Executive Summary

Dominion High Voltage Holdings, Inc (DHV) is submitting these comments in response to the apparent conclusions PJM has drawn regarding the ten proposals being selected for final consideration for the Artificial Island RFP as presented at the May 19, 2014 TEAC. DHV will demonstrate that Option 1A, which installs two TCSC's and an SVC, provides the most value to PJM stakeholders and ratepayers while meeting the reliability requirements set forth by PJM and NERC. It offers tremendous advantages that no other proposal offers and is the best overall solution. Therefore PJM should reconsider its position on option 1A.

DHV also requested DNV GL Energy Americas to perform an independent review of its proposal 1A. See separate report titled "Project 1A: Application to Artificial Island Area System Performance," (DNV GL report). DHV encourages PJM to review the DNV GL report, its findings and conclusions. DHV believes that this report demonstrates that the solution proposed in Project 1A is just as effective in resolving the stability issues as the ten line proposals, has the lowest construction risk of all the proposals, and is by far the most cost-effective solution. The DNV GL report contains supporting information regarding TCSC and SVC technology that is being proposed. As identified in the report, this technology is not new, is reliable, and has been used successfully to solve similar problems around the world for many decades.
The arguments in this response and the supporting documentation enclosed strongly refutes concerns presented at the May 19 TEAC meeting that this technology is unreliable, new, and not accepted by stakeholders and the industry.

To summarize, some of the many attributes and advantages of option 1A include:

- ✓ The least costly option
- ✓ Effective resolution of the stability issues
- ✓ Lowest construction risk
  - o Least amount of permitting
  - o Least amount of real estate
- ✓ Least impact
  - o No river crossing
  - o Minimal wetland/environmental issues
- ✓ Quickest Relief of the stability problem
  - o Only 36 months to permit and construct
  - o Less risk for the nuclear generators since it avoids 2-5 years of SPS tripping risk
- ✓ Reliable and proven technology used for decades all over the world
- ✓ No adverse impacts to the nuclear plants

DHV Proposal 1A Recommendation

Dominion High Voltage Holdings, Inc. (DHV) submitted three proposals to the PJM Artificial Island proposal window, with its Project 1A proposal being the lowest cost, least complex, and one of the best performing solution options proposed.[1] This proposal uses a technology that has been operating successfully worldwide since the early 1990s. After preliminary analysis, however, PJM appeared to dismiss further study of this project for inclusion into the constructability assessment.

DHV believes that PJM should properly evaluate DHV's Project 1A proposal, and also believes that the solution presented is the least-cost option with more than sufficient stability performance for the criteria specified. In addition, considering ancillary risks such as project schedule delays, project complexity, land acquisition, stakeholder opposition, siting and permitting, Project 1A is superior due to its simplicity of constructability. Therefore, DHV argues that this proposal provides the most value to PJM stakeholders and ratepayers while meeting the reliability requirements set forth by PJM and NERC. DHV strongly recommends that Project 1A be evaluated and considered since it is the best solution for the RTEP Artificial Island proposal window.

Proposal 1A Introduction

Proposal 1A consists of a new Static Var Compensator (SVC) and two Thyristor-Controlled Series Compensation devices (TCSCs) on two existing 500kV transmission circuits (Lines 5023 and 5024). A new 500kV switching station near New Freedom substation would contain all new SVC, TCSC, and associated components, with no additional transmission-line facilities required. After initial assessment, PJM modified DHV's initial Project 1A proposal increasing the 500/-250 MVAR SVC to a larger +750/-250 MVAR SVC. DHV notes that this increases Project 1A's cost by approximately $22 million. The SVC would operate based on local bus voltage, and the two TCSCs would operate independently based on the power flow monitored on each corresponding line using local measurements. No complicated coordinated controls or algorithms would be deployed in this proposal.

The TCSCs simply monitor local line flow and boost line compensation to 90% for a designed short-term duration of 2.5 seconds immediately following the fault clearing. This enables significant synchronizing torque by reducing the effective impedance of lines 5023 and 5024—effectively reducing the electrical distance between the new switching station and Artificial Island from 40-50 miles to 4-5 miles.

Expected costs for DHV's Project 1A proposal are in the range of $133-155 million. PJM selected ten proposals for further constructability review, with costs ranging from $216 million to $446 million. Following the initial assessment, PJM determined that all ten remaining proposal would require an SVC in addition to the submitted solution to meet the PJM Planning Criteria. The SVC component of each of the ten proposals represents an additional cost of approximately $80M to be included in the cost of each

[1] The proposal was initially submitted by Virginia Electric & Power Company (DVP), a pre-qualified Transmission Owner within PJM. Subsequent to its pre-qualification, DHV was identified as the entity proposing the technical solutions.

of the ten proposals. The addition of an SVC and resultant cost increase applicable to all ten proposals reinforces the case for fully evaluating Project 1A by PJM.

Technical Performance & Operational Experience

At its May 19, 2014 TEAC meeting, PJM stated that Project 1A's "stability performance is not as good as 230kV [and] 500kV options + SVC". PJM uses maximum swing-angle following the worst case critical contingency as a primary metric for stability performance. Table 1 below summarizes stability results for the critical contingency for each proposal. The information from the table is from PJM's own assessment and presented in previous TEAC meetings. The results highlight that the TCSC+SVC option outperforms the other proposals from a technical standpoint.

