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August 24, 2015

Ms. Alice Lippert
United States Department of Energy
Office of Electricity Delivery and Energy Reliability
Forrestal Building, Room 1E-078
1000 Independence Avenue SW
Washington DC, 20585

Via Electronic Delivery
(lpt.rfi.2015@hq.doe.gov)

Dear Ms. Lippert:

Delta Star, Inc. ("Delta Star") is pleased to offer the following information in response to the Department of Energy's "Request For Information" regarding the necessity, feasibility, development, and utilization of a National Power Transformer Reserve program ("the Program"). Delta Star is a leading manufacturer of electric power transformers, autotransformers, mobile power transformers and mobile substations in the United States. Delta Star manufactures all of its products in North America at locations in San Carlos, California; Lynchburg, Virginia; and Saint-Jean-sur-Richelieu, Quebec, Canada. This role as a leading manufacturer of the very sort of equipment that is the scope of this Request for Information provides Delta Star with a unique perspective and decades of experiences for the Department's consideration.

The Program as outlined in the Request for Information relates to setting aside a reserve of Large Power Transformers ("LPTs") in strategic locations to mitigate the risk to the reliability of the grid arising from the loss of LPTs.[1] While Delta Star supports the development of the Program, it has concerns related to the scope of the contemplated reserve. The reserve storage of LPTs is a very important component of a more effective and encompassing policy that addresses the full risk scope associated with the large-scale disruption to the transmission grid. To limit the reserve program to only LPTs, while not addressing the risk to the rest of the electric system, would be self-defeating. Thus, while supportive of the proposed Program, Delta Star recommends in its comments below the program be revised to include the following three categories of components:

[1] While the Request for Information does not specify, Delta Star understands the Department's use of the undefined "LPT" to reference transformers in excess of 100 MVA.

1. The large power transformers ranging from 100 to 400 and larger MVA as outlined in the Request for Information;

2. The U.S. International Trade Commission's expansion of LPTs to include medium sized power transformers ranging from 60 to 100 MVA[2]; and

3. Transmission and other critical infrastructure used to serve defense and other facilities critical to the security of the Untied States.

In addition, Delta Star recommends the inclusion within the reserve of mobile power transformers and mobile substations. These units range from medium to extra high voltage units and are already mounted on truck beds or skids designed to operate within the Department of Transportation's ("DOT") existing regulations governing the delivery of the large equipment from origin to pad, meaning they are capable for rapid mobile deployment, connections, and energization without the delays required by regular non-mobile power transformers.

The installation of a non-mobile, or a fixed, power transformer takes up to four weeks under normal circumstances. In the context of a disruptive emergency event that could also impact delivery options (i.e., railroad availability, fuel shortage, ability to transport to/from rail yards, etc.), installation of a non-mobile transformer will take even more time. In contrast, because it is already mounted for travel according to DOT regulations, a mobile solution would truly be capable of rapidly restoring electricity within a few hours. Mobiles provide the flexibility to be used for short-term power recovery, medium-term replacement equipment or long-term sustained use. In addition, mobile units do not need to be custom built to serve a specific substation. Rather, each mobile unit can be built with configurable voltage ratings, allowing each unit to provide flexibility as to where it can be replaced. Thus, these mobile units provide the maximum flexibility to address a wide range of disruptive events.

Furthermore, Delta Star strongly urges the implementation of a standardized control scheme and universal monitoring device for utilities that will allow for the maximum flexibility to communicate with multiple utility SCADA systems. These systems can fluctuate between different utilities, or even within a single utility. If equipment is to be set in reserve for the potential use of different utilities or different substations within a single utility, each of which could have its own communications and SCADA systems, it is important that such reserve equipment have the functionality to communicate effectively among the multiple platforms.

In conclusion, as detailed in Attachment A to this letter, Delta Star highly recommends that the National Power Transformer Reserve program include the following items:

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[2] Large Power Transformers from Korea, U.S. International Trade Commission (USITC), Publication 4256, September 2011, as referenced in the DOE Large Power Transformers and the U.S. Electric Grid report from April 2014, established LPTs as "large liquid dielectric power transformers having a top power handling capacity greater than or equal to 60,000 kilovolt (60 megavolt amperes). See, http://energy.gov/sites/prod/files/2014/04/f15/LPTStudyUpdate-040914.pdf.

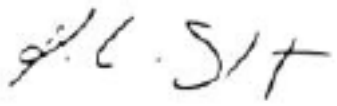
1. Revise the reserve program to include not just LPTs, but also medium transformers and transmission and other infrastructure used to serve defense facilities and other facilities critical to the security of the United States.

