August 22, 2017

Mr. Joseph Carter
Quality Assurance Manager
Flowserve Corporation
1900 S. Saunders St.
Raleigh, NC 27603

SUBJECT: FLOWSERVE CORPORATION'S NUCLEAR REGULATORY COMMISSION INSPECTION REPORT NO. 99901356/2017-201 AND NOTICE OF NONCONFORMANCE

Dear Mr. Carter:

On July 17-20, 2017, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an inspection at the Flowserve Corporation's (hereafter referred to as Flowserve) facility in Raleigh, North Carolina. The purpose of this reactive inspection was to assess Flowserve's compliance with provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 21, "Reporting of Defects and Noncompliance," and selected portions of Appendix B, "Quality Assurance Program Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

This technically-focused inspection specifically evaluated Flowserve's implementation of the quality activities associated with the design, fabrication, and testing of safety-related valves and valve replacement parts being supplied for the Westinghouse Electric Company AP1000 reactor design and to the current operating reactors. The enclosed report presents the results of the inspection. This NRC inspection report does not constitute NRC endorsement of Flowserve's overall quality assurance (QA) program.

During this inspection, the NRC inspection team found that the implementation of your QA program did not meet certain regulatory requirements imposed on you by your customers or NRC licensees. Specifically, the NRC inspection team determined that Flowserve was not fully implementing its QA program in the areas of instructions, procedures, and drawings, control of purchased equipment, materials, and services, and control of special processes. The specific findings and references to the pertinent requirements are identified in the enclosures to this letter. In response to the enclosed notice of nonconformance (NON), Flowserve should document the results of the extent of condition review for these findings and determine if there are any effects on other previously delivered safety-related components.

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

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's Public Document Room or from the NRC's Agencywide Documents Access and Management System, which is accessible at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response

(and 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, 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 be 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 would 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, "Protection of Safeguards Information: Performance Requirements."

Sincerely,

/RA/

John P. Burke, Chief
Quality Assurance Vendor Inspection Branch-2
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Docket No.: 99901356

Enclosures:
1. Notice of Nonconformance
2. Inspection Report No. 99901356/2017-201
   and Attachment

SUBJECT: FLOWSERVE CORPORATION'S NUCLEAR REGULATORY COMMISSION INSPECTION REPORT NO. 99901356/2017-201 AND NOTICE OF NONCONFORMANCE

Dated: August 22, 2017

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OFC	NRO/DCIP	NRO/DCIP	NRO/DEI	NRO/DEI
NAME	YDiaz-Castillo	RMcIntyre	JHoncharik (YDiaz-Castillo for)	NHansing
DATE	08/21/17	08/18/17	08/21/17	08/17/17
OFC	RIII/DRS	RIII/DRS	NRO/DCIP	NRO/DCIP
NAME	ADunlop*	LRodríguez*	SSmith	JBurke
DATE	08/03/17	08/17/17	08/22/17	08/22/17

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NOTICE OF NONCONFORMANCE

Flowserve Corporation
1900 S. Saunders St.
Raleigh, NC 27603

Docket No. 99901356
Report No. 2017-201

Based on the results of a U.S. Nuclear Regulatory Commission (NRC) inspection conducted at the Flowserve Corporation's (hereafter referred to as Flowserve) facility in Raleigh, NC, from July 17, 2017, through July 20, 2017, Flowserve did not conduct certain activities in accordance with NRC requirements that were contractually imposed upon Flowserve by its customers or NRC licensees:

A. Criterion VII, "Control of Purchased Material, Equipment, and Services," 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 "Measures shall be established to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures shall include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery."

   Subsection NCA-1140 (a), "Use of Code Editions, Addenda, and Cases," in Subsection NCA, "General Requirements for Division 1 and Division 2," of Section III, "Rules for Construction of Nuclear Facility Components," of the American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel (B&PV) Code, 2015 Edition, states, in part, that "Except as otherwise permitted by this Code and stipulated in the Scope of a certificate, the latest Code Edition and Addenda shall become mandatory for Quality System Program (NCA-3800) and Quality Assurance (Article NCA-4000) requirements 6 months after the date of issuance."

   Subsection NCA-3842.2, "Evaluation of the Qualified Material Organization's Program by Certified Material Organizations of Certificate Holders," in Subsection NCA of Section III of the ASME B&PV Code, states, in part, that "Evaluation of a Material Organization's Quality System Program by parties other than the Society, as provided by NCA-3820(b), shall be performed in accordance with the requirements of (a) through (i) below. […] (b) The Quality System Manual (NCA-3853.1) shall be the party's guide for surveying and auditing the qualified Material Organization's continued compliance with the accepted Quality Systems Program."

   Subsection NCA-3851.2(a), "Scope and Applicability," in Section III of the ASME B&PV Code, 2015 Edition, states, in part, that "The Quality System Manual shall define the specific activities included in the scope of the work the Material Organization proposed to perform, including any combination of […]"

Subsection NCA-3853.1, “Quality System Manual,” in Section III of the ASME B&PV Code, 2015 Edition, states, in part, that “The Quality Program shall be described and summarized in a Quality System Manual that shall be a major basis for demonstration of compliance with the rules of this Section.”

Contrary to the above, as of July 20, 2017, Flowserve failed to establish adequate measures for source evaluation and selection of contractors and subcontractors to assure that purchased material, equipment, and services conformed to procurement documents. Specifically, the NRC inspection team determined that Flowserve failed to adequately qualify material organizations (i.e., castings and forgings) as approved suppliers in accordance with the requirements of NCA-3842.2. The NRC inspection team identified several instances in which the audit checklists did not provide sufficient objective evidence to support the conclusion that the suppliers had met the controls and applicable requirements of Subsection NCA-3850, “Quality System Program Requirements.”

This issue has been identified as Nonconformance 99901356/2017-201-01.

B. Criterion VII of Appendix B to 10 CFR Part 50, states, in part, that “Measures shall be established to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures shall include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery.”

Subsection 7.2.5 of Flowserve’s Quality Assurance Manual (QAM), Revision 41, dated September 18, 2015, states that “The QA Engineer/Lead Auditor shall select a qualified Lead Auditor to perform the initial survey of the vendor's facility to determine whether the Quality Program in effect complies with the applicable requirements of the Code and other pertinent specifications.”

Subsection 7.2.6.1 of Flowserve’s QAM states that “Additional audits of nuclear vendors shall be commensurate with the schedule of production or procurement but shall be at least once triennially of all elements of the previously approved Quality System Program during the interval in which the Material/Item/service is being controlled by the Vendor. Audits shall be performed in accordance with Paragraph 7.2.5.”

Contrary to the above, as of July 20, 2017, Flowserve failed to establish adequate measures for source evaluation and selection of contractors and subcontractors and failed to establish adequate measures to obtain objective evidence of quality furnished by the contractors or subcontractors. Specifically, the NRC inspection team determined that:

1. Flowserve’s evaluation to audit and approve safety-related heat treating and testing service suppliers’ (Bodycote, East Caroline Metal Treating, and Exova), quality assurance programs failed to provide sufficient objective evidence to demonstrate that they had met these programs.

2. Flowserve's external audit reports of Aruna Alloy Steels Pvt. Ltd., Pradeep Metals ltd., Trinity Forge, and Wodin Incorporated, failed to provide objective evidence to confirm that the applicable quality criteria were adequately verified.

This issue has been identified as Nonconformance 99901356/2017-201-02.

C. Criterion IX "Control of Special Processes," of Appendix B to 10 CFR Part 50, states, in part, that "Measures shall be established to assure that special processes, including welding, heat treating, and nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements."

Section 5.2 of Flowserve's Plant Internal Operating Procedure (PIOP) No. 36-40-14, "Control of Welding Materials," Revision 14, dated June 12, 2017, states that "The Supervisor or his designee shall make the necessary entries in the Welding Material Control Log (Exhibit IV), and obtain the designated WMS [Welding Method Specification, same as the Welding Procedure Specification] and appropriate welding materials as referenced in the WMS. The time of entry shall be made in the Welding Material Control Log by the Welding Supervisor or his designee." In addition, Section 5.6 states that "Covered electrodes shall be returned to the weld rod ovens within three (3) hours. Non consumed coated electrodes shall be placed in designated holding ovens marked #1 and #2, which are controlled per paragraph 8.0. Number 1 is for the first shift and Number 2 is for second and third shift returned electrodes." Furthermore, Section 8.1 states that "Covered electrodes that are returned within the three (3) hour time limit shall be appropriately identified with heat and/or lot number and placed in an electrode holding oven maintained at 275F+/- 25F for a minimum of eight (8) hours. (There are two holding ovens; No. 1 - first shift, and No. 2 - second and third shift.) This material shall then be transferred from the holding oven to electrode storage oven to electrode storage ovens maintained at 275F +/- 25F by the shift supervisor at the start of shift."

Subsection NX-2440, "Storage and Handling of Welding Material," of Section III of the ASME B&PV Code, states that "Suitable storage and handling of electrodes, flux, and other welding material shall be maintained. Precautions shall be taken to minimize absorption of moisture by fluxes and cored, fabricated, and coated electrodes."

Contrary to the above, as of July 20, 2017, Flowserve failed to assure that special processes were controlled and accomplished using qualified procedures in accordance with applicable codes, standards, and specifications. Specifically, Flowserve failed to issue, control, and record weld filler metal as required by PIOP No. 36-40-14. The NRC inspection team noted that (1) the filler metal control area is unlocked and unattended, (2) each welder is issuing their own filler metal, and (3) welders are returning unused coated electrodes to the electrode storage oven in lieu of the holding oven as required by PIOP No. 36-40-14 to assure that the welding electrodes are baked for 8 hours to remove moisture prior to being used again in production. Coated welding electrodes that are not properly baked can contain moisture and could introduce hydrogen into the weld and result in delayed cracking and degradation of the weld.

This issue has been identified as Nonconformance 99901356/2017-201-03.

D. Criterion V, “Instructions, Procedures, and Drawings,” of Appendix B to 10 CFR Part 50, states that “Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings, of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.”

Criterion XIII, “Handling, Storage and Shipping,” of Appendix B to 10 CFR Part 50, states, in part, that “Measures shall be established to control the handling, storage, shipping, cleaning and preservation of material and equipment in accordance with work and inspection instructions to prevent damage or deterioration.”

Section 2.2.3.2, “Grinding, Brushing, Welding, and Brazing,” of Westinghouse Electric Company’s (WEC) Technical Specification No. APP-GW-Z0-602, “Cleaning and Cleanliness Requirements for Equipment for Use in Nuclear Supply and Associated Systems,” Revision 3, dated February 18, 2013, states, in part, that “Tools used in abrasive work operations on corrosion resistance alloys, such as grinding or wire brushing, shall not be used on or contain carbon steel or other materials that could contaminate the corrosion resistance alloy.”

Contrary to the above, as of July 20, 2017, Flowserve failed to establish work instructions or procedures to assure that activities affecting quality have been satisfactorily accomplished, and failed to control the cleaning and preservation of material and equipment to prevent damage or deterioration. Specifically, Flowserve did not have a work instruction or a procedure for the welders that specified that only stainless steel wire brushes are to be used on stainless steel components as required by the WEC Technical Specification No. APP-GW-Z0-602. In addition, Flowserve did not maintain cleanliness of safety-related stainless steel components to prevent damage or deterioration. Weld contamination can affect the components’ ability to resist degradation and affect the maintenance of the plant chemistry in the safety-related systems.

