ATTACHMENT 8

"FIV Sensors, Signal Cond. & Data Acquis. System for Dryer Test," Design Specification, GE Report 26A6366, Revision 2, dated April 22, 2005

GE Nuclear Energy

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1.0 Scope

1.1 Purpose

This specification contains general engineering requirements associated with sensors and data acquisition system for steam dryer flow induced vibration (FIV) and acoustic pressure measurement during reactor operation.

1.2 Use

This document serves as an overview of the hardware involved for steam dryer vibration and dynamic pressure measurement. The dryer test program will provide information needed to verify the adequacy of the new steam dryer design with respect to flow-induced vibrations and acoustic pressure loading during power operation. Conduits and wiring are not in the scope of this specification.

2.0 Reference Documents

2.1 Pressure Transducers GE-RS Drawing No. E8-1000-202-2

2.2 Accelerometers GE-RS Drawing No. E8-1000-201-18

2.3 Strain Gauges GE-RS Drawing No. E8-1000-208-1

2.4 Vibration Instrumentation Installation Drawing, 234C6821

3.0 Instrumentation

3.1 General

The vibration of the instrumented dryer and dynamic pressure due to acoustics shall be detected by the installed sensors inside the reactor and on the main steam lines. The signals from the sensors shall be amplified sufficiently for proper analysis by employing suitable signal conditioning devices. The signal conditioning, data acquisition & analysis, data storage and data recording equipment shall be located outside the secondary containment in an environmentally controlled vibration recording room. The placement of the sensors shall be detailed on the Vibration Instrumentation Installation Drawing, Reference 2.4. The overall signal conditioning and data acquisition system block diagram is shown in Figure 1.

3.1.1 The signals from all sensors shall be recorded on the data acquisition system controlled by a workstation. The workstation shall display the data as it acquires the signal from the sensors via the signal conditioning system. Optionally, the data can be recorded simultaneously on a magnetic tape recorder as a back-up.

3.2 Sensors and Signal Conditioning System

3.2.1 General

The sensors consist of accelerometers, pressure transducers and strain gauges.

3.2.2 Acceleration Sensors

The accelerometers shall be of the piezoelectric type and have ungrounded sensor elements with leads connected to a remote charge converter located inside the drywell. The remote charge converters shall be located close to the sensor leads emerging from the instrument nozzle. It shall withstand drywell temperatures up to a maximum of 240° F. The accelerometer shall have a minimum sensitivity of 10 pC/g. The signal conditioning system for the accelerometer shall have sufficient gain so that the accelerometer will have a gain of 1.0V per 1.0g acceleration at the sensor and shall have a flat (+/- 5 percent) frequency response from 4Hz to 400Hz. The signal conditioning system shall have the ability to increase or decrease the gain to adjust the sensitivity of the overall system. The signal conditioning system shall provide sufficient gain such that 1V output corresponds to 0.01 inch of displacement after double integration.

3.2.3 Strain Gauges

Strain Gauges shall be of a resistive type that requires external carrier current excitation and demodulation in the signal conditioning system. The overall system shall have a minimum basic sensitivity of 1.0V at the signal conditioning output terminal for 100 micro-strain (+/- 5 percent) at the gauge and must have a flat (+/- 5 percent) frequency response from 0 to 400Hz. The signal conditioning system shall have a calibrated step-type gain control to provide an approximately 2:1 increase in gain per step change. The full-scale output of the signal conditioning unit should be at least 5.0V at all gain settings.

3.2.4 Pressure Transducers

Pressure transducers shall be of the piezoelectric type and have ungrounded sensor elements with leads connected to a remote charge converter. The minimum overall system gain with sensor, charge converter and the signal conditioning system shall be 1.0V output for 1 psi input and must have a flat (+/- 5 percent) frequency response from 5Hz to 400Hz.

3.2.5 Low Frequency Cut-Off Filter

The charge converters of pressure and accelerometer sensors should have a low frequency cut-off filter to eliminate DC.

3.3 Data Acquisition System (DAS)

3.3.1 General

The recording equipment shall be comprised of a digital storage system and an optional tape recorder. Data shall be acquired at specific times during power-up and during EPU (Extended Power Uprate) ramp-up. An environmentally controlled area outside of containment will house the digital storage system and signal conditioning system.

