APPENDIX 7.5A

PLANT MONITORING COMPUTER

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I. INTRODUCTION

The Waterford 3 plant monitoring computer (PMC), a non-safety related system, is designed as a single, large-scale nuclear plant computer system which integrates balance-of-plant (BOP) computer monitoring with extensive nuclear steam supply system (NSSS) application software into a comprehensive computer-based tool for plant operations.

The Plant Monitor Computer (PMC) is a real-time monitoring computer system which integrates computerized balance-of-plant monitoring with nuclear applications software for both normal plant operations and emergency operations. The original plant monitoring computer was designed and developed by LP&L in 1975.

In 1995 the plant monitoring computer was replaced with a new state of the art system. The total system consists of remote multiplexers, communication networks, redundant process computers, and Man-Machine Interfaces (MMI).

II. SYSTEM FUNCTIONS

The Waterford 3 plant monitoring computer, a non-safety related system, is designed as a single, large-scale nuclear plant computer system which integrates balance-of-plant (BOP) computer monitoring with extensive nuclear steam supply system (NSSS) application software into a comprehensive computer-based tool for plant operations.

A. Functions in Support of Normal Plant Operations

1) Scans and converts raw plant data, approximately 2500 analog and 5000 digital inputs, to engineering units for displaying, alarming, and reporting.
2) Performs calculations to obtain parameters such as differences, flows, rates, etc.
3) Displays alarms when data point value exceeds predefined setpoint (alarm limit).
4) Generates periodic station logs and preselected special logs.
5) Performs complex core calculations which allows plant operation at 100% power.
6) Provides graphical and digital trending displays of plant data.
7) Calculates core burnup factors for fuel usage determination.

B. Functions in Support of Emergency Plant operations

1) Provides plant emergency personnel with the Safety Parameter Display system (SPDS) and historical data collection.

2) Provides SPDS data to the Emergency offsite facilities.

3) Provides post-trip review of sequence-of-events information.

III. SYSTEM DESCRIPTION (Ref. 5817-11570 sh.1, sh.2, and sh.3)

A. Remote Multiplexers

A remote multiplexer site establishes the electrical connection between plant systems and the plant monitoring computer. The two-fold purpose for these remote sites is: 1) to meet the overall plant requirement of numerous field inputs to be monitored with limited cable tray space allocations and 2) to establish reliability by providing redundant data acquisition hardware and communications to the process computer nodes. There are 30 remote multiplexers in the present configuration at Waterford 3.

B. Networks

→(EC-36174, R307)

Local Area Networks (LAN) provide the data communication paths between each part of the plant monitoring computer system. Four network technologies are employed:

Description	Media	Application
Dual 20 Mbps SDLC ring	Fiber Optic	Remote Multiplexer Communications
Dual 100Mbps FDDI ring	Fiber Optic	Data Acquisition Controller communications
10Mbps CSMA/CD Ethernet	Coax	Man-Machine Interface Communications
10/100/1000 Base-T	Twisted pair	Man-Machine Interface Communications

←(EC-36174, R307)

C. Process Computer Nodes

Two Digital Equipment Corporation (DEC) Alpha computers form the nucleus of the plant monitoring computer system. The two CPU's are arranged as a redundant pair. Either CPU can operate as the primary computer.

D. Man-Machine Interfaces

The principal interface between the plant monitoring computer and its users are the Satellite Display Stations (SDS). The SDS workstations provide the color graphics displays. Display selection is accomplished by keyboard commands, trackball or mouse actions.

The SDS is a high performance graphics workstation. The SDS assemblies are connected to the MMI Ethernet network. An SDS consists of a dedicated computer, color CRTs, and spill-proof keyboard and mouse for each MMI station.

E. Auxiliary Protection Cabinet Multiplexer Sites

The Auxiliary Protection Cabinet Multiplexer (APC MUX) Sites RA4603 and RA4604 are specially designed employing a different configuration than the standard remote multiplexers.