This issue has been identified as Nonconformance 99901356/2017-201-04.

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, Quality Assurance Vendor Inspection Branch-2 Vendor 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 and the results achieved; (3) the corrective steps that will be to avoid further noncompliance; and (4) the date when the corrective action will be completed. Where good cause is shown, the NRC will consider extending the response time.

Because your response will be made available electronically for public inspection in the NRC’s Public Document Room or from the NRC’s Agencywide Documents Access and Management System, which is 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 the NRC can make it 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 be withheld, 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 would 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, "Protection of Safeguards Information: Performance Requirements."

Dated this the 22nd day of August 2017.

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

Docket No.:	99901356
Report No.:	99901356/2017-201
Vendor:	Flowserve Corporation 1900 S. Saunders St. Raleigh, NC 27603
Vendor Contact:	Mr. Joseph Carter Quality Assurance Manager Email: joe.carter@flowserve.com Phone: 1-919-831-3220
Nuclear Industry Activity:	Flowserve Corporation (hereafter referred to as Flowserve) is an American Society of Mechanical Engineers Boiler & Pressure Vessel Code Certificate Holder with a scope of supply that includes design, fabrication, assembly and testing of valves, and flow control devices for safety-related applications, including commercial-grade dedication activities for parts, repairs, and services for existing installations. Flowserve is under contract with Westinghouse Electric Company to provide valves and valve components to the AP1000 reactor design. Flowserve also provides valves and valve replacement parts to the current fleet of operating reactors.
Inspection Dates:	July 17-20, 2017

Inspectors:			
	Yamir Diaz-Castillo	NRO/DCIP/QVIB-2	Team Leader
	John P. Burke	NRO/DCIP/QVIB-2	Branch Chief
	Richard P. McIntyre	NRO/DCIP/QVIB-2	
	John Honcharik	NRO/DEI/MCB	
	Nicholas J. Hansing	NRO/DEI/MEB	
	Andrew Dunlop Jr.	RIII/DRS/EB2	
	Lionel Rodríguez	RIII/DRS/EB2	Observer

Approved by:	John P. Burke, Chief Quality Assurance Vendor Inspection Branch-2 Division of Construction Inspection and Operational Programs Office of New Reactors

EXECUTIVE SUMMARY

Flowserve Corporation
99901356/2017-201

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a vendor inspection at the Flowserve Corporation's (hereafter referred to as Flowserve) facility in Raleigh, N.C, 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 also verified that Flowserve implemented a program under 10 CFR Part 21, "Reporting of Defects and Noncompliance," that met the NRC's regulatory requirements. The NRC inspection team conducted the inspection on July 17-20, 2017. This was the third NRC inspection at the Flowserve facility.

This technically-focused inspection specifically evaluated Flowserve's implementation of quality activities associated with the design, fabrication, and testing of safety-related valves and valve replacement parts for the Westinghouse Electric Company (WEC) AP1000 reactor design and for the current fleet of operating reactors. Specific activities observed by the NRC inspection team included:

- hydrostatic and pneumatic testing on a 6-inch motor operated valve (MOV) for Virgil C. Summer Nuclear Station (hereafter referred to as V.C. Summer) Unit 2
- hydrostatic testing on an 8-inch automatic depressurization system (ADS) MOV for Vogtle Electric Generating Plant (hereafter referred to as Vogtle) Unit 3
- functional testing on an 8-inch ADS MOV for Vogtle Unit 3
- receipt inspection of a body casting for a gate valve for Arkansas Nuclear One
- final inspection of two ½-inch globe valves for Browns Ferry Nuclear Plant
- ultrasonic testing inspection of a hinge pin replacement part for LaSalle County Station
- liquid penetrant testing (LP) inspection of a seat ring for a 38-inch valve for Vogtle Unit 3
- LP inspection of a bonnet for a 6-inch valve for Vogtle Unit 3
- radiographic testing of a welder as part of their American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code qualification
- welding on a stainless steel disk piston for an 8-inch valve for V.C. Summer Unit 2
- calibration of a digital micrometer, a digital caliper, and a micrometer at the calibration laboratory
- dimensional inspections and material verification of five actuator housings at the calibration laboratory as part of the commercial-grade dedication process

- attended the Management Review Board meeting, which consisted a morning walk through the shop to review reject tickets and an afternoon meeting to review actions associated with corrective action reports

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.

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 January 27, 2017, IP 43003, "Reactive Inspection of Nuclear Vendors," dated December 14, 2015, IP 43004, "Inspection of Commercial-Grade Dedication Programs," dated January 27, 2017, and IP 36100, "Inspection of 10 CFR Part 21 and Programs for Reporting Defects and Noncompliance," dated February 13, 2012.

With the exception of the nonconformances described below, the NRC inspection team concluded that Flowserve's QA policies and procedures comply with the applicable requirements of Appendix B to 10 CFR Part 50 and 10 CFR Part 21, and that Flowserve's personnel are implementing these policies and procedures effectively. The results of this inspection are summarized below.

Supplier Oversight

The NRC inspection team issued Nonconformances 99901356/2017-201-01 and 99901356/2017-201-02 associated with Flowserve's failure to implement the regulatory requirements of Criterion VII, "Control of Purchased Material, Equipment, and Services," of Appendix B to 10 CFR Part 50. Nonconformance 99901356/2017-201-01 cites Flowserve for failing to establish adequate measures for source evaluation and selection of contractors and subcontractors to assure that purchased material, equipment, and services conformed to procurement documents. Specifically, Flowserve failed to adequately qualify material organizations (i.e., castings and forgings) as approved suppliers in accordance with the requirements of NCA-3842.2, "Evaluation of the Qualified Material Organization's Program by Certified Material Organizations of Certificate Holders," in Subsection NCA, "General Requirements for Division 1 and Division 2," of Section III, "Rules for Construction of Nuclear Facility Components," of the ASME B&PV Code.

Nonconformance 99901356/2017-201-02 cites Flowserve for failing establish adequate measures for source evaluation and selection of contractors and subcontractors and for failing to establish adequate measures to obtain objective evidence of quality furnished by the contractors or subcontractors. Specifically, Flowserve's evaluation to audit and approve safety-related heat treating and testing service suppliers' (Bodycote, East Caroline Metal Treating, and Exova), quality assurance programs failed to provide sufficient objective evidence to demonstrate that they had met these programs. In addition, Flowserve's external audit reports of Aruna Alloy Steels Pvt. Ltd., Pradeep Metals ltd., Trinity Forge, and Wodin Incorporated, failed to provide objective evidence to confirm that the applicable quality criteria were adequately verified.

Manufacturing Control

The NRC inspection team issued Nonconformance 99901356/2017-201-03 associated with Flowserve's failure to implement the regulatory requirements of Criterion IX, "Control of Special Processes" of Appendix B to 10 CFR Part 50. Nonconformance 99901356/2017-201-03 cites Flowserve for failing to assure that special processes were controlled and accomplished using qualified procedures in accordance with applicable codes, standards, and specifications. Specifically, Flowserve failed to issue, control, and record weld filler metal as required by PIOP No. 36-40-14. The NRC inspection team noted that (1) the filler metal control area is unlocked and unattended, (2) each welder is issuing their own filler metal, and (3) welders are returning unused coated electrodes to the electrode storage oven in lieu of the holding oven as required by PIOP No. 36-40-14 to assure that the welding electrodes are baked for 8 hours to remove moisture prior to being used again in production. Coated welding electrodes that are not properly baked can contain moisture and could introduce hydrogen into the weld and result in delayed cracking and degradation of the weld.

In addition, the NRC inspection team issued Nonconformance 99901356/2017-201-04 associated with Flowserve's failure to implement the regulatory requirements of Criterion V, "Instructions, Procedures, and Drawings," and Criterion XIII, "Handling, Storage and Shipping," of Appendix B to 10 CFR Part 50. Nonconformance 99901356/2017-201-04 cites Flowserve for failing to establish work instructions or procedures to assure that activities affecting quality have been satisfactorily accomplished, and failed to control the cleaning and preservation of material and equipment to prevent damage or deterioration. Specifically, Flowserve did not have a work instruction or a procedure for the welders that specified that only stainless steel wire brushes are to be used on stainless steel components as required by the WEC Technical Specification No. APP-GW-Z0-602, "Cleaning and Cleanliness Requirements for Equipment for Use in Nuclear Supply and Associated Systems," Revision 3, dated February 18, 2013. In addition, Flowserve did not maintain cleanliness of safety-related stainless steel components to prevent damage or deterioration. Weld contamination can affect the components' ability to resist degradation and affect the maintenance of the plant chemistry in the safety-related systems.

Other Inspection Areas

The NRC inspection team determined that Flowserve is implementing its programs for training and qualification, 10 CFR Part 21, design control, commercial-grade dedication, utilization of unqualified source material, test control, control of M&TE, nonconforming material, parts, or components, and corrective action in accordance with the applicable regulatory requirements of Appendix B to 10 CFR Part 50 and 10 CFR Part 21. Based on the limited sample of documents reviewed and activities observed, the NRC inspection team also determined that Flowserve is implementing its policies and procedures associated with these programs. No findings of significance were identified.

REPORT DETAILS

1. Supplier Oversight

   a. Inspection Scope

   The NRC inspection team reviewed Flowserve Corporation's (hereafter referred to as Flowserve) 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, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." The NRC inspection team reviewed a sample of purchase orders (POs), external audits, and receipt inspection records to evaluate compliance with the applicable regulatory and technical requirements. The NRC inspection team also reviewed the disposition of audit findings for adequacy and timeliness.

   The NRC inspection team verified that the external audits were performed by qualified lead auditors and auditors. In addition, the NRC inspection team also reviewed a sample of training and qualification records of Flowserve's lead auditors and auditors and confirmed that auditing personnel had completed all the required training and had maintained qualification and certification in accordance with Flowserve's policies and procedures.

   The NRC inspection team also discussed the procurement document control and supplier oversight programs with Flowserve's management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

   b. Observations and Findings

   As an American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code N-Type Certificate Holder, Flowserve can qualify suppliers as Material Organizations (MOs) in accordance with Subsection NCA-3842.2, "Evaluation of the Qualified Material Organization's Program by Certified Material Organizations of Certificate Holders," in Subsection NCA, "General Requirements for Division 1 and Division 2," of Section III, "Rules for Construction of Nuclear Facility Components," of the ASME B&PV Code. These suppliers' quality assurance (QA) programs must meet the requirements of NCA-3800, "Metallic Organization's Quality System Program." In Information Notice No. 86-21, "Recognition of American Society of Mechanical Engineers Accreditation Program for N Stamp Holders," the NRC stated that having a quality assurance (QA) program based on NCA-3800 is evidence that the supplier has a documented QA program that meets the requirements of Appendix B to 10 CFR Part 50. However, since the NRC's recognition only applied to the programmatic aspects of the ASME accreditation program, users are still responsible for ensuring that the supplier is effectively implementing the approved QA program. For the procurement of safety-related components and services, these suppliers must also have a program that meets the requirements of 10 CFR Part 21, "Reporting of Defects and Noncompliance."

