Mr. Joseph Holonich
Senior Project Manager
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation
United States
Nuclear Regulatory Commission
Washington, DC 20555-0001

July 29, 2013

Subject: Lockheed Martin Responses to Requests for Additional Information Dated May 15, 2013; Numbers 6 and 16. (TAC NO. ME7900).

Dear Mr. Holonich,

By letter dated June 28, 2011, (Agencywide Documents Access and Management System Accession No. ML11201A323), Lockheed Martin Nuclear Systems and Solutions (LMNSS) and State Nuclear Power Automation Systems (SNPAS) submitted Topical Report NuPAC_ED610000-47-P titled "Generic Qualification of the NuPAC Platform for Safety-related Application" (Proprietary). By letter dated May 15, 2013, the US NRC transmitted Requests for Additional Information (RAI's) to Lockheed Martin for action and response. Attached are Lockheed Martin's responses to RAI Numbers 6 and 16 for US NRC consideration.

If you have any questions related to the attached responses, please contact me at 570-803-2123 at your earliest convenience.

Sincerely,

Patrick J. Troy
Program Licensing Manager
Lockheed Martin
Nuclear Systems and Solutions

RAI #6: Please identify the equipment that serves as the electrical isolation boundary between redundancies and with other systems. Please describe how this equipment meets the associated regulatory criteria (e.g., IEEE 603-1001 Clause 5.6, RG 1.75 Rev. 3 & IEEE 384-1992 Section 6.7, and SRP BTP 7-11).

1 Organization of This Response

- NuPAC platform Approach to Isolation
- Details of I/O Mezzanine Isolation Approach
- Future Approach for Implementation of Safety System Isolation using NuPAC
- Conclusions

2 NuPAC Platform Approach to Isolation

The NuPAC platform has integral isolation built into every I/O mezzanine card as described in Section 3 of this response and Section 3.2.1.2 of LTR NuPAC_ED610000-047-P_A. The built-in isolation provides each I/O point in the NuPAC system electrical isolation from external systems as well as from all other NuPAC I/O points. Other than the built-in isolation there is currently no additional external isolation equipment of device bundled with the NuPAC platform.

Compliance with IEEE Std 603-1991 Section 5.6 is facilitated by inclusion of built-in isolation on every I/O mezzanine (I/O point) but adherence to this requirement must be evaluated on a case by case basis for each safety system application that is proposed or developed using the NuPAC platform. As a generic platform, NuPAC has no inherent reliance on any external system. Any interaction, intentional or otherwise, between any external system and the NuPAC platform will need to be addressed and resolved as part of future safety system development.

Consistent with the intent to pursue a generic SER for both existing and new units, and in the absence of a true safety application, the approach has been to qualify based on the recommended practice of EPRI TR-107330 for generic broad spectrum platform qualification. For this generic platform qualification the NuPAC I/O mezzanine isolation will be tested using test procedure NuPAC_TP610000-008. The testing will be performed at the fully assembled chassis level by application of test voltages to external NuPAC connections. This testing will provide evidence that all I/O types comply with EPRI 107330 Section 4.6.4 Class 1E to Non-1E Isolation Requirements and results of this testing will be provided in the phase 2 (final) LTR as report NuPAC_TR610000-008. The built-in isolation now precludes the use of traditional external isolators or fiber optic converters which would then provide a second (or additional) electrical isolation barrier.

While each I/O mezzanine card provides isolation it is possible (and in the case of serial communication most probable) that additional external isolators located within the cabinet will be used. When utilizing NuPAC in future applications it is expected that a fiber optic media converter will be qualified and used

to transfer serial data between divisions. A fiber optic converter will provide a second isolation barrier while also extending communication distances and allowing high data rates. However, these types of external isolators are not included as part of the NuPAC generic platform qualification.

3 Details of I/O Mezzanine Isolation Approach

Each I/O mezzanine has a segregated portion of the circuitry that is isolated from the GLM logic and power. The isolated circuit is connected to chassis external field connectors using printed circuit cards and connectors that are designed to provide at least 1000 volts of line to line isolation protection. Each I/O mezzanine generates local isolated power for use by this segregated portion of the I/O mezzanine circuit. With the exception of the RS-422 I/O mezzanine, each I/O mezzanine utilizes a high speed quad digital isolator. The digital isolator has logic input and output buffers separated by a silicon dioxide (SiO2) isolation barrier. Used in conjunction with isolated power supplies, these devices block high voltage, isolate grounds, and prevent noise currents from entering the local ground and interfering with or damaging sensitive circuitry. The isolation barriers are capable of withstanding a 4000 volt transient overvoltage for 60 seconds with maximum continuous insulation withstand voltage of 560 volts peak.

