Request for Information

National Power Transformer Reserve

Department of Energy
Office of Electricity Delivery and Energy Reliability

Contact:

Mark Olson
PEICo President
T 302.888.5211
F 302.571.1750
Pooled Equipment Inventory Company (PEICo)
42 Inverness Center Parkway / Bin B737
Birmingham, Alabama 35242

Randy W. Mundy
T 205-992-7581
F 205-992-5271
Pooled Equipment Inventory Company (PEICo)
42 Inverness Center Parkway / Bin B737
Post Office Box 1295
Birmingham, Alabama 35201

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INTRODUCTION

Pooled Equipment Inventory Company (PEICo), AREVA Inc. and Barnhart Crane and Rigging, Inc. have teamed to respond to this Request for Information (RFI) requesting input into the development of the Department of Energy's (DOE) policy related to the establishment of a national reserve of power transformers to support the bulk power grid as an aid to mitigate the risks associated with the potential loss of transformers.

PEICo's experience in the commercial nuclear industry includes over 30 years supporting emergent needs of the industry through acquisition, long term storage, maintenance, and expedited shipping of critical components. AREVA is a global organization with expertise in nuclear engineering, emergent issue response and outage support across the U.S. nuclear industry. Barnhart provides innovative solutions to complex lifting, transportation, and storage challenges that face the power industry. Barnhart's network of over 40 branches throughout the United States provides a national footprint to efficiently support all emergent transformer situations along with extensive experience in the transformer replacement market.

Following the Fukushima Incident, the Nuclear Regulatory Commission (NRC) committed to establish on-site and off-site capabilities to provide crucial equipment in the event of similar emergency situations at U.S. nuclear plants and enacted Order EA-12-049, Diverse and Flexible Coping Strategies (FLEX). In 2012, through a competitive bid process, the commercial nuclear industry selected PEICo and AREVA, which comprise the Strategic Alliance for FLEX Emergency Response (SAFER) team, to implement off-site capabilities in compliance with the Order. The SAFER team provides equipment and technician deployment abilities through contractual agreements with every commercial nuclear owner or operating company in the U.S. for delivery of crucial equipment within 24 hours of a plant emergency. This model can be adapted to the DOE's need for critical large power transformers (LPT) in the event of a wide spread power grid failure.

QUESTION RESPONSES

Our responses to the questions included in the RFI follow:

1. Program Need

Based on DOE's assessment that 1) electric service is one of the nation's four lifeline functions, 2) disruption or loss of electric service will affect other critical infrastructure, and 3) LPTs are a major concern in such a scenario, we believe there is indeed a need for a National Power Transformer Reserve. A Reserve, modeled after SAFER's cost-effective program, would establish and maintain LPT equipment storage facilities, maintenance of the LPTs, as well as manned control centers to coordinate a response to any such event. A Reserve would provide LPTs to any participating utility in the U.S. within a guaranteed timeframe, ensuring resiliency of the bulk power system.

2. Power Transformer Criteria

It is recommended that a detailed scoping and evaluation process be performed to systematically determine compatibility and groupings, while also considering susceptibility and potential of external events by region. These groupings would be reviewed by working groups to determine national standards for both functional requirements and installation considerations. Ultimately this will determine the quantities and locations for the reserve LPTs. As discussed in Reference [1], the Western Area Power Administration estimated a program cost of $324 million that would include 110 LPTs to back up roughly 20,000 LPTs. Certain substations are particularly vulnerable. Load controllers typically plan for a loss of a single high voltage transformer substation, however a simultaneous loss of more than three substations could exceed the capability of a regional network to reroute power through secondary lines for extended periods. Loss of multiple substations in a regional event would be considered in the scoping phase to prioritize implementation.

3. Ownership and Economics

The PEICo/AREVA/Barnhart team suggests an inventory sharing program that would provide a mechanism for utilities to jointly procure and store spare LPTs that are not cost effective for utilities to stock individually due to the prohibitive cost. Access to this shared equipment would allow participants to hold smaller individual inventories and reduce their procurement and maintenance cost without increasing the risks associated with equipment failure. The inventory sharing program would function through an equipment pooling company, such as Shared Inventory Management, LLC (a PEICo affiliate), where the company holds title to the equipment, is operated on a not-for-profit basis and allows the equipment costs to be shared among participants in order to minimize cost and capital investment.

4. Technical Considerations

With the standard lead times and substantial logistical challenges of deploying LPTs, it is recommended that the off-site emergency response be completed in two phases consisting of both short term restoration and long term repair and restoration.

- *Short term restoration* – As stated in Reference 1, the use of smaller, less-efficient, temporary replacement transformers may be appropriate for emergency circumstances. The Department of Homeland Security's (DHS's) Recovery Transformer Program has developed and tested a flexible transformer that is transportable over the road via truck and can be installed within approximately five days of an incident. These technologies would be evaluated and additional restoration transformers beyond the existing stabilization/recovery protocol would be added if deemed appropriate to provide restoration plans that would achieve the short term restoration of critical electric services.
- *Longer term repair and restoration* – The long term recovery would deploy additional critical components and functional replacements from the equipment pool to fully restore electric service.

