



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 3, 2019

Tracy Bolt, Director of Quality Assurance
AZZ Nuclear | NLI
7410 Pebble Drive
Fort Worth, TX 76118

SUBJECT: NUCLEAR REGULATORY COMMISSION INSPECTION OF AZZ
NUCLEAR | NLI, REPORT NO. 99901471/2019-201, NOTICE OF
NONCONFORMANCE

Dear Mr. Bolt:

On May 20 through May 24, 2019, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an inspection of the AZZ NUCLEAR | NLI (hereafter referred to as NLI) facility in Ft. Worth, TX. The purpose of this limited-scope routine inspection was to assess NLI'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 Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

This limited-scope inspection specifically evaluated NLI's implementation of the quality activities associated with design control and equipment qualification, commercial-grade dedication, and nonconforming materials/parts/components and corrective action for equipment being supplied to the U.S. operating nuclear power plants. The NRC inspectors also reviewed NLI's corrective actions to previously identified NRC issues. The enclosed report presents the results of the inspection. This NRC inspection report does not constitute NRC endorsement of NLI's overall quality assurance (QA) or 10 CFR Part 21 programs.

Based on the results of this inspection, the NRC inspectors 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 inspectors determined that NLI was not fully implementing its QA program in the area of design control with regard to the environmental qualification of safety-related components. The specific finding and references to the pertinent requirements are identified in the enclosures to this letter. In response to the enclosed notice of nonconformance (NON), NLI should document the results of the extent of condition review for the finding and determine if there are any effects on other 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 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, should not include any personal privacy, proprietary, or Safeguards Information (SGI) 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 SGI 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."

Kerri A. Kavanagh, Chief **/RA/**
Quality Assurance Vendor Inspection Branch
Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation

Docket No.: 99901471

EPID: 1-2019-201-0043

Enclosure:

1. Notice of Nonconformance
2. Inspection Report No. 99901471/2019-201
and Attachment

SUBJECT: NUCLEAR REGULATORY COMMISSION INSPECTION OF AZZ
 NUCLEAR | NLI, REPORT NO. 99901471/2019-201, NOTICE OF
 NONCONFORMANCE Dated July 3, 2019

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NOTICE OF NONCONFORMANCE

AZZ Nuclear | NLI
7410 Pebble Drive
Fort Worth, TX 76118

Docket No. 99901471

Based on the results of a U.S. Nuclear Regulatory Commission (NRC) inspection conducted at the AZZ Nuclear | NLI (NLI) facility located in Fort Worth, TX, on May 20 through May 24, 2019, certain activities were not conducted in accordance with NRC requirements which were contractually imposed on NLI by its customers or NRC licensees.

- A. Criterion III, "Design Control," 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," states in part that, "Measures shall also be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions for the structures, systems and components." Criterion III also states in part that, "Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, it shall include suitable qualification testing of a prototype unit under the most adverse design conditions."

Contrary to the above, as of September 22, 2016, NLI failed to ensure the suitability of equipment that is essential to the safety-related functions for certain components supplied to the nuclear industry associated with the environmental qualification testing of certain relays. Specifically, as part of its process for performing qualification testing, NLI failed to justify the activation energies used in the thermal aging analysis/calculations. Also, NLI failed to fully evaluate anomalies that were identified during the functional testing portion of the qualification program.

This issue is identified as Nonconformance 99901471/2019-201-01.

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, Division of Inspection and Regional Support, Office of Nuclear Reactor Regulation, within 30 days of the date of the letter transmitting this Notice of Nonconformance. This reply should be clearly marked as a "Reply to a Notice of Nonconformance" and should include for each noncompliance: (1) the reason for the noncompliance, or if contested, the basis for disputing the noncompliance; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken to avoid noncompliances; and (4) the date when your corrective action will be completed. Where good cause is shown, consideration will be given to extending the response time.

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

Enclosure

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

Dated this the 3rd day of July 2019.

**U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
DIVISION OF INSPECTION AND REGIONAL SUPPORT
VENDOR INSPECTION REPORT**

Docket No.: 99901471

Report No.: 99901471/2019-201

Vendor: AZZ NUCLEAR | NLI
7410 Pebble Drive
Fort Worth, TX 76118

Vendor Contact: Tracy Bolt, Director of Quality Assurance
TracyBolt@AZZ.com
817-284-0077

Nuclear Industry Activity: AZZ | NLI fabricates, tests, and dedicates a variety of components for nuclear facilities, including breakers, relays, switches, and software for the U.S. operating fleet.

