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"Design Evaluation of MNSA for Various Applications at

Calvert Cliffs Units 1 and 2"

WESTINGHOUSE NON-PROPRIETARY CLASS 3

ABB

ABB Combustion Engineering Nuclear Operations

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ENGINEERING REPORT

Design Evaluation of MNSA for Various Applications at Calvert Cliffs Units 1 & 2

Engineering Report Number B-NOME-ER-0133

Revision 00

ABB COMBUSTION ENGINEERING NUCLEAR POWER
Windsor, Connecticut

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The Safety-Related design information contained in this document has been verified to be correct by means of Design Review.

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1.0 INTRODUCTION

A Mechanical Nozzle Seal Assembly (MNSA) is a device designed for use on certain primary pressure boundary nozzles in a reactor system. These nozzles are attached to the pressurizer, steam generator or RCS pipe by a partial penetration ("J") weld on the inside of the vessel or pipe. The weld joins the inconel nozzle to the carbon steel vessel or pipe. This weld, in some applications, has been found to be susceptible to Primary Water Stress Corrosion Cracking (PWSCC) creating the possibility of a primary pressure boundary leak.

A MNSA is installed onto the nozzle that has a weld or nozzle deemed susceptible to PWSCC. MNSA replaces the two functions of the weld, 1) it forms a primary pressure boundary seal and, 2) it prevents the nozzle from ejecting in the event that either the weld should fail completely or that the nozzle develop a 360° crack.

ABB CENP performed successful qualification test programs for three MNSA (Mechanical Nozzle Seal Assembly) designs. The test program included a hydrostatic leak test (3175 ± 50 psi pressure at ambient conditions), three thermal cycle leak tests to 2500 psi at 650°F, and vibration testing which replicated the seismic spectrum for the San Onofre Nuclear Generating Station (SONGS) plants, Units 2 and 3, (see References 5.1.1 and 5.1.2). Each of the MNSA designs was subjected to the seismic test conditions with the system pressurized to a minimum of 3125 psi. No leakage occurred.

The three designs qualified as described above are:

- "Bottom Pressurizer" MNSA for the pressure tap nozzle on the bottom of the pressurizer, Reference 5.2.1.
- "Side Pressurizer RTD" MNSA for the RTD nozzle on the side of the pressurizer, Reference 5.2.2.
- "Hot Leg RTD" MNSA for the RTD nozzle on the hot leg pipes, Reference 5.2.3.

All MNSA configurations are designed and fabricated to Section III requirements of the ASME Boiler and Pressure Vessel Code.

Each Calvert Cliffs MNSA assembly is designated an appurtenance as defined by the ASME Boiler and Pressure Vessel Code (Code) and will be "stamped" in accordance with the Code. One of the requirements for Code stamping is a hydrostatic test to 1.25 times the appurtenance's design pressure, this test will be performed on each individual Calvert Cliffs MNSA assembly.

2.0 PURPOSE

The purpose of this report is to perform an engineering evaluation of the six MNSA designs intended for use at Calvert Cliffs. A comparison of these designs will be made to other qualified MNSA designs and a determination will be made whether the new designs can be deemed qualified without additional testing beyond the hydrostatic tests planned for each MNSA assembly

Six MNSA designs are intended for use at Calvert Cliffs as follows.

Design	MNSA Application	Reference Drawing
1	Hot Leg RTD Nozzle	5.2.4
2	Hot Leg PDT or Sampling Nozzle	5.2.5
3	Pressurizer Heater Sleeve Nozzle	5.2.6
4	Upper Pressurizer Instrument Nozzle	5.2.7
5	Side Pressurizer RTD Nozzle	5.2.8
6	Bottom Pressurizer Instrument Nozzle	5.2.9

3.0 RESULTS

The six Calvert Cliffs MNSA designs have been evaluated for two operating conditions, (1) normal static operation and (2) operability during and after a seismic event.

Normal Static Operation

For a failed nozzle with an installed MNSA, the MNSA is considered the primary pressure boundary seal. As such it is exposed to the pipe or vessel's operating temperature and pressure.

