PSE&G N-1-1 RELIABILITY CRITERIA

SUB REGIONAL TEAC MEETING

DECEMBER 19,2017

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WHAT IS THE N-1-1 RELIABILITY CRITERIA?

As stated in PSE&G's Transmission Planning Criteria in FERC Form No. 715 Part 4, Section III.C., dated March 2017:

- "For all substations and/or multiple substations that are supplied by only two circuits and when one circuit [or transformer] is out (scheduled or forced maintenance) and loss of the remaining circuit [or transformer] will cause loss of 20MW or more load for more than 24 hours, providing a third supply to the substation or to the load area will be required."

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WHY DOES PSE&G HAVE THIS CRITERIA?

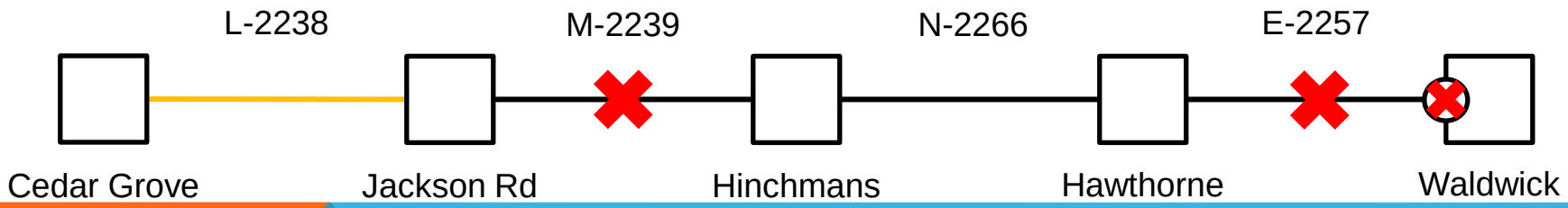
On November 29, 2011, there was a cable failure on the M-2239 circuit during a planned outage of the L-2238 circuit. Luckily, there were 26kV contingency backups set up at Jackson Rd, Hinchmans, and Hawthorne due to the planned outage of L-2238.

The cable failure on M-2239 resulted in the failure of a Phase Angle Regulator at Waldwick in series with the E-2257 circuit.

The loss of both M-2239 and E-2257 left Hinchmans and Hawthorne without a transmission supply.

Repairs on the M-2239 cable and replacement of the Waldwick PAR took roughly 7 months.

During this time, ~14,000 customers with ~60MVA of load at Hawthorne and ~13,000 customers with ~90MVA of load at Hinchmans were fed by the high risk and expensive 26kV contingency backups.



WHY IS PSE&G ADDRESSING THIS NOW?

The risk of dropping significant load for over 24 hours has been considered unacceptable.

The PSE&G underground transmission system has been in service since 1952.

- End of life for UG transmission is typically estimated at 40-80 years of age, based on the condition of the asset.
- A significant portion of PSE&G's UG transmission is expected to reach end of life in the near future, so cable outages are expected to become more frequent.
- In recent years, PSE&G has had issues with thermal mechanical stresses (movement or bending) on UG cables.
- Of the 31 UG cable failures from 1952 – 2016, 11 have occurred since 2006, including 5 failures in 2016 alone.

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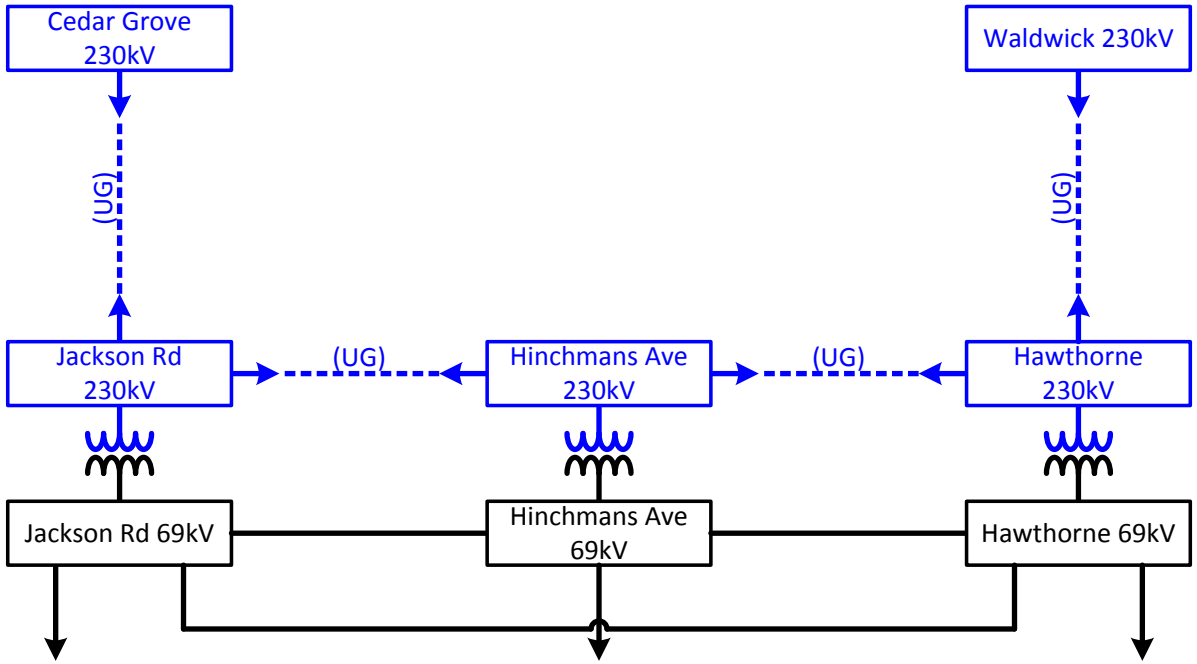
HOW IS PSE&G ADDRESSING THIS?

