August 12, 2015

Richard Kuntz, Quality Assurance Manager
SPX, Copes-Vulcan
5620 West Road
McKean, PA 16426-1504

SUBJECT: NUCLEAR REGULATORY COMMISSION INSPECTION OF SPX, COPES-VULCAN, REPORT NO. 99900080/2015-201

Dear Mr. Kuntz:

On January 12-14, March 30-April 1, and July 8, 2015, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a limited scope inspection of SPX, Copes-Vulcan. The inspection was performed on the premises of Tech Source Engineering in Erie, Pennsylvania and Pennsylvania State University (Penn State) in State College, Pennsylvania, who are commercial contractors to SPX. The inspection was focused on the design validation testing of squib valve initiators, which are components that are being supplied for use in safety-related applications in the Westinghouse AP1000 reactor design. As part of the inspection, the NRC also reviewed controls associated with the irradiation (both gamma and neutron) of the initiator samples being utilized in the testing program. Since neither Tech Source Engineering nor Penn State have a nuclear quality assurance program, this inspection focused on SPX's commercial grade dedication and oversight of these activities. The enclosed report presents the results of this inspection. This NRC inspection report does not constitute NRC endorsement of your overall quality assurance or Part 21 programs.

The activities inspected were also associated with inspections, tests, analyses, and acceptance criteria (ITAAC) from Appendix C from the Combined License for Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3. Specifically, these activities were associated with ITAAC s 2.1.02.12a.iv, 2.1.02.12a.v, 2.2.03.12.a.i, and 2.2.03.12a.ii. No findings were identified that were associated with these ITAAC.

In accordance with Title 10 of the *Code of Federal Regulations* 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

/RA/ (SSmith for)

Richard A. Rasmussen, Chief
Electrical Vendor Inspection Branch
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Docket No.: 99900080

Enclosure:
Inspection Report No. 99900080/2015-201
and Attachment

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

Docket No.:	99900080		
Report No.:	99900080/2015-201		
Vendor:	SPX, Copes-Vulcan 5620 West Road McKean, PA 16426-1504		
Vendor Contact:	Mr. Richard Kuntz, Quality Assurance Manager		
Background:	SPX, Copes Vulcan is currently manufacturing squib valves that are being supplied for use in safety related systems as part of the Westinghouse AP1000 reactor design at the Vogtle and V.C. Summer nuclear plants.		
Inspection Dates:	January 12-14, March 30-April 1, and July 8, 2015		
Inspection Team:	Jeffrey Jacobson	NRO/DCIP/CEVB	Team Leader
	Timothy Steadham	Region II/DCI/CIB3	
	Paul Carman	Region II/DCI/CIB3	
Approved by:	Richard A. Rasmussen, Chief Electrical Vendor Branch Division of Construction Inspection and Operational Programs Office of New Reactors		

Enclosure

EXECUTIVE SUMMARY

SPX, Copes-Vulcan
99900080/2015-201

During the period from January 12-14, March 30-April 1, and July 8, 2015, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a limited scope inspection of SPX, Copes-Vulcan, the supplier of the safety related squib valves for the Westinghouse (WEC) AP1000 design. The inspection was performed on the premises of Tech Source Engineering in Erie, Pennsylvania and Pennsylvania State University in State College, PA, who are commercial sub-contractors to SPX, and were working under SPX oversight.

The activities inspected were associated with inspections, tests, analyses, and acceptance criteria (ITAAC) from Appendix C from the Combined License for Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3. Specifically, these activities were associated with ITAACs 2.1.02.12a.iv, 2.1.02.12a.v, 2.2.03.12a.i and 2.2.03.12a.ii.

The following regulations served as the bases for the NRC inspection:

- Appendix B to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50
- 10 CFR Part 21
- 10 CFR 50.49

The inspection focused on testing being performed by SPX of the squib valve initiators, in response to a previously identified NRC Nonconformance (99900080/2012-201-01). As part of the inspection, the NRC also reviewed the irradiation (both gamma and neutron) of selected initiator test samples. The test program was designed to show that the performance of the initiators is repeatable and would not be adversely affected by radiation (both gamma and neutron) or by thermal aging. The results of this inspection are summarized below.