For static operating conditions, the applicable qualification test involved ambient hydrostatic testing, and thermal cycle testing to design operating and pressure conditions, for an RTD MNSA. This testing is described in Reference 5.1.1.

Seismic Conditions

The primary issue is to confirm that seismic loading on the six Calvert Cliff MNSA designs will not adversely effect the seal function. The function of the seal is preserved if the bolts that preload and capture the seal are not overloaded. Two approaches were used to evaluate this issue.

It is to be noted that the SONGS Bottom Pressurizer MNSA was subjected to vibration testing with an intensity that exceeded the San Onofre seismic spectra by a factor of five. The test was conducted with the system at a pressure of 3175 ± 50 psi, no leakage occurred. The seismic testing is described in Reference 5.1.2.

3.1 Evaluation of the six Calvert Cliffs MNSA designs for their ability to withstand normal static loading

3.1.1 Ambient temperature testing

Each MNSA assembly for Calvert Cliffs will be subjected to an ambient temperature hydrostatic test at a minimum of 3125 psi or 1.25 times its design pressure of 2500 psi. This test will verify the integrity of the assembly for normal static loading.

The test performed by ABB is more severe than that required for Code stamping because it also tests the functioning of the Grafoil seals used in the MNSA design when they are subjected to the dynamic loads imposed by a simulated nozzle ejection.

3.2.1 A calculation, Reference 5.3.1, was performed to determine the loading in the bolts created by a unit G load applied perpendicular to the nozzle centerline, through the Center of Gravity of the MNSA design. Calculation, Reference 5.3.3 was performed to determine the G loading in the hot leg pipe and pressurizer regions at Calvert Cliffs.

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3.2.2 The following evaluation compares the MNSA design configurations between Calvert Cliffs and the qualified MNSAs for external seismic loads. Table 4 below shows the bending moment created in the nozzle at San Onofre by the seismic loads imposed during testing. San Onofre has an essentially free standing 20 lb. valve mounted on the nozzle at a distance of 13.3 inches from the pressurizer surface. A comparison to the Calvert Cliffs MNSAs, shown in Table 5, will be made. Tables 4 and 5 evaluate the moment at the Calvert Cliffs MNSA to that created at the qualified Bottom Pressurizer MNSA. Although the pipe moment is analyzed below it is only used as a method to quantify the difference in the loading of the MNSA components at Calvert Cliffs compared to the design tested. The loading into the MNSA components would be proportional to the pipe moment.

Comparing the results in Tables 4 and 5 shows that the seismic loading experienced by the qualified Bottom Pressurizer MNSA is more severe than will be experienced by the Calvert Cliffs PDT or Sampling nozzle MNSA.

3.2.2.2 The seismic loading at the other nozzles where MNSA may be used was evaluated but Engineering judgement shows that their installed configurations prevent any significant loads from developing. An explanation for this conclusion is given for each of the other configurations below.

(1) Hot leg RTD nozzle

Each RTD location has only the RTD instrument itself installed, and some light cabling attached, there are no large valves in this system to create significant bending loads into the MNSA.

(2) Bottom, and Upper Pressurizer nozzle

As shown on References 5.4.6 for Unit 1 and 5.4.7 for Unit 2, the valves connecting to these nozzles are not mounted in line but are at right angles to the nozzles. There are supports in the system which prevent the weight of the valves from applying bending moments into the nozzles due to seismic loading.

(3) Side Pressurizer RTD nozzle

As stated for number (1) above.

(4) Heater Sleeve nozzles

This system, like the RTD system, has no heavy valves mounted in line with the nozzles. There is the weight of the heater itself in the nozzle but as can be seen by inspection from Reference 5.2.10 it a small item compared to the large valves used in the other applications.

the San Onofre seismic spectra. The MNSA maintained its structural integrity and did not leak even after this severe load.

4.0 CONCLUSION

5.0 REFERENCES

5.1 ABB CENP Test Reports

5.1.1 "Test Report for MNSA Hydrostatic and Thermal Cycle Tests", Test Report Number TR-PENG-042, Revision 00.

