Generation Interconnection
Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue
Position X3-004

Essex 230 kV

November 2012

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Pursuant to this Interconnection Request, Queue position X3-004, Hess NEC, LLC ("Hess") is proposing to uprate its proposed combined cycle natural gas plant, under Queue position T107, by 35 MW. This generator will be located in Essex County, NJ. This Interconnection Request was studied as 35 MW Energy (35 MW Capacity) resource interconnecting into the Public Service Electric and Gas Company ("PSE&G") area. Hess has proposed in-service date is for May 2015 and requests a backfeed date of July 2014.

X3-004 was studied with the understanding that Hess is entering into a transaction to purchase Capacity Interconnection Rights ("CIRs") from a third party who has Essex substation CIRs available for sale. In the event the CIR transaction is not accepted by the Federal Energy Regulatory Commission or otherwise is not effectuated, Hess understands that PJM reserves the ability to restudy this Interconnection Request to determine if there are any needed upgrades to accommodate this request.

Point of Interconnection

X3-004 will interconnect with the PSE&G at the Essex 230 kV substation as shown in figure 1.

Attachment Facilities

Attachment Facilities are being constructed in accordance with the T107 ICSA.

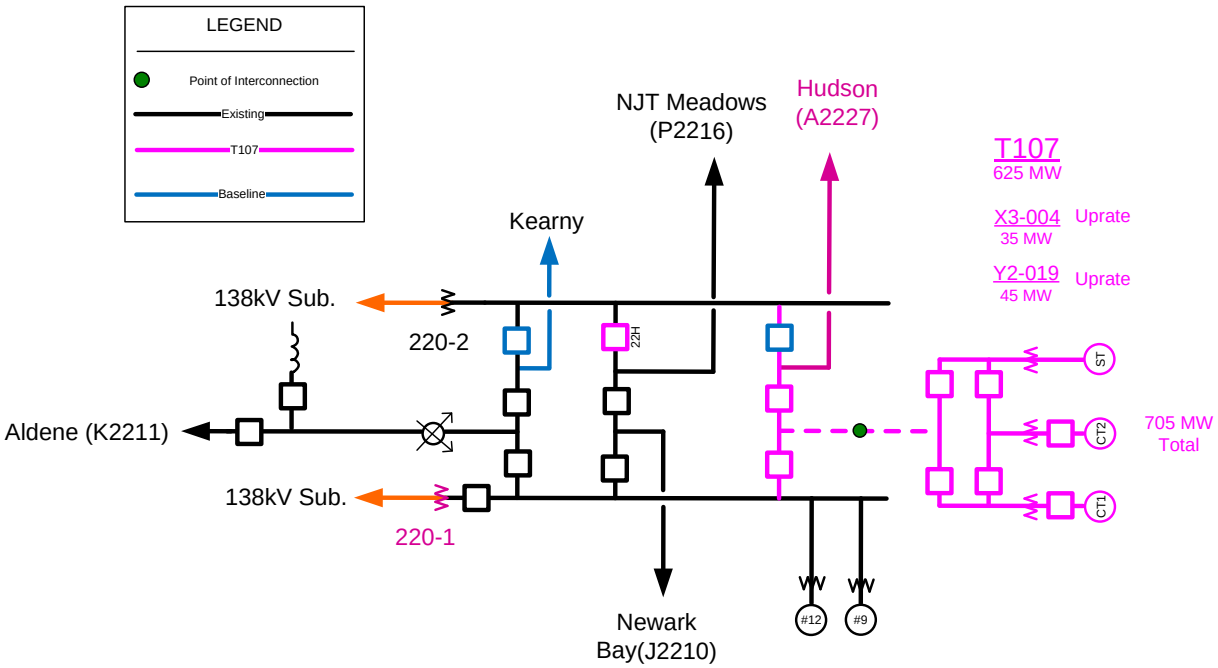
Direct Connection Cost Estimate

Detailed Direct Connection cost estimates can be found in the T107 Facilities Study.

Revenue Metering and SCADA Requirements

Revenue Metering requirements are detailed the T107 ISA and ICSA.

Essex 230 kV



Note: The Point of Interconnection (POI) shall be at the terminals of the pothead rack for the radial transmission cable constructed by Hess for the generating site to the Essex Switching Station.

Figure 1. Single Line Diagram

While the study modeled the retirement of Essex 12 and the transfer of its CIRs to Hess NEC, the one-line diagram will not reflect those changes until the CIR transaction is final.

Network Impacts

The Queue Project X3-004 was studied as a 35 MW (Capacity 35 MW) injection into the Essex 230 kV Substation in the PSE&G area. The X3-004 Interconnection Request was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:[1]

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None

Multiple Facility Contingency

(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

None

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

Short Circuit

(Summary of impacted circuit breakers)

None

Steady-State Voltage Requirements

(Summary of VAR requirements based upon the results of the steady-state voltage studies)

None

Stability and Reactive Power Requirement

(Summary of VAR requirements based upon the results of the dynamic studies.)

