

September 18, 2014

Mr. Dong Soo Lee, General Manager  
Quality Assurance  
Doosan Heavy Industries and Construction  
555 Gwigok-Dong, Changwon  
Gyeongnam 641-792  
Korea

SUBJECT: NUCLEAR REGULATORY COMMISSION INSPECTION REPORT OF DOOSAN  
HEAVY INDUSTRIES AND CONSTRUCTION QUALITY ASSURANCE  
PROGRAM IMPLEMENTATION NO. 99901373/2014-201

Dear Mr. Lee:

On July 28 through August 1, 2014, U.S. Nuclear Regulatory Commission (NRC) staff conducted an inspection at the Doosan Heavy Industries & Construction (Doosan) facility in Changwon, South Korea. The purpose of the inspection was to assess Doosan's compliance with the provisions of selected portions of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 21, "Reporting of Defects and Noncompliance."

This limited-scope inspection evaluated that Doosan's fabrication activities associated with reactor coolant pump casings, steam generators, reactor vessels, and reactor vessel closure heads for the Westinghouse Electric Company (WEC) AP1000 reactor design were effectively implemented and meet the applicable requirements of Appendix B, and Section III, "Rules for Construction of Nuclear Facility Components," of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code.

This inspection specifically evaluated Doosan's implementation of fabrication activities for the reactor coolant pump casings for VC Summer Unit 2, the reactor pressure vessel and reactor pressure vessel closure head for VC Summer Unit 3 and steam generators for VC Summer Unit 2 and Unit 3. This inspection also verified corrective actions related to the Vogtle Unit 3 reactor vessel nozzle to safe-end welding issues described in NRC Information Notice (IN) 2013-21, "Welding Problems during Fabrication of Reactor Plant Components." The enclosed report presents the results of the inspection. This NRC inspection report does not constitute NRC endorsement of Doosan's overall quality assurance (QA) program.

During this inspection, the NRC inspection team reviewed documentation and controls related to fabrication activities associated with inspections, tests, analyses, and acceptance criteria (ITAAC) from Revision 19 of the WEC certified AP1000 Design Control Document (DCD), Tier 1. Specifically, these activities were associated with ITAAC 2.1.02.02a, 2.1.02.03a, 2.1.03.03, and 2.1.03.04 for welding and nondestructive examination in accordance with the requirements of Section III of the ASME BPV code. The NRC inspection team did not identify any findings associated with the ITAAC contained in Section 4 of the attachment to this report.

Based on the results of this inspection, the NRC inspection team concluded that Doosan met all program requirements, and the team did not identify any violations or nonconformances within the scope of the inspection.

In accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding," of the NRC's "Rules of Practice," the NRC will make available electronically for public inspection a copy of this letter, its enclosure, and your response through the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), which is accessible at <http://www.nrc.gov/reading-rm/adams.html>.

Sincerely,

Edward H. Roach, Chief */RA/*  
Mechanical Vendor Inspection Branch  
Division of Construction Inspection  
and Operational Programs  
Office of New Reactors

Docket No.: 99901373

Enclosures:

1. Inspection Report No. 99901373/2014-201  
and Attachment

D. Lee

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Based on the results of this inspection, the NRC inspection team concluded that Doosan met all program requirements, and the team did not identify any violations or nonconformances within the scope of the inspection.

In accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding," of the NRC's "Rules of Practice," the NRC will make available electronically for public inspection a copy of this letter, its enclosure, and your response through the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), which is accessible at <http://www.nrc.gov/reading-rm/adams.html>.

Sincerely,

Edward H. Roach, Chief **/RA/**  
Mechanical Vendor Inspection Branch  
Division of Construction Inspection  
and Operational Programs  
Office of New Reactors

Docket No.: 99901373

Enclosures:

- 1. Inspection Report No. 99901373/2014-201  
and Attachment

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**U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF NEW REACTORS  
DIVISION OF CONSTRUCTION INSPECTION AND OPERATIONAL PROGRAMS  
VENDOR INSPECTION REPORT**

Docket No.: 99901373

Report No.: 99901373/2014-201

Vendor: Doosan Heavy Industries and Construction  
555 Gwigok-Dong, Changwon  
Gyeongnam 641-792  
Korea

Vendor Contact: Mr. Dong Soo Lee  
General Manager, Quality Assurance Team  
[ds.lee@Doosan.com](mailto:ds.lee@Doosan.com)

Nuclear Industry Activity: Doosan is one of the largest manufacturers of reactor vessels, steam generators, reactor internals, and balance of plant components for the nuclear industry worldwide. Doosan provides components to the current US fleet of nuclear reactors as replacement components and has been selected as the primary manufacturer of large components for the AP1000 reactors to be built in the United States.

Inspection Dates: July 28 – August 1, 2014

Inspection Team: Richard P. McIntyre NRO/DCIP/MVIB, Inspection Lead  
Kerri Kavanagh NRO/DCIP/QVIB  
Jonathan Ortega NRO/DCIP/MVIB  
John Honcharik NRO/DE/MCB, Technical Specialist  
Alain Artayet R-II/DCI/CIB3

Approved by: Edward H. Roach, Chief  
Mechanical Vendor Inspection Branch  
Division of Construction Inspection  
and Operational Programs  
Office of New Reactors

Enclosure

## **EXECUTIVE SUMMARY**

Doosan Heavy Industries and Construction  
99901373/2014-201

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a vendor inspection at the Doosan Heavy Industries & Construction (Doosan) facilities in Changwon, South Korea, to verify that it had implemented an adequate quality-assurance (QA) program that complies with the requirements of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities." In addition, the NRC inspection team also verified that Doosan had implemented a program under 10 CFR Part 21, "Reporting of Defects and Noncompliance," and Section III, "Rules for Construction of Nuclear Facility Components," of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code, that met the NRC's regulatory requirements. The NRC inspection team conducted the inspection from July 28 through August 1, 2014.

This was the fourth NRC inspection of Doosan's implementation quality activities. The NRC performed inspections in 2008 and 2009, and participated in a joint inspection led by the Korea Institute of Nuclear Safety (KINS) in 2011. Previous inspections identified findings related to 10 CFR Part 21, commercial grade dedication, qualification of suppliers, and corrective action. This inspection also verified Doosan took appropriate corrective actions to address a 2009 NRC Inspection Report Nonconformance finding.

Three individuals from the KINS observed this inspection. These observations foster the sharing of international experiences with the construction of new reactors, oversight of vendors, and modular construction techniques consistent with the objectives of the Multinational Design Evaluation Program.

This inspection specifically evaluated Doosan's implementation of quality activities associated with the fabrication for reactor coolant pump casings, steam generators, reactor vessels, and reactor vessel closure heads for the Westinghouse Electric Company (WEC) AP1000 reactor design. These activities were specific to the VC Summer Units 2 and 3 and Vogtle Unit 3 plants. This inspection also verified corrective actions related to the Vogtle Unit 3 reactor vessel nozzle to safe-end weld issues described in Information Notice (IN) 2013-21.