The APC MUX acquires data from the Core Protection Calculators (CPC), Control Element Assembly Calculators (CEAC), and Fixed Incore Amplifiers (FICA). The multiplexing is accomplished through fiber optic linked modems. Fiber optic linked modems transmit data between the APC MUXs and the redundant arrangement of the network terminal servers. This optic link provides the isolation from the Class 1E APC MUX and the non-Class 1E terminal servers. The APC MUX CPI chassis' are seismic Category I.

F. Control Room Capabilities

→(LBDCR 15-041, R309)

In the control room, the operator has three separate stations within the main control board where he can communicate with the plant monitoring computer. Each station consists of multiple 19 inch color monitors and an operator's console. The console consists of one or more keyboards, and trackball or mouse. The operator uses the console to display information on the monitors available at a particular station.

In addition to the four stations on the main control board, the control room operator has a similar station at this desk. This consists of three CRTs and two consoles. The Shift Supervisor's office is equipped with a monitor, keyboard and mouse.

The computer stations within the control room provide the operations staff with important plant information at all the necessary locations in the control room. For log printing and other text output, the control room is equipped with hardcopy printers. Additionally, as backup to the monitors, one hardcopy device is provided to record display images. Site drawing G-134 shows a layout of the control room and operator stations.

IV. FUNCTIONAL CAPABILITIES

A. Remote Data Links

→(DRN 03-287, R13; EC-36174, R307)

The plant monitoring computer communicates with several external computer systems. A deterministic device for cyber security purposes has been put in place between the plant (PMC) network and the business network. This device allows transmission only in one direction from the plant to the business network.

←(DRN 03-287, R13; EC-36174, R307, LBDCR 15-041, R309)

1) Radiation Monitor System (RMS) Link

→(LBDCR 15-041, R309)

The RMS Computer provides for collection of current data and status values for all channels associated with area radiation monitors (RM-80 monitors) that are attached to the RMS via a communications loop. The RMS Computer is linked to the plant monitoring computer through a network connection. Both the plant monitoring computer and the RMS can transmit and/or receive messages at the same time.

2) Qualified Safety Parameter Display System (QSPDS) Link

The plant monitoring computer acquires approximately 250 individual data points from the QSPDS at a frequency of at least once every three (3) seconds. The incoming QSPDS data represents key reactor parameters such as Core Exit Thermocouple (CET) data and safety system bi-stable status. The QSPDS data is used by the plant monitor computer Safety Parameter Display System.

3) Bulk Power Management System (BPMS) Link

No longer in service.

4) Emergency Response Data System (ERDS) Link

During emergency operations, the plant monitoring computer transmits data to a remote computer system monitored by the NRC. The plant monitoring computer database, transmits data to the NRC using a secured network connection.

←(LBDCR 15-041, R309)

B. Control and Sequencing

1) CEA Programs

The CEA software module is an operator aid in tracking rod positions, dropped rods, out of sequence groups, regulating group averages, CEA limit checking and alarming, and power dependent and prepower dependent insertion limits. The software modules contain the following programs.

a) CEA Position Sensing

→(EC-2800, R307)

The CEA Position sensing program receives a pulse count for 87 CEAs. The pulse count is converted to 0.75 inch increments of withdrawal. CEA positions is determined by counting the up down pulses for each of the 87 CEAs where each pulse is equal to 0.75 inches of travel. A special pulse counter card in the remote

←(EC-2800, R307)

multiplexer determines the CEA positions by summing the "RAISE" and LOWER" pulses from the CEDMCS. Accurate CEA position measurement ensures that (1) acceptable power distribution limits are maintained, (2) the minimum shutdown margin is maintained, and (3) the potential effects of CEA misalignments are limited to acceptable levels.

b) Dropped CEA Detection Program

The dropped rod detection program monitors the dropped CEA contacts to determine if a CEA has reached the bottom position.

c) Out-of-Sequence

This program detects, documents, and initiates a contact alarm output when out of sequence groups have been detected.

d) CEA Group Sequencing

The purpose of this program is to provide permissive contacts to the Control Element Drive Mechanism Control System (CEDMCS) to sequence the insertion and withdrawal of the regulating groups on the Automatic Sequential and Manual Sequential Modes of Operation.

e) CEA Limit Checking

The CEA Limit Checking program compares CEA and control group positions against several limits and perform certain alarming functions as required.

f) Power Dependent Insertion Limit (PDIL) Program

This program calculates the power dependent insertion limits (PDIL) and the prepower insertion limits (PPDIL) from reactor power. Every time plant power changes or CEA movement is detected, these limits are compared to the lowest CEA in each regulating group. The PDIL checking program is invalid if COLSS is out of service or in testing modes.