Inspection Dates: May 20 - 24, 2019

Inspection Team: Jeffrey Jacobson NRR/DIRS/IQVB, Inspection Leader
Philip Natividad NRR/DIRS/IQVB
Nicholas Savvoir NRR/DIRS/IQVB
Jonathan Ortega-Luciano NRR/DIRS/IQVB
Gabriele Giobbe (observer) Canadian Nuclear Safety Commission

Approved by: Kerri A. Kavanagh, Chief
Quality Assurance Vendor Inspection Branch
Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation

Executive Summary

AZZ Nuclear | NLI, Fort Worth, TX
999002074/2019-201

On May 20 through May 24, 2019, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a limited scope inspection of the AZZ NUCLEAR | NLI (hereafter referred to as NLI) in Ft. Worth, TX. The purpose of this limited scope inspection was to assess NLI'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 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 NLI's implementation of the quality activities associated with design control and equipment qualification, commercial-grade dedication, and nonconforming materials/parts/components and corrective action for equipment being supplied to the U.S. operating nuclear power plants.

The NRC inspection team used Inspection Procedure (IP) 43002, "Routine Inspections of Nuclear Vendors," and IP 36100, "Inspection of 10 CFR Part 21 and Programs for Reporting Defects and Noncompliance."

The results of the inspection are summarized below.

Design Control and Equipment Qualification

The NRC inspectors reviewed safety-related purchase orders (POs) from different customers to verify that the supplied equipment met all technical requirements, including supporting equipment qualification documentation. With regard to the one environmental qualification package reviewed, the NRC inspectors identified issues regarding NLI's justification for the activation energies used as part of the thermal aging analysis/calculations. Issues were also identified regarding NLI's evaluation of anomalies identified during the functional testing portion of the qualification program. These issues are identified as Notice of Nonconformance (NON) 99901471/2019-201-01. NLI issued corrective and preventive action request (CAPAs) NLI-CAPA-539 and NLI-CAPA-543 to address the identified concerns.

The NRC inspectors also reviewed NLI's policies and implementing procedures that govern Electromagnetic Interference (EMI) / Radio-Frequency Interference (RFI) qualification testing in accordance with Criterion III, "Design Control," of Appendix B to 10 CFR Part 50. The NRC inspectors reviewed a sample of EMI/RFI testing which included the EMI/RFI qualification testing for NLI's NLI-072034-CSI-K-5-A inverter assembly. The NRC inspectors identified two minor issues related to EMI/RFI testing. The NRC inspectors identified Electromagnetic Compatibility (EMC) testing on the inverter assembly was performed using an earlier revision of a testing standard than required by the purchase order, and NLI did not apply susceptibility testing methodology in its entirety. NLI initiated CAPAs NLI-CAPA-541 and 542 to address these issues. No findings of significance were identified regarding the EMI/RFI testing.

Commercial-Grade Dedication

The NRC inspectors reviewed NLI's policies and implementing procedures that govern the implementation of its commercial-grade dedication (CGD) programs to verify compliance with the requirements of Criterion III, "Design Control," Criterion IV, "Procurement Document Control," and Criterion VII, "Control of Purchased Material, Equipment, and Services," of Appendix B to 10 CFR Part 50. The NRC inspectors reviewed a sample of CGD packages to assess the different elements of the CGD program. The NRC inspectors identified one minor issue related to CGD. Specifically, the NRC inspectors identified an inconsistency between the purchase order requirements and the commercial manufacturer's specifications regarding the output voltage for an inverter NLI was commercially dedicating. The NRC inspectors determined this to be a minor issue since actual testing performed on the inverters at NLI indicated the equipment met the purchase order requirements. NLI initiated CAPA NLI-CAPA-540 to address this issue. No findings of significance were identified.

Nonconforming Materials/Parts/Components and Corrective Action

The NRC inspectors reviewed NLI's policies and implementing procedures that govern the implementation of its nonconformance and corrective action program to determine 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. No findings of significance were identified.

Closeout of Previously Identified NRC Issues

With regard to the closeout of issues previously identified in NRC Inspection Report 99901471/2016-201, the NRC inspectors were able to close out NOV 99901471/2016-201-01 and NONs 9990147/2016-201-02, 3, and 5. The NRC inspection team did not close NON 99901471/2016-201-04 which involved NLI's failure to identify and verify commercial interrupting ratings as a critical characteristic as part of its CGD process. The NRC inspectors identified that for circuit breakers and other similar devices supplied by NLI as part of motor control centers, NLI has not taken sufficient actions to verify that the supplied items are identical in form, fit, and function to those that were previously qualified and tested by NLI. This is of concern as NLI does not have control of the design process for these commercial devices and does not repeat the qualification testing which was used to validate the commercial ratings on the originally supplied equipment. Also, NLI does not perform inspections, surveys or other activities that might be sufficient to verify that no changes have occurred to the commercial components that would invalidate their previously established commercial ratings (including interrupting ratings). Based upon these concerns this NON 99901471/2016-201-04 is being left open. NLI opened up CAPA No. NLI-CAPA-534 to address the NRC inspectors' concerns.

Report Details

1. Design Control and Equipment Qualification

a. Inspection Scope

The NRC inspectors reviewed NLI's implementation of its policies and procedures governing design control, to verify compliance with the requirements of Criterion III, "Design Control," of Appendix B to 10 CFR Part 50. The NRC inspectors focused the majority of their effort on design control activities associated with NLI's supply of commercially procured and dedicated components. The NRC inspectors reviewed safety-related POs from different customers to verify the supplied equipment met all technical requirements, including supporting equipment qualification documentation.