2. Include mobile power transformers and mobile substations, along with skid-mounted transformers, into the National Power Transformer Reserve.

3. Require the development and implementation of a standardized control scheme to ensure expeditious setup and installation transformers, as well as effective communications among the various SCADA platforms.

Thank you for the opportunity to be included in this Request for Information and we look forward to continuing to provide appropriate levels of assistance as requested.

Respectfully,



Karlee N. Shelton
Delta Star, Inc.
Customer Solutions Strategist

Attachment A

Delta Star, Inc.

Department Of Energy

Request For Information

National Power Transformer Reserve

Question Set 2. Power Transformer Criteria

What type and sizes of power transformers should be considered for inclusion in a transformer reserve program versus operational spare capacity? What are the design considerations for replacement transformers to support the bulk power system?

The reserve storage of LPTs is a very important component of a more effective and encompassing policy that addresses the full risk scope associated with a large-scale disruptive to transmission grid. To limit the reserve program to only LPTs, while not addressing the risk to the rest of the electric system, fails to fully protect the grid if the disruptive event similarly impacts the sub-LPT portion of the grid. Thus, while supportive of the proposed Program, Delta Star recommends the DOE revised the proposed program the include the following four categories of components:

1. The large power transformers ranging from 100 to 400 and larger MVA as contemplated in the Request for Information;

2. Large power transformers and mobiles substations to include MVA ratings at 60 MVA or above[1], which includes portable, skid mount, removable and fixed axle mobile solutions which can be designed for quick deployment, temporary or permanent placement. Mobile power transformers and mobile substations[2] have been used throughout the industry to restore power within hours since the mid 1970s. These mobile platforms are used to restore power during emergency shut downs, maintenance, substation damage, and natural disasters, among scores of other uses.

3. The at-site installation of a non-mobile power transformer can take up to four weeks under normal circumstances, which does not even include the time it may take to transport the transformer to the site. In the context of a disruptive emergency event that could also impact delivery options for the LPTs (i.e., railroad availability, fuel shortages, ability to transport to/from rail yards, availability to skilled technicians to install, etc.), transportation and installation of a non-mobile fixed-pad transformer will take even more time. In contract, because it is already mounted for travel

[1] See note 2.

[2] Delta Star manufactures transformers, autotransformers, mobile power transformers and mobile substations. Delta Star manufactures all of its products in North America. Plant locations include San Carlos, California; Lynchburg, Virginia; and Saint-Jean-sur-Richelieu, Quebec, Canada.

according to DOT regulations, a mobile solution would truly be capable of rapidly restoring electricity in matter of hours, not weeks.

Design configurations should be dynamic and adaptable for any mobile power transformer or mobile substation, such that one unit can work in multiple applications. This would include dynamic and adaptable voltage, phase angle, impedance, and even control schemes accomplished through partial series parallel link connections, full capacity voltage regulation, phase angle-regulating windings, and standardized control and communication schemes. The dynamic and adaptable nature of mobile platforms allows each unit to provide maximum flexibility as to where it can be utilized—thus providing the maximum flexibility to address a wide range of disruptive events.

4. The National Power Transformer Reserve should also include transformers for Critical Infrastructure and Defense Critical systems below 100 MVA based rating. Transformers with a base rating below 100 MVA will often service military installations, defense and intelligence contractors, sensitive intelligence sites, water and waste water management systems, hospitals, educational facilities, prisons, and other critical and defense electrical infrastructure necessary to maintain a stabilized society and national security.

Delta Star supports the proper development of a robust reserve program, and strongly encourages the Department to consider these additional programs.

Question Set 4. Technical Specifications.

Is it technically feasible to develop a reserve of large power transformers when most are custom engineered? 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?

Yes, it is technically feasible to develop a reserve of large power transformers and mobile substations even if custom engineered. Most are custom engineered, designed, and performance characteristics covered by the industry standards make it feasible to build a reserve that closely matched the existing fleet of transformers, though further research and development would be useful in developing technology in the 100 to 400 MVA range. For instance, if the Department is looking for a truly mobile platform in the 100 to 400 MVA range with multiple taps allowing for maximum flexibility, there is an opportunity to invest in the technology to continue current development in the R&D phase.