Table 1. PJM Stability Results - Maximum Angle Swing

Project ID	Project	SVC Location	Maximum Swing Angle
P2013_1-1A	TCSC + SVC (+750 Mvar)	Near New Freedom	88
P2013_1-5B-SVC	500 kV Line + SVC	Orchard	98
		New Freedom	102
P2013_1-2C-SVC	500 kV Line + SVC	Orchard	98
		New Freedom	101
P2013_1-1C-SVC	500 kV Line + SVC	Orchard	96
		New Freedom	99
P2013_1-4A-SVC	500 kV Line + SVC	Orchard	99
		New Freedom	102
P2013_1-5A-SVC	230 kV Line + SVC	Orchard	108
		New Freedom	112
P2013_1-2B-SVC	230 kV Line + SVC	Orchard	105
		New Freedom	109
P2013_1-2A-SVC	230 kV Line + SVC	Orchard	107
		New Freedom	112
P2013_1-1B	230 kV Line + SVC	Orchard	106
		New Freedom	110

Given that PJM has modeled an SVC with each of the ten proposed solutions without considering Project 1A further, it is evident that there may be hesitation regarding the use of TCSC technology in DHV's application. It is important to note the extensive operational experience with both SVC and TCSC technology in electric systems worldwide. TCSC applications have been operating successfully since 1992, including the use of TCSCs for maintaining post-contingency stability in the U.K., China, India and Brazil (DNV GL report). In addition, (static) series compensation is widely used throughout North America and in PJM; DHV has the benefit of extensive in-house expertise and years of experience with series compensation connecting its affiliate DVP's Bath County generating facility through compensated 500kV transmission circuits. In addition, DHV's affiliate DVP is currently commissioning two 500kV

SVCs approved by PJM in 2012, as well as three 230 kV STATCOMs to compensate for generation retirements. The TCSC and SVC technology are very similar in nature, as described in (DNV GL report), because both include the same primary components: 1) thyristor valve controls, 2) air core AC reactors, and 3) high voltage AC capacitors. This is technology that is proven and currently being approved and applied elsewhere in PJM today.

Risk Assessment

DHV applied to the Project 1A proposal the full complement of risk criteria proscribed by PJM for the selected ten projects, as detailed in Tables I thru V. Comparing the proposals against Project 1A, the following conclusions are drawn:

1. Permitting – Minimal permitting is required for the TCSC + SVC option due to its compact footprint. Project 1A requires significantly fewer permits, with minimal impact to wetlands and wildlife, no significant view-shed or impact on the public, no historic or scenic highway obstruction, and no Delaware River crossing. See Table V.

2. Right-of-Way – Project 1A requires no new right-of-way (RoW) because it is built adjacent to the existing transmission right of way and only requires cutting into the existing 5023 and 5024 lines. This significantly reduces risk of permitting delays, as well as public and stakeholder opposition. Combined with minimal permitting, Project 1A drastically minimizes risks for stakeholders, including at the local, state and federal levels.

3. Project Complexity – Project 1A is one of the simplest solutions in terms of modification of existing Bulk Electric System facilities. Additional breakers at Hope Creek and Red Lion are the only modification to existing facilities, with possible relay modifications. The absence of line crossings also simplifies this solution and is responsive to the space constraints at a number of facilities.

4. Project Schedule Risks – Minimal permitting, straightforward construction, no new right-of-way, and no long lead-time materials result in significantly reduced risks of not meeting project timelines and budget requirements. DHV, with support from its affiliates, is a leader in building new transmission facilities, meeting project requirements on time and under budget for extremely challenging projects. As mentioned above, DHV's affiliate DVP is currently commissioning two 500 kV SVCs at Mt. Storm and Mosby stations. These projects were approved by PJM in 2012 and will be in service for the summer of 2014, resulting in an approximately 24-month completion period from approval to in-service. It is reasonable to expect a similar completion period for Proposal 1A. Again, the TCSC portion of Proposal 1A uses the same technology configured in a series versus shunt manner.

5. Nuclear Regulatory Commission (NRC) – There have been a number of unfounded concerns raised about using FACTs technology near a nuclear plant. In fact, there are a number of benefits to the nuclear plant of the TCSC+SVC solution:

    - It meets all NPIR stability requirements.

- The TCSC/SVC will eliminate 2-5 years of tripping risk for the Salem units. With a three (3) year construction schedule, it will be the quickest path to eliminating the use of AI Cross Trip Scheme SPS.

- It is unlikely that for any option, an SVC can be sited on the Artificial Island. As stated in the DNV GL report the series capacitor compensation makes the SVC look about four miles away from the plant post event. This proximity will assist the SVC to quickly lift voltages to the plant safety systems to adequate levels.

Based on DHV's experience, there would be minimal concerns raised by the NRC regarding Project 1A. See Appendix A for more details.

Cost Assessment

Table 2 shows incremental costs of each project, excluding the SVC cost common to all projects. A more detailed description of the proposed and revised costs for each proposal is provided in (DNV GL report). Project 1A is increased by $22 million to account for the increased size requirement of the SVC, as modified by PJM. Removing the $80 million cost PJM estimated for these SVCs brings the incremental cost of the proposal 1A down to $75M to meet the reliability needs at Artificial Island. This is roughly one-third of the cost of any other transmission solution alternative proposed. In fact, project 4A in the table below is the lowest cost line proposal. This means to fully meet the reliability performance as required by the PJM RFP, project 4A will cost an additional $210 to $263 million above the SVC as compared to proposal 1A $75 million. This will be very difficult for stakeholders, and regulatory agencies to ignore.

Table 2. Project Cost ($M) of Proposal 1A versus alternatives excluding common SVC cost

Project cost ($M)

		PJM pre-selected [fully-reviewed] projects									
Estimate	1A	4A	5Aovh	5B	2C	1B	1C	7K	5Asub	2B	2A
Low	75	216	233	221	232	233	242	249	248	257	366
High		263	283	269	282	283	294	304	302	313	446