These regulations served as the bases for the NRC inspection:

- Appendix B to 10 CFR Part 50
- 10 CFR Part 21

During the course of this inspection, the NRC inspection team implemented Inspection Procedure (IP) 43002, "Routine Inspections of Nuclear Vendors," dated July 15, 2013; IP 36100, "Inspection of 10 CFR Part 21 and Programs for Reporting Defects and Noncompliance," dated February 13, 2012; IP 65001.B, "Inspection of the ITAAC-related Welding Program," dated September 25, 2013; and IP 65001.F, "Inspection of ITAAC-related Design and Fabrication requirements," dated September 20, 2013.

Some of the specific activities observed by the NRC inspection team included the following VC Summer fabrication activities.

- Welding for the Unit 2 reactor cooling pump (RCP) casings to the primary outlet nozzles of both steam generators;
- Review of postweld heat treatment (PWHT) strip charts of the Unit 3 reactor vessel (RV) upper and lower shells;
- Welding of the Unit 3 RV direct vessel injection (DVI) nozzle B to the safe-end;
- Calibration of welding machines and digital thermometer with thermocouple probe;
- Nondestructive examination (NDE) Liquid penetrant examination (NDE-PT) of the Unit 3 steam generator 3B primary inlet nozzle safe-end; and
- Final weld radiographic examination (NDE-RT) records and films for the Unit 3 RV DVI nozzle A to safe-end, and inlet nozzles B and C to safe-ends.

In addition to observing these activities, the NRC inspection team verified that measuring and test equipment (M&TE) was properly identified, marked, calibrated, and used within its calibrated range. The inspectors also walked down Doosan's assembly floor areas and verified that nonconforming components were properly identified, marked, and segregated when practical, to ensure that they were not reintroduced into the manufacturing processes.

The NRC inspection team determined that, in general, the fabrication activities that Doosan performed in support of safety-related reactor coolant pump casings, steam generators, reactor vessels, and reactor vessel closure heads were performed in accordance with the Commission's rules and regulations and the technical and quality requirements passed down to Doosan from NRC licensees or its contractors. The information below summarizes the results of this inspection.

#### 2012 Reactor Vessel Nozzle to Safe-end Weld Corrective Action

The inspection team verified implementation of corrective actions related to previous fabrication issues at Doosan in 2012 associated with the Vogtle Unit 3 reactor vessel nozzle to safe-end welds as described in Information Notice (IN) 2013-21. The primary cause for these fabrication issues in 2012 was loss of weld shielding gas during welding operations due to the ventilation configuration in the vicinity of welding. The inspectors verified implementation of the proposed corrective actions that included revising procedures to better control ventilation configurations to ensure that the correct weld shielding gas is maintained, repairing the welds by excavating the defects from the inside diameter, and adding angle beam ultrasonic testing (UT) of nozzle buttering area.

The inspectors reviewed the new work instruction AP-1000RV-W1009, and found that the corrective actions were applied properly by including information about controlling ventilation to ensure that the correct weld shielding gas is maintained, and revised the UT Procedure for examining the buttering of the dissimilar metal welds.

### Other Inspection Areas

The NRC inspection team determined that Doosan is implementing its programs for 10 CFR Part 21, control of special processes such as welding, nondestructive examination (NDE) and postweld heat treatment, control of measuring and testing equipment, oversight of suppliers, procurement document control, nonconformance control, corrective actions, and training in accordance with the applicable regulatory requirements of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed and activities observed, the NRC inspection team also determined that Doosan is implementing its policies and procedures associated with these programs.

As a result of this inspection, Doosan generated three quality assurance Issue Reports (IRs) to address concerns of low significance identified by the NRC inspection team that did not meet the threshold of more than minor concerns as defined by Inspection Manual Chapter 0617, "Vendor and Quality Assurance Implementation Inspection Reports."

No findings of significance were identified.

## REPORT DETAILS

### 1. 10 CFR Part 21 Program

#### a. Inspection Scope

The NRC inspection team reviewed Doosan Heavy Industries and Construction's (Doosan) policies and implementing procedures that govern its Title 10 of the Code of Federal Regulations (10 CFR) Part 21, "Reporting of Defects and Noncompliance," program to verify that the requirements had been effectively implemented for evaluating deviations and failures to comply. The inspectors reviewed Doosan's procedures that govern corrective actions, the control and correction of nonconforming items, as well as interviewed quality assurance staff and engineers, to verify an adequate and direct connection to the 10 CFR Part 21 program, and compliance with regulatory requirements. Additionally, the inspectors reviewed and evaluated postings for compliance with 10 CFR 21.6, "Posting Requirements."

The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

#### b. Observations and Findings

No findings of significance were identified.

#### c. Conclusion

The NRC inspection team determined that the implementation of Doosan's program for 10 CFR Part 21 was consistent with the regulatory requirements of 10 CFR Part 21. No findings of significance were identified.

### 2. Control of Special Processes

#### a. Inspection Scope

The NRC inspection team reviewed Doosan policies and implementing procedures that govern the control of special processes to verify compliance with the regulatory requirements of Criterion IX, "Control of Special Processes," of Appendix B to 10 CFR Part 50. Specifically, for welding and heat treatment activities, the NRC inspection team reviewed shop travelers, weld procedure specifications (WPS), supporting procedure qualification records (PQR), heat treatment procedures, welding operator qualifications, and the calibration certificates of the measuring equipment. For nondestructive examination (NDE), the NRC inspection team reviewed liquid penetrant testing (PT) procedures, PT reports, PT examiner qualifications, radiographic (RT) procedures, ultrasonic Testing (UT) procedures, and UT Level III inspector qualifications. The NRC inspection team also reviewed the calibration certificates of the measuring equipment related to these NDE activities.



Some of the specific activities observed by the NRC inspection team included the following VC Summer fabrication activities.

- Welding for the Unit 2 reactor cooling pump (RCP) casings to the primary outlet nozzles of both steam generators;
- Review of postweld heat treatment (PWHT) strip charts of the Unit 3 reactor vessel (RV) upper and lower shells;
- Welding of the Unit 3 RV direct vessel injection (DVI) nozzle B to the safe-end;
- Calibration of welding machines and digital thermometer with thermocouple probe;
- Liquid penetrant examination (NDE-PT) of the Unit 3 steam generator (SG) 3B primary inlet nozzle safe-end; and
- Final weld radiographic examination (NDE-RT) records and films for the Unit 3 RV DVI nozzle A to safe-end, and inlet nozzles B and C to safe-ends.

