JUNE 10, 2020 AFTER-ACTION REPORT

At the June 11 Public Works Committee meeting, SWBNO relayed that it would provide information regarding the performance of its power and drainage equipment during the rain event on the morning of June 10, 2020. Members of the committee asked specifically about the cause of the Turbine 4 (T4) trip, status and use of the Electro-Motive Diesel generators (EMDs), and plans to mitigate any ongoing issues. The information below, gathered through SWBNO's after-action analysis, addresses those issues and details our storm response:

Rain Timeline

SWBNO uses briefings from the National Weather Service (NWS) to prepare for rain events. On the morning of June 10, the NWS briefing indicated that 1 – 2" of rain was possible for our area, with a "marginal" risk for more intense rain to the east of New Orleans (around Gulfport). That brief was shared internally at 6:37 a.m. by SWBNO's Emergency Management group.

At 6:45, the operations team[1] at Central Control called for rain load, which triggers notification of additional operations staff and the startup of Frequency Changers. Turbine 4 (T4) was already on line producing approximately 6MW of 25 Hz power. At about 7:00, the operations team began ramping up the number of pumps running at the drainage pumping stations as the water at the stations reached the threshold height for pump activation. At around 7:15, based on the water elevation levels at several of the drainage pumping stations and station operator requests to start and load additional drainage pumps, Central Control called for Turbine 1 (T1) for additional power. At that time, T4 was carrying about 14MW.

At 7:28 a.m., NOLAReady issued a street flood warning indicating that heavy rain was falling in the area; the NWS issued a flash flood warning at 7:51. In the meantime, the operations team was monitoring the rain, pump status and power output of T4. Between 6:35 a.m. and 7:45 a.m., approximately 3.25" of rain was recorded at DPS 2.

As the storm unexpectedly stalled over parts of New Orleans, several drainage pumping stations – including DPS 2, 3, 4 and 7 – were running at or near a "full house," meaning the maximum number of pumps capable of running at the same time were on. As a result, T4 was nearing 17.5MW of power generation. SWBNO has internal policies in place to avoid overloading turbines, and 18MW is the cap for T4. Before T4 reached that cap, the operations team started moving load from T4 to T1 to reduce the load on T4.

The first attempt to move a pump off T4 was successful. At 8:52 a.m., when the team stopped a 25Hz potable water pump at the Claiborne Station to further reduce demand on T4, the turbine tripped and went offline. At that time, T4 was generating 17.3MW of power.

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[1] The drainage system is operated by several groups, including Central Control (power operators), station operators (running the drainage power stations), boiler room (creating steam for all steam power assets), and others. They communicate constantly via radio during rain events and will refenced as the "operations team" for purposes of this report.

T4 – Causal Analysis

- The power generated by T4 did not exceed the internal cap of 18MW. As a result, the trip was not caused by operator error. To the contrary, the operations team was monitoring the turbine closely and began taking action to reduce the load when it approached the cap.
- Rather, T4 experienced a mechanical issue, triggered when the 25Hz pump at Claiborne Station was stopped. At that point, the governor on the turbine tried to react to maintain proper speed, but it did not react fast enough to keep the turbine from momentarily speeding up fast enough for the safety system to trip the turbine.
- The outstanding question is why the governor did not react appropriately in this instance. We are looking at a number of possibilities based on historical data, because we know T4 has run at higher loads in the past. One clue may be related to the temperature of the cooling water - based on data pulled from heavy rain events last year, higher cooling water temperature may be a contributing factor on the load T4 can handle.
- Additional analysis will be required to discern if this is a significant contributing cause of the trip and what can be done to eliminate the possibility of such trips in the future.

Operational Response

- When T4 tripped offline, T1 and the frequency changers already were running. The operations team had begun to reduce the load on T4 and redistribute power to other sources using available feeder routes
- The team also turned on all three available EMDs immediately; they were online by approximately 9:06 a.m. The EMDs typically have been used as a last resort for several reasons: they were originally 60 Hz power generators that have been reconfigured to produce 25 Hz power for our older pumps, and have not proven to be as reliable as our other power generation equipment; they are very loud and impact the surrounding neighborhoods; and they can be dangerous to cold start during lightning storms because they require team members to go outside to prep and cold start each machine. Given the loss of T5, however, these challenges will have to be met with creative solutions so the generators can be used with more frequency.
- T4 was brought back online to help complete draining streets at 11:37 a.m., after ensuring that the machine had not sustained damage and all electrical relays were appropriately reset.

System Impact

- A total of 57 pumps were running across the system when T4 tripped. Fifteen primed pumps went offline due to the loss of power. The operations team redistributed power among T1, EMDs, and frequency changers to bring necessary pumps back online as water began to recede, focusing primarily on DPS 2, 3 and 4, where the heaviest rain was reported.
- There is no question that, had T4 stayed online, we could have finished pumping the city dry earlier. It is hard to estimate how much time could have been saved, primarily because fewer pumps were needed as the storm ended – so, a one-for-one pump replacement was not required.
- After watching video of the flooding for this rainfall event, however, it does not appear that the loss of T4 significantly affected the depth of the flood waters (likely because the great majority of the rain had fallen by that point).

Future Action Plan

- T4 is available for use. The built-in trip function is a safety feature and prevented damage to the turbine. Going forward, the internal cap for running T4 will be lowered to 17MW, particularly in

warmer weather, based on the data collected on the possible impact of the cooling water temperature.

- Additionally, the team will work to provide greater visibility in Central Control (the group making power decisions) on T4's governor set point. The goal is to rely less on the MW load and more on the turbine's real time operational parameters to make load adjustments necessary to maintain stability.
- Going forward, the Emergency Management notice to the operations team will be triggered by the threat of medium rain, rather than severe thunderstorm or flood warnings. In the past few years, un-forecasted intense storms have occurred frequently. This change will enable the operations team to be ready and more proactive on short notice.
- Similarly, we will take a more conservative approach on turning on the EMDs. During the after-action analysis, the operations team established a new operating procedure to warm up EMDs for any medium rain notification. Once warm (oil temp has to reach 110 degrees), there is an 8-hour window during which the EMDs can be utilized very quickly.