None – see Appendix I attached at the end of this report

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

[1] As noted in the General section of this report concerning the CIR transaction that is contemplated. As noted, if that transaction is not effectuated, PJM reserves the ability to conduct a restudy to determine if there are any network impacts.

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

As a result of the aggregate energy resources in the area, no violations were identified.

Appendix 1

Transient Stability Study

X3-004/Y2-019 (Essex 230 kV)

10/26/2012

Description

Under PJM Queue position T107, Hess proposed a new, 675 MW combined cycle natural gas plant interconnecting to the existing Essex 230 kV substation. This generating plant comprises three generators. The queue projects X3-004 and Y2-019 will upgrade the total maximum gross output of the generating plant to 755 MW.

Stability analysis for the X3-004 and Y2-019 Interconnection Requests was performed at 2015 light load conditions. The range of contingencies evaluated was limited to that necessary to assess compliance with the applicable criteria. Simulation time was limited to no more than 15 seconds for all faults.

Three fault types were considered in this study:

- Type A: Three-phase faults (3ph) with primary clearing time
- Type B: Stuck breaker fault cleared with backup clearing time
- Type C: Zone 2 faults cleared with secondary protection

Specific fault descriptions and breaker clearing times used for this study are provided in Appendix A.

Results

Transient Stability**:** For all cases studied, transient stability is maintained with all monitored machines remaining in synchronism.

Voltage Recovery: Under all contingencies, the voltage levels returned to normal for all cases following the fault clearance. Hence, no transient stability issues were concluded.

Steady State Stability: All oscillations stabilized within 15 seconds and were in compliance with the damping ratio criteria.

The maximum angle deviations for all three fault types are shown in Tables I - III.

Table I. Maximum angle deviation for type A faults

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1A	274	217076	1	42.84	38.12	0.2917
2A	275	217077	1	53.33	46.52	0.3292
3A	273	217065	1	41.97	27.25	0.3500
4A	275	217077	1	53.33	23.62	0.3250
5A	275	217077	1	53.33	23.68	0.3250
6A	291	217146	1	48.41	43.20	0.2500
7A	276	217078	1	51.61	38.03	0.3042
8A	291	217146	1	48.41	44.31	0.2542
9A	291	217146	1	48.41	43.97	0.2542
10A	291	217146	1	48.41	43.58	0.2542
11A	295	218307	1	37.31	27.90	0.3000
12A	295	218307	1	37.31	27.54	0.3000
13A	291	217146	1	48.41	30.86	0.2500
14A	291	217146	1	48.41	30.79	0.2500
15A	285	217118	1	68.96	32.77	0.5084
16A	285	217118	1	68.96	31.00	0.4959
17A	281	217112	1	60.48	34.08	0.3667
18A	281	217112	1	60.48	34.99	0.3709
19A	281	217112	1	60.48	34.94	0.3709
20A	281	217112	1	60.48	34.95	0.3709
21A	281	217112	1	60.48	36.48	0.3792

Table II. Maximum angle deviation for type B faults

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1B	274	217076	1	42.84	36.47	0.4292
2B	275	217077	1	53.33	11.17	0.7376
3B	273	217065	1	41.97	16.66	0.4625
4B	275	217077	1	53.33	13.35	0.4417
5B	275	217077	1	53.33	13.45	0.4417
6B1	276	217078	1	51.61	47.99	0.4334
6B2	276	217078	1	51.61	48.23	0.4375
6B3	276	217078	1	51.61	47.82	0.4334
6B4	276	217078	1	51.61	47.91	0.4334
6B5	276	217078	1	51.61	47.70	0.4334
7B1	275	217077	1	53.33	48.88	0.4750
7B2	275	217077	1	53.33	48.38	0.8292
8B1	276	217078	1	51.61	48.26	0.4334
8B2	276	217078	1	51.61	48.17	0.4334
9B1	275	217077	1	53.33	49.54	0.4792
9B2	275	217077	1	53.33	49.89	0.4792
10B1	275	217077	1	53.33	48.58	0.4750
10B2	275	217077	1	53.33	48.95	0.4792
11B1	295	218307	1	37.31	20.46	0.4209
11B2	295	218307	1	37.31	20.47	0.4209
12B1	295	218307	1	37.31	17.27	0.4084
12B2	295	218307	1	37.31	17.35	0.4084
13B1	285	217118	1	68.96	31.44	0.5709