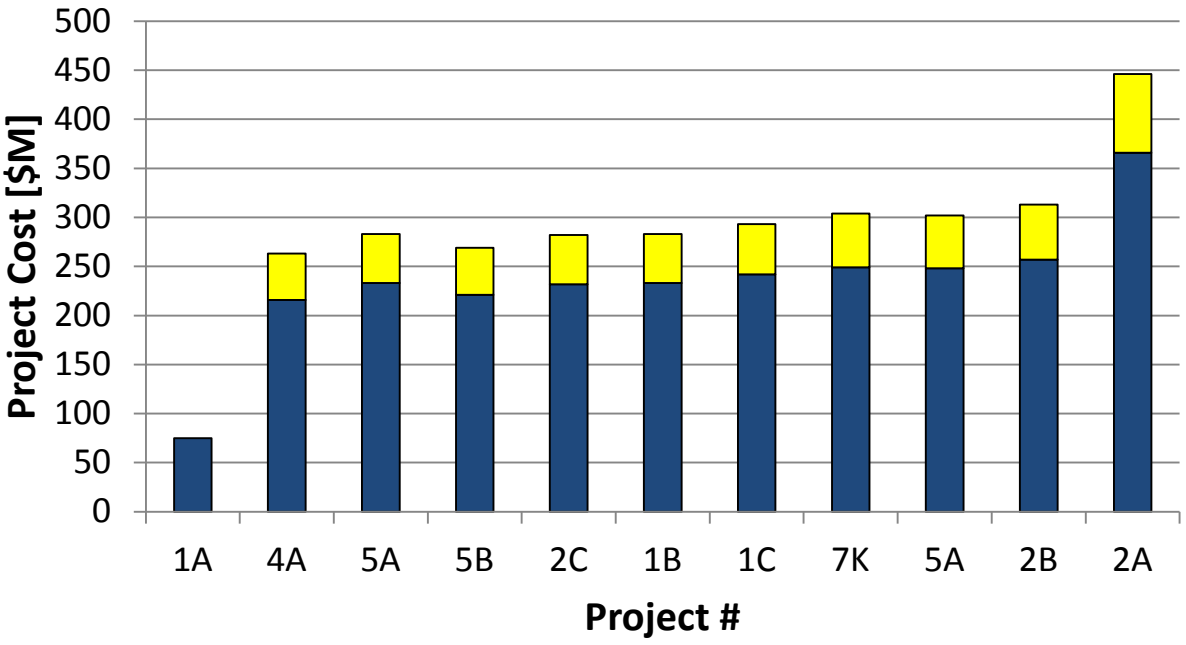

Figure 1. Project Cost ($M) of Proposal 1A versus alternatives excluding common SVC cost (yellow depicts contingency $)

Additional Documentation Included

Table I: Dominion Project 1A Comparison with Southern Line Crossing Options (Submarine)

Table II: Dominion Project 1A Comparison with Southern Line Crossing Options (Overhead)

Table III: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Salem)

Table IV: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Hope Creek)

Table V: Required Permits Comparison between Proposal 1A and the other ten Line proposals

Appendix A: Commentary on Nuclear Regulatory Commission Concerns

Table I: Dominion Project 1A Comparison with Southern Line Crossing Options (Submarine)

			Southern Crossing Lines (Submarine)		
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**LS Power 5A-Submarine Option**	**Transource 2B-North Cedar Creek**	**Transource 2A-Cedar Creek Expansion**
Technical Analysis	Stability	Max angle swing of 88 deg	Max angle swing range 80-120 deg, dependent on solution and SVC location		
	Thermal	Preliminary analysis indicates no thermal overloads	Preliminary analysis indicates no thermal overloads		
	Market Efficiency	Not studied	Approximate $92M cost savings over 15 years		
	Short Circuit	No overdutied breakers	Three overdutied 230kV breakers		No overdutied breakers
	NERC Cat D Cont				
Cost Factors	PJM Estimated Project Costs	Not provided	248-302	257-313	366-446
	PJM Est + SVC	Approx. 150	328-382	327-393	446-526
	Proposed Project Costs	130	148	165-208	213-269
	Proposed Total Cost + SVC	Approx. 150	228	245-288	293-349
	Market Efficiency	Not studied	Approximately $92 over 15 years		
	Outage Cost	500kV outage during 5023, 5024 cut-ins	230kV outage during substation cut-in	230kV outage during substation cut-in	230kV outage during substation cut-in
Project Schedule	Permitting	Minimal permits required	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits
	Construction	Not impacted by nesting seasons	Submarine cable installation requires specialized equipment; spawning/neesting seasons of endangered species may impact construction timeframes	Submarine cable installation requires specialized equipment; spawning/neesting seasons of endangered species may impact construction timeframes	Submarine cable installation requires specialized equipment; spawning/neesting seasons of endangered species may impact construction timeframes
	Long Lead Time Materials	Series capacitors and SVC	Submarine cable and auto-transformers	Submarine cable and auto-transformers	Submarine cable and auto-transformers

Table I: Dominion Project 1A Comparison with Southern Line Crossing Options (Submarine)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	LS Power 5A-Submarine Option	Transource 2B-North Cedar Creek	Transource 2A-Cedar Creek Expansion
Project Complexity	Line Crossings	None	None	None	None
	Outage Requirements	5023 and 5024 line cut-ins for TCSCs	New bay tie-in at Salem	Relocation of 5024 line at Salem	Relocation of 5024 line at Salem; Cedar Creek ring bus expansion
	Modification to Other Transmission Facilities	5023 and 5024 line cut-ins for TCSCs	Cutting the two 230kV lines into new Delaware substation; installing one new span on 5024 line.	Cutting the two 230kV lines into new Delaware substation; installing one new span on 5024 line.	Expanding Cedar Creek ring bus by two positions to bring in Salem line and existing Red Line to Cartanza line; installing one new span on 5024 line.
	Modification to Artificial Island Substations	Additional breakers at Hope Creeek	New bay and auto-transformer to south in Salem	New bay for 5024 line to south in Salem	New bay for 5024 line to south in Salem
	Modification of Red Lion Substation	Additional breaker	N/A	N/A	N/A
Right of Way and Land Acquisition	No Eminent Domain in Delaware	No new RoW required	1.5-3 miles of new RoW to acquire in Delaware	1.5-3 miles of new RoW to acquire in Delaware	1.5-3 miles of new RoW to acquire in Delaware
	New Right of Way Required	No new RoW required	1.5-3 miles of new RoW to acquire in Delaware	1.5-3 miles of new RoW to acquire in Delaware	1.5-3 miles of new RoW to acquire in Delaware
	Substation Land Required	New substation land near New Freedom in NJ	Acquired an option on substation location in Delaware	New substation land required in Delaware and NJ	New substation land required in Delaware and NJ