During the review of a sample of external audit reports, the NRC inspection team noted that most of Flowserve's suppliers of safety-related forgings and castings have QA programs that are based on the International Organization for Standardization (ISO) 9001:2008, "Quality Management System - Requirements." In order to qualify these suppliers as MOs, Flowserve must ensure that the suppliers' QA programs meet the requirements of Section NCA-3850, "Quality System Program Requirements," of Section III of the ASME B&PV Code, as required by Subsection NCA 3842.2 (a). Specifically, Subsection NCA-3442.2 (a) states: "The Quality System Program shall be surveyed, accepted, and audited by the party performing the evaluation on the basis of its compliance with the applicable material requirements of this Section and the requirements of NCA-3850." In addition, the quality manuals of these suppliers must meet the requirements of NCA-3853.1, "Quality System Manual," of Section III of the ASME B&PV Code, which states, in part, that "The Quality Program shall be described and summarized in a Quality System Manual that shall be a major basis for demonstration of compliance with the rules of this Section."

The NRC inspection team identified several instances in which the audit checklists did not provide sufficient objective evidence to support the conclusion that the suppliers' QA programs had the processes and controls in place to meet the applicable requirements of Subsection NCA-3850. For example, the NRC inspection team noted that the audit checklist requirements were identified as being met, however, there was no additional information provided within the checklist to support the auditor's conclusion that the applicable NCA-3850 requirement was met. In addition, the NRC inspection team reviewed the quality manuals of several of these suppliers to independently verify whether they met the requirements of NCA-3853.1, however, the quality manuals did not contain additional attachments or appendices that would address the gap between a QA program based on ISO 9001:2008 and a QA program based on Subsection NCA-3800.

The NRC inspection team identified this issue as an example of Nonconformance 99901356/2017-201-01 for Flowserve's failure to establish adequate measures for source evaluation and selection of contractors and subcontractors and failed to establish adequate measures to obtain objective evidence of quality furnished by the contractors or subcontractors. Flowserve initiated corrective action report (CAR) No. 1684 to address this issue. Flowserve should document the results of the extent of condition review for this Nonconformance and determine the effects on any previously delivered safety-related components.

In addition, during the review of a sample of external audit reports of suppliers of safety-related testing services, the NRC inspection team noted that the external audits did not contain adequate documented objective evidence to demonstrate that the suppliers had the processes and controls in place to meet the applicable requirements of Appendix B to 10 CFR Part 50. The NRC inspection team noted that these suppliers have QA programs that are based on the ISO/International Electrotechnical Commission (IEC) 17025:2005, "General Requirements for the Competence of Testing and Calibration Laboratories." Upon further discussions with Flowserve's staff, the NRC inspection team learned that it was Flowserve's intent to qualify these laboratories as suppliers of safety-related services even though these laboratories are commercial suppliers with QA programs that do not meet the applicable requirements of Appendix B to 10 CFR Part 50.

For commercial suppliers with QA programs that are based on ISO 17025:2005 as accredited by the International Laboratory Accreditation Cooperation (ILAC), the NRC has stated[1] that the accreditation provided by ILAC of the laboratories' ISO 17025:2005 programs may be used in lieu of performing a commercial-grade survey as part of the commercial-grade dedication process provided some specific conditions are met. The NRC inspection team identified this issue an example of Nonconformance 99901356/2017-201-02 for Flowserve's failure to establish adequate measures for source evaluation and selection of contractors and subcontractors and failed to establish adequate measures to obtain objective evidence of quality furnished by the contractors or subcontractors. Flowserve initiated CAR No. 1684 to address this issue. Flowserve should document the results of the extent of condition review for this Nonconformance and determine the effects on any previously delivered safety-related components.

Furthermore, for a sample of additional external audits reviewed, the NRC inspection team noted that the audit checklists did not adequately document the objective evidence necessary to confirm that the applicable quality criteria of the external audits were adequately verified. The audit checklists have two columns: the left column is titled "Method of Verification," which lists the requirements that needs to be verified, and the right column is titled "Assessment/Summary," which is where the lead auditor or auditor writes his or her assessment of how the requirement was met. The NRC inspection team noted that the objective evidence provided on how the requirements was met under the "Assessment/Summary" column was a verbatim statement from the description of the requirements that need to be verified with the substitution of the word "Verify" or "Assess" with the word "Confirmed." The NRC inspection team identified this issue as another example of Nonconformance 99901356/2017-201-02 for Flowserve's failure to establish adequate measures for source evaluation and selection of contractors and subcontractors and failed to establish adequate measures to obtain objective evidence of quality furnished by the contractors or subcontractors. Flowserve initiated CAR No. 1684 to address this issue. Flowserve should document the results of the extent of condition review for this Nonconformance and determine the effects on any previously delivered safety-related components.

c. Conclusion

The NRC inspection team issued Nonconformances 99901356/2017-201-01 and 99901356/2017-201-02 associated with Flowserve's failure to implement the regulatory requirements of Criterion VII of Appendix B to 10 CFR Part 50. Nonconformance 99901356/2017-201-01 cites Flowserve for failing to establish adequate measures for source evaluation and selection of contractors and subcontractors to assure that purchased material, equipment, and services conformed to procurement documents. Specifically, Flowserve failed to adequately qualify material organizations (i.e., castings and forgings) as approved suppliers in accordance with the requirements of NCA-3842.2 in Subsection NCA of Section III of the ASME B&PV Code.

Nonconformance 99901356/2017-201-02 cites Flowserve for failing establish adequate measures for source evaluation and selection of contractors and subcontractors and for failing to establish adequate measures to obtain objective evidence of quality furnished by the contractors or subcontractors. Specifically, Flowserve's evaluation to audit and

[1] Regulatory Issue Summary 16-01, "Nuclear Energy Institute Guidance for the Use of Accreditation in Lieu of Commercial Grade Surveys for Procurement of Laboratory Calibration and Test Services."

approve safety-related heat treating and testing service suppliers' (Bodycote, East Caroline Metal Treating, and Exova), quality assurance programs failed to provide sufficient objective evidence to demonstrate that they had met these programs. In addition, Flowserve's external audit reports of Aruna Alloy Steels Pvt. Ltd., Pradeep Metals ltd., Trinity Forge, and Wodin Incorporated, failed to provide objective evidence to confirm that the applicable quality criteria were adequately verified.

2. Manufacturing Control

a. Inspection Scope

The NRC inspection team reviewed Flowserve's 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 and with the requirements of Subsection NCA, Subsection NB, "Class 1 Components," Subsection NC, "Class 2 Components," and Subsection ND, "Class 3 Components," of Section III, Section V, "Nondestructive Examination," and Section IX, "Welding and Brazing Qualification," of the ASME B&PV Code, 1998 Edition, 2000 Addenda, and American Society for Nondestructive Testing (ASNT) SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing."

The NRC inspection team reviewed shop travelers/routing cards, Quality Assurance Procedures (QAPs), Standard Operating Instructions (SOI), weld procedure specifications (WPS)/weld metal specifications (WMS), supporting procedure qualification records (PQRs), and the calibration certificates of the welding equipment. The NRC inspection team also reviewed the processes for controlling weld filler metal and cleanliness of valve components to applicable procedures and technical specifications.

The NRC inspection team also reviewed the associated welder qualification records and confirmed that the welders had completed the required training and had maintained their qualifications in accordance with the applicable Flowserve procedures. The NRC inspection team also verified that the Flowserve procedure for welder qualification meets the applicable requirements of Sections III and IX of the ASME B&PV Code.

In addition, the NRC inspection team reviewed a sample of procedures and test reports associated with ultrasonic testing (UT), liquid penetrant testing (PT), radiographic testing (RT); Level II and Level III inspector qualifications, and the calibration certificates of the measuring and test equipment (M&TE). The NRC inspection team confirmed that the non-destructive examination (NDE) personnel were qualified in accordance with the requirements of ASNT SNT-TC-1A.

Furthermore, the NRC inspection team witnessed PT inspections of a seat ring for a 38-inch valve and of a bonnet for a 6-inch valve for Vogtle Electric Generating Plant (hereafter referred to as Vogtle) Unit 3. The NRC inspection team also witnessed UT inspection of a hinge pin replacement part for LaSalle County Station and an RT inspection as part of the ASME B&PV Code welder qualification. The NRC inspection team confirmed that all these inspections were performed in accordance with Flowserve's procedures. The NRC inspection team verified that the examinations were performed by qualified personnel and qualified procedures in accordance with the requirements of Sections III and V of ASME B&PV Code, and ASNT SNT-TC-1A.

The NRC inspection team also discussed the manufacturing control program with Flowserve's management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observation and Findings

At the time of the inspection, Flowserve was fabricating AP1000 valves for V.C. Summer, Units 2 and 3, and for Vogtle Units 3 and 4. The NRC inspection team witnessed manual shielded metal arc welding on an 8-inch stainless steel disk for V.C. Summer Unit 2. The NRC inspection team verified that the WPS was qualified in accordance with the applicable requirements of Sections III and IX of the ASME B&PV Code and the applicable PQRs. The PQRs were verified to meet the requirements of Section IX of the ASME B&PV Code.

The NRC inspection team verified that the applicable welding data; such as the weld material and heat/lot number, WPS, inspection procedures used, and that the final inspection results were recorded in accordance with the applicable Flowserve procedures and instructions. The welding data was recorded on the associated weld record for each weld joint along with the applicable NDE results.

While walking through the weld material storage area to verify how weld material was controlled, the NRC inspection team noted that the welding supervisor was not issuing and recording the filler metal used as required by Flowserve's Plant Internal Operating Procedure (PIOP) No. 36-40-14, "Control of Welding Materials," Revision 14, dated June 12, 2017. Specifically, Section 5.2 of PIOP No. 36-40-14 states that "The Supervisor or his designee shall make the necessary entries in the Welding Material Control Log (Exhibit IV), and obtain the designated WMS [Welding Method Specification, same as the Welding Procedure Specification] and appropriate welding materials as referenced in the WMS. The time of entry shall be made in the Welding Material Control Log by the Welding Supervisor of his designee." The NRC inspection team also noted that the filler metal control area is unlocked and unattended and each welder is issuing their own filler metal contrary to the requirements of PIOP No. 36-40-14. Filler metal control is required to assure that each heat of material is documented in the associated traveler/route card and that the correct filler material is used.

The NRC inspection team noted that Flowserve had previously identified another instance of lack of filler metal control the week before the inspection. This issue was documented in CAR No. 1679, dated July 14, 2017, which stated that "Contrary to the requirements of Quality Assurance Manual, Revision 41, SO#91376 had (2) valves where the welding operations/filler metal used could not be accurately confirmed and/or identified, based off of documentation reviewed. Welding completed between April 15, 2017, and April 18, 2017, showed evidence of missing/incorrect information within the weld logs, incorrect filler metal information, and welding of areas not intended for repair."

