understanding of commitments to be completed prior to restart of Units 1 and 2 in a letter dated March 11, 1988.

After a review of your short term corrective actions by the NRC Augmented Inspection Team we gave you verbal concurrence to restart Unit 2 on March 18, 1988 at about 9:00 a.m. Concurrence was given with the understanding that the Auxiliary Feedwater (CA) Condensate Storage Tank (CST) isolation valve (CA-6) would remain open pending your analysis of CA system transient data. Also, it is our understanding that if your short term analysis of CA system transient data supports a change in system configuration to assure a supply of quality condensate grade water you will keep NRC Region II and the Catawba Resident Inspectors informed.

If your understanding is different from the above, please inform this office promptly.

Sincerely,

J. N. Grace

J. Nelson Grace
Regional Administrator

cc: J. W. Hampton, Station Manager
Senior Resident Inspector - McGuire

8804010045 -1p

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

March 11, 1988

Docket Nos. 50-413, 50-414
License Nos. NPF-35, NPF-52

Duke Power Company
ATTN: Mr. H. B. Tucker, Vice President
Nuclear Production Department
422 South Church Street
Charlotte, NC 28242

Gentlemen:

SUBJECT: CONFIRMATION OF ACTION LETTER - DOCKET NOS. 50-413 AND 50-414

This letter is to confirm our understanding of commitments made during a telephone call between Mr. T. Owen, Catawba Plant Manager, and Mr. T. Peebles of my staff on March 10, 1988. The telephone discussions related to the Catawba Unit 2 reactor trip and subsequent swap-over of the suction to the auxiliary feedwater pumps and degraded auxiliary feedwater flow. Subsequent discussions were held between our staffs to fully understand your actions relative to the Notice of Unusual Event and shutting down of Catawba Unit 1 as follow-up actions to the Unit 2 degraded auxiliary feedwater flow circumstances.

With regard to this situation, it is our understanding that you have committed to notify the NRC Region II and Senior Resident Inspector, with adequate advance notice in order to obtain the concurrence of the NRC Region II Regional Administrator or his designee prior to startup (Mode 2).

If your understanding of this matter differs from that stated above for either unit, contact this office promptly.

Sincerely,

J. N. Grace

J. Nelson Grace
Regional Administrator

CAL 50-413-8801
50-414-8801

cc: T. B. Owen, Station Manager
Senior Resident Inspector - McGuire

8803280024

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

MAR 17 1988

Docket Nos. 50-413, 50-414
License Nos. NPF-35, NPF-52

Duke Power Company
ATTN: Mr. H. B. Tucker, Vice President
Nuclear Production Department
422 South Church Street
Charlotte, NC 28242

Gentlemen:

SUBJECT: CONFIRMATION OF CONCURRENCE - STARTUP OF UNIT 1 - DOCKET NO. 50-413

This letter is to confirm our concurrence with your intention to restart Unit 1 following completion of your corrective actions relative to declaration of an Unusual Event and shutting down of Unit 1 on March 10, 1988. We had earlier confirmed with you our understanding of commitments to be completed prior to restart of Units 1 and 2 in a letter dated March 11, 1988. After a review of your corrective actions by the NRC Augmented Inspection Team we gave you verbal concurrence to restart Unit 1 on March 11, 1988 at about 11:00 p.m. Also, as stated in our March 11, 1988 letter, you have committed to obtain NRC Region II concurrence prior to Unit 2 restart.

If your understanding is different from the above, please inform this office promptly.

