

ATTACHMENT 7

**"Steam Dryer Vibration Measurement," Test Specification, GE
Report 26A6388, Revision 3, dated April 20, 2005**



IDENT:

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1.0 SCOPE

1.1 Purpose:

The purpose of this document is to outline the requirements for performing a vibration test of the newly redesigned steam dryer for Quad Cities Unit 2. The scope of this document is limited to testing requirements for the dryer and associated vibration sensors at the dryer final assembly facility and at Quad Cities Unit 2.

1.2 Application:

The vibration tests described in this specification are applicable to Quad Cities-2 Nuclear Power Plant. Application of the test results and need for testing of other dryers are out of the scope of this document.

2.0 APPLICABLE CODES AND STANDARDS

The following codes and standards form a part of this specification to the extent specified herein:

ASME Boiler and Pressure Vessel Code, Section III, for Class 1 components, 1977 Edition with addenda thru Summer 1977.

3.0 REFERENCES

The following documents are to be used as reference:

- a. Steam Dryer Instrumentation Philosophy, GE-NE-0000-0030-1244-01
- b. Dryer Instrumentation Design Specification, 23A6395
- c. Dryer vibration acceptance criteria document, GE-NE-0000-0036-2077
- d. Dryer Vibration Sensors installation drawing, 234C6821
- e. Data Acquisition System installation and test procedure, 26A6499
- f. Data Acquisition System Specification, 26A6366
- g. Dryer Hammer Test Specification, 26A6380
- h. Dryer Vibration Instrument Installation Procedure, 26A6492
- i. Quad Cities Unit 2 Power Ascension Test Procedure for the Reactor Vessel Steam Dryer Replacement



4.0 REQUIREMENTS

The following tests shall be performed on the dryer:

4.1 Hammer Test:

This shall consist of impact testing the instrumented dryer components in air and water (skirt partially submerged in water to simulate reactor water level) to determine the natural frequencies and damping. The impact testing can be performed prior to moving the dryer to the reactor site. The details of this test are contained in the Dryer Hammer Test Specification, Reference 3.0g.

4.2 Static Deflection Test:

The static deflection test shall be performed on the outer bank hood panel on the 270-degree side only. Temporary strain gages shall be installed at a predetermined high stress location while performing this test. This test shall consist of applying a known static load on the panel and measuring the static strain on the panel. This test shall be conducted at the dryer manufacturing facility before or after the completion of the hammer test.

4.3 Sensor Response Measurement and Plant Startup Test:

After the completion of the dryer sensor installation, a sensor response test shall be performed prior to plant startup testing and data collection. The requirements for these tests are specified in Sections 5 and 6.

5.0 SENSOR RESPONSE MEASUREMENT

5.1 Sensor Response Test of the Dryer Sensors:

After installation of the sensors on the dryer, a response test shall be performed to verify the functionality of the installed sensors, consisting of dynamic pressure transducers, accelerometers and strain gages. This test shall be performed at the dryer final assembly facility prior to transporting the dryer to the plant. The sensors shall be connected one by one or a few at a time to a temporary data acquisition system. For strain gauges and accelerometers, the dryer shall be impacted with a medium hammer with a soft tip and the responses of the sensors shall be recorded. In addition, the strain gage response shall be observed by blowing warm air to the sensor for confirmation of response and the location. For pressure transducers, air will be blown across the sensors and the responses of the sensors will be recorded. When the dryer is relocated to Quad Cities Unit 2, sensor resistance measurements and insulation resistance measurements shall be performed and recorded.

5.2 Sensor Response Test of the Main Steam Line Sensors:

The component piping on which the Main Steam Line strain gages are located, shall be impacted with a medium hammer with a soft tip and the responses of the sensors shall be recorded. The responses from the strain gages installed in the hoop



direction is expected weak or none. So, in addition to the impact test, warm air shall be blown on the strain gages installed on the Main Steam Lines and their response shall be observed to confirm their functionality.

6.0 PLANT STARTUP AND POWER OPERATIONAL TESTS:

6.1 Pre-requisites and DAS Functional Checks:

- 6.1.1 Sensor element and insulation resistance of all sensors shall be measured and recorded after the dryer is in place and the vessel head closed but before the MI cables are connected to the soft line cables in the drywell, Reference 3.0e.
- 6.1.2 All main steam line strain gages shall be installed and insulation resistance and sensor resistances measured and recorded, Reference 3.0e.
- 6.1.3 End to end continuity check and lead wire resistances from drywell to the junction box at the DAS area shall be measured and recorded. The same type of measurement shall also be performed for the lead wires for steam line sensor leads outside the drywell, Reference 3.0e.
- 6.1.4 Data acquisition system shall be installed and all the wiring from drywell to the data acquisition system completed, Reference 3.0e.
- 6.1.5 Field calibration of the pressure and accelerometer channels shall be completed and functional tests for the strain gage channels performed, Reference 3.0e.
- 6.1.6 Functional test for main steam line sensors shall be performed by impacting the steam lines near the sensor location with a large soft tipped hammer.
- 6.1.7 The dryer sensors shall be connected, all strain gage resistances measured from the DAS area and recorded, strain gages balanced and shunt calibration performed, Reference 3.0e.
- 6.1.8 Electrical noise levels shall be within acceptable limits for all sensors as specified in the data acquisition system field installation and test procedure, Reference 3.0e.
- 6.1.9 The engineering units per volt shall be recorded for all sensors. The recommended values are 1V= 1 psi for pressure, 1V = 1G for acceleration or 1V = 10 mil in displacement mode, and 1V = 100 micro strain.
- 6.1.10 Vibration Acceptance Criteria, Reference 3.0c, shall be developed for the dryer sensors.