In addition, the NRC inspection team observed a welder returning unused coated electrodes to the electrode storage oven in lieu of holding oven as required by PIOP No. 36-40-14 to assure that the welding electrodes are baked for 8 hours to remove moisture prior to being used again in production. Specifically, Section 5.6 of PIOP

No. 36-40-14 states that “Covered electrodes shall be returned to the weld rod ovens within three (3) hours. Non consumed coated electrodes shall be placed in designated holding ovens marked #1 and #2, which are controlled per paragraph 8.0. Number 1 is for the first shift and Number 2 is for second and third shift returned electrodes.” Section 8.1 of PIOP No. 36-40-14 states that “covered electrodes that are returned within the three (3) hour time limit shall be appropriately identified with heat and/or lot number and placed in an electrode holding oven maintained at 275°F+/- 25°F for a minimum of eight (8) hours. (There are two holding ovens; No. 1 – first shift, and No. 2 – second and third shift.) This material shall then be transferred from the holding oven to electrode storage oven to electrode storage ovens maintained at 275°F+/- 25°F by the shift supervisor at the start of shift.” Furthermore, Subsection NX-2440, “Storage and Handling of Welding Material,” of Section III of the ASME B&PV Code, states that “Suitable storage and handling of electrodes, flux, and other welding material shall be maintained. Precautions shall be taken to minimize absorption of moisture by fluxes and cored, fabricated, and coated electrodes.” Coated welding electrodes that are not properly baked can contain moisture and could introduce hydrogen into the weld and result in delayed cracking and degradation of the weld.

The NRC inspection team identified this issue as an example of Nonconformance 99901356/2017-201-03 for Flowserve’s failure to assure that special processes were controlled and accomplished using qualified procedures in accordance with applicable codes, standards, and specifications. Flowserve initiated CAR No. 1680 to address this issue. Flowserve should document the results of the extent of condition review for this Nonconformance and determine the effects on any previously delivered safety-related components.

While the NRC inspection team was observing manual shielded metal arc welding on an 8-inch stainless steel disk on shop traveler/routing card No. 6601739117022 for V.C. Summer Unit 2, the NRC inspection team noted that the welder was using a wire brush with no identification on the stainless steel weld and on the disk. Section 2.2.3.2, “Grinding, Brushing, Welding, and Brazing,” of Westinghouse Electric Company’s Technical Specification No. APP-GW-Z0-602, “Cleaning and Cleanliness Requirements for Equipment for Use in Nuclear Supply and Associated Systems,” Revision 3, dated February 18, 2013, states, in part, that “Tools used in abrasive work operations on corrosion resistance alloys, such as grinding or wire brushing, shall not be used on or contain carbon steel or other materials that could contaminate the corrosion resistance alloy.”

The NRC inspection team proceeded to ask the welder and the welding supervisor what kind of material was the wire brush made out of, and initially, the welder and the welding supervisor stated that the wire brush was stainless steel. However, upon further questioning by the NRC inspection team and after performing material verification using Positive Material Identification (PMI), it was confirmed that the wire brush was in fact carbon steel and not stainless steel. At that time, an indeterminate number of these wire brushes or similar brushes could be in a welder’s possession and in the tool room area. By using the carbon steel wire brush on the stainless steel weld, the welder contaminated the stainless steel weld. Contamination can affect the components’ ability to resist degradation and affect the maintenance of the plant chemistry in the safety-related systems.

The NRC also identified that Flowserve did not have a work instruction or a procedure for the welders that specified that only stainless steel wire brushes are to be used on stainless steel components as required by the WEC's technical specification No. APP-GW-Z0-602. The shop traveler/routing card No. 006601739117022 for the welding of the 8-inch stainless steel disk for V.C. Summer Unit 2 and Flowserve's WMS/WPS No. P8-123N, Revision 2, did not specify that only stainless steel wire brushes are to be used on stainless steel. Also, Flowserve's QAP No. 09-91175, "Nuclear Valve Order –Westinghouse," Revision 43, dated November 11, 2016, which is used to develop route cards for WEC valves, did not specify that only stainless steel wire brushes are to be used on stainless steel.

The NRC inspection team identified this issue as an example of Nonconformance 99901356/2017-201-04 for Flowserve's failure to establish work instructions or procedures to assure that activities affecting quality have been satisfactorily accomplished, and failed to control the cleaning and preservation of material and equipment to prevent damage or deterioration. Flowserve initiated CAR No. 1686 to address this issue. Flowserve should document the results of the extent of condition review for this Nonconformance and determine the effects on any previously delivered safety-related components.

c. Conclusion

The NRC inspection team issued Nonconformance 99901356/2017-201-03 associated with Flowserve's failure to implement the regulatory requirements of Criterion IX of Appendix B to 10 CFR Part 50. Nonconformance 99901356/2017-201-03 cites Flowserve for failing to assure that special processes were controlled and accomplished using qualified procedures in accordance with applicable codes, standards, and specifications. Specifically, Flowserve failed to issue, control, and record weld filler metal as required by PIOP No. 36-40-14. The NRC inspection team noted that (1) the filler metal control area is unlocked and unattended, (2) each welder is issuing their own filler metal, and (3) welders are returning unused coated electrodes to the electrode storage oven in lieu of the holding oven as required by PIOP No. 36-40-14 to assure that the welding electrodes are baked for 8 hours to remove moisture prior to being used again in production. Coated welding electrodes that are not properly baked can contain moisture and could introduce hydrogen into the weld and result in delayed cracking and degradation of the weld.

In addition, the NRC inspection team issued Nonconformance 99901356/2017-201-04 associated with Flowserve's failure to implement the regulatory requirements of Criterion V and Criterion XIII of Appendix B to 10 CFR Part 50. Nonconformance 99901356/2017-201-04 cites Flowserve for failing to establish work instructions or procedures to assure that activities affecting quality have been satisfactorily accomplished, and failed to control the cleaning and preservation of material and equipment to prevent damage or deterioration. Specifically, Flowserve did not have a work instruction or a procedure for the welders that specified that only stainless steel wire brushes are to be used on stainless steel components as required by the WEC Technical Specification No. APP-GW-Z0-602. In addition, Flowserve did not maintain cleanliness of safety-related stainless steel components to prevent damage or deterioration. Weld contamination can affect the components' ability to resist degradation and affect the maintenance of the plant chemistry in the safety-related systems.

3. Design Control

a. Inspection Scope

The NRC inspection team reviewed Flowserve's policies and implementing procedures that govern the design control program to verify their compliance with the regulatory requirements of Criterion III, "Design Control," of Appendix B to Title 10 CFR Part 50, Subsection NCA, Subsection NB, Subsection NC, and Subsection ND of Section III of the ASME B&PV Code 1998 Edition, 2000 Addenda.

The NRC inspection team reviewed a sample of documents associated with the valve orders for V.C. Summer Units 3 and 4, and Vogtle Units 2 and 3 that including engineering drawings, method specifications, design specifications, route cards, engineering change notices (ECNs), and design reports and verified that these documents contained the required technical information in accordance with Flowserve's procedures and the applicable ASME B&PV Code requirements.

The NRC inspection team reviewed a design package for an 8-inch globe balanced stop valve with a Limitorque actuator for Vogtle Unit 3. Specifically, the NRC inspection team reviewed the certified design specification, design and seismic analysis report, design review meeting summary, ECNs, and the ASME B&PV Code Qualification of Active Mechanical Equipment Used in Nuclear Facilities-1 functional qualification report. The NRC inspection team confirmed that these documents included the correct technical and regulatory requirements per the customer specifications, Flowserve's procedures, and the applicable ASME B&PV Code requirements.

The NRC inspection team reviewed ECN No. 20399 to modify the stem thread length for an 8-inch globe balanced stop valve for Vogtle Unit 3. The NRC inspection team verified that the design change request received a level of review commensurate with that applied to the original design by a qualified design engineer, which included an analysis of the acceptability of the change request in relation to the associated applicable requirements of the ASME B&PV Code and Appendix B to 10 CFR Part 50. The NRC inspection team verified that the Flowserve design change process effectively translated the customer's request into the affected Flowserve documentation. Specifically, the Flowserve design engineer identified the applicable procedures, analyses, reports, drawings, and components affected by the design change request and verified that the revised design documentation continued to meet the necessary requirements.

The NRC inspection team also reviewed the corrective actions, including the engineering evaluations performed, associated with the recent failures of Anchor/Darling double disc gate valves that have occurred in the nuclear industry. More detailed information on this issue is provided in the "Observation and Findings" section below.

The NRC inspection team also discussed the design control program with Flowserve's management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observations and Findings

In February 2013, Flowserve submitted a 10 CFR Part 21 report associated with the failure of an Anchor/Darling double disc gate valve at the Browns Ferry Nuclear Plant (here after referred to as Browns Ferry). The failure was due to the shearing of the wedge pin, which serves a joint locking function at the threaded interface between the valve stem and upper wedge. The pin is designed to ensure the stem/wedge connection does not loosen, but is not designed to withstand the load applied by the motor actuator. In this case, once the pin sheared due to the high load applied by the valve actuator, the stem was able to rotate into the wedge during closing strokes an additional 90 degrees. The valve continued to function and was only disassembled after failing a local leak rate test. Upon disassembly, it was noted that the disc retainer clips that are normally attached with the wedge pin, had fallen into the valve. Further disassembly of the stem/wedge identified the sheared pin. The 10 CFR Part 21 report identified the issue to be the lack of pre-torque on the stem/wedge connection, which allowed an excessive load from the valve actuator to be applied to the wedge pin causing the pin to shear as it was not designed to withstand the full actuator output torque. A specific stem preload torque value based on valve size and class was not implemented by Flowserve until 1996. Actions recommended by Flowserve were to evaluate the susceptible valves for potential wedge pin failures and re-torque the stem/wedge connection.

In February 2017, LaSalle County Station (hereafter referred to as LaSalle) had an additional failure of an Anchor/Darling double disc gate valve. In this case, the wedge pin had sheared and the stem had pulled out of the wedge rendering the valve inoperable. Damage to the wedge threads from the sheared pin along with the high thrust exerted on the threaded connection over many years led to the ultimate failure of the wedge threads that sheared from the wedge itself. Based on this failure, the NRC initiated a Special Inspection Team (Inspection Report Nos. 05000373/2017007; 05000374/2017007) to review the licensee's response to the failure. The failure analysis performed by LaSalle concluded the failure was a design issue in that the pressed-on stem collar, even if it was properly torqued to the wedge assembly as recommended by the 10 CFR Part 21 report from 2013, would not be able to support the loads produced by the valve's motor-operator. This design issue was not addressed during the original 10 CFR Part 21 report as this type of failure was never assessed. In the early 1990's, Anchor/Darling had provided LaSalle with a weak link analysis for this valve in support of the licensee's motor-operated valve program. The analysis did not assess the wedge pin or the pressed-on collar, but assessed the whole stem/wedge assembly. This weak link analysis was not correct based on the licensee's failure analysis. As a result of this failure, Flowserve issued an additional 10 CFR Part 21 notification in July 2017 that addressed the failure at LaSalle in which the stem separated from the wedge after pin failure. The new 10 CFR Part 21 report discussed the failure analysis performed for the LaSalle valve and provided additional recommendations to address the issue that included: 1) torqueing stem into the wedge to maximum joint capacity; 2) replacement stems should have integral collars; 3) replacement pins are manufactured from high strength material; and 4) actuator stem thrust is less than the maximum allowed to maintain the stem preload.

