Enclosure 5

MFN 12-065, Revision 1

ESBWR Design Control Document Marked-Up Pages

Public Version

This is a non-proprietary version of Enclosure 1, from which the proprietary information has been removed. Portions of the document that have been removed are identified by white space within double brackets, as shown here [[ ]].

bolts or other suitable fastening strong enough to prevent overturning or sliding. The effect of friction on the ability to resist sliding is neglected. The effect of upward dynamic loads on overturning forces and moments is considered. Unless specified otherwise, anchorage devices are designed in accordance with the requirements of the ASME B&PV Code, Subsection NF, or ANSI/AISC-N690 and ACI 349.

Dynamic design data are provided in the form of acceleration response spectra for each floor area of the equipment. Dynamic data for the ground or building floor to which the equipment is attached are used. For the case of equipment having multiple supports with different dynamic motions, an upper bound envelope of all the individual response spectra for these locations is used to calculate maximum inertial responses of items with multiple supports.

Refer to Subsection 3.9.3.5 for additional information on the dynamic qualification of valves.

Supports

Subsections 3.9.3.7 and 3.9.3.8 address analyses or tests that are performed for component supports to assure their structural capability to withstand seismic and other dynamic excitations.

3.9.2.3 Dynamic Response of Reactor Internals Under Operational Flow Transients and Steady-State Conditions

[*The major reactor internal components within the vessel are subjected to extensive testing, coupled with dynamic system analyses, to properly evaluate the resulting FIV phenomena during normal reactor operation and from anticipated operational transients.*

In general, the vibration forcing functions for operational flow transients and steady-state conditions are not predetermined by detailed analysis. The vibration forcing functions for operational flow transients and steady state conditions are determined by first postulating the source of the forcing function, such as forces due to flow turbulence, symmetric and asymmetric vortex shedding, pressure waves from steady state and transient operations. Based on these postulates, prior startup and other test data from similar or identical components are examined for the evidence of the existence of such forcing functions. Special analysis of the response signals measured for reactor internals of many similar designs is performed to obtain the parameters, which determine the amplitude and modal contributions in the vibration responses. Based on these examinations, the magnitudes of the forcing functions and response amplitudes are derived. These magnitudes are then used to calculate the expected ESBWR responses for each component of interest during steady state and transient conditions. This study provides useful predictive information for extrapolating the results from tests of components with similar designs. This vibration prediction method is appropriate where standard hydrodynamic theory cannot be applied due to complexity of the structure and flow conditions. Elements of the vibration prediction method are outlined as follows:

- *Dynamic modal analysis of major components and subassemblies is performed to identify vibration modes and frequencies. The analysis models used for Seismic Category I structures are similar to those outlined in Subsection 3.7.2.*
- *Data from previous plant vibration measurements are assembled and examined to identify predominant vibration response modes of major components. In general, response modes are similar but response amplitudes vary among Boiling Water Reactors (BWRs) of differing size and design.*

- *Parameters are identified which are expected to influence vibration response amplitudes among the several reference plants. These include hydraulic parameters such as velocity and steam flow rates and structural parameters such as natural frequency and significant dimensions.*
- *Correlation functions of the parameters are developed which, multiplied by response amplitudes, tend to minimize the statistical variability between plants. A correlation function is obtained for each major component and response mode.*
- *Predicted vibration amplitudes for components of the prototype plants are obtained from these correlation functions based on applicable values of the parameters for the prototype plants. The predicted amplitude for each dominant response mode is stated in terms of a range, taking into account the degree of statistical variability in each of the correlations. The predicted mode and frequency are obtained from the dynamic modal analyses.*

The dynamic modal analysis forms the basis for interpretation of the initial startup test results (Subsection 3.9.2.4). Modal stresses are calculated and relationships are obtained between sensor response amplitudes and peak component stresses for each of the lower normal modes.

Details of the special signal analyses of the vibration sensors are given below:

The test data from sensors (accelerometers, strain gages, and pressure sensors) installed on reactor internal components are first analyzed through signal processing equipment to determine the spectral characteristics of these signals. The spectral peak magnitudes and the frequencies at the spectral peaks are then determined. These spectral peak frequencies are then classified as natural frequencies or forced frequencies. If a spectral peak is classified as being from a natural frequency, its amplitude is then determined using a band-pass filter if deemed necessary. The resultant amplitude is then identified as the modal response at that frequency. This process is used for all frequencies of interest. Thus the modal amplitudes at all frequencies of interest are determined. If a spectral peak is identified as being from a forced frequency, the source (such as the vane passing frequency of a pump) is identified. Again, its magnitude is determined using a band-pass filter if deemed necessary.