Table II. Maximum angle deviation for type B faults

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
13B2	285	217118	1	68.96	31.44	0.5709
14B1	285	217118	1	68.96	33.30	0.5834
14B2	285	217118	1	68.96	34.03	0.5917
15B1	285	217118	1	68.96	36.72	0.5917
15B2	285	217118	1	68.96	36.89	0.5959
16B	285	217118	1	68.96	36.57	0.5959
17B1	281	217112	1	60.48	36.22	0.4750
17B2	281	217112	1	60.48	36.27	0.4750
18B	281	217112	1	60.48	39.87	0.4834
19B	281	217112	1	60.48	39.65	0.4834
20B1	281	217112	1	60.48	39.18	0.4834
20B2	281	217112	1	60.48	39.15	0.4834
21B	285	217118	1	68.96	35.98	0.5750

Table III. Maximum angle deviation for type C faults

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
7C	275	217077	1	53.33	31.13	0.5792
8C	275	217077	1	53.33	36.89	0.5584
9C	305	903583	1	7.364	-19.77	9.5966
10C	298	292143	3	69.83	-17.15	1.5960
11C	305	903583	1	7.364	-20.95	9.9924

Table III. Maximum angle deviation for type C faults

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
12C	305	903583	1	7.364	-23.52	9.9924
13C	285	217118	1	68.96	26.89	0.6417
17C	285	217118	1	68.96	27.81	0.6459
18C	305	903583	1	7.364	-23.15	9.9924
19C	305	903583	1	7.364	-19.92	9.9924
20C	305	903583	1	7.364	-16.92	9.9924

Note: While the stability analysis has been performed at extreme system conditions, there is a potential that evaluation at a different level of generator MW and/or MVAR output at different system load levels and operating conditions may disclose unforeseen stability problems. The regional reliability analysis routinely performed to test all system changes will include one such evaluation. Any problems uncovered in that or other operating or planning studies will need to be resolved.

Moreover, when the proposed generating station is designed and plant specific dynamics data for the plant and its controls are available, and if it is different than the data provided for this study, a transient stability analysis at a variety of expected operating conditions using the more accurate data shall be performed to verify impact on the dynamic performance of the system. As more accurate or unit specific dynamics data for the proposed facility, as well as plant layout become available, it must be forwarded to PJM.

APPENDIX A

X3-004

(Essex 230 kV)

A.1) POWER FLOW CONDITIONS

2015 Light Load Base Case

A.2) BREAKER CLEARING TIMES (CYCLES)

Table A.1. PSEG Clearing Times (Cycles)

Station	Primary (3ph/slg)	Stuck Breaker (Total)	Zone 2 (Total)	Re-closing
500 kV	4	16	4	N/A
230 kV	5	17	30	N/A
138 kV	6	18	30	N/A

A.3) NETWORK CONDITIONS

All facilities in service (base case)

A.4) FAULTS CONSIDERED

Essex 138 kV

1a 3ph fault @ Essex 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Essex-Newark 138 kV Ckt-1

Essex Unit #11

Newark 138 kV

1b slg fault @ Essex 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Newark 138 kV

Breaker Failure

slg fault @ Essex 138 kV

Fault cleared within 138 kV breaker backup clearing time

Loss of: Essex - Newark 138 kV Ckt-1

Essex Unit #11

Essex 230/138 kV transformer #2

Essex 138/26 kV transformer #2

2a 3ph fault @ Essex 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Essex-ECRRF 138 kV Ckt-1

ECRRF Unit #1 (Not explicitly modeled)

Essex Unit #10

2b slg fault @ Essex 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Essex-ECRRF 138 kV Ckt-1

ECRRF Unit #1 (Not explicitly modeled)

Breaker Failure

slg fault @ Essex 138 kV

Fault cleared within 138 kV breaker backup clearing time

Loss of: Essex 230/138 kV transformer #1

Essex 138/26 kV transformer #1

Foundry 138 kV

3a 3ph fault @ Foundry 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Foundry-Newark 138 kV Ckt-1

Foundry 138/13 kV transformer #1

Newark 138/13 kV transformer #2

3b slg fault @ Foundry 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Foundry-Newark 138 kV Ckt-1

Newark 138/13 kV transformer #2

Breaker Failure

slg fault @ Essex 138 kV

Fault cleared within 138 kV breaker backup clearing time

Loss of: Foundry 138 kV

Newark 138 kV

4a 3ph fault @ Newark 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Newark - Federal Square 138 kV Ckt-1

Federal Square 230/13 kV transformer #1

Newark 138 kV Bus #3

4b slg fault @ Newark 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Newark - Federal Square 138 kV Ckt-1

Federal Square 230/13 kV transformer #1

Breaker Failure

slg fault @ Newark 138 kV

Fault cleared within 138 kV breaker backup clearing time

Loss of: Newark 138 kV

5a 3ph fault @ Newark 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Newark - Dormus Place 138 kV Ckt-1

Dormus Place 138/13 kV transformer #2

Dormus Place 138/13 kV transformer #4

Newark 138/13 kV transformer #1

5b slg fault @ Newark 138 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Newark - Dormus Place 138 kV Ckt-1

