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O&M Concession
Independent Engineering Report
Vega Baja Power Plant

Prepared for

Puerto Rico Electric Power Authority

Report SL-015976.VB

Draft A

September 13, 2021

Project 14200.001

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VERSION LOG

Version	Issue Date	Sections Modified
Draft A	September 13, 2021	Initial Issue for Comment

ISSUE SUMMARY AND APPROVAL PAGE

This is to certify that this document has been prepared, reviewed, and approved in accordance with Sargent & Lundy's Standard Operating Procedure SOP-0405, which is based on ANSI/ISO/ASSQC Q9001 Quality Management Systems.

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ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition/Clarification
API	American Petroleum Institute
Btu/kWh	British thermal unit per kilowatt hour
CAPEX	capital expenditure
CFR	United States Code of Federal Regulations
CT	current transformer
COD	commercial operation date
DCS	distributed control system
DMR	discharge monitoring reports
EAF	equivalent availability factor
ECHO	Enforcement and Compliance History Online (EPA)
EFH	equivalent fired hours
EFOR	equivalent forced outage rate
EMS	energy management system
EOH	equivalent operating hours
EPA	Environmental Protection Agency (United States)
EPC	engineering, procurement, and construction
EPCRA	Emergency Planning and Community Right to Know Act
EQB	Environmental Quality Board (Puerto Rico)
ES	effective starts
FY	fiscal year
gpm	gallons per minute
GT	gas turbine
GTG	gas turbine generator
hp	horsepower
HP	high pressure
IRP	integrated resource plan
LP	low pressure
LTSA	long-term service agreement
MATS	Mercury and Air Toxics Standards

Acronym/Abbreviation	Definition/Clarification
MCC	motor control center
MPT	main power transformer
NAAQS	National Ambient Air Quality Standards
NCF	net capacity factor
NOX	nitrogen oxide
NPDES	National Pollution Discharge Elimination System
O&M	operations and maintenance
OEM	original equipment manufacturer
Phase I ESA	Phase I Environmental Site Assessment
Plant	Vega Baja plant
PM	particulate matter
PRASA	Puerto Rico Aqueduct and Sewer Authority
PREB	Puerto Rico Energy Bureau
PREPA	Puerto Rico Electric Power Authority
PSD	prevention of significant deterioration
psia	pounds per square inch, absolute
psig	pounds per square inch, gage
PT	potential transformer
RFP	request for proposals
SCR	selective catalytic reduction
SPCC	spill prevention, control, and countermeasure
T&D	transmission and distribution
TRI	toxic release inventory
UIC	underground injection control

EXECUTIVE SUMMARY

OVERVIEW

The Puerto Rico Electric Power Authority (PREPA) is the electric power company responsible for generating, transmitting, and distributing electricity for the island of Puerto Rico. PREPA engaged Sargent & Lundy to perform an independent technical review of the Vega Baja Power Plant ("Vega Baja" or "Plant").

The Plant is located on the central northern coast of Puerto Rico in the town of Vega Baja. It consists of two simple-cycle combustion turbines (Unit 1-1 and Unit 1-2) with a combined total nameplate capacity of 42 MW.

This technical report includes an assessment of the plant design, operations and maintenance (O&M) activities, plant organization and personnel, technical performance, commercial arrangements and obligations, and provisions for environmental permitting from information provided through April 2021 by PREPA, its advisors, and as observed during a site visit on December 8, 2020. Sargent & Lundy understands that this review is connected to the request for proposals (RFP) to manage, operate, maintain, and decommission, as applicable, one or more of the base-load generation plants and gas turbine peaking plants ("peakers"[1]) located throughout the island of Puerto Rico, including Vega Baja.

TECHNICAL REVIEW

The combustion turbines in the Plant are both based on the GE Frame 5 design and are fired using No.2 fuel oil (Diesel). The Plant primarily consists of the respective combustion turbines and their associated balance-of-plant mechanical and electrical systems. Each generator is rated for 27,400 kVA, and each unit is rated 21 MW. The plant began commercial service in 1971.

The No. 2 fuel oil for the units is trucked to site and unloaded into the site's lone storage tank with a capacity of approximately 276,400 gallons. Redundant AC fuel forwarding pumps draw suction from this tank and fuel the units during operation.

The units are connected to the PREPA transmission and distribution (T&D) system through a shared main power transformer (MPT) to the 38-kV switchyard. These units connect to the nearby switchyard via overhead cable.

