

**GOVERNMENT OF PUERTO RICO
PUERTO RICO PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU**

NEPR

Received:

Nov 21, 2022

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IN RE:

IN RE: EVENTO DE INTERRUPCIÓN DE
LA LÍNEA DE TRANSMISIÓN 38900
OCURRIDO EL 22 DE AGOSTO DE 2021

CASE NO. NEPR-IN-2021-0003

**SUBJECT: Motion in Compliance with Order of
September 26, 2022**

MOTION IN COMPLIANCE WITH ORDER OF SEPTEMBER 26, 2022

TO THE HONORABLE PUERTO RICO ENERGY BUREAU:

COMES NOW LUMA Energy ServCo, LLC (“ServCo”), (“LUMA”), and respectfully states and requests the following:

1. On October 26, 2021, this Puerto Rico Energy Bureau of the Public Service Regulatory Board (“Energy Bureau”) issued a Resolution and Order (“October 26th Order”) whereby it initiated an investigation of “the causes of Incident 38900 and the investigative or corrective actions taken by the [Puerto Rico Electric Power Authority (“PREPA”)] and LUMA in connection therewith”. *See* October 26th Order at p. 3 (translation ours).

2. As described in the October 26th Order, “Incident 38900” refers to “events related to a failure of transmission line 38900 occurring on August 22, 2021 which caused this line to trip and the subsequent exit of certain generation units”. *See id.* at p. 1 (translation ours).

3. The October 26th Order required LUMA and PREPA to provide, on or before November 17, 2021 at noon, the following information regarding Incident 38900:

- i. A summary of Incident 38900 including, but not limited to, a chronological description of the events and their effect, if any, on the Authority's generation fleet, as well as the investigative, corrective or any other actions taken by LUMA and the Authority;

- ii. Any information received, obtained or collected in the course of investigative, corrective or any other efforts made by LUMA and/or the Authority, its agents, lawyers or consultants to determine the cause of Incident 38900 and its effect, if any, on the Authority's generation fleet;
- iii. Any document produced, prepared or received by LUMA and/or the Authority, its agents, lawyers or consultants in the course of investigative, corrective or any other efforts or efforts made to determine the cause of the Incident including, but not limited to, the "root cause report" of Incident 38900 and its effect, if any, in the Authority's generation fleet;
- iv. Any information, data, video, audio, photos, report or document submitted to federal or local authorities in relation to Incident 38900 and its effect on the generation fleet of the Authority.

October 26th Order at p. 2 (translation ours).

4. In compliance with the October 26th Order, on November 17, 2021, LUMA submitted an *Analysis for Outage Events on August 22, 2021* ("LUMA's Analysis on August 22nd Event"). See *Motion Submitting Report in Compliance with Order and Request for Confidential Treatment* and Exhibit 1 to same. LUMA's Analysis on August 22nd Event included the sequence of events of two significant disturbances that occurred on August 22, 2021. To wit, the fault at line 38900 from Martin Peña Transmission Center to Berwind Transmission Center, and a load shed event caused by the Costa Sur outage at generator #6. LUMA's Analysis on August 22nd Event was based on information and documents that LUMA had gathered at the time of the filing as well as on LUMA's findings, assessments and recommendations with the information that was then available. Finally, LUMA's Analysis on August 22nd Event identified key action points to prevent similar future events.

5. On November 17, 2021, PREPA filed a motion with an Exhibit that included a report dated October 27, 2021 on the Forced Outages of Units 3 and 4 and the Palo Seco Plant on

August 22, 2021 and a Report dated August 23, 2021 on the Outage in Vapor Unit 5 and Unit 6 of August 22, 2021 (jointly and hereinafter, “PREPA’s Reports”).

6. On September 26, 2022, this Energy Bureau issued a Resolution and Order with the Subject “Final Report,” whereby it took notice of LUMA’s Analysis on August 22nd Event and of PREPA’s Reports (“September 26th Order”). This Energy Bureau directed that by November 20, 2022, LUMA should file a “final amended report” to consider PREPA’s Reports.¹ Similarly, this Energy Bureau directed that PREPA should file a final amended report to consider LUMA’s Analysis on August 22nd Event. Finally, the Energy Bureau directed that LUMA should submit a public version of its Analysis on August 22nd Event.

7. LUMA hereby informs that its Analysis on August 22nd Event considered PREPA’s Reports. In fact, several of the images and data included in LUMA’s Analysis on August 22nd Event, were obtained from the PREPA Reports. Additionally, LUMA’s Analysis on August 22nd Event which was filed and received confidentially by this Energy Bureau, includes references to PREPA’s Reports. *See e.g.* LUMA’s Analysis on August 22nd Event at pages 2-3; 9-13;19. Those references pertain to information that is included in PREPA’s Reports. Because LUMA’s Analysis on August 22nd Event already includes the information that this Energy Bureau requested in the September 26th Order, LUMA respectfully submits that an amendment to LUMA’s Analysis on August 22nd Event is not needed at this time.