Initiator Testing-Test Control

The inspectors concluded that the Bruceton testing results were sufficient to resolve the concerns raised previously in Nonconformance 99900080/2012-201-01 regarding the initiator performance. The inspectors determined that SPX had developed an appropriate method to adequately establish the performance of the initiator assemblies used in the AP1000 squib valves and that the testing was being conducted in compliance with Criterion XI, “Test Control,” of Appendix B, to 10 CFR Part 50. No findings of significance were identified.

Initiator Testing - Calibration of Test Equipment

The NRC inspectors determined that SPX was implementing its measurement and test equipment program in accordance with the regulatory requirements of Criterion XII, “Control of Measuring and Test Equipment,” of Appendix B to 10 CFR Part 50. No findings of significance were identified.

Neutron Irradiation

The NRC inspectors determined that the SPX procedures for performing the neutron aging of the squib valve initiators appropriately modeled the conditions provided by WEC specifications. The NRC inspectors concluded that SPX was implementing its test control program in accordance with the regulatory requirements of Criterion XI, “Test Control,” of Appendix B to 10 CFR Part 50. Based on the samples reviewed, the NRC inspectors determine that SPX’s test control was adequate to meet the requirements committed to in their test control documentation. No findings of significance related to SPX’s test control activities for the neutron irradiation were identified.

Gamma Irradiation

The NRC inspectors determined that the SPX procedures for performing the gamma aging of the squib valve initiators appropriately modeled the conditions provided by WEC specifications. The NRC inspectors concluded that SPX was implementing its test control program in accordance with the regulatory requirements of Criterion XI, “Test Control,” of Appendix B to 10 CFR Part 50. Based on the samples reviewed, the NRC inspectors determine that SPX’s test control was adequate to meet the requirements committed to in their test control documentation.

No findings of significance related to SPX’s test control activities for the gamma irradiation were identified.

REPORT DETAILS

Background

Squib valves are relied upon to provide important safety functions within the WEC AP1000 passive design. They are used to depressurize the reactor as part of the automatic depressurization system, to actuate passive safety injection from the in-containment refueling water storage tank, and to activate sump recirculation. Each AP1000 reactor contains 12 squib valves (8-8" valves and 4-12" valves). Each squib valve contains an explosive cartridge that provides the motive force necessary to operate the valves. Each explosive cartridge is composed of two parts: the primary cartridge and the initiator. When called upon to operate, plant interfacing systems supply a current pulse to the initiator sufficient for detonation. Once detonated, the initiator releases its energy into the primary cartridge, igniting the primary explosive mixture, which then operates the valve.

During this inspection, the inspectors focused on testing being performed by SPX of the initiators, in response to a previously identified NRC nonconformance 99900080/2012-201-01. The test program was designed to show that the performance of the initiators is repeatable, that the design contains sufficient margin, and that the initiators would not be adversely affected by radiation (both gamma and neutron) or by thermal aging. The testing reviewed during this inspection supplements the testing being performed on the entire explosive cartridge assembly as part of the Institute of Electrical and Electronics Engineers (IEEE) 323 Equipment Qualification program.

Initiator Testing-Test Control

a. Scope

SPX chose a Bruceton test methodology to demonstrate that the initiators would be able to perform acceptably during end of life conditions once installed into the reactor plant. The Bruceton test is a well-documented commercial test methodology intended specifically to characterize performance of explosive devices such as the squib valve initiators. The goal of the testing is to show, that with a high degree of confidence, the initiators will reliably detonate when supplied with a current pulse synonymous with that which will be supplied by interfacing plant protection systems once the valves are installed in the reactor plant.

