

## 4.0 REACTOR

### 4.4 THERMAL AND HYDRAULIC DESIGN

#### 4.4.6.4 Digital Metal Impact Monitoring System (DMIMS)

The DMIMS continuously monitors the reactor coolant system for the presence of loose metallic parts. An advanced microprocessor based system design, employing digital technology, automatically actuates audible and visual alarms if a signal exceeds the preset alarm level. In addition, a multichannel tape recorder is automatically started to record the initial impact signal and subsequent signals to permit location of the loose part.

The sensors are high sensitivity piezoceramic accelerometers which produce an electrical charge proportional to acceleration and transmit it to a charge preamplifier, inside containment, where conversion is made to a voltage signal. The voltage signal is transmitted to a signal conditioner in the DMIMS cabinet, outside containment, and then to the monitor board for analog to digital conversion for processing channel impact data.

System capability is 24 active channels. The standard installation consists of two redundant sensors located at natural collection regions in the system:

- o Reactor Vessel Head
- o Reactor Vessel Bottom
- o Each Steam Generator

It has been determined that most metallic impacts will occur in the frequency range of 2 kHz to 10 kHz. The DMIMS accelerometers have a linear response between 5 Hz and 20 kHz. The system will detect a loose part that weighs from 0.25 to 30 lbs impacting with a kinetic energy of 0.5 ft-lb within 3 ft of a sensor.

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Rather than relying on impact signal amplitude alone for actuation, each signal is analyzed by the DMIMS to virtually eliminate false system actuation. For example, spurious alarming due to control rod stepping is automatically inhibited. Discrimination against normal, or anticipated, background noise is provided by use of a floating threshold so that small impact signals above background, but below actuation setpoint, can be investigated by the system prior to alarming the onset of potentially damaging conditions.

The DMIMS is not a Class 1E system. It serves as a diagnostic aid to reliably detect loose parts in the reactor coolant system before damage could occur. Equipment inside containment is designed to remain functional during an operating basis earthquake and anticipated radiation exposures. Data base calibration is made prior to plant startup and periodic online channel checks and channel functional tests are incorporated in the DMIMS design.

Operators will be trained in the operation and maintenance of the DMIMS prior to plant startup. The DMIMS conforms to Regulatory Guide 1.133 Revision 1.

#### 4.4.6.5 Inadequate Core Cooling Instrumentation

##### Core Subcooling Monitor

The core subcooling monitor is provided to meet the requirements of item II.F.2 of NUREG-0737 to provide instrumentation for the detection of inadequate core cooling. The core subcooling monitor utilizes inputs from the existing hot and cold leg resistance temperature detectors, selected incore thermocouples, and the reactor coolant system pressure sensors. This safety monitoring system is employed to determine thermocouple temperatures and then the degree of core subcooling. The monitor calculates the reactor coolant system saturation temperature for the existing system pressure, compares this value to the measured reactor coolant system temperature, and continuously indicates the margin-to-saturation on the safety display. Margin-to-saturation is available on the safety display based on both auctioneered high

hot leg temperature and on auctioneered high incore thermocouple temperature. In addition to the safety display, alarms are provided to indicate first the development of off-normal conditions and then the approach to loss of normal core subcooling.

#### Reactor Vessel Level Instrumentation System

A reactor vessel level instrumentation system (RVLIS) is provided to meet the requirement of item II.F.2 of NUREG-0737 to provide instrumentation for the detection of inadequate core cooling. Reactor vessel level is also utilized to indicate the need to vent noncondensable gases from the reactor vessel head. The RVLIS utilizes two sets of differential pressure cells to measure reactor vessel level. The RVLIS system provides the following three measurements, with indications in the control room:

- a. Upper Range - a measurement that provides an indication of reactor vessel level above the hot leg pipe when the reactor coolant pump (RCP) in the loop with the hot leg connection is not operating.
- b. Full Range - a measurement that provides an indication of reactor vessel level from the bottom of the reactor vessel to the top of the reactor vessel during natural circulation.
- c. Dynamic Range - a measurement that provides an indication of reactor core and internals pressure drop for any combination of operating RCP's. Comparison of the measured pressure drop with the normal single phase pressure drop will provide an approximate indication of the relative void content or density of the circulating fluid. This instrument monitors coolant conditions on a continuous basis during forced flow conditions.