In the area of equipment qualification, the NRC inspectors reviewed NLI report QR-351027976-1, "Qualification Report for Struthers-Dunn Relay, P/N: 450XBX406990-110/125 VDC and VCC Indicating Light, P/N: 2150A1," Revision 0, dated 3/19/2019. These relays were supplied to Exelon (Dresden), under PO #660681, and are part of a pressure relief valve controller. As part of the qualification program, the NRC inspectors reviewed NLI's thermal aging analysis which was utilized to establish a qualified life for the subject relays. The NRC inspectors assessed whether NLI appropriately considered all non-metallic materials contained within the relays, including the basis for the bounding activation energy of the most limiting material used as an input to the thermal aging analysis. The NRC inspectors also reviewed documentation associated with radiation aging and functional testing of the test specimens.

In the area of Electromagnetic Interference (EMI)/Radio-Frequency Interference (RFI) testing, the NRC inspectors assessed whether NLI's EMI/RFI testing program scope and methodology implemented was consistent with their customer's purchase order requirements. In particular, the NRC inspectors reviewed EMC qualification test report QR-351026560-1 for NLI's inverter assembly NLI-072034-CSI-K-5-A.

The attachment to this inspection report lists the individuals interviewed and documents reviewed by the NRC inspectors.

b. Observations and Findings

Equipment Qualification

With respect to NLI's thermal aging analysis and accelerated aging of the Struthers-Dunn relays, the NRC inspectors identified that NLI performed material analysis on each of the non-metallic relay sub-components. The material analysis identified the material type (by family), from which NLI then assigned activation energies based upon data contained in reference material. The lowest of these activation energies was then used as an input into the thermal aging Arrhenius calculations. As part of this process, the NRC inspectors identified that NLI failed to identify the coil wire insulation as one of the non-metallic materials to be considered. Thermal breakdown of this insulation could

cause the relay coils to short out, thus directly impacting the operation of the relays. Since the coil wire insulation was not considered, it was not clear at the time of the inspection whether NLI had utilized the most limiting (lowest) activation energy for the materials contained within the relays in performing the thermal aging analysis (and subsequent accelerated thermal aging).

In addition, for the relay materials for which activation energies were identified, although NLI included a reference for the source of the activation energy, there was no indication as to whether the activation energy utilized was for the material property of concern for this particular application. NLI utilized an activation energy of .96eV which was associated with the material of acetal, identified by NLI as the relay material with the lowest identified activation energy. The NLI qualification report stated that the activation energy for acetal was taken from another test report in possession of NLI written by Acton Environmental Testing Corporation for an unrelated component (a battery charger), Test Report No. 17666, "Qualification of Class 1E Electrical Equipment Used for Nuclear Power Generating Stations Per IEEE 650-1979, NUREG-0588, Category 1, and IEEE 344-1975," dated 10/12/1984. In the thermal aging section of the Acton report there was a listing of various applicable materials for the battery charger, including the material delrin for which an activation energy of .96eV was assigned. NLI indicated that delrin is a brandname for a specific type of acetal. There was no reference in the Acton report as to where the delrin activation energy value came from, how it was derived, or what material characteristic it was associated with. Also, the NRC inspectors identified that there are many types of delrin material that are produced, and it was not clear how similar the delrin material referenced in the Acton report was to the acetal material contained in the Struthers-Dunn relays. Based upon the concerns identified above, the NRC inspectors concluded that NLI had not adequately justified the basis for their selection of .96 eV as the lowest activation energy value and the corresponding qualified life of 20 years that NLI had established for this equipment. This was identified by the NRC inspectors as contrary to Criterion III of Appendix B to 10 CFR Part 50 which requires in part that, "Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, it shall include suitable qualification testing of a prototype unit under the most adverse design conditions." This issue is included as part of Nonconformance 99901471/2019-201-01. During the inspection NLI documented these concerns in CAPA No. NLI-CAPA-539.

With regard to radiation aging, the NRC inspectors identified that NLI had contracted out the radiation aging portion of the qualification program to Steris Isomedix, a commercial service provider. The NRC inspectors reviewed Commercial-Grade Survey Report No. CGSR-AVL-4-11, Revision 0, dated 7/20/2017, which was used to assess whether Steris Isomedix maintained sufficient controls to ensure the critical characteristics identified on Commercial-Grade Verification Plan, VP-Irradiation-2, Revision 1, were being met. The NRC inspectors determined the survey was thorough and that appropriate critical characteristics associated with irradiation process had been identified and verified.

