November 1, 2013

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

SUBJECT: NUCLEAR REGULATORY COMMISSION VENDOR INSPECTION REPORT NO. 99900080/2013-201 AND NOTICE OF NONCONFORMANCE

Dear Mr. Kuntz:

On September 23-27, 2013, 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 UTC Aerospace Systems (UTC) in Fairfield, California, a division of United Technologies Corporation, who is a subcontractor to SPX. UTC, under SPX oversight, is performing the design and manufacture of the explosive system for the squib valves which are safety related components that are being supplied for use in safety related applications in the Westinghouse AP1000 reactor design. Since UTC does not have an approved nuclear quality assurance program, this inspection focused on SPX's oversight of these activities. During this inspection, the NRC staff looked at the adequacy of the manufacturing, design analysis, and testing programs associated with the squib valve explosive system. 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 NRC inspectors found that the implementation of your quality assurance (QA) program failed to meet certain NRC requirements imposed on you by your customers. Specifically, the NRC inspection team determined that SPX was not fully implementing its quality assurance program in the areas of design control, control of special processes, and corrective actions consistent with regulatory and contractual requirements, and applicable procedures. The specific findings and references to the pertinent requirements are identified in the enclosures to this letter.

Please provide a written statement or explanation within 30 days from the date of this letter in accordance with the instructions specified in the enclosed Notice of Nonconformance. We will consider extending the response time if you show good cause for us to do so.

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.a.iv, 2.1.02.a.v, 2.2.03.12.a.i, and 2.2.03.12a.ii. This report contains two ITAAC findings associated with these ITAACs. Nonconformance 99900080/2013-01-01 is material to ITAACs 2.1.02.a.iv and 2.2.03.12a.i because the finding concerns the adequacy of the testing performed to ensure that the squib valve explosive cartridge will reliably ignite under all design basis conditions. Nonconformance 99900080/2013-01 is material to ITAACs 2.1.02.a.v and 2.2.03.12a.ii because

the finding concerns the adequacy of controls designed to ensure that production explosive cartridges are bounded by environmental qualification testing performed on test specimens.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure(s), and your response 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. To the extent possible, your response, (if applicable), should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request that such material is withheld from public disclosure, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information).

If Safeguards Information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21.

Sincerely,

/RA/

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

Docket No.: 99900080

Enclosures:
1. Notice of Nonconformance
2. Inspection Report No. 99900080/2013-201
   and Attachment

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NOTICE OF NONCONFORMANCE

SPX, Copes-Vulcan
5620 West Road
McKean, PA 16426-1504

Docket No. 99900080
Report No. 2013-201

Based on the results of a U.S. Nuclear Regulatory Commission (NRC) inspection conducted of SPX, Copes-Vulcan (hereafter referred to as SPX), at the facilities of UTC Aerospace Systems in Fairfield, CA, from September 23-27, 2013, it appears that certain activities were not conducted in accordance with NRC requirements that were contractually imposed upon SPX by its customers or by NRC licensees.

A. Criterion III, "Design Control," 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," states, in part, that "The design control measures shall provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program."

   Contrary to the above, as of September 27, 2013, SPX failed to sufficiently verify the adequacy of the design of the explosive system that provides the motive force for the squib valves. Specifically, the team determined that sufficient testing or analysis was not performed to ensure the squib valve initiator output would be sufficient to reliably ignite the explosive cartridge under all design basis conditions. The sizing of the initiator, its orientation, and other critical aspects of the design were chosen largely based upon engineering judgment and an analytical basis was not developed for determining cartridge ignition input requirements or initiator output. Also, an insufficient number of cartridge firings were performed to statistically support reliable performance.

   This issue has been identified as Nonconformance 99900080/2013-201-01.

B. Criterion III, "Design Control," of Appendix B to 10 CFR Part 50, states, in part, that "applicable regulatory requirements and the design basis are correctly translated into specifications, drawings, procedures, and instructions." It also states that "measures shall be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems, and components."

   Contrary to the above, as of September 27, 2013, SPX failed to establish sufficient measures for the selection and review for suitability of application of parts that are essential to the safety-related functions of the squib valves. Specifically, SPX failed to identify as a critical characteristic whether the explosive powder mix was free of contaminants that could potentially degrade performance under design basis conditions.

   This issue has been identified as Nonconformance 99900080/2013-201-02.

C. Criterion XVI, "Corrective Action," of Appendix B to 10 CFR Part 50 states, in part, "Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected."

Contrary to the above, as of September 27, 2013, in two instances, SPX failed to promptly correct conditions adverse to quality. In the first example, SPX failed to correct issues associated with the loss of manufacturing traceability for a lot of carbon potassium nitrate (CPN) Powder as described in Corrective Action Request (CAR) 881. SPX closed this CAR prior to verifying that the specified corrective actions were completed. The inspection team identified that as of September 27, 2013, the specified corrective actions had not been taken.

In the second example, SPX failed to correct issues associated with the improper mixing of CPN powder as described in CAR 850. According to CAR 850, SPX was to monitor the effectiveness of the specified corrective actions for three months. On April 12, 2013, SPX closed the CAR without verifying that the corrective actions had been accomplished. The inspection team identified that as of September 27, 2013, the specified corrective actions had not been taken.

This issue has been identified as Nonconformance 99900080/2013-201-03.

