SIEMENS

Response to Request for Information (RFI)

For:

DEPARTMENT OF ENERGY

Office of Electricity Delivery and Energy Reliability (OE)

For

Design and Implementation of a National Power Transformer Reserve Program

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INTRODUCTION

In more than 100 countries and for more than 100 years, transformers made by Siemens have been synonymous with top quality. The extremely low mean time between failures is only one example of this quality. To ensure things stay this way, we are constantly working with high level experts on research and new developments. Furthermore, we are always close to our customers – thanks to our global manufacturing and service network.

We are pleased to respond to the request for information from the Department of Energy (DoE), Office of Electricity Delivery and Energy Reliability (OE), to inform its policy development related to the possible establishment of a national reserve of power transformers that support the bulk power grid.

We would be pleased to provide any additional information or comments to support the DoE in achieving their aims.

1.0 PROGRAM NEED

IS THERE NEED FOR A NATIONAL POWER TRANSFORMER RESERVE?

Yes, there is a real need for a National Power Transformer Reserve as reliability and resiliency are of critical importance to the stability of the grid especially on critical components like Large Power Transformers (LPTs). This could be an additional security measure for High Impact Low Frequency (HILF) events which are due to the unpredictability of the weather, and security of the system and cannot be adequately covered under current programs.

HOW WOULD SUCH A RESERVE AFFECT THE RELIABILITY AND RESILIENCY OF THE NORTH AMERICAN BULK POWER SYSTEM?

A reserve program improves the overall reliability and resilience of the bulk power system by reducing the response time to restore the system.

ARE THERE ALTERNATIVES TO A POWER TRANSFORMER RESERVE PROGRAM THAT CAN HELP ENSURE THE RELIABILITY, RESILIENCY, AND RECOVERY OF THE BULK POWER SYSTEM?

Several alternatives to a Power Transformer Reserve Program are:

- Fortification of existing critical transformer installations against vandalism, attack, and/or natural disasters.
- Development of comprehensive fleet monitoring systems that allows tracking the health of the LPTs installed base.

IS THERE A NEED FOR A NATIONALLY-MAINTAINED INVENTORY OF LARGE POWER TRANSFORMERS?

Yes, there is a real need for a nationally-maintained inventory of LPTs. A physical inventory is required because of the long lead-time to delivery replacement LPTs and the lack of inter-changeability of LPTs. In particular, we note that the recent challenges with obtaining GOES for the LPT cores, a stockpile program could help mitigate potential even greater lead times in the future.

2.0 POWER TRANSFORMER CRITERIA

WHAT TYPES AND SIZES OF POWER TRANSFORMERS SHOULD BE CONSIDERED FOR INCLUSION IN A TRANSFORMER RESERVE PROGRAM VERSUS OPERATIONAL SPARE CAPACITY?

All transformers (autos, generator step-up, and high voltage direct current), above 100 MVA and 230 kV, should be included in the reserve programs due to the comparably long lead times for procuring new units. The particular types and size should be dependent on an in-depth analysis by each of the bulk power system operators to determine how an available stock-pile of transformers could best mitigate long lead time in an emergency. These bulk system operators are in the best position to determine the most necessary sizes and special designs, which should be developed to cover as many contingencies, with the least amount of designs, by using advanced technologies for rapid transport, rapid installation, and multiple connections (e.g. reconnectable windings).

WHAT ARE THE DESIGN CONSIDERATIONS FOR REPLACEMENT TRANSFORMERS TO SUPPORT THE BULK POWER SYSTEM?

Design considerations should include:

- Light weight, single-phase transformers designed for speed of transport and installation for as many critical stations and substations as possible.
- High and low voltage windings should be reconnectable to allow for operation at multiple line voltages.
- Tap changers should be designed with extended tap ranges to extend the range of voltage connections.
- Higher operating temperatures and cooling systems should be based on extended over-loading during critically high loads.

3.0 OWNERSHIP AND ECONOMICS

WHAT WOULD BE AN APPROPRIATE STRUCTURE FOR PROCURING AND INVENTORYING POWER TRANSFORMERS?

Central procurement by government program is the recommend procurement approach. Inventorying, local storage and maintenance within the suggested service regions is the recommended approach. This includes maintenance by utilities or local partners.

HOW, AND BY WHOM, SHOULD A PROGRAM OF THIS TYPE BE ADMINISTERED?

The administration of the program should be handled by the DoE to ensure that the needs of the various Bulk Power providers are properly coordinated across the county, and that the stockpile locations are strategically located for the quickest possible response times. This administration should also include properly dispersing from the stock-pile based on need in the event of a large scale emergency.

HOW WOULD A TRANSFORMER RESERVE BE FUNDED?