C. Process and Equipment Monitoring and Alarming

One of the main purposes of the plant monitoring computer is to monitor the status of the plant. By comparing the actual plant status with known limits, the plant monitoring computer can inform plant staff when something is malfunctioning. With the large number of inputs the plant monitoring computer can provide plant personnel with an accurate status of major plant systems and their components.

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1) COLSS

The Core Operating Limit Supervisory System (COLSS) consists of process instrumentation and algorithms implemented by the plant monitoring computer to continually monitor the limiting conditions for operation on:

a) Peak linear heat rate
b) Margin to DNB
c) Total core power
d) Azimuthal tilt

The COLSS continually calculates DNB margin, peak linear heat rate, total core power, and azimuthal tilt magnitude and compares the calculated values to the limiting condition for operation on these parameters. If a limiting condition for operation is exceeded for any of these parameters, COLSS alarms are initiated by the plant monitoring computer and operator action is taken as required by Technical Specifications.

COLSS is further described in Subsection 7.7.1.5.1.

2) Vibration Monitoring

Vibration monitoring is provided on the major rotating equipment. The plant monitoring computer monitors these detectors and alarms if any exceed their preset limits.

3) Sequence-of-Events Monitoring

The sequence-of-events program monitors PPS bistable trip units and records status of changes (channel trips) with a resolution of several milliseconds as a means of determining the cause of reactor trip.

This program also monitors the status of major pieces of equipment throughout the plant. This information assists plant personnel in determining the cause of most trips in the plant.

D. Evaluation and Analysis

1) Plant Performance Calculations

The plant monitoring computer calculates performance data for the major systems in the plant. This information is provided to plant personnel responsible for the safe and reliable operation of Waterford 3. This information is used to monitor the efficiency of the plant and to detect any degradation of system performance. The following is a list of the major performance packages:

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a) Condenser Performance
b) Feedwater Heater Performance
c) Cooling Tower Performance
d) Main Feed Pumps Performance
e) NSSS Performance
f) Main Turbine Performance

2) On-Line Reactor Core Analysis

→(LBDCR 15-041, R309)

The CECOR Information File (CIF) program collects a "snapshot" of incore detector data and other relevant information needed for fuel management and core performance monitoring. The data is transmitted to the Online Reactor Core Analysis System (ORCA) computer on an as needed basis.

3) Historical Data Records

The plant monitoring computer has the capability to store a limited amount of data on-line using disc storage device provided with the system. When this data is too large to store on-line it can be archived to other media for recall at a later date.

←(LBDCR 15-041, R309

4) MARMOND

The Meteorological and Radiological Monitoring and Data Processing System (MARMOND*) continuously acquires, verifies, and stores meteorological data. The validated data is available in the Control Room, Technical Support Center, Emergency Operations Facility, and the Backup Emergency Operations Facility.

C. Evaluation and Analysis

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a) Condenser Performance
b) Feedwater Heater Performance
c) Cooling Tower Performance
d) Main Feed Pumps Performance

e) NSSS Performance
f) Main Turbine Performance

2) Historical Data Records

The plant monitoring computer has the capability to hold on line, a minimum of 7 days of archived plant data in a compressed format. The system also has a circular sequential file that contains values and quality codes for a subset of the data base once per second for 60 minutes. The system has been designed to provide an efficient and reliable method of data storage and retrieval. The data is retrievable for any user defined time span as well by subsets defined by point attributes. The plant monitoring computer system utilizes both optical disk storage and tape for archived data storage medium.

3) MARMOND

The Meteorological and Radiological Monitoring and Data Processing System (MARMOND*) continuously acquires, verifies, and stores meteorological data. The validated data is available in the Control Room, Technical Support Center, Emergency Operations Facility, and the Backup Emergency Operations Facility. (See the Waterford 3 Emergency Plan for more detailed information.)