Please provide a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to the Chief, Electrical Vendor Inspection Branch, Division of Construction Inspection and Operational Programs, Office of New Reactors, within 30 days of the date of the letter transmitting this Notice of Nonconformance. This reply should be clearly marked as a "Reply to a Notice of Nonconformance" and should include for each noncompliance: (1) the reason for the noncompliance, or if contested, the basis for disputing the noncompliance; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken to avoid noncompliances; and (4) the date when your corrective action will be completed. Where good cause is shown, consideration will be given to extending the response time.

Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html, to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information.

If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21.

Dated this 1st day of November 2013

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

Docket No.:	99900080		
Report No.:	99900080/2013-201		
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. Summery nuclear plants.		
Inspection Dates:	September 23 - 27, 2013		
Inspection Team:	Jeffrey Jacobson Shavon Edmonds Ralph Way Sirri Oguz	NRO/DCIP/CEVB NRO/DCIP/CEVB NSIR/DSO Consultant, National Aeronautics and Space Administration	Team Leader
Approved by:	Richard A. Rasmussen, Chief Electrical Vendor Inspection Branch Division of Construction Inspection and Operational Programs Office of New Reactors		

EXECUTIVE SUMMARY

SPX, Copes-Vulcan
99900080/2013-201

During the period from September 23-27, 2013, 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 AP1000 design. The inspection was performed on the premises of UTC Aerospace Systems (UTC) in Fairfield, California, a division of United Technologies Corporation, who as a subcontractor to SPX, is performing the design and manufacture of the explosive system for the squib valves. Since UTC does not have an approved nuclear quality assurance program, this inspection focused on SPX's oversight of these activities including the methods being employed by SPX to commercially "dedicate"[1] these sub-components. During this inspection, the NRC staff looked at the adequacy of the design, manufacturing, and qualification testing programs associated with the squib valve explosive.

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 2.2.02.a.iv, 2.2.02.a.v, 2.2.03.12.a.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 CFR50.49

The NRC inspection team observed various activities associated with the design, manufacturing, and assembly of the explosive system for the squib valves. The team reviewed design validation testing data, observed selected fabrication and assembly steps, inspected material storage methods, reviewed applicable procedures and fabrication documents, and conducted interviews with responsible SPX personnel to determine if SPX performed these activities in accordance with the applicable design, quality, and technical requirements imposed on them by their customers. The results of this inspection are summarized below.

Design Validation and Testing of Explosive System

The team reviewed documentation and held discussions with UTC, SPX, and Westinghouse personnel associated with the design validation and testing of the squib valve explosive system. The team focused its review on two critical aspects of the explosive system: (1) ensuring that the explosive cartridge produces the correct output (motive force necessary to operate the valve) when fired; and (2) ensuring that sufficient margin exists in the cartridge design to ensure reliable ignition given a successful firing of the initiator.

[1] 10 CFR Part 21.3, defines "Dedication" as … an acceptance process undertaken to provide reasonable assurance that a commercial grade item to be used in a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR Part 50, Appendix B, quality assurance program. This assurance is achieved by identifying the critical characteristics of the item and verifying their acceptance by inspections, tests, or analysis performed by the purchaser or third party dedicating entity…."

With respect to Item (1) above, the team concluded that SPX/UTC had performed sufficient testing and analysis to ensure that given the successful ignition of the explosive cartridge, its output would be sufficient to operate the valve. No findings of significance were identified associated with this aspect of the team's review. With respect to Item (2), the team determined that sufficient testing or analysis was not performed to ensure the initiator output would be sufficient to reliably ignite the explosive cartridge under all design basis conditions. This issue was identified as Nonconformance 99900080/2013-201-01. This inspection finding is associated with ITAAC s 2.2.02.a.iv and 2.2.03.12a.i and is material to the ITAAC acceptance criteria because the finding concerns the adequacy of the testing performed to ensure that the squib valve explosive cartridge will reliably ignite under all design basis conditions.

Manufacturing Controls on Production and Testing of Explosive Powder Production

The inspection team reviewed procurement, manufacturing, and testing records associated with the production by UTC of the carbon potassium nitrate (CPN) powder used in the explosive cartridges. The team determined that contrary to 10 CFR Part 21.3 and Criterion III of Appendix B to 10 CFR Part 50, "Design Control," SPX/UTC had not identified all critical characteristics of the explosive powder mix nor has SPX instituted controls sufficient to ensure the absence of contaminants from the explosive powder mix through inspections, tests, or analysis. This item was identified as Nonconformance 99900080/2013-201-02. This inspection finding is associated with ITAAC s 2.2.02.a.v and 2.2.03.12a.ii.and is material to the ITAAC acceptance criteria because the finding concerns the adequacy of the testing performed to ensure that the production squib valves will be bounded by those that were tested through the qualification program.

Review of Root Cause Analysis Reports Associated with Anomalous Cartridge Performance

The team reviewed the Failure Analysis Report (FAR) and Root Cause Analysis which were conducted by SPX/UTC after several explosive cartridges exhibited anomalous performance during previous testing. The inspection team identified that the SPX/UTC FAR consisted of a detailed fault tree analysis. The team identified that the most possible failure modes were analyzed and evaluated properly; however, the fault tree did not assess as a possibility that the initiator design output was insufficient to reliably ignite the cartridge. Failure of SPX/UTC to sufficiently validate this aspect of the design was identified above as Nonconformance 9990080/201-01-01.