Dormus Place 138/13 kV transformer #2

Dormus Place 138/13 kV transformer #4

Breaker Failure

slg fault @ Newark 138 kV

Fault cleared within 138 kV breaker backup clearing time

Loss of: Newark 138 kV

Essex 230 kV

6a 3ph fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex 230/138 kV transformer #1

6b1 slg fault @ Essex 230 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Essex 230/138 kV transformer #1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - Aldene 230 kV Ckt-1

6b2 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex 230/138 kV transformer #1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - Kearney 230 kV ckt 1

6b3 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex 230/138 kV transformer #1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - NJT Meadows 230 kV ckt 1

6b4 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex 230/138 kV transformer #1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - Hudson 230 kV ckt 1

6b5 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex 230/138 kV transformer #1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - Newark Bay 230 kV ckt 1 & Units

7a 3ph fault @ Essex 230kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex-Kearny-NJT Meadows 230 ckt 1

Kearny CTs

NJT Meadows 230/13 kV transformer 1

7b1 slg fault @ Essex 230kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Kearny-NJT Meadows 230 ckt 1

NJT Meadows 230/13 kV transformer 1

Breaker Failure

slg fault @ Essex 230kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex-Kearny (217087) 230 kV ckt 1

Kearny CTs

Essex- 230/138 kV transformer #1

7b2 slg fault @ Essex 230kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Kearny-NJT Meadows 230 ckt 1

NJT Meadows 230/13 kV transformer 1

Breaker Failure

slg fault @ Essex 230kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex-Kearny (217087) 230 kV ckt 1

Kearny CTs

Essex-Aldene 230 kV ckt 1

Essex Unit #112

7c slg fault @ 80% of Essex-NJT Meadows 230 kV ckt 1

NJT Meadows breaker tripped within 230 kV primary time

Essex breakers tripped within 230 kV secondary time

Loss of: Essex-Kearny-NJT Meadows 230 ckt 1

Kearny CTs

NJT Meadows 230/13 kV transformer 1

8a 3ph fault @ Essex 230kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex-Kearny (new) 230 ckt 1

8b1 slg fault @ Essex 230kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex-Kearny (new) 230 ckt 1

Breaker Failure

slg fault @ Essex 230kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex- 230/138 kV transformer #1

8b2 slg fault @ Essex 230kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex-Kearny (new) 230 ckt 1

Breaker Failure

slg fault @ Essex 230kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - Newark Bay 230 kV ckt 1 & Units

8c slg fault @ 80% of Essex-Kearny (new) 230 ckt 1

Kearny breakers tripped within 230 kV primary time

Essex breakers tripped within 230 kV secondary time

Loss of: Essex-Kearny (new) 230 ckt 1

9a 3ph fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex - Aldene 230 kV ckt 1

15th Street

Stanley Terrace 230 kV

9b1 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Stanley Terrace - Aldene 230 kV ckt 1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - Aldene 230 kV ckt 1

15th Street

Essex 230/138 kV transformer #1

Essex Unit #11

9b2 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Stanley Terrace - Aldene 230 kV ckt 1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex - Aldene 230 kV ckt 1

15th Street

Essex - NJT Meadows 138 kV Ckt-1

9c slg fault @ 80% of Essex - Aldene 230 kV ckt 1

Kearny breakers tripped within 230 kV primary time

Aldene breaker tripped within 230 kV secondary time

Loss of: Essex - Aldene 230 kV ckt 1

15^{th} Street

Stanley Terrace 230 kV

10a 3ph fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex - Hudson 230 kV ckt 1

10b1 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex - Hudson 230 kV ckt 1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Exxex Unit #9

10b2 slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Essex - Hudson 230 kV ckt 1

Breaker Failure

slg fault @ Essex 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Essex 230/138 kV transformer #1

10c slg fault @ 80% of Essex - Hudson 230 kV ckt 1

Hudson breakers tripped within 230 kV primary time

Essex breakers tripped within 230 kV secondary time.

Loss of: Essex - Hudson 230 kV ckt 1

Aldene 230 kV

11a 3ph fault @ Aldene 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Aldene - Westfield 230 kV ckt 1

Westfield 230/13 kV Transformer #2

Aldene 230/26 kV Transformer #3

11b1 slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Aldene - Westfield 230 kV ckt 1

Westfield 230/13 kV Transformer #2

Breaker Failure

slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Aldene - Stanley Terrace 230 kV ckt 1

Aldene 230/26 kV Transformer #3

11b2 slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Aldene - Westfield 230 kV ckt 1

Westfield 230/13 kV Transformer #2

Breaker Failure

slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Aldene 230/13 kV Transformer #20

Aldene 230/26 kV Transformer #3

11c slg fault @ 80% of Aldene - Westfield 230 kV ckt 1

Westfield breaker tripped within 230 kV primary time

Aldene breakers tripped within 230 kV secondary time

Loss of: Aldene - Westfield 230 kV ckt 1

Westfield 230/13 kV Transformer #2

Aldene 230/26 kV Transformer #3

12a 3ph fault @ Aldene 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Aldene - Warinaco 230 kV ckt 1

