Reverse Engineering Guidance Update

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What does *reverse engineering mean to you*?

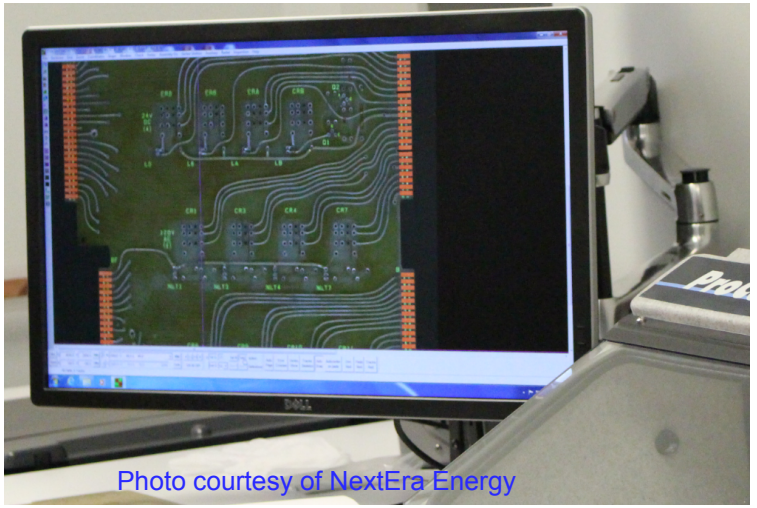
Photo courtesy of NextEra Energy

- Different “tiers” exist
  - Items manufactured to industry specifications and standards
  - Simple items, straightforward design requirements
  - Complex items and assemblies

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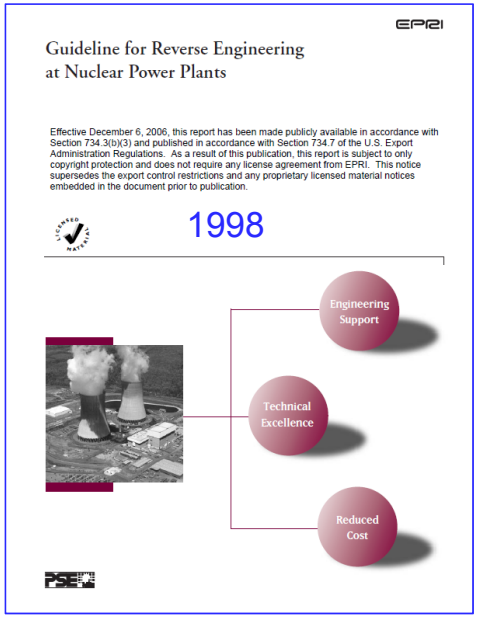
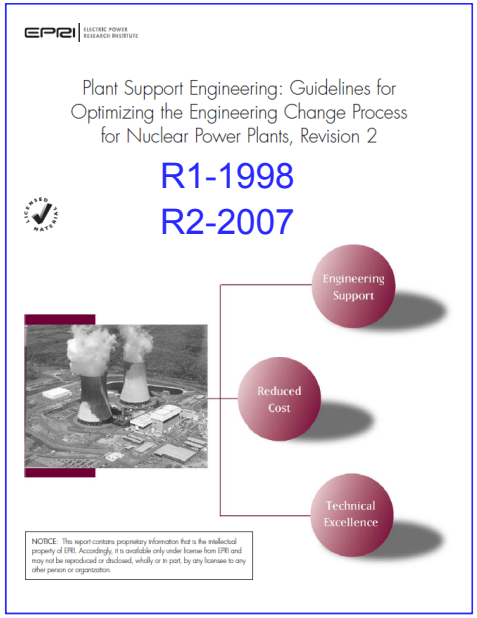
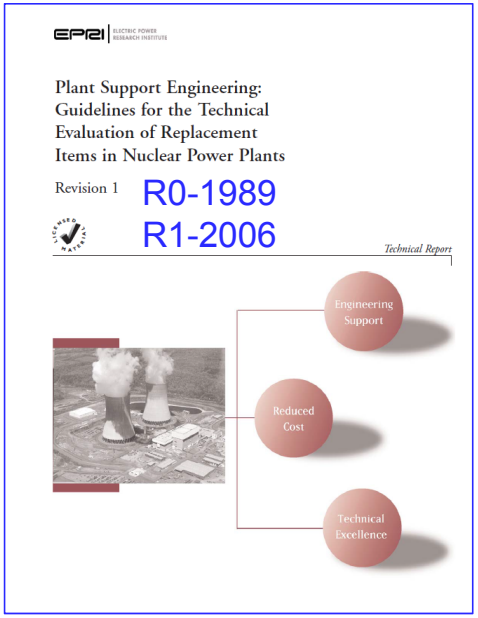
Currently Available Guidance