SPX allocated 127 total initiators to undergo this destructive Bruceton testing. The initiators chosen for the testing were identical to production units. Sixty one of the initiators were new and unaged and were used to form a baseline of performance. The other 66 initiators underwent various degrees of thermal and radiation aging (both neutron and gamma). The Bruceton test is structured in such a way as to provide a statistical basis for ensuring that a given production initiator will detonate when supplied with a proper current pulse. While the derivation of the statistical basis for the test is complex, the actual testing is quite simple and involves applying increasing and decreasing current pulses to the initiator samples as necessary to establish a statistically significant mean detonation point. The distribution of initiators that detonate (fires) and that do not detonate (no fires) around that point is then analyzed and a statistical basis is created that can be correlated with the probability of detonation.

The initiators are fired into an instrumented, closed metal chamber designed to contain the explosion and also allow for readings to be taken of the explosive force (in terms of the pressure generated in the chamber). Performing the test this way allows for both an estimation of firing probability as well as a quantification of any degradation in the output of the initiator that might be created due to the irradiation and thermal aging.

During the first inspection period which involved the baseline testing of the unaged initiators, the inspectors reviewed the adequacy of the test equipment being utilized, the adequacy of the test procedures, the data acquisition methods, and assessed the overall control of the testing process. Since originally SPX did not have the proper Alcohol Tobacco and Firearm (ATF) license necessary to store or transport the initiators, the actual testing was performed at a nearby subcontractor's facility (Tech Source Engineering). Subsequent Bruceton testing of the aged and irradiated initiator samples was performed at Penn State University utilizing the same testing equipment and procedures. The overall test operation was controlled by SPX personnel, with the majority of the test equipment supplied by SPX.

The inspectors reviewed SPX Test Plan 4.1.456, "Test Plan for Verification Testing of Squib Valve Initiators," Revision 5, dated 3/13/2015 and SPX Test Procedure 4.4.634 "Bruceton Test Procedure for Squib Valve Initiators" Revision 1, dated December 29, 2014. The inspectors reviewed the overall methods being utilized to ensure the testing was being conducted in compliance with Criterion XI, "Test Control," of Appendix B, to 10 CFR Part 50.

b. Findings and Observations

The inspectors observed a number of the initiators being tested and determined that the testing was being properly performed and controlled in accordance with the test procedures. The testing results for the unaged initiators showed a very tight correlation of performance with all initiators firing well within the acceptable band of performance with respect to the applied current pulses. Subsequent testing performed on the thermally aged and irradiated initiators showed no statistically significant change in performance.

c. Conclusions

The inspectors concluded that the Bruceton testing results were sufficient to resolve the concerns raised previously in nonconformance 99900080/2012-201-01 regarding the initiator performance.

The inspectors determined that SPX had developed an appropriate method to adequately establish the performance of the initiator assemblies used in the AP1000 squib valves and that the testing was being conducted in compliance with Criterion XI, "Test Control," of Appendix B, to 10 CFR Part 50. No findings of significance were identified.

Initiator Testing - Calibration of Test Equipment

a. Scope

The NRC inspection team reviewed calibration records for 12 pieces of measurement and test equipment being utilized to perform the initiator testing to ensure that the instruments were properly calibrated, accurate, and reliable. The inspectors assessed whether the calibration of equipment was in compliance with Criterion XII, “Control of Measuring and Test Equipment,” of Appendix B, to 10 CFR Part 50.

b. Observation and Findings

The NRC inspectors confirmed the equipment was calibrated and appropriate for the range of operation of the test. The NRC inspectors confirmed that all test instrumentation was appropriate for the test use and was capable of conducting measurements to the precision required in the test plan.

c. Conclusions

The NRC inspectors determined that SPX was implementing its measurement and test equipment program in accordance with the regulatory requirements of Criterion XII of Appendix B to 10 CFR Part 50. No findings of significance were identified.

Neutron Irradiation

a. Scope

10 CFR 50.49, associated NRC Regulatory Guides, and associated IEEE standards are silent on the need to include neutron irradiation as part of the nuclear equipment qualification testing program for safety-related electrical equipment; however, since little information was available regarding the impact of radiation on explosive devices, WEC chose to include neutron irradiation as part of the overall qualification program for the squib valve actuators.