Table I: Dominion Project 1A Comparison with Southern Line Crossing Options (Submarine)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	LS Power 5A- Submarine Option	Transource 2B-North Cedar Creek	Transource 2A-Cedar Creek Expansion
Siting and Permitting	Wetlands Impact	Minimal wetlands impact	New route will allow flexibility	New route will allow flexibility	Impacts approximately 10 acres of forested wetlands
	Land Permitting	No major permit identified	No major permit identified	No major permit identified	No major permit identified
	Public Opposition Risk	No view-shed impact: minimal opposition to substation work (SVCs and TCSCs)	No view-shed impact: some opposition to any river crossing is expected	No view-shed impact: some opposition to any river crossing is expected	No view-shed impact: some opposition to any river crossing is expected
	Historic and Scenic Highway	None	New line parallels Delaware State Route 9	New line parallels Delaware State Route 9	N/A
	Delaware River Crossing	No river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing
Operational Impact	Artificial Island Facility Requirements	Possible relay updates/replacements at Hope Creek, Salem, and New Freedom. No expansion of control house(s) required.	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained
	Blackstart	No blackstart advantage	Additional access to blackstart resources	Additional access to blackstart resources	Additional access to blackstart resources
	Route Diversity	No additional route	New route	New route	New route
	Ongoing Maintenance	TCSC maintenance require bypass switching; SVC maintenance additional	Salt spray concern with proximity to Delaware river; auto-transformer maintenance may increase line outage frequency	Salt spray concern with proximity to Delaware river; auto-transformer maintenance may increase line outage frequency	Salt spray concern with proximity to Delaware river; auto-transformer maintenance may increase line outage frequency

Table II: Dominion Project 1A Comparison with Southern Line Crossing Options (Overhead)

			Southern Crossing Lines (Overhead)	
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**LS Power 5A-Overhead**	**Dominion 1B-500kV Overhead**
Technical Analysis	Stability	Max angle swing of 88 deg	Max angle swing range 80-110, dependent on solution and SVC lcoation	
	Thermal	Preliminary analysis indicates no thermal overloads	Preliminary analysis indicates no thermal overloads	
	Market Efficiency	Not studied	Approximate $92M cost savings over 15 years	
	Short Circuit	No overdutied breakers	Three overdutied 230kV breakers	
	NERC Cat D Cont			
Cost Factors	PJM Estimated Project Costs	Not provided	211-257	233-283
	PJM Est + SVC	Approx. 150	328-382	313-303
	Proposed Project Costs	130	116	133
	Proposed Total Cost + SVC	Approx. 150	196	213
	Market Efficiency	Not studied	Approximately $92 over 15 years	
	Outage Cost	500kV outage during 5023, 5024 cut-ins	230kV outage during substation cut-in	230kV outage during substation cut-in
Project Schedule	Permitting	Minimal permits required	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits
	Construction	Not impacted by nesting seasons	Spawning/nesting seasons of endangered species may impact construction timeframes	Spawning/nesting seasons of endangered species may impact construction timeframes
	Long Lead Time Materials	Series capacitors and SVC	Auto-transformers	Auto-transformers

Table II: Dominion Project 1A Comparison with Southern Line Crossing Options (Overhead)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	LS Power 5A- Overhead	Dominion 1B-500kV Overhead
Project Complexity	Line Crossings	None	None	Generator Lead Line
	Outage Requirements	5023 and 5024 line cut-ins for TCSCs	New bay tie-in at Salem	New tie-in at Salem will necessitate a unit outage; breaker installation may require multiple Salem outages
	Modification to Other Transmission Facilities	5023 and 5024 line cut-ins for TCSCs	Cutting the two 230kV lines into new Delaware substation	Cutting the two 230kV lines into new Delaware substation
	Modification to Artificial Island Substations	Additional breakers at Hope Creeek	New bay and auto-transformer to south in Salem	Installing two breakers into open middle bay in Salem
	Modification of Red Lion Substation	Additional breaker	N/A	N/A
Right of Way and Land Acquisition	No Eminent Domain in Delaware	No new RoW required	1.5-3 miles of new RoW to acquire in Delaware	1.5-3 miles of new RoW to acquire in Delaware
	New Right of Way Required	No new RoW required	1.5-3 miles of new RoW to acquire in Delaware	1.5-3 miles of new RoW to acquire in Delaware
	Substation Land Required	New substation land near New Freedom in NJ	Acquired an option on substation location in Delaware	New substation land required in Delaware

Table II: Dominion Project 1A Comparison with Southern Line Crossing Options (Overhead)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	LS Power 5A-Overhead	Dominion 1B-500kV Overhead
Siting and Permitting	Wetlands Impact	Minimal wetlands impact	New route will allow flexibility	New route will allow flexibility
	Land Permitting	No major permit identified	No major permit identified	No major permit identified
	Public Opposition Risk	No view-shed impact: minimal opposition to substation work (SVCs and TCSCs)	Creates a new view-shed impact and would become the southern-most aerial infrastructure on the Delaware River	Creates a new view-shed impact and would become the southern-most aerial infrastructure on the Delaware River
	Historic and Scenic Highway	None	New line parallels Delaware State Route 9	New line parallels Delaware State Route 9
	Delaware River Crossing	No river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing
Operational Impact	Artificial Island Facility Requirements	Possible relay updates/replacements at Hope Creek, Salem, and New Freedom. No expansion of control house(s) required.	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained
	Blackstart	No blackstart advantage	Additional access to blackstart resources	Additional access to blackstart resources
	Route Diversity	No additional route	New route	New route