Warinaco 230/13 kV Transformer #2

Aldene 230/26 kV Transformer #1

12b1 slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Aldene - Warinaco 230 kV ckt 1

Warinaco 230/13 kV Transformer #2

Breaker Failure

slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Aldene 230/13 kV Transformer #10

Aldene 230/138 kV Transformer #1

Aldene 230/26 kV Transformer #1

12b2 slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Aldene - Warinaco 230 kV ckt 1

Warinaco 230/13 kV Transformer #2

Breaker Failure

slg fault @ Aldene 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Aldene 230/13 kV Transformer #20

Aldene 230/26 kV Transformer #1

12c slg fault @ 80% of Aldene - Warinaco 230 kV ckt 1

Warinaco breaker tripped within 230 kV primary time

Aldene breakers tripped within 230 kV secondary time

Loss of: Aldene - Warinaco 230 kV ckt 1

Warinaco 230/13 kV Transformer #2

Aldene 230/26 kV Transformer #1

<u>Hudson 230 kV</u>

13a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Kearney 230 kV ckt 1

13b1 slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Kearney 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: None

13b2 slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Kearney 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson-Belleville 230 kV Ckt-1

13c slg fault @ 80% of Hudson - Kearney 230 kV ckt 1

Kearney breakers tripped within 230 kV primary time

Hudson breakers tripped within 230 kV secondary time

Loss of: Hudson - Kearney 230 kV ckt 1

14a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson 230/138 kV Transformer #1 (Marion)

14b1 slg fault @ Hudson 230 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Hudson 230/138 kV Transformer #1 (Marion)

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson -Essex 230 V Ckt-1

14b2 slg fault @ Hudson 230 kV

Fault cleared within 138 kV breaker primary clearing time

Loss of: Hudson 230/138 kV Transformer #1 (Marion)

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson 345/230 kV transformer #2

15a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson 345/230 kV transformer #2

15b1 slg fault @ Hudson 230 kV

Fault cleared within 345 kV breaker primary clearing time

Loss of: Hudson 345/230 kV transformer #2

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson 230/138 kV Transformer #1 (Marion)

15b2 slg fault @ Hudson 230 kV

Fault cleared within 345 kV breaker primary clearing time

Loss of: Hudson 345/230 kV transformer #2

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson - South Waterfront 230 kV ckt 1

16a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - South Waterfront 230 kV ckt 1

16b slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - South Waterfront 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson 345/230 kV transformer #2

17a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Kearney (U1321) 230 kV ckt 1

17b1 slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Kearney(U1321) 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson 230/138 kV transformer #2 (Marion)

17b2 slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Kearney(U1321) 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson - Belleville 230 kV ckt 1

Belleville 230/26 kV transformer #1

17c slg fault @ 80% of Hudson - Kearney (U1321) 230 kV ckt 1

Kearney breakers tripped within 230 kV primary time

Hudson breakers tripped within 230 kV secondary time

Loss of: Hudson - Kearney (U1321) 230 kV ckt 1

18a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Belleville 230 kV ckt 1

Belleville 230/26 kV transformer #2

18b slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Belleville 230 kV ckt 1

Bellevile 230/26 kV transformer #2

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson - Kearney (U1321) 230 kV ckt 1

18c slg fault @ 80% of Hudson - Belleville 230 kV ckt 1

Belleville breaker tripped within 230 kV primary time

Hudson breakers tripped within 230 kV secondary time

Loss of: Hudson - Belleville 230 kV ckt 1

Belleville 230/26 kV transformer #2

19a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Hoboken - Newport 230 kV ckt 1

Penhorn Y 230 kV

Hoboken 230 kV

19b slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hoboken - Newport 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson - Hoboken 230 kV ckt 1

Hudson - Penhorn X 230 kV ckt 1

Hoboken 230 kV

Penhorn Y 230 kV

19c slg fault @ 80% of Hudson - Hoboken - Newport 230 kV ckt 1

Newport breaker tripped within 230 kV primary time

Hudson breakers tripped within 230 kV secondary time

Loss of: Hudson - Hoboken - Newport 230 kV ckt 1

20a 3ph fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: Hudson - Penhorn X - N . Bergen - Bergen 230 kV ckt 1

20b1 slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: N. Bergen - Bergen 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson - Penhorn X - N. Bergen 230 kV ckt 1

Hudson - Hoboken 230 kV ckt 1

20b2 slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker primary clearing time

Loss of: N. Bergen - Bergen 230 kV ckt 1

Breaker Failure

slg fault @ Hudson 230 kV

Fault cleared within 230 kV breaker backup clearing time

Loss of: Hudson - Penhorn X - N. Bergen 230 kV ckt 1

Hudson 230/138 kV transformer #2 (Marion)

