#Q48 Calvert Cliffs 1640 MW

Generator Interconnection

This analysis was completed to assess the reliability impact for a new generator interconnecting to the PJM System as a Capacity Resource.

Network Impacts

The **#Q48 project was studied as an injection of 1640 MW (capacity) into the Calvert Cliffs 500 kV station.** Project #Q48 was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

Generator Deliverability
No problems identified.

Multiple Facility Contingency
No problems identified.

Short Circuit

Pepco Zone

- Short circuit analysis indicates a total of thirty six 230 kV breakers are overdutied as a result of Q48 generation addition. At Oak Grove 230 kV substation, 13 breakers are overdutied and will require replacement by 63 ka breakers. At Chalk Point 230 kV substation, 23 breakers are overdutied and will require replacement by 80 ka breakers. Four of the 230 kV breakers at Chalk Point are owned by Mirant.

BG&E Zone

- Five 500 kV breakers at Calvert Cliff (Existing) station and Four 230 kV breakers at Waugh Chapel were determined to be overdutied as a result of Q48 generation addition.

Dominion Zone

- The 230 kV Ox L242 and Possum Point SC192 breakers were found to be overdutied.

New System Reinforcements
Breaker replacements – see Attachment #1 for details.

Pepco Zone

- Pepco's preliminary cost estimate to replace each of the 13 breakers at Oak Grove to 63 ka breakers is approximately $1.5 million, and the cost to replace each of

the 23 breakers at Chalk Point to 80 ka breakers is $2.0 million for a total cost of **$65.5 Million** .

- With Pepco's present capabilities, Pepco estimates the number of breakers that can be changed out in one year is approximately four. (Work in Spring and Fall only), therefore the replacement of 36 breakers will take approximately **9 years**.

BG&E Zone

- Calvert Cliff (Existing) station 500 kV breakers 21, 22, 23, 61 and 62 can be replaced at an estimated cost of **$3.5M**.
- Waugh Chapel 230 kV breakers 24, 25, 39 and 42 can be replaced at an estimated cost of **$2.0M**.
- The Calvert Cliffs and Waugh Chapel breakers can be replaced concurrently during an 18 month timeframe.

Dominion Zone

- Replacement of the Ox L242 breaker is estimated to cost $305,000, and replacement of the Possum Point SC192 breaker is estimated to cost $400,000.
- Both breakers can be replaced in **18 months**.

Contribution to Previously Identified Overloads

None.

Note about N-2 (e.g. maintenance outage) contingencies:

The current generator deliverability test is not performed for N-2 "maintenance outage" contingencies (one facility out of service, readjustment of the system, followed by an N-1 contingency). However, the Interconnection Customer may want to consider upgrades to allow operation for maintenance conditions where otherwise some generation may be curtailed. **Since this is not a required reliability upgrade responsibility for the generator interconnection, the Interconnection Customer must submit a "Transmission Interconnection Request" in order to get this transmission work completed.**

Pepco's analysis for N-2 contingencies of one Calvert Cliffs—Waugh Chapel 500 kV circuit followed by the other parallel 500 kV circuits indicated overloads on Chalk Point - Calvert Cliffs 500 kV circuit, Chalk Point 500/230 kV transformer, Brighton - Doubs 500 kV and other 230 kV overloads at Chalk Point - Oak Grove and Oak Grove - Burtonsville circuits. These overloads ranged from 137% to 107%.

In order to remedy the above situation (i.e. prevent potential curtailment of some generation during maintenance outages) the addition of a 500 kV circuit from Chalk Point – Calvert Cliffs 500 kV is required or a special relay scheme that would trip the appropriate amount of Calvert Cliffs generation for the outage of the Calvert Cliffs—Waugh Chapel 500 kV circuit. Also, without the additional 500 kV circuit, maintenance of Calvert Cliff—Waugh Chapel 500 kV circuit or the Calvert Cliffs—Chalk Point 500 kV circuit may require an curtailment of an appropriate amount of Calvert Cliffs generation during the transmission maintenance duration.