These activities were associated with inspections, tests, analyses, and acceptance criteria (ITAAC) 2.1.02.02a, 2.1.02.03a, 2.1.03.03, and 2.1.03.04 related to welding fabrication and NDE in accordance with the requirements of the 1998 Edition including 2000 Addenda of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NB, Class 1 Components.

b. Observations and Findings

b.1 Welding Process

At the time of the inspection, Doosan was fabricating the AP1000 reactor vessel for VC Summer Unit 3 and AP1000 SG for VC Summer Units 2 and 3 and Vogtle Units 3 and 4. The NRC inspection team witnessed mechanized gas tungsten arc welding (GTAW) welding for VC Summer Unit 3 RV nozzle to safe-end (weld joint number 401-20B) for the DVI nozzle B and VC Summer 2 SG primary outlet nozzle to RCP casing welds for SG A (weld joints 201-96A and 201-96B) and SG B (weld joints 201-96A and 201-96B). The NRC inspection team verified that the WPS AT-0843-129, Revision 4, and WPS AT-0843-147, Revision 3, were qualified in accordance with the requirements of ASME Code, Sections III and IX using the supporting PQRs and the applicable Doosan procedures.

The NRC inspection team verified that the applicable welding data; such as weld material and heat/lot number, WPS, inspection procedures used, and that the final inspection results were recorded in accordance with the applicable Doosan procedures and instructions. The NRC inspection team reviewed two weld travelers 101220200 for RCP-B casing weld to SG-A and 101220201 for RCP-A casing weld to SG-B and also observed the control of welding parameters for the mechanized narrow-groove gas GTAW process of the RCP casing to the SG outlet nozzles. The NRC inspection team determined that the traceability of weld

filler materials and welding operators, adherence to quality control (QC) and authorized nuclear inspector (ANI) inspection hold points, and the control of welding were in accordance with the requirements of ASME Section III and recorded on the associated weld log for each weld joint along with the applicable NDE results.

The NRC inspection team also reviewed PWHT strip charts for the upper and lower shells (Serial Nos. F08697-030 and F09157-050, respectively) for the VC Summer Unit 3 RV. The NRC inspection team determined that the heating and cooling rates, and hold time and temperature were in accordance with the requirements of ASME Section III.

The NRC inspection team reviewed calibration records for two orbital welding machines (Nos. WY153 and WY136) and a digital thermometer with Type K thermocouple surface probe used for welding the RCP casings to the SG outlet nozzles. The NRC inspection team determined that the equipment were within the allowable ranges in accordance with the requirements of the Doosan calibration procedures with referenced standards of the National Institute of Standards and Technology (NIST).

## b.2 Welding Corrective Actions

### Vogtle Unit 3 Reactor Vessel Nozzle to Safe-end Welds

The NRC inspection team reviewed corrective actions related to 2012 fabrication issues associated with the Vogtle Unit 3 RV nozzle to safe-end welds that were described as part of NRC Information Notice (IN) 2013-21, which resulted in corrective actions being taken to ensure consistent quality welds. The primary cause for these fabrication issues in 2012 was identified as a loss of weld shielding gas during welding operations due to the ventilation configuration in the vicinity of the welding. Proposed corrective actions included revising procedures to better control ventilation configurations to ensure that the correct weld shielding gas is maintained, repairing the welds by excavating the defects from the inside diameter, and adding angle beam ultrasonic testing of the nozzle buttering area.

To verify the implementation of the 2012 corrective action, the NRC inspection team observed current welding using WPS AT-0843-129, revision 4, on the VC Summer 3 Unit RV nozzle to safe-end (weld joint number 401-20B) for the DVI nozzle B. The work package included work instruction AP-1000RV-W1009, Revision 2, which is specifically for welding the RV nozzle to safe-end welds. The NRC inspection team reviewed the work instruction and found that the corrective actions were applied properly and the work instructions included information about controlling ventilation to ensure that the correct weld shielding gas is maintained, and added the angle beam UT examination method of UT procedure EPAU-1105, Revision 0 for examining the buttering of the dissimilar metal welds.

### VC Summer Unit 3 Reactor Vessel Nozzle to Safe-end Welds

During observation of the VC Summer Unit 3 DVI nozzle B welding, the NRC inspection team discovered that the VC Summer 3 RV inlet nozzles A, B, and C to safe-end welds and the outlet nozzle B to safe-end weld were previously welded, but the welds were removed by machining due to the identification of numerous defects during NDE. The NRC inspection team noted that these welds were completely removed and re-welded, which is the preferred method. Weld repairs initiated from the piping inside diameter in contact with reactor coolant, may introduce residual tensile stresses on the surface of the weld in contact with reactor coolant. This can potentially contribute to weld degradation mechanisms such as primary water stress-corrosion cracking (PWSCC) as stated in NRC IN 2013-21. Doosan generated nonconformance report (NCR) 14100283 and NCR 14100324 for these nonconforming conditions discovered in 2014. The NRC inspection team reviewed these NCRs along with the associated corrective action report (CAR) 1401841. The root cause analysis dated May 16, 2014, determined that the cause was the absence of the gas diffuser screen in the gas cup of the welding machines. The proposed corrective action was to issue a checklist to verify the presence of the diffuser screen prior to welding. The corrective action was reviewed by the NRC inspection team and found to be properly implemented by requiring a procedure checklist which is signed by the welding operator and also implementing a pre-job briefing that includes details for verifying that the gas diffuser screen is in gas cup, prior to welding. During inspection of the welding activities for the VC Summer Unit 3 RV DVI nozzle B to the safe-end, the NRC inspection team verified that the gas diffuser screen was in position in gas cup of the welding machine.

### VC Summer Unit 2 Steam Generator Primary Outlet Nozzle to Reactor Coolant Pump Casing Welds

The NRC inspection team reviewed welding procedure, AT-0843-147, Revision 3, for the VC Summer Unit 2 SG primary outlet nozzle to RCP casing welds for SG A (weld joints 201-96A and 201-96B) and SG B (weld joints 201-96A and 201-96B). During review of the weld traveler number 101220200, the NRC inspection team noticed that these welds were repaired previously for porosity found during radiographic examination. Doosan generated NCR 14100144 for this nonconforming condition and the referenced CAR 140097 for additional corrective actions. CAR 140097 documented radiographic indications found on the VC Summer Unit 2 and Vogtle Unit 3 RCP casing UT calibration block mockup fabricated using the same welding procedure, AT-0843-147, Revision 3. The common cause failure based on a root cause analysis, dated May 14, 2014, identified the absence of the gas diffuser screen in the gas cup of the welding machines. The NRC inspection team noted that the welds for the SG primary nozzle to RCP casing and the RV to safe-end were all welded in the same time period between 2013 and 2014. The indications were not realized until Doosan completed the radiographic examination of the VC Summer Unit 2 and Vogtle Unit 3 RCP casing UT calibration block mock-up. The NRC inspection team reviewed Doosan's corrective action and found it to be properly implemented

through the procedure checklist which is signed by the welding operator and a pre-job briefing that included details of verifying the gas diffuser screen prior to welding.