[1] Peakers are power plants that generally run only when there is high or "peak" demand for electricity.

There is also an open-air substation adjacent to the plant that is maintained and controlled by PREPA's T&D department, now operated by LUMA.

EQUIPMENT CONDITION

The two simple-cycle combustion turbine generators at Vega Baja are serviceable but advanced in age and lack the heat rates expected of newer units built with modern technological advances. The units are generally in a condition similar to other gas turbine (GT) generators of this type and vintage; however, Unit 1-2 had a recent failure in the second stage of the GT that has rendered the unit inoperable since July of 2020. No root cause analysis of this failure was shared with Sargent & Lundy, but PREPA staff reports that a repair plan is in place to return Unit 1-2 to service in the fourth quarter of 2021. Unit 1-1 was not running during the December 2020 site visit, but plant staff noted that it was operational and available for dispatch at the full rated 21 MW.

The Plant staff notes that the GTs are regularly inspected with the periodicity recommended by the original equipment manufacturer (OEM) based on equivalent operating hours (EOH), and these inspections are performed by PREPA staff, as there is no service agreement with the OEM due to the units' age. Also due to age and proximity to retirement, the peaker facilities are given low priority among PREPA generators for operational and maintenance funding. The limited maintenance budgets afford minimal preventative care, and only the most critical repairs and replacements are approved.

Both of the BRUSH generators from the Plant's original commissioning remain in service, with nameplates dated in 1970. Testing on the generator breakers occurs every eighteen months, and testing on the bus bar occurs every three years. PREPA has noted that excessive humidity has caused electrical failures on the bus bar.

The potable water connection to the Puerto Rico Aqueduct and Sewer Authority (PRASA) municipal water system, and much of the onsite water piping, is underground; thus, it could not be inspected during the site visit. Facility plumbing and service water hose spigots on site were serviceable, and emergency eyewash stations and firehose stations appeared to be in working condition, though they were not tested during the site visit. No issues with the potable water system were noted by the plant staff.

The plant staff did not report any issues with the self-contained closed cooling water systems on the two units, but the radiator mounting bolts on the exterior wall of the accessory enclosure were rusted.

Equipment and piping in the fuel oil truck unloading area shows characteristic signs of aging with chipped coatings and minor surface rust, but they remain serviceable. Fuel Oil Storage Tank S-1 was repaired and recoated in 2017 and appears in good condition. The fuel forwarding system is functional, but one of the

2x100% AC motors for the fuel forwarding pumps was removed for servicing, which eliminates the redundancy of the system.

The Plant's original CO_2 fire protection system is not operational, and fire protection for the units is currently provided by handcart-mounted dry-pressure transfer extinguisher assemblies located next to the combustion turbines and by hose stations connected to the potable water system. Hand extinguishers are hung at other high-risk locations. Considering the impending retirement of the units, Sargent & Lundy recommends that PREPA consult with the local fire marshal to discuss least-cost solutions to improve the site's fire safety capabilities for the final years of operation.

Structural steel on site appears to be generally serviceable, but some pronounced corrosion was noted on and around the base plates of several of the combustion air intake duct support columns. The Plant security fencing generally appeared to be in functional working order, but there were some areas in which the barbed wire at the top was severely compromised. The used oil storage structure appeared to be reasonably organized and maintained.

The MPT appeared to be in good working condition, and PREPA indicated that there are no known operating issues at this time. There was some minor rusting on the MPT and ancillary components throughout, which is to be expected for equipment approaching 50 years of outdoor service.

The station batteries appeared to be in good condition, and a visual inspection did not reveal any wearing or damage. The cables connected to the batteries, however, were in poor condition, and several had long lengths covered by electrical tape. Other cables throughout the site were hung loosely, including along boundary fences. Sargent & Lundy recommends that all aboveground cables are installed in raceway to address any safety and reliability concerns.

The emergency diesel generator enclosure and internals appeared to be in good condition, but Plant staff noted an overheating issue that prevents the generator from running longer than 30 minutes at a time. Sargent & Lundy recommends determining and correcting the root cause of the generator overheating and continuing with regular testing and maintenance to ensure availability.

The controls enclosure appears to be weather tight and fully functional, but some concerns were noted with the condition and arrangement of the equipment inside. The MARK VI cabinets are in satisfactory condition, but the network cabinet consists of a loose rack of network and communications equipment that was open and vulnerable to tampering or accidental damage. The relay and metering cabinets appear to be in good condition. Sargent & Lundy noted several openings on the front of the cabinets where equipment was removed. The motor control centers (MCCs) for both units appeared to be in working condition with minor

dirt, rust, and signs of wear. There were also several breaker compartment doors with unoccupied instrumentation cutouts that were not covered with a plate or did not fully close.

