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 RECIP. NAME: EISENHUT, D.G. RECIPIENT AFFILIATION: Division of Licensing

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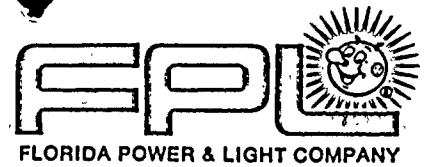
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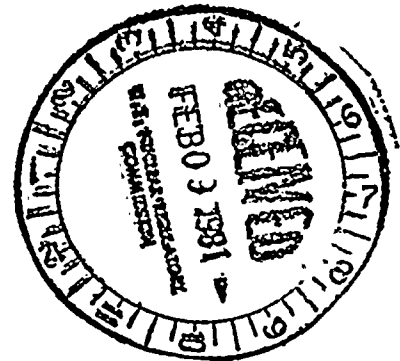


February 3, 1981  
L-81-36

Office of Nuclear Reactor Regulation  
Attention: Mr. Darrell G. Eisenhut, Director  
Division of Licensing  
U.S. Nuclear Regulatory Commission  
Washington, D. C. 20555

Dear Mr. Eisenhut:

RE: Turkey Point Units 3 & 4  
Docket Nos. 50-250 and 50-251  
NUREG 0737 Item II.E.1.2  
(Auxiliary Feedwater System)



Our report on Parts 1 and 2 of NUREG 0737 Item II.E.1.2 (Auxiliary Feedwater System Automatic Initiation and Flow Indication) is attached.

If you or your staff should have any questions on this report, we would be glad to arrange a meeting to provide clarification.

Very truly yours,

Robert E. Uhrig  
Vice President  
Advanced Systems & Technology

REU/PLP/ras

Attachment

cc: J. P. O'Reilly, Region II  
Harold F. Reis, Esquire

*Handwritten notes:*  
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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

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## ATTACHMENT

Re: Turkey Point Units 3 & 4  
Docket Nos. 50-250, 50-251  
NUREG 0737 Item II.E. 1.2 (Parts 1 and 2)

### Auxiliary Feedwater (AFW) System Automatic and Flow Indication

#### 1. Function of AFW System

The function of the Turkey Point Plant AFW System is to supply auxiliary feedwater to the steam generators in case of loss of the normal feedwater, in order to keep the unit in hot standby for a limited period or to lower the reactor coolant temperature and pressure to levels where the Residual Heat Removal (RHR) system can be put into operation to take the unit to cold shutdown.

#### 2. System Description

As shown on the attached sketch, three steam turbine driven Auxiliary Feedwater pumps are aligned to deliver feedwater to the three steam generators of either unit. (One pump is normally aligned to each unit and the third is a shared standby for either unit). Under a design basis accident only one pump would be required to cool the unit down to a condition where the RHR system could be put into operation. These pumps take suction from the 250,000 gallon, seismic Category I, Condensate Storage Water Tanks. Water is also available from the Water Treatment System and from the Main Feed Systems of units 1 and 2 (non-nuclear).

The turbine driven pumps are supplied with steam from the main steam line of either or both units upstream of the MSIV. The AFW auto initiation system selects the steam supply from the unit which has lost its normal feedwater supply. The turbines have an atmosphere exhaust. Steam can also be manually supplied from the unit having normal feedwater supply and from an auxiliary steam system connection to Units 1 & 2. The turbine driven pump steam supply line has a normally closed AC motor operated valve in series with a normally closed DC solenoid air operated pressure control valve. Two of the three AC motor operated steam supply valves will be changed to DC power. The pump discharge control valves are DC solenoid/air operated valves. The air supply for all valves are backed by a seismically qualified nitrogen supply that automatically initiates on loss of normal air supply.