The NRC inspection team also noted that since the inspection of the welds was not performed as each weld was completed; the common cause failure was not discovered by Doosan until numerous welds were fabricated. This resulted in a missed opportunity to identify the failure mode and perform trending in the corrective action process. This missed opportunity resulted in multiple welds being reworked for the same common cause failure of not having a diffuser screen in the gas cup of the welding machine.

b.3 Nondestructive Examination

The NRC inspection team evaluated PT inspections of the VC Summer Unit 3B SG in accordance with the applicable Doosan procedures. The NRC inspection team witnessed PT inspections of the SG 3B primary inlet nozzle safe-end Part-No. 55-101 of SA336-F316LN stainless steel on weld traveler No. 101202950. The inspector verified that the examinations were performed in accordance with Doosan Procedure EPAP1101 and were performed by qualified personnel and qualified procedures in accordance with the requirements of ASME Code, Sections III and V and American Society for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing," 1992 Edition.

The NRC inspection team reviewed three radiographic examination reports and films for the RV weld joints 401-20A for the DVI nozzle to safe-end, and joints 201-20B and 201-20C for the upper shell inlet nozzles to safe-ends. The NRC inspection team determined that the hole-type Image Quality Indicator (IQI), film density in the area of interest using a calibrated densitometer, and weld identification and radiograph location markings were performed in accordance with the requirements of ASME Section V, Article 2, Radiographic Examination.

b.4 Qualification and Training of Welding and Nondestructive Testing Personnel

The NRC inspection team reviewed the associated welding operator qualification records and confirmed that the welding operators had completed the required training and had maintained their qualifications in accordance with Doosan procedures. The NRC inspection team also verified that the applicable procedure for welding operator qualification meets the requirements of ASME Code, Sections III and IX. The NRC inspection team reviewed the Doosan procedures for PT, RT and UT inspections, and verified that they were consistent with the applicable code requirements. The NRC inspection team also reviewed the Level II non-destructive inspector qualification records and confirmed they were qualified in accordance with the requirements in ASNT SNT-TC-1A and had sufficient training and previous inspection experience.

The NRC inspection team also reviewed procedure QCP-0204, and the qualifications and certifications of the Principal Level III for NDE-RT, UT, magnetic particle (MT), and PT, (including annual examinations for near-vision acuity, and gray and color contrast differentiation). The NRC inspection team determined that the procedures and personnel qualifications and certifications were in accordance with the 1992 Edition of the ASNT SNT-TC-1A.

c. Conclusion

The NRC inspection team concluded that Doosan is implementing its process to control the use of special processes in accordance with the regulatory requirements of Criterion IX of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed and interviews conducted, the NRC inspection team also determined that Doosan is adequately implementing a special process control program. No findings of significance were identified.

3. Oversight of Contracted Activities

a. Inspection Scope

The NRC inspection team reviewed Doosan policies and implementing procedures that govern the implementation of its oversight of contracted activities to verify compliance with the requirements of Criterion IV, "Procurement Document Control," and Criterion VII, "Control of Purchased Material, Equipment, and Services" of Appendix B to 10 CFR Part 50.

The NRC inspection team reviewed a sample of safety-related purchase orders (POs), material specifications, and certified material test reports (CMTRs) for U.S. projects to verify that specific procurement requirements were met and documented correctly. The NRC inspection team also verified that the POs included, as applicable, scope of work, right of access to facilities and records for source inspections and audits, reporting and approving disposition of nonconformances, and references to specific drawings, codes, and specifications. In addition, the NRC inspection team confirmed that all of the safety-related POs reviewed included clauses that invoke the provisions of 10 CFR Part 21 and that required the supplier to conduct safety-related work under its approved QA program. The NRC inspection team also reviewed Doosan's processes and management of their supplier database and its interfaces with generating supplier limitations and capabilities on their Approved Vendors List (AVL) and POs. A list of POs sampled is included at the end of this report.

The NRC inspection team reviewed a sample of external supplier survey and supplier audit reports, and the qualifications of the lead auditors and auditors to evaluate compliance with Doosan program and technical requirements. The NRC inspection team also reviewed the disposition of audit findings for adequacy and timeliness. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observations and Findings

No findings of significance were identified.

c. Conclusion

The NRC inspection team determined that Doosan is implementing its programs for Criteria IV and VII in accordance with the applicable regulatory requirements of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team also determined that Doosan is implementing its policies and procedures associated with these programs.

4. Material Traceability

a. Inspection Scope

The NRC inspection team reviewed Doosan's policies and implementing procedures that govern material traceability to verify compliance with the regulatory requirements of Criterion VIII, "Identification and Control of Material, Parts, and Components," of Appendix B to 10 CFR Part 50.

The NRC inspection team observed that all materials were marked with unique identifiers traceable to procurement records. For a sample selected, the NRC inspection team observed that identification markings were: (1) traceable to design and shop drawings, (2) carried and remained legible through the manufacturing process, and (3) applied using materials and methods that provided a clear and legible identification and did not adversely affect the function or service life of structure systems or components observed.

The NRC inspection team discussed the material traceability program with Doosan's management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observations and Findings

No findings of significance were identified.

c. Conclusions

The NRC inspection team concluded that Doosan is implementing its material traceability program in accordance with the regulatory requirements of Criterion VIII of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team also determined that Doosan is implementing its policies and procedures associated with the material traceability program.

5. Control of Measuring and Test Equipment

a. Inspection Scope

The NRC inspection team reviewed Doosan policies and implementing procedures that govern the measuring and test Equipment (M&TE) program to verify compliance with the requirements of Criterion XII, "Control of Measuring and Test Equipment," of Appendix B to 10 CFR Part 50. The NRC inspection team reviewed a sample of calibration records for various M&TE. The NRC inspection team additionally verified that the M&TE program ensured that devices used in activities affecting quality were of the proper range, type, and accuracy to verify conformance to established requirements.

The NRC inspection team also verified that when M&TE equipment is found to be out of calibration, Doosan generates a NCR to identify items that have been accepted using this equipment since the last valid calibration date and to perform an extent-of-condition review. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observations and Findings

No findings of significance were identified.

c. Conclusion

The NRC inspection team concluded that Doosan is implementing its M&TE program in accordance with the regulatory requirements of Criterion XII of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team also determined that Doosan is implementing its policies and procedures associated with the M&TE program. No findings of significance were identified.

6. Nonconforming Materials, Parts, or Components

a. Inspection Scope

The NRC inspection team reviewed policies and implementing procedures that govern the control of nonconforming materials, parts, and components to verify compliance with Criterion XV, "Nonconforming Materials, Parts, or Components," of Appendix B to 10 CFR Part 50. The NRC inspection team verified that Doosan's processes and procedures include the identification, documentation, segregation, evaluation, and disposition of nonconforming items. These processes also apply the categories of "repair," "rework," "reject," or "use-as-is" and list the applicable justifications that will be adequately supported and properly documented.