INFRASTRUCTURE AND INTERCONNECTIONS

The units operate on No. 2 fuel oil stored onsite in a single tank with a nameplate capacity of 6,581 bbls. Fuel is delivered via tanker trucks and unloaded into the storage tank using the onsite truck unloading pump station.

On November 21, 2019, PREPA entered a contract (Contract 902-01-19) with Puma Energy Caribe, LLC for the supply of No. 2 fuel to all the PREPA plants that operate with this fuel. PREPA and Puma Energy Caribe are currently finalizing details for the extension of this contract until November 20, 2021. In 2021, PREPA will undergo a competitive process to secure its next No. 2 fuel oil supply agreement.

The Plant uses a municipal potable water supply from PRASA for domestic use in the facility buildings, fire hose stations, service water hose stations, and the eyewash and safety showers on site. Drains from the units and curbed containments that may be subject to oil contamination are directed to the plant's oil-water separator prior to being discharged back to the municipal sewer system.

OPERATIONS AND MAINTENANCE

The Vega Baja facility is typically staffed with one person operating and performing minor maintenance on the units. While the units were originally designed for remote start, the aged equipment has developed issues requiring an operator on site trained to follow special protocols to bring each unit online. The regular shift is Monday through Friday, 7:30 am to 4:00 pm. Due to the populous location, the Vega Baja facility is limited to operation between the hours of 6:00 am and 10:00 pm for noise mitigation. Personnel are brought on site to start the unit as required.

Most maintenance activities are performed by third parties or staff borrowed from the larger local PREPA generating facilities. Limited budget allocations to the peaker facilities prohibit many of the capital expenditures that would be required for equipment upgrades and typical preventative maintenance activities. Critical fuel oil tank maintenance and the recoating of piping, enclosures, ductwork, structural steel, etc. for corrosion protection is performed under the PREPA fleetwide maintenance programs.

Plant staff noted that the preventative maintenance program for PREPA's peaker plants was dismantled between 2010 and 2012. Turbine inspections are now generally limited to combustion inspections performed by PREPA mechanics at the manufacturer's recommended EOH intervals. Major inspections are not regularly performed and require special budget approval. As is typical with units of this vintage,

major inspections and work, including replacement parts and overhauls, are procured and contracted with third-party entities, as the turbine OEM is no longer engaged for any of the GT maintenance or inspection activities.

Corrective maintenance for PREPA's peaker units is conducted on an as-needed basis. Due to the low dispatch of the units, corrective maintenance can generally be performed as required when the unit is not dispatched. Maintenance and operational issues are recorded in a log by the operations staff, prioritized by plant and PREPA corporate management, and addressed when possible during forced and scheduled outages.

When parts are needed, part requisitions are routed through the PREPA's purchasing department using the Ventyx™ Asset Suite purchasing software. As budgets for the older and less-used plants have been prioritized below the other newer plants, maintenance requests, including part and supply requests, have been delayed or deferred as necessary. Plant personnel have been conscientious of this and typically limit their budgetary requests to fund component replacement and maintenance activities most critical to sustaining unit operability.

PERFORMANCE BENCHMARK

Sargent & Lundy reviewed historical key performance indicators of the Plant from 2015 through 2020 and benchmarked them against a group of its peers. Vega Baja has been used more frequently in recent years compared to earlier years and has increased the capacity factor above that of its peers; however, the decline in performance and reliability is expected during the operating life of a thermal power generation plant, and this decline is evident in the case of Vega Baja, as indicated by the high heat rate (for performance) and high equivalent forced outage rate (for reliability).

FINANCIAL REVIEW

Sargent & Lundy compiled the historical O&M and capital expenditures (CAPEX) for Vega Baja from reported PREPA data and fiscal plan forecasts for comparison with O&M and CAPEX for existing units in operation in North America of similar configurations and operating profiles. This data was for the period FY 2015 – FY 2020 and was analyzed in conjunction with the historical generation. From the data, Sargent & Lundy determined that the Vega Baja costs are higher than average, but within the typical range of costs for similar units. There was no reported CAPEX in the data reported to Sargent & Lundy.