- Available Guidance
  - EPRI TR-107372, Guideline for Reverse Engineering at Nuclear Power Plants
  - EPRI 1008254, Engineering Change Optimization
  - EPRI 1008256, Technical Evaluation of Replacement Items







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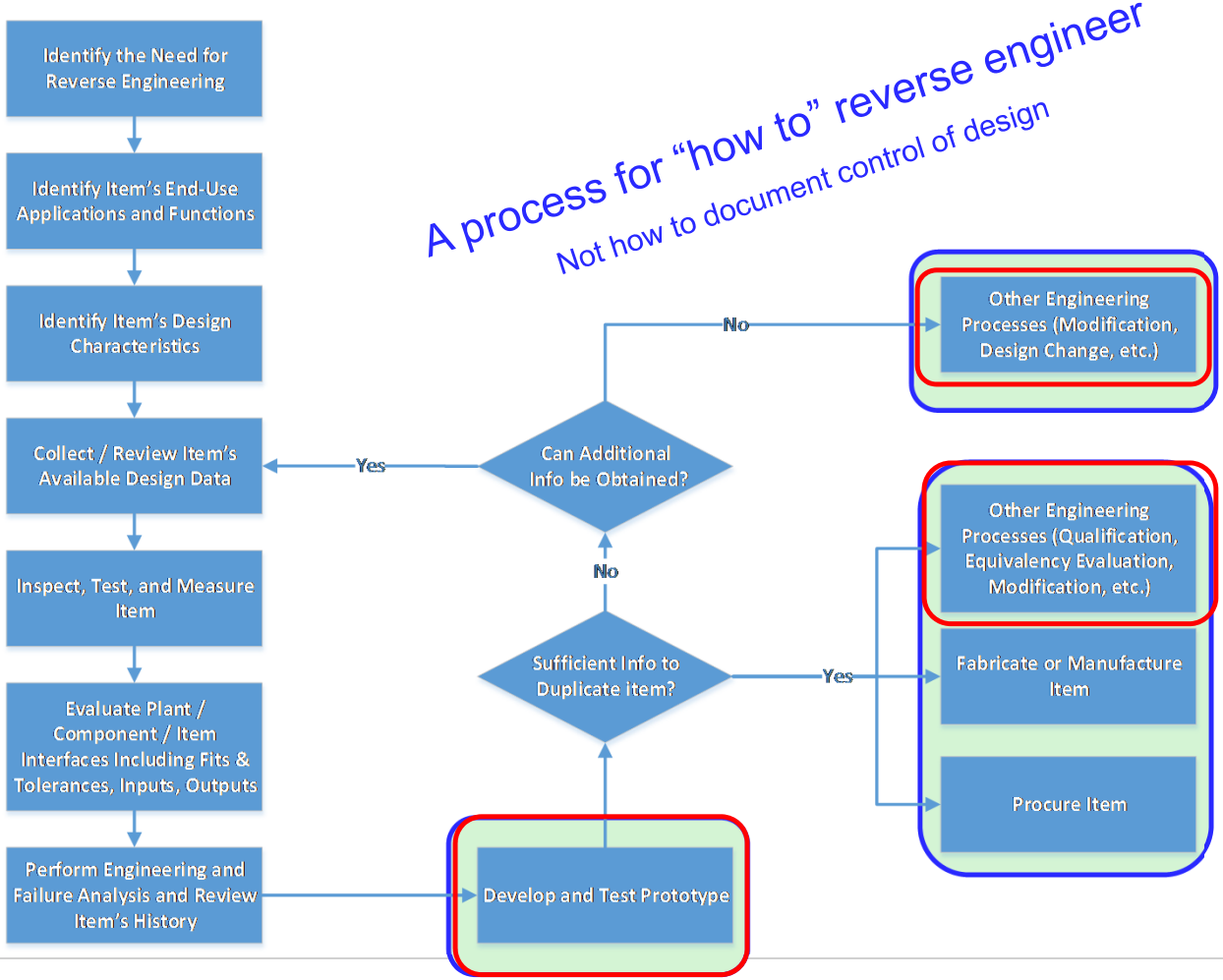
Reverse Engineering in a nutshell (EPRI TR-107372)



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Impetus for Reverse Engineering Guidance Revision