Table II: Dominion Project 1A Comparison with Southern Line Crossing Options (Overhead)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	LS Power 5A-Overhead	Dominion 1B-500kV Overhead
	Ongoing Maintenance	TCSC maintenance require bypass switching; SVC maintenance additional	Salt spray concern with proximity to Delaware river; auto-transformer maintenance may increase line outage frequency	Salt spray concern with proximity to Delaware river; auto-transformer maintenance may increase line outage frequency

Table III: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Salem)

			Red Lion to Artificial Island Lines From Salem		
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**PHI/Exelon 4A-Red Lion to Salem**	**LS Power 5B-Red Lion to Salem**	**Transource 2C-Red Lion to Salem**
Technical Analysis	Stability	Max angle swing of 88 deg	Max angle swing range 77-102 deg, dependent on solution and SVC location		
	Thermal	Preliminary analysis indicates no thermal overloads	Preliminary analysis indicates no thermal overloads		
	Market Efficiency	Not studied	Approximate $57M cost savings over 15 years		
	Short Circuit	No overdutied breakers	No overdutied breakers		
	NERC Cat D Cont				
Cost Factors	PJM Estimated Project Costs	Not provided	216-263	221-269	232-282
	PJM Est + SVC	Approx. 150	296-343	301-349	312-362
	Proposed Project Costs	130	181	171	123-156
	Proposed Total Cost + SVC	Approx. 150	261	251	203-336
	Market Efficiency	Not studied	Approximately $57 over 15 years		
	Outage Cost	500kV outage during 5023, 5024 cut-ins	5015 outage estimated 30 days	5015 outage estimated 30 days	5015 outage estimated 14 days
Project Schedule	Permitting	Minimal permits required	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits
	Construction	Not impacted by nesting seasons	Spawning/nesting seasons of endangered species may impact construction timeframes	Spawning/nesting seasons of endangered species may impact construction timeframes	Spawning/nesting seasons of endangered species may impact construction timeframes
	Long Lead Time Materials	Series capacitors and SVC	None	None	None

Table III: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Salem)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	PHI/Exelon 4A-Red Lion to Salem	LS Power 5B-Red Lion to Salem	Transource 2C-Red Lion to Salem
Project Complexity	Line Crossings	None	5023, 5021k, 5024 lines	5015 and 5023 lines	5023 line
	Outage Requirements	5023 and 5024 line cut-ins for TCSCs	5015 line position changing at both ends; raising the three 500kV lines	Raising 5015 line and moving it to new position at Red Lion. Relocation of 5037 line at Salem; raising 5023 line.	Relocating 5024 and 5021 lines at Salem; new line crosses 5023 line
	Modification to Other Transmission Facilities	5023 and 5024 line cut-ins for TCSCs	Impacts detailed in other sub-criteria	Installing one new span on 5037 line	Use of existing 5021 for a number of spans and build a portion of 5021 along that length; installing one new span for 5024 line.
	Modification to Artificial Island Substations	Additional breakers at Hope Creeek	New bay to south in Salem	New bay for 5037 line to north in Salem	New bay for 5024 line to the south and relocate 5021 line in Salem
	Modification of Red Lion Substation	Additional breaker	Moving 5015 line into new ring bus position	Moving 5015 line into new ring bus position	Moving 5015 line into new ring bus position
Right of Way and Land Acquisition	No Eminent Domain in Delaware	No new RoW required	0.5 miles of RoW to expand in Delaware; land is coastal and under state jurisdiction	0.5 miles of RoW to expand in Delaware; land is coastal and under state jurisdiction	0.5 miles of RoW to expand in Delaware; land is coastal and under state jurisdiction
	New Right of Way Required	No new RoW required	Participants in the LDV agreement which governs 5015 RoW	Negotiate with LDV parties or individuals	Negotiate with LDV parties or individuals
	Substation Land Required	New substation land near New Freedom in NJ	None	None	None

Table III: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Salem)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	PHI/Exelon 4A-Red Lion to Salem	LS Power 5B-Red Lion to Salem	Transource 2C-Red Lion to Salem
Siting and Permitting	Wetlands Impact	Minimal wetlands impact	Impacts approximately 350 acres of forested wetlands	Impacts approximately 350 acres of forested wetlands	Impacts approximately 350 acres of forested wetlands
	Land Permitting	No major permit identified	USFWS RoW permits to cross Supawna National Wildlife Refuge required	USFWS RoW permits to cross Supawna National Wildlife Refuge required	USFWS RoW permits to cross Supawna National Wildlife Refuge required
	Public Opposition Risk	No view-shed impact: minimal opposition to substation work (SVCs and TCSCs)	View-shed minimized by proximity to the existing 5015; some opposition to any river crossing is expected	View-shed minimized by proximity to the existing 5015; some opposition to any river crossing is expected	View-shed minimized by proximity to the existing 5015; some opposition to any river crossing is expected
	Historic and Scenic Highway	None	N/A	N/A	N/A
	Delaware River Crossing	No river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing
Operational Impact	Artificial Island Facility Requirements	Possible relay updates/replacements at Hope Creek, Salem, and New Freedom. No expansion of control house(s) required.	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained
	Blackstart	No blackstart advantage	No blackstart advantage	No blackstart advantage	No blackstart advantage
	Route Diversity	No additional route	Parallels existing 5015 line	Parallels existing 5015 line	Parallels existing 5015 line

Table III: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Salem)

Criteria	Sub-Criteria	Dominion 1A- SVC + 2 TCSC	PHI/Exelon 4A-Red Lion to Salem	LS Power 5B-Red Lion to Salem	Transource 2C-Red Lion to Salem
	Ongoing Maintenance	TCSC maintenance require bypass switching; SVC maintenance additional	Salt spray concern with proximity to Delaware River	No impact	Salt spray concern with proximity to Delaware River

Table IV: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Hope Creek)