As part of the follow-up on this issue, the NRC inspection team reviewed the 2013 and 2017 10 CFR Part 21 reports and held discussions about the Anchor/Darling failures with Flowserve's engineering staff. The Flowserve staff recognized the stem-collar role in maintaining the pre-load as stated in TA-158, which is an internal document (shop floor instruction) that was generated in 1993. The document addressed the lack of properly pre-torqueing the joints prior to wedge pin installation, which could result in distortion of the wedge pin when full operating torques were applied. Pre-torque performed before 1996 was not controlled and no specific torque values were used by the individuals assembling the stem/wedge connection. Tightening of the connection was left to the individuals assembling the connection. The TA-158 document was an attempt to ensure that the pre-torque was applied during assembly so that the pin would not see applied actuator loads during valve operation. However, the initial design incorrectly assumed that the collar was more than capable of withstanding applied actuator loads. Due to the incorrect assumption, the collar's capability was never analyzed. Based on discussions with Flowserve's engineering staff, since previous failures could be attributed to other causes, the capability of the collar was never questioned. In the engineering review of the Browns Ferry event in 2013, Flowserve did discuss the capability of the collar. However, because collar movement was not identified, this was dismissed. It was not until the LaSalle failure in 2017, when there was significant collar movement, along with the failure analysis, it was realized the collar was not capable of withstanding applied actuator loads.

Flowserve indicated that when production of the Anchor/Darling valve line moved from Williamsport, Pennsylvania to Raleigh, North Carolina, in the early 2000's, Flowserve introduced a change from the pressed-on stem collar to an integral stem collar to match stems produced for other valve lines. In addition, the original wedge pin material in many cases was not designed to independently withstand the actuator stem torque. The use of pins made of high strength material, along with the integral stem collar was part of the repairs for both the 2013 and 2017 10 CFR Part 21 reports. Furthermore, Flowserve continues to support the BWROG as requested to revise the industry guidance to address this issue.

During the inspection, the NRC inspection team noticed that although a 10 CFR Part 21 evaluation had been adequately documented for the LaSalle issue, a formal corrective action tracking Flowserve's internal corrective actions for the deficient weak link analysis provided to LaSalle in 1990 had not been generated. As previously stated, LaSalle requested a weak link analysis for the failed valve in support of the motor-operated valve program in the early 1990s. This analysis did not assess the stem collar or the wedge pin, but only addressed the whole stem/wedge assembly. Based on the LaSalle failure analysis, the weak link analysis performed by Anchor/Darling was deficient to address all of the valve's components to support the analysis. Flowserve indicated that weak link analyses are performed on a case by case basis and their engineers understood the actions necessary to address the issue although it was not formally documented in any procedure or process. The NRC inspection team was concerned future weak link analyses could be performed incorrectly, such as was the case with the previous deficient LaSalle analysis, if the lessons learned from the failed LaSalle valve were not incorporated into future analyses. Upon further discussions with Flowserve's engineering staff, Flowserve initiated CAR No. 1687 to formally track Flowserve's corrective actions to address the issue.

The NRC inspection team also reviewed a PO from Exelon Corporation for a new stem/wedge assembly for an Anchor/Darling double disc gate valve. The new stem/wedge assembly with an integral stem collar, Inconel pin, and a pre-torqued stem/wedge connection was ordered by the licensee to replace a susceptible stem/wedge assembly to resolve the issue associated with the two 10 CFR Part 21s for this valve design. The NRC inspection team verified that the part number and material change received a level of review by a qualified design engineer, which included an analysis of the acceptability of the change in relation to the associated requirements of the ASME B&PV Code and Appendix B to 10 CFR Part 50. The NRC inspection team verified that the Flowserve's design process effectively translated the customer's request into the affected Flowserve documentation. Specifically, the Flowserve design engineer identified the applicable procedures, analyses, reports, drawings, and components for the purchase order and verified that the design documentation met the necessary requirements.

No findings of significance were identified.

c. Conclusion

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

4. Commercial-Grade Dedication and Utilization of Unqualified Source Material

a. Inspection Scope

The NRC inspection team reviewed Flowserve's policies and implementing procedures that govern the commercial-grade dedication and utilization of unqualified source material programs to verify their compliance with the regulatory requirements of Criterion III of Appendix B to Title 10 CFR Part 50 and Subsection NCA-3855.5, "Utilization of Unqualified Source Material," of Section III of the ASME B&PV Code, and 1998 Edition, 2000 Addenda.

The NRC inspection team observed commercial-grade dedication activities and reviewed completed commercial-grade dedication packages to verify that Flowserve properly developed and implemented a process for dedicating commercial-grade items. Specifically, the NRC inspection team witnessed dimensional inspections and material verifications for as part of the commercial-grade dedication process of 5 actuator housings.

The commercial-grade dedication process starts with a technical evaluation performed to verify that the correct part number and description are specified in the Bill of Material. As part of this process, an investigation or evaluation is performed against previous like-product manufactured items to identify any potential changes. If personnel identify changes, they must perform an evaluation to ensure that the changes do not affect the form, fit, or function of the part, and that adequate documentation is prepared to support this conclusion. For each part dedicated by Flowserve, an engineer prepares a

“Dedication of Commercial Grade Item” form (Form 36-Q-657). This form contains the information relevant to the part/material being dedicated (i.e., part number, description, purchase order number, etc.), the Raleigh technical evaluation (RTE) number and also includes the critical characteristics of the particular part. In addition, the form provides instructions on what acceptance methods need to be used by the Flowserve staff to verify the critical characteristics identified.

The NRC inspection team also reviewed the commercial-grade dedication packages for the following items: wave spring washer for an 8-inch stainless steel globe valve, target mounting block for an 8-inch stainless steel globe valve, Belleville washers for an 8-inch stainless steel globe valve, valve stem, body castings, valve yoke, disc check, and a solenoid valve. Within these packages, the NRC inspection team reviewed the associated drawings and inspection reports to verify that the critical characteristics and verification methods were correctly specified in the Form 36-Q-657 dedication sheet, that the drawings and material specifications containing the associated acceptance criteria for each critical characteristic were referenced, and that the inspection reports adequately documented the acceptance of the critical characteristics.

In addition, the NRC inspection team discussed with Flowserve the recently issued NRC Regulatory Guide (RG) 1.164, “Dedication of Commercial-Grade Items for Use in Nuclear Power Plants,” in June 2017. This RG describes methods that the NRC staff considers acceptable in meeting regulatory requirements for dedication of commercial-grade items and services used in nuclear power plants. This new RG approves for use, with two regulatory exceptions, the 2014 EPRI Technical Report, “Plant Engineering: Guideline for the Acceptance of Commercial-Grade Items in Nuclear Safety-Related Applications, Revision 1 to EPRI NP-5652 and TR-102260.” Flowserve stated they will review the appropriate PIOPs, and SOIs that support the commercial grade dedication program for consistency with the new EPRI Guideline (The current commercial-grade dedication process is based on EPRI NP-5652).

With respect to Flowserve’s process for upgrading material in accordance with the requirements of NCA-3855.5, the NRC inspection team reviewed a sample of material Certificate of Conformances, receiving documents, and the supporting laboratory test reports that included the test results of the chemical analysis and mechanical properties testing that was performed on each piece of material. These upgrading activities were related to the purchase of an ASME SA-351 alloy CF8M valve body, valve disc and valve plug casting to be part of the fabrication of an 8-inch valve disk model control valve supplied to STP Nuclear Operating Co. The NRC inspection team also verified that the test results were consistent and from the same heat No. as part of the NCA-3855.5 material upgrade process. The NRC inspection team also confirmed that Flowserve received extra material for testing to support the material upgrade process.

The NRC inspection team also discussed the commercial-grade dedication and utilization of unqualified source material programs with Flowserve’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. Conclusion

The NRC inspection team concluded that Flowserve is implementing its commercial-grade dedication and utilization of unqualified source material programs in accordance with the regulatory requirements of Criterion III of Appendix B to 10 CFR Part 50 and NCA-3855.5 of Section III of the ASME B&PV Code. Based on the limited sample of documents reviewed, the NRC inspection team also determined that Flowserve is implementing its policies and procedures associated with the commercial-grade dedication and utilization of unqualified source material programs. No findings of significance were identified.

5. Test Control

a. Inspection Scope

The NRC inspection team reviewed Flowserve's policies and implementing procedures that govern the test control program to verify compliance with the requirements of Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50.

The NRC inspection team observed a hydrostatic and pneumatic test for a 6-inch motor operated gate valve for V.C. Summer Unit 2 and a hydrostatic and functional test for an 8-inch globe balanced stop valve with a Limitorque actuator for Vogtle Unit 3. The NRC inspection team verified that the test was performed within the required parameters using calibrated gages and demineralized water and that the results were within the acceptance criteria. The NRC inspection team also reviewed a sample of completed test records and confirmed that all the test requirements have been met. The NRC inspection team also verified that the M&TE used during the tests was within calibration.

The NRC inspection team confirmed that the following testing elements were satisfied, verified, and recorded, as appropriate: (1) test parameters and initial conditions, (2) test acceptance criteria, (3) test prerequisites, (4) test instrument range, accuracy, and uncertainty appropriate for the test; (5) current calibration, and (6) proper procedure sequence followed and any deviations documented and evaluated.

The NRC inspection team discussed the test control program with Flowserve'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. Conclusion

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

6. Control of Measuring and Test Equipment

a. Inspection Scope

The NRC inspection team reviewed Flowserve' policies and implementing procedures that govern the 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 also witnessed the calibration of a digital micrometer, a digital caliper, and a micrometer at the calibration laboratory.

For a sample of M&TE, the NRC inspection team determined that the M&TE had the appropriate calibration stickers and current calibration dates, including the calibration due date. The NRC inspection team also verified that the M&TE had been calibrated, adjusted, and maintained at prescribed intervals prior to use. In addition, the calibration records reviewed by the NRC inspection team indicated the as-found or as-left conditions, accuracy required, calibration results, calibration dates, and the due date for recalibration. The NRC inspection team also verified that the selected M&TE was calibrated using procedures traceable to known industry standards.

The NRC inspection team also verified that when M&TE equipment is received from the calibration service supplier and the calibration certificate states that it was found to be out of calibration, Flowserve generates a nonconformance report (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 NRC inspection team also discussed the M&TE program with Flowserve'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. Conclusion

The NRC inspection team concluded that Flowserve 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 Flowserve is implementing its policies and procedures associated with the M&TE program. No findings of significance were identified.

7. Nonconforming Materials, Parts, or Components and Corrective Action

a. Inspection Scope

The NRC inspection team reviewed Flowserve' policies and implementing procedures that govern the control of nonconformances to verify compliance with the requirements of Criterion XV, "Nonconforming Materials, Parts, or Components," and Criterion XVI, "Corrective Action," of Appendix B to 10 CFR Part 50.