230/138KV OPTION	69KV OPTION
Underground cable: $20M/mile Requires new right-of-way. Aggravates short circuit duty concerns in Northern PSE&G territory. This could require an expensive, large-scale project to address.	Overhead circuits: $1.5M/mile Wood poles along city streets. Improves area reliability by replacing old 26kV poles and provides a 69kV source for upgrade of nearby 26kV stations in poor condition. Negligible contribution to short circuit duties.

EXAMPLE OF 69KV SOLUTION



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WHAT STATIONS HAVE BEEN ADDRESSED?

Station Name	PJM #	Primary Driver	Station kV	Solution
Bayonne	b1100	N-1-1 criteria	138kV	One additional 138kV line
Bergenfield	s0234	69kV conversion of area stations due to poor reliability of 26kV supplies	230kV	69kV bus with three 69kV lines
Carlstadt	b2934	N-1-1 criteria	69kV	One additional 69kV line
Cuthbert Boulevard	b1156	Burlington-Camden 230kV conversion	230kV	Two additional 230kV lines
East Rutherford	s0087, s0088, s0238	Relieve heavily loaded 26kV, reduce area reliance on poor reliability 26kV	138kV	69kV bus with two 69kV lines
Federal Square	s0929	Voltage support for Ironbound and Port St 69kV	138kV	69kV bus with three 69kV lines
Foundry St	s0929, s0930	Voltage support for Ironbound and Port St 69kV	138kV	69kV bus with three 69kV lines
Hasbrouck Heights	b2934	N-1-1 criteria	69kV	One additional 69kV line
Hawthorne	b2151	Voltage violation	230kV	69kV bus with three 69kV lines
Hillsdale	First pass on 10/31/2017	N-1-1 criteria	230kV	69kV bus with two 69kV lines
Hinchmans	b1101	N-1-1 criteria	230kV	69kV bus with three 69kV lines
Jackson Road	b2151	Voltage violation	230kV	69kV bus with three 69kV lines
Kuller Road	First pass on 10/31/2017	N-1-1 criteria	138kV	Replace 138kV with 69kV bus and three 69kV lines
Leonia	b0025	Bergen-Leonia 230kV conversion	230kV	One additional 230kV line
Locust St	s0277	N-1-1 criteria	69kV	One additional 69kV line
North Avenue	b2436	Bergen-Linden Corridor	138kV	Replace 138kV with 345kV bus and four 345kV lines
PVSC	s0928	138kV supplies going to 345kV as part of BLC, cheaper to operate at 69kV than rebuild at 345kV	138kV	Convert 138kV to 69kV bus and construct three 69kV lines
Saddle Brook	b1304	Northeast Grid	230kV	Two additional 230kV lines
Springfield Road	b2933	N-1-1 criteria	230kV	69kV bus with three 69kV lines
Stanley Terrace	b2933	N-1-1 criteria	230kV	69kV bus with two 69kV lines

WHAT STATIONS ARE LEFT?

Station Name	Station kV	Proposed Solution
Doremus Place	138kV	Replace station with two new 69kV stations with three 69kV lines each. Requires additional property.
Ironbound	69kV	One additional 69kV line. Requires additional property.
Maywood	230kV	69kV bus with two 69kV lines. Requires additional property.
Trenton Network (Clinton Ave, Ewing, Liberty St, Hamilton)	69kV	One additional 230/69kV transformer to supply network. Requires additional property.

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