20c slg fault @ 80% of Hudson - Penhorn X - N . Bergen - Bergen 230 kV ckt 1
Bergen breakers tripped within 138 kV primary time
Hudson breakers tripped within 138 kV secondary time
Loss of: Hudson - Penhorn X - N . Bergen - Bergen 230 kV ckt 1

21a 3ph fault @ Hudson 230 kV
Fault cleared within 230 kV breaker primary clearing time
Loss of: Hudson 345/230 kV Transformer #2

21b slg fault @ Hudson 230 kV
Fault cleared within 345 kV breaker primary clearing time
Loss of: Hudson 345/230 kV Transformer #2
Breaker Failure
slg fault @ Hudson 230 kV
Fault cleared within 230 kV breaker backup clearing time
Loss of: Hudson Unit #2

A.4.1) Maintenance outage faults

No faults with outages due to maintenance were studied.

A.5) Reinforcements

The following reinforcements were considered in the study:

??

APPENDIX B

Generator Dynamic Data (CTG)

Queue Letter/Position/Unit ID: _____ T107/X3-004/Y2-019

MVA Base (upon which all reactances, resistances and inertia are calculated): _____264

Nominal Power Factor: _____ 0.85

Maximum Gross MW Output (each unit): _____ 249.16

Unsaturated Reactances (on MVA Base)

Direct Axis Synchronous Reactance, $X_d(i)$: _____ 2.24

Direct Axis Transient Reactance, $X'_d(i)$: _____ 0.28

Direct Axis Sub-transient Reactance, $X''_d(i)$: _____ 0.21

Quadrature Axis Synchronous Reactance, $X_q(i)$: _____ 2.13

Quadrature Axis Transient Reactance, $X'_q(i)$: _____ 0.480

Quadrature Axis Sub-transient Reactance, $X''_q(i)$: _____ 0.21

Stator Leakage Reactance, X_1: _____ 0.159

Negative Sequence Reactance, X_2: _____ 0.209

Zero Sequence Reactance, X_0: _____ 0.108

Time Constants (seconds)

Direct Axis Transient Open Circuit, T'_{do}: _____ 7.75

Direct Axis Sub-transient Open Circuit, T''_{do}: _____ 0.039

Quadrature Axis Transient Open Circuit, T'_{qo}: _____ 0.601

Quadrature Axis Sub-transient Open Circuit, T''_{qo}: _____ 0.077

Inertia, H (kW-sec/kVA, on kVA base): _____ 6.2336

Speed Damping, D: _____ 0.0

Saturation Values at Per-unit Voltage [S(1.0), S(1.2)] _____0.0752, 0.6835

Unit GSU Data (CT)

Queue Letter/Position/Unit ID: _____ T107/X3-004/Y2-019

Generator Step-up transformer MVA Base: _____159

Generator Step-up Transformer Impedance (R+jX, or %, on transformer MVA Base): _____ 10%

Generator Step-up Transformer Reactance-to-Resistance Ratio (X/R):_____42

Generator Step-up Transformer Rating (MVA): _____ 159/212/265

Generator Step-up Transformer Low-side Voltage (kV):_____18

Generator Step-up Transformer High-side Voltage (kV): _____230

Generator Step-up Transformer Off-nominal Turns Ratio: _____ N/A

Generator Step-up Transformer Number of Taps and Step Size:_____ 4 taps of 2½%

APPENDIX B

Generator Dynamic Data (ST)

Queue Letter/Position/Unit ID: _____ T107/X3-004//Y2-019

MVA Base (upon which all reactances, resistances and inertia are calculated): _____336

Nominal Power Factor: _____ 0.85

Maximum Gross MW Output (each unit): _____ 276.66

Unsaturated Reactances (on MVA Base)

Direct Axis Synchronous Reactance, $X_d(i)$: _____ 1.77

Direct Axis Transient Reactance, $X'_d(i)$: _____ 0.285

Direct Axis Sub-transient Reactance, $X''_d(i)$: _____ 0.22

Quadrature Axis Synchronous Reactance, $X_q(i)$: _____ 1.70

Quadrature Axis Transient Reactance, $X'_q(i)$: _____ 0.48

Quadrature Axis Sub-transient Reactance, $X''_q(i)$: _____ 0.22

Stator Leakage Reactance, X_1: _____ 0.163

Negative Sequence Reactance, X_2: _____ 0.219

Zero Sequence Reactance, X_0: _____ 0.120

Time Constants (seconds)

Direct Axis Transient Open Circuit, T'_{do}: _____ 5.462

Direct Axis Sub-transient Open Circuit, T''_{do}: _____ 0.038

Quadrature Axis Transient Open Circuit, T'_{qo}: _____ 0.485

Quadrature Axis Sub-transient Open Circuit, T''_{qo}: _____ 0.071

Inertia, H (kW-sec/kVA, on kVA base): _____ 4.1898

Speed Damping, D: _____ 0.00

Saturation Values at Per-unit Voltage [S(1.0), S(1.2)] _____0.0490, 0.4207

Unit GSU Data (ST)

