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Sept 12, 2014

Steven Herling
Vice President - Planning
PJM
2750 Monroe Boulevard
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Re: Artificial Island Supplemental Proposal Response
Dominion High Voltage Project P2013_1-1A

Dear Steve:

Dominion High Voltage Holdings, Inc. ("Dominion High Voltage") submits this supplemental response as requested in the August 12, 2014 letter on the following project proposal submitted to resolve the identified potential criteria violations for the Artificial Island area:

- Dominion High Voltage Project P2013_1-1A - two (2) Thyristor Controlled Series Compensation ("TCSC") Devices near New Freedom ("Project P2013_1-1A")

Dominion High Voltage would first like to thank PJM and the PJM Board of Directors for deferring selection of the Artificial Island project solution and allowing us an opportunity to provide information relevant to this important decision. Dominion High Voltage, in its July 16, 2014 letter to the Board, identified certain critical technical considerations for the TCSC component of Project P2013_1-1A that are important in making the best project selection to resolve the Artificial Island area reliability issues. Dominion High Voltage agrees with PJM that cost is only one of several factors to be used by the Board in its final selection and appreciates the PJM Board's decision to request additional technical review of TCSC Project P2013_1-1A in addition to the supplemental cost-related information requested.

The following discussion is intended to specifically address cost-related issues expressed in the August 12, 2014 PJM letter as well as the "additional information" referenced in Footnote 1, page 1, as noted:

> *Based on Dominion's July 16th letter, PJM has determined that it would be appropriate to seek additional information as outlined above regarding the Dominion 1A project.*

In this supplemental response, Dominion High Voltage will not be proposing a cost cap for Project P2013_1-1A, but rather offering a discussion of cost controls and reasons for confidence in our estimate and ability to complete this project. We will be discussing aspects of cost control to include an experienced team, an extensive project construction track record, and estimates

from our partners in supply chain to address equipment cost control. In addition, this response addresses the aspects of rights of way, land acquisition, and constructability for this project that are advantages compared to the four alternative line proposals.

Project Scope:

This proposal as submitted by Dominion High Voltage and modified by PJM meets all the reliability objectives requested in the April 29, 2013 RFP. Additionally, this proposal meets or exceeds all FERC and NERC reliability requirements, to include all FERC and NERC reliability criteria specifically engineered for stability performance at the interface between the electric transmission system and nuclear generating facilities.

Project P2013_1-1A consists of the following major components:

New Facilities:

- Install one 750/-375 MVAR SVC plus two Thyristor Controlled Series Compensation (TCSC) Devices and associated transformers, breakers, controls and protection at a new Substation near New Freedom

Incumbent Upgrades to Existing Facilities:

- Add two 500 kV breakers at East Windsor Substation
- Add two 500 kV breakers at Hope Creek Substation
- Add two 500 kV breakers at New Freedom Substation
- Add one 500 kV breaker at Red Lion Station

Cost Control Measures:

Team Capabilities:

One aspect of cost control is having an experienced team in place that consistently delivers complex projects on time, on scope and on budget. Dominion High Voltage's very capable Transmission Project Execution team has an unparalleled track record for the engineering, permitting, and construction of electric transmission facilities including transmission lines and switching stations.

The Project Execution team is directly responsible for engineering, acquiring all rights of way, securing necessary permits, and overall project management with supply chain and construction support provided within the project teams. A dedicated Project Manager is assigned and directly responsible for managing this team to deliver projects within specified schedule and budget.