Welding of Internal and External Seals

The inspectors determined that SPX/UTC established a program that adequately controls the welding of the internal and external seals of the squib valve cartridges in accordance with the regulatory requirements of Criterion IX "Control of Special Processes" of Appendix B to 10 CFR Part 50. No findings of significance were identified.

Non-destructive Testing of Explosive Cartridge

The inspection team reviewed activities and documentation associated with the non-destructive testing of the production cartridges, initiators, and propellant. The non-destructive test protocol was found to be sufficient to ensure the proper manufacture and assembly of the cartridges. All personnel interviewed were trained and knowledgeable of the testing procedures and could explain procedures for addressing material that did not conform to design standards. No findings of significance were identified.

Loading of Explosive Powder

The inspection team reviewed the manufacturing procedure for cartridge assembly of the 8-Inch high pressure squib valves, including specific instructions concerning the loading of the propellant into the cartridge. The team also reviewed the Moisture Test Data Report for the propellant being loaded and the scale calibration certification report for the scale being used. The team witnessed the loading of propellant into the cartridge. Loading personnel were interviewed and their training and qualifications forms were reviewed. The team reviewed the results of the last explosive safety inspection (October 24 through November 15, 2012), conducted by the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATFE). No findings of significance were identified.

Review of Nonconformance Reports and Corrective Action Documents

The inspection team reviewed SPX/UTC's implementing procedures governing the corrective action process to verify compliance with the requirements of Criterion XVI, "Corrective Action," of Appendix B to 10 CFR Part 50. The team determined that SPX had closed corrective action request (CAR) 850 and 881 before ensuring that the specified corrective actions had been implemented. These CARs involved issues with traceability of explosive powder lots and a lost work order at UTC. The team determined that SPX had closed the CARs upon the receipt of UTC's proposed corrective actions without verifying whether the proposed corrective actions had been implemented. This issue was identified as Nonconformance 99900080/2013-01-03.

Review of Calibration Records for Critical Instruments

The inspectors determined that SPX/UTC established a program that adequately controls the calibration and use of measuring and test equipment 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.

REPORT DETAILS

During the inspection the Nuclear Regulatory Commission (NRC) inspection team observed various activities associated with the design, manufacturing, and assembly of the explosive system for the squib valves. The team reviewed design validation testing data, observed selected fabrication and assembly steps, inspected material storage methods, reviewed applicable procedures and fabrication documents, and conducted interviews with responsible SPX personnel to determine if SPX performed these activities in accordance with the applicable design, quality, and technical requirements imposed on them by their customers.

1. Design Validation and Testing of Explosive System

a. Inspection Scope

The team reviewed documentation and held discussions with UTC, SPX, and Westinghouse personnel associated with the design validation and testing of the squib valve explosive system. The squib valve explosive system consists of an explosive cartridge that provides the primary motive force necessary to operate the valve, and an initiator which is a small explosive device that is mounted onto the explosive cartridge and which electrically interfaces with the plants reactor protection systems. The explosive cartridge is further divided into two compartments, one containing carbon potassium nitrate (CPN) powder and one containing CPN granules. The design is such that once an electrical signal is received by the initiator, the initiator ignites transferring pressure and hot particles into the CPN powder contained in the upper portion of the explosive cartridge. Once ignited, the CPN powder then ignites the CPN granules which provide the primary motive force to operate the valve.

The team focused its review on two critical attributes of the explosive system: (1) ensuring that the explosive cartridge produces the correct output (motive force necessary to operate the valve) when fired; and (2) ensuring that sufficient margin exists in the cartridge design to ensure reliable ignition given a successful firing of the initiator. With respect to Item (1), the team reviewed the test data used by SPX/UTC to establish acceptance criteria which are then applied to cartridges from each lot that are tested (fired) in a closed bomb pressure vessel. The team reviewed the basis for the acceptance criteria which were given in terms of peak pressure and maximum time from initiation to peak pressure.

With respect to Item two, the team reviewed the methods used by SPX/UTC to validate the design of the initiator/cartridge interface including those activities which would ensure reliable ignition of the explosive cartridge given a successful firing of the squib valve initiator. The team reviewed the design basis for the output of the electrically fired initiator, including the basis for ensuring adequate margin exists between the energy output of the initiator and the energy input requirements of the explosive cartridge, taking into account considerations for aging, radiation, manufacturing tolerances, and other factors.

The documents reviewed by the inspectors are included in the attachment to this inspection report.

b. Findings and Observations

With respect to the cartridge output (critical attribute one above), the team reviewed the pressure versus time signature data curves created from the test firings of the cartridges into a closed bomb vessel and used by SPX/UTC to derive acceptance criteria for production

cartridges. Data from 80% and 120% closed bomb margin tests were used to generate peak pressure and time-to-peak pressure limits. A sample size of eight units (four with 80% and four with 120% cartridge load) was used for each cartridge configuration. UTC set the criteria limits by applying a tolerance interval that covers the 99% population at a 95% confidence band. UTC criteria also require that the variation within a specific lot is controlled and that the standard deviation of the entire lot stays within the established criteria in addition to the individual samples. The team had no findings of concerns in this area.

