NLI-QA-3595, Rev. 1
Date 6/16/2017

Mr. Paul Krohn
Division of Construction Inspection and Operational Programs
Office of New Reactors
Nuclear Regulatory Commission
Washington DC, 20555-0001

SUBJECT: RESPONSE TO TWO NOTICES OF NONCONFORMANCE CONTAINED IN NUCLEAR REGULATORY COMMISSION INSPECTION REPORT 99901471/2016-201

Dear Mr. Krohn,

I am responding to your letter dated April 10, 2017, in which your team has refuted our previous response for the disputed Nonconformances 99901471/2016-201-03 and 99901383/2016-201-04 as identified in the Notice of Nonconformance (NON) attached to the Nuclear Regulatory Commission (NRC) Inspection Report 99901471/2016-201 dated December 14, 2016 (ADAMS Accession No. ML16305A097) of AZZ NUCLEAR | NLI (hereafter referred to as NLI). The NRC staff identified these NONs during an inspection conducted from September 19 through 22, 2016, at our facility in Fort Worth, TX.

We have re-evaluated our responses based on the feedback from the NRC independent review and concur that we needed to provide additional supporting data for our position. In addition we also realized that there was cause for required corrective action. NLI Engineering and Quality Assurance has re-evaluated the issues identified and in addition, has solicited input from the industry leaders in regard to the NON's that were identified during the NRC Inspection in September 2016. NLI believes that there is additional information that could have been provided that could have eliminated the concerns that arose during the inspection. In this response NLI will provide the additional supporting information and data to substantiate our position.

In our original letter, we disputed NON 99901471/2016-201-03, which concerned the use of Masterpact circuit breakers as motor starters with overcurrent trip devices that are powered from the load side of the breakers supplied to Public Service Enterprise Group for use at the Hope Creek Nuclear Station. Based on the information provided during the inspection, the NRC identified that NLI had not verified the adequacy of this aspect of the design as part of their design verification or commercial-grade dedication processes. The original NLI reply stated that the design of the Masterpact circuit breaker was verified extensively by review, qualification testing and dedication testing activities, in addition to review of operating history. Contained within this response is the additional supporting information that the function of the Masterpact Circuit breaker was evaluated for the ability to function properly with the trip unit powered from the load side.

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We also disputed NON 99901471/2016-201-04 regarding two examples of inadequate commercial-grade dedication. In the first example, NLI failed to verify the critical characteristic of total harmonic distortion and power quality on the output of a repaired Exeltec inverter supplied to Entergy and in the second example NLI failed to identify and verify the critical characteristic of current interrupting rating for Masterpact circuit breakers supplied to Tennessee Valley Authority. NLI has re-evaluated the original response and agrees that there is additional information that needed to be provided.

The response on page 9 of 9 has been revised.

Responses for the following: Statement of Nonconformance 99901471/2016-201-03 and 99901471/2016-201-04 are contained in pages 3 through 9.

Sincerely,

Tracy Bolt
Director of Quality Assurance

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NLI RESPONSES

Statement of Nonconformance 99901471/2016-201-03

Criterion III, "Design Control," of Appendix B "Quality Assurance Program Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," states, in part, that, "The design control measures shall provide for verifying the adequacy of the design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program."

Contrary to the above, as of September 22, 2016, AZZ failed to take adequate actions to verify the adequacy of the design for Masterpact breakers supplied to Public Service Enterprise Group, for use at the Hope Creek Nuclear Station, and that are used as motor starters with overcurrent trip devices that are powered from the load side of the breakers. Since the overcurrent trip devices for these breakers only receive power once the breakers are shut (upon starting of a motor), there is an undefined startup time before the breaker can accurately process load current data. When used as a motor starter, this startup time could potentially cause erroneous data to be acquired or make them more susceptible to noise interference. AZZ had not verified the adequacy of this aspect of the design as part of their design verification or commercial-grade dedication processes.

Basis for Disputing the Nonconformance

In the previous response NLI failed to provide the detailed information to substantiate our position in regard to the verification of the adequacy of the start-up time for the trip unit. In the information provided below, NLI will provide the basis for our original evaluation that the breaker was suitable for the intended design including being able to be used as a motor starter. The design criteria for the equipment was specified by PSEG in the Design Specification provided to NLI in the contract. Verification of the design requirements were performed and completed and approved by PSEG. The specific criteria of being used as a motor starter was not included in the specification requirements and therefore, was not included as specific criteria in the dedication and qualification program. NLI performed the design, qualification and dedication testing in accordance with the contract requirements and as approved by the end user.