Funding can be from a number of sources, including direct government funding, Public Utilities Commissions (PUCs), members of the bulk power system, or private investment.

4.0 TECHNICAL CONSIDERATIONS

IS IT TECHNICALLY FEASIBLE TO DEVELOP A RESERVE OF LARGE POWER TRANSFORMERS WHEN MOST ARE CUSTOM ENGINEERED?

Yes, it is technically feasible to develop a reserve of LPTs. An expert team of utilities and suppliers should work on a countable number of resilient / emergency transformers. (Target: Operation for more than 3 utilities and maximum three year operation). However, given the amount of customization that normally occurs for LPT installation at a given facility, we recommend that the core / standard elements, that contribute most to the long lead time, of a LPT be procured and inventoried. If a HILF-type event should occur, the reserve LPTs could be mobilized at the DoE's authorization. Knowledgeable "fly away" installation teams would then be dispatched for site-installation of the necessary customization components and final start-up of the system, to dramatically reduce the overall response time.

IS ADDITIONAL RESEARCH AND DEVELOPMENT (R&D) NECESSARY TO DEVELOP SUITABLE REPLACEMENT TRANSFORMERS THAT CAN BE RAPIDLY DEPLOYED FROM INVENTORY IN THE EVENT OF AN EMERGENCY?

Current technology exists to produce suitable replacement transformers. However, the designs can be improved with R&D in the areas of advanced insulation materials (solid and liquid) and improved analysis of the impact from HILF events (Geomagnetic Disturbance, Electro-magnetic Pulse).

5.0 PROCUREMENT AND MANAGEMENT

HOW SHOULD PROCUREMENT, MAINTENANCE AND MANAGEMENT OF THE RESERVE POWER TRANSFORMERS BE CONDUCTED?

Procurement could be per industry standard practices (i.e. sealed tendering by pre-approved vendors). Maintenance and management could also be tendered or the direct responsibility of the owners, depending on the ownership structure. (See section: 3.0 Ownership and Economics.) A series of long-term Basic Ordering Agreements (BOAs) or IDIQ Single Award Task Order Contracts (SATOCs) could be put in place with LPT manufacturers and service vendors, to pre-approve them for participation in the National Power Transformer Reserve Program (competition exists to get pre-approved and win a BOA or IDIQ SATOC. One idea would be to award the BOAs / SATOCs on a regional basis. Then, upon need to activate the Program, task orders are issued to the holder of the regional BOA/SATOC in the region(s) impacted by the critical outage(s).

FOR EXAMPLE, SHOULD MANUFACTURERS BE PRE-QUALIFIED, AND IF SO, ACCORDING TO WHAT CRITERIA?

Manufacturers should be pre-qualified in accordance to industry standards and practices commonly used by the participants in the bulk power system.

6.0 SUPPLY CHAIN

WHAT ARE THE CRITICAL SUPPLY CHAIN COMPONENTS FOR THE MANUFACTURE AND DELIVERY OF LARGE POWER TRANSFORMERS (E.G., ELECTRICAL STEEL, COPPER, SILICONE, HIGH VOLTAGE BUSHINGS, ETC.)?

Some of the critical supply chain components are:

- GOES
- high-grade copper conductor
- bushings

Transformer bushings are long lead time items due to their fabrication requirements, and GOES and high grade copper conductors are commodities that have lead times that can change dramatically over relatively short periods of time. As noted previously, there is currently a shortage of readily available GOES for use in the transformer cores. Having a stockpile program will aid in mitigating these lead times and commodity swings, to restore the affected grid and bring back online in a shorter duration.

ARE THERE SHORTAGES OR OTHER CONSIDERATIONS THAT COULD NECESSITATE USING THE DEFENSE PRODUCTION ACT PRIORITY RATINGS TO ENSURE SUFFICIENT PARTS ARE AVAILABLE IN A TIME OF NEED?

Beyond the critical supply chain components listed above, the balance of the components required have sufficient availability through various manufacturers and supply chain sourcing. However, the use of the Defense Production Act Priority Ratings would likely reduce lead time. The use of this act may be beneficial for the "fly away" installation teams to ensure that they are immediately able to respond when they may be pre-scheduled for a commercial customer.

ARE THERE RELATED SKILLED WORKFORCE ISSUES?

Skilled workers have become progressively more difficult to obtain, but there are sufficient at this time to develop a reserve program.

7.0 MANUFACTURING

IS THERE ADEQUATE MANUFACTURING CAPACITY TO SUPPORT A TRANSFORMER RESERVE PROGRAM?

There is adequate manufacturing among suppliers currently providing LPTs for the bulk power system.

WHAT IS THE LEAD TIME FOR ENGINEERING, MANUFACTURE, AND DELIVERY OF LARGE POWER TRANSFORMERS?