ENVIRONMENTAL AND REGULATORY

Sargent & Lundy performed a limited environmental review of publicly available information and information provided by PREPA to evaluate the compliance status for Vega Baja. There were no compliance-related issues that would prevent renewal of the existing permits or impact the near-term operation of the facility.

RECOMMENDATIONS AND CONCLUSIONS

Overall, the Vega Baja facility is in serviceable condition with the combustion turbines and many of their ancillary systems approaching the end of their useful service lives. Ongoing proposals for plant repairs, replacements, and upgrades should consider the near-term plans for retirement of the GTs and any new equipment to be installed on site with funds from the FEMA 404 hazard mitigation program.

Vega Baja is not directly on the coast like other PREPA facilities; however, the Plant is still subject to high chloride deposition from salt-laden coastal winds, presenting corrosive conditions for any equipment exposed to the elements. Care must be taken to ensure that replacements or upgrades to the Plant are suitable for the environmental conditions and properly hardened against potential extreme weather events. Typically, competitively priced OEM standards for power generation and balance-of-plant equipment are not well-suited for this type of operating environment. Any new equipment must be configured for the challenging conditions at Vega Baja. Failure to make allowances for suitable materials, equipment selection, buildings/enclosures, and other aspects of the facility design to protect the Plant from its operating environment may result in excessive future O&M costs, forced outages, and a shorter plant design life for any new installation. Suitable design specifications appropriate for this operating environment include corrosion-resistant material specifications, use of protective equipment enclosures, proper system selections, and robust coatings systems. Due to these requirements, tropical power generation sites are inherently more expensive than those installed in less aggressive operating environments.

PREPA continues to study the need for additional grid support and generation throughout the island. While both GTs have fully realized their expected useful lives and are soon to be retired, the site is being considered as a candidate for new peaker units. Synchronous condensers are also being considered for the site, which would offer grid stabilization benefits.

Understanding that the Vega Baja GTs are expected to be retired in the next several years, this report does not include recommendations for large capital investments for improvements to greatly extend the life of these units. Guidance is limited to improvements and maintenance practices which will mitigate life-safety and environmental risks, minimize potential catastrophic failures, or otherwise improve the facility for its continued use if or when new generation is added to the site.

Recommendations for the Plant focus on two elements of the facility: the two power generation units and the common systems. Recommendations for Unit 1-1 and Unit 1-2 include the following:

- Regularly check and replace air intake prefilters as required.
- Resurface and coat corroded portions of the intake filter housing.
- Clean up any spilled oil within the GT enclosures.
- Continue regular inspections of the MPT and replace if necessary.
- Repair cracking in the MPT foundation pad and containments and clear vegetation.
- Perform the manufacturer-recommended maintenance and testing per the manuals for the generator electrical enclosure.

Recommendations for the common systems include the following:

- Fix or replace the MCC compartment doors that cannot close and provide covers for any vacant openings.
- Perform regular testing of the MCCs and add master nameplates or tags to each lineup that clearly indicate voltage, amperage, etc.
- Add space heaters to the enclosure to prevent moisture buildup on the bus bars.
- Maintain updates to the security software for the operator console.
- Relocate the network and communications equipment within a lockable cabinet to prevent tampering or damage.
- Install cover plates over any openings in the relay and metering cabinets.
- Install a plant-wide alarm system to provide locally audible alerts for critical alarms.
- Troubleshoot and correct the overheating issue with the emergency diesel generator and continue bi-weekly test-runs.
- Continue current battery maintenance and testing, replace cables with damaged insulation, and route cables though raceways to prevent future damage.
- Route all aboveground cables through raceway (cable tray, conduit, etc.) to prevent damage and increase safety.
- Exercise more diligent vegetation control to prevent fire hazards and clogging of plant drainage systems.
- Regularly check underground drain piping for leaks to prevent oily water from leaking into soil.
- Monitor coating systems for degradation and recoat equipment as necessary to ward off corrosion and premature failure.
- Repair or replace and reinstall the second AC motor for the fuel forwarding pumps to reestablish the 2 x 100% redundancy of the fuel forwarding system.

- Consult with the local fire marshal to discuss least-cost solutions to improve the site's fire safety capabilities for the next several years of operation.
- Repair the damaged barbed wire segments of the perimeter fencing and add more effective concertina wire for improved security.

