efficiency bulletin

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# Material Cost Reduction While Maintaining Quality

DELIVERING THE NUCLEAR PROMISE

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Material cost reduction may be realized through cost-effective procurement scenarios such as application of commercial grade dedication, reverse engineering and electronic component repairs, ensuring efficient processes with metrics to measure quality production and savings.

**Addressees:** **Chief nuclear officers, NEI APCs and INPO APCs**

**Issue:** **SC-02, Material Cost Reduction**

**Summary of Efficiency Opportunity**

- Desired end-state—Nuclear plant sites' supply chain technical services group consisting of procurement engineering, commercial grade dedication, seismic testing, electronic component repairs and reverse engineering will be transitioned from a traditional site-centric structure to a central, corporate-led organization.

  It is recognized that not all utilities are structured the same way with single-reactor and multireactor stations; some are strictly nuclear utilities, while others have a blended portfolio of generation. However, the optimum structure to maximize benefits for material cost reduction is through a centralized procurement engineering services organization with very clear interface boundaries with supply chain, engineering, maintenance and planning as defined and agreed upon by upper management. This allows for greater focus on core business efficiencies, governance and oversight, reduced overlap of personnel performing duplicate functions, shared test equipment in labs, standardized policies and procedures, utility-wide prioritization, and aggressive focus on fiscally responsible procurement decisions.

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NUCLEAR ENERGY INSTITUTE

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This bulletin and additional information about nuclear energy are available at nei.org.

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**NEI.org**

- Value proposition (vision of excellence)—For maximum material cost reductions, all options with the procurement engineering area of responsibility (including but not limited to procurement engineering, commercial grade dedication, seismic testing, electronic component repairs and reverse engineering) should be used with engineering technical rigor to assure that the procurement strategies result in the least cost to the utility. For long-term fiscal sustainability, it is recommended that the industry settle on consistent measurements for these initiatives and their relative cost savings calculations. For internal customer charges, each utility will need to address overhead dependence on their overall supply chain organizational structure and accepted accounting practices. Consideration of savings does recognize that successful implementation may involve upfront investment in terms of additional equipment, personnel, training and facilities and may require prompt initiation of internal processes such as procedures, process development and business cases to expedite implementation. As organizational experience increases and investments in capital equipment are amortized over time, the cost of expansion decreases. By using these strategies, you may save an average of 50 percent on materials. With mature organizations currently performing these cost-effective processes, the savings are expected to be $750,000 per generating unit.

- Why is it important?—The benefits include, but are not limited to: reduced parts cost and lead times, buying in bulk to bring down the cost of dedication, bridging strategy support for engineering modifications and capital projects, and readily available in-house expertise in multiple disciplines. Safety and reliability will be enhanced through cohesive, standard application of work flows and prioritization of production schedules. Economic performance will come in the form of cost reduction driven by the output of described services and long-term savings will be derived by application of those services on a fleetwide basis leading to optimization of head count and removal of low-value work.

- Industry benchmark value(s)—Per the SC-02 industry survey, it was determined that, on average, each utility is dedicating approximately 20 percent of safety-related inventory. This shows that the industry has the potential to grow in commercial grade dedication and seismic testing. Each utility is reverse engineering less than 5 percent of safety-related inventory (on average), which also shows that the industry has the potential to grow in reverse engineering. Eight utilities said that they had some form of a circuit card lab, but most of these labs have very limited capabilities. Therefore, there is room to grow in all areas of responsibility for the supply chain technical services group.

**Relevant Standards**

- EPRI TR 3002002982, “Guideline for the Acceptance of Commercial-Grade Items in Nuclear Safety-Related Applications.”
- EPRI TR-107372, “Guidelines for Reverse Engineering at Nuclear Power Plants.”