The modal amplitudes and the forced response amplitudes are then used to calculate the expected ESBWR amplitudes for the same component. These ESBWR expected amplitudes are determined by calculating the expected changes in the forcing function magnitudes from the test component to the ESBWR component. For example, for flow turbulence excited components, the magnitudes are determined by ratio with the flow velocity squared.

A flow chart of the above process is shown in Figure 3.9-6.

The allowable vibratory amplitude in each mode is that which produces a peak stress amplitude of ±68.95 MPa (±10,000 psi). For the steam dryer and its components, a higher allowable peak stress limit is used as explained in the following paragraphs.

Vibratory loads are continuously applied during normal operation and the stresses are limited to ±68.95 MPa (±10,000 psi), with the exception of the steam dryer, in order to prevent fatigue failure. Prediction of vibration amplitudes, mode shapes, and frequencies of normal reactor operations are based on statistical extrapolation of actual measured results on the same or similar components in reactors now in operation.

Extensive predictive evaluations have been performed for the steam dryer loading and structural evaluation. These evaluations are described in Appendix 3L.4. In the dryer design and in the development of the initial strain and accelerations acceptance limits used during startup, the fatigue analysis performed for the ESBWR steam dryer uses a fatigue limit stress amplitude of 93.7 MPa (13,600 psi). For additional conversavism in the predictive analysis, the analysis stress results will also meet a minimum alternating stress ratio of 2.0 between the analysis results and the fatigue acceptance limit. ~~For the outer hood component, which is subjected to higher pressure loading in the region of the main steamlines, the fatigue limit stress amplitude is 74.4 MPa (10,800 psi).~~ Following the startup testing of the first unit or if an acceptance limit is reached during power ascension, the ~~load~~ FIV load definition is defined from the recorded dryer pressure ~~or dryer pressure and steam line~~ data. ~~The load definition bias and uncertainty is benchmarked against the dryer pressure sensor data.~~ A structural assessment is performed to benchmark the FE model strain and acceleration predictions against the measured data. The dryer peak stress based on test data, adjusted for ~~load, FE model, and instrument~~ end-to-end benchmark bias and uncertainties, is then calculated and maintained less than 93.7 MPa (13,600 psi). The subsequent ESBWR steam dryers ~~includes~~ will follow the same ~~dryer~~ FIV monitoring ~~via~~ process using ~~main steam line~~ on-dryer instruments. The acceptance limits for subsequent plants is based on assuring that the stresses remain less than 93.7 MPa (13,600 psi) allowable stress. The limit is justified because first steam dryer is heavily instrumented, subsequent plants is also monitored for FIV loads, and the load and response is explicitly evaluated based on test data with consideration of bias and uncertainty. The steam dryer is a nonsafety-related component, performs no safety-related functions, and is only required to maintain its structural integrity (no loose parts generated) for normal, transient and accident conditions.

The dynamic loads caused by FIV of the steam separators have been determined using a full-scale separator test under reactor conditions. During the test, the flow rate through the steam separator was 226,000 kg/hr (499,000 lbm/hr) at 7% quality. This is higher than the ESBWR maximum separator flow of 100,700 kg/hr (222,000 lbm/hr) at rated power. Test results show a maximum FIV stress of less than 49.6 MPa (7200 psi), well below the GEH acceptance criterion of 68.9 MPa (10,000 psi). Thus it can be concluded that separator FIV effects are acceptable. Jet impingement from feedwater flow has no significant effect on the steam separator assembly since the separator outer-most cylindrical structure (also referred to as the separator "skirt") is above the feedwater flow impingement area.]*

* Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior Nuclear Regulatory Commission (NRC) approval is required to change.

3.9.2.4 Initial Startup Flow Induced Vibration Testing of Reactor Internals

A reactor internals vibration measurement and inspection program is conducted only during initial startup testing. This meets the guidelines of RG 1.20 with the exception of those requirements related to preoperational testing which cannot be performed for a natural circulation reactor.

Initial Startup Testing

Vibration measurements are made during reactor startup at conditions up to 100% rated flow and power. Steady state and transient conditions of natural circulation flow operation are evaluated.