With respect to the cartridge/initiator interface, (critical attribute two above), the team determined that sufficient testing or analysis was not performed to ensure the initiator output will reliably ignite the explosive cartridge under all design basis conditions. The team determined that the sizing of the initiator, its orientation, and other critical aspects of the design were chosen largely based upon engineering judgment and that an analytical basis was not developed for determining cartridge ignition input requirements or initiator output. The team determined that the initiator selected by SPX/UTC was previously qualified for a commercial cartridge assembly that consisted of a different type of propellant and ignition powder. The initiator design or charge size was not re-sized for the SPX cartridges.

The team determined that to date, SPX/UTC has relied on testing to demonstrate cartridge performance; however, the focus of the test program was primarily to ensure that proper cartridge output is achieved given cartridge ignition, rather than on ensuring cartridge ignition will reliably occur. The team determined an insufficient number of cartridge firings were performed to statistically support reliable ignition will occur. Furthermore, the large majority of the test firings were performed under ambient as opposed to design basis conditions and there was no demonstration that sufficient margin exists in this aspect of the design to account for changes in cartridge/initiator performance that could occur due to environmental or aging factors. Also, sufficient testing was not performed as necessary to account for differences in performance between manufacturing lots or other unknown factors that could affect ignitability of the cartridges.

Highlighting the above concern is the fact that anomalous cartridge ignition was detected on some cartridge firings during lot acceptance testing, including one cartridge that failed to fire after successful firing of its initiator. The team's review of the SPX/UTC root cause analysis reports and the subsequent corrective actions associated with this issue is contained in paragraph 3 of this report.

The team determined that contrary to Criterion III of Appendix B to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Design Control," SPX/UTC has not performed sufficient testing or analysis to validate the design, specifically the ability of the initiator to reliably ignite the explosive charge under all design basis conditions. This item is identified as Nonconformance 99900080/2013-01-01 and is associated with inspections, tests, analyses, and acceptance criteria (ITAAC) 2.2.02.a.iv and 2.2.03.12a.i. It is material to the ITAAC acceptance criteria because the finding concerns the adequacy of the testing performed to ensure that the squib valve explosive cartridge will reliably ignite under all design basis conditions.

In response to the team's concerns, SPX generated Corrective Action Request (CAR) #943, dated September 25, 2013, which indicated they are evaluating several options to demonstrate that sufficient margin exists in this aspect of the design, including possibly performing a series of tests with reduce load initiators or making a design change to increase the explosive load in the initiator.

c. Conclusions

The team concluded that SPX/UTC had performed sufficient testing and analysis to ensure that given the successful ignition of the explosive cartridge, its output would be sufficient to operate the valve. No findings of significance were identified associated with this aspect of the team's review. With respect to the cartridge/initiator interface, the team determined that sufficient testing or analysis was not performed to ensure the initiator output would be sufficient to reliably ignite the explosive cartridge. This item is identified as Nonconformance 99900080/2013-01-01 and is associated with ITAAC s 2.2.02.a.iv and 2.2.03.12a.i. It is material to the ITAAC acceptance criteria because the finding concerns the adequacy of the testing performed to ensure that the squib valve explosive cartridge will reliably ignite under all design basis conditions.

2. Manufacturing Controls on Production and Testing of Explosive Powder Production

a. Scope

The inspection team reviewed procurement, manufacturing, and testing records associated with the production by UTC of the carbon potassium nitrate (CPN) powder used in the explosive cartridges. SPX/UTC has determined that producing the correct formulation of CPN is critical to ensuring reliable ignition and output of the squib valve explosive cartridges.

b. Findings and Observations

The team identified that UTC commercially procures the individual components that go into the CPN powder and then mixes the components to produce the completed product. Of specific concern is that the correct powder particle size be produced, that the end product contains the correct ratios of individual components, and that the mixture does not contain any contaminants. The team reviewed UTC procedure 17399(0)MP, "General Procedure For The Preparation of Carbon Potassium Nitrate (CPN) Powder," Revision C, dated 9/30/2009. The team verified the procedure provided sufficient guidance for production of the CPN powder.

As identified in the SPX/UTC root cause analysis reports performed in response to anomalous cartridge performance, establishing the correct particle size of the explosive powder is critical to ensuring reliable cartridge ignition. The team identified that UTC verifies correct particle size by performing sample testing of each powder lot using a Microtrac SRA150 particle analyzer. The team witnessed UTC perform a calibration check of the analyzer and verified that the analyzer was appropriately calibrated for the range of use applicable to the CPN powder. The resultant mixture actually contains a range of particle sizes and SPX/UTC has specified a maximum mean particle size as an acceptance criteria for the CPN powder mixture. The team questioned whether the particle size distribution around the mean could also be important to ensuring reliable cartridge ignition. In response to the team's questions, SPX generated Corrective Action Request #943, dated 9/25/2013, and indicated that they would add an additional check to either quantitatively or qualitatively evaluate the particle distribution size for each lot of CPN. The team considered this to be a minor issue and an enhancement to the current procedures.

The team identified that UTC manufactures the CPN from individual mix constituents procured from commercial suppliers. As defined in CDI 399896, Revision 8, dated 5/16/2013, SPX's overall process for "dedicating"[2] the explosive cartridges being manufactured by UTC, requires

[2] 10 CFR Part 21.3, defines "Dedication" as … an acceptance process undertaken to

specific testing of each powder mix for heat of explosion and carbon content. The SPX dedication process does not however require that testing or methods be employed to verify the composition of the CPN individual mix constituents. While certificates of conformance were provided to UTC by the commercial suppliers of the mix constituents stating that the products meet the purchase specifications (which include purity requirements), the certificates of conformance were not validated by either UTC or SPX through an audit of the supplier or through any other means. While not a specific concern for powder lots that will actually be subjected to environmental qualification testing, the team was concerned that subsequently produced powder lots could contain contaminants that could degrade performance under design basis conditions but would not be detected by the currently specified dedication process. This concern would make it difficult to verify that any production cartridges containing explosive powder from a different lot were in fact bounded by components that were actually subjected to the qualification testing.