The NRC inspection team verified that Doosan's nonconformance process provides a link to the 10 CFR Part 21 program. In addition, the NRC inspection

team reviewed a sample of NCRs and nonconforming items on the shop floor to verify implementation of Doosan's nonconformance program.

b. Observations and Findings

During the review of Doosan NCRs, the NRC inspection team found that the recommended disposition documented in NCR-14100110 for "use-as-is," did not provide an adequate technical justification to properly disposition the nonconformance. Doosan had generated NCR-14100110 to document a deviation from Westinghouse Electric Company (WEC) Process Specification, APP-MB01-VW-021, "Additional Requirements for AP1000 Steam Generator Welding Consumables." This document required the performance of tensile tests in the as-welded and PWHT conditions for stainless steel welding materials for Vogtle Units 3 and 4, and Summer Units 2 and 3 SGs. However, ASME Section III NB-2431 "Mechanical Properties Test," for welding materials only requires tensile tests in the as-welded condition. The NRC inspection team questioned Doosan about the lack of engineering justification for their disposition of the nonconformance for only performing the tensile test in the as-welded condition. Doosan explained that they cannot meet the additional WEC specification requirements, which has become a recurring nonconformance.

Doosan documented this issue in CAR 140044. The tensile test deviation was first documented in NCR-111113 and NCR-111114 back in December 2011 for the Vogtle Units 3 and 4 and VC Summer Units 2 and 3 RV closure heads. In 2012, Doosan revised several WPSs to incorporate these additional specification requirements imposed by WEC. However, during the use of the WPSs, Doosan explained that the weld material used and stocked before the additional requirements were imposed by WEC, could not meet the new requirements and as a result the deviation was documented in NCRs- 111113 and 111114. The Doosan NCRs were submitted to WEC for disposition and WEC recommended disposition of the nonconformance as "use-as-is." The WEC justification was based on that the fact that these additional requirements are a conservative approach that are not required by ASME Section III NB-2430 (1998 Edition and 2000 Addendum is the applicable code year for the AP1000 steam generators). Therefore, WEC concluded that the Vogtle Unit 3 and 4 steam generators, which had already used this weld material, met ASME code requirements and should be used in an "as-is" condition. WEC provided the same recommendation and justification to disposition the nonconformance as "use-as-is" for NCR-14100110, as they had previously done for NCR-111113 and NCR-111114.

Since these additional requirements were beyond the ASME Code requirements and are only a conservative approach to add more consistency between components; are not a design requirement as documented in NCR-111113 and NCR-111114; Doosan submitted an engineering and design change request (E&DCR) to Westinghouse requesting to delete the additional tensile test requirements of the stainless steel material after PWHT and to correct the discrepancies among these specification requirements in order to meet the design requirements for future welding. After the E&DCR was rejected, Doosan



conducted a study and prepared a technical report to demonstrate that certain additional specification requirements imposed by Westinghouse could not be met.

At the time of the inspection the additional tensile testing requirements after PWHT remained in place and Doosan has continued procurement and fabrication for AP1000 projects. Doosan has continued to generate NCRs for this issue, which were then dispositioned as “use-as-is” by WEC without providing adequate justification for Doosan not meeting these additional specification requirements as it relates to the applicable design.

During the inspection, the NRC inspection team discussed this issue with both Doosan and the WEC Doosan on-site resident inspector to understand the rationale for this method of NCR disposition. WEC indicated that they are going to perform an engineering design change evaluation and issue an engineering design change notice to clarify the specification and remove the additional specification requirements. At the conclusion of the inspection, Doosan had not received the proposed design change notice from WEC. Therefore, this issue is identified as Unresolved Item 99901373/2014-201, pending NRC review of the completed Doosan evaluation.

c. Conclusion

The NRC inspection team concluded that Doosan is implementing its nonconforming material, parts, or components program in accordance with Criterion XV of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team also determined that Doosan is implementing its policies and procedures associated with its nonconforming material, parts, and components. No findings of significance were identified. However, Unresolved Item 99901373/2014-201-01 was issued related to the Doosan disposition of certain NCRs as “use-as-is” without an adequate documented technical justification.

7. Corrective Actions

a. Inspection Scope

The NRC inspection team reviewed the current status of the corrective actions implemented in response to the findings from the 2009 NRC inspection at Doosan. In addition, the NRC inspection team verified the root cause analysis and corrective actions related to the Vogtle Unit 3 RV nozzle weld issues described in Information Notice (IN) 2013-21.

The NRC inspection team also reviewed Doosan’s policies and implementing procedures that govern the corrective action program to verify compliance with the requirements of Criterion XVI, “Corrective Action,” of Appendix B to 10 CFR Part 50. The NRC inspection team reviewed a sample of CARs and verified that (1) the CARs’ disposition and control provide adequate documentation and description of conditions adverse to quality, and (2) the CARs specify the cause

of these conditions and the corrective actions to prevent recurrence. In addition, the NRC inspection team discussed the corrective action program with Doosan's management and technical staff.

b. Observations and Findings

b.1 Vogtle Unit 3 Reactor Vessel Nozzle to Safe-end Weld Issues

The NRC inspection team evaluation of the corrective action and verification of its implementation by Doosan are documented under the section of Control of Special Processes. Please refer to section 2.b.b.2 of this report.

b.2 Corrective Action Associated with Nonconformance 99901373/2009-201-01

During the 2009 NRC inspection the NRC inspection team issued Nonconformance (NON) 99901373/2009-201-01 for failure to determine the cause of the condition and prevent reoccurrence of a significant condition adverse to quality. The NRC inspection team concluded that Doosan's procedure for performing root cause analyses was inadequate. With the exception of the above noted nonconformance, the NRC inspection team determined that Doosan's corrective action program was consistent with the regulatory requirements of Criterion XVI "Corrective Action," of Appendix B to 10 CFR Part 50.

During the review of Doosan's corrective action for NON 99901373/2009-201-01, the NRC inspection team found that Doosan had not entered the NON in their corrective action program. There was no CAR associated to the 2009 NON or any supporting documentation to verify how the NON was evaluated, dispositioned, completed, and verified by Doosan. In the letter from Doosan to NRC, Response to US NRC Inspection Report, dated June 17, 2009, Doosan described the cause of the NON and the corrective actions to prevent recurrence. In a second letter dated July 31, 2009, Doosan provided status and completion of these corrective actions described in the June 17, 2008 letter. To verify if the corrective action was adequate, the NRC inspection team reviewed the documents referenced in these letters.