Sincerely,

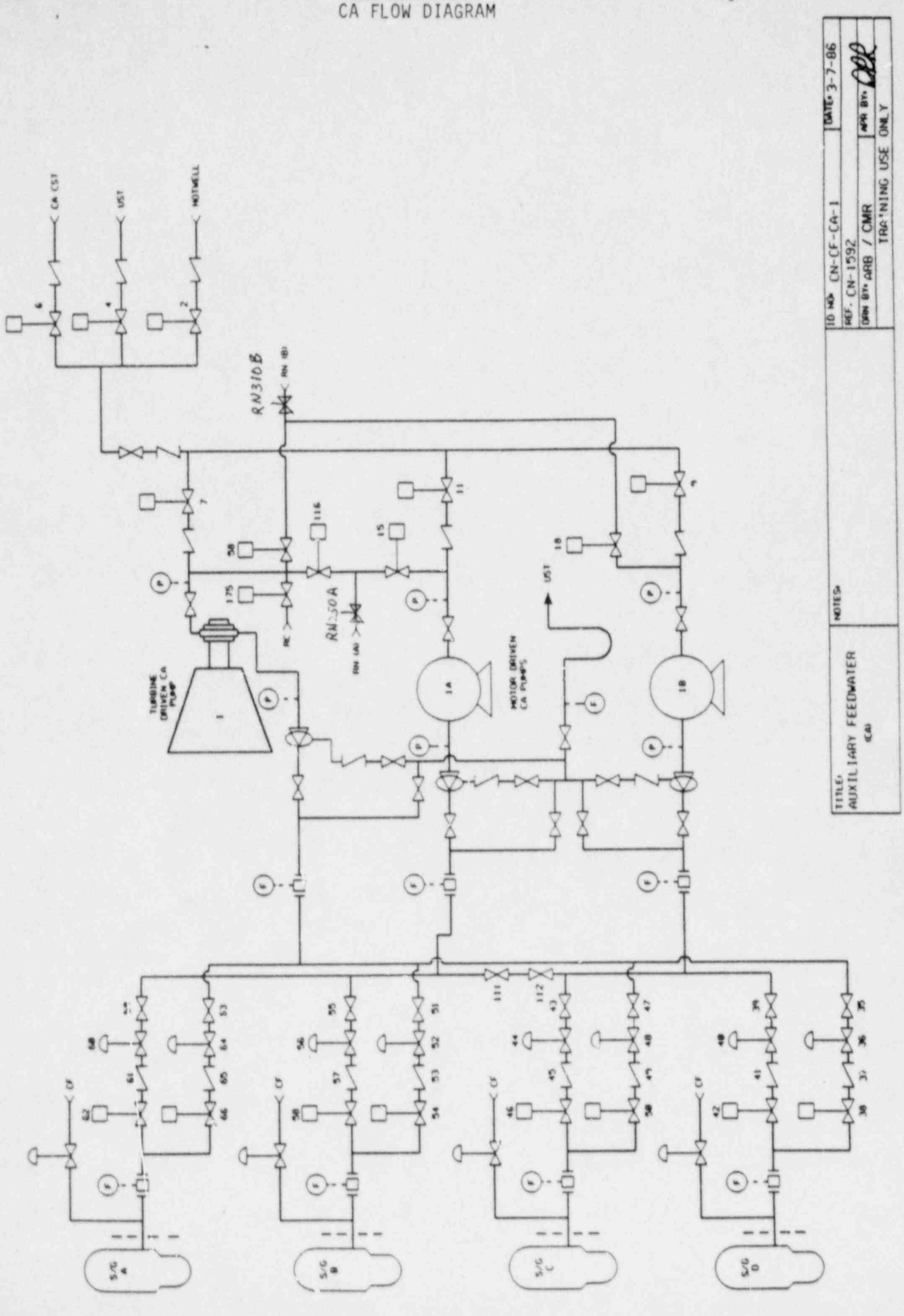
for J. Nelson Grace
Regional Administrator