As indicated in Delta Star's response to Question 2 above, it is critical for the Department to consider setting up a reserve not only for LPTs, but also for medium size transformers and facilities used to serve for Critical Infrastructure and Defense Critical systems below 100 MVA base rating. This is supported by the reality that it takes a substantial lead-time to manufacture power transformers. Based on Delta Star's experience:

1. Large power transformer manufacturing lead times ranges from 44 to 70 weeks depending on the market and supplier.

2. Medium power transformer manufacturing lead times range between 28 to 48 weeks depending on the market and supplier.

3. Mobile power transformer manufacturing lead times are currently approximately 42 weeks.

In light of the substantial advance time needed to manufacture the equipment, the Department should consider the use of the most flexible platform to satisfy the broadest possible needs. The use of mobile platforms with multiple technical options satisfies that flexibility goal. The technology exists for medium and critical infrastructure mobile platforms, though further research and development would be useful in developing technology in the 100 to 400 MVA range.

In addition, a large part of rapid deployment includes the control systems contained within the equipment itself and their interface with different SCADA systems. If the Department is considering a reserve of equipment that will serve as a replacement network, it is important that the reserve equipment possess a flexible SCADA system that can communicate information effectively and perform ongoing monitoring of performance of the transformers. A universal control system capable of communicating with all industry protocols is the best solutions to this hurdle and improves flexibility of the reserve system. The control system should offer real time monitoring services and incorporate substation security to prevent malicious transformer outages and physical attacks. This technology exists today and can be incorporated into the reserve equipment.

Question Set 6. 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.)? 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? Are there related skilled workforce issues?

While Delta Star will not opine on whether use of the Defense Production Act Priority Ratings is appropriate, there are substantial supply chain aspects the Department will need to consider in developing its Reserve program. For instance, transformers are manufactured from commodities such as electrical grade core steel, porcelain, copper, tank steel, and mineral oil. These items are severely impacted by foreign economies and supply and demand. Shortage or trade embargos could result in escalated lead times and extremely high prices. Further, load tap changers, bushings and other transformer components also have lengthy lead times, which contributes to long lead times for transformer manufacturing. The standard lead-time to order the items listed above is between 14 to 18 weeks prior to the beginning of construction of the transformer, depending on the complexity and size of the transformer.

As indicated in Delta Star's response to Question 4 above, it takes a substantial lead-time to manufacture power transformers. Based on Delta Star's experience:

1. Large power transformer manufacturing lead times ranges from 44 to 70 weeks depending on the market and supplier.

2. Medium power transformer manufacturing lead times range between 28 to 48 weeks depending on the market and supplier.

3. Mobile power transformer manufacturing lead times are currently approximately 42 weeks.

Of course, the above timelines are under ideal circumstances and current conditions. A disruptive event or emergency conditions will, by necessity, expand these timelines. In light of the substantial advance time needed to manufacture the equipment, the Department should consider the use of the most flexible platform to satisfy the broadest possible needs, including the use of mobile platforms within the Reserve program.

In terms of personnel, there may be a need to address technical limitations in the field of transformer engineering and manufacturing. Transformer engineering and manufacturing are specialized skills that cannot be learned quickly. Most power engineers spend years before designing their first transformer under close supervision. The delicacy of transformer manufacturing includes highly trained and skilled craftsman, each specializing in coil winding, assembly, testing, and processing. Each of these skills sets requires continual engineering oversight at each stage of the manufacturing process.

Question Set 8. 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? What should be the number and location of transformer storage sites? What are feasible delivery times for LPTs that reside in a reserve to an affected site?

In addition to the large lead-time for the manufacturing of transformer equipment, there are additional logistical issues associated with the transportation of this equipment to/from the reserve locations. Transportation logistics and timelines include a number of factors, including but not limited to the following—distance from spare or reserve asset to the destination/substation; availability of a rail car, availability of qualified heavy hauling/rigging, and crane companies; availability of engineers and crews to offload, assemble, install, and test the transformer; procuring the right escorts, whether civilian or police, and the right number of escorts (varies by state); procuring the permits for interstate and intrastate transportation; number and location of road closures; unavailability of fuel; need for engineering survey to transport across highways, bridges, etc. Taking these factors into consideration, the duration between shipment from a factory or the origin to the substation or destination can vary from a few days to several months. Any one of the above factors can extend the timeline by days or weeks.

The Department should analyze transportation logistics associated with transporting a fixed LPT between the reserve site and permanent pad in three separate phases: before shipment, during shipment, and after delivery. The below paragraphs identify the transportation logistics associated with each phase of moving the fixed-pad LPTs and assume that the necessary equipment has been manufactured and delivered to the reserve site in advance.