ATTACHMENT #1

(Q48 Breaker Upgrade Requirement Details)

Station	Voltage	T.O.	Breaker	Int Rating Amps	Rating Basis	Calculation Method	Calculated Short Circuit Current				Upgrade Cost	Upgrade Time	Upgrade Type
							Before Q48		After Q48				
							3-phase	Ph-Gnd	3-phase	Ph-Gnd			
Oak Grove	230kV	PEPCO	2B	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	4A	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	6A	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	6C	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	7A	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	7C	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	9A	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	9B	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	9C	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	10A	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	10C	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	13A	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Oak Grove	230kV	PEPCO	13B	45243.5	Symm	IEEE C37.10	45089	38498	45753.9	38757	$1,500,000	note 1	Replace with 63kA breaker
Chalk Point	230kV	PEPCO	1A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	1B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	2A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$1,500,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	2B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$1,500,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	2C	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$1,500,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	3A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	3B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	3C	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	4A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	4B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	5A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	5B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	6A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	6B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker

Note 1 About 4 of 36 PEPCO breakers can be replaced per year. Total replacement time for 36 breakers is approximately 9 years.

Note 2 These 2 breakers can be replaced concurrently in a 9 month timeframe

Note 3 These 9 breakers can be replaced concurrently in an 18 month timeframe

Station	Voltage	T.O.	Breaker	Int Rating Amps	Rating Basis	Calculation Method	Calculated Short Circuit Current				Upgrade Cost	Upgrade Time	Upgrade Type
							Before Q48		After Q48				
							3-phase	Ph-Gnd	3-phase	Ph-Gnd			
Chalk Point	230kV	PEPCO	7B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	8A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	8B	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	7A	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	1C	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	4C	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	5C	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	6C	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	PEPCO	7C	63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	Mirant		63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	Mirant		63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	Mirant		63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Chalk Point	230kV	Mirant		63000	Symm	IEEE C37.10	61530	62417.5	62587	63646.3	$2,000,000	note 1	Replace with 80kA breaker
Ox	230kV	Dominion	L242	40000	Symm	IEEE C37.10	38885	34777	40263.3	35975	$305,000	9 mos.[2]	Replace with 63kA breaker
Possum Point	230kV	Dominion	SC192	42800	Symm	IEEE C37.10	39705	41701	40792	42823	$400,000	9 mos.[2]	Replace with 63kA breaker
Calvert Cliffs	500kV	BG&E	22	55769.4	Total I	IEEE Std. C37.5	30987	31810	37720	55814	$700,000	18 mos[3]	Replace with 63kA breaker
Calvert Cliffs	500kV	BG&E	41	55769.4	Total I	IEEE Std. C37.5	30987	31810	37720	55814	$700,000	18 mos[3]	Replace with 63kA breaker
Calvert Cliffs	500kV	BG&E	43	55769.4	Total I	IEEE Std. C37.5	30987	31810	37720	55814	$700,000	18 mos[3]	Replace with 63kA breaker
Calvert Cliffs	500kV	BG&E	61	51999.6	Total I	IEEE Std. C37.5	30987	31810	37720	55814	$700,000	18 mos[3]	Replace with 63kA breaker
Calvert Cliffs	500kV	BG&E	62	51999.6	Total I	IEEE Std. C37.5	30987	31810	37720	55814	$700,000	18 mos[3]	Replace with 63kA breaker
Waugh Chapel	230kV	BG&E	25	75600.3	Total I	IEEE Std. C37.5	57038	45868	77214.3	46704	$400,000	18 mos[3]	Replace with 80kA breaker
Waugh Chapel	230kV	BG&E	24	75600.3	Total I	IEEE Std. C37.5	57038	45868	76474.8	46704	$400,000	18 mos[3]	Replace with 80kA breaker
Waugh Chapel	230kV	BG&E	39	75600.3	Total I	IEEE Std. C37.5	57763	45837	76474.9	47065	$400,000	18 mos[3]	Replace with 80kA breaker
Waugh Chapel	230kV	BG&E	42	75600.3	Total I	IEEE Std. C37.5	58730	47168	76150.9	48235	$400,000	18 mos[3]	Replace with 80kA breaker

Note 1 About 4 of 36 PEPCO breakers can be replaced per year. Total replacement time for 36 breakers is approximately 9 years.

Note 2 These 2 breakers can be replaced concurrently in a 9 month timeframe

Note 3 These 9 breakers can be replaced concurrently in an 18 month timeframe