The NRC inspection team reviewed procedure NQCP-1603, the document which Doosan had revised to address NON 99901373/2009-201-01. NQCP-1603 now provides the details to identify quality related issues, develop and implement appropriate corrective actions, identify actions to prevent recurrence, and describe any follow-up actions. The NRC inspection team also verified the implementation of this procedure by reviewing several root cause analysis and apparent cause analysis. In addition, the NRC inspection team discussed with management and technical staff the implementation and closure of these corrective actions and Doosan's failure to document the 2009 NON in their corrective action program.

As a result, Doosan generated Issue report (IR) 140217 to revise step 5.1 of NQCP-1602, "Control of Corrective Action." Step 5.1 of NQCP-1602 allowed

Doosan the option to generate a CAR as a result of an audit finding or any of the other requirements listed under this section. IR140217 recommended revising this section to always document a finding raised during an external audit, an inspection by a Regulatory or Certification Body, and customer observations, in Doosan's corrective action program,. The NRC inspection team reviewed the documentation that provided the objective evidence for the completion of the corrective actions. The NRC inspection team confirmed that Doosan issued revised NQCP-1603 and provided the associated training to address NON 99901373/2009-201-01. The corrective actions detailed above, provided objective evidence of the completion and effective implementation of the corrective actions documented in the letters submitted to the NRC by Doosan. The NRC inspection team determined that Doosan's corrective actions were adequate to address the identified finding. Based on this review, the NRC inspection team closed NON 99901373/2009-201-01.

c. Conclusions

The NRC inspection team concluded that Doosan is implementing its corrective action program in accordance with Criterion XVI of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team also determined that Doosan is implementing its policies and procedures associated with its corrective action program. No findings of significance were identified.

18. Entrance and Exit Meetings

On July 28, 2014, the NRC inspection team discussed the scope of the inspection with Mr. Suk Kwan Kim, Vice President, Nuclear Quality Control, and other members of Doosan management and technical staff. On August 1, 2014, the NRC inspection team presented the inspection results and observations during an exit meeting with Mr. Se Wan Park, Vice President, Quality Assurance, and other members of Doosan management and technical staff. The attachment to this report lists the attendees of the entrance and exit meetings, as well as those individuals whom the NRC inspection team interviewed.

## ATTACHMENT

### 1. ENTRANCE/EXIT MEETING ATTENDEES

<b>Name</b>	<b>Title</b>	<b>Affiliation</b>	<b>Entrance</b>	<b>Exit</b>	<b>Interviewed</b>
Su Hyun Kim	Asst. Manager Nuclear Quality Control Team 2	Doosan	X	X	X
Jeong Sun Kim	Senior Manager Quality Assurance Team	Doosan	X	X	X
Jong Youn Park	Asst. Manager Nuclear Purchasing Team	Doosan			X
Young Min Hyun	Senior Manager Steam Generator Design Team	Doosan			X
Yong Kee Jung	Asst. Manager Nuclear Quality Control Team 2	Doosan			X
Chan Kim	Asst. Manager Nuclear Quality Control team 1	Doosan	X	X	X
Seung Wook Kim	Asst. Manager Reactor Design Team 1	Doosan	X	X	X
Su Hyun Kim	Asst. Manager Nuclear Quality Control Team 2	Doosan	X	X	X
Hwoang Yoon Park	General Manager Nuclear Quality Control Team 2	Doosan	X	X	X
Yoo Kyung Kim	Manager Nuclear Quality Control Team 2	Doosan	X	X	X
Young Woong Shim	Asst. Manager Steam Generator Design Team	Doosan	X	X	X
Joo Youl Hong	General Manager Quality Assurance Non-Destructive Examination (NDE) Dep't	Doosan	X	X	X
Gyoung Back Ko	Senior Manager Nuclear Manufacturing Engineering Team 1	Doosan	X	X	X
R. Acomb	Authorized Nuclear Inspector	Hartford Steam Boiler			X
Se Wan Park	Vice President Quality Assurance	Doosan	X		
Suk Kwan Kim	Vice President Nuclear Quality Control	Doosan	X		
Dong Soo Lee	General Manager Quality Assurance	Doosan	X	X	X
Hyung Ju Yu	Manager NDE QA team	Doosan	X	X	
Hong Kyu Kang	General Manager USA AP1000 Project Mgt	Doosan	X	X	X
Sung Ho Yang	Director QAE	KINS		X	

Name	Title	Affiliation	Entrance	Exit	Interviewed
Hyunsop Chang	New Reactor Regulation	KINS	X	X	
Yeong Sueng Kim	Senior Researcher QA Department	KINS	X	X	
Alan Newcomer	Lead Resident Quality Engineer	Westinghouse	X	X	X
Ron Nam	Resident Project Mgr	Westinghouse	X	X	
Keith Savastano	Welding Engineer	SCANA	X		
Evelyn Eunsil Choi	NRC Interpreter	SG English Cntr	X	X	
Jin Min Wong	General Manager	Doosan	X		
Seok Jo Chang	Senior Manager, QA	Doosan		X	
Nam Yeol Hur	General Manager Quality Control Team 1	Doosan	X	X	
Cheng Bok Choi	Shop Manager	Doosan	X		
Seung Jin Ahn	Shop Manager	Doosan	X		
Woo Sik Jung	Shop Manager	Doosan	X		
Moontaek Lin	QA Manager	Doosan	X	X	
Yunsik Sung	Production Controller	Doosan	X		
Hong Gon Non	Manager	Doosan	X		
Neung Hwon Kim	QA Engineer	Doosan		X	
Seong Ouk Youn	QA Engineer	Doosan	X	X	
Ki Joon Lee	QA Engineer	Doosan	X		
Dae Young Son	QA Engineer	Doosan	X	X	
Jong Seok Yoon	QA Engineer	Doosan	X	X	
A Reun Jang	QA Engineer	Doosan	X	X	
Jung Noo Kim	QA Engineer	Doosan	X	X	

## 2. INSPECTION PROCEDURES USED

Inspection Procedure (IP) 36100, "Inspection of 10 CFR Part 21 and Programs for Reporting Defects and Noncompliance," dated February 13, 2012.

IP 43002, "Routine Inspections of Nuclear Vendors," dated July 15, 2013.

IP 43004, "Inspection of Commercial-Grade Dedication Programs," dated April 25, 2011.

IP 65001.B, "Inspection of the ITAAC-related Welding Program," dated September 25, 2013

IP 65001.F, "Inspection of the ITAAC-related Design and Fabrication Requirements," dated September 20, 2013

IP 65001.6, "Inspection of ITAAC-related Installation of Mechanical Components," dated April 18, 2008.

3. LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Item Number	Status	Type	Description
99901373/2014-201-01	Opened	URI	Criterion 15
99901373/2009-201-01	Closed	NON	Criterion 16

4. INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

The U.S. Nuclear Regulatory Commission (NRC) inspection team identified the following inspections, tests, analyses, and acceptance criteria (ITAAC) related to components being fabricated, inspected and tested at Doosan. At the time of the inspection, Doosan was performing fabrication activities associated with reactor coolant pump casings, steam generators, reactor vessels, and reactor vessel closure heads for the AP1000 reactor design. For the ITAAC listed below, the NRC inspection team reviewed Doosan’s quality assurance controls in the areas of fabrication and inspection, special processes (such as welding and nondestructive examination [NDE]), control of measuring and test equipment, nonconforming materials parts and components, and corrective actions. The NRC inspection team performed both direct inspection of in-process welding and NDE activities and review of records related to the ITAAC. These included records such as welding procedure specifications (WPS), welding procedure qualifications (WPQ), weld travelers, welding operator performance qualification records, liquid penetrant (NDE-PT) and final weld radiographic examination (NDE-RT) reports and films, postweld heat treatment (PWHT) strip charts, NDE Personnel Certification Program and the qualifications and certifications of the Principal Level III for NDE-RT, UT, MT, and PT.

The ITAAC design commitments cited below are for future use by the NRC staff during the ITAAC closure process; the listing of these ITAAC design commitments does not signify that they have been met and/or closed. The NRC inspection team did not identify any findings associated with the ITAAC listed below.

Appendix C to the Combined License for Virgil C. Summer Nuclear Station Unit 3	No. 13	ITAAC 2.1.02.02a
Appendix C to the Combined License for Virgil C. Summer Nuclear Station Unit 2	No. 15	ITAAC 2.1.02.03a
Appendix C to the Combined License for Virgil C. Summer Nuclear Station Unit 3	No. 72	ITAAC 2.1.3.03
Appendix C to the Combined License for Virgil C. Summer Nuclear Station Unit 3	No. 73	ITAAC 2.1.3.04

3. DOCUMENTS REVIEWED

Policies and Procedures

QM-200, Doosan, “QAM for ASME III and KEPIC-MN & SN Construction and Material Organization Applications,” Revision 30, July 18, 2014

NQCP-300, "Nuclear BG Quality Control Procedure," Revision 50, July 7, 2010

QCP-0401, "Procurement Documents Control Procedure," Revision 18, June 25, 2014

QCP-0102, "Control of Quality Control Procedure," Revision 18, April 28, 2014

NQCP-0104, "Matrices for Quality Program," Revision 7, January 2, 2013

NQCP-0601, "Documents Control," Revision 27, June 30, 2014

QCP-0205, "Procedure for the Qualification and Certification of Nuclear Audit Personnel," Revision 10, April 28, 2014

NQCP-0201, "Indoctrination and Training Procedure," Revision 9, February 21, 2014

QCP-0701, "Vendor Evaluation Procedure for Nuclear Project," Revision 21, April 28, 2014

QCP-0702, "Control of Subcontracted Services," Revision 12, April 28, 2014

PS-11102AA, "General Purchase Requirements for Standard AP1000 Project," Revision 4, December 26, 2008

NQCP-1502, Control of Significant Deficiencies, Revision 5 dated July 2, 2014

PQAP-1602, "Reporting of 'Defects' and 'Failures to Comply Pursuant to 10CFR21'," Revision 9 dated June 30, 2014

NQCP-1501, "Control and Correction of Nonconforming Items and Activities," Revision 18 dated July 9, 2014

QCP-1601, "Preventive Action," Revision 9 dated April 29, 2014

NQCP-1602, "Control of Corrective Actions," Revision 9 dated July 14, 2014

NQCP-1603, "Cause Analysis and Corrective Action Procedure," Revision 8 dated March 7, 2014

Procedure EPAP1101, Revision 5, Liquid Penetrant Examination with ANI review and demonstration

QCP-0204, "NDE Personnel Certification Program," Revision 8, dated May 15, 2013

#### Procurement Related Documents and Purchase Orders (POs)

PO 2007023531, "Forging Materials for Vogtle Unit 3 SG & RV," Revision 9, October 27, 2010

Purchase Requisition (PR) 7026252, "PR for (2) ASME SA508-3-2 Spherical Radius 4824 x 121 T x 1843 L Head Forging," August 17, 2007

AA-MSP21-001R, "Material Purchase Specification for SA-508 Grade 3 Class 2 Forging for Steam Generator for AP1000 NPP," Revision 1, September 12, 2008

JQA-10-175, "Certified Material Test Report," December 22, 2010

PO 2008020738, "Industeel France – Stainless Steel Plate for AP1000 (Vogtle 3/4, Summer 2/3, & Levy Co 1/2), Revision 5, November 17, 2009

PR 8030865, "PR for Round Plates (SA240-405)," August 18, 2008

AA-MPS21-011, "Material Purchase Specification for SA-240 Type 405 Stainless Steel Plate (Section III-NB) for Steam Generators for AP1000 NPP," Revision 3, December 26, 2008

Industeel CMTR 48904, Revision 2, June 10, 2009

PO 2010002200, "Anti-Vibration Bar for AP1000 VC Summer Units 2 & 3," Revision 0, January 26, 2010

PR 9034275, "PR for AVBs for SGs," October 1, 2009

AA-MSP21-002R, "Material Purchase Specification for A-479, Stainless Steel Anti-Vibration Bar. Type 405 (UNS 540500) ASTM Standard for Steam Generators for AP1000 NPP," Revision 0, March 25, 2009

AA-MSP21-003R, "Material Purchase Specification for SA-479, Type 405 (UNS 540500), Stainless Steel Hot-Rolled Bar (Section II) for Steam Generators for AP1000 NPP," Revision 0, March 25, 2009

AA-MSP21-38, "Material Purchase Specification for SB-166, UNS N06690, Alloy 690 Rod and Bar (Section II) for Steam Generators for AP1000 NPP," Revision 0, March 25, 2009

Apex Nuclear Equipment, "AP1000 Nuclear Plant Projects Material Certification and Documentation Package – NPP Steam Generator Anti-Vibration Bars & AVB Retaining Devices," June 28, 2012

PO 2009010521, "VC Summer 2/3 Steam Separator," Revision 5, January 11, 2012

PR 9005760, February 13, 2009

AA-PS21-006, "Purchase Specification for Primary Separator and Feedwater Ring Assembly for Steam Generators for AP1000 NPP," Revision 0, February 5, 2009

Kyung Sung Precision Machining Co., "Quality Verification Document, KS-QVD-120118-01, US AP1000, Vogtle 3A," January 18, 2012

PO 2012009381, "US AP1000 Bolt Package," Revision 4, September 21, 2012

PR 12010944, "PR for Double End Stud ASME SA193-B7," March 10, 2012



AA-MPS21-23, "Purchase Specification for SA-193 Steel Bars and Bolting Grade B7 Chromium-Molybdenum (Section III-NB) for Steam Generators for AP1000 NPP," Revision 0, July 13, 2009