Criterion III, "Design Control," of Appendix B to 10 CFR Part 50, states, in part, that "applicable regulatory requirements and the design basis are correctly translated into specifications, drawings, procedures, and instructions." It also states that "measures shall be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems, and components."

The team determined that contrary to Criterion III of Appendix B to 10CFR Part 50, "Design Control," SPX/UTC had not established sufficient measures for the review for suitability of application of the explosive powder which is a safety-related component within the squib valve system. Specifically, SPX/UTC had not identified all critical characteristics of the explosive powder mix nor had SPX/UTC instituted controls sufficient to ensure the absence of contaminants from the explosive powder mix through inspections, tests, or analysis. This item was identified as Nonconformance 99900080/2013-01-02. This inspection finding is associated with ITAAC s 2.2.02.a.v and 2.2.03.12a.ii.and is material to the ITAAC acceptance criteria because the finding concerns the adequacy of the testing performed to ensure that the production squib valves will be bounded by those that were tested through the qualification program.

c. Conclusions

The team verified the procedure provided sufficient guidance for production of the CPN powder. The team identified that UTC verifies correct particle size by performing sample testing of each powder lot using a particle analyzer. The team determined that SPX had not identified all critical characteristics of the explosive powder mix or instituted controls sufficient to ensure the absence of contaminants from the explosive powder mix through inspections, tests, or analysis. This item was identified as Nonconformance 99900080/2013-01-02. This inspection finding is associated with ITAAC s 2.2.02.a.v and 2.2.03.12a.ii.and is material to the ITAAC acceptance criteria because the finding concerns the adequacy of the testing performed to ensure that the

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provide reasonable assurance that a commercial grade item to be used in a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR Part 50, Appendix B, quality assurance program. This assurance is achieved by identifying the critical characteristics of the item and verifying their acceptance by inspections, tests, or analysis performed by the purchaser or third party dedicating entity…."

production squib valves will be bounded by those that were tested through the qualification program.

3. Review of Root Cause Analysis Reports Associated with Anomalous Cartridge Performance

a. Scope

The team reviewed the Failure Analysis Report (FAR) and Root Cause Analysis which were conducted by SPX/UTC after several explosive cartridges exhibited anomalous performance during previous testing. During the 80% margin testing of HP cartridges and the lot acceptance testing of LP and ADS cartridges, UTC observed unusually large and variable time delays between the application of electrical current to the initiator and first indication of pressure in the cartridge. Most significant was the fact that one of the cartridges failed to fire even though its initiator fired successfully.

b. Findings and Observations

The inspection team identified that the SPX/UTC FAR consisted of a detailed fault tree analysis. The team identified that the most possible failure modes were analyzed and evaluated. The report concluded that the root cause of the ignition anomalies was a CPN powder particle size that was too large (even though it was within the specified tolerance range that had been developed for the powder at that time); however, the report did not address what aspect of the design development process failed, resulting in the selection of an inappropriate mean particle size for the CPN powder. Also, the report did not assess as a possibility that the initiator design output was insufficient to reliably ignite the cartridge. The team found SPX/UTC's specific corrective actions to this issue (which included the establishment of a new lower limit on the CPN powder mean particle size) to be reasonable to address the stated root cause. The corrective actions also included establishing a new requirement to monitor the ignition pressure and time to ignition for the cartridges subjected to lot acceptance testing; however, the corrective actions were incomplete in that they failed to address the possibility of insufficient initiator output. Failure of SPX/UTC to sufficiently validate this aspect of the design is identified as a nonconformance in paragraph 1 of this report. No additional findings were identified.

c. Conclusion

The inspection team identified that the SPX/UTC FAR consisted of a detailed fault tree analysis. The team identified that the most possible failure modes were analyzed and evaluated properly; however, the fault tree did not assess as a possibility that the initiator design output was insufficient to reliably ignite the cartridge. Failure of SPX/UTC to sufficiently validate this aspect of the design is identified as a nonconformance in paragraph 1 of this report. No additional findings were identified.

4. Welding of Internal and External Seals

a. Scope

The inspection team reviewed activities and documentation associated with the welding of the cartridge internal and external seals. The external seal prevents moisture intrusion into the cartridge. The internal seal separates the granular from explosive powder and allows sufficient pressure to develop inside the powder chamber of the cartridge to ensure reliable ignition. SPX/UTC's Standard 5059 and UTC Standard 3.3.8-3 provides detailed welding requirements

for welding these seals in accordance with the overlying Westinghouse Design Specification APP-PV98-ZO-001. These standards specify requirements for non-structural resistance spot welding for pyrotechnic bridgewires, the development of the laser weld schedules, and the acceptance criteria consisting of visual inspections of the weld joints and non-destructive tests. The NRC inspection team witnessed the test set-up for welding of the internal and output closure disks and interviewed the laser welding technician onsite. The team determined that the test-setup was in accordance with the detailed welding instructions of UTC's 17399. The team also witnessed helium leak rate tests for the 14-inch ADS squib valve cartridge assemblies that were performed to demonstrate the integrity of the internal and external welds.