5.1.2 "Test Report- Seismic Qualification of the San Onofre, Units 2 and 3 MNSA Clamps for Pressurizer Instrument Nozzles and RTD Hot Leg Nozzles", Test Report Number TR-PENG-033, Revision 00.

5.2 ABB CENP Drawings

5.2.1 E-MNSA-228-001, Revision 02, "Bottom Pressurizer Mechanical Nozzle Seal Assembly".

5.2.2 E-MNSA-228-002, Revision 02, "Side Presssurizer RTD Mechanical Nozzle Seal Assembly".

5.2.3 E-MNSA-228-003, Revision 05, "Hot Leg RTD Sampling MNSA".

5.2.4 E- MNSABGE -228-001, Revision 02, "Hot Leg RTD Mechanical Nozzle Seal Assembly".

5.2.5 E- MNSABGE -228-002, Revision 02, "Hot Leg PDT/Sampling MNSA".

5.2.6 E- MNSABGE -228-003, Revision 02, "Heater Sleeve Mechanical Nozzle Seal Assembly".

5.2.7 E- MNSABGE -228-005, Revision 02, Upper Pressurizer Mechanical Nozzle Seal Assembly".

5.2.8 E- MNSABGE -228-006, Revision 02, Side Pressurizer RTD Mechanical Nozzle Seal Assembly".

5.2.9 E- MNSABGE -228-007, Revision 02, Bottom Pressurizer Mechanical Nozzle Seal Assembly".

5.2.10 E-233-479, Revision 5, "Heater Arrangement and Details"

5.2.11 E-232-634, Revision 7, "Nozzle Details"

5.2.12 E-232-637, Revision 4, "Internals Details"

5.2.13 E-233-586, Revision 6, "Nozzle Details"

5.2.14 E-233-585, Revision 6, "Nozzle Details"

5.3 ABB CENP Calculations

5.3.1 "Calculation of Vertical Pull-Out Loads Due to Seismic Loading of 1G for Calvert Cliffs Units 1 &2 ", Calculation Number B1-NOME-CALC-0119, Revision 00.

5.3.2 "Nozzle Loads for which SONGS Bottom Mounted PZR MNSA was Qualified", Calculation Number S-PENG-CALC-008, Revision 00.

5.3.3 "Analysis of BGE Hot Leg and Pressurizer MNSAs Seismic Acceleration", Calculation Number B-PENG-CALC- 022, Revision 00.

5.3.4 Design Report Number B-PENG-DR-006, Revision 00 "Addendum to CENC-1187, Analytical Report for Baltimore Gas And Electric Calvert Cliffs Station, Units I and II Pressurizers.

5.3.5 "Seismic Qualification of Steam Generator PDT, Hot Leg PDT and Hot Leg Sampling MNSA Hardware, Calculation Number S2-NOME-CALC-0085, Revision 00.

5.4 Calvert Cliffs Supplied Drawings

5.4.1 "CC-9, PDT – Root Valve Details for Reactor Primary Lines to Steam Generator #21 and #22", Drawing Number FSK/MP 3120, Revision 6.

5.4.2 "Rockwell – Edward Hermavalve", 12847-0062, Revision 00.

5.4.3 "CC-9, PDT – Root Valve Details for Reactor Primary Lines to Steam Generator # 11 and # 12", Drawing Number FSK-MP-879, Revision 9.

5.4.4 "CC-8 & CC-16 – Nuclear, Sample Conn's Off Surge Line & Primary Loop", Drawing Number FSK-MP-3191, Revision 7.

5.4.5 "CC-16 – Sample Conn's Off Surge Line & Primary Loop", Drawing Number FSK-MP-910, Revision 7.

5.4.6 "CC-2 – Instrument Conn. Trim on Pressurizer No.11", Drawing Number FSK-MP-933, Revision 15.

5.4.7 " Instrument Conn. Trim on Pressurizer No.21", (Scanned from) Drawing Number FSK-MP-3195, Revision 6.

5.4.8 "Upper Instrument Nozzles 96 I.D. Pressurizer", Drawing Number 12019 – 0036, Revision 3.

Figure 1

Basic MNSA Configuration