**Relevant Regulatory Requirement**

- U.S. Code of Federal Regulations, Title 10, Chapter 1, Appendix B to Part 50, “Quality Assurance Criteria for

Key to Color Codes:

Red: NSIAC initiative – full participation required for viability
Blue: Action expected at all sites, but is not needed for broad industry viability
Green: Utility discretion to implement, consistent with its business environment

Nuclear Power Plants and Fuel Reprocessing Facilities." And, Part 21, "Reporting of Defects and Noncompliance." Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, D.C.

**Guidance**

- NRC IN 2016-09 "Recent Issues Identified When Using Reverse Engineering Techniques in the Procurement of Safety-Related Components"
- NRC Inspection Procedure 43004 , "Inspection of Commercial Grade Dedication"
- NRC IN 2014-11 "Recent Issues Related to the Qualification and Commercial Grade Dedication of Safety-Related Components"
- NRC IN 2011-01, "Commercial Grade Dedication Issues Identified During NRC Inspection"
- NRC DG-1292, "Dedication of Commercial-Grade Items for Use in Nuclear Power Plants."

**Recommended Industry Actions**

- Implement actions in the SC-02 white paper titled "Material Cost Reduction," dated July 19, 2016.
- Material cost reduction should consider items that can leverage economies of scale in the industry:
    - Standardization of procurement engineering practices and documentation to create consistent documentation packages and support the sharing of procurement engineering personnel and inventory between utilities.
    - Creation of "Centers of Excellence" within utilities, utility groups (e.g. Utilities Services Alliance), and/or among suppliers to support procurement engineering, commercial grade dedication, seismic testing, electronic component repairs and reverse engineering activities. These Centers of Excellence would be the focal points for the completion of these activities for utilities, minimizing required individual utility investments in each area. They would allow utilities to focus on their core business of operating their plants.

**Change Management Considerations**

*Industry Activities*

- Industry webinar to provide background for initiative, discussion, and an open forum to clarify expectations and ask questions. Webinar information can be found at the following site: https://web.inpo.org/Pages/Nuclear-Promise-Issues.aspx.
- Discuss at regional supply chain meetings and routine industry conference calls.
- The Electric Power Research Institute is evaluating an update to TR-107372 to address current NRC concerns with reverse engineering.

*Company Actions*

- Obtain an understanding of organizational models, financial models (number of times or length of time that savings can be claimed for each line item, method used to include cost of labor and facilities in the calculation, etc.), economies of scale (number of units supported, ability to aggregate) and maturity of commercial grade dedication/reverse engineering/electronic component repairs programs to gain an understanding of actions needed to obtain savings.
- Implement team to lead the efforts for this initiative.

*Guiderails*

- Ensure that a process exists for the utility to be able to calculate and report out cost savings.

**Report Your Site's Results**

Please report your company's implementation of this improvement opportunity, including the date of completion. Send this information along with your company point of contact to EfficiencyBulletin@NEI.org.

**Industry Contacts**

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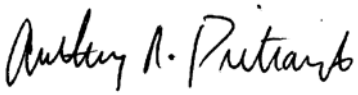
**Industry Approval:**

**Adam C. Heflin, CNO Lead**

**Anthony R. Pietrangelo, Nuclear Energy Institute**



# Material Cost Reduction

July 19

# 2016

*Material cost reduction may be realized through cost effective procurement scenarios such as the application of commercial grade dedication, reverse engineering, and electronic component repairs, ensuring efficient processes with metrics to measure quality production, and savings.*