8. In compliance with the September 26th Order, LUMA hereby submits as **Exhibit 1**, a public version of LUMA’s Analysis on August 22nd Event.

¹ Per Section 1.09 of Energy Bureau Regulation 8543, because November 20, 2022 is a Sunday, the deadline moves to the next business day, November 21st.

WHEREFORE, LUMA respectfully requests that the Energy Bureau **take notice** of the aforementioned; **accept** the public version of LUMA's Analysis on August 22nd Event that is submitted as **Exhibit 1** to this Motion; and **deem** that LUMA complied with the September 26th Order.

RESPECTFULLY SUBMITTED.

In San Juan, Puerto Rico, this 21st day of November 2022

I hereby certify that I filed this Motion using the electronic filing system of this Energy Bureau.



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Exhibit 1
Public Version of Analysis for Outage Event of August 22, 2021



Public Report - Analysis for Outage Events on August 22, 2021

NEPR-IN-2021-0003

November 21, 2022

1.0 Introduction

This report is based on the forensic analysis about the system's behavior during two significant disturbances on August 22, 2021, as described below. The two events that occurred 10 hours apart will be separately discussed.

1.1 **Disturbance 1 at 12:25:01 – Line 38900 fault, Palo Seco & San Juan generation outages, and load shed disturbance event:**

At 12:25:01 a fault on a 115 kV line (38900) was cleared correctly by the protection with a total delay of 0.318 s. The outage line was not directly connected to any generation facility nor the 230kV system and the fault was cleared in the established time for Puerto Rico stand-alone system stability. The 230kV system to which the Costa Sur 6 generation unit is connected was operating within design limits and did not register any issues. All generation remained firmly connected.

Transmission line faults of this nature are the most predominant type in overhead lines. Transmission and generation systems are built, operated, and maintained in accordance with reasonable and prudently applied industry standards. Utility systems are expected to be robust enough to safely ride through these types of transient disturbances and maintain operation with the disconnection of the faulted equipment. Furthermore, transmission and generation equipment would be reasonably expected to have extensive electrical and mechanical protection, that if properly maintained, will safeguard the transmission and generation assets.

However, after the fault on the 115 kV line was cleared by the protection, a sequence of unexpected generation events occurred that led to instability in the system, required extensive load shedding and caused the loss of 251,431 customers.

The following lists the sequence of the events for the first disturbance.

- I. Pre-event – Transmission system and generation system operating at nominal, stable, steady state conditions, with adequate spinning reserve, system frequency at 59.94 Hz.
- II. 12:25:01 – Single phase to ground fault and breaker failure at line 38900 between Martín Peña and Berwind Transmission Centers due to broken insulation. The location of the fault is shown in Figure 1-1 indicated with a yellow lightning bolt symbol. The Berwind line terminal breaker interrupted the fault current after 0.1 s and the Martín Peña line terminal removed the fault from the system with a delay based on a breaker failure situation with a typical trip time of 0.318 s.
- III. 12:25:03 – Generation event: San Juan 5 and 6 steam units tripped for undetermined reasons. San Juan 5 and 6 combustion turbines remained operating initially sustaining generation levels, but then gradually ramping down generation, removing generation from the system.
- IV. 12:25:11 – With generation removed from the system at San Juan, the protection system correctly reclosed the Berwind 115 kV breaker which opened in 0.119 seconds (7 cycles).

- V. 12:25:36 – Conventional fired boiler/steam turbine unit Palo Seco 4 tripped for undetermined reasons, while similar unit Palo Seco 3 remained in operation. Loss of San Juan 5 and 6 Steam Units and Palo Seco 4 resulted in a rapid decrease of system frequency, from 60.3 Hz to 59.8 Hz. Most operating generation units on the system at that time provided very little, if any, normally expected free governor primary response or sustained secondary response to raise and maintain generation levels. As a result, system frequency continued a gradual decline, activating automatic load shedding blocks in order to maintain system frequency. Palo Seco 3 continued a gradual ramp down in generation level for undetermined reasons, removing additional generation from the system. Based on the alarm displays, at about the time of the transmission fault event, both Palo Seco units 3 and 4 steam turbine generator automatic voltage regulation (AVR) equipment apparently switched from automatic operation to manual operation, for undetermined reasons. It is suspected that this AVR switch to manual resulted in the loss of the normally very fast acting automatic control of the associated generator terminal voltage, coupled with the localized voltage depression during the transmission fault event, resulted in depression of internal generating unit auxiliary 480V electrical bus voltages to a point where loss of operation of various process pumps, and the shutdown of these auxiliary systems is suspected to have activated steam turbine unit protection to trip Palo Seco 3.
- VI. 12:29:36 – Various line overloads required grid operators to manually activate load shedding, to preserve the system from collapse.
- VII. 12:31:03 – Palo Seco 3 tripped for an undetermined reason, and system frequency immediately fell to below 58.8 Hz, activating automatic load shedding blocks. Operating generation units provided very little, if any normally expected free governor primary response or sustained secondary response to raise and maintain generation levels in response to this drop in frequency.
- VIII. 12:32:24 – Both Dos Bocas 1 and 2 hydro units increased generation in an apparent manually activated fashion, to add 10 MW of generation to the system.
- IX. 12:32:36 – San Juan combustion turbine 6 tripped for an undetermined reason (~100 MW loss), while San Juan 5 remained in operation, but for some undetermined reason continuing to decrease generation on what appears to be a controlled ramp, eventually settling at 50 MW at ~12:36:00.
- X. 12:33:50 – Mayaguez 1 synchronized to the system and gradually increased generation
- XI. 12:34:20 – Mayaguez 2 synchronized to the system and gradually increased generation.
- XII. Due to various other renewable generation losses, load increases, and generation capacity redeclarations throughout the day, available generation reserves were reduced to almost zero.