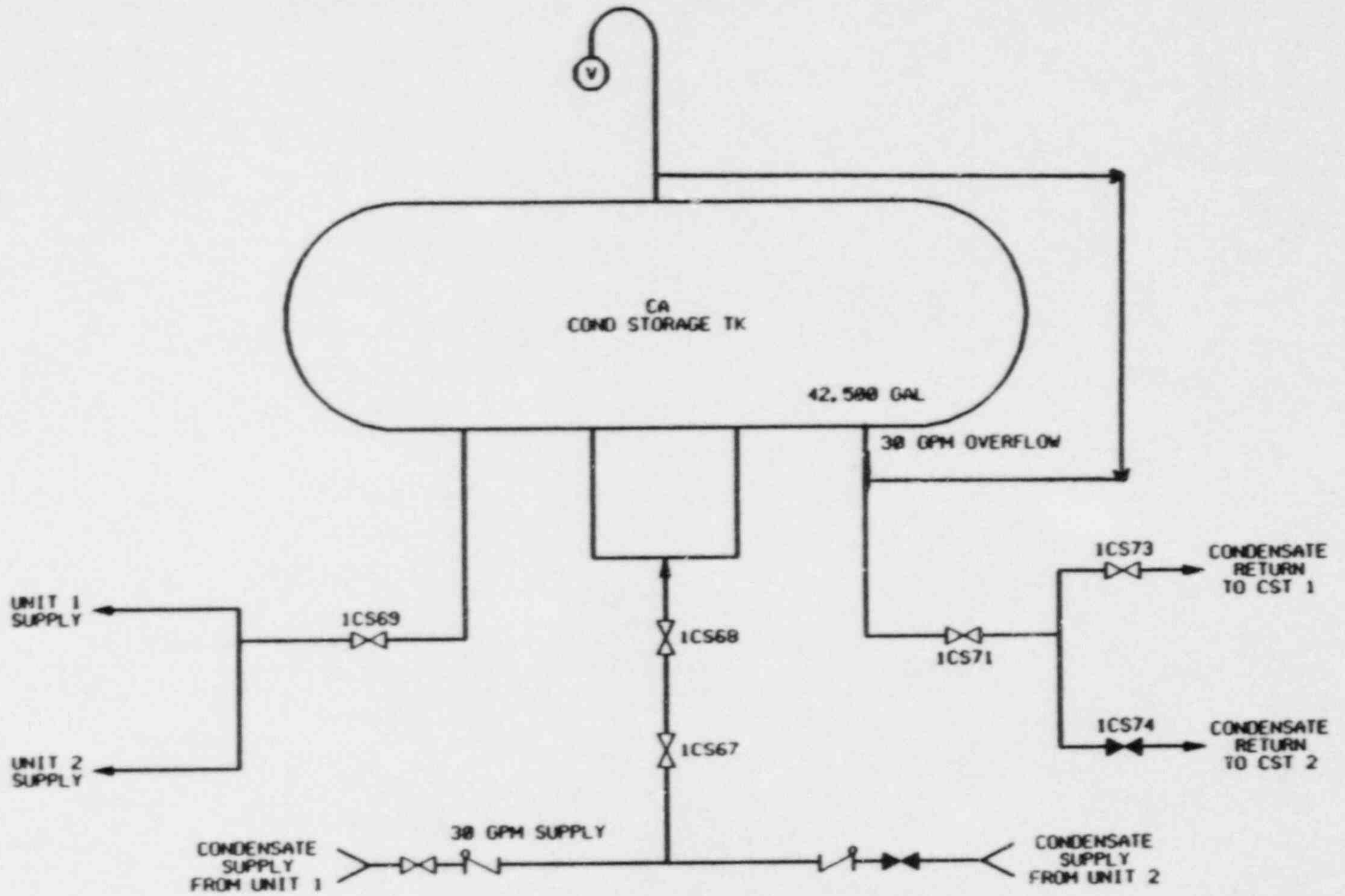
cc: T. B. Owen, Station Manager
Senior Resident Inspector - McGuire