Sam Jin Metal Co., LTD, "CMTR SJQ2012-019," October 4, 2012

PO 2012029134, "RV Upper Shell Cladding Heat Treatment for VC Summer U3," Revision 3, November 29, 2012

PR 12042057, no approval date

PO 2014000055, "Vogtle Unit 4 Channel Head & Tubesheet Lower and Upper Heat Treatment," Revision 1, February 17, 2014

PR 10011574, June 16, 2011

#### Drawings and Specifications

Doosan Drawing B-AA-21145-M04, "AP1000 Steam Generator Manway Stud," Revision 1, March 14, 2011

Drawing D-AA-11152-M04, Guide Studs for Ap1000 Vogtle Unit 3 & 4

Drawing APP-MV01-V6-401 Guide Studs Revision 3

Drawing APP-MV01-V1-001 AP1000 Reactor Vessel Outline Elevation Revision 9

Drawing APP-MV01-V2-021 AP1000 Reactor Vessel Specification and Parts Identification Revision 2

#### Welding, NDE, Calibration, Heat Treatment, and Inspection Reports

AP-1000SG-WI020, "Final PWHT of SG upper Shell Assembly," Revision 2, dated December 6, 2011

AP-1000SG-WI029, "Local Heat Treatment of SG Upper Shell Final Girth Seam," Revision 0, dated November 16, 2012

PS-APGN-103, "General Intermediate and Final Post Weld Heat Treatment Procedure for AP1000 SG of Nuclear Components, Revision 2, dated April 16, 2012

Radiographic Procedure EPAR1102, Revision 2

General Weld Procedure PS-APGN-203, Revision 3

General Weld Repair Procedure PS-APGN-203, Revision 2

PWHT Procedure AP-1000RV-DVI-001, Revision 0

Procedure EPAP1101, Revision 5, Liquid Penetrant Examination with ANI review and demonstration

Ultrasonic Procedure EPAU-1105, Ultrasonic Examination Procedure of Dissimilar Weld for AP1000 RV [angle beam], Revision 0

EPAU1107 UT Examination Procedure of Buttering/Build-up for RV [straight beam]

AP-1000RV-W1009 Revision 2 dated 5/20/2014 Work Instruction Upper Shell Assembly Safe-end Welding

Work Instruction AP-1000SG-W1020, Revision 4 RCP Casing Weld

Pre-job briefing Summer #2A RCP Casing B nozzle

Traveler Item N080322-AP11111M04-0403

Summer 3 RV Quickloc Weld Buildup Nozzles Joints 403-11A through 11H

Welding Procedure Specifications (WPS) No. A-T-0843-129 Rev 3 4/25/2013 Safe-End Welding

WPS No. A-T-0843-147 (Machine Welding of RCP)

WPS No. A-T-0843-148 (Manual Welding of RCP Hoop Shrinkage Buildup)

WPS No. A-T- 0843-129 4/25/13 Revision 3

Procedure Qualification Record (PQR)-QA-T-0843-029

PQR QA-T-0843-023

WPQ of welding operator BGQ for machine GTAW on August 19, 2009 by NDE-RT

WPQ of welding operator BWR for machine GTAW on June 2, 2014 by NDE-RT  
Table of Certified Welding Operators continuity log showing January 26, 2015 expiration date for both welding operators BGQ and BWR

Weld traveler 101220200, Revision 0, for RCP-B casing weld to SG-2A

Weld traveler 101220201, Revision 0, for RCP-A casing weld to SG-2B

Process Specification (PS) 6001, Revision 3, Calibration of Automatic Welding Equipment  
Calibration Certificate No. Z131214001 for digital thermometer Fluke 5520A, Serial-No. 7730021 using ID-No. 08D8P0023-0465

Process Specification (PS) 55504, Revision 6, Calibration of Thermocouple Type Thermometer and Recorder (only indicator)

Calibration Certificate No. Z140307015 for Type K thermocouple surface probe temperature sensor, Serial-No. 812412 using ID-No. 08D8J1040-1315

Process Specification (PS) 55508, Revision 8, Calibration of Thermocouple and Thermocouple Type Temperature Sensor (including sheath type)

PWHT strip chart for VCS Unit 3 RV upper shell with Serial-No. F08697-030

PWHT strip chart for VCS Unit 3 RV lower shell with Serial-No. F09157-050

Radiographic Examination Record for VCS Unit 3 RV weld joint 401-20A for DVI nozzle to safe-end

Radiographic Examination Record for VCS Unit 3 RV weld joint 201-20B for the upper shell inlet nozzle to safe-end

Radiographic Examination Record for VCS Unit 3 RV weld joint 201-20C for the upper shell inlet nozzle to safe-end

Weld traveler 101202950, Revision 0, Operation 50 for PT of Part-No. 55-101  
Sherwin Incorporated Material Certificate Test Report NR13 for remover batch-no. 13NPR14, dated March 25, 2013 and certified by Nawoo Tech Ltd.

Sherwin Incorporated Material Certificate Test Report NP13 for penetrant batch-no. 13NPP14, dated March 25, 2013 and certified by Nawoo Tech Ltd.

Sherwin Incorporated Material Certificate Test Report ND13 for developer batch-no. 13NPD14, dated March 25, 2013 and certified by Nawoo Tech Ltd

#### Vendor Audit and Surveys Reports

VSR-1207-11, "Doosan Survey of Apex Nuclear Equipment," July 25, 2012

VSR-1312-14, "Doosan Survey of Cotec Corporation," December 16, 2013

VSR-1203-56, "Doosan Survey of Sungil Engineering," April 12, 2012

VAR-1406-02, "Doosan Audit of Chosun Steel & Wire," July 14, 2014

VAR-1401-11, "Doosan Audit of Sam Jin Metals," January 20, 2014

VSR-1212-01, "Doosan Survey of Valinox," December 28, 2012

#### Lead Auditor and Auditor Qualifications

LAQR-0909-01, September 30, 2009

LAQR-1201-01, January 9, 2012

LAQR-0811-01, November 10, 2008

LAQR-1107-01, July 20, 2011

AQR-1204-03, April 19, 2013

AQR-1204001, April 16, 2012

Nonconformance Reports

13100169, 13100478, 13100478 R0 and R1, 14100006 R0 and R1, 14100110, 121199, 13100132, 13100168, 14101739 R0 and R1, 120051, 13100269, 13100462, 13100269, 13100726,

Condition Reports

130281, 130105, 130203, 130211, 130435, 140044, 130036, 140063, 140150

Issue Reports

120052

Issue Reports Generated During the NRC Inspection

140211, 140213, 140217

Miscellaneous

RCA-CAR-130281 R2

RCA-CAR-130203

RCA-CAR-130036

RCA-CAR-140063

ACA-CAR-120052

ACA-CAR-130105

ACA-CAR-130435

ACA-CAR-140150

MU-NCR-13100462

SAE AMS2481, Aerospace Material Specification Revision J