3L.4 STEAM DRYER EVALUATION PROGRAM

3L.4.1 Steam Dryer Design and Performance

The ESBWR steam dryer consists of a center support ring with dryer banks on top and a skirt below. A typical steam dryer is shown in Figure 3L-2. The dryer units, made up of steam drying vanes and perforated plates, are arranged in six parallel rows called dryer banks. The ESBWR steam flow rate is approximately 15% higher than ABWR. The ESBWR RPV has a larger inner diameter at the vessel flange than ABWR, which allows dryer banks to be extended, thereby accommodating the higher steam flow. The additional dryer unit face area results in approximately the same flow velocity through the drying vanes as ABWR and helps maintain moisture removal performance requirements. The support ring is supported by RPV support brackets. The steam dryer assembly does not physically connect to the chimney head and steam separator assembly. The cylindrical skirt attaches to the support ring and projects downward to form a water seal around the array of steam separators. Normal operating water level is approximately mid-height on the steam dryer skirt.

Wet steam from the core flows upward from the steam separators into an inlet header, then horizontally through the inner perforated plate, the dryer vanes and the outlet perforated plates, then vertically in the outlet header and out into the RPV dome. Dry steam then exits the RPV through the steam outlet nozzles. Moisture (liquid) is separated from the steam by the vane surface and the hooks attached to the vanes. The captured moisture flows downward, under the force of gravity, to a collection trough that carries the liquid flow to vertical drain channels. The liquid flows by gravity through the vertical drain channels to the lower end of the skirt where the flow exists below the normal water level.

The prototype for the ESBWR steam dryer builds on the successful operating experience of the ABWR steam dryer. Although the ESBWR steam dryer will have a larger diameter and wider vane banks to accommodate close to 15% higher steam flow, the vane height, skirt length, outer hood setback from the main steam nozzle, and water submergence will be similar to the ABWR steam dryer. The ESBWR steam dryer also draws experience from operating plant replacement steam dryer program fabrication, testing and performance. Steam dryers recently tested and installed in BWR/3 ~~and BWR/4~~ plants had experienced high pressure loads under extended power uprate operating conditions. These loads were characterized by an abnormally high pressure tone at approximately 155 Hz that emanated from an acoustic resonance in one or more of the safety relief valve (SRV) standpipes. The replacement steam dryers were specifically designed to withstand the FIV and acoustic resonance loading that led to fatigue failures in the steam dryers for these plants. In addition, the SRV/SV standpipes and main steamline branch lines in ESBWR are specifically designed to preclude first and second shear layer wave acoustic resonances that could be a significant contributor to steam dryer loading at normal operating conditions. Table 3L-1 provides a comparison between major configuration parameters of the ESBWR, the ABWR prototype and a BWR/3 replacement steam dryer.

3L.4.2 Materials and Fabrication

Current industry and replacement steam dryer practices are applied to the materials and fabrication of the ESBWR steam dryer. The steam dryer materials are selected to be resistant to corrosion and stress corrosion cracking in the BWR steam/water environment, see Table 4.5-1.

3L.4.3 Load Combinations

Design loads for the steam dryer are based on evaluation of the ASME B&PV Code load combinations provided in Table 3.9-2 except that the load definitions that pertain to the steam dryer are modified as shown in Table 3L-2. These load combinations consist of deadweight loads, static and fluctuating differential pressure loads (including turbulent and acoustic sources), seismic, thermal, and transient acoustic and fluid impact loads.

3L.4.4 Fluid Loads on the Steam Dryer

During normal operation, the steam dryer experiences a static differential pressure loading across the steam dryer plates resulting from the pressure drop of the steam flow across the vane banks. The steam dryer also experiences fluctuating pressure loads resulting from turbulent flow across the steam dryer and acoustic sources in the vessel and main steamlines. During transient and accident events, the steam dryer also experiences acoustic and flow impact loads that result from system actions (e.g., turbine stop valve closure) or from the system response (e.g., the two-phase level swell following a main steamline break).

Of particular interest are the fluctuating acoustic pressure loads that act on the steam dryer during normal operation that have led to fatigue damage in previous steam dryer designs. In the low frequency range, these pressure loads have been correlated with acoustic sources driven by the steam flow in the outer hood and vessel steam nozzle region. In the high frequency range, acoustic resonances in the stagnant steamline side branches (e.g., relief valve standpipes) are coupled to the vessel, thus imparting a pressure load on the steam dryer. Vessel acoustic modes may also be excited by sources inside and outside the vessel, resulting in additional acoustic pressure loads in the middle frequency range.