Unparalleled Track Record:

This team's approach will be instrumental in meeting the project construction needs for Project P2013_1-1A. Since initially joining PJM on May 1, 2005, Dominion High

Voltage and its affiliates have completed approximately $3 billion of transmission construction projects on time, on scope and on budget, including the following examples:

- Line #580 to Loudoun 500 kV line (Part of 502 Junction-Loudoun) – Obtained PJM approval in Summer 2006 and constructed line by the PJM target date of 6/01/2011 meeting the approved PJM budget projections;
- Carson to Suffolk 500 kV line – Obtained PJM approval in summer 2006 and constructed line by the PJM target date of June 1, 2011, meeting the budget projections approved by PJM;
- Mt. Storm to Doubs 500 kV wreck and rebuild project (96.4 miles) – Obtained PJM approval in summer 2010 and energized the rebuilt line in June 2014 (one year in advance of PJM target date), meeting budget projections approved by PJM;
- Mt. Storm 250 MVAR Static VAR Compensator ("SVC") – Obtained PJM approval in April 2012 and constructed a Flexible Alternating Current Transmission System (FACTS) solution by PJM target date of June 2014 meeting the PJM budget projections;
- Mosby 500 MVAR SVC – Obtained PJM approval in April 2012 and constructed FACTS solution by PJM target date of June 2014, meeting the budget projections approved by PJM.

Strategic Supply Chain efforts:

Dominion High Voltage consulted with three major vendors, ABB, Mitsubishi Electric Power Products, Inc. ("MEPPI"), and Siemens AG, to ensure the application of this solution is viable and to provide cost estimates for the major two components, SVC and TCSCs, of Project P2013_1-1A.

Both MEPPI and Siemens have provided Dominion High Voltage with a budgetary cost estimate along with not-to-exceed quotes. Their schedules for delivery and installation of the SVC and TCSCs fully support the overall project construction schedule. The cost quotation and scope letters from MEPPI and Siemens are included as *confidential* attachments to this response.

Permitting, licensing and approval:

River crossing. Each of the other four alternative line proposals includes an interstate river crossing that will likely cause long permitting and approval delays, and possibly, failure. Project P2013_1-1A does not include a river crossing and therefore has less risk to project execution.

Transmission line siting and construction. The other four alternative line proposals have between three (3) and seventeen (17) miles of overhead transmission line to site. The long lines to the north also cross wetlands and national wildlife refuges that pose additional complications that could result in delays or difficulties in getting approved

siting. Project P2013_1-1A has little to no transmission right of way; only enough to allow for the existing transmission lines to tap into the new SVC/TCSC station.

Agency approvals. The numerous agency approvals required for the four alternative line proposals will increase the possibility of delays and potentially increase costs. All four alternative line proposals require review by regulatory bodies at the local, state and federal level. Project P2013_1-1A has minimal land use, no river crossing, the least amount of agency approval of all proposals and therefore significantly less permitting exposure compared to the four alternative line proposals.

Construction Schedule:

Dominion High Voltage estimates that it can have Project P2013_1-1A in service within 36 to 48 months after receipt of PJM Board approval and assigned construction responsibility. Assuming a December 2014 Board approval, Project P2013_1-1A could be in service and improving performance in the Artificial Island area as early as December 31, 2017 and no later than November 05, 2018.

Evidence this can be achieved is demonstrated by Dominion High Voltage's affiliate Dominion Virginia Power's installation of two SVC solutions at Mt. Storm and Mosby Stations within 24 months of PJM Board approval. Both stations now contain much of the same equipment as the Project P2013_1-1A solution, with the exception of the TCSCs.

Cost Evaluation:

To ensure a complete and accurate cost assessment has been provided to PJM, Dominion High Voltage has revised the overall cost estimate. Highlighted in Table 1 below is a breakdown of the major project components. In compiling this revised cost estimate, Dominion High Voltage has included the not-to-exceed cost information provided by MEPPI and Siemens on the SVC and TCSCs, respectively, for Project P2013_1-1A.

Table 1: Total Projected Project Cost for Project P2013_1-1A

Components	Dominion High Voltage Estimated Cost (Includes 10% Contingency)	Not To Exceed Provided by Vendor	*Additional Contingency Factor*	Maximum Expected Cost
750/-375 MVAR SVC		$50.6 M	*N/A*	$50.6 M
Two TCSCs		$35.8 M	*N/A*	$35.8 M
SVC Coupling Transformers	$12.8 M		*10%*	$14.1 M
Engineering Labor, Construction Labor and Other Material Costs	$41.4 M		*10%*	$45.5 M
Real Estate/Permitting	$6.2 M		*50%*	$9.3 M
Incumbent construction – breaker installations at 4 stations	$17.1 M		*10%*	$18.8 M
Total	**$163.9 M**			**$ 174.1 M**

The six major components of the project addressed in Table 1 each have different risks for cost escalation contingency. Each of these will be briefly discussed so it is clear how overall risk and cost control is being managed for this project.