While WEC, under a separate program is qualifying the entire explosive cartridge assembly for the squib valves, the WEC qualification program does not include separate effects testing of the initiators themselves, and as such, the NRC had previously raised questions with regard to whether sufficient margin exists in the overall squib valve actuator design. (See nonconformance 99900080/2012-201-01). In response, SPX is performing separate effects testing on the initiators themselves, using the Bruceton testing method as described above. As part of the Bruceton testing program, SPX has contracted with Penn State University to perform the neutron radiation on a sample of the initiators utilizing the Breazeale Reactor at Penn State Radiation Science and Engineering Center.

A sample of the total population of the initiators being tested were irradiated, three at a time, by inserting the initiators into the fast neutron irradiation fixture which is positioned directly next to the operating reactor. The testing at Penn State was designed to envelope the neutron levels that were provided in the WEC specification. The reactor power and exposure time was adjusted to meet the neutron fluence required by WEC specifications. The inspectors reviewed the processes used to ensure the reactor was producing the required neutron fluence and energy levels. A Monte Carlo Neutron Particle (MCNP) model was used to develop a theoretical neutron fluence verse energy level curve based on the reactor design and test equipment used for the initiator aging. The MCNP model was used as a starting point to determine the reactor power and exposure time for the test. Prior to the neutron aging of the initiators, a test run of the reactor was performed to determine the neutron fluence and compare it to the theoretical MCNP model. Dosimetry readings were taken during reactor operations to obtain a spectrum of activity counts over various energy levels using the National Institute of Standards and Technology (NIST) traceable dosimetry wires. The peak counts were identified and converted into neutron fluences. A second neutron fluence verse energy level curve was developed using the conversion of dosimetry readings taken during the test. These curves were used to define the acceptance criteria for neutron aging. Each of the three initiators were irradiated for a period of approximately 18 minutes at a reactor power of 700 kw.

Since Penn State does not have a nuclear quality assurance program, this service was dedicated by SPX. The inspectors reviewed the SPX Commercial Grade Dedication Instruction-Radiation, Revision 1, dated 11/19/2014. The dedication instruction listed the critical characteristics associated with the radiation of the initiators and referenced the SPX QC86, Commercial Grade Safety Related Check List, which provided the methods planned to verify the critical characteristics. At the time of the first inspection, the check list was incomplete in that it did not acceptably account for each aspect of the dosimetry process (wires, reading wire counts, conversion of counts to neutron fluence); however, this was not considered to be an adverse finding as the testing was still in progress.

The NRC inspectors reviewed relevant test procedures and interviewed personnel utilized by SPX to perform neutron aging of the squib valve initiators. The inspectors compared the neutron aging parameters being utilized against expected maximum neutron exposure levels which had been previously been provided to SPX in WEC developed specifications. The WEC specifications included both a neutron fluence and a neutron energy level applicable to establishing the qualified life of the initiators.

b. Observations and Findings

The NRC reviewed the neutron fluence verse energy level curves used for the neutron aging acceptance criteria. The inspectors noted that the curve developed from the dosimetry met the WEC specification for neutron fluence throughout all energy levels. SPX used the curve developed from the dosimetry as the acceptance criteria, and added additional margin by a factor of two.

The inspectors observed that once the proper time and reactor power were determined using the NIST traceable dosimetry wires, subsequent runs were verified using sulfur tablets, which were compared to sulfur tablets run concurrent with the NIST traceable wires.

The inspectors observed the loading and unloading of the initiators into the reactor and the reading of the NIST wires and sulfur tablets. The actual radiation procedure appeared to be well controlled and repeatable.

Based on the review of the methods used to develop the neutron fluence verse energy level acceptance curve, and the additional margin added by WEC specifications and SPX's calculations, the inspectors determined that the SPX neutron aging test procedure meets the specifications analyzed by WEC for the qualified life of the squib valve initiators.

c. Conclusions

The NRC inspectors determined that the SPX procedures for performing the neutron aging of the squib valve initiators appropriately modeled the conditions provided by WEC specifications. The NRC inspectors concluded that SPX was implementing its test control program in accordance with the regulatory requirements of Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50. Based on the samples reviewed, the NRC inspectors determine that SPX's test control was adequate to meet the requirements committed to in their test control documentation.