Delivering the Nuclear Promise - Improvement Opportunity SC-02

It is recognized that not all utilities are structured the same way with single and multi-unit stations, and some are strictly nuclear utilities and others have a blended portfolio of generation. The optimum structure to maximize benefits for material cost reduction is through a centric-led Procurement Engineering Services organization that envelopes industry standard functional areas of responsibility, with very clear interface boundaries with Supply Chain, Engineering, Maintenance, and Planning defined and agreed upon by upper management. This allows for greater focus on core business efficiencies, reduction in overlap of personnel performing duplicate functions, shared test equipment in labs, standardized policies and procedures, utility wide prioritization, and aggressive focus on fiscally responsible procurement decisions. Even if personnel shifts cannot occur, all utilities can transition to centric-led decision making through procurement engineering services governance and oversight. It is imperative to keep quality and compliance as a core value when making procurement decisions. There are proven ways to ensure the most cost effective procurement while maintaining safety performance of equipment. Standard industry-wide guidance is critical to assure the industry keeps a strong reputation with safe operations. For ease of financial analysis, this whitepaper was written from the perspective of mature organizations that are currently performing these techniques to some degree but with opportunities for growth. Material cost reduction may be realized through cost effective procurement scenarios such as the application of commercial grade dedication, reverse engineering, and electronic component repairs, ensuring efficient processes with metrics to measure quality production, and savings.

Procurement of replacement items from the original equipment supplier may not always be the most cost-effective option. When engineering is involved in the procurement process, methodology such as alternate sourcing and commercial grade dedication can be used to achieve substantial cost savings without compromising safety, quality, or compliance. However, it is imperative that the procurement method selected be performed correctly and in accordance with current regulatory and industry guidance.

**Commercial grade dedication (CGD)** is an acceptance process used to establish reasonable assurance that a commercial grade item is capable of performing its safety function(s). During the procurement process, supply chain and procurement engineering organizations should question whether there is a more cost effective, risk averse way to buy an item such as using in-house dedication, in-house dedication using third party testing, third party dedicators and/or leveraging bulk buying. CGD requires technical expertise (Refer to Exhibit A for references that will assist with development of expertise) and test equipment (Refer to Exhibit B for some examples of CGD testing). Consideration should be given to certain commodity types

that may create opportunities for bulk commercial grade dedication leveraging across nuclear fleets and possibly across the industry. These commodities are capable of being tested to industry standards and may be procured in bulk at discounted rates. Third party testing may be used if in-house test equipment is not beneficial to the utility. In addition, third party dedicators may be used when a cost-benefit analysis shows the third party dedicator to be more effective or in-house technical expertise is not available. To remain cost effective, the use of any third party must remain less than the cost to purchase from the original equipment supplier as a basic component. When reviewing these CGD options, it is imperative that the industry (utilities and vendors) maintain a high level of technical rigor with CGD testing as well as with procurement engineering technical evaluations. EPRI 3002002982 'Guideline for the Acceptance of Commercial-Grade Items in Nuclear Safety-Related Applications' should be used as a baseline.

When selecting CGD candidates, it is important to keep in mind the complexity of the item, net cost savings, commercial availability and in house (or 3rd party) capabilities. It is recommended that the centric-led Procurement Engineering group review all Safety Related Procurement Requisitions on a daily basis utilizing the criteria noted above to identify those potential CGD candidates worth pursuing. This will ensure that all material purchased Safety Related for your fleet is reviewed for possible CGD.

Additional industry documents, such as industry recent operational experience (OE), should also be reviewed and kept up with to assure skill sets are kept relevant and updated (Refer to EPRI and INPO websites for timely information on OE). Most importantly, a successful CGD program requires technically qualified personnel, proper equipment, sound basis for the application of this methodology, and compliance with Part 21. It should be noted that upon completion of the dedication process, the dedicating entity is responsible for reporting of defects and noncompliance in accordance with 10CFR, Part 21. For assistance when implementing CGD or any portions of this white paper, readers are encouraged to please contact a member of the SC-02 Team (Refer to Exhibit E for team member contact information).

**Reverse Engineering (RE)** is also an effective option to pursue for replacement parts where the OEM/OES are no longer in business or for material cost reduction by allowing procurement of material from other than the original supplier/manufacturer. The term "reverse engineering" is used to describe a wide range of activities, from simple identification of what an item only described by OEM part number but can be purchased from an alternate supplier with support from engineering, to a project that recovers enough design information to manufacture and establish suitability of design with documented engineering basis. In general, RE is a process used to identify or recover enough design information about an item to properly develop a specification and identify required technical attributes. These attributes are selected at such a level to ensure the item can adequately perform all required design and safety functions. RE can be accomplished internally or using specialized suppliers. References include EPRI TR-107372 "Guideline for Reverse Engineering at Nuclear Power Plants" and the NRC IN 2016-09 "Recent Issues Identified When Using Reverse Engineering Techniques in the Procurement of Safety Related Components". When RE is implemented in accordance with 10CFR50 Appendix B, it can maintain all required technical and quality requirements and can deliver material cost reduction.