750/-375 MVAR SVC – Dominion High Voltage consulted with MEPPI to obtain a detailed estimate for the SVC on this project. Their estimate of $46 million includes a turnkey proposal for the construction and installation of the SVC. MEPPI also provided a not-to-exceed cost that includes a 10% contingency factor, bringing the total maximum cost for the proposal to $50.6 million. This represents 29% of the total project maximum estimate.

Two TCSCs – Dominion High Voltage consulted with Siemens to obtain a detailed estimate for the two TCSCs on this project. Their estimate of $35.8 million is a not-to-exceed cost proposal that provides for turnkey construction and installation of the TCSCs. This represents 21% of the total project estimate.

SVC Coupling Transformers – The estimates for these transformers range from $12.8 million to $14.1 million including additional contingency. Dominion High Voltage and its affiliates purchase transformers regularly and have established relationships with many vendors. Additionally, Dominion High Voltage affiliate Dominion Virginia Power has recently installed two SVCs at Mt. Storm and Mosby Stations, providing recent guidance on these cost estimates.

Engineering Labor, Construction Labor and Other Material Costs – Dominion High Voltage estimates the costs associated with engineering labor, construction labor and other material costs to be $41.4 million. A large portion of this cost is the additional

equipment, breakers, control house, bus work, system protection and other equipment. This equipment is routinely purchased and installed by Dominion High Voltage and its affiliates, and the most recent actual costs were used to develop these estimates. The remaining portion of this estimate is engineering and construction labor estimates, which again Dominion High Voltage and its affiliates have a high degree of confidence in this estimate based on their experience.

Real Estate/Permitting – Dominion High Voltage has estimated the Real Estate and Permitting for Project P2013_1-1A to be $6.2 million, which includes a contingency margin for land purchase and permitting. Although this is the lowest cost portion of this project, it has the highest risk from a cost standpoint; therefore, Dominion High Voltage included an additional 50% contingency in Table 1.

Incumbent Construction – This is work to install seven breakers at four existing substations. This work would be performed by the incumbent transmission owner of these substations. Dominion High Voltage based on experience and review of these facilities has estimated the total cost of this work to be $17.1 million which already includes a 10% contingency factor. Dominion High Voltage believes this estimate including the contingency factor is more than adequate to cover this work including any potential rearrangement or bus work to be done; however, an additional 10% contingency factor is provided in Table 1 to account for other potential cost variance.

"Additional Technical Information"

Stability Performance

One measure PJM has been using throughout this evaluation on stability performance is maximum swing angle. This is the maximum any unit swings in relation to the system angle in degrees just after the fault occurs. For the Artificial Island area, the criteria for swing angle is not to exceed 120 degrees. Based on the analysis performed by PJM and presented at the various TEAC meetings, the worst case swing angle for Project P2013_1-1A is 88 degrees for the outage of Line 5038. The swing angle for the four alternative line proposals still under consideration range from 99 to 112 degrees. This side-by-side comparison of worst case contingency results for maximum swing angle demonstrates that Project P2013_1-1A not only meets the specified reliability criteria, it has the best stability performance of all submitted projects.

Application of TCSCs

Although this application of TCSCs has not yet been implemented in the PJM region, these devices are used globally for power system transient stability and small signal stability as is shown in Table 2 below[1].

[1] DNV-GL *Project 1A: Application to Artificial Island Area System Performance* (Jun. 2, 2014) at 24 (submitted with Dominion High Voltage response to PJM on June 2, 2014).