No findings of significance related to SPX's test control activities for the neutron irradiation were identified.

Gamma Irradiation

a. Scope

Similar to what was done with regard to the neutron irradiation, SPX contracted with Penn State University to perform gamma irradiation on a sample of the initiators using a Cobalt 60 source. A sample of eight of the total population of the initiators undergoing Bruceton tested were exposed to the gamma source for a time period to ensure the minimum required dose, including instrument and test set-up inaccuracies, was achieved. These initiators had also previously been exposed to neutron irradiation and had been thermally aged and were therefore exposed to the combination of all three potential environmental factors.

The inspectors reviewed SPX Design Calculation No. NTH 150602 dated 6/26/15 which described the process used by SPX to irradiate the initiators. The initiators were irradiated at Penn State University using their MDS Nordion Gamma Cell which had been loaded with Cobalt 60 sources.

The NRC inspectors reviewed relevant test procedures and interviewed personnel utilized by SPX to perform gamma aging of the squib valve initiators. The inspectors compared the gamma aging parameters being utilized against expected maximum gamma exposure levels which had been previously provided to SPX in WEC developed specifications.

b. Observations and Findings

The inspectors verified that the dose rate internal to the cell was certified by MDS Nordion's Dosimetry Laboratory which was recognized under NIST's National Voluntary Laboratory Accreditation Program (NVLAP Lab Conde 200370-0). The inspectors verified the accuracy of the SPX calculation that had been performed to determine the expected dose rate inside the gamma cell, taking into consideration the decay of the gamma cell sources since they were originally certified in May of 2003.

Once the expected dose rate at the midpoint inside the cell was calculated, SPX performed another calculation to determine the amount of shielding provided by the fixtures which were constructed to hold the initiators within the cell. To accomplish this, sample dosimeters were exposed to determine a reference point, and then were compared against dosimeters that were installed inside the gamma cell in the actual fixture which was to be utilized for irradiating the initiators. This provided an estimate of the amount of shielding provided by the fixture and the expected dose rate that would be received by the initiators internal to the fixture. Once this expected dose rate internal to the fixture was known, the dose applied to the initiators could be calculated based upon time alone. SPX then added margin (46.4%) onto the dose applied to the initiators to account for uncertainties in the process which seemed reasonable to the inspectors.

The inspectors verified that records existed that indicated that eight of the initiators had been thermally aged, and had also received gamma and neutron radiation. The inspectors verified that SPX had added sufficient margin onto the applied gamma dose to account for all uncertainties in the process.

Based on the review of the methods used to develop the gamma exposure time and the additional margin added by SPX's calculations, the inspectors concluded that SPX had provided reasonable assurance that initiators had been irradiated to levels commensurate with the WEC specifications that had been provided to SPX.

c. Conclusions

The NRC inspectors determined that the SPX procedures for performing the gamma aging of the squib valve initiators appropriately modeled the conditions provided by WEC specifications. The NRC inspectors concluded that SPX was implementing its test control program in accordance with the regulatory requirements of Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50. Based on the samples reviewed, the NRC inspectors determine that SPX's test control was adequate to meet the requirements committed to in their test control documentation.

No findings of significance related to SPX's test control activities for the gamma irradiation were identified.

ITAAC

The NRC inspectors identified the following inspections, tests, analyses, and acceptance criteria (ITAAC) related to components being tested by SPX. At the time of the inspection, SPX was involved in the neutron aging, gamma aging, and testing of the squib valve initiators, used as automatic depressurization valves in the reactor coolant system and injection and recirculation valves in the passive core cooling system for the AP1000 reactor design. This testing is part of the overall equipment qualification program for the squib valves and will be used to demonstrate that the ITAAC acceptance criteria shown below have been met. The ITAAC's design commitment referenced below are for future use by the NRC staff during the ITAAC closure process; the listing of these ITAAC design commitments does not constitute that they have been met and/or closed. The NRC inspectors did not identify any findings associated with the ITAAC identified below.