			Red Lion to Artificial Island Lines From Hope Creek			
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**Dominion 1C-Red Lion to Hope Creek**	**PSE&G 7K-Red Lion to Hope Creek**	**Dominion 1C-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**	**PSE&G 7K-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**
Technical Analysis	Stability	Max angle swing of 88 deg	Max angle swing range 77-102 deg, dependent on solution and SVC location			
	Thermal	Preliminary analysis indicates no thermal overloads	Preliminary analysis indicates no thermal overloads			
	Market Efficiency	Not studied	Approximate $57M cost savings over 15 years			
	Short Circuit	No overdutied breakers	No overdutied breakers			
	NERC Cat D Cont					
Cost Factors	PJM Estimated Project Costs	Not provided	242-294	249-304	211-257	211-257
	PJM Est + SVC	Approx. 150	322-374	329-384	328-382	328-382
	Proposed Project Costs	130	199	297	N/A	N/A
	Proposed Total Cost + SVC	Approx. 150	279	377	N/A	N/A
	Market Efficiency	Not studied	Approximately $57 over 15 years			
	Outage Cost	500kV outage during 5023, 5024 cut-ins	5015 outage estimated 40 days	5015 outage estimated 40 days	5015 outage estimated 14 days	5015 outage estimated 14 days
Project Schedule	Permitting	Minimal permits required	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits	Multiple permits req'd including CPCNs from two states and ACE permits

Table IV: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Hope Creek)

			Red Lion to Artificial Island Lines From Hope Creek			
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**Dominion 1C-Red Lion to Hope Creek**	**PSE&G 7K-Red Lion to Hope Creek**	**Dominion 1C-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**	**PSE&G 7K-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**
	Construction	Not impacted by nesting seasons	Spawning/nesting seasons of endangered species may impact construction timeframes	Spawning/nesting seasons of endangered species may impact construction timeframes	Spawning/nesting seasons of endangered species may impact construction timeframes	Spawning/nesting seasons of endangered species may impact construction timeframes
	Long Lead Time Materials	Series capacitors and SVC	None	None	None	None
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**Dominion 1C-Red Lion to Hope Creek**	**PSE&G 7K-Red Lion to Hope Creek**	**Dominion 1C-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**	**PSE&G 7K-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**
Project Complexity	Line Crossings	None	5015 line; aerial tie has multiple crossings	5015 line	None	None
	Outage Requirements	5023 and 5024 line cut-ins for TCSCs	Multiple 500kV outages to convert Red Lion ring bus to a breaker and a half scheme; new line crosses 5015 line; outages to support new Hope Creek to Salem tie	Multiple 500kV outages to convert Red Lion ring bus to breaker and a half scheme; nwee line crosses 5015 line; outages to support new Hope Creek to Salem tie; 5027 into new position at Hope Creek	5015 line position changing at Red Lion; new bay tie-in at Hope Creek	5015 line position changing at Red Lion; new bay tie-in at Hope Creek
	Modification to Other Transmission Facilities	5023 and 5024 line cut-ins for TCSCs	Impacts detailed in other sub-criteria	Impacts detailed in other sub-criteria	Impacts detailed in other sub-criteria	Impacts detailed in other sub-criteria

Table IV: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Hope Creek)

			Red Lion to Artificial Island Lines From Hope Creek			
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**Dominion 1C-Red Lion to Hope Creek**	**PSE&G 7K-Red Lion to Hope Creek**	**Dominion 1C-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**	**PSE&G 7K-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**
	Modification to Artificial Island Substations	Additional breakers at Hope Creeek	New bay in Hope Creek an new tie between Hope Creek and Salem	New bay in Hope and new tie between Hope Creek and Salem; moving 5037 into existing open bay at Hope Creek	New bay in Hope Creek	New bay in Hope Creek
	Modification of Red Lion Substation	Additional breaker	Rebuild substation as a double bus-double breaker scheme	Rebuidling substation as a breaker and a half scheme	Moving 5015 line into new ring bus position	Moving 5015 line into new ring bus position
Right of Way and Land Acquisition	No Eminent Domain in Delaware	No new RoW required	0.5 miles of RoW to expand in Delaware; land is coastal and under state jurisdiction	0.5 miles of RoW to expand in Delaware; land is coastal and under state jurisdiction	0.5 miles of RoW to expand in Delaware; land is coastal and under state jurisdiction	0.5 miles of RoW to expand in Delaware; land is coastal and under state jurisdiction
	New Right of Way Required	No new RoW required	Negotiate with LDV parties or individuals	Participants in the LDV agreement which governs 5015 RoW	Negotiate with LDV parties or individuals	Participants in the LDV agreement which governs 5015 RoW
	Substation Land Required	New substation land near New Freedom in NJ	None	None	None	None
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**Dominion 1C-Red Lion to Hope Creek**	**PSE&G 7K-Red Lion to Hope Creek**	**Dominion 1C-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**	**PSE&G 7K-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**
Siting and Permitting	Wetlands Impact	Minimal wetlands impact	Impacts approximately 350 acres of forested wetlands	Impacts approximately 350 acres of forested wetlands	Impacts approximately 350 acres of forested wetlands	Impacts approximately 350 acres of forested wetlands
	Land Permitting	No major permit identified	USFWS RoW permits to cross Supawna National Wildlife Refuge required	USFWS RoW permits to cross Supawna National Wildlife Refuge required	USFWS RoW permits to cross Supawna National Wildlife Refuge required	USFWS RoW permits to cross Supawna National Wildlife Refuge required

Table IV: Dominion Project 1A Comparison with Red Line to Artificial Island Lines (From Hope Creek)