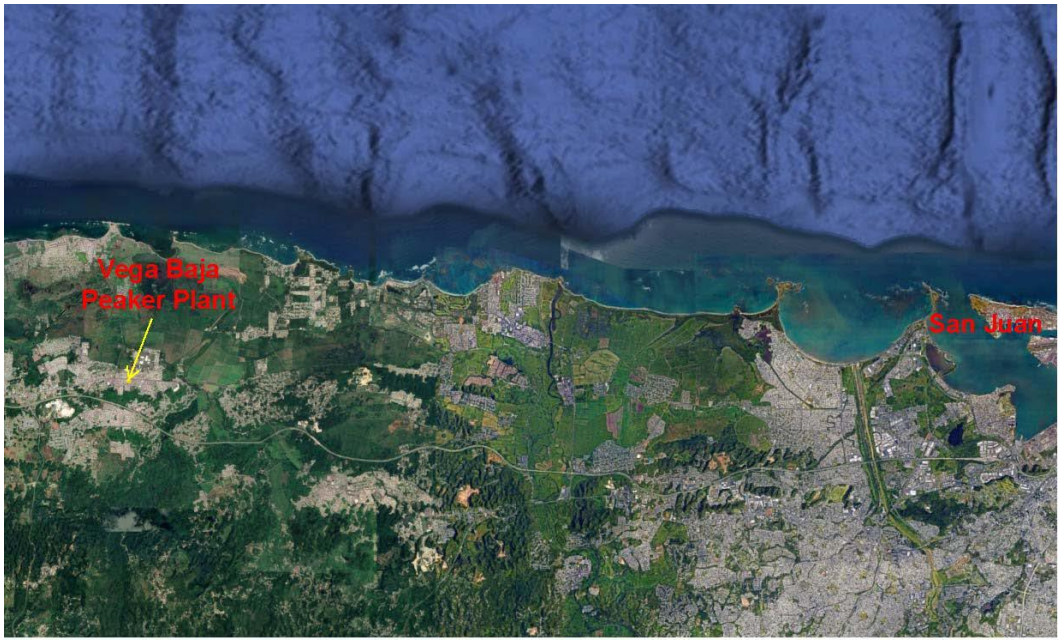
1. INTRODUCTION

The Puerto Rico Electric Power Authority (PREPA) is responsible for generating, transmitting, and distributing electricity for the island of Puerto Rico. PREPA engaged Sargent & Lundy to perform an independent technical review of the Vega Baja Power Plant ("Vega Baja" or "Plant").

1.1. PLANT DESCRIPTION

The Plant is located on the central northern coast of Puerto Rico in the town of Vega Baja. It consists of two simple-cycle combustion turbines (Unit 1-1 and Unit 1-2) with a combined nameplate capacity of 42 MW. Vega Baja provides system reliability support for the PREPA fleet and is considered only partially operational. As of April 2021, Unit 1-2 is was out of service due to a second-stage turbine failure.

Figure 1-1 — Vega Baja Power Plant Geographic Location



Source: Google Earth

The Plant is a peaking[2] facility, and both combustion turbines are GE Frame 5 type designs manufactured by John Brown Engineering and are fired using No.2 fuel oil (diesel). The Plant primarily consists of the respective combustion turbines and their associated balance-of-plant mechanical and electrical systems. Each generator is rated 27,400 kVA, and each unit is rated 21 MW. Units 1-1 and 1-2 are each connected to a common main power transformer (MPT) via elevated non-segregated bus, and the transformer