With regard to functional testing of the two relay test specimens, the NRC inspectors identified that NLI had documented as a test anomaly that after the mechanical cycling portion of the qualification test, both relays exhibited high resistance across the main

contacts. NLI did not definitively identify the cause of this high resistance, but rather dispositioned the anomaly as acceptable based upon the fact that even given the high resistance, the relays were able to operate a test load (in the form of a solenoid valve coil) that had been hooked up to the relays during the functional test. In addition, for the one relay that was chosen to continue on through the qualification program, the high resistance reading went away after completion of the function testing performed after high energy line break test. Although NLI had not definitively defined the cause of the high resistance readings, they stated in the anomaly evaluation that the high readings were likely due to some minor wear or discoloration deposits caused by arcs created during repetitive mechanical cycling. Furthermore, the evaluation stated that the high readings would not be a safety concern as the relays were able to pass sufficient current through the contacts to activate the connected load, even given the high resistance. The NRC inspectors identified that this evaluation did not sufficiently account for differences between the test load and the actual loads that would be applied once installed in the plant. Also, the NRC inspectors identified that while the test plan indicated that inrush currents to the connected load were to be monitored during the testing, this was not done and no data on the current supplied to the connected loads was recorded. This was identified by the NRC inspectors to be contrary to Criterion III of Appendix B to 10 CFR Part 50 which requires in part that, "Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, it shall include suitable qualification testing of a prototype unit under the most adverse design conditions." This issue is included as part of Nonconformance 99901471/2019-201-01. During the inspection NLI documented these concerns in CAPA No. NLI-CAPA-543.

EMI/RFI Testing

The NLI test report was performed in accordance with Qualification Procedure (QP)-351026560-1, Baseline Functional Test (BFT)- BFT-351026560-1, MIL-STD-461D, Electric Power Research Institute (EPRI) TR-102323, "EPRI Guidelines for Electromagnetic Interference Testing of Power Plant Equipment," Revisions 1 and 2. NLI performed conducted susceptibility (CS) low frequency testing per CS101, radiated high frequency electrical per radiated susceptibility (RS) RS103, impulse and burst susceptibility per International Electrotechnical Commission (IEC) EN 610004-4, surge withstand susceptibility (SWC) per IEC EN 610004-5 and sub-contracted susceptibility high frequency in accordance with CS114. NLI also performed emissions test in accordance with conducted emissions (CE) CE101, CE102, radiated emissions (RE) RE101, and RE102.

The NRC inspectors identified one minor inconsistency between what testing standards were imposed on the purchase order to NLI and what standards were actually utilized. The latest revision of PO 663381 requested the inverter shall meet the requirements of EPRI Report TR-102323 Revision 4; however, NLI performed qualification in accordance with EPRI Report TR-102323 Revisions 1 and 2. NLI failed to identify the PO requirements and applicable test guideline differences between the EPRI TR-102323 revisions. Later revisions of EPRI TR-102323 include multiple changes in susceptibility and emissions testing. During the inspection, NLI contacted the licensee and discovered

the reference to Revision 4 of the EPRI standard was due to an administrative error by the licensee and that testing in accordance with EPRI TR-102323 Revision 1 and 2 was acceptable. The NRC inspectors evaluated the significance of administrative PO error to be minor because it was determined to not affect the licensee requirements. NLI initiated CAPA NLI-CAPA-541 to address this issue

During the review of susceptibility testing; the NRC inspectors also identified that in some instances, NLI may have mixed tests taken from both the IEC and military standards, as opposed to performing the complete suite of tests from one or the other. The EMI/RFI testing methodology for ensuring acceptable performance with regard to EMI, RFI and SWC conditions at nuclear power plants originates from military standards (MIL-STD-461) or commercial standards (IEC 61000). Each suite of tests included within the standards includes specific test criteria, test setup, test methods, and operating envelopes. The mixing of military and IEC tests within a specific suite of tests can result in gaps in the frequency range coverage and parameters being measured (e.g., voltage vs current). Therefore, unless the gaps are identified and a technical basis for these differences is provided, it is intended that either the IEC or military set of test methodology be applied in their entirety, without selective application of individual methods (i.e., no mixing and matching of test methods). The NRC inspectors determined this issue to be minor because NLI's customer specifically approved the NLI test methodology and NLI met the PO requirements. The NRC inspectors also verified this met the customer's licensing bases. NLI initiated CAPA NLI-CAPA-542 to address this issue.

c. Conclusion

The NRC inspectors identified NON 99901471/2019-201-01 associated with issues regarding NLI's justification for the activation energies used as part of the thermal aging analysis/calculations. Issues were also identified regarding NLI's evaluation of anomalies identified during the functional testing portion of the qualification program. With the exception of the issues identified above, NLI has established its design control and equipment qualification programs in accordance with the regulatory requirements of Criterion III of Appendix B to 10 CFR Part 50.

2. Commercial-Grade Dedication

a. Scope

The NRC inspectors reviewed NLI's policies and implementing procedures that govern the implementation of its CGD program to verify compliance with the requirements of Criterion III, "Design Control," Criterion IV, "Procurement Document Control," and Criterion VII, "Control of Purchased Material, Equipment, and Services," of Appendix B to 10 CFR Part 50.