b. Findings and Observations

The team identified that the cartridge assembly consists of a thin internal steel disc separating the ignition cavity from the main propellant chamber. The internal disc is laser welded onto the shoulder in the ignition cavity and has an etched pattern that allows a controlled fracture along the etched lines. The team identified that a documented basis did not exist to demonstrate that the method used to weld the internal disc was strong enough to prevent premature disc separation from the cartridge body prior to the desired etched pattern fracture. As a result of the team's questions, SPX initiated CAR #943, dated September 25, 2013, to document this issue. The CAR specified as a corrective action that a sample cartridge will be tested from each production lot to ensure that the weld strength is sufficient. This was identified as a minor issue as there was no indication that the weld strength is insufficient and the correctives action specified in the CAR should be sufficient to address any potential concerns.

No findings of significance were identified.

c. Conclusions

The inspectors determined that the implementation of SPX/UTC programs for the welding of the internal and external seals was in accordance with the regulatory requirements of Criterion IX of Appendix B to 10 CFR Part 50. No findings of significance were identified.

5. Non-destructive Testing of Cartridge

a. Scope

The inspection team reviewed activities and documentation associated with the non-destructive testing of the production cartridges, initiators and propellant. This testing is important as it ensures that the component parts of the cartridge have been properly manufactured and assembled to meet design specifications. The specified testing included a(n):

- Proof Pressure Test
- Leak Test
- X-Ray
- Insulation Resistance
- Dielectric
- Bridge Wire Resistance
- Electrostatic Discharge

- Product Examination
- Moisture Content Test

The team reviewed manufacturing, individual, and lot sample acceptance test procedures and work orders requesting the tests and describing test results. The team interviewed personnel who performed equipment testing and calibration of equipment used in non-destructive testing.

b. Findings and Observations

The non-destructive test protocol was found to be sufficient to ensure the proper manufacture and assembly of the cartridges. All personnel interviewed were trained and knowledgeable of the testing procedures and could explain procedures for addressing material that did not conform to design standards.

c. Conclusions

The inspection team reviewed activities and documentation associated with the non-destructive testing of the production cartridges, initiators and propellant. No findings of significance were identified.

6. Loading of Explosive Powder

a. Scope

The inspection team reviewed the manufacturing procedure for cartridge assembly of the 8-Inch high pressure squib valves, including specific instructions concerning the loading of the propellant into the cartridge. The team also reviewed the Moisture Test Data Report, “Standard 3.5.1.1.1 (w)” for the propellant being loaded and the scale calibration certification report for the scale being used. The team witnessed the loading of propellant into the cartridge. Loading personnel were interviewed and their training and qualifications forms were reviewed.

The team reviewed the results of the last explosive safety inspection conducted by the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATFE). In that inspection four issues were identified.

b. Findings and Observations

The personnel loading the cartridge were found to be trained and knowledgeable of their duties in the loading process. The team verified that the four issues contained in the ATFE report had been corrected and had no impact on the subject activities. No findings of significance were identified.

c. Conclusion

No findings of significance were identified associated with the controls instituted to load explosive powder into the squib valve cartridges.

7. Review of Non-conformance Reports and Corrective Action Documents

a. Scope

The NRC inspection team reviewed several nonconformance and corrective action documents with an emphasis on the squib valve explosive cartridges to verify that procedures were established and implemented for controlling nonconforming materials, parts or components and for correcting conditions adverse to quality in accordance with Criteria XV and XVI of Appendix B to 10 CFR Part 50. The team assessed whether SPX/UTC had (1) dispositioned the nonconformance reports in accordance with approved procedures, (2) presented an appropriate technical justification for various dispositions, and (3) taken appropriate corrective actions with regard to the nonconforming materials or items. In addition, the inspection team discussed the nonconformance and corrective action programs with SPX/UTC management and technical staff.

b. Findings and Observations

The inspectors verified that the nonconformance reports were reviewed and evaluated in accordance with SPX/UTC QA manual and procedures. The inspection team had no findings of concern in this inspection area; however, the team determined that SPX had closed two corrective action reports (CARs 850 and 881) before ensuring that the specified corrective actions had been implemented. These CARs involved issues with traceability of explosive powder lots and a lost work order at UTC. The team determined that SPX had closed the CARs upon the receipt of UTC's proposed corrective actions without verifying whether the proposed corrective actions had been implemented. The specified corrective actions included the revisions of work instructions for issuing work orders, creating storage locations for work orders, training in all departments for a new work order process, and monitoring the effectiveness of the corrective actions that were implemented. During the inspection, the team could find no objective evidence that all these corrective actions had been implemented on site. The team determined that contrary to Criterion XVI, "Corrective Action," of Appendix B to 10 CFR Part 50, SPX/UTC had failed to promptly correct conditions adverse to quality associated with the traceability of explosive powder and control of work orders. This issue is identified as Nonconformance 99900080/2013-01-03.

c. Conclusions

The NRC inspection team determined, that for the samples inspected, SPX/UTC adequately implemented its procedures to control nonconforming materials, parts, and components as required by Criterion XV of Appendix B to 10 CFR Part 50.