In the original design verification, the operation of the trip unit being powered from the load side of the breaker was evaluated and documented. Following the identification of the Nuisance trip, NLI has evaluated the condition of using a Masterpact breaker as a motor starter. NLI has performed extensive testing and software dedication in both of these areas to validate the acceptability of the Masterpact breaker and Micrologic trip unit for use. Based on the testing of the Masterpact breaker starting a motor and validation performed by NLI during the validation and dedication of the trip unit software, the Masterpact breakers and trip units are acceptable for use to start a motor and when powered from the load side of the breaker.

NLI evaluated and dedicated the Masterpact circuit breaker operation including a Verification and Validation Dedication for the Micrologic trip unit, as documented in NLI VVR-042181-1. In the Verification and Validation report the operation of the trip unit is discussed in detail. The following contains information derived from that report to further demonstrate that the operation of the trip unit was evaluated as part of the original dedication activities performed for the supplied equipment.

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In the NRC response letter dated 4/10/2017, it is stated that NLI has not performed an analysis of the acceptability of the overcurrent trip circuitry when used in this application. However, NLI had evaluated the trip unit circuitry in detail and the timing of the circuit process was documented in the original report that was issued May 7, 2004. The timing of the circuit is documented in VVR-042181-1;

Excerpt from VVR-042181-1 section 2.2.3.1:

Response Time from input to output with change of state:

- Digital: 544 µ-seconds + user selected trip delay time + 20 milli-seconds.
- Analog: 1 µ-second + 20 milli-seconds.
- Note: Change of state is defined to be the total time from current detection to when the breaker contacts transition from fully closed to contacts fully open.

Excerpt from VVR-042181-1 section 2.2.3.3:

Operation of the Application Specific Integrated Circuit (ASIC) is summarized below. The NLI survey report and Schneider/Square D design data provides additional information.

- A 2.0 MHz clock drives the ASIC microprocessor. A crystal oscillator controls the clock frequency. The sequence of events performed by the microprocessor is dictated by the masked code set located in the MCROM.
- The ASIC startup or restart sequence completes 384 microseconds after the trip unit is powered. During the 384 microseconds start sequence the digital words created by the interface of the rotary switch positions or Incremental Fine Tuning (IFT) and the state of the (and-or) gates are restored. All other information to perform the safety-related function of the ASIC is contained in the MCROM and THROM.
- A complete protection cycle occurs every 544 microseconds. Poles are evaluated in the sequence: O, A, B, C. The logic for each pole is processed in 128 microseconds and the decision to trip or not trip is processed in 32 microseconds. The Longtime (L), Short Time (S), Instantaneous (I) and Ground Fault (G) for each pole are calculated separately every 544 microseconds, as applicable.
- Each pole (A, B, C) is calculated separately.
- Each function (L, S, I, G) is calculated separately.
- User selectable trip functions (L, S, I, and G with time delays) are chosen by rotary switch position selection. The rotary switch position configures its portion of the hardwired decision logic by means of and-or gates. Regardless of model, each rotary switch has its own and-or gate matrix. Each matrix is independent but all are contained in the same silicon device.

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Each function (L, S, I, G) is logically independent, except as follows:

- Long time pickup and long time delay are dependent.
- Short time pickup and short time delay are dependent.
- Ground fault pickup and ground fault delay are dependent.
- The neutral protection setting is chosen thru the electronic menu.

Based on the process cycle time of 544 micro-seconds, the assumption that the trip unit receives an erroneous signal and is processing the data incorrectly is not viable. After the first cycle time of 928 microseconds [0.000928 seconds] (0.000384 + (0.000128 x 4)+0.000032), the trip unit repeats the process loop every 544 micro-seconds. The nuisance trip times reported by PSEG were in the range of approximately 0.5 to 4 seconds. Therefore, if the trip unit tripped the breaker in 0.5 seconds then the process loop would have been repeated approximately 920 times, which would indicate that the trip unit was operating properly after the initial startup.
After the trip command is issued, the mechanical operation of the breaker to move from the closed to the fully open position is approximately 20 milliseconds. From the issuance of a signal to trip, the total time for tripping the breaker is less than 25 milliseconds. Based on the information provided above regarding the start-up time of the trip unit, if the trip was caused by the processor being confused, the nuisance trip would have occurred within the first 25 milliseconds of operation. Due to the fact that the trips were anywhere from 0.5 to 4 seconds (as reported by PSEG) it is concluded that the trips were not as a result of the startup time of the trip unit.

Figure 1 below illustrates the timing of the trip unit and breaker.