Source Document	ITAAC Index No.	ITAAC	Acceptance Criteria
Appendix C from the Combined License for Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3	No. 56	2.1.02.12a.iv	A test report exists and concludes that each squib valve changes position as indicated in Table 2.1.2-1 under design conditions.
Appendix C from the Combined License for Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3	No. 57	2.1.02.12a.v	A report exists and concludes that the as-built squib valves are bounded by the tests or type tests.
Appendix C from the Combined License for Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3	No. 214	2.2.03.12a.i	A test report exists and concludes that each squib valve changes position as indicated in Table 2.2.3-1 under design conditions.
Appendix C from the Combined License for Vogtle Units 3 and 4 and V.C. Summer Units 2 and 3	No. 215	2.2.03.12a.ii	A report exists and concludes that the as-built squib valves are bounded by the tests or type tests.

ATTACHMENT

1. PERSONS CONTACTED

Name	Affiliation	Entrance	Exit	Interviewed
Richard Kuntz	SPX	X	X	X
Michael Valore	WEC	X	X	
Gerald Riegel	WEC	X	X	
Nathan Hansen	SPX	X	X	X
Braden Shaffer	Tech Source Engineering	X		X
Kevin Cooney	Tech Source Engineering	X		X
Ron Wessel	WEC	X	X	
Randolph Copeland	SCANA	X	X	
Robert Mohr	Southern Nuclear	X	X	
Thierry Daubuepeck	Penn State University	X	X	X
Dave Ristau	SPX	X		X

2. INSPECTION PROCEDURES USED

Inspection Procedure 43002, “Routine Inspections of Nuclear Vendors,” dated April 25, 2011.

Inspection Procedure 43004, “Inspection of Commercial-Grade Dedication Programs,” dated April 25, 2011.

3. LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Item Number	Status	Type	Description
99900080/2012-201-01	Closed	NON	Criterion III

4. DOCUMENTS REVIEWED

SPX Copes-Vulcan Test Procedure No. 4.4.634, Bruceton Test Procedure for Squib Valve Initiators, rev. 2, dated 01/27/2015.

Test Plan for Verification Testing of Squib Valve Initiators, rev. 5, dated 3/13/2015

Certificate of Analysis for Standard Reference Material 953 Neutron Density Monitor Wire, dated 1/29/2015.

Certificate of Calibration for Instrument No. 38927, Pressure Sensor, dated 11/17/2014

Certificate of Calibration for Instrument No. 38593, Pressure Sensor, dated 08/07/2014

Certificate of Calibration for Instrument No. 38928, Pressure Sensor, dated 11/17/2014

Certificate of Calibration for Instrument No. 38929, Pressure Sensor, dated 11/17/2014

Certificate of Calibration for Instrument No. LW7396, Signal Conditioner, dated 10/13/2014

Certificate of Calibration for Instrument No. 310, Amplifier, dated 01/06/2015

Certificate of Calibration for Instrument No. 317, Amplifier, dated 01/06/2015

Certificate of Calibration for Instrument No. 63877, Analog-Digital Converter, dated 01/06/2015

Certificate of Calibration for Instrument No. 404526-013, Initiator Test Chamber, dated 12/11/2014

Certificate of Calibration for Instrument No. 404526-027, Initiator Test Chamber, dated 12/11/2014

Certificate of Calibration for Instrument No. 404526-022, Initiator Test Chamber, dated 12/11/2014

Certificate of Calibration for Instrument No. 404526-024, Initiator Test Chamber, dated 12/11/2014

SPX Copes-Vulcan Test Plan No. 4.1.456, Test Plan for Verification Testing of Squib Valve Initiators, rev. 5, dated 3/13/2015.

SPX Copes-Vulcan Test Plan No. 4.1.456, Test Plan for Verification Testing of Squib Valve Initiators, rev. 6, dated 04/02/2015.

APP-PV70-VPH-001, AP1000 Squib Valve Equipment Qualification Test Plan, rev. 4, dated 2/11/2015