All three AFW pumps will automatically start by any of the following signals:

- (a) safety injection
- (b) low-low water level in any of the three steam generators
- (c) loss of voltage on both 4160V buses
- (d) loss of both main feedwater pumps

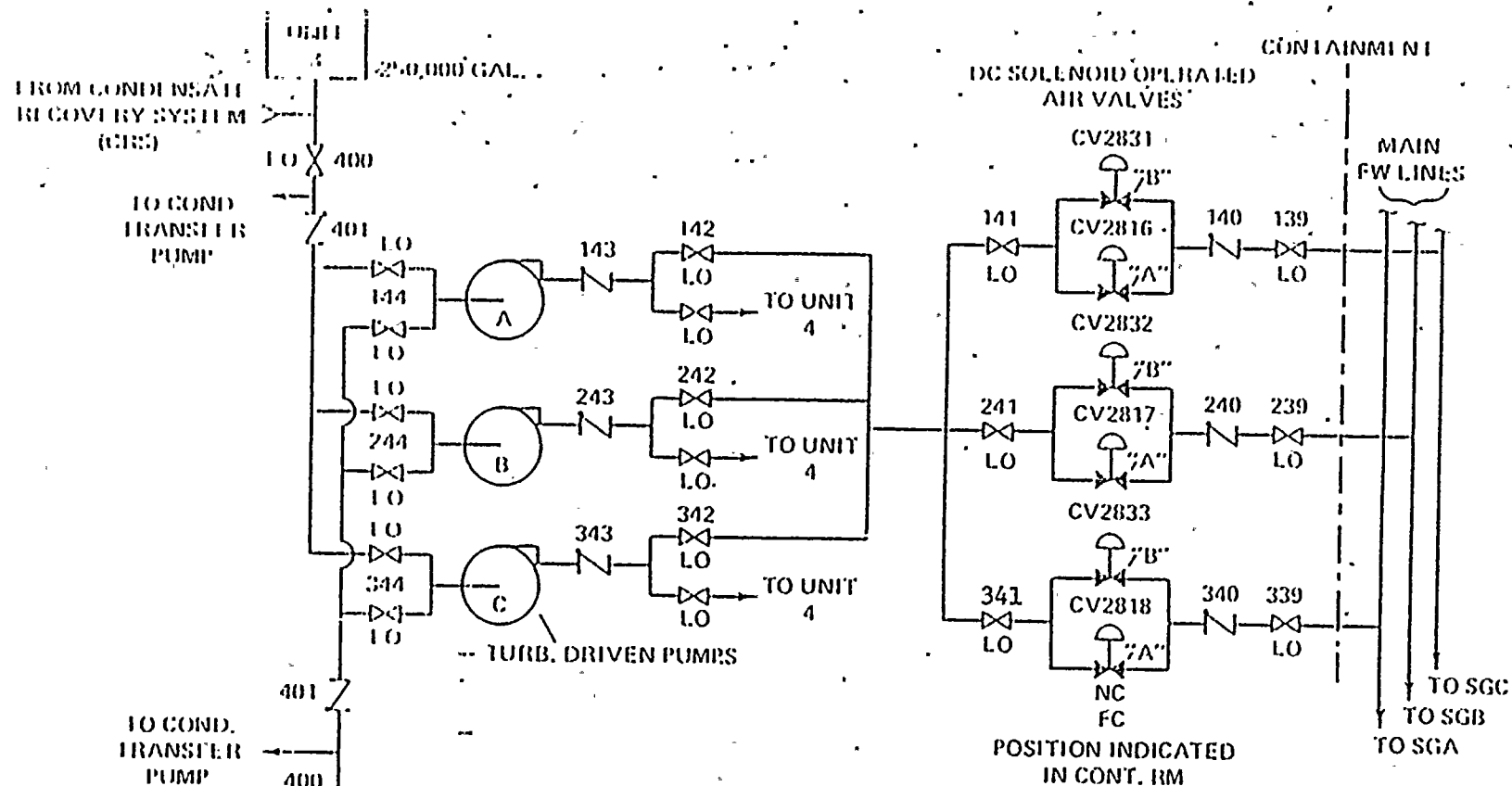
Any one of these signals will automatically open the normally closed

Any one of these signals will automatically open the normally closed motor operated valve and air operated pressure control valve in series which isolate the main steam lines from the steam supply header of each AFW pump turbine. Air to operate the AFW flow control system to the steam generators is supplied when the steam supply valves commence opening. The AFWS can also be started manually in the control room or from the local station.