The inspectors also reviewed SPX/UTC's implementing procedures governing the corrective action process to verify compliance with the requirements of Criterion XVI, "Corrective Action," of Appendix B to 10 CFR Part 50. Based on this review, the inspectors issued Nonconformance 99900080/2013-201-03, for failure to implement all corrective actions associated with CARs 881 and 850.

8. Review of Calibration Records for Critical Instruments

a. Scope

The NRC inspection team reviewed measuring and test equipment (M&TE) policies and procedures to determine if SPX/UTC's controls were in compliance with the regulatory requirements of Criterion XII, "Control of Measuring and Test Equipment," of Appendix B to 10 CFR Part 50. The NRC inspection team sampled calibration records for M&TE to ensure that the instruments and testing devices used in the production and testing of the squib valve cartridges were properly controlled. The inspection team verified calibration records for M&TE used during the dedication process to verify the correct dimensions of the cartridges. The inspection team confirmed that these instruments were calibrated and appropriate for the range of operation for each described activity. The NRC inspection team also reviewed calibration records for UTC's laser particle size analyzer and glass microspheres which are used to measure the particle size of the CPN powder which is critical to ensuring reliable cartridge ignition. The inspection team verified that the certificates of calibration services were traceable to National Institute of Standards and Technology (NIST) standards and verified the accuracy of critical values used in the testing requirements of this equipment. In addition, the inspectors verified the implementation of M&TE control through direct observation of inspection activities of SPX/UTC personnel and discussed M&TE processes with SPX/UTC management and technical staff. Specifically, during the helium leak rate testing activities the NRC inspection team witnessed the calibration of the helium leak machine and associated equipment and verified calibration stickers and calibration dates were current.

b. Findings and Observations

No findings of significance were identified.

c. Conclusions

The inspectors determined that SPX/UTC has established a program that adequately controls calibration and use of M&TE 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.

9. Exit Meeting

On September 27, 2013 the inspectors presented the inspection scope and findings during an exit meeting. Representatives from UTC, SPX, and Westinghouse were in attendance.

ATTACHMENT

1. PERSONS CONTACTED

Name	Title	Affiliation	Entrance	Exit	Interviewed
Jeffrey Jacobson	Inspection Team Leader	NRC	x	x	
Ralph Way	Senior Level Advisor	NRC	x	x	
Sirri Oguz	Consultant	NASA	x	x	
Shavon Edmonds	Inspector	NRC	x		
Richard Kuntz	Quality Assurance Manager	SPX	x	x	x
David Ristau	Engineering Manager	SPX	x	x	x
Ron Wessel	Licensing Engineer	Westinghouse	x	x	
Steve McDonald	Chief Engineer	SPX	x	x	x
April Maestas	Quality Analyst	UTC	x	x	x
Daniel Galasso	Program Manager	UTC	x	x	x
Mike Laubham	Lead Quality Engineer	Westinghouse	x		
Tom Bierman	Director of Quality Assurance	SPX	x		
Preston Vock	Mechanical Engineering Manager	Westinghouse	x		
Aaron Bennetts	Site Leader	UTC		x	
Dana Mays	Quality Assurance Inspector	SPX	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
99900080/2013-201-01	Open	NON	Criterion III
99900080/2013-201-02	Open	NON	Criterion III
99900080/2013-201-03	Open	NON	Criterion XVI

INSPECTIONS, TESTS, ANALYSES AND ACCEPTANCE CRITERIA

The U.S. Nuclear Regulatory Commission (NRC) inspectors identified the following inspections, tests, analyses, and acceptance criteria (ITAAC) related to components being designed, manufactured, and tested by SPX. At the time of the inspection, SPX was involved in design, manufacturing, and testing of squib valves for the Westinghouse AP1000 reactor design. For the ITAAC listed below, the NRC inspection team reviewed applicable quality assurance controls, test data, and analyses in the areas of design validation and lot acceptance testing, manufacturing and assembly, corrective actions, control of special processes, non-destructive testing of the explosive cartridge, and calibration of critical instruments. 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 closed. The NRC inspection team identified findings associated with the ITAAC identified below.

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.

5. DOCUMENTS REVIEWED

- Purchase Orders
    - PO 4500338123 from SPX Flow Technology to UTC dated September 20th, 2013
    - PO 4500720345 from SPX Flow Technology to UTC dated September 20th, 2013
    - PO 4500750662 from SPX Flow Technology to UTC dated September 20th, 2013

- Corrective Actions and Nonconformance Reports
    - SPX Nonconformance Report 051483, “Equipment: Cartridge Housing” dated September 25th, 2013
    - SPX Corrective Action Report (CAR) 881, “Lost traceability of the QME 2 powder” date issued to UTC June 5th , 2013
    - SPX Corrective Action Report (CAR) 756, “Initiator Housing supplied not machined to print” date issued to UTC August 7th , 2012
    - SPX Corrective Action Report (CAR) 850, “Cartridge powder mixing issue at UTAS PN 17399105-1” date issued to UTC March 7th, 2013
    - UTC Corrective Action Report (PCAR) # 5480, “Cartridge powder mixing issue” dated March 8th, 2013
    - UTC Corrective Action Report/Root Cause (RRCA) Form R5523, “Manufacturing work order for CPN Powder” dated June 17th , 2013
    - UTC PCAR # 5442 “Accratronics machines the body of the initiator” dated November 5th,2012