			Red Lion to Artificial Island Lines From Hope Creek			
Criteria	**Sub-Criteria**	**Dominion 1A- SVC + 2 TCSC**	**Dominion 1C-Red Lion to Hope Creek**	**PSE&G 7K-Red Lion to Hope Creek**	**Dominion 1C-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**	**PSE&G 7K-Red Lion to Hope Creek (Remove HC-S 2nd Tie)**
	Public Opposition Risk	No view-shed impact: minimal opposition to substation work (SVCs and TCSCs)	View-shed minimized by proximity to the existing 5015; some opposition to any river crossing is expected	View-shed minimized by proximity to the existing 5015; some opposition to any river crossing is expected	View-shed minimized by proximity to the existing 5015; some opposition to any river crossing is expected	View-shed minimized by proximity to the existing 5015; some opposition to any river crossing is expected
	Historic and Scenic Highway	None	N/A	N/A	N/A	N/A
	Delaware River Crossing	No river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing	Numerous approvals and permits will be required for any Delaware river crossing
Operational Impact	Artificial Island Facility Requirements	Possible relay updates/replacements at Hope Creek, Salem, and New Freedom. No expansion of control house(s) required.	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained	Expansion at Salem needs to incorporate maintenance access to substation equipment; Salem is space constrained; control house access is also constrained	Land available to north of Hope Creek for expansion and control house has adequate space and access for expansion	Land available to north of Hope Creek for expansion and control house has adequate space and access for expansion
	Blackstart	No blackstart advantage	No blackstart advantage	No blackstart advantage	No blackstart advantage	No blackstart advantage
	Route Diversity	No additional route	Parallels existing 5015 line	Parallels existing 5015 line	Parallels existing 5015 line	Parallels existing 5015 line
	Ongoing Maintenance	TCSC maintenance require bypass switching; SVC maintenance additional	New gas-insulated bus tie line between Salem and Hope Creek may require more frequent maintenance	Limited physical access could lead to maintenance issues on the new tie line between Salem and Hope Creek	No impact	No impact

Table V: Required Permits Comparison between Proposal 1A and the other ten line proposals

The table below was created from the UC Synergetic, LLC study "Constructability Analysis of Artificial Island Delmarva Peninsula Project Proposals" dated April 30, 2014. The TCSC option was not a part of the constructability report. Dominion has made an evaluation of required permits. Below is a comparison of permit requirements. There are 56 permits required for the Southern Crossing options and 26 permits required for the TCSC/SVC option. The TCSC/SVC option avoids most of the most difficult permits which will challenge timely completion of any line option crossing the river. Additionally, for some permits which are common to both proposals, option 1A will face less challenges to obtain the permit because the TCSC/SVC has less impact.

Responsible Agency	Permit/Certificate/Clearance/Compliance	Required Permits Southern Crossing	Required Permits TCSC/SVC substation
	Federal		
Delaware River Basin Commission	Approval for construction crossing the Delaware River	Yes	No
USACE	Section 404 of the Clean Water Act	Yes	Yes
USACE	Section 10 of the Rivers and Harbors Act	Yes	No
USFWS and NOAA	Threatened & Endangered Species – Section 7 Consultation	Yes	Yes
USFWS	Migratory Bird Treaty Act (MBTA) & Bald and Golden Eagle Protect	Yes	Yes
NOAA/National Marine Fisheries Service and	Fish & Wildlife Coordination Act	Yes	No
NOAA/National Marine Fisheries Service	Mangnuson-Stevens Fisheries Conservation and Management Act	Yes	No
NOAA/NOS/OCRM	Coastal Zone Management Act coordination with states and cons	Yes	Yes
US Coast Guard	Permit/Authorization; Aid to Navigation	Yes	No
US EPA	National Env Policy Act (NEPA) - compliance	Yes	Yes
FAA Regional Office	Obstruction to Air Navigation	Yes	No
Advisory Council on Historic Preservation	Section 106 – National Historic Preservation Act Compliance	Yes	Yes
	New Jersey State		
New Jersey Board of Public Utilities	Review/Approval	Yes	No
NJ DEP – Historic Preservation Office (SHPO)	Section 106 – National Historic Preservation Act Compliance	Yes	Yes

Table V: Required Permits Comparison between Proposal 1A and the other ten line proposals

Responsible Agency	Permit/Certificate/Clearance/Compliance	Required Permits Southern Crossing	Required Permits TCSC/SVC substation
NJ DEP – Division of Land Use Regulation	Utility Line Crossing Permit (General Permit 2)	Yes	Yes
NJ DEP – Division of Land Use Regulation	Underground Utility Line (General Permit 7)	Yes	Yes
NJ DOT	Temporary Road Crossing Permit	Yes	Yes
NJ DEP – Division of Water Quality	Section 401 Water Quality Certification (WQC)	Yes	Yes
NJ DEP – Division of Water Quality	Section 402 New Jersey National Pollutant Discharge Elimination	Yes	Yes
NJ DEP – Division of Fish & Wildlife	Threatened & Endangered (T&E) Species Consultation	Yes	Yes
NJ DEP – Division of Land Use Regulation	Flood Hazard Area Permits	Yes	Yes
NJ DEP – Division of Land Use Regulation	Waterfront Development/Coastal Wetlands Permit	Yes	No
NJ DEP – Division of Land Use Regulation	Tidelands Conveyance – License or Grant	Yes	No
NJ DEP – Division of Land Use Regulation	Federal Coastal Zone Consistency Review/CAFRA permit	Yes	Yes
NJ DEP – Green Acres Program	Farmland and open space impacts/preservation	Yes	Yes
Cumberland Salem Conservation District	Soil Erosion and Sediment Control Plan/Construction Permit	Yes	No
	New Jersey Local		
County or Municipality (Salem Co; LAC Twp)	Road Crossing	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Hauling	Yes	Yes

Table V: Required Permits Comparison between Proposal 1A and the other ten line proposals