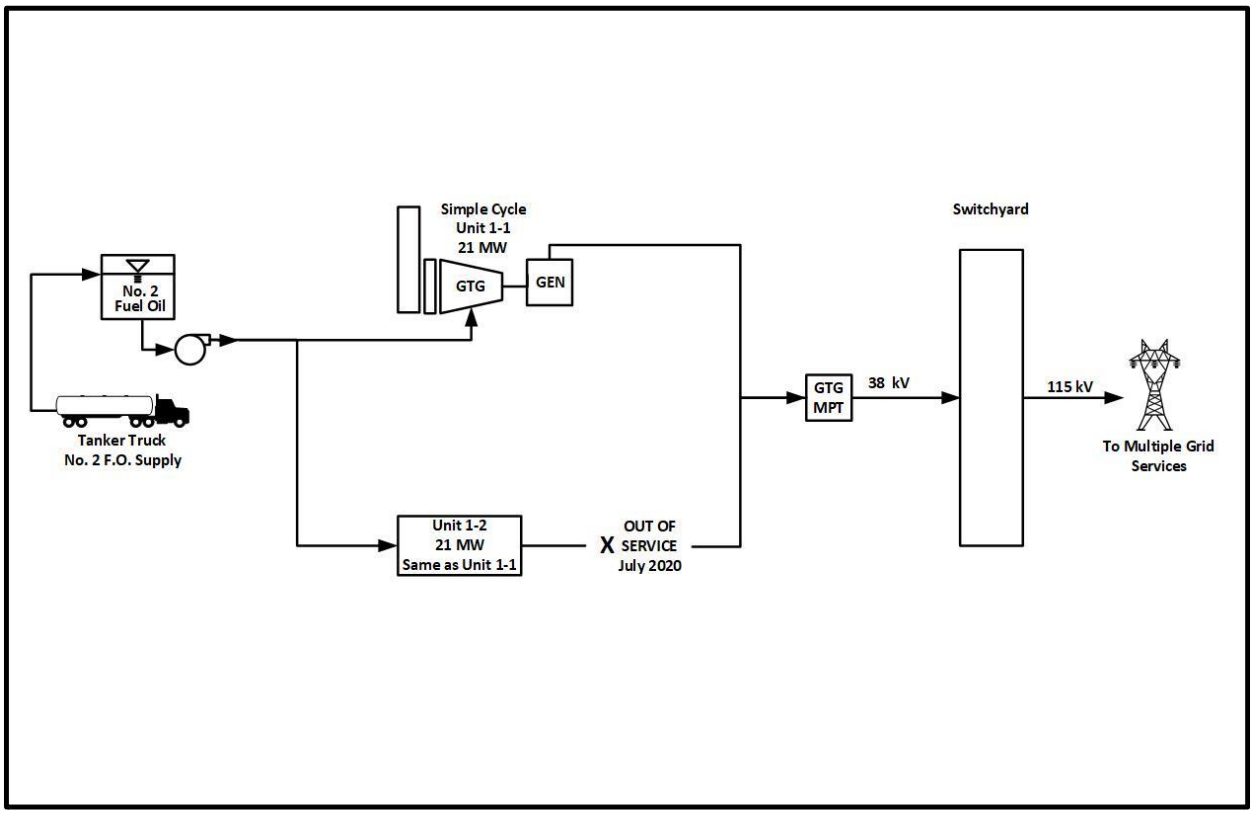
[2] Peakers are power plants that generally run only when there is high or "peak" demand for electricity.

connects the station to the adjacent 38-kV substation via overhead conductors and a short run of below-grade cable. The substation is tied to PREPA's 115-kV Manati and Dorado transmission centers via a 115/28-kV tie transformer and high-voltage transmission lines. The plant began commercial service in 1971.

No. 2 fuel oil is delivered to the Plant's onsite fuel oil storage tank via trucks using the truck unloading pump station. Water is provided via the PRASA[3] connection onsite near the northern end. A 100-kW/125-kVA generator made by MTU Onsite Energy provides the facility with black-start capability.

An overview schematic representation of Vega Baja is provided in Figure 1-2.

Figure 1-2 — Vega Baja Overall Plant Configuration



1.2. SCOPE OF REVIEW

This technical report includes an assessment of the Plant design, operations and maintenance (O&M) activities, plant organization and personnel, technical performance, commercial arrangements and obligations, and provisions for environmental permitting. Sargent & Lundy's objective is to provide an overview of the condition of the asset, assess whether the facility has been operated and maintained in

[3] Puerto Rico Aqueduct and Sewer Authority

accordance with generally accepted industry practices, and identify significant challenges to continued successful operation. Recommendations for equipment upgrades or operational improvements are also included.

Sargent & Lundy acquired information to conduct its review:

- Documentation provided by PREPA's corporate operations and plant personnel as of April 2021
- Discussions with Plant personnel on the phone and during a site visit to the facility on December 8, 2020
- Industry data obtained from market research databases and publicly available sources to evaluate plant characteristics

Sargent & Lundy understands that this review is connected to the request for proposals (RFP) to manage, operate, maintain, and decommission, as applicable, one or more of the base-load generation plants and gas turbine peaking plants located throughout Puerto Rico, including Vega Baja.

2. TECHNICAL DESCRIPTION

The characteristics of the generating units at Vega Baja are shown in Table 2-1. Sargent & Lundy's December 2020 site visit confirmed that one of the units is currently "Non-Operational" due to a forced outage; thus, only 21 MW can be classified as operational and currently available for dispatch. Repairs to Unit 1-2 are expected to return the Plant to its full 42 MW capacity.

Table 2-1 — Production Plant Overview

Unit Name	Commercial Operation Date (COD)	Technology	