The NRC inspectors reviewed a sample of CGD packages to assess the different elements of the CGD program. The CGD packages contained such documents as the supplier's POs, CGD plans, QA checklists, material verification reports, shop travelers,

final inspection reports, and testing certificates, as applicable. The CGD packages included the technical evaluation for the identification and documentation of the basis and justification for the selection of the critical characteristics, acceptance methods and acceptance criteria, and sampling methodologies. The NRC inspectors evaluated the criteria for the identification of item functions, credible failure mechanisms/modes, selection of critical characteristics and acceptance criteria, and the identification of verification methods to verify effective implementation of NLI's CGD process.

One PO reviewed by the NRC inspectors included software/firmware embedded within a digital controller. The NRC inspectors reviewed the documented critical characteristics, test reports, and certificates of conformance to confirm that a functional test was verified as a critical characteristic. The NRC inspectors also assessed whether the configuration control of software/firmware revisions was being maintained via documented equivalency evaluations.

The NRC inspectors also discussed the CGD program with NLI's management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspectors.

b. Observations and Findings

While reviewing the CGD of NLI-072034-CSI-K-5-A inverter assembly (NLI-model 072034-CS), the NRC inspectors identified an inconsistency between the PO requirements and the commercial manufacturer's specifications regarding the inverter output voltage. The incoming PO requirements specified that the inverter would need to be capable of supplying an output voltage within the range of 114-127 volts alternating current (VAC) under all input voltage variations and output loading conditions. NLI indicated that they receive the inverters from their commercial manufacturer with a nominal output setting of 115 VAC which is adjustable. Since NLI supplies the inverters with a nominal unloaded output of 115 VA and the manufacture specifies the voltage regulation (no load to full load) of the inverter to be 2%, the NRC inspectors was concerned that under full loaded conditions the output of the inverters might not meet the PO requirements (115 minus 2% would be 112.7 VAC which is below the 114 VAC requirement).

The NRC inspectors determined this to be a minor issue since actual testing performed on the inverters at NLI indicated the equipment performance actually exceeded the manufacturer's specifications with respect to voltage regulation, and that testing demonstrated the inverter output never fell below 114 VAC under all variations of input and output loads. NLI initiated CAPA NLI-CAPA-540 to assess whether the nominal output voltage of the supplied inverters should be raised to provide sufficient margin between their customer's and their manufacturer's specifications.

With regard to the CGD of software/firmware, for the limited sample reviewed, the NRC inspectors noted that NLI had appropriately identified a discrepancy in software revisions and determined it to be solely due to a change in the filename without technical changes,

as identified during a commercial-grade survey of the subsupplier and dispositioned by an NLI nonconformance report.

c. Conclusion

The NRC inspectors concluded that with the exception of the minor issues identified herein, NLI has established its CGD program in accordance with the regulatory requirements of Criterion III, Criterion IV, and Criterion VII of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspectors also determined that NLI is implementing its policies and procedures associated with the CGD program. No findings of significance were identified.

3. Nonconforming Material/Parts/Components; and Corrective Action

a. Inspection Scope

The NRC inspectors reviewed NLI's implementation of its policies and procedures governing nonconformances and corrective actions, in order to verify compliance with the requirements of Criterion XV, "Nonconforming Materials, Parts, or Components," and Criterion XVI, "Corrective Actions," of Appendix B to 10 CFR Part 50. The NRC inspectors also reviewed NLI's actions associated with its response to a Notice of Violation and Notice of Nonconformance contained in NRC Inspection Report 99901471/2016-201.

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

b. Observations and Findings

The NRC inspectors reviewed several anomaly reports, deficiency reports, significant deficiency reports, and nonconformance reports during the course of inspecting the sampled POs. In addition to requiring a CAPA for conditions adverse to quality, the NRC inspectors noted that AZZ-QAP-16 allows any employee to initiate a CAPA for remedying or prevent recurrence of any deficient condition. NLI initiated nine CAPAs during the course of this NRC inspection for issues identified as findings by the NRC inspectors as well as minor issues. A listing of the CAPAs initiated is included in the attachment to this inspection report.

The NRC inspectors reviewed a PO and NLI's failure analysis of two circuit boards, which were returned from a licensee as having failed during calibration. In turn, these circuit boards had been originally manufactured by NLI as part of a previous PO to reverse-engineer and manufacture spare part components for a safety-related battery charger. For the previous reverse-engineering PO, the customer had been able to provide original design drawings and specifications for the circuit boards, which NLI manufactured to specifications. Although the circuit boards were returned as failed NLI products, it turns out it was the customer that had incorrectly mis-applied excess voltage during calibration on their test bench. Therefore, this issue did not represent an NLI

design failure nor an installed plant condition. The NRC inspectors also reviewed a subsequent Engineering Change Notice for these circuit boards, intended to improve the robustness of the design for both the customer's test bench as well as its final application in the plant.

c. Conclusion

The NRC inspectors determined that NLI's implementation of its policies and procedures associated with nonconformances and corrective actions met the requirements of Criterion XV, "Nonconforming Materials, Parts, or Components," and Criterion XVI, "Corrective Actions," of Appendix B to 10 CFR Part 50 based on the limited sample of POs reviewed. No findings of significance were identified.