Another opportunity for material cost reduction is **Electronic Component Repairs (ECR)** encompassing electronic component testing, forensics, repair, and refurbishment. Electronic Components consist of circuit boards, power supplies, modules, etc. Repairing electronic components in-house or by using specialized suppliers can be more cost effective than purchasing new replacements or repair by OEMs. Though all of the cost savings decisions discussed in this whitepaper require technically qualified personnel, proper equipment, and sound basis for the application of methodologies, electronic component repairs uniquely requires highly skilled technicians needed to do the 'hands-on' part of the service to include expertise with circuit boards and knowledge of plant systems. (Refer to Exhibit C for possible services that may be offered by an in house ECR Lab and relevant terminology). Utilities that currently have ECR facilities have noted that the identification and sourcing of replacement parts may take significant time to research and require item equivalency evaluations due to obsolescence. A lack of specific information relative to the circuit board problem, available design and functional data, schematics, test requirements and parts availability can turn what looks like a simple project into a complex and labor intensive effort. However, even with significant challenges, electronic component repair can yield significant benefits. With management support, the repair facility can be outfitted with the 'state of the art' diagnostic and forensics equipment needed to diagnose problems. Combine that with highly trained and skilled technicians and some problems may even be able to be diagnosed with limited or no schematics and design data (a form of reverse engineering).

In conclusion, for maximum material cost reductions all options within the procurement engineering area of responsibility including but not limited to those described herein should be utilized with engineering technical rigor to assure the procurement strategies results in the least cost to the utility. These options range from straight forward to very complex that may need design engineering assistance. Some of these evaluations are required to be used in conjunction with each other, e.g., CGD and RE to support ECR but the engineering and technician support required does offset the cost of the OEM parts. For long-term fiscal sustainability, it is recommended that the industry settle on consistent measurements for these initiatives and their relative cost savings calculations. (Refer to Exhibit D for cost savings calculations relative to this white paper). For internal customer charges each utility will need to address overhead dependent on their overall supply chain organizational structure and generally accepted accounting practices. For cost savings comparisons to the industry, they should not be factored in due to variability. Consideration of savings does recognize that successful implementation may involve internal start-up costs in terms of equipment, training, facilities, procedure and process development including adaptation of existing information systems. As the organizational experience with these engineering methods increase and investments in capital equipment are amortized over time, the cost of expansion decreases. By using these strategies, you may save on average **50%** of the cost of materials. Overall, material cost reductions may be realized through a centric focus on the maximum utilization and application of procurement engineering functions to support commercial grade dedication, reverse engineering, and electronic component repair. With mature organizations currently performing these cost effective processes, the savings are expected to be $750,000/generating unit. This expected savings will be removed from each station's applicable O&M budget.

**EXHIBIT A: Commercial Grade Dedication (CGD) References**

This is only a few key references relative to CGD, for a more exhaustive list please refer to Section 15 of EPRI TR 3002002982 "Guideline for the Acceptance of Commercial-Grade Items in Nuclear Safety-Related Applications"

- U.S. Code of Federal Regulations, Title 10, Chapter 1, Appendix B to Part 50, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Facilities. And, Part 21, Reporting of Defects and Noncompliance. Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, D.C.
- NRC Inspection Procedure 43004: Inspection of Commercial Grade Dedication Programs
- NRC Regulatory Issue Summary 2016-05: Embedded Digital Devices In Safety-Related Systems
- IN 2014-11: Recent Issues Related to the Qualification and Commercial Grade Dedication of Safety-Related Components.
- IN 2011-01: Commercial Grade Dedication Issues Identified During NRC Inspections