Table 2: Summary of currently installed TCSC applications

Year	Country	KV	Appliction			Location	Source
			SSR mitigation	Post-contingency stability	Dynamic flow control		
1992	USA	230			✔	Kayenta substation, AZ	1, 2
1993	USA	500	✔		✔	C.J.Slatt substation, OR	1
1998	Sweden	400	✔			Stöde	1, 3
1999	Brazil	500	✔	✔		Imperatriz and Sarra de Mesa	1, 4
2002	China	500	✔	✔		Pinguo substation, Guangzhou	1
2004	India	400	✔	✔		Raipur substation	1, 5
2004	China	220	✔	✔		North-West China	1
2014	United Kingdom	400	✔	✔	✔	Hutton substation	6

Notes:

1. Maruf, Nasimul Islam, et.al. , *Study of Thyristor Controlled Series Capacitor (TCSC) as A Useful Facts Device*, International Journal of Engineering Science and Technology, Vol. 2(9), 2010, pages 4357-4360.
2. Jalali, J. and R. Hedin, *Thyristor Controlled Series Compensation (TCSC) Impedance and Linearized Models for Power Swing and Torsional Analysis*, Electric Power research Institute, May 1988.
3. Holmberg, D., et. al., *The Stöde Thyristor Controlled Series Capacitor*, Cigré 1998 Session, Paper 14-105.
4. Grünbaum, R. and Jacques Pernot, *Thyristor-Controlled Series Compensation: A State of The Art Approach for Optimization of Transmission Over Power Links*, ABB Power Systems, 2001.
5. *North – South 500 kV AC power interconnection: transmission stability improvement by means of TCSC and SC India*, ABB FACTS brochure, 2011.
6. *ABB's FACTS Solution to Facilitate Increased Power Flow from Scotland to England*, ABB UK, 2014.

Nuclear Regulatory Commission Discussion:

PJM has also been requested by the PJM Board of Managers to discuss technical issues with the Nuclear Regulatory Commission ("NRC") associated with certain proposals impacting nuclear switchyards. With respect to Project P2013_1-1A, a FACTS device proposal, there are inherent performance advantages that need to be understood. Generally, FACTS devices provide advantages of capacity enhancement, power flow control, transient stability improvement, power oscillation dampening, and voltage stability; with a relatively small footprint as to environmental impacts. The Office of Interconnection has not provided an explanation as to why the FACTS-based Project P2013_1-1A represents a different nuclear regulatory concern than the SVC that PJM added to the four alternative line proposals under consideration. Dominion High Voltage Project P2013_1-1A satisfies all NERC and PJM Reliability Planning Criteria, to include all FERC and NERC reliability criteria specifically engineered for stability performance at the interface between the electric transmission system and nuclear generating facilities.

FACTS technology is also in use at Exelon Corporation's Clinton Nuclear Power Station. At the Clinton station, SVCs are needed to meet the plant's GDC-17 obligations. In 1998, Exelon requested the installation of two +28.5/-14.0 MVAR SVCs for the 4 kV safety system buses. The nuclear operator depends on these SVCs to have adequate safety system voltages. The attached link below is an NRC licensing document in which Exelon amended the proposed protection. The term "LOCA" used in the excerpts below refers to a loss of coolant accident, which would be a very severe accident by potentially resulting in reactor core damage.

http://pbadupws.nrc.gov/docs/ML0209/ML020990658.pdf

Excerpts from the document are provided below:

Introduction

In 1997, the licensee determined that as a result of load growth, the voltages on the offsite power sources could not be maintained above the minimum required value assuming a LOCA and unit trip with certain grid conditions. By letter dated May 4, 1998, Illinois Power (licensee) proposed to install one Static VAR Compensator (SVC) to the secondary (4.16 kV) side of the reserve auxiliary transformer (RAT) and the other SVC to the secondary (4.16 kV) side of the emergency reserve auxiliary transformer (ERAT) to correct this voltage condition. The RAT is associated with the offsite 345 kV transmission system, and the ERAT is associated with the offsite 138 kV transmission system. These two transmission systems constitute the two required offsite electrical power sources for the plant. In addition, the licensee also proposed to incorporate SVC protection system requirements under a new technical specification.