The NRC inspection team observed a Material Review Board (MRB) meeting held by Flowserve's staff from the Quality, Engineering, Purchasing, and Manufacturing departments. The purpose of the MRB is to discuss the dispositioning of reject tickets (nonconforming items) submitted by Flowserve staff. There were two parts to this activity: 1) MRB morning walk-around the shop to review reject tickets from the previous day's work to disposition as use-as-is, rework, or scrap, and 2) the afternoon meeting to review CAR actions. The NRC inspection team also confirmed that Flowserve monitors reject tickets for trends to determine if the issue should be entered in the corrective action program.

The NRC inspection team also reviewed a sample of reject tickets to verify that Flowserve: (1) dispositioned the nonconforming item in accordance with procedures, (2) documented an appropriate technical justification for various dispositions, (3) took adequate corrective action with regard to the nonconforming items, and (4) identified nonconforming items, as appropriate, for 10 CFR Part 21 applicability. For reject tickets that were dispositioned as use as is, the NRC inspection team confirmed that the technical justifications were documented to verify the acceptability of the nonconforming item. In addition, the NRC inspection team performed a walk down of the nonconformance segregation areas to verify that nonconforming materials were properly identified, marked, and segregated, when practical, to ensure that they were not reintroduced into the production processes.

The NRC inspection team reviewed a sample of CARs to ensure that conditions adverse to quality were promptly identified and corrected. In addition, the NRC inspection team verified that the CARs provide: (1) adequate documentation and description of conditions adverse to quality; (2) an appropriate analysis of the cause of these conditions and the corrective actions taken to prevent recurrence; (3) direction for review and approval by the responsible authority; (4) a description of the current status of the corrective actions; and (5) the follow-up actions taken to verify timely and effective implementation of the corrective actions. In addition, the NRC inspection team verified that the Flowserve's nonconformance and corrective action process provides a link to the 10 CFR Part 21 program.

The NRC inspection team also discussed the nonconforming materials, parts, or components and corrective action programs with Flowserve's management and technical staff. In addition, the NRC inspection team verified the implementation and closure of Flowserve's corrective actions in response to the findings from the last NRC inspection in September 2012. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observations and Findings

b.1 Corrective Action Associated with Nonconformance 99901356/2012-201-01

Following the September 2012 inspection of Flowserve, the NRC issued Nonconformance 99901356/2012-201-01 for Flowserve's failure to establish adequate measures for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of certain structures, systems, and components. Specifically, for eight dedication packages, Flowserve did not provide objective evidence that technical evaluations had been performed to justify that the critical characteristics selected for the valve components would provide reasonable assurance that the valves would perform their intended safety-related functions.

In its response dated November 16, 2012, Flowserve stated that it had initiated CAR No. 943 to determine and document the causes and corrections actions for this issue. In addition, the response stated that Flowserve would revise Standard Operating Instruction (SOI) No. 70-39-09, "Dedication of Commercial Grade Components to 10 CFR Part 21," Revision 9, dated June 6, 2009, to document the technical evaluations and have the dedication sheets reference the applicable technical evaluation. The response also stated that the dedication database would be changed to use the technical evaluation to identify the critical characteristics for dedication. However, the response did not address the documentation of technical evaluations for dedication that had already been performed. In a follow-up response dated December 21, 2012, Flowserve stated that if a technical evaluation reveals a historical dedication did not adequately identify the critical characteristics of a component, an investigation into the impact of the condition would be addressed in accordance with Flowserve's QA program.

The NRC inspection team reviewed the documentation that provided objective the evidence for the completion of the corrective actions. The NRC inspection team confirmed that SOI No. 70-39-09 was revised to include guidance to document technical evaluations and to have the dedication sheets reference the applicable technical evaluation. Based on its review, the NRC inspection team closed Nonconformance 99901356/2012-201-01.

b.2 Corrective Action Associated with Nonconformance 99901356/2012-201-02

The NRC also issued Nonconformance 99901356/2012-201-02 for Flowserve's failure to control special processes in accordance with qualified procedures. Specifically, Flowserve: (1) exceeded the maximum weld bead thickness of 1/8-inch, (2) an NDE technician failed to perform a post-emulsification LP examination on the correct area of interest for an 8-inch gate valve body casting, (3) an NDE technician failed to use a "gentle air stream" during an MT examination for a hemispherical head and weld of a 24-inch gate valve, and (4) NDE technician failed to perform an UT examination on the entire volume for four, 8-inch feedwater valve stems.

In its response dated November 16, 2012, Flowserve stated that it had initiated CAR Nos. 935, 936, 937, and 939, and 942 to determine and document the causes and corrections actions for these issues. In addition, the response stated that Flowserve's management would re-affirm to employees the need to fully adhere to

the details of work instructions during implementation, and that SOI No. 23-19-00, "Performance Observation Monitoring," Revision 0, dated November 19, 2012; and SOI No. 40-08-00, "Monitoring QC Inspection Performance," Revision 0, dated November 5, 2012, were developed to address scheduled monitoring oversight activities. Monitoring activities are conducted in accordance with Monitoring Checklists prepared to verify the employee's implementation of Method Specifications so as to assure the details of these work instructions are being fully implemented.

The NRC inspection team reviewed the documentation that provided objective evidence for the completion of the corrective actions. The NRC inspection team confirmed that SOI Nos. 23-19-00 and 40-08-00 were developed. In addition, the NRC inspection team observed the monitoring of a PT exam by a Level II technician and a QC inspector performing a dimensional check with calipers. Based on its review, the NRC inspection team closed Nonconformance 99901356/2012-201-02.

c. Conclusion

The NRC inspection team concluded that Flowserve is implementing its nonconforming materials, parts, or components and corrective action programs in accordance with the regulatory requirements of Criterion XV and 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 Flowserve is implementing its policies and procedures associated with the control of nonconforming materials, parts, or components and corrective action. No findings of significance were identified.

8. 10 CFR Part 21 Program

a. Inspection Scope

The NRC inspection team reviewed Flowserve's policies and implementing procedures that govern Flowserve's 10 CFR Part 21 program to verify compliance with the regulatory requirements. In addition, the NRC inspection team evaluated the 10 CFR Part 21 postings and a sample of Flowserve's POs for compliance with the requirements of 10 CFR Part 21.21, "Notification of Failure to Comply or Existence of a Defect and its Evaluation," and 10 CFR Part 21.31, "Procurement Documents." The NRC inspection team also verified that Flowserve' nonconformance and corrective action procedures provide a link to the 10 CFR Part 21 program.

For a sample of 10 CFR Part 21 evaluations performed by Flowserve, the NRC inspection team verified that Flowserve had effectively implemented the requirements for evaluating deviations and failures to comply. The NRC inspection team verified that the notifications were performed in accordance with the requirements of 10 CFR Part 21.21, as applicable.

The NRC inspection team also discussed the 10 CFR Part 21 program with Flowserve'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. Conclusion

The NRC inspection team concluded that Flowserve is implementing its 10 CFR Part 21 program in accordance with the regulatory requirements of 10 CFR Part 21. Based on the limited sample of documents reviewed, the NRC inspection team also determined that Flowserve is implementing its policies and procedures associated with the 10 CFR Part 21 program. No findings of significance were identified.

9. Entrance and Exit Meetings

On July 17, 2017, the NRC inspection team discussed the scope of the inspection with Robert Sherman, Flowserve's General Manager, and other members of Flowserve's management and technical staff. On July 20, 2017, the NRC inspection team presented the inspection results and observations during an exit meeting with Mr. Sherman, and other members of Flowserve's 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

Name	Title	Affiliation	Entrance	Exit	Interviewed
Robert Sherman	General Manager	Flowserve	X	X	
James Pilant	General Manager of Operations	Flowserve	X	X	
Joseph Carter	Quality Assurance Manager	Flowserve	X	X	X
Mike Roy	Business Development Manager	Flowserve	X	X	
Mark Stiefbold	Project Management Manager	Flowserve	X	X	
Robert Casking	Order Fulfillment Manager	Flowserve	X	X	
Wade Shephard	Engineering Manager	Flowserve	X	X	X
Randy Johnson	Supply Chain Manager	Flowserve	X	X	X
Hylton Kipe	Commercial Operations Manager	Flowserve	X	X	
Brent Semler	Manufacturing Manager	Flowserve		X	
Matt Hobbs	Design Engineering Manager	Flowserve		X	
Jamison Marsh	Quality Control (QC) Supervisor	Flowserve	X	X	X
James Haithcox	Nondestructive Examination (NDE) Supervisor	Flowserve	X	X	X
Rebecca Blankenship	Quality Assurance (QA) Engineer Supervisor	Flowserve	X	X	X

Name	Title	Affiliation	Entrance	Exit	Interviewed
Jeff Johnson	Large Cast Weld Area Supervisor	Flowserve			X
George Hinson	Engineering Supervisor	Flowserve		X	
Mark Cowell	Engineering Specialist	Flowserve	X		X
Reid Davis	Manufacturing Manager	Flowserve	X		X
Sheila Knarowski	Human Resources Representative	Flowserve	X	X	
Michael Roberson	QA Engineer/Lead Auditor	Flowserve	X	X	X
George White	QA Engineer/Lead Auditor	Flowserve	X	X	X
Jason Thompson	QA Engineer/Lead Auditor	Flowserve	X		
Thomas Roger	Engineer	Flowserve			X
David Craddock	Lead Inspector	Flowserve			X
Marlene Hebert	QA Engineer	Flowserve			X
Karen Hay	QA Engineer	Flowserve			X
Latisha Williams	QA Engineer	Flowserve			X
Donnie Harper	QA/QC Inspector	Flowserve			X
Taiwan Barber	QA/QC Inspector	Flowserve			X
Brandon Houts	QC Inspector	Flowserve			X
Kevin Worth	QC Inspector	Flowserve			X
George Willis	QC Inspector	Flowserve			X
Schott Rehl	QC Inspector	Flowserve			X
Phillip Trammell	QC Inspector	Flowserve			X
Tish Williams	QC Inspector	Flowserve			X
Josh Joseph	QC Technician	Flowserve			X
Martha Todd	Gage Technician	Flowserve			X

Name	Title	Affiliation	Entrance	Exit	Interviewed
David Godwin	Testing Technician	Flowserve			X
Courtney Christie	Testing Technician	Flowserve			X
Danny Hinnant	Testing Technician	Flowserve			X
Duke Schott	Welding Technician	Flowserve			X
Bernie Carothers	Welding Engineer	Flowserve			X
Erwin Crews	Welder	Flowserve			X
Josh McCrea	Welder	Flowserve			X
Timothy Jeffries	Welder	Flowserve			X
Pat Miller	NDE Level II Technician	Flowserve			X
Michael Lenhart	Authorized Nuclear Inspector (ANI)	Hartford Steam Boiler Inspection and Insurance Company			X
Howard Coe	ANI	Hartford Steam Boiler Inspection and Insurance Company			X
Yamir Diaz-Castillo	Inspection Team Leader	NRC	X	X	
John P. Burke	Branch Chief	NRC	X	X	
Richard P. McIntyre	Inspector	NRC	X	X	
John Honcharik	Inspector	NRC	X	X	
Nicholas J. Hansing	Inspector	NRC	X	X	
Andrew Dunlop Jr.	Inspector	NRC	X	X	
Lionel Rodríguez	Observer	NRC	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 January 27, 2017.