### 3. Documentation

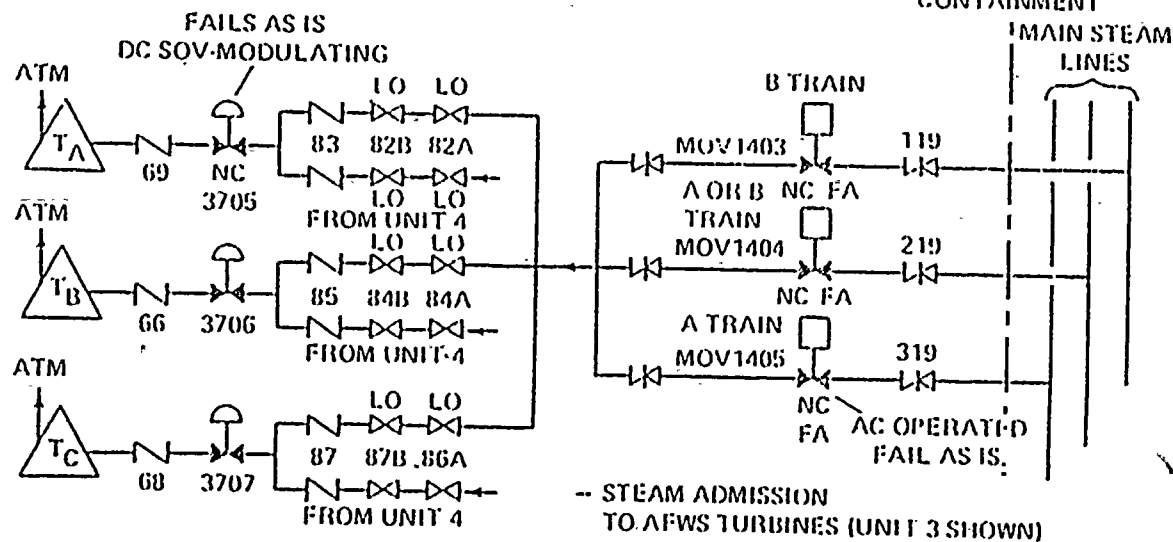
The following enclosures are attached as documentation of the indicated NUREG requirements.

1. Sketch of AFW system
2. Part 1 IEEE 279-1971 discussion
3. Part 1 System design description
4. AFW flow initiation and control P&ID (Drawing 5117-110-M-1)
5. Part 2 Westinghouse plant discussion
6. Part 2 IEEE 279-1971 discussion
7. Part 2 System design description
8. Diagrams
  - a. Elementary Diagram AFW flow control and indication (5177-109-E-05 Sheets 1, A, B)
  - b. Connection Diagram AFW flow control and containment pressure monitor racks and junction boxes Unit 3 (5177-109-E-07)
  - c. Connection Diagram AFW flow control and containment pressure monitor racks and junction boxes Unit 4 (5177-109-E-09)
  - d. Connection Diagram AFW flow control and indication control panel 3CO2 and missc. components. Unit 3 (5177-109-E-08)
  - e. Connection Diagram AFW flow control and indication control panel 4CO2 and misc. components. Unit 4 (5177-109-E-10)



# LEGEND:

- FO FAIL OPENED
- FC FAIL CLOSED
- FA FAIL AS IS
- NORMALLY OPENED
- NORMALLY CLOSED
- MOTOR OPERATED
- AIR OPERATED



Auxiliary Feedwater System  
Turkey Point (Units 3 and 4)

ENCLOSURE 2

NUREG Item II.E.1.2 (Part 1)

Compliance with IEEE-279-1971

The following discussions are keyed to Section 4 of IEEE Std. 279-1971 and demonstrate compliance with the above mentioned standard.

1. General Function Requirements - The auxiliary feedwater initiation and control system will, with precision and reliability, automatically perform its protective function whenever the station conditions, as described in FSAR Table 7.2-1, reach preset levels.
2. Single Failure Criterion - No single failure can prevent the auxiliary feedwater initiation and control system from performing its protective function.
3. Qualification of Components and Modules - The auxiliary feedwater initiation and control system consists of high quality components and modules with minimum maintenance requirements and low failure rates. Quality control procedures were used during fabrication and testing to verify compliance with the requirements specified for the equipment.
4. Equipment Qualification - Type test data is available to verify that the auxiliary feedwater initiation and control equipment meet, on a continuing basis, the performance requirements.
6. Channel Independence - Each auxiliary feedwater initiation and control logic channel are located in separate cabinets. The cabinets act as a barrier against fire and mechanical damage from external sources.  
  