Queue Letter/Position/Unit ID: _____ T107/X3-004//Y2-019

Generator Step-up transformer MVA Base: _____201

Generator Step-up Transformer Impedance (R+jX, on transformer MVA Base): _____ 10%

Generator Step-up Transformer Reactance-to-Resistance Ratio (X/R):_____50

Generator Step-up Transformer Rating (MVA): _____ 201/268/335

Generator Step-up Transformer Low-side Voltage (kV):_____18

Generator Step-up Transformer High-side Voltage (kV): _____230

Generator Step-up Transformer Off-nominal Turns Ratio: _____ N/A

Generator Step-up Transformer Number of Taps and Step Size:_____ 4 taps of 2½%

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PLANT MODELS

REPORT FOR ALL MODELS BUS 292331 [T-107 ST 18.000] MODELS

** GENROU ** BUS X-- NAME --X BASEKV MC C O N S S T A T E S

292331 T-107 ST 18.000 1 88948-88961 40951-40956

MBASE Z S O R C E X T R A N GENTAP

336.0 0.00000+J 0.22000 0.00000+J 0.00000 1.00000

T'D0 T''D0 T'Q0 T''Q0 H DAMP XD XQ X'D X'Q X''D XL

5.46 0.038 0.49 0.071 4.19 0.00 1.7700 1.7000 0.2850 0.4800 0.2200 0.1630

S(1.0) S(1.2)

0.0490 0.4207

** UPSS2B ** BUS X-- NAME --X BASEKV MC C O N S S T A T E S V A R S I C O N S

292331 T-107 ST 18.000 1 109420-109442 57606-57622 9552-9555 8127-8132

IC1 REMBUS1 IC2 REMBUS2 M N

1 0 3 0 5 1

TW1 TW2 T6 TW3 TW4 T7 KS2 KS3

2.000 2.000 0.000 2.000 0.000 2.000 0.160 1.000

T8 T9 KS1 T1 T2 T3 T4 T10 T11

```
     0.500    0.100   10.000    0.150    0.030    0.150    0.030    0.000    0.000

      VS1MAX   VS1MIN   VS2MAX   VS2MIN    VSTMAX   VSTMIN
    99.000   -99.000   99.000   -99.000    0.100   -0.100


** ESST4B **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S
           292331 T-107   ST   18.000 1  202007-202023  83352-83355

    TR    KPR     KIR     VRMAX    VRMIN    TA     KPM     KIM    VMMAX   VMMIN
  0.000   2.650   2.650   1.000  -0.800   0.010   1.000   0.000   1.000  -0.800

           KG      KP      KI    VBMAX     KC      XL    THETAP
         0.000   7.540   0.000   9.430   0.170  0.0000   0.000


** IEEEG1 **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     V A R S
           292331 T-107   ST   18.000 1  267883-267902 105226-105231  26590-26591

     K      T1      T2      T3     UO      UC    PMAX   PMIN     T4      K1
  20.00   0.000   0.000   0.150  0.012  -0.012 1.0000 0.0000   0.275   0.224

   K2      T5      K3      K4      T6      K5      K6      T7      K7      K8
 0.000   0.100   0.395   0.000   0.300   0.381   0.000   0.000   0.000   0.000
```

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PLANT MODELS

REPORT FOR ALL MODELS BUS 292332 [T-107 CT1 18.000] MODELS

** GENROU ** BUS X-- NAME --X BASEKV MC C O N S S T A T E S

292332 T-107 CT1 18.000 1 88962-88975 40957-40962

MBASE	Z S O R C E	X T R A N	GENTAP
264.0	0.00000+J 0.21000	0.00000+J 0.00000	1.00000

T'D0	T''D0	T'Q0	T''Q0	H	DAMP	XD	XQ	X'D	X'Q	X''D	XL
7.75	0.039	0.60	0.077	6.23	0.00	2.2400	2.1300	0.2800	0.4800	0.2100	0.1590