4. Closeout of Previous Issues

NOV 99901471/2016-201-01 (Closed)

In response to the NOV, on January 18, 2017, NLI issued Technical Bulletin #TB-17-001, "Micrologic Trip Unit Spurious Trip," Revision 0, which fully explained the technical issues surrounding the NON and recommended to their customers that for applications of the Masterpact breakers similar to those that were installed at Hope Creek (used as motor starters), that the trip units be powered by a separate 24 VDC power supply. Based upon NLI's issuance of the bulletin, the NRC inspectors consider this issue to be closed.

NON 99901471/2016-201-02 (Closed)

Following the December 2016 inspection of NLI, the NRC issued NON 99901471/2016-201-02 for NLI's failure to ensure that appropriate quality standards were specified and included in design documents. Specifically, NLI used the latest revision of the EPRI testing standards assuming the different revisions were acceptable to a previous revision stated in the PO requirements. In NLI's response dated January 13, 2017, NLI entered the NON into the corrective action program to 1) internally published a reference table that has the appropriate quality standards, 2) reconcile the standard years used for testing and standard years required per EPRI and RG 1.180, 3) review qualification plans to ensure correct standards, and 4) perform a review on a sample of projects to ensure correct standards were utilized.

The NRC inspectors reviewed several recent POs to ensure the test methodology and standards requested in the POs met the test methodology in NLI's qualification reports. Based on the review, the NRC inspectors closed NON 99901471/2016-201-02.

NON 99901471/2016-201-03 (closed)

In NLI's response to the NON dated May 22, 2017, NLI provided additional information regarding analyses and testing that was previously performed regarding the adequacy of the design of the Masterpact breakers supplied to Public Service Enterprise Group,

specifically, the use of the breakers in a motor starter application. Included within the additional information provided by NLI was data on the suitability of powering the digital overcurrent trip units from the load side of the breakers. Based upon this additional information provided, the NRC inspectors considered the issue to be closed.

NON 99901471/2016-201-04 (Open)

With regard to the first example contained within the NON and associated with the total harmonic distortion testing of an inverter, NLI provided a summary of its corrective actions as well as additional information in its response to the NON dated May 22, 2017, and based upon NLI's response, the NRC inspectors considered this part of the previously issued NON to be closed.

Regarding the second part of the NON, involving NLI's failure to identify and verify commercial interrupting ratings as a critical characteristic as part of its CGD process, the NRC inspectors identified that as a corrective action to the previously issued NON, that for circuit breakers and other similar devices, NLI now specifically states to their customers that they are not verifying the component's interrupting ratings as part of the dedication process. This is documented in NLI's Commercial-Grade Item Dedication Technical Evaluation and Test Plan, CGD-MCCB-1, Revision 5. This resolves the issue (from NLI's perspective) for individual replacement components, thus leaving it up to NLI's customers to determine whether the interrupting rating for a particular replacement component would be a critical characteristic for a given application.

Conversely, with regard to NLI's supply of more complete switchgear (replacement motor control center (MCC) buckets, complete MCCs, etc.), NLI typically certifies that the switchgear they supply meets certain customer requirements, including the capability to interrupt fault currents up to and including nameplate ratings. The NRC inspectors identified that for such equipment, NLI performs first article design testing which includes testing to verify the validity of the nameplate interrupting ratings on the commercial components. Such testing is considered destructive in nature and is performed only on the test specimens. For subsequently manufactured production equipment, NLI utilizes individual components that have gone through its CGD process. Consequently, although NLI has performed qualification/design testing to verify interrupting ratings on test samples, sufficient actions have not been taken to verify that replacement items are identical in form, fit, and function to those that were previously tested, particularly with regard to any changes to the devices that could impact its interrupting rating. This is of concern as NLI does not have control of the design process for these commercial devices and has not performed testing, inspections, surveys or other activities that might be sufficient to verify the validity of the commercial ratings (including interrupting ratings) on subsequently procured equipment. Based upon these concerns, this NON is being left open. NLI documented these concerns on CAPA No. NLI-CAPA-534.

NON 99901471/2016-201-05 (Closed)

Subsequent to the inspection that was conducted in 2016, on September 22, 2016, NLI revised its 10 CFR Part 21 notification and also the associated technical bulletin, TB 12-

007, Revision 3, "Masterpact Breakers Fail To Close," associated with the issue of binding Masterpact circuit breakers. Based upon review of the revised Part 21 notification and technical bulletin, the NRC inspectors considered this issue to be closed.

5. Entrance and Exit Meetings

On May 20, 2019, the NRC inspection team discussed the scope of the inspection with Mr. Tracy Bolt, Director of Quality Assurance, and other members of NLI's management and technical staff. On May 24, 2019, the NRC inspection team presented the inspection results and observations during an exit meeting with Mr. Bolt and other NLI staff. The attachment to this report lists the entrance and exit meeting attendees, as well as those individuals whom the NRC inspection team interviewed.