The cabinets are located in the cable spreading room which offers environmental and missile protection.
7. Control and Protection System Interaction -
  - a. Classification of Equipment - Equipment that is used for protection and control function is classified as part of the protection system and meets the requirements of IEEE-279-1971.
  - b. Isolation devices - The auxiliary feedwater initiation and control system is considered a complete protection system and no isolation devices are utilized between signal and control.

- c. Single Random Failure - A single random failure resulting in a control system action, simultaneously causing a channel failure and a station condition requiring protective action is considered incredible.
  - d. Multiple Failures Resulting from a Credible Single Event - No control system action can result in a condition requiring protective action and can concurrently prevent the protective action of the auxiliary feedwater initiation and control system.
9. Capability of Sensor Checks - The initiating parameters are monitored in the control room which permits cross checking between channels.
10. Capability for Test and Calibration - Manual testing is provided for each initiating parameter.
- Manual calibration is provided for at the auxiliary feedwater flow transmitters which can be independently isolated and simulated process parameters applied to check calibration.
11. Channel Bypasses or Removal from Operation - Maintenance is permissible to each separate, independent logic system without the necessity for bypasses. Removing one logic system will remove one initiating channel to provide a two out of two logic in lieu of the two out of three as stated in the FSAR Table 7.2-1.
12. Operating Bypasses - Operating bypasses are not provided.
13. Indication of Bypasses - Since no operating bypasses are provided, there is no indication of bypasses necessary.
17. Manual Initiation - Manual initiation is provided at a system level from the main control console by means of hand switches to open the auxiliary feedwater pump turbine steam immission valves and hand controllers to manually open the auxiliary feedwater valves.



Enclosure 3

SYSTEM DESCRIPTION

FOR

AUXILIARY FEEDWATER FLOW INITIATION AND CONTROL

(SAFETY GRADE)

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1.0 FUNCTION

The auxiliary feedwater flow controllers hold the pump discharge flowrate to a maximum of 200 GPM per loop on initial pump start up. Changes in flowrate can be accomplished if required by operator manipulation of the flowrate setpoint in the control room.

## 2.0 DESIGN BASES

### 2.1 Safety Design Bases

The auxiliary feedwater flow control system is designed in accordance with safety-grade requirements as shown in Table 2.1.

Automatic or manual initiation of the auxiliary feedwater system will automatically initiate the flow control system.

Control circuitry is powered from the emergency buses.

Single failure design criteria is inherent in the design of the steam generator system, and is therefore met in the design of the flow control system by applying a separate control loop to each of the three steam generators.

The flow transmitters form part of the steam generator pressure boundary, and are therefore qualified to meet the acceptance criterion for Qp devices, which is, that they maintain their structural integrity, leaktightness and operability during and after a seismic event.

### 2.2 Power Generation Design Bases

Each flow controller is a rack mounted proportional plus reset controller with a manual set point received from a control room control station. The controller output drives existing flow control valves.

The electrical signals received by and transmitted from the control system are 4-20 milliamps.

TABLE 2.1

Codes and Standards

<u>SPONSOR</u>	<u>NUMBER</u>	<u>SUBJECT</u>
ANSI	B2.1-1968	Pipe Threads (except Dryseal)
ANSI	B16.5-1973	Steel Pipe Flanges and Flanged Fittings
ANSI	B16.11-1973	Forged Steel Fittings, Socket Welding and Threading
IEEE	323-1974	General Guide for Qualifying Class 1E Electric Equipment for Nuclear Power Generating Stations
IEEE	344-1975	IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations
NEMA	ICS-1970	Industrial Controls and Systems
NEMA	WC5-1973	Standard for Thermoplastic - Insulated Wire and Cable for the Transmission and Distribution of Electric Energy

### 3.0 DESCRIPTION

#### 3.1 General Description

The auxiliary feedwater flow initiation and control loops are shown on P&ID 5177-110-M-1.

The electronic flow control system totally replaces a pneumatic flow control system up to the existing solenoid valves mounted on the flow control valves.