- Procedures
    - UTC standard 8.1.17, “Work instructions for internal and supplier preventive and corrective actions”, Revision R, dated October 1st , 2012
    - UTC standard 8.1.18, “Work instructions for nonconforming material”, Revision R, dated December 6th, 2002
    - UTC Standard 5059, “Process specification for bridgewire welding with the Huges welder”, Revision D, dated Jan 4th 1994
    - UTC Standard 3.3.8-3, “Laser Beam Welding With an ND: Yag Welder” Revision A, dated December 29th, 1993
    - UTC 17399(03), MP “Manufacturing Procedure for the cartridge housing assembly 8-inch High pressure squib valve”, dated September 24th, 2009
    - UTC 17399(04), MP “Manufacturing Procedure for the assembly 14-inch ADS squib valve”, dated September 24th, 2009
    - UTC 17399(02), MP “Manufacturing Procedure for the assembly 8-inch low pressure squib valve”, dated September 24th, 2009
    - UTC Standard 8.1.52, “Calibration system-work instructions”, dated Jan 6th , 2003
    - UTC standard M-1291, “Microtrac Particle Size Analysis”, Revision C, dated April 11th , 2007
    - Acceptance Test Procedures (ATP) - Manufacturing Procedures for the Initiator Assembly PN 17399400-1, dated 23 September 2009

- Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Initiator Assembly, PN 17399400-1; Westinghouse Specification APP-PV98-ZO-001, dated 22 September 2009
- X-Ray Inspection Procedure for the Initiator Assembly PN 17399400-1; Westinghouse Specification APP-PV98-ZO-001, dated 22 September 2009
- Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Cartridge Assembly, 8" LP;l UTAS PNs 399896-1,-2 & 3 and Initiator Assembly, PN 17399400-1, Prepared by UTC Aerospace systems Interiors, dated 31 January 2012
- Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Cartridge Assembly, 14" ADS; UTAS PNs 17399300-1,-2, & 3 or SPX PNs 400967-1, -2 & -3 and Initiator Assembly PN 17399400-1, dated 31 January 2012
- Manufacturing Procedure for Cartridge Assembly, 8-Inch High Pressure Squib Valve UTAS PNs 17399300-1,-2, & 3; SPX PNs 400967 -1, -2, & -3; Prepared by UTC Aerospace systems Interiors, dated 24 September 2009
- Manufacturing Procedure for Cartridge Housing Assembly UTAS PNs 17399300-1,-2, & 3 SPX PNs 400967 -1, -2, & -3; dated 24 September 2009
- General Procedures for the Preparation of Carbon Potassium Nitrate (CPN) Powder, PN 17399105-1, dated 30 September 2009
- General Procedures for the Preparation of Carbon Potassium Nitrate (CPN) Granules PN 17399105-2, dated 30 September 2009

- MISC

  - SPX/Copes-Vulcan Commercial Grade Dedication Instruction CDI# 400966 for "8" HIGH pressure squib valve cartridge assembly", Revision 9, dated May 16th, 2013
  - SPX/Copes-Vulcan Commercial Grade Dedication Instruction CDI# 400967 for "8" ADS squib valve cartridge assembly", Revision 9, dated May 16th, 2013
  - SPX/Copes-Vulcan Commercial Grade Dedication Instruction CDI# 399896 for "8" LOW pressure squib valve cartridge assembly", Revision 8, dated May 16th, 2013
  - QC86-399896 "8" LP Squib valve Cartridge Assembly", Revision, 5 dated June 1st, 2012
  - QC86-400967 "14" ADS Squib valve Cartridge Assembly", Revision 5, dated June 1st, 2012
  - QC86-400966 "8" HP Squib valve Cartridge Assembly", Revision 5, dated June 1st, 2012

- Calibration Data

  - Dukes Standards "Borosilicate Glass Microspheres" NIST Traceable Mean Diameter, calibrated on November 13th , 2012
  - UTC Calibration of 2'Digital indicator Model # 543-525-1, calibrated on April 30, 2013
  - UTC Calibration of 6' Caliper Model #599-579-5, calibrated on November 7th , 2012
  - UTC Calibration of Optical Comparator Model #HB400, calibrated on June 15th, 2013
  - UTC Calibration of 2.4-2.8 DIA Intrimik Model#531B 2.4-2.8, calibrated on April 10, 2013

- UTC Calibration of 2.0-2.4 DIA Intrimik Model# 281, calibrated on December 1st 2012
- UTC Calibration data on the Helium Leak machine equipment #GTO1856, calibrated on July 20th, 2013

- Work Orders
  - Work Order 17771A0002 dated January 28, 2011/ Manufacturing Procedures for the Initiator Assembly
  - Work Order 17771A0002 dated January 28, 2011 for Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Initiator Assembly
  - Work Order 17771A0002 dated January 28, 2011 for / X-Ray Inspection Procedure for the Initiator Assembly
  - Work Order 18172A0003 dated 5/31/2012 for Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Cartridge Assembly, 8" LP
  - Work Order 18172A0002 dated June 4, 2012
  - Work Orders 18172A0001/001 dated June 15, 2012, for Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Cartridge Assembly, 14" ADS
  - Work Orders 18172A0001/002 dated June 15, 2012 for Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Cartridge Assembly, 14" ADS
  - Work Orders 18172A0001/002 dated June 15, 2012 for Individual Acceptance Test and Lot Sample Acceptance Test Procedures for the Cartridge Assembly, 14" ADS
  - Work Order 18172A2001/dated December 15, 2011