ATTACHMENT

1. Entrance/Exit Meeting Attendees and Persons Interviewed

Name	Title	Organization	Entrance	Exit	Interviewed
Jefferey Jacobson	Inspection Team Leader	NRC	X	X	
Jonathan Ortega-Luciano	Inspector	NRC	X	X	
Nicholas Savvoir	Inspector	NRC	X	X	
Phil Natividad	Inspector	NRC	X	X	
Kerri Kavanagh	Branch Chief	NRC		X	
Gabrielle Giobbe	Observer	CNSC	X	X	
Matt Allen	Mechanical Engineer	NLI		X	X
Moses Garcia	Material Test Technician	NLI			X
Jeff Stubblefield	Principal Electrical Engineer	NLI		X	X
Chris Tribble	Engineering Manager	NLI			X
Les Taggart	Quality Assurance Program Manager	NLI	X	X	X
Tracy Bolt	Director of Quality Assurance	NLI	X	X	X
Angela Harper	Supplier Quality Auditor	NLI		X	X
Mark Harness	Director of Operations	NLI	X	X	X
Victor Lara	Director of Engineering	NLI		X	X
Kathy Baker	Supervisor Document Control	NLI		X	
Kerri Bolicy	Shipping Receiving	NLI		X	
Kim Tomlinson	Scheduling/	NLI	X		

	Materials Manager				
Steven Redman	Engineering Manager	NLI	X		X
Angela Harper	Supplier QA, Lead Auditor	NLI	X		
Edward Wynne	Procurement Engineering Manager	NLI	X	X	X

1. INSPECTION PROCEDURES USED

- IP 43002, "Routine Inspections of Nuclear Vendors," dated January 27, 2017
- IP 43004, "Inspection of Commercial-Grade Dedication Programs," dated January 27, 2017

2. LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Item Number	Status	Type	Description
99901471/2016-201-01	CLOSED	NOV	10 CFR Part 21
99901471/2016-201-02	CLOSED	NON	Criterion III
99901471/2016-201-03	CLOSED	NON	Criterion III
99901471/2016-201-04	OPEN	NON	Criterion III
99901471/2016-201-05	CLOSED	NON	Criterion XVI
99901471/2019-201-01	OPEN	NON	Criterion III

3. DOCUMENTS REVIEWED

Policies and Procedures

- AZZ Nuclear Engineered Solution Quality Assurance Manual Second Edition, Revision 1, dated October 27, 2017
- AZZ-ENG-01, "Nuclear Engineering Procedure Commercial-Grade Item Dedication AZZ-ENG-01," Revision 2, dated August 31, 2016
- AZZ-ENG-07, "Control of Software and Software Dedication", Revision 4, August 31, 2018
- AZZ-ENG-18, "Engineering Change Notice", Revision 1, dated March 18, 2019
- AZZ-ENG-03, "Equivalency Qualification", Revision 1, dated April 11, 2016
- AZZ-ENG-19, "Engineering Risk Assessment", Revision 4, dated March 4, 2019

- AZZ-QAP-16, “Corrective and Preventive Actions”, Revision 2, dated August 3, 2018

Qualification Documents

- QR-351026560-1, Revision 3, October 2018
- QR-351026164-2 Revision 0, August 2017
- Baseline Functional Test (BFT)- BFT-351026560-1, Revision 0
- Qualification Procedure (QP)- QP-351026560-1, Revision 0
- QR-351024835-1, “Qualification Report”, Rev. 1, dated February 2017
- QR-351027976-1, “Qualification Report for Struthers-Dunn Relay, P/N: 450XBX406990-110/125 VDC and VCC Indicating Light, P/N: 2150A1,” Revision 0, dated 3/19/2019
- Acton Environmental Testing Corporation Test Report No. 17666, “Qualification of Class 1E Electrical Equipment Used for Nuclear Power Generating Stations Per IEEE 650-1979, NUREG-0588, Category 1, and IEEE 344-1975,” dated 10/12/1984

Commercial-Grade Dedication Documents

- CGD-06DM8086Gc3150-1, “Commercial-Grade Item Dedication Technical Evaluation and Test Plan for Semi-Hermetic Reciprocating Compressor,” Revision 2, dated June 25, 2018
- CGD-VAL02843-01, “Commercial-Grade Item Dedication Technical Evaluation and Test Plan for Solenoid Valve with Coil and Gasket, load/unload Valve for Trane Chiller,” Revision 0, dated April 9, 2019
- CGD-3060-185, “Commercial-Grade Item Dedication Technical Evaluation and Test Plan for Relief Valve, 1” MNPT x 1” FNPT, Set at 185 PSIG, ASME Section VIII, Brass Body,” Revision 0, dated January 17, 2017
- CGD-351025140-1, “Commercial-Grade Item Dedication Technical Evaluation and Test Plan for Spare Parts for Foxboro 44BT Pneumatic Temperature Transmitter,” Revision 1, dated March 4, 2016
- CGD-VV-NLI-072034-CSI-K-5-A, “Commercial-Grade Dedication”, Rev. 4, dated May 21, 2018
- CGSR-AVL-245-02, “Commercial-Grade Survey Report”, rev.0, dated December 20, 2017
- Commercial-Grade Survey Report No. CGSR-AVL-4-11, Revision 0, dated 7/20/2017