With the urgency necessary to restore power it is necessary to identify critical substations based on susceptibility to external events. Each substation would have a predefined emergency restoration plan which would include the above phases. These would be an extension of current utility emergency plans, and would detail the coordination of the off-site response. National reserve warehouses would have predefined restoration transformers for rapid recovery. Additionally, critical long lead spare components would also be maintained. It is recommended that a combination of both spare components and complete LPTs be warehoused. The spare components would serve both for field repairs and modifications of LPTs. This phased approach for emergency deployment of off-site resources is in place in the U.S. commercial nuclear industry and serves as a viable proof of concept for the LPT program. The United States Nuclear Regulatory Commission has evaluated and approved the off-site emergency deployment of critical equipment as required in Reference 2.

5. Procurement and Management

The equipment pooling company described in Question 3 would require contractual agreements with all participating utilities, including provisions for equipment procurement, maintenance, testing, calibration, storage and control. The equipment pooling company would be responsible for procuring the required equipment, developing warehouse storage and maintenance procedures, and monitoring and directing contract support activities to ensure all requirements are implemented correctly.

6. Supply Chain

Raw materials make up a significant cost of the LPT (typically over 50%) with electrical steel and copper being the biggest cost factors. Electrical steel is the most critical component and makes up the core of the LPTs.

7. Manufacturing

The average lead time for manufacturing is between 5 and 16 months from time of customer order to delivery. The typical manufacturing process includes design and engineering, core manufacturing and assembly, drying of the core, tank production, final assembly and finally factory acceptance testing. Once testing is completed, a power transformer is disassembled for transport, including the removal of oil, radiators, bushings, convertors, arrestors, etc. The number of suppliers for high voltage LPTs is limited to approximately ten in North America. A competitive bid process will be utilized to select the supplier(s). One rapid recovery transformer has been built to date and is in operation, as a successful proof of concept.

8. Transport and Deployment

A minimum of two redundant storage locations are recommended to ensure that a single event does not impact both the LPT reserve and the substation or generating station. Proximity to transportation infrastructure is critical to ensure successful deployment. Barge, air freight, rail, and over-the-road shipping are all viable options to be considered in the transportation plan and would be considered in a deployment timeline to critical locations. Over-the-road, rail and water movement is considered; however, specialized equipment is necessary for LPTs. The available specialized equipment is limited and must be preplanned for deployment; however, defense in depth is important in planning for emergency conditions.

Predetermined deployment plans are recommended, both for short term restoration transformers and long term repair and restoration (rapid recovery) transformers and longer term repair and restoration. These plans would pre-evaluate routes and transportation modes and be periodically reviewed to consider potential changes.

It is feasible to develop a timeline for short term restoration equipment, such as temporary replacement transformers and critical repair components, to be delivered in less than seven days. Larger components necessary for longer term repair or replacement of LPTs would likely require permitting. However, equipment selection would be broken down to the smallest possible size that would still allow field installation. Deployment plans would consider Department of Transportation (DOT) requirements and pre-approval of permits would be developed (where required) to expedite shipping.

SIM
SHAREDINVENTORYMANAGEMENT

LPT delivery via road by Barnhart

9. Field Engineering and Installation

A dedicated team of trained deployment technicians would provide field engineering, installation and site support services across the country. All technicians would be trained and certified to appropriate standards. Long term contracts can be established to maintain access to adequate hardware and personnel for the short term restoration. These contracts would also support the long term repair plans. A roster of these technicians would be maintained, utilizing an emergency call-out system via a command center for deployment. Field use procedures would be developed and utilized for installation and testing and include the following general steps:

- Lifting and rigging upon delivery
- Installation of bushings, lightning arrestors, cable boxes, etc., in the field
- Oil filling – vacuum hold times (up to 48 hours)
- Pre-energization testing
- Energization and loading

10. Criteria for Deploying Transformers

Procedures would be developed to ensure that no single external event would preclude the capability to supply the needed equipment and resources to the utility site. These may include redundant response centers in different locations, off-site equipment for more than one simultaneous grid failure, and trained deployment technicians. The criteria could also be broadened beyond widespread infrastructure loss to support recovery or maintenance on critical LPTs located throughout the grid.

11. Additional Comments

The proposed model for an inventory sharing company discussed above has already been successfully implemented by PEICo using the Pooled Inventory Management (PIM) program. The below information is provided to better describe the suggested solution offered in response to the RFI.

The PIM program provides a mechanism for utilities to jointly procure, store and maintain nuclear generating unit equipment items which are very expensive, have a long lead time for production, and have such a low probability of failure that it is not cost effective for utilities to individually stock them. Access to this equipment pool allows utilities to hold smaller individual inventories; thereby, they reduce their procurement and maintenance costs without increasing the risks associated with major component failure. This program holds over $200 million in inventory.

There is a management committee, which is the governing body of PIM, and is made up of one representative from each participating utility. This committee approves all major decisions and policies relating to the overall program operation.

Operation of the SAFER program discussed in the preceding RFI response is a part of the PIM program.

Reference 1: *QER Report: Energy Transmission, Storage, and Distribution Infrastructure, April 2015*

Reference 2: *United States Nuclear Regulatory Commission, Order to Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events, EA-12-049*

Reference 3: *"Physical Security of the U.S. Power Grid: High-Voltage Transformer Substations", Paul W. Parfomak, June 17, 2014*

Reference 4: *"LARGE POWER TRANSFORMERS AND THE U.S. ELECTRIC GRID", Infrastructure Security and Energy Restoration Office of the Electricity Delivery and Energy Reliability U.S. Department of Energy, June 2010*