The hand indicating controllers mounted on the main control consoles 3 and 4 CO2, provide indications for auxiliary feedwater flow, flow controller setpoint and flow controller output signal. The flow measurement and setpoint scales are 0 to 300 gallons per minute. The controller output scale is 0 to 100% of valve opening signal. The flow measurement pointer is red while the set point and output pointers are black. A setpoint knob on the hand controller adjusts the control loop setpoint. A mode transfer switch also exists on the hand controller. This lever selects the control loop operating mode: automatic or manual. Output adjustments may be made by moving this lever up or down in the "M" slot.

The actual control function circuitry for the system is in racks 3QR80 and 4QR80 located in the lower cable spreading room. The hand controller communicates to the rack mounted control function card by 0 to 10 volt signals via a 30-conductor cable. As all signals within the rack mounted control system are 0 to 10 volts, converters are used to interface the controller and signal processing electronics with the 4 to 20 milliamp signals in the field.

A 4 to 20 milliamp signal is developed by the associated feedwater line flow transmitter. This signal is converted to 0 to 10 volts

### 3.1 continued

at the control system rack where it is then processed by a square root converter. The control function card then uses the set point from the hand controller and the measurement from the flow transmitter to develop a 0 to 10 volt control signal.

The 0 to 10 volt control signal is then converted to a 4 to 20 milliamp signal which drives an I/P transducer mounted adjacent to each control valve.

Upon initiation of the auxiliary feedwater system, the turbine steam isolation valves open and actuate position switches that energize the solenoid valves mounted on the auxiliary feedwater control valves to permit the instrument air control signal to modulate the control valve as required by the flow control signal.

### 3.2 System Operation

When the auxiliary feedwater system is in standby mode, the main control console mounted hand indicating controller is preset to 200 GPM. However, the controller output is disconnected from the control valves by the solenoid valves. With no signal coming from the controller, the control valves will be driven to a closed position. Also, since a long term error signal is produced between the 200 GPM setpoint and the 0 GPM flow measurement, the proportional plus reset controller will "wind up", charging the reset circuitry with a signal sufficient to drive the control valves fully open.

On an auxiliary feedwater initiation signal, steam is applied to the auxiliary feedwater pump turbines. An initiation signal is also applied to the feedwater flow control solenoid valves which then permits instrument air to be supplied to the flow control valves. The full output signal from the controller is then applied to the control valves driving them wide open.

Under normal conditions the check valve in the feedwater discharge line will remain closed until the turbine has developed sufficient shaft horsepower to enable the pumphead to overcome the head in the steam generator. At that point the check valve will then open and feedwater will begin to flow to the steam generator.

The increasing flowrate will be sensed by the flow transmitter and its output signal will increase affecting the controller balance and unwinding the reset. The controller will initially over shoot then decay to control flow at 200 GPM

The operator may change the auxiliary feedwater flow to any desired value by changing the flow controller set point from the main control console.

For a description of the flow transmitters see the System Description for the Auxiliary Feedwater Flow Indication at Enclosure 7.

Manual position of the control valves can be accomplished in the control room by taking the hand indicating controller out of the automatic mode and putting it in the manual mode. The driving signal to the valve, which is indicated on the hand controller by a 0 to 100% scale, can be increased or decreased by



### 3.2 (continued)

moving the manual adjustment level up or down in the manual slot. While in the manual mode the control unit holds the last output value until the operator changes it. Switching from manual to automatic and back to manual is a bumpless, balanceless type of switching procedure.

In order to assure a greater degree of system operability during maintenance, the automatic and manual circuitry for the controller has been placed on two separate rack mounted cards. In this type of arrangement, if the control loop is on manual the automatic card may be removed and replaced without interruption to the system. If the loop is on automatic, the manual card may be removed and changed without interruption to the system. If the loop is on automatic and the automatic card is removed, the loop will switch to manual. To avoid a sudden upset of the output signal when replacing unplugged cards, the following steps must be taken:

- (1) When replacing the removal manual unit, put the transfer switch on the hand controller in automatic ("A").
- (2) When replacing the automatic proportional reset control unit, put the transfer switch in manual ("M").