Standards

- EPRI Guidelines for Electromagnetic Interference Testing of Power Plant Equipment TR-102323 Revisions 1,2,3,4
- MIL-STD-461D, MILITARY STANDARD: REQUIREMENTS FOR THE CONTROL OF ELECTROMAGNETIC INTERFERENCE EMISSIONS AND SUSCEPTIBILITY (11 JAN 1993)
- MIL-STD-462D MILITARY STANDARD: MEASUREMENT OF ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS (11 JAN 1993)
- MIL-STD-416E, August 20, 1999 “Department of Defense Interface Standard Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment”
- IEEE Std C62.45-1992, IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits, Institute of Electrical and Electronics Engineers.

- IEEE 519-1992 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, June 18, 1992
- Regulatory Guide 1.180, Revision 0, January 2000, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems"
- Regulatory Guide 1.180, Revision 1, October 2003, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems"

Purchase Orders

- PO 606902- Exelon (Limerick), Revision 0, March 27, 2017
- PO 606902- Exelon (Limerick), Revision 1, March 31, 2017
- PO 02358373- Florida Power and Light (St. Lucie Plant), Revision 2, May 4, 2017
- PO 0350825- Duke Energy Revision 0, June 29, 2017
- PO 626642- Exelon (Limerick), Revision 1, September 27, 2017
- PO 663381- Exelon (Limerick), Revision 0, August 13, 2018
- PO 663381- Exelon (Limerick), Revision 1, October 11, 2018
- PO 684578- Exelon (Limerick), Revision 3, April 19, 2019
- PO 351028561 (PIDF-028798)
- PO 351028705 (PIDF-028898)
- PO 351027050 (PIDF-026765)
- PO 351027170 (PIDF-026748)
- PO 351024791
- PO 351027477 (PIDF-28814)
- PO 351026560

Discrepancy Reports

- DR-19693
- DR-19786
- DR-16263
- DR-15421
- DR-19701
- DR-19911

Corrective and Preventive Action Request Generated during NRC Inspection

- NLI-CAPA-534, dated May 23, 2019
- NLI-CAPA-535, dated May 23, 2019
- NLI-CAPA-536, dated May 23, 2019
- NLI-CAPA-537, dated May 23, 2019
- NLI-CAPA-538, dated May 23, 2019
- NLI-CAPA-539, dated May 23, 2019
- NLI-CAPA-540, dated May 23, 2019
- NLI-CAPA-541, dated May 23, 2019
- NLI-CAPA-542, dated May 23, 2019
- NLI-CAPA-543, dated May 23, 2019

Miscellaneous

- CC-139-351028561-1, "Certificate of Conformance", Rev. 0, dated April 10, 2019
- VP-913205-1, "Verification Plan", Rev. 7, dated February 18, 2019
- TE-E-35, "Technical Evaluation", Rev. 1, dated March 15, 2018
- CC-037-351028705-1, "Certificate of Conformance", Rev. 0, dated May 10, 2019
- CC-052-351027050-1, "Certificate of Conformance", Rev. 0, dated November 9, 2017
- DCCE-351024835-1, "Digital Configuration Change Evaluation Report", dated January 23, 2017
- VP-NLI-72-16601-100, "Validation Plan", Rev. 1, dated May 25, 2016
- FA-351027477-01, "Failure Analysis"
- Engineering Change Notice Form ECNF-8200, "VORD", rev.0, dated 1/15/2019
- CRR-351027477-1, "Component Refurbishment/Repair Report", Rev. 0
- VP-NLI-72-16601-100, "Validation Plan", Rev.6, dated January 14, 2019
- EE-351026560-1, "Equivalency Evaluation for Inverter Assembly", rev. 0, dated April 2, 2018
- SDR-AVL-245-2017-01, "Supplier Deficiency Report", rev.0, dated December 20, 2017
- NCR-773, "NonConformance Report", rev.2, dated 1/11/18, closed 4/2/18
- SDR-AVL-245-2017-01, "Supplier Deficiency Report", rev. 1, dated 5/23/2019

4. LIST of ACRONYMS

alternating current	ac
commercial grade dedication	CGD
conducted emissions	CE
conducted susceptibility	SE
Corrective and Preventative Action Request	CAPA
Electric Power Research Institute	EPRI
electromagnetic compatibility	EMC
electromagnetic interference	EMI
Institute of Electrical and Electronic Engineers	IEEE
International Electrotechnical Commission	IEC
motor control center	MCC
Notice of Nonconformance	NON
Nuclear Regulatory Commission	NRC
purchase order	PO
quality assurance	QA
radiated emissions	RE
radiofrequency interference	RFI
surge withstand susceptibility	SWC
volts ac	Vac