8803250032

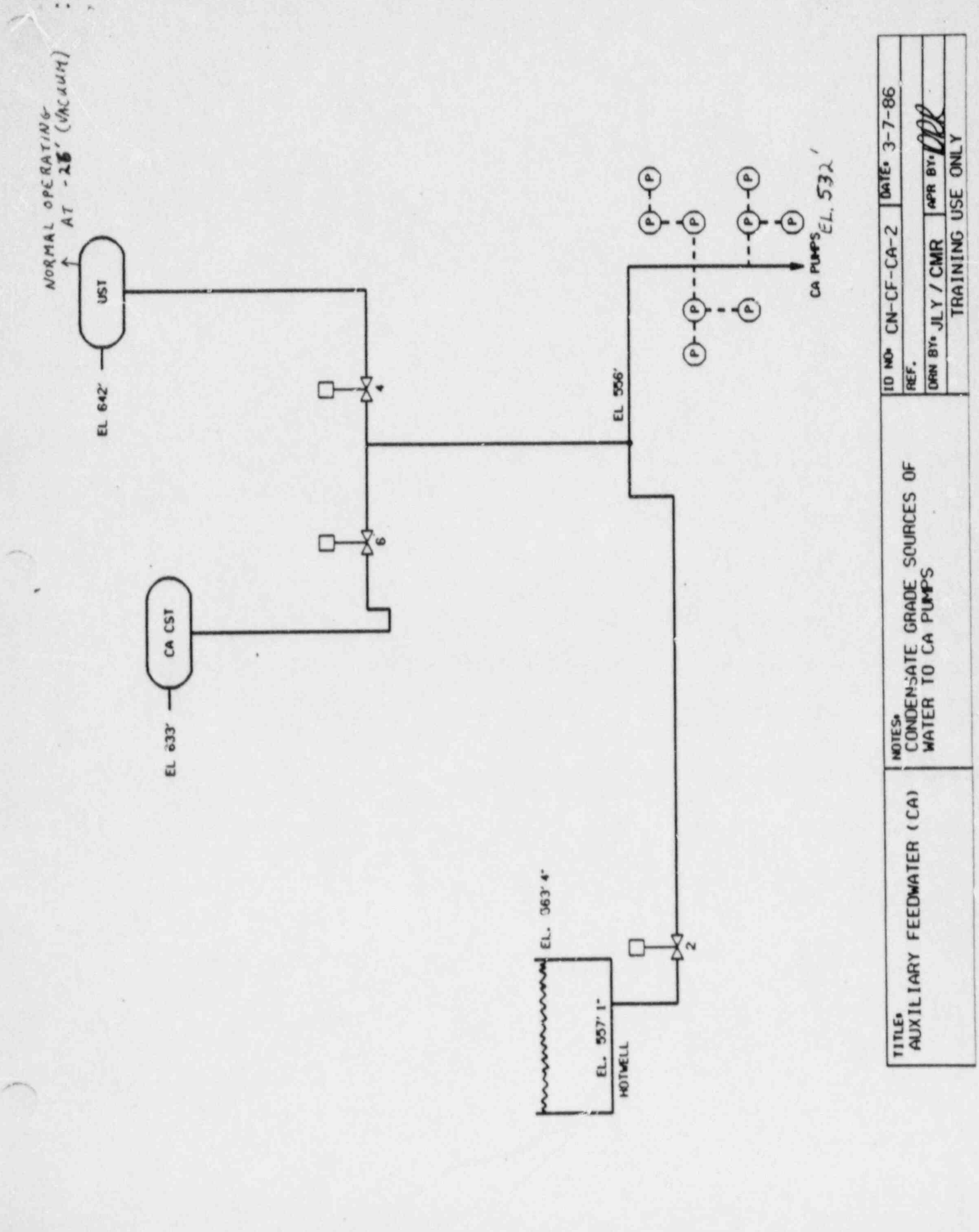
ATTACHMENT 4

CA FLOW DIAGRAM





TITLE:	NOTES:	ID NO: CN-CF-CA-3	DATE: 3-7-86
AUXILIARY FEEDWATER (CA)	CACST SUPPLY/OVERFLOW NORMAL LINEUP	REF.	
		DRN BY: JLY / CMR	APR BY: OLR
		TRAINING USE ONLY	


NORMAL OPERATING
(VACUUM)
UST
EL 642'
4
6
CA CST
EL 633'
EL 556'
P
CA PUMPS
EL 532'
EL. 563' 4"
EL. 557' 1"
HOTWELL
2
TITLE: AUXILIARY FEEDWATER (CA)
NOTES: CONDENSATE GRADE SOURCES OF WATER TO CA PUMPS
ID NO: CN-CF-CA-2
DATE: 3-7-86
REF.
DRN BY: JLY / CMR
APR BY:
TRAINING USE ONLY