Cycle time for engineering is typically one to four months. Cycle time for manufacture is typically two to five months. Delivery time is one to three months depending on logistics. Total lead time, including existing backlog, can be from eight to 20 months depending on market conditions and individual manufacturers.

ARE THERE APPROACHES THAT COULD HELP TO SPEED MANUFACTURE AND DELIVERY OF LARGE POWER TRANSFORMERS?

Reductions in lead times can be obtained by using pre-existing designs, having critical materials on hand or pre-arranged with suppliers and the use of the Defense Priority Act Ratings to ensure that a critical federal need is addressed in advance of previous, but less critical, orders, reserving production slots among manufacturers. Additionally, by utilizing a "fly away" team of manufacturer-certified specialist LPT technicians for site-installation of the customization components and final start-up, the complete cycle time could be further reduced.

8.0 TRANSPORT AND DEPLOYMENT

WHAT SPECIALIZED TRANSPORT INFRASTRUCTURE WOULD BE NECESSARY TO SHIP LARGE POWER TRANSFORMERS FROM MANUFACTURING SITE TO STORAGE LOCATIONS, AND FROM STORAGE LOCATIONS TO FIELD SITE IN THE EVENT OF AN EMERGENCY?

Ocean going vessels with heavy lift capability, super depressed rail cars, Schnabel rail cars and Goldhofer road transporters are examples of specialty equipment required. An improved rail system with lines to handle the necessary weight, plus pre-approved clearance profiles is very useful. Pre-approved road permits and pre-established transport routes are also necessary. Road studies need to be conducted in order to plan ahead for any route requirements, capacity and availability in the event of a natural disaster. Special plane transport might be considered as well.

WHAT SHOULD BE THE NUMBER AND LOCATION OF TRANSFORMER STORAGE SITES?

The number of sites will be defined by the types and the location of possible application of the LPTs. A detailed study is necessary to determine the total number and location of potential LPT storage sites.

WHAT ARE FEASIBLE DELIVERY TIMES FOR LPTS THAT RESIDE IN A RESERVE TO AN AFFECTED SITE?

The units should be mobile (e.g. three single-phase transformers on trucks) and this would dramatically reduce the installation time to weeks.

9.0 FIELD ENGINEERING AND INSTALLATION

ARE THERE ADEQUATE DOMESTIC ENGINEERING AND INSTALLATION RESOURCES AVAILABLE THROUGHOUT THE UNITED STATES TO INSTALL MULTIPLE BULK POWER TRANSFORMERS SIMULTANEOUSLY?

Yes, in addition to many extremely well-qualified electrical utility companies, there are many manufacturers and service companies capable of LPT replacement. Developing a network of pre-approved service vendors would facilitate contracting when needed. This would include having fly-away teams prepared and on-call via a previously established set of BOAs or individual IDIQ SATOCs where individual task orders could be quickly issued to the selected service vendors to get the fly-away teams mobilized along with necessary equipment and supporting materials to the meet up with the LPT(s) at the impacted site(s).

WHAT ADDITIONAL RESOURCES WOULD BE NECESSARY?

It might be useful to store spare parts and oil handling equipment at the designated storage facilities, to ensure 100% readiness.

10.0 CRITERIA FOR DEPLOYING TRANSFORMERS

WHAT CRITERIA SHOULD BE USED FOR ACTIVATING AND DEPLOYING TRANSFORMERS FROM THE RESERVE?

There needs to be a clear and predefined priority plan implemented by the DoE and supported by the utilities and manufacturers which defines the criteria for activating and deploying LPTs from the reserve. This plan should consider various HILF scenarios from a single weather/electrical isolated incident to a coordinated terrorist attack to bring down the national grid. These scenarios would then be used to create a deployment response plan based on the anticipated immediate need to bring the affected potions of the grid back on-line as quickly as possible.

HOW WOULD DEPLOYMENT BE FUNDED?

The program could be funded by an immediate fee sharing agreement between the Federal Government and the bulk power providers based off a percentage split that is appropriate for the market. These providers could build the cost of this fee sharing into their rates, and in the event of a deployment of any of the stockpile to their facilities, the utility would either reimburse the Government the balance of the cost or, in the event of a national emergency, receive additional funding to reimburse to the stockpile program to ensure its continued availability.

11.0 ADDITIONAL COMMENTS

ARE THERE ADDITIONAL CONCERNS REGARDING A NATIONAL POWER TRANSFORMER RESERVE PROGRAM THAT NEED TO BE CONSIDERED?

The average age of a LPT in the bulk power system is fast approaching 40 years. The reliability and resilience of LPTs is inversely proportional to the age of the fleet. A reserve program is necessary to ensure reliability under critical emergencies, where there exists the risk of an extended outage, affecting millions of people with dire consequences for the economy and safety of our citizens.