- U.S. NRC IN 2016-09, Recent Issues Identified When Using Reverse Engineering Techniques in the Procurement of Safety-Related Components
- RE Guidance addresses “how to” reverse engineer from a licensee’s perspective
- Design control is not inherent in all reverse engineering activities / techniques
- Additional guidance on how suppliers or licensees control design when using a reverse engineered item will be beneficial to the industry
- Incorporate lessons learned by suppliers and licensees that have employed reverse engineering techniques

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Reverse Engineering Guidance Update Team

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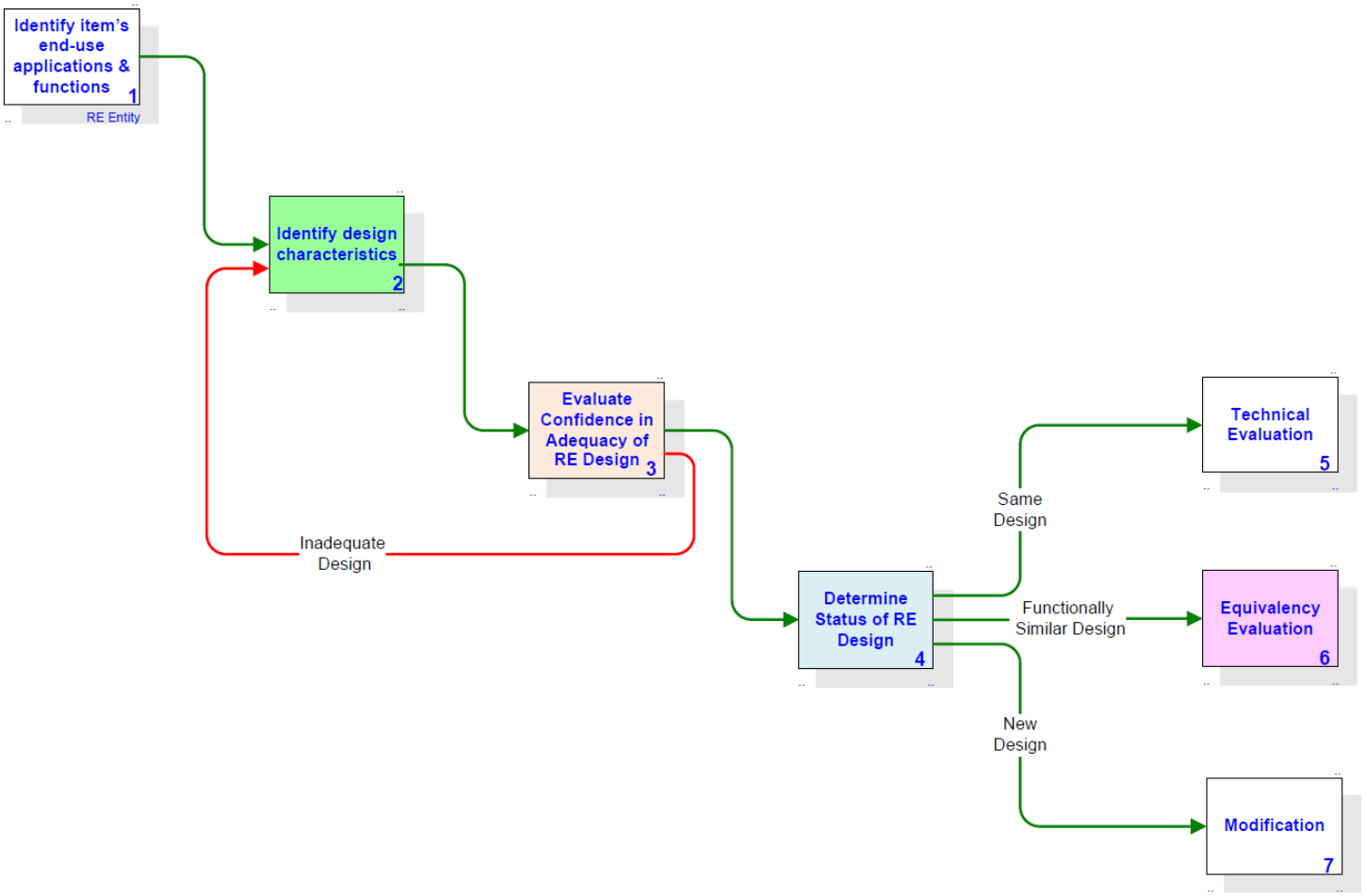
Enhanced Process Flow Diagrams



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Additional Process Guidance / Detail

- Develop sufficient understanding of design requirements
  - Collect available design information
  - Consider application/plant specific requirements
  - Consider what may not be known

- Determine status of items associated with use of reverse engineering techniques
  - The same design
  - Functionally equivalent design
  - New design (requires establishing suitability of design)