3.3.2 Data Acquisition and Analysis

The DAS shall have the capability of acquiring data from all sensors simultaneously or in groups and shall be capable of online analysis and of storing data for offline analysis.

The DAS shall be configured with associated software and hardware. It shall be functionally tested prior to shipping to the site.

The digital storage system shall be controlled by one PC and shall record signals from all channels simultaneously. The storage system shall be comprised of modules converting analog voltage signals into digital signals. The digital data shall be stored on redundant hard disk drives. Data shall be converted and archived in a non-proprietary format. The system shall have an appropriate transfer rate to support direct data transfer without the need of a data buffer.

The data acquisition and analysis system shall be capable of performing spectrum analysis and displaying time history of signals for selected channels.

3.3.3 Spectrum Analysis

The data analyzer shall be capable of real time spectrum analysis with a minimum of 400 line resolution and at least 60 dB dynamic range. The unit shall have frequency ranges up to 2,000 Hz. Outputs must be available for hard copy printout.

3.3.4 Tape Recorder

The tape recorder, if used, shall record all channels simultaneously or in groups. It shall be calibrated and be used as backup storage to the primary PC storage system. The tape recorder shall be capable of recording and playback of signals for a minimum of frequency bandwidth from DC to 800 HZ per channel. The input voltage range shall be at least +/-0.5V to a minimum of 10V programmable. It shall support voice recording for identification.

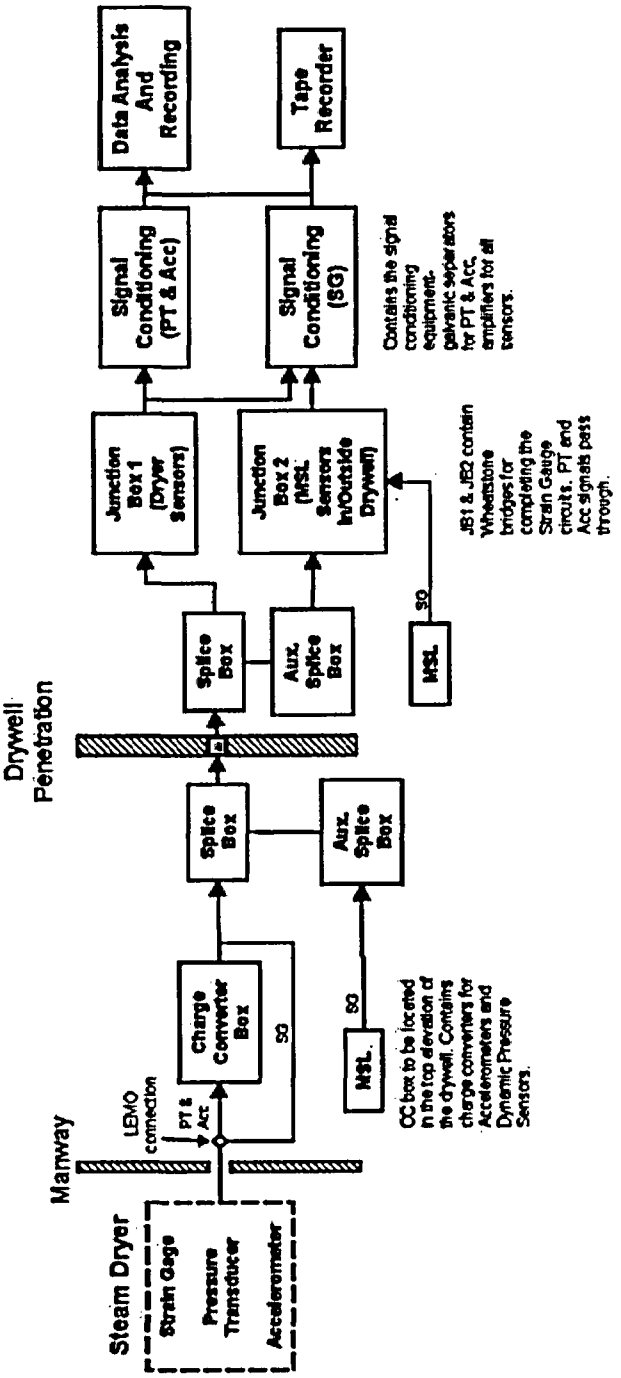

Figure 1: DAS Block Diagram

Note:
PT – Pressure Transducer
Acc – Accelerometer
SG – Strain Gauge
MSL – Main Steam Line