1. **Before Shipment:** Prior to shipping a fixed LPT, regardless of type or size, key personnel must be involved in the coordination and preparation of the transport. A logistics coordinator must coordinate the schedule from shipment to delivery with a field service crew, a heavy hauler and/or rail car company, and a crane company. Each of the three groups (or four if transport is via rail) must report to the coordinator for times, dates, and the details related to the transport. Preparation is key to a safe and reliable delivery. In reference to the current request, preparation can also lessen the timeline, provided all parties are communicating openly with another. There are multiple elements to the preparation plan, including obtaining outline drawings, procuring permits, and testing.

    a. First, outline drawings depict the type of fixed LPT, including the weight, length, width, and height. Without these four measurements, the coordinator cannot plan the shipment with precisions. For a fixed transformer, a rail car must be available that can handle the weight and height restrictions of the transformer. Furthermore, many roads and bridges between the reserve site and the rail yard, and between the terminating rail yard and the pad, have weight and height restrictions. Should the transformer be moved across the road from the origin to the destination, or from the rail site to the pad, the dimensions must be provided to the appropriate companies, which include the rail company and all heavy hauling companies. Crane operators also must utilize certain cranes depending on the height and weight of the transformer. Even the permitting process will require dimensions of the equipment to be moved across the highway or bridges. If outline drawings of the transformers within the program were provided prior to an event, it would allow a coordinator to eliminate or lessen one step of the timeline procuring the drawings to coordinate with the right companies for shipment and delivery.

    b. Second, the permitting process not only requires an assessment of the roads, to be travelled, but also the bridges and, depending on the region, an engineering survey. Individual state Department of Transportation offices will require an engineering report be conducted prior to issuing a permit. Once a permit is issued, many states require escorts to accompany the transformer as it travels across the highways. In some states, police escorts are required. Other states may require civilian escorts, but may require both front and back escorts. If the fixed LPT is going by rail, the permitting requirement may only consist of the permits in the origin state and the destination state. Conversely, if the fixed LPT will be moved across state lines, via a heavy hauling company, permits for each individual state are required.

c. Best practices dictate that spare transformers or those in storage must be fully assembled and oil-filled. Depending on whether the transformer is fully assembled and oil-filled will determine whether oil draining and disassembly is required, thereby adding additional time to the transportation process. Initially, engineers at the origin site must test the transformer and associated equipment, including the existing bus, control cables, grounds, grounding resisters, and the transformer itself. Once all testing is complete, the transformer tank must be sealed for shipment. If best practices are followed, all the oil must be drained at a rate greater than 100 gallons a minute; conversely, if an oil processing trailer is needed, then oil can only be drained at a rate of 25 gallons per minute. After all the oil has been drained, the transformer must then be disassembled. Following this procedure, a foreman will perform a site-specific walk-down to ensure the safety of the site and all crewmembers who will be working at the site prior to shipment. Once the walk-down is complete, the transformer must be loaded onto the rail car or a heavy hauler and all loose parts, including bushings, arrestors, radiators, etc. must be loaded onto a flatbed truck. A crane is necessary to load the transformer onto the transporting vehicle, whether rail car or heavy hauler, and the loose parts must also be loaded onto the transformer in the same manner.

d. Only once the outline drawings, permits, and tests have been completed will the fixed LPT be ready for shipment. The process to complete these three steps may take anywhere from 3-10 days. Once the preparation work has been completed, the right personnel must be available for the shipment and delivery. The Department of Energy should consider the significant preparation involved, while also noting that many rail cars and heavy haulers are not available at any time and must be given sufficient notice. Moreover, many state transportation departments do not issue permits within 7-10 days, especially if an engineering survey is required prior to the issue.

2. **During Shipment:** Once a transformer has been prepared for transport, a field service crew must be dispatched to manage the equipment, including the fixed LPT, as it ships. During the shipment phase, the coordinator will ensure the crane and the flatbed of loose parts is on schedule to arrive at the destination shortly before the transformer is to arrive. Depending on whether the fixed LPT will be shipped via a rail car or a heavy hauler can greatly increase the timeline from shipment to delivery. Shipments via a rail car have been known to exceed two months, due to multiple reasons, including rail car availability, over-scheduling, and rail closures. Shipments via a heavy hauler may take anywhere from 2 to 3 days, or up to several weeks. Factors to consider include weather, frost laws, road closures, and the size of the transformer. It is not uncommon that a new permit is required when certain delays take place. For example, if a state's permit validity is only five days and a delay exceeds five days, the coordinator will be required to apply for and procure another permit. In the interim, the heavy hauler cannot move from its current position until the new permit is issued and necessary escorts, etc. are procured. Outside of

emergency situations, permits are generally not issued under an "expedited" option. The Department of Energy should consider what types of emergencies constitute a waiver or an expedited option for the state transportation departments to issue permits.