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Additional Process Guidance / Detail

- Consider functional design requirements
  - Consider application / plant-specific requirements
  - Consider what may not be known
- Plant design, component design, and “below level of detail” design considerations
- Do not *assume* replacement item designs based on reverse engineering techniques are “equivalent” to current item design
  - Replacement items can be
    - The same as existing design
    - Functionally equivalent to existing design
    - New design (requires establishing suitability of design)

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Additional Process Guidance / Detail

- Knowledge of item functions
- Use of informed failure modes & effects analysis
- Communication between reverse engineering entity and licensee

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Additional Process Guidance / Detail

- Addressing the limitations of physical examination
  - Items with active functions
  - Complex assemblies

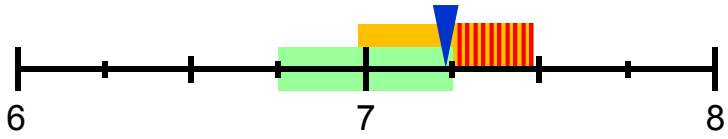
Measured from Sample: 7.23

Tolerance based on machining process: +/- 0.25

RE Design Requirement / Tolerance: 6.98 - 7.48

We didn't know OEM Requirement / Tolerance was 7+/- 0.25 6.75 - 7.25

Could there be a problem?



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Activities that employ “reverse engineering” techniques

Activity	Purchasing an item with known attributes or design from a different supplier	Recover characteristic information for dedication	Produce a functionally equivalent “part” (simple item)	Produce a functionally equivalent “component” (complex item)
Description	• Capturing information about an item that is necessary to create a purchase specification • Examining a standard product or its specification to identify information needed to purchase it directly from a manufacturer or alternate source • Purchasing an item directly from a manufacturer or alternate source	• Examining a specimen to identify acceptance criteria / characteristics pursuant to the commercial grade dedication process	• Recovering information about a part so that a functionally equivalent part can be fabricated and installed in existing equipment	• Recovering information about a component so that a functionally equivalent component can be fabricated and installed in existing equipment
Purpose	• Expand supplier options, reduce cost or lead-time	• Recover information about the item’s original design characteristics to help establish acceptance criteria	• Recover information about the item’s original design so that a fully functional replacement can be fabricated	• Recover information about the component’s original design so that a fully functional replacement can be fabricated
Example	• Recovering information about a fastener, o-ring, drive belt so it can be purchased from a different source	• Using FTIR to determine material type • Examining surface finish to determine machining process used to fabricate	• Recovering dimensional and material information from an existing MOV stem-nut and creating drawings so that a machine shop can create a replacement	• Recovering dimensional, material and functional information from an existing circuit card, prototyping and fabricating a replacement.
Conditions / Boundaries	• Items are fabricated in accordance with standards or known design parameters	• Used for commercial grade dedication	• Item is simple in design requiring only dimensional and material of construction information	• Component is complex in design, multiple parts must interface to achieve function
Design	• Same design	• Same design	• Functionally equivalent or new design	• Functionally equivalent or new design

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Graded approach to understanding scope & complexity

Items manufactured to industry standards	Simple items	Complex items	
O-rings Fasteners Drive belts Discrete electronic components	Gaskets Machined parts (no active function) Thermocouple / Thermowell	Printed circuit board Machined parts (active functions)	HCU accumulator
Technical evaluation	Equivalency evaluation that documents functionally equivalent design characteristics & functions via side-by-side comparison	Equivalency evaluation that documents functionally equivalent design characteristics & functions via bounding technical requirements or a modification	Modification – establish suitability of the RE design

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Understanding Division of Responsibilities

Design information	Examples	Customer Responsibilities	Supplier Responsibilities	Plans to market as an "aftermarket" basic component replacement
Known Design	• Customer provides complete design information • Manufactured to industry standard	• Customer provides complete design • Customer maintains design control (other eval, EE or Mod)	• Supplier does no design work • Supplier manufactures to customer design • Supplier certifies to customer design	• Supplier publishes product capabilities / specifications • Supplier verifies suitability of design for published capabilities (testing, design review, alternate calculations)
Unknown Design	• Customer provides working / non-working sample • Sample purchased from alternate source • Customer provides quality and technical requirements / equipment specification	• Customer verifies supplier is approved for design activities • Design responsibility is addressed in the purchase order • Customer Engineering approves design • Customer maintains design control (EE or Mod)	• Supplier recovers design information • Supplier verifies suitability of design for identified functions (testing, design review, alternate calculations) • Supplier submits design to customer for approval • Design responsibility is addressed in certification	• Same as above

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