A detailed description of the pressure load definition for the ESBWR steam dryer is provided in Reference 3L-5. The load definition is based on the Plant Based Load Evaluation Methodology described in Reference 3L-8. Reference~~s~~ 3L-8 ~~and 3L-9~~ provides the theoretical basis of the methodology, describe the analytical model and provide benchmark and sensitivity comparisons of the methodology predictions with measured pressure data taken from instrumented steam dryers. The fluctuating load definition is based on the load definitions based on in-plant measurements that were developed for the steam dryer structural analyses in several extended power uprates. These load definitions provide a fine-mesh array of pressure time histories that are consistent with the structural finite element model nodalization. Multiple load definitions are used in the ESBWR steam dryer analysis in order to evaluate the steam dryer response over a wide frequency range. These load definitions include the limiting low and high frequency loads observed in plants with instrumented steam dryers. Based on the unique plant configurations (e.g., dead legs in the main steamlines that may amplify the low frequency acoustic response) and operating conditions (e.g., high steam line flow velocities) in these instrumented plants, the load definitions from these plants are expected to provide a robust load definition for the ESBWR. The load definitions developed for the ESBWR are also benchmarked against the instrumented steam dryer measurements taken during startup testing for the lead ABWR. The ESBWR and ABWR have the same vessel diameter and vessel steam nozzle design (with flow restricting venturi), and similar main steamline layouts; therefore, it is expected that the frequency content of the ESBWR steam dryer pressure loads will be similar to those measured on the ABWR.

Reference 3L-~~9~~ 8 provides the results of benchmarking and sensitivity studies of the pressure load definition methodology against measured pressure data taken during power ascension testing of a replacement steam dryer installed at an operating nuclear plant. Reference 3L-~~9~~ 8 concludes that, based on comparisons of model predictions to actual measurements, the methodology predicts good frequency content and spatial distribution, and the safety relief valve resonances are well captured. ~~The methodology provides accurate predictions of main steamline phenomena occurring downstream of the main steamline sensors, valve whistling (safety relief valve branch line) and broadband excitations (venturi, main steam isolation valve turbulence). The methodology also accurately predicts the dryer pressure loads resulting from vessel hydrodynamic phenomena.~~

3L.4.5 Structural Evaluation

A FEA is performed to confirm that the ESBWR steam dryer is structurally acceptable for operation. The FEA uses the load definitions described in Subsection 3L.4.4. The FEA is performed using a whole steam dryer analysis model to determine the most highly stressed locations, also see Subsection 3L.5.5.1.3. The FEA consists of dynamic analyses for the load combinations identified in Subsection 3L.4.3. If required, locations of high stress identified in the whole steam dryer analysis are further evaluated using solid finite element models to more accurately predict stresses at these locations. Additional analysis confirms that the RPV steam dryer support lugs accommodate the predicted loads under normal operation and transient and accident conditions. (Also see Subsection 3L.5.5.1.3.)

The structural evaluation of the ESBWR steam dryer design is presented in Reference 3L-6.

3L.4.6 Instrumentation and Startup Testing

The ESBWR steam dryer is instrumented with temporary vibration sensors to obtain flow induced vibration data during power operation. The primary function of this vibration measurement program is to confirm FIV load definition used in the structural evaluation is conservative with respect to the actual loading measured on the steam dryer during power operation, and to verify that the steam dryer can adequately withstand stresses from flow induced vibration forces for the design life of the steam dryer. The detailed objectives are as follows:

- Determine the as-built frequency response parameters: This is achieved by frequency response testing the steam dryer components. The results yield natural frequencies, mode shapes and damping of the components for the as-built steam dryer. These results are used to verify portions of the steam dryer analytical model.
- Confirm FIV loading: In order to confirm loading due to turbulence, acoustics and other sources, dynamic pressure sensors are installed on the steam dryer. These measurements will provide the actual pressure loading on the steam dryer under various operating conditions.
- Verify the design: Based on past knowledge gained from different steam dryers, as well as information gleaned from analysis, selected areas are instrumented with strain gages and accelerometers to measure vibratory stresses and displacements during power operation. The measured strain values are compared with the allowable values (acceptance criteria) obtained from the analytical model to confirm that the steam dryer alternating stresses are within allowable limits.