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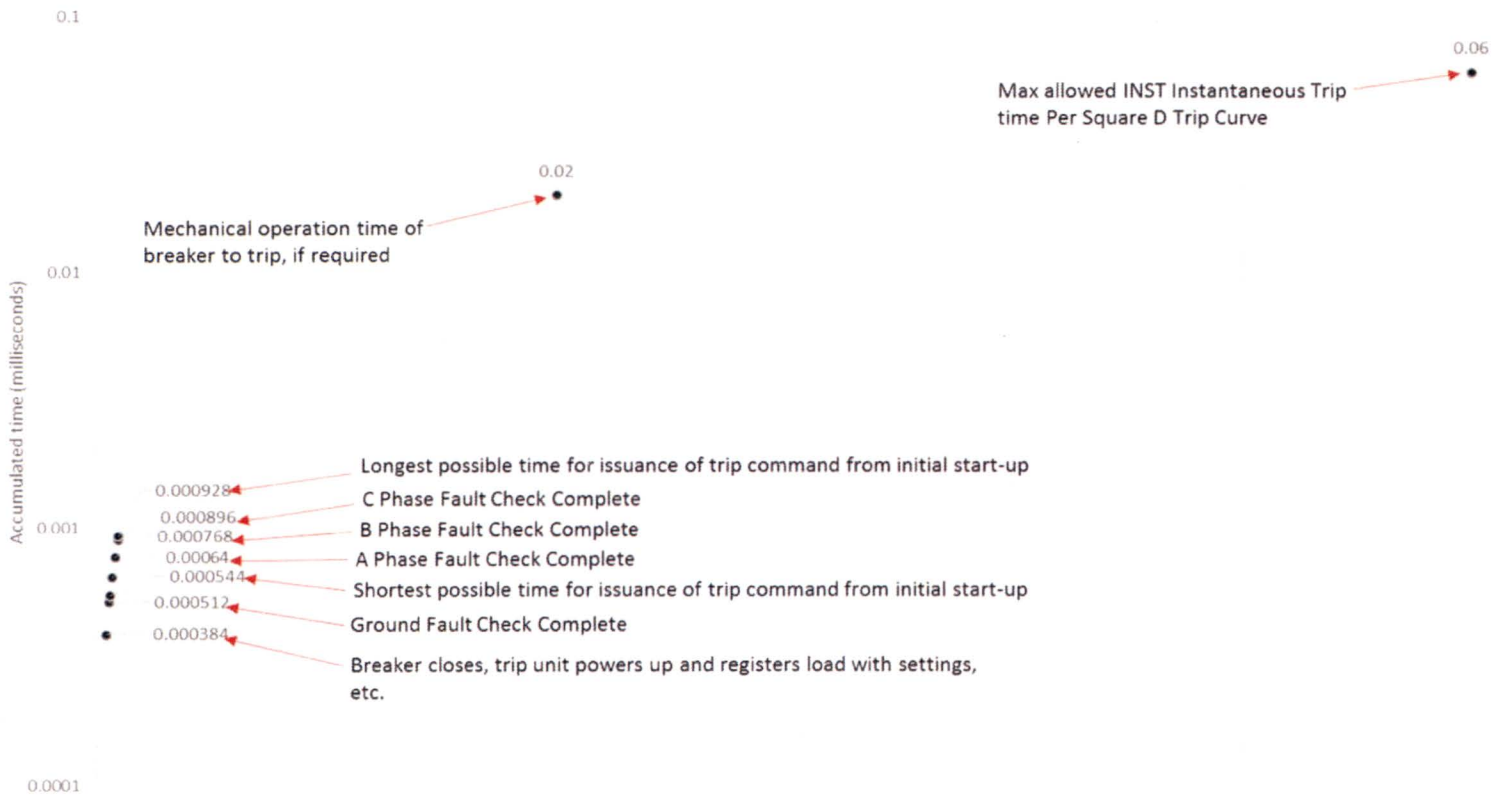

Note: The above plot shows the time required for a trip unit start-up from no power to issuance of a trip command. After the initial start-up time of 384 micro seconds (0.000384 sec), the trip unit runs through the process loop every 512 micro seconds (0.000512 seconds) checking the breaker for faults.

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In addition to the above design verification to ensure that Micrologic trip unit adequately protects the breaker from a non-powered state, NLI performed testing to address the use of a Masterpact circuit breaker in the application of starting a motor. NLI performed approximately 400 tests (motor starts) of starting a motor with a Masterpact breaker. During the tests, NLI injected various EMC signals into the trip unit at varying voltage levels and frequencies in an attempt to cause the trip unit to inadvertently trip the Masterpact breaker. The signals were injected before, during and after the startup of the trip unit and motor. All tests passed successfully and no trips were recorded. After the tests were completed, NLI verified that the trip unit was still operating properly by performing primary injection trip testing on the trip unit. All tests passed successfully. The NLI analysis of the Micrologic trip unit involved both hardware and software. The testing results are documented in NLI report RCA-042-351023474-1.

Additionally, NLI has had no reported instances of breakers tripping when starting a motor except from PSEG. All of the PSEG trips occurred in the same application of starting motors and in switchgear of identical configuration. All other applications have had no reported nuisance trips. Although not recommended by the OEM for use as a motor starter, NLI has found no evidence that the breaker will not perform satisfactorily when starting a motor load, except for the PSEG specific application. PSEG was formally notified by NLI on January 13, 2017 that we were unable to evaluate the condition reported.