S(1.0)	S(1.2)
0.0752	0.6835

** UPSS2B ** BUS X-- NAME --X BASEKV MC C O N S S T A T E S V A R S I C O N S

292332 T-107 CT1 18.000 1 109443-109465 57623-57639 9556-9559 8133-8138

IC1	REMBUS1	IC2	REMBUS2	M	N
1	0	3	0	5	1

TW1	TW2	T6	TW3	TW4	T7	KS2	KS3
2.000	2.000	0.000	2.000	0.000	2.000	0.239	1.000

T8	T9	KS1	T1	T2	T3	T4	T10	T11
0.500	0.100	10.000	0.150	0.030	0.150	0.030	0.000	0.000

```
      VS1MAX   VS1MIN   VS2MAX   VS2MIN    VSTMAX   VSTMIN
     99.000   -99.000   99.000   -99.000    0.100   -0.100


** ESST4B **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S
           292332 T-107   CT1  18.000 1  202024-202040  83356-83359

    TR    KPR     KIR     VRMAX    VRMIN    TA     KPM     KIM    VMMAX   VMMIN
  0.000   3.270   3.270   1.000  -0.800   0.010   1.000   0.000   1.000  -0.800

            KG      KP      KI    VBMAX     KC      XL    THETAP
          0.000   6.110   0.000   7.640   0.130  0.0000   0.000


 **  GGOV1 ** BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     V A R S        ICONS
           292332 T-107   CT1  18.000 1  267903-267935 105232-105241  26592-26611   10432-10433

    R    TPELEC   MAXERR  MINERR  KPGOV   KIGOV   KDGOV   TDGOV    VMAX    VMIN
  0.040   0.100   0.050  -0.050   5.500   1.500   0.000   1.000   1.000   0.170

   TACT   KTURB    WFNL     TB      TC    TENG   TFLOAD  KPLOAD   KILOAD  LDREF
  0.500   1.710   0.220   0.100   0.000   0.000   3.000   3.300   1.000   1.000

    DM    ROPEN  RCLOSE    KIMW    ASET      KA     TA    TRATE    DB
  0.000  10.000 -10.000   0.000   0.010  10.000   0.100 230.000   0.000

   TSA     TSB     RUP    RDOWN
 12.000  15.000  99.000 -99.000


             ICON(M)= 1 (Feedback signal for governor droop)

             ICON(M+1)= 1 (Switch for fuel source characteristic)
```

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E MON, OCT 22 2012 11:40

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PLANT MODELS

REPORT FOR ALL MODELS BUS 292333 [T-107 CT2 18.000] MODELS

** GENROU ** BUS X-- NAME --X BASEKV MC C O N S S T A T E S

292333 T-107 CT2 18.000 1 88976-88989 40963-40968

MBASE Z S O R C E X T R A N GENTAP

264.0 0.00000+J 0.21000 0.00000+J 0.00000 1.00000

T'D0 T''D0 T'Q0 T''Q0 H DAMP XD XQ X'D X'Q X''D XL

7.75 0.039 0.60 0.077 6.23 0.00 2.2400 2.1300 0.2800 0.4800 0.2100 0.1590

S(1.0) S(1.2)

0.0752 0.6835

** UPSS2B ** BUS X-- NAME --X BASEKV MC C O N S S T A T E S V A R S I C O N S

292333 T-107 CT2 18.000 1 109466-109488 57640-57656 9560-9563 8139-8144

IC1 REMBUS1 IC2 REMBUS2 M N

1 0 3 0 5 1

TW1 TW2 T6 TW3 TW4 T7 KS2 KS3

2.000 2.000 0.000 2.000 0.000 2.000 0.239 1.000

T8 T9 KS1 T1 T2 T3 T4 T10 T11

0.500 0.100 10.000 0.150 0.030 0.150 0.030 0.000 0.000

VS1MAX	VS1MIN	VS2MAX	VS2MIN	VSTMAX	VSTMIN
99.000	-99.000	99.000	-99.000	0.100	-0.100

** ESST4B **	BUS	X-- NAME --X	BASEKV	MC	C O N S	S T A T E S
	292333	T-107 CT2	18.000	1	202041-202057	83360-83363

TR	KPR	KIR	VRMAX	VRMIN	TA	KPM	KIM	VMMAX	VMMIN
0.000	3.270	3.270	1.000	-0.800	0.010	1.000	0.000	1.000	-0.800

KG	KP	KI	VBMAX	KC	XL	THETAP
0.000	6.110	0.000	7.640	0.130	0.0000	0.000

** GGOV1 **	BUS	X-- NAME --X	BASEKV	MC	C O N S	S T A T E S	V A R S	ICONS
	292333	T-107 CT2	18.000	1	267936-267968	105242-105251	26613-26632	10434-10435

R	TPELEC	MAXERR	MINERR	KPGOV	KIGOV	KDGOV	TDGOV	VMAX	VMIN
0.040	0.100	0.050	-0.050	5.500	1.500	0.000	1.000	1.000	0.170

TACT	KTURB	WFNL	TB	TC	TENG	TFLOAD	KPLOAD	KILOAD	LDREF
0.500	1.710	0.220	0.100	0.000	0.000	3.000	3.300	1.000	1.000

DM	ROPEN	RCLOSE	KIMW	ASET	KA	TA	TRATE	DB
0.000	10.000	-10.000	0.000	0.010	10.000	0.100	230.000	0.000

TSA	TSB	RUP	RDOWN
12.000	15.000	99.000	-99.000

ICON(M)= 1 (Feedback signal for governor droop)

ICON(M+1)= 1 (Switch for fuel source characteristic)