The objective of the steam dryer frequency response test is to identify the as-built frequencies and mode shapes of several key components of the steam dryer at ambient conditions. Different components of the steam dryer have different frequencies and mode shapes associated with them. The areas of interest are the drain channel, the outer hood panel, the inner hood panel, the side panel, and the skirt. These results are used to verify portions of the finite element model of the steam dryer.

The concern is that local natural frequencies may coincide with existing forcing functions to cause resonance conditions. The resonance could cause high stresses to occur in localized areas of the steam dryer. A finite element frequency response analysis can calculate the frequency and mode shape of a component, but they are only ideal approximations to the real values due to variations such as plate thickness, weld geometries, configuration tolerances and residual stresses that affect the assumed boundary conditions in the finite element model. The mode shapes and frequencies determined by the frequency response test are used to validate the finite element frequency response analysis and determine the uncertainty in the finite element model predictions of the frequency response. The FE model and experimental transfer functions are then used to derive frequency dependent amplitude bias and uncertainty of the FE model for key areas of the dryer. This is described further in Reference 3L-6.

The frequency response test is performed following final assembly of the steam dryer. The tests are performed with the steam dryer resting on simulated support blocks similar to the way the steam dryer is seated inside the reactor vessel.

Two types of ~~impact~~ frequency response tests are performed on the steam dryer: (1) Dry frequency response test, and (2) Wet frequency response test with the steam dryer skirt and drain channels partially submerged in different water levels (to approximate in-reactor water level). Both tests are conducted in ambient conditions. Temporary bondable accelerometers are installed at predetermined locations for these tests. An instrumented input force is used to excite the steam dryer at several pre-determined locations and the input force and the structural responses from the accelerometers are recorded on a computer. The data is then used to compute experimental transfer functions mode shape, frequency and damping of the instrumented steam dryer components using appropriate software. The temporary sensors are then removed and the steam dryer is cleaned prior to installation in to the reactor vessel.

The steam dryer vibration sensors consist of strain gages, accelerometers and dynamic pressure sensors, appropriate for the application and environment. A typical list of vibration sensors with their model numbers is provided in Table 3L-3. The selection and total number of sensors is based on past experience of similar tests conducted on other BWR steam dryers. These sensors are specifically designed to withstand the reactor environment. The pressure instrument locations are selected to provide a good measure of the acoustic loading through the frequency range of interest. A proper distribution of the steam dryer pressure instruments facilitates accurate assessments of FIV loads. The layout of the steam dryer pressure instrument locations is evaluated using the RPV acoustic FEA Model. The distribution of ~~steamline~~ dryer instruments is determined using the Plant Based Load Evaluation model (Reference 3L-8) to provide an adequate measure of the acoustic loading through the frequency range of interest. ~~The instrument layout permits steam dryer load development with steam dryer data alone, steamline data alone, or a combination using both sets of data.~~ The approach used to determine the number and locations of pressure instruments is described in Subsections 2.3.2 and 4.4.2 of Reference 3L-8~~ and Subsections 4.4.3.1 and 4.4.4 of Reference 3L-9~~.

The steam dryer startup test and monitoring power ascension limits are developed on a similar basis as the monitoring limits used for recent extended power uprate replacement steam dryers. The power ascension limits are based on the final FIV analysis performed for the as-built steam dryer. Strain gages and accelerometers are used to monitor the structural response during power ascension. Accelerometers are also used to identify potential rocking and to measure the accelerations resulting from support and vessel movements. The approach used to determine the number and locations of the strain gages and accelerometers is described in Section 9.0 of Reference 3L-6. Specific information utilized to verify the FIV load definition during startup testing is described further in References 3L-5 and 3L-6.

Each of the sensors are pressure tested in an autoclave prior to assembly and installation on the steam dryer. An uncertainty analysis is performed to calculate the expected uncertainty in the measurements.

Prior to initial plant start-up, strain gages are resistance spot-welded directly to the steam dryer surface. Accelerometers are tack welded to pads that are permanently welded to the steam dryer surface. Surface mounted pressure sensors are welded underneath a specially designed dome cover plate to minimize flow disturbances that may affect the measurement. The dome cover plate with the pressure transducer are welded to an annular pad that is welded permanently to the steam dryer surface. The sensor conduits are routed along a mast on the top of the steam dryer and fed through the RPV instrument nozzle flange to bring the sensor leads out of the pressure boundary. Sensor leads are routed through the drywell to the data acquisition area outside the primary containment.