**EXHIBIT B: Commercial Grade Dedication (CGD) and Electronic Component Repair (ECR) Testing Equipment**

- This is only a few key types of equipment relative to CGD and ECR, for a more exhaustive list please refer to Appendix J of EPRI TR 3002002982 " Guideline for the Acceptance of Commercial-Grade Items in Nuclear Safety-Related Applications"

## Configuration/Dimensions

- Calipers
- Micrometers
- pin gages
- plug gages
- ring gages
- radius gages
- protractors
- video inspection system

## Physical properties

**Material analysis**

- Oxford Instruments PMI Master Pro OE Spectrometer
- Oxford Instruments X-Met 5100 XRF Spectrometer
- Innov-X Systems Alpha 2000 XRF Spectrometer
- SpectroMax LMXM3 OE Spectrometer
- Spectro TXC03 OE Spectrometer
- Perkin Elmer Spectrum 100 FT-IR Spectrometer

**Tensile Strength**

- Tinius Olsen H100KU Tensile Tester

**Hardness Testing**

- Tinius Olsen FH-2-1 Universal Hardness Tester
- Newage Indentron NI-300C Hardness Tester
- Proceq Equotip 3 Portable Hardness Tester
- Wilson 1202 Micro Hardness Tester
- Durometer Shore D, A and M

## Functional Testing (Electrical)

- Megger Oden AT Primary Current Injection Test Sets
- Megger CB-845 Primary Current Injection Test Sets
- Megger MS-2A Primary Current Injection Test Sets
- Megger DDA6000 Circuit Breaker Test Set
- Megger SMRT-36 Relay Test Sets
- Megger Sverker 750 Relay Test Set

## Functional Testing (Mechanical)

- Barbee Hydrostatic Test Bench
- Barbee Portable Hydrostatic Tester
- Deluca DTE HV-HTS-12 Valve Test Bench
- Ventil VCB250 Valve Test Bench
- Imada Mechanical Force Gauges

## Seismic Testing

- ANCO R-100EK Seismic Table
- Dytran Accelerometers

## Electronic Component Repair/Testing

- Huntron Trackers (Analog Signature Analysis)
- Function Generators
- Oscilloscopes
- Programmable DC Loads
- Programmable Power Supplies

## EXHIBIT C: Electronic Component Repair (ECR)

### ECR Services

- Electronic components consist of circuit boards, power supplies, modules, etc.
- Provide electronic component maintenance support
- Support electronic component lifecycle program leveraging across enterprise where applicable
- Provide services where vendor support has degraded or become non-existent
- Perform diagnostics and failure analysis
- Support periodic testing of electronic components to proactively detect degrading sub-component performance
- Support routine and accelerated burn-in services
- Set-up test stands and perform electronic component performance testing
- Support Preventive Maintenance involving sub-component replacements (e.g., electrolytic capacitors)