IP 43003, “Reactive Inspections of Nuclear Vendors,” dated December 14, 2015.

IP 43004, “Inspection of Commercial-Grade Dedication Programs,” dated January 27, 2017.

3. LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Item Number	Status	Type	Description
99901356/2012-201-01	Closed	NON	Criterion III
99901356/2012-201-02	Closed	NON	Criterion IX
99901356/2017-201-01	Opened	NON	Criterion VII
99901356/2017-201-02	Opened	NON	Criterion VII
99901356/2017-201-03	Opened	NON	Criterion IX
99901356/2017-201-04	Opened	NON	Criterion V & XIII

4. DOCUMENTS REVIEWED

Policies and Procedures

- Flowserve’s Corporation (hereafter referred to as Flowserve) Quality Assurance Manual, Revision 41, dated September 18, 2015
- Plant Internal Operating Procedure (PIOP) No.36-40-03-12, “Methods for Reporting to NRC Defects Creating Substantial Safety Hazards,” Revision 12, dated January 19, 2017
- PIOP No. 36-40-05-15, “Qualification and Certification of Quality Assurance Personnel,” Revision 15, dated March 6, 2017
- PIOP No. 36-40-06-21, “Gage Control,” Revision 21, dated November 29, 2016
- PIOP No. 36-40-10-23, “Nonconforming Material Control - Rejection Procedure and Material Review Board Involvement,” Revision 23, dated November 29, 2016
- PIOP No. 36-40-19-13, “Material Substitutions,” Revision 13, dated May 22, 2017

- PIOP No. 36-40-23-20, “Quality Assurance Internal Audits,” Revision 20, dated January 24, 2017

- PIOP No. 36-40-31-06, “Controlling Subcontracting for Nuclear and Traceable Material,” Revision 6, dated December 18, 2016

- PIOP No. 36-40-38-05, “Certified Material Test Report Documentation Review,” Revision 5, dated May 15, 2017

- PIOP No. 36-40-41-01, “Use of Anti-spatter Compound to Protect Surfaces During Welding and Heat Treatment,” Revision 1, dated September 14, 2012

- PIOP No. 36-40-42-01, “Calibration of Welding Gas Flowmeters,” Revision 1, dated July 3, 2014

- PIOP No. 36-40-45-00, “Completing Inspection Test Plans,” Revision 0, dated December 17, 2015

- PIOP No. 36-41-01-24, “Procedure for Performance of Vendor Audits, Evaluations, and Assessments,” Revision 24, dated July 30, 2015

- PIOP No. 36-41-04, “Routing of Casting Repair Sheets and Welding Repair Data Sheets,” Revision 9, dated April 9, 2009

- PIOP No. 36-41-07, “Welder Performance Qualification Status (Continuity QW-322),” Revision 14, dated June 12, 2017

- PIOP No. 36-41-08-06, “Receiving,” Revision 6, dated July 28, 2008

- PIOP No. 36-41-09-10, “Dedication of Commercial Grade Items,” Revision 10, dated May 11, 2017

- PIOP No. 36-41-13-07, “Corrective Action Procedure,” Revision 7, dated February 27, 2017

- PIOP No. 36-50-14-01, “Qualification and Certification of Operations Personnel Performing Hydrostatic Testing,” Revision 1, dated February 24, 2017

- PIOP No. 36-70-02-26, “Engineering Change Notices,” Revision 26, dated May 31, 2017

- PIOP No. 36-70-03-32, “Design Control,” Revision 32, dated August 25, 2015

- PIOP No. 36-70-06-13, “Controlled Distribution of New Drawings, Valve Actuator Specification Sheets, B/M’s & Design Engineering Documents,” Revision 13, dated September 26, 2012

- PIOP No. 36-70-07-10, “Emergency Drawing Change Procedure,” Revision 10, dated February 17, 2009

- PIOP No. 36-70-12-13, “Development, Revision and Distribution of Assembly (Sales) Drawings,” Revision 13, dated May 25, 2016

- PIOP No. 36-70-15-04, “Torque Requirements for Threaded Fasteners,” Revision 4, dated February 10, 2016

- PIOP No. 36-70-18-02, “Method 2 Commercial Grade Dedication Plan for the Use of Accreditation to ISO/IEC-17025:2005 In Lieu of Commercial Grade Surveys For Laboratory Calibration and Test Services,” Revision 2, dated March 27, 2017

- PIOP No. 36-70-22-00, “Utilization of Unqualified Source Material,” Revision 0, dated September 18, 2015

- PIOP No. 36-80-33, “Standard Non-Destructive Examination Requirements for Valves,” Revision 1, dated November 21, 2013

- Standard Operating Instruction (SOI) No. 20-02, “Storage of Finish “N” Stamp Material,” Revision 4, dated August 22, 2000

- SOI No. 21-11-06, “Processing Engineering Change Notices,” Revision 6, dated August 22, 2000

- SOI No. 23-18-00, “Shop Floor Route Cards,” Revision 0, dated November 11, 2011

- SOI No. 23-21-00, “Edward Forged Steel ID Tagging & Data Verification,” Revision 0, dated June 13, 2013

- SOI No. 23-24-05, “Welder/Operator Fundamental Best Practices,” Revision 5, dated July 20, 2016

- SOI No. 40-01-27, “Inspection Instructions for Incoming Material,” Revision 27, dated September 28, 2016

- SOI No. 40-10-11, “Inspection, Calibration, and Control of Pressure Gages,” Revision 11, dated August 10, 2015

- SOI 40-16-04, “Instructions for Use of Inspection,” Revision 4, dated September 7, 2000

- SOI 40-21-11, “Monitoring Welding Electrode Ovens,” Revision 11, dated October 22, 2009

- SOI No. 40-23-14, “Qualification & Training of Quality Assurance Auditors,” Revision 14, dated January 4, 2016

- SOI No. 40-28-19, “Quality Inspection of Valves & Components Prior to Shipment,” Revision 19, dated June 30, 2017

- SOI No. 40-32-14, “Revision Control of Method Specifications, Welding Method Specifications and Similar Vendor Procedures,” Revision 6, dated March 16 2009

- SOI No. 40-58-08, “Training Programs for Q.A. Personnel,” Revision 8, dated August 14, 2015

- SOI No. 40-59-33, “Gage Calibration, Calibration Intervals, and Instructions,” Revision 33, dated January 19, 2016

- SOI No. 40-60-06, “Inspection Reports and Dimensional Reports,” Revision 6, dated March 9, 2017

- SOI 40-64-03, “Requirements for Visual Inspector Training,” Revision 3, dated May 5, 2005

- SOI No. 40-78-01, “Material Verification for Commercial Grade Dedication Purposes,” Revision 1, dated September 12, 2012

- SOI No. 40-81-00, “Instruction for Creation and Implementation of Inspection Test Plans,” Revision 0, dated December 17, 2015

- SOI 50-02, “Welding Verification Sign-Off Procedure,” Revision 1, dated September 19, 2016

- SOI No. 70-39-11, “Dedication of Commercial Grade Components to 10CFR21,” Revision 11, dated June 20, 2014

- SOI 70-18-11, “Engineering Department Training Program,” Revision 11, dated August 21, 2015

- SOI 70-23-11, “Granting Authorization To Certify Design Reports and Design Specifications,” Revision 11, dated September 16, 2015

- SOI No. 70-14-12, “Identification of Basic Components Under 10 CFR 21,” Revision 12, dated June 8, 2009

- SOI No. 70-56-02, “Technical Evaluation for Dedication of Commercial Grade Components to 10CFR21,” Revision 2, dated June 24, 2014

- SOI 70-39-11 “Dedication of Commercial Grade Items to 10CFR Part 21,” Revision 11, dated June 10, 2014

- SOI 80-03-04, “Manufacturing Master Route Sheet,” Revision 4, dated October 1, 2012

- SOI 80-04-03, “Engineering Change Notice,” Revision 3, dated June 28, 1991

- Bodycote Thermal Processing procedure No. BMS HH-WI-9.01.00, “10CFR21 Reporting Procedure,” Revision 0, dated April 19, 2012

- East Carolina Metal Treating, Inc. Management System Work Instruction for 10 CFR Part 21 Reporting, Revision 0, dated June 26, 2012

- MS 9034, “Hydrostatic and Functional Test Procedure for Motor Operated Gate and Globe Valves – Westinghouse AP1000 PV01,” Revision 12, dated October 5, 2016

- MS 9761, “Functional Diagnostic Test Procedure for Motor Operated Gate and Globe Valves,” Revision 1, dated August 12, 2015

- Quality Assurance Plan (QAP) No. 16-118167 for a 3-inch gate valve for Arkansas Nuclear One, Revision 6, dated April 24, 2017

- QAP 09-91175, “Nuclear Valve Order –Westinghouse,” Revision 43, dated November 11, 2016

Design and Commercial-Grade Dedication Records

- Westinghouse Electric Company (WEC) Technical Specification No. APP-GW-Z0-602, “Cleaning and Cleanliness Requirements for Equipment for Use in Nuclear Supply and Associated Systems,” Revision 3, February 18, 2013

- WEC Technical Specification No. APP-PV01-Z0-001, “3” and Larger Motor Operated Gate and Globe Valves, ASME Boiler and Pressure Vessel Code Section III, Class 1, 2, and 3,” Revision 9, dated May 11, 2016

- Flowserve Drawing No. D-4128313, “Size 6 Class 1500-FW Bonnet,” Revision 1, dated July 29, 2016

- Flowserve Drawing No.09-91170-09, “6” Alloy Steel Flex Wedge Gate Valve with Limitorque SB-2-80 Motor Operator,” Revision C, dated May 24, 2011

- Flowserve Drawing No. 03-25394-06, “Globe Valve Socket Ends, Carbon Steel With 3” Dia. Handwheel & Non-Cobalt Trim,” Revision 3

- Flowserve Drawing No.09-91175-22, “8” Edward Stainless Steel Globe Balanced Stop Valve with Limitorque SMB-0-5 Motor Operator,” Revision C, dated June 22, 2011,

- Technical Advisory (TA) No. 179, “Flame Cut Surfaces,” Revision B, dated June 2005

- TA No. 194, “Finish Requirements for Power Threads - ACME Threads,” Revision A, dated June 2005

- Engineering Change Notification No. 20399, No Revision, dated February 26, 2013

- Route Card for a 6-inch motor operated gate valve for V.C. Summer

- “Design Review Meeting Summary, Size 8 Fig. BD2026,” dated September 15, 2009

- RAL-20726, “Design and Seismic Analysis Report,” Revision 3, dated May 15, 2017

- RAL-7989, “QME-1 Functional Qualification Report per ASME QME-1-2007 Size 8 Figure BD2026(CF3M)JMTY with SMB-0-5,” Revision 3, dated March 13, 2015

- RAL-70122, “Weak Link Supplement to Report R95.002 Analysis of the Wedge-Stem Threaded and Pinned Joint,” Revision 2

- Method Specification 9429, “Assembly and Fit-up of Anchor/Darling Double Disc Gate Valve Trim,” Revision 1