Pressure transducers and accelerometers are typically piezoelectric devices, requiring remote charge converters that are located in junction boxes inside the drywell. The data acquisition system consists of strain gages, pressure transducers and accelerometer signal conditioning electronics, a multi-channel data analyzer and a data recorder. The vibration data from all sensors is recorded on magnetic or optical media for post processing and data archival. The strain gages, accelerometer and pressure transducers are field calibrated prior to data collection and analysis. The temporary vibration sensors are removed after the first outage.

~~In addition to the instrumentation on the steam dryer, the main steamlines are instrumented in order to measure the acoustic pressures in the main steamlines. The main steamline pressure measurements with the steam dryer pressure measurements are used as input to an acoustic model for determining the pressures acting on the steam dryer in order to provide a pressure load definition for use in performing confirmatory structural evaluations.~~

During power ascension, the steam dryer instrumentation (strain gages, accelerometers and dynamic pressure transducers) is monitored against established limits to assure the structural integrity of the steam dryer is maintained. If resonant frequencies are identified and the vibrations increase above the pre-determined criteria, power ascension is stopped. The acceptability of the steam dryer for continued operation is evaluated by revising the load definition based on the measured loading, repeating the structural analysis using the revised load definition, and determining revised operating limits based on the results of the structural analysis.

It is expected that subsequent ESBWR units will ~~be monitored using the main steam lines pressure data~~follow the same FIV monitoring process using on-dryer instrumentation. Additional information on power ascension testing, acceptance criteria, benchmarking loads, and benchmarking of the FE model for the first and subsequent ESBWR units is included in references 3L-5 and 3L-6.

Specific steam dryer inspection recommendations for the ESBWR steam dryer design are developed based on the final as-built design and structural analysis results. The steam dryer inspection recommendations are consistent with Reference 3L-2, and consistent with Boiling Water Reactor Vessel Internals Program guidance issued by the BWR owners group specific to reactor internals vibration.

understood that the value calculated is conservatively high, and it is not an accurate prediction of the actual stress amplitude. If a stress calculated in this manner should exceed the limit in a few situations, then a less conservative calculation can be used in those few cases.

In summary, all three methods involve two significant conservatisms:

- The assumption of the maximum stresses occurring at the same location in a component, and
- The assumption that the maximum stresses for different modes occur at the same time.

Inclusion of these two significant conservatisms results in significantly higher calculated stresses.

3L.5.5.3 (Deleted)

3L.6 REFERENCES

3L-1 GE Hitachi Nuclear Energy, "Reactor Internals Flow Induced Vibration Program", NEDE-33259P-A, Revision 3, Class III (Proprietary), October 2010, and NEDO-33259-A, Revision 3, Class I (Non-proprietary), October 2010.

3L-2 General Electric Company, "BWR Steam Dryer Integrity", Service Information Letter (SIL) 644 Revision 2, August 30, 2006.

3L-3 ANSYS Engineering Analysis System User's Manual, see Table 3D.1-1 for the applicable revision.

3L-4 Elements of Vibration Analysis, Leonard Meirovitch, McGraw Hill Book Co., 1975.

3L-5 GE Hitachi Nuclear Energy, "Steam Dryer - Acoustic Load Definition," NEDE-33312P-A, Revision 2, Class III (Proprietary), October 2010, and NEDO-33312, Revision 2, Class I (Non-Proprietary), October 2010.

3L-6 GE Hitachi Nuclear Energy, "Steam Dryer - Structural Evaluation," NEDE-33313P-A, Revision 2, Class III (Proprietary), October 2010, and NEDO-33313, Revision 2, Class I (Non-Proprietary), October 2010.

3L-7 (Deleted)

3L-8 GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, " NEDC-33408P-A, Revision 1, Class III (Proprietary), October 2010, and NEDO-33408, Revision 1, Class I (Non-proprietary), October 2010.

~~3L-9 GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology Supplement 1," NEDC-33408, Supplement 1P-A, Revision 2, Class III (Proprietary), October 2010, and NEDO-33408, Supplement 1-A, Revision 2, Class I (Non-Proprietary), October 2010.~~