| CCR Term | Standard Terminology |
|---|---|
| **Burn-in** | A process of operating a Printed Circuit Board or electronic device before it is placed into service to identify early service failures (infant mortalities) in electronic components and assemblies. |
| **Electrostatic Discharge (ESD)** | The release of static electricity when two objects come in contact. An ESD can be in excess of thousands of volts. ESD can result in the immediate failure of an electronic component or the weakening of an electronic component such that a subsequent failure is more likely to occur. |
| **Electrostatic Discharge Tape** | Tape that has a metal film grid built into it and is designed to be used where Electrostatic Discharge sensitive devices, components, and Printed Circuit Board external packaging requires the use of tape. |
| **Electrostatic Shielding Bags** | Metalized bags that provide a barrier to static charges through a layering of a metal film within the bag. |
| **Infant Mortality** | The failure of a component early in its operation, well before its expected useful life has passed. |
| **Hot Rack** | Equipment used to energize and/or test Printed Circuit Boards (PCB) prior to installation in the plant. Some hot racks are considered satellite inventory storage areas which allow PCBs to remain energized and ready for use. |
| **Pink-Poly** | A non-static generating material that provides a barrier between the Printed Circuit Board or electronic device and the static shielding bag. Pink-poly eliminates the tribo-electric or rubbing of the interior of the static shielding bag and provides protection from component terminations pushing through the static shielding bag and rendering it non-ESD protective. The pink-poly wrapped assembly is then inserted into a static shielding bag and sealed. Pink-poly bags and pink-poly bubble wrap do not generate static electricity. |
| **Printed Circuit Board (PCB)** | A modular component with connections designed to hold a variety of electronic components such as transistors, integrated circuits, capacitors, and resistors. A PCB contains electrical conductive pathways to connect these sub-components. When combined, these sub-components and pathways perform specific design functions. |
| **Electronic Device /Assembly** | An electronic device or assembly is a component that is constructed from a variety of sub-components that may consist of single printed circuit board or several, transformers, switches, etc., and assembled into a common housing or case. When combined, these sub-components and pathways perform specific design functions. |
| **Failure** | Any occurrence that requires replacement or repair of an electronic device, to assure that the associated component will continue to perform its in-situ design function is considered a "failed" item. Such occurrences include failure to achieve stable calibration settings, repetitive findings of excessive drift, anomalous performance characteristics, and board failure. |
| **Repair** | The act of restoring the functional capability of an item by replacing components that are found to be defective. This process does not include proactive replacement of components that may have age-related issues or may be part of vendor upgrades or improvements. |
| **Refurbishment** | The replacement of prescribed subcomponents based on predictive maintenance requirements using rework and/or repair processes. This process includes upgrading components based on age-related mechanisms or Original Equipment Manufacturer/Supplier design improvements. This is a more complex and involved process when compared to repairs. |

## EXHIBIT D: Cost Savings

### Definitions and Calculations

These savings are not absolute in that many variables affect the calculations especially if a current quote from a qualified SR vendor is not available.

- Overhead should not be included in raw industry comparison of commercial grade dedication and reverse engineering due to the inconsistencies in how they are charged back to stations.
- For example, some utilities are already paying receipt inspectors to be available for SR receipts adding CGD testing may be absorbed; some utilities are already paying for facility in support of on-site SR receipts, etc.
- SR Material Cost may be determined from a direct quote, from previous recent purchase history, from similarly purchased items, from commodity analysis, etc.
- Commercial Grade --
    - Overhead: Salary
    - Overhead: computer, training, facility
- Commercial Grade:
- **Commercial Grade Dedication Savings** : SR Material Cost – Commercial Material Cost – Cost of Dedication
- **Reverse Engineering Cost Gross Savings** = OEM SR Material Cost – Alternate Supplier Material Cost
- **Electronic Component Repair Cost Gross Savings** = OEM Repair Service Cost – [Repair Material Costs + Non-OEM Repair Service Cost]

### Other Considerations

- Overhead should be used in calculations with utility customers to paint a true overall financial picture:
- Engineering Evaluation Labor
- Test Technician Labor
- Maintenance Contract Cost of Test Equipment
- Amortized Capital Equipment Expenditures
- Facility charges (including computer, electricity)
- Support Services (IT, HR, Training, etc.)
- O&M Expenses
    - Continuing training of engineers and technicians
    - Maintenance contracts for test equipment
    - T&E associated with maintaining equipment in the stations' M&TE programs

- Soft Cost Savings
  - identify current commercial grade risks post issue/ install testing performed by maintenance
  - reduction in commercial grade item lead time
  - reduction in T&E associated with auditing and assuring vendors are maintained on an ASL
- Cost Avoidances
  - Future commercial grade item procurement savings for repeat buys (on-going savings, limit to 3 years)

## EXHIBIT E: Improvement Opportunity SC-02 Team

| SC-02 Team Members | Utility | Telephone | E-Mail |
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