3. **After Deliver:** Once the transformer has been delivered, a number of actions must be taken prior to energizing the transformer, including setting up the crane, man-lift, and generators; procuring a dumpster for remaining equipment or another avenue to dispose of waste; installing and assembling the transformer; processing the transformer; followed by oil filling and testing the transformer. Once these actions have been completed, the transformer is ready to be energized. However, delays at the site are also commonplace if the coordinator fails to procure the proper cranes, testing failures arise, an insufficient crew has been dispatched, or the rail car, heavy hauler or crane companies are delayed for reasons of their own.

4. **Necessity of Mobile Transformers and Substation:** As a general rule, in the worst case scenarios a fixed LPT is likely to be delivered within three weeks by a heavy hauler or more than two months if by rail car. If limited issues arise, which there will likely be some issues with transportation, the entire process from shipment to delivery and commissioning can take place in roughly ten days. If there are zero issues and the Department is able to work under a best-case scenario option, some fixed LPTs may be transported in under five days, from origin to destination. However, these last two scenarios assume no rail car is involved and the transformer has been shipped via a heavy hauling company. Conversely, the use of mobile transformers and substations significantly decrease the length of a power outage from weeks to days, to just hours. Mobile platforms provide flexibility in ways fixed LPTs cannot. As referenced in the above subsections, the transportation logistics alone can cause increased delays in restoring power, while expanding multiple and costly resources. Mobile platforms require minimal resources, mainly personnel, and can provide restoration of power within the same day as the outage.

The Department must keep in mind that the above timelines and scenarios contemplate current non-emergency situations. To the extent that a disruptive event caused an emergency, the timelines to facilitate transportation can be substantially prolonged. Also, the use of mobile platforms already mounted on truck beds or skids can alleviate the need to perform a number of the above requirements imposed on the transportation of fixed LPTs. With the proper preparation, a mobile platform can be transported and in use in a matter of hours, not a couple of months.

Question Set 9. Field Engineering and Installation

Are there adequate domestic engineering and installation resources available throughout the United States to install multiple large bulk power transformers simultaneously? What additional resources would be necessary?

The industry's ability to install multiple LPTs simultaneously is relative to the availability of resources of key personnel, including heavy hauling and crane companies and the availability of

appropriate rail car services as discussed above in Delta Star's response to Question 8. Similar to the factors included in transportation and logistics needs, the availability of crews, engineers, equipment, fuel, etc. are imperative to any mass transportation and installation event.

In order to transport and install multiple fixed LPTs, the location of each individual transformer, relative to the destinations, is important, as more resources are required for longer transportation times. Once a fixed LPTs is delivered to the substation, the availability of crane operators and engineers to set, assemble, install, test, and commission the transformer will decrease as more transformers are brought into a specific region of the country. During the Hurricane Sandy and Nor'easter Storm, hundreds of power transformer and substations were partially and wholly destroyed. Some of the largest issues the industry faced were unavailability of spare transformers, personnel to assist in restructuring and maintenance, and fuel. Should a reserve program be established, the issue of spare transformers decreases; however, the required personnel and fuel may still be elevated.

The industry will need to breakdown and have a complete analysis of all the resources available in different regions of the country, e.g., number of heavy hauling and crane companies, and engineers in specific regions, including contact information; outline drawings of all spare equipment, including a detailed review of which heavy haulers, rail cars, and crane companies can transport each, individual spare transformer; availability of engineers able to assemble, install, and test specific sizes and types of transformers.

As indicated, the use of mobile platforms held in reserve that are already mounted on truck beds or skids can alleviate the need to perform a number of the above requirements imposed on the transportation of fixed LPTs. With proper preparation, a mobile platform can be transported and in place in a manner of a couple days, not a couple of months.

Question Set 11. Additional Comments

Are there additional concerns regarding a National Power Transformer Reserve program that need to be considered?

In addition to the above concepts, the Department will need to consider what entity will manage the Reserve program. Is it operated under the DOE penumbra, or some other government or private agency? How will the managing entity address physical security concerns?

In addition, not captured within the scope of the Request for Information, is the issue of the path by which costs and cost recovery will be addressed. Who will acquire the reserve units and, if a utility how does the utility recover the costs it incurs to participate in the Reserve program? Finally, in the event of a disruption and delivery of the Reserve equipment is needed, how are the costs made known to the utility and recovered?

Finally, Delta Star recommends the industry pursue a standard control scheme for units within the Reserve program that provides a secure and complete transformer health monitoring. Delta Star is willing to work together with participating utilities to establish/propose a "next generation" control scheme that provides the critical components listed above and simplifies the SCADA interface.