1.2 Disturbance 2 at 22:29:54 - Costa Sur 6 outage and load shed event

Before Costa Sur 6 (CS6) outage event, the specific conditions of the generator are undetermined. For this reason, LUMA requested information and reports of CS6 TRIP that caused another massive load to shed on August 22, 2021, with reported total of 278,913 clients affected.

LUMA System Operations logs show notification of auxiliary feed pump problems at both generators 5 and 6 at Costa Sur approximately 1 day prior to the Costa Sur event that the units could not operate below 310 MWs and 300 MWs respectively. The remaining Puerto Rico electrical system was in the normal operational state.

Records show normal expected performance and stabilization from CS6 during the first disturbance at 12:25:01 (discussed above). No alarms or unusual conduct of this generator were reported then.

- I. 19:23:28 – Approximately 7 hours after the initial transmission line fault and undetermined generation outage at Palo Seco and San Juan, it was reported that CS6 steam turbine experienced high steam vibrations. The generation level was gradually decreased in an apparent attempt to alleviate the vibration. SCADA shows the load at CS6 was decreased from 410 MW to 365 MW. Contingency load sheds were performed by System Operations.
- II. 19:59:58 - Load was further decrease from 365 MW to 363 MW and remained for an hour and fifty minutes until 21:49:45. From this instant, the load was reduced constantly from 363 MW to 248 MW.
- III. 22:29:54 – CS6 steam turbine was tripped by plant operator, apparently due to sustained, high turbine vibration of bearings 5, 6, 7 and 8. An initial report from Mechanical Dynamics & Analysis, LLC (MD&A) during disassembly of this unit following this trip event, appears to show extensive erosion, cracking and foreign object turbine damage, at least three bucket losses from one turbine wheel, as well as cracked and missing bucket end covers and other damage. The root cause(s) of this damage is not identified in the initial inspection report. The consequence of this generator trip was a load shed.

1.3 Conclusions and Next Steps

Two major disturbances took place in Puerto Rico's power system on August 22, 2021 that resulted in significant customer outages. Disturbance 1 occurred at 12:25:01 and involved Line 38900 fault, Palo Seco & San Juan generation outages, and a load shed disturbance event. Disturbance 2 occurred at 22:29:54 and involved Costa Sur 6 outage and a load shed event. The two events occurred 7 hours apart. The information analyzed in this report indicates that the two events were not related.

In summary, the generation trip causes are unclear as the reports from PREPA do not identify root causes. From the preliminary third-party inspection report of Costa Sur 6, extensive steam turbine damage was identified which is the likely source of the vibration, but the root cause was not identified.

On September 26, 2022, the Energy Bureau ordered LUMA to submit an amended Final Report taking into account PREPA's report. LUMA conducted a thorough review of the report that PREPA provided to the Energy Bureau. PREPA's report contained no new information that LUMA did not already have prior to filing LUMA's Final Report on November 17, 2021. Therefore, LUMA concludes that there is no need to amend its Final Report.

It should be noted that PREPA has not yet provided LUMA with the following information, as per LUMA's analysis of the Outage Event Conclusions and Next Steps dated November 21, 2021: (i) Costa Sur technical advisor final report, (ii) metallurgical and root cause analysis, and (iii) intended actions from any recommendations and current status of actions.

From the time this report was submitted to the Energy Bureau, on November 17, 2021, LUMA has been collaborating with PREPA in performing the following tasks:

1. Implementing the required information procedure established by LUMA to report all generation outages. A process has been developed by LUMA that includes a template that was provided to all generators for events, and a tracker.
2. Performing a root cause analysis to understand generation events. PREPA has provided 82 of 126 disturbance reports requested.
3. Creating a System Stabilization Task Force.
4. Performing a Dynamic Stability study.
5. Developing an initiative to improve frequency regulation.

LUMA looks forward to continuing to collaborate closely with the system operations stakeholder committee to better understand the cause of outage events in order to help mitigate potential future events.