### 3.3 Component Description

Hand Indicating Controllers:

Foxboro Series N-250 H Model #N-250HM-M2NH-F

Range: 0-10 volts DC

### 3.3 (Continued)

#### Control Units:

Foxboro Model - N-2AC - D + A4 + RM

Includes removable manual unit in dual module

Range: 0-10 volts DC

Proportional: 2-500%

Reset: 0.01-60 minutes/repeat

#### Square Root Converters:

Foxboro Model - N-2AP + SQE

Range: 0-10 volts DC

#### Current to Voltage Converters:

Foxboro Model - N-2AI-I2V

Input Signal: 4-20 milliamps DC

Output Signal: 0-10 volts DC

Converter contains a 24 volt DC power supply for the flow transmitters.

#### Voltage to Current Converters:

Foxboro Model - N-2AO-V3I

Input Signal: 0-10 volts DC

Output Signal: 4-20 milliamps DC

#### Control Valve Positioners:

Transducer

Model (number not available)

Input Signal: 4-20 milliamps DC

Output Signal: 3-15 PSIG

Positioner

Model (number not available)

Input Signal: 3-15 PSIG

Output Signal (as required by valve) Max. 70 PSIG

### 4.0 REFERENCES

4.0 REFERENCES

4.1 P&ID 5177-110-M-1

4.2 System Description Auxiliary Feedwater Flow Indication 5177-110-J001  
(Enclosure 7)

4.3 NUREG 0578 Item 2.1.7A

ENCLOSURE 5

NUREG ITEM II.E.1.2 (Part 2)

AUXILIARY FEEDWATER SYSTEM FLOWRATE INDICATION

2) For Westinghouse Plant

- (a) To satisfy these requirements, Westinghouse plants must provide as a minimum one auxiliary feedwater flowrate indicator and one wide-range steam-generator level indicator for each steam generator or two flow-rate indicators.

The system is designed with two flow rate indications. Narrow range and wide range level are presently available.

- (b) The flow indication system should be:

- (i) environmentally qualified.

The system is qualified to IEEE 323-1974 and IEEE 344-1974.

- (ii) powered from highly reliable, battery-backed non-Class 1E power source.

The system is powered from the vital bus system which is a Class 1E power source.

- (iii) periodically testable

The system is testable. One channel can be tested with the other in service.

- (iv) part of plant quality assurance program

The system is part of the program.

2) Westinghouse Plant (continued)

(v) capable at display on demand.

System will display at all times there is flow.

The addition of this equipment will not increase the potential for operator error because this addition will only replace existing equipment. It actually reduces the possibility of operator error with the additional channel of indication.

NUREG Item II.E.1.2 (Part 2)Compliance with IEEE-279-1971

The following discussions are keyed to Section 4 of IEEE-279-1971 and demonstrate compliance with the above mentioned standard.

1. General Function Requirements - The auxiliary feedwater flow indication system will, with precision and reliability, provide both remote and local auxiliary feedwater flow indication whenever the station conditions as described in FSAR Table 7.2-1 reach preset levels thereby initiating auxiliary feedwater flow to the steam generators.
2. Single Failure Criterion - No single failure can prevent the auxiliary feedwater flow indication system from providing the operator with auxiliary feedwater flow indication to all three steam generators.
3. Qualification of Components and Modules - The auxiliary feedwater flow indication system consists of high quality components and modules with minimum maintenance requirements and low failure rates. Quality control procedures were used during fabrication and testing to verify compliance with the requirements specified for the equipment.
4. Equipment Qualification - Type test data is available to verify that the auxiliary feedwater flow indication equipment meets, on a continuing basis, the performance requirements.
6. Channel Independence - Each auxiliary feedwater flow indication logic channel is located in separate cabinets. These cabinets act as a barrier against fire and mechanical damage from external sources.  
  
These cabinets are located in the cable spreading room which offers environmental and missile protection.
7. Control and Protection System Interaction -
  - a. Classification of Equipment - Equipment for the auxiliary feedwater flow indication is classified as part of the auxiliary feedwater initiation and control and meets the requirements of IEEE-279-1971.
  - b. Isolation devices - The auxiliary feedwater flow indication system is considered as part of the auxiliary feedwater initiation and control system and no isolation devices are utilized between signal and control.