Based on the Information gathered and the issues that have been discussed, the NLI corrective action is to ensure that the application specific criteria is addressed in the dedication plans when being created. NLI will inquire with the client in regard to the application specific criteria when not provided in the contract or specification. When the End User does not provide the specific application criteria, NLI will evaluate the safety function based on the general use of the component. It is imperative that the end user provide the application specific criteria to ensure that the item will be verified for the intended safety related application. In this scenario, NLI did work with the end user to establish the verification criteria for the breaker as a replacement for the original equipment that it was replacing. Unfortunately, although extensive testing has been conducted to attempt to repeat the nuisance trip that has been experienced by PSEG, the actual cause has yet to be determined.

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Statement of Nonconformance 99901471/2016-201-04

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."

Contrary to the above, as of September 22, 2016, AZZ failed to ensure the suitability of equipment that is essential to the safety-related functions for certain components supplied to the nuclear industry on two occasions. First, AZZ failed to verify the critical characteristic of total harmonic distortion and power quality on the output of a repaired Exeltec inverter supplied to Entergy under purchase order (PO) 10454062. In the second instance, AZZ failed to identify and verify the critical characteristic of current interrupting rating for Masterpact circuit breakers supplied to Tennessee Valley Authority under PO 758798.

Basis for Disputing the Nonconformance

In the original response to the NRC, NLI stated that for the first example, the inverter was returned to NLI from the client to have refurbishment activities performed on the unit. This unit had been previously dedicated by NLI using the dedication plan that had been approved by the client for the application. The dedication plan was revised to include a reference to the generic technical evaluation for inverters (TE-E-5). There was no reference or explanation made on the dedication plan as to why the harmonic distortion was not required to be verified for the unit being tested following the required activities that were being performed on the unit. The unit was tested utilizing the critical characteristics that had been approved by the client. For this portion of the NON, NLI agrees that a corrective action is required and has been administered to revise the Technical Evaluation and the respective dedication plans to provide the required information to ensure that the potential critical characteristics identified in the technical evaluation are verified when it is applicable for the application, and when it is not required for the application it will be stated as such. Although not all applications require the harmonic distortion to be verified, NLI agrees that for some applications, the total harmonic distortion is required to be verified as a critical characteristic which is why it is included in the technical evaluation. This type of issue, a generic technical evaluation containing critical characteristics that are not included in a specific dedication plan, has been identified previously and has been corrected on an individual basis. The critical characteristics that were required for the application were verified, however the documentation did not contain the proper evaluation and explanation regarding why the critical characteristic that was identified in the referenced technical evaluation was not being verified for this application. NLI Engineering has revised the referenced Technical evaluation and has placed a hold on the associated verification plans to not be used until the required information has been added to the documents.

The corrective action to revise the necessary documentation has been completed.

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In the second example
NLI agrees that the short circuit design testing is an essential design characteristic of the circuit breaker. This criteria is evaluated and verified in accordance with specific purchase order and contract requirements. The breaker cradle configuration for TVA was tested to ensure the design criteria was met. The ANSI design report was approved by NLI and was provided to TVA. The verification activities in regard to the design testing were conducted by the manufacturer. The manufacturer is an approved vendor for NLI and the controls for design were verified to be adequate to maintain traceability of the existing design to the ANSI report that was generated. During the dedication process at NLI, NLI ensures there have been no design changes with the circuit breaker or cradle that would invalidate the existing ANSI design report, similar to environmental and seismic qualification traceability.

NLI re-evaluated the generic circuit breaker technical evaluation TE-E-2 to ensure that the evaluation of the interrupt rating was properly addressed. The Technical Evaluation TE-E-2 has been revised to clearly document how the Circuit Interrupt Rating (CIR) is verified when required. It is our opinion and an opinion that we believe is shared widely in the US Nuclear Industry that CIR is an important Design Characteristic[1] that is tested as part of the design testing as well as being validated by the ANSI C37 certification of that breaker design.

When the Circuit Interrupt Rating is included in the contract as a required critical characteristic to perform the safety function for the intended application as defined by the end user, it will be included in the dedication process documentation.

In the same manner that a Seismic Qualification and EMI/RFI qualification test establish a design's acceptability for certain conditions, Circuit Interrupt Rating, once established need not be verified for subsequent supply of commercial breakers when there is a valid and reasonable expectation that the design is being maintained by the manufacturer. That expectation is supported by successful verification of other design characteristics that were evaluated as critical characteristics and the continued UL or ANSI certification of the breakers.

[1] Guidelines for the Technical Evaluation of Replacement Items in Nuclear Power Plants (Revision 1) EPRI, Palo Alto, CA 2006. 1008256

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