6.2 Baseline Data Acquisition:

- 6.2.1 With all sensors connected and calibrated, baseline data shall be collected and recorded prior to plant startup, preferably with recirculation pumps off. The reactor vessel dome temperature and pressure shall be recorded.

- 6.2.2 When the vessel temperature increases to rated value, the strain gage resistance readings shall be taken, strain gage channels balanced and recalibrated. The vibration data shall be collected and recorded. The reactor vessel dome temperature and pressure shall be recorded.

6.3 Power Operational Test:

- 6.3.1 Data shall be collected and recorded during power ascension per the Quad Cities Unit 2 Power Ascension Test Procedure for the Reactor Vessel Steam Dryer Replacement, Reference 3.0.i.

- 6.3.2 Changes to the test plan may be made by the lead test engineer as needed with concurrence of the cognizant QA/QC personnel assigned in accordance with the QA Program in effect at the time of the test.

7.0 DATA RECORDING AND REPORTS

- 7.1 Sensor Records: The following records shall be prepared for each sensor connected to the DAS:
 - a. As-installed sketch or drawing. The as-installed location and orientation of all sensors must be confirmed by a description, sketch, or updated drawing of their actual location and orientation, or a statement that they are in accordance with issued drawings. Photographs shall be taken of all sensors at their mounted locations.

 - b. Sensor data sheets and calibration information.

 - c. Sensor element and insulation resistance recorded at different times during the test.

 - d. All data shall be verified by a knowledgeable second party.



7.2 Dynamic Response Measurements:

The sensor response data shall be recorded either on magnetic tape or in a retrievable digital format.

7.3 Flow Induced Vibration Data Collection:

7.3.1 The signals from all or selected sensors shall be recorded simultaneously on magnetic tape and digital storage media. Data shall be recorded for at least 5 minutes duration on the tape recorder for all steady state test conditions. For transient test conditions, the data recording must start at least ten seconds before initiation of the transient and terminate no sooner than twenty seconds after the end. The data recording on the hard disk shall be at least for 45 seconds duration for each test conditions.

7.3.2 Voice identification must be recorded on all magnetic tape records.

7.3.3 For each test point, a Control Room Data Sheet must be completed documenting the significant reactor operating conditions during the test. This shall include date, time, thermal power, electrical power, total core flow and loop flows, steam flow in each line, feedwater flow, dome pressure and temperature, core plate differential pressure, recirculation pump speeds, bottom head drain temperature and reactor water level.

7.4 Dryer Vibration Test Reports:

7.4.1 Three reports shall be made. The first is a verbal report to be made immediately after the recording of each test. The second is a brief preliminary test report containing test results for each test condition until the plant reaches rated power levels. Third is the final report at the completion of all vibration measurements. The detailed requirements of each of these reports are given below:

7.4.1.1 Verbal Report:

- a. Whether data was satisfactorily recorded.
- b. Whether any vibration amplitude appears to be approaching or exceeding the maximum allowable value.
- c. Any problems that will result in delay of the test or require the test to be repeated.
- d. Whether to proceed to the next test point.



7.4.1.2 Preliminary Test Report:

This report will be prepared at the completion of the data collection within 5 days after the plant reaches the rated power levels. This report shall contain significant test results as shown below:

- a. The maximum strain and displacement amplitudes, as a percent of the acceptable limits (documented in the acceptance criteria document, Reference 3.0c) observed during the test period.
- b. The maximum dynamic pressure amplitudes.
- c. The vibration frequencies (Hz) and corresponding amplitudes for the dominant responses for all the sensors.

7.4.1.3 Final Report:

The final report shall be issued within 30 days after the completion of the test. This comprehensive report shall contain:

- a. A description of the test, including sensor types and locations, test conditions, and the description and specifications of the data acquisition system.
- b. Test results, including significant vibration amplitudes and frequencies and comparisons to acceptable limits.
- c. A discussion of the acoustic pressure measurement, significant peaks, its initiation points and trend and its effect on the dryer and other relevant components.
- d. A discussion of significant observations in the measurements, unusual or unexpected events, and conclusions.