Issues Identified In The Procurement of Reverse Engineered Components

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Background

- Reverse engineering is a relatively new topic for regulatory/industry engagement
- Reverse engineering is becoming more prevalent due to:
  - Obsolescence
  - Long lead times
  - Attempted cost savings
- Currently there is no regulatory guidance or NRC endorsed industry guidance on this topic

Typical Purchasing Methods for Replacement Components

- There are several methods for procuring replacement nuclear safety-related components
  - Original safety-related OEM replacement
  - "Identical" commercial component, dedicated by either a third party or the utility
  - "Equivalent" component, either safety-related or commercial grade and dedicated
    - Reverse engineered components would typically fall under this method

Design Verification

- Criterion III “Design Control” of Appendix B applies to the procurement of all safety-related components and requires licensees to ensure that:
  - Appropriate component design and quality specifications are considered
  - Design interfaces are established within the organization and/or supplier
  - Testing or calculations provide adequate verification of the component’s design
  - Suitable qualification program exists, if needed
  - Ensuring that the component’s necessary design attributes are controlled
  - Ensuring adequate documentation is maintained to meet the requirements of Criterion III
- Criterion III is applicable at both the system and the component level and requires processes be implemented to ensure a component meets the design requirements for its intended application
- From a supplier’s perspective, design verification would include the testing and analysis performed to ensure that the as-designed component meets the as-specified design requirements

Reverse Engineered Components

- No regulatory definition of what constitutes a reverse engineered component
- EPRI definition - The process of developing technical information sufficient to “duplicate” an item by physically examining, measuring, or testing existing items; reviewing technical data; or performing engineering analysis.
- In most cases, while possibly equivalent, reverse engineered components can not be considered “identical” or “like for like” as they are they are not typically produced by the same manufacturer using the same processes, materials, and design specifications as the original component
- Design verification is required for components produced using reverse engineering techniques

Equivalency Evaluations

- Non-identical (not like for like) safety-related components can be determined to be suitable for use through a properly performed equivalency evaluation
- Can not typically be considered equivalent unless:
  - the safety-related design requirements for the component are understood and documented including all relevant physical and functional interfacing requirements
  - methods such as testing and/or analysis are established to verify the component meets the design requirements
  - as required, specific qualification requirements (seismic, 10CFR 50.49, EMI/RFI, etc.) are addressed through either a
    - requalification program, or
    - an evaluation that provides a basis as to why the original qualification testing or analysis is still valid

Development of Design Requirements

- Various methods can be utilized to help regenerate component level design requirements
  - Original OE design documentation
  - System descriptions
  - System/component test data
  - Engineering evaluation
  - Examination and/or testing of the original component
- Examination and/or testing of the original component alone is usually not sufficient to fully determine all safety-related design requirements
- Typically this is a shared responsibility between a licensee and its supplier

Design Requirements - Specific Considerations (Electrical)

- Operating and accident temperatures/pressures/humidity/radiation (as applicable) including self heating contributions
- Seismic requirements
- EMI/RFI as applicable
- Mechanical/electrical interface connections
- Required range of input and output operating voltages/currents
- Voltage/current withstand requirements
- Assumed failure rates
- Design life

Design Requirements – Specific Considerations (Mechanical)

- Dimensions
- Material strength
- Surface finishes
- Heat treatment and other special processes
- Internal to component fits/tolerances
- Lubrication
- Thermal expansion requirements
- Operating cycles
- Seismic requirements

NRC Identified Weaknesses in Reverse Engineered Procurements

- Not identifying all important (safety-related) design requirements
- Not verifying that all safety-related design requirements have been met, either by testing or analysis
- Not clearly specifying interface requirements (physical and functional) to the supplier performing the reverse engineering
- Not clearly delineating who is responsible for which portions of the equivalency evaluation/reverse engineering/design verification process

NRC Identified Weaknesses in Reverse Engineered Procurements – cont.

- Assuming that a reverse engineered component is identical to the OEM component even though it was not subject to the same design and manufacturing specifications and processes as the original component
- Assessing only the physical attributes of the component and not properly evaluating functional design requirements
- Taking credit for past qualification without performing an evaluation to address similarity

Questions