Findings

We have evaluated the licensee's submittal and determined the following:

The proposed SVC installation would improve the voltages during degraded grid conditions at the Class 1E 4.16 kV safety buses. The addition of the SVCs will help to maintain voltages at the site for both offsite electrical power sources consistent with the "capacity and capability" requirements of GDC 17. Tripping of the SVCs in response to an SVC failure or abnormal condition does not result in a loss of power from the offsite sources, however, tripping of the SVC may result in an offsite source becoming inoperable. This is described in the Technical Specification bases for 3.8.1 and 3.8.2 regarding offsite sources.

The nuclear license currently in force shows these SVCs are still in use 16 years later. (http://pbadupws.nrc.gov/docs/ ML0527/ML052720312.pdf

Summary:

An understanding of the uniqueness of Project P2013_1-1A and its technical advantages is critical in establishing how costs and the timing for construction activity can be more predictably and reliably estimated. Unlike the other four alternative proposals, Project P2013_1-1A has significantly less construction and permitting issues, and consequently lower risk of cost escalation and earlier final in-service date. Dominion High Voltage feels it is important to clarify and restate these technical and construction advantages in order to further explain how costs can be controlled, construction schedule be more predictable, and to fully address footnote 1 of the PJM August 12, 2014 letter request.

Project P2013_1-1A is a solution that has been successfully implemented globally for power system transient stability and small signal stability issues similar to the conditions identified at Artificial Island. With the exception of small upgrades at four existing substations, the major components of this proposal are all contained with one new substation near the New Freedom

area in New Jersey. This station solution provides a significant advantage over all other proposals for completion on time, on scope and on budget. This proposal will have minimal land use impact, limited regulatory hurdles, no transmission line siting, no condemnation, and limited work at existing stations, which collectively minimize the risk of cost escalation and construction schedule delay. Except for the associated incumbent breaker work in the Red Lion station, all work is in the State of New Jersey and unaffected by any possible limitation on the legal ability of non-incumbents to construct transmission facilities in Delaware.

To summarize the Project P2013_1-1A information that PJM has requested in the August 12, 2014 letter:

- This unique solution provides for a proven FACTS solution to resolve the Artificial Island Reliability Drivers.
- A target in-service date of 36-48 months after PJM Board approval is obtained
- Less regulatory hurdles and permits to obtain, reducing risk of project delay and cost escalation
- Dominion High Voltage has received from vendors not-to-exceed cost estimates for two major components of Project P2013_1-1A which represent approximately 50% of the total project cost.
- Real estate and permitting requirements add risk to cost and schedule. For Project P2013_1-1A, this risk is minimal compared to the four alternative line proposals and only represents 3% to 5% of the total project cost.
- The estimated maximum cost for this proposal, including contingency, is $174.1 million. This makes Project P2013_1-1A at least $106 million less expensive than the lowest cost alternative line proposal as estimated by PJM.

Dominion High Voltage has reviewed PJM's August 29, 2014 letter to Hon. Curtis L. Wagner, Jr. seeking support in the Alternative Dispute Resolution process. We support this process and welcome the opportunity to actively participate and discuss the aspects of the project in person with Judge Wagner and PJM.

I would like to reiterate our appreciation to PJM staff and the PJM Board of Managers for the on-going opportunity to discuss Project P2013_1-1A to address the reliability issues associated with the Artificial Island area. I would also like to add on behalf of Dominion High Voltage my confidence in our very capable and talented team to leverage our unparalleled track record to execute Project P2013_1-1A on time, on scope, and on budget.

If you have any further questions, please feel free to contact me.

Sincerely

Scot C. Hathaway
Vice President, Transmission

Enclosures

cc:
Terry Boston
Mike Kormos
Paul McGlynn
Mark Simms
Suzanne Glatz
Pauline Foley