- ABW-93-3, “MOV 1E51-F063 Failure 2/10/93,” dated February 17, 1993

- ABW-90-10, “Discharge Recirculation Gate Valves,” dated November 1, 1990

- TA-158, “Pre-torqueing of DD Stem/Upper Wedge Joints,” Revision C

American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel (B&PV) Code and Welding Records

- Welding Procedure Specification (WPS) No. P1-121N, “Fillet, Groove, and Repair Welding of P-1 Materials Without PWHT for Nuclear Applications-SMAW,” Revision 8, dated September 24, 2008

- WPS No. P8-121N, “Fillet, Groove, and Repair Welding of Stainless Steel Materials Per ASME III -SMAW,” Revision 4, dated September 9, 2009

- WPS No. P8-3231NW, “Fillet, Groove, and Repair Welding of P8 Materials Per ASME III & Reg. Guide 1.44 w/o PWHT 0.08% Max. Carbon Base Material -GTAW,” Revision 2, dated September 17, 2010

- WPS No. P8-123N, “Fillet, Groove, and Repair Welding of Stainless Steel Materials Per ASME III -SMAW,” Revision 2, dated September 17, 2009

- Route Card/Shop Traveler No. 04138140119921001, hinge pin for LaSalle County Station

- Route Card/Shop Traveler No. 013150519117701, Seat Ring - 38 inch valve for Vogtle Electric Generating Plant (hereafter referred to as Vogtle) Unit 3

- Route Card/Shop Traveler No. 006601739117022, 8 inch Disk Piston for V.C. Summer Unit 2

- Route Card/Shop Traveler No. 0412831391175082, 6 inch Bonnet for Vogtle Unit 3

Calibration, Heat Treatment, Non-Destructive Examination, Inspection and Test Records

- Calibration Certificate No. F31989 for an electronic timer, dated July 18, 2017

- Calibration Certificate No. F33561 for a 0 to 3,000 psi pressure gage, dated July 18, 2017

- Calibration Certificate No. F33564 for a 0 to 6,000 psi pressure gage, dated July 18, 2017

- Calibration Certificate No. F34766 for a 100 to 600 Foot Lb. torque wrench, dated July 18, 2017
- Calibration Certificate No. F35317 for a 50 to 250 Foot Lb. torque wrench, dated July 18, 2017
- Calibration Certificate No. F35589 for a 10 to 80 Foot Lb. torque wrench, dated July 18, 2017
- Calibration Certificate No. M-17 1310-23 for a pneumatic torque wrench, dated March 28, 2017
- Calibration Certificate No. 123806 for a gage block set (no date available)
- Calibration Certificate No. F35608 for a 0 to 100 psi pressure gage, dated July 18, 2017
- Calibration Certificate No. F35823 for a digital micrometer, dated July 18, 2017
- Calibration Certificate No. F35824 for a caliper, dated July 18, 2017
- Calibration Certificate No. F35825 for a 3-point micrometer, dated July 18, 2017
- Calibration Certificate No. 52089-3 for a plug gage, dated June 29, 2017
- MS1151NW, "Liquid Penetrant (PT) Examination," Revision 2, dated December 19, 2012
- MS1026RTW-ASME, "Radiographic (RT) Examination," Revision 1, dated January 12, 2017
- MS1029NE, "Ultrasonic (UT) Examination," Revision 13, dated October 29, 2014
- RRR-13002, "Double Disk Gate Valve Wedge Pin Test to Failure," dated June 27, 2013
- 119922-001, "Final Inspection Check Sheet," dated July 20, 2017
- 17-119922, "Sales Order QAP," May 15, 2017

<u>Purchase Orders, Audit Reports, and Commercial-Grade Dedication</u>

- Purchase order (PO) No. 256387 to Advance Machine Group for machining services, dated July 12, 2017
- PO No. 253266 to Alden Research Laboratory Inc., for flow testing services, Revision 1, dated March 14, 2017
- PO No. 223838 to American Foundry Group (AFG) for a disc casting, dated August 5, 2014
- PO No. 239107 to Anhui Yingliu Group Huoshan for valve body castings, Revision 4, dated January 30, 2017

- PO No. 250936 to Aruna Alloy Steels for valve body castings and disc castings, Revision 7, dated April 5, 2017
- PO No. 255385 to Aruna Alloy Steels for a bonnet casting, Revision 1, dated June 13, 2017
- PO No. 225221 to Bodycote Thermal Processing for heat treating services, dated September 9, 2014
- PO No. 255855 to Bureau Veritas Laboratories for tensile testing services, Revision 0, dated June 19, 2017
- PO No. 252577 to Corry Forge Company for a machined cylinder, Revision 0, dated February 8, 2017
- PO No. 255289 to Crispin Multiplex Manufacturing Company for valve springs, bushings, and seats, Revision 0, dated May 27, 2017
- PO No. 243931 to East Carolina Metal Treating Inc. for a bonnet casting, valve body casting, Revision 0, dated March 22, 2016
- PO No. 250774 to Ellwood Texas Forge Navasota for a body forging, Revision 0, dated November 23, 2016
- PO No. 254931 to Exelon Power Labs for calibration services, Revision 0, dated May 11, 2017
- PO No. 250737 to Exova, Inc. for testing services, Revision 0, dated November 22, 2016
- PO No. 256284 to Fastenal Company for an eyebolt, Revision 0, dated July 7, 2017
- PO No. 255141 to F.D. Hurka for calibration services, Revision 0, dated May 19, 2017
- PO No. 256126 to Flexitallic for a gasket, Revision 0, dated June 28, 2017
- PO No. 24453 to Hanna Cylinders for a rod bushing, Revision 0, dated April 1, 2016
- PO No. 239937 to Keokuk Steel Castings Company for a disc casting, Revision 0, dated November 12, 2015
- PO No. 254464 to Loire Industrie for a stem forging, Revision 0, dated April 26, 2017
- PO No. 252681 to Pradeep Metals Ltd., for a valve body forging, Revision 0, dated February 11, 2017
- PO No. 255615 to R.A. Hiller Company for a packing piston, Revision 0, dated June 8, 2017
- PO No. 256403 to Suhm Spring Works, Inc. for a spring, Revision 0, dated July 13, 2017

- PO No. 2532668 to Tech Cast LLC for a bonnet casting, Revision 0, dated March 28, 2017
- PO No. 255932 to Torcup Inc. for calibration services, Revision 0, dated June 22, 2017
- PO No. 255071 to Trinity Forge Inc. for a body forging, Revision 0, dated June 22, 2017
- PO No. 255970 to Wodin Inc for stem forging, Revision 0, dated June 22, 2017
- PO No. 1049004 from Entergy Operations, Inc. to Flowserve Corporation for a 3-inch gate valve for Arkansas Nuclear One
- PO No. 601803 from Exelon to Flowserve for stem, wedges, and pin assembly for 12-inch double disc gate valve for LaSalle County Station, Unit 1, dated May 4, 2017
- Audit report of Acuren Inspections, Inc., dated November 10, 2016
- Audit report of Advance Machine Group, dated March 3, 2015
- Audit report of AFG, dated March 11, 2015
- Audit report of Alden Research Laboratory, Inc. dated May 2, 2014
- Audit report of Anhui Yingliu Huoshan Casting Company, Ltd., dated September 30, 2016
- Audit report of Aruna Alloy Steels PVT Ltd., dated November 14, 2016
- Audit report of Bodycote Thermal Processing, dated April 1, 2015
- Audit report of Crispin Valves, dated June 23, 2016
- Audit report of Corry Forge Company, dated March 30, 2015
- Audit report of East Carolina Metal Treating, dated August 12, 2016
- Audit report of Elwood Texas Forge Navasota, dated February 28, 2014
- Audit report of Exova Inc., dated December 9, 2016
- Audit report of Exova America (Los Angeles), dated April 27, 2016
- Audit report of Exova Americas (Glendale), dated October 12, 2015
- Audit report of Fastenal Inc., dated August 17, 2016
- Audit report of Flexitallic Gasket Company, dated May 1, 2014
- Audit report of Hanna Cylinders, dated April 11, 2017

- Audit report of Keokuk Steel Castings, dated September 24, 2014
- Audit report of Pradeep Metals, Ltd., dated February 9, 2017
- Audit report of R.A. Hiller Company, May 19, 2014
- Audit report of Suhm Spring Works, dated July 5, 2017
- Audit report of Tech Cast LLC., dated August 21, 2014
- Audit report of Trinity Forge, dated June 26, 2017
- Audit report of Wodin, dated October 27, 2016
- Commercial grade survey report of Fastenal Inc., dated August 17, 2017

10 CFR Part 21 Evaluations

- 10 CFR Part 21 File No. 75; Failure of a 10" Double Disc Gate Valve Installed at 1-BFN-073-0002, HPCI Inboard Steam Isolation Valve; November 27, 2012
- 10CFR Part 21 File No. 90, "Multiple discrepancies with two paint reports," dated June 12, 2015
- 10CFR Part 21 File No. 93 "Body Gasket for 4-inch Vacuum Breaker Valve Item no. 7 on Drawing No. 14-108972-001 Revision 1," dated May 4, 2017
- 10 CFR 21 File No. 94, "Size 12-900 Double Disc Gate Valve Stem-Wedge Separation at Exelon - LaSalle County Station, Unit 2," dated July 11, 2017
- Flowserve 10 CFR Part 21 Report: "Wedge Pin Failure of an Anchor/Darling Double Disc Gate Valve at Browns Ferry Nuclear Plant Unit 1," dated February 25, 2013
- Flowserve 10 CFR Part 21 Report: "Stem-Wedge Separation of an Anchor/Darling Double Disc Gate Valve at Exelon, LaSalle County Station, Unit 2, February 2017," dated July 11, 2017
- Flowserve Letter to Exelon LaSalle: "Size 12 Class 900 DD Gate Valve Maximum Thrust Analysis," dated June 6, 2017
- "Size 10-900 Double Disc Gate Valve Wedge Pin Failure at TVA - Browns Ferry," dated December 21, 2012

Nonconformance Reports (Reject Tickets)

163015, 164578, 164616, 166256, and 166284

Corrective Action Reports

936, 942, 943, 1386, 1389, 1396, 1397, 1400, 1402, 1404, 1405, 1419, 1426, 1430, 1528, 1540, 1554, 1600, 1601, 1602, 1633, 1647, 1654, 319679, 319680, 319932, 320352, 320652, and 335152

Corrective Action Requests Opened During the NRC Inspection

1680, 1683, 1684, 1686, 1688

Training Records

- Lead auditor training records for Wilbert Meadows, Sheila Cawley, Michael Roberson, and George White

- Non-Destructive Examinations training records for Scott Rehl for magnetic particle testing (MT)-II, PT-II, and RT-II; George Willis for PT-II, MT-II, RT-II, and UT-II; Kevin Worth for PT-II, MT-II, RT-II, and UT-II; and James Haithcox for PT-III, MT-III, RT-III, and UT-III; Taiwan Barber for Qualification Level II Inspector

- Diagnostic Functional Testing Training Record for Thomas Rogers

- Hydrostatic Testing Training Records for Courtney Christie, Danny Hinnant, and David Godwin

- Quality Control Training Records for Tish Williams