Responsible Agency	Permit/Certificate/Clearance/Compliance	Required Permits Southern Crossing	Required Permits TCSC/SVC substation
County or Municipality (Salem Co; LAC Twp)	Utility Permit	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Floodplain Development Permit	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Soil Erosion & Sediment Control Certification	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Zoning Permit	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Building Permit	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Electrical Permit	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Noise Regulation Compliance	Yes	Yes
County or Municipality (Salem Co; LAC Twp)	Dust Control Permit	Yes	Yes
	Delaware State		
Delaware Public Service Commission	Review/Approval	Yes	No
Delaware Dept of State – Division of Historical	Section 106 – National Historic Preservation Act Compliance	Yes	No
Delaware DNREC – Office of the Secretary	Coastal Zone Act Determination	Yes	No

Table V: Required Permits Comparison between Proposal 1A and the other ten line proposals

Responsible Agency	Permit/Certificate/Clearance/Compliance	Required Permits Southern Crossing	Required Permits TCSC/SVC substation
Delaware DNREC – Office of the Secretary	Federal Coastal Zone Consistency Review/Coordination	Yes	No
Delaware DNREC – Division of Watershed St	Sediment and Stormwater Management Plan	Yes	No
Delaware DNREC – Division of Water	Section 402 Delaware National Pollutant Discharge Elimination	Yes	No
Delaware DNREC – Division of Water	Wetlands and Subaqueous Lands Section Permit	Yes	No
Delaware DOT	Highway crossing, Occupancy and Road Turnout Permits	Yes	No
Delaware DNREC – Division of Fish &Wildlife	Threatened & Endangered (T&E) Species Consultation	Yes	No
Delaware Dept of Agriculture	Farmland and open space impacts/preservation	Yes	No
	Delaware Local		
County or Municipality (New Castle County)	Utility Permit	Yes	No
County or Municipality (New Castle County)	Floodplain Development Permit	Yes	No
New Castle County Soil Conservation District	Soil Erosion & Sediment Control Certification	Yes	No
County or Municipality (New Castle County)	Zoning Permit	Yes	No
County or Municipality (New Castle County)	Building Permit	Yes	No
County or Municipality (New Castle County)	Electrical Permit	Yes	No
County or Municipality (New Castle County)	Noise Regulation Compliance	Yes	No

Table V: Required Permits Comparison between Proposal 1A and the other ten line proposals

Responsible Agency	Permit/Certificate/Clearance/Compliance	Required Permits Southern Crossing	Required Permits TCSC/SVC substation
County or Municipality (New Castle County)	Dust Control Permit	Yes	No
County or Municipality (New Castle County)	Road Crossing	Yes	No
County or Municipality (New Castle County)	Hauling	Yes	No
Total Permits		56	26

Appendix A: Commentary on Nuclear Regulatory Commission Concerns

Consideration of Nuclear Issues

At the May 19, 2014 TEAC Artificial Island Technical Review meeting, representatives from the plant had concern about relying on FACTS technologies such as SVC's. The nuclear operating license and design basis (NRC filing) varies from plant to plant and is not related to the NERC TPL standards, or the PJM standards. Per NERC standard NUC-001 R1, the nuclear plant is required to disclose its Nuclear Plant Interface Requirements (NPIR) to PJM. These plant NPIRs are documented in PJM Manual 14B. Table 3 is an excerpt from the manual and shows the three tests that must be performed.

Table 3 Stability NPIRs

Hope Creek Stability NPIR	Salem Stability NPIR
Loss of Hope Creek Generator	Loss of One Salem Nuclear Unit
Loss of most critical Generating Unit on the Grid	Loss of most critical Generating Unit on the Grid
Loss of the Most Critical Transmission Line	Loss of the Most Critical Transmission Line

Note that there is no requirement to ensure stability for breaker failure or for maintenance outages. So, the stability NPIRs are not as demanding as the NERC/PJM standards. Therefore if PJM meets the NERC standards, NRC requirements are more than adequately met.

Federal regulation 10 CFR 50 Appendix A, General Design Criterion 17 (GDC-17) is the guiding principle for design and operation of offsite power sources to a nuclear plant. This criterion states, in part:

> *…Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable…*
>
> *Provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.*

One alleged reason that the Dominion's TCSC/SVC option 1A was discarded was that "we need another outlet." As can be seen from the GDC-17 regulations above, a nuclear plant only needs two circuits. Both Salem and Hope Creek already have three circuits feeding their plants.

Not all changes in a nuclear plant require NRC approval. For instance, replacing the generator's automatic voltage regulator (AVR) or installing a power system stabilizer (PSS) does not require NRC

approval, even though both of these enhance angular stability. Note however that Dominion's studies have shown no adverse interactions between the plant control systems and the TCSC/SVC.

Dominion's 1A option is the cheapest solution to meet the NERC reliability requirements. It also is sufficient to meet the requirements of the nuclear plants' design basis. If either nuclear plant wants something more (i.e. a line option) than what is required to meet the NERC/PJM standards then the plant MUST pay the incremental increased cost of that option versus the TCSC+SVC solution. Per manual 14B, section G.9.2 Nuclear Station Testing (page 117):

> *The nuclear owner will be responsible for reinforcements necessary to comply with criteria that are specific to the Nuclear Plant and that are more stringent than the standard PJM and Transmission Owner tests.*

There are a number of benefits to the nuclear plant of the TCSC+SVC solution.

- It meets all NPIR stability requirements
- The TCSC/SVC will eliminate 2-5 years of tripping risk for the Salem units. With a three (3) year construction schedule, it will be the quickest path to eliminating the use of AI Cross Trip Scheme SPS. Although the consultants for the line constructability estimated between five (5) and 5.5 years to construct a line solution, it could take as long as eight (8) years.
- It is unlikely that for any option, an SVC can be sited on the Artificial Island. As stated in the DNV GL report[2] the series capacitor compensation makes the SVC look about four miles away from the plant post event. This proximity will assist the SVC to quickly lift voltages to the plant safety systems to adequate levels.

[2] Jeffrey Palermo, Gregory F. Reed, "Project 1A: Application to Artificial Island Area System Performance," DNV GL report, June 2, 2014.