The RS-422 I/O mezzanine used for external serial communications uses two separate transceiver devices, one for transmit and one for receive. Each provides a 2500 VRMS isolation barrier between the transceiver I/O and the logic interface. Because these devices are provided in a Land Grid Array (LGA) package (package bottom surface comes in contact with the circuit board surface), a slot (i.e. cutout) is located between the isolated sections to ensure that contamination does not compromise the isolation voltage rating. Isolated power conversion is built into this device so no additional power isolation circuitry is required.

4 Future Approach for Implementation of Safety System Isolation Using NuPAC

4.1 Elements of Redundant Divisions or Trains Co-Located on a Single GLM or Within a Single NuPAC Chassis

For redundancy with the safety system such as divisional redundancy, additional clarification may provide benefit with respect to the potential NuPAC system approach. Section 2.4.3 of the NuPAC Application Guide expressly prohibits the mixing of divisional functions as follows: "Each chassis shall be assigned to a specific electrical division. Each chassis shall not be split between electrical divisions." The NuPAC Application Guide is attached to the LTR as Appendix A. Any signal or communication entering a given chassis that is not part of the assigned electrical division will require qualified 1E to non-1E isolation.

4.2 Safety and Non-Safety I/O Serviced by a Single GLM Card

Every I/O point in the NuPAC platform has built-in isolation so by design all incoming or outgoing signals must transition through isolation circuitry to enter or exit any GLM card. Having all I/O points isolated could allow non-1E I/O to be mixed with 1E I/O on the same GLM. Technically this is feasible but the likelihood is considered remote for the following reasons.

It is expected that any approved safety application would require that all non-safety system connections could be severed without loss of safety system function. In other words the safety system requires no information or connection to any non-safety system to fulfill its purpose. This then limits possible effects from any non-safety interface to the possibility of propagating damage or disruption into the safety system through the isolated interface. Even though each I/O mezzanine will be qualified as an isolation device it is expected that the system failure modes and effects analysis (FMEA) for future applications will identify the possibility of a breakdown in the isolation barrier as a potential failure. This will result in a mitigation strategy of segregating non-1E isolated I/O to dedicated logic cards (GLM) that perform no safety function. See LTR Section 3.4.2 for restrictions on GLM communications which endorses this logical GLM isolation.

The need to maintain physical separation between non-1E and 1E wires within the cabinet will lead to grouping or segregation of non-safety wiring. Assigning non-safety signals to a dedicated GLM card will simplify the required 1E to non-1E wire separation within the cabinet. The final approach will need to be justified as part of each future safety system development but unless there are unusual circumstances it is expected that the default approach will be to segregate non-1E signals to dedicated GLM card(s).

4.3 Communication Between Redundant Divisions

For guidance on safety system communications refer to LTR NuPAC_ED610000-047-P_A Section 3.4.2 and Application Guide Sections 2.3.27 through 2.3.30.

Application Guide Section 2.3.27 states: "If any hardwired connections cross-divisional boundaries, the copper cable shall be separated in accordance with IEEE Standard 384-1992, as endorsed by RG 1.75, Revision 3, "Criteria for Independence of Electrical Safety Systems." In accordance with that standard, the cable shall be separated based on the division applying power to the cable." The application guidance establishes that the preferred method of transferring information between redundant divisions is by using communication links rather than hardwired isolated discrete signals.

NuPAC_ED610000-047-P_A Section 3.4.2 provides information on the recommended approach for imposing limitations on GLM card functionality when the GLM is used to perform various types of communication. In general this imposes limits on any safety function being combined on a GLM that is tasked with receiving external communications.

5 Conclusions

The requirements and expectations outlined in the cited and referenced regulatory criteria do apply to the NuPAC platform but are more commonly applied to complete safety systems. To that end, the response provided to this RAI endeavors to cover both the aspects of the NuPAC platform as well as potential future system applications. Physical isolation within NuPAC can be controlled by the number and type of I/O on any given GLM card (this is discussed in the body of this report based on guidance provided in both the LTR and the NuPAC Application Guide). Other aspects of physical isolation will be application specific such as cabinet wiring, barriers, walls, and separation distances for wire placement in conduits.

In the absence of a safety application the approach taken has been to follow the recommended qualification activities as outlined in EPRI 107330 including 1E to non-1E electrical isolation testing. This testing will be performed on all NuPAC I/O and a test report will document the results. While this will show that the NuPAC is adequate for use in developing future safety applications it will not address all regulatory concerns regarding independence, physical, electrical, and functional isolation. These can only be fully addressed at the system level as part of a future safety system development and approval activities.

RAI #16: Provide clarification on the unit test coverage criteria to be employed, which should be identified and justified in the test plan.

1 **Response:** The coverage criteria to be employed for Independent Verification & Validation testing are identified and justified in the Field Programmable Logic (FPL) Verification & Validation Plan (FVVP), NuPAC_FVVP610000-001, Section 5.4.3.5. Further definition of the coverage criteria will be documented in the Component V&V test plan per the FVVP.