- c. Single Random Failure - A single random failure resulting in a control system action, simultaneously causing a channel failure and a station condition requiring protective action is considered incredible.
  - d. Multiple Failures Resulting from a Credible Single Event - No control system action can result in a condition requiring protective action and can concurrently prevent the auxiliary feedwater flow indication system from providing the indication required.
9. Capability of Sensor Checks - The auxiliary feedwater flow indication system has multiple readouts in the control room which permits cross checking between channels and other feedwater parameters.
10. Capability for Test and Calibration - Manual testing and calibration is provided for each auxiliary feedwater flow transmitter which can be independently isolated and simulated process parameters applied to check response and calibration.

ENCLOSURE 7

SYSTEM DESCRIPTION

FOR

AUXILIARY FEEDWATER FLOW INDICATION

(SAFETY GRADE)



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## 1.0 FUNCTION

The auxiliary feedwater flow indication instrument loops provide the operator with redundant flow indication from the auxiliary feedwater pumps to each steam generator.

## 2.0 DESIGN BASES

### 2.1 Safety Design Bases

The auxiliary feedwater flow indication system is designed in accordance with safety-grade requirements, as shown in Table 2.1.

Indication circuitry is powered from the emergency buses.

Redundant measurement and indication is provided for each auxiliary feedwater line.

The flow transmitters form part of the steam generator pressure boundary and are therefore qualified to meet the acceptance criterion for Qp devices, which is, that they maintain their structural integrity, leaktightness and operability during and after a seismic event.

### 2.2 Power Generation Design Bases

Each steam generator auxiliary feedwater line has one flow element (orifice plate).

The normal signal transmission will be 4-20 milliamps DC.

TABLE 2.1

Codes and Standards

<u>SPONSOR</u>	<u>NUMBER</u>	<u>SUBJECT</u>
ANSI	B2.1-1968	Pipe Threads (except Dryseal)
ANSI	B16.5-1973	Steel Pipe Flanges and Flanged Fittings
ANSI	B16.11-1973	Forged Steel Fittings, Socket Welding and Threading
ANSI	C39.1-1972	Requirements for Electrical Analog Indicating Instruments
ANSI	C39.5-1964	Electrical Safety Requirements for Measuring and Controlling Instrumentation
IEEE	323-1974	General Guide for Qualifying Class 1E Electric Equipment for Nuclear Power Generating Stations
IEEE	344-1975	IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations
NEMA	WC5-1973	Standard for Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

### 3.0 DESCRIPTION

#### 3.1 General Description

The auxiliary feedwater flow indication loops are shown on P&ID 5177-110-M-1.

Each steam generator auxiliary feedwater line has two redundant feedwater flow indication loops. Both loops on each feedwater line share a common flow element. Redundant flow transmitters have common taps on the feedwater line. Signal conditioning is provided by an electronic square root extractor to give linear flow indication. Redundant indication is given in the control room and locally at the auxiliary feedwater control valve location.

The signal conditioning and control room indication of one of the redundant feedwater flow loops occurs within the auxiliary feedwater flow control system. The square root extraction for this particular loop takes place in racks 3QR80 and 4QR80 located in the lower cable spreading room. The indication for this loop is contained within the hand indicating controllers for the auxiliary feedwater flow control system located on the main control consoles 3C02 and 4C02.

The square root extraction for the other flow indication loops is done in redundant racks 3QR80 and 4QR80 located in the lower cable spreading room. Control room indication for this loop appears on vertical panels 3C04 and 4C04.

The required 24 volt DC power supplies for the flow transmitters are contained within current to voltage convertors located in the same racks as the square root extractors.

3.1

(continued)

For a description of the signal conditioning electronics see the System Description for Auxiliary Feeder Flow Initiation and Control at Enclosure 3.

3.2 .

Component Description

Flow Elements: Orifice Plates

Flow Transmitters: Westinghouse Model (number not available)

Calibration Range: 200" WC Differential Pressure

Output Range: 4 - 20 milliamps DC

Flow Indicators: Sigma Model 1151/1251

Vertically mounted edgewise indicator

Input Range: 4 - 20 milliamps DC

Scale Range: 0 - 300 GPM

#### 4.0 REFERENCES

- 4.1 P&ID 5177-110-M-1
- 4.2 System Description for Auxiliary Feedwater Flow Initiation  
and Control 5177-109-J002 (Enclosure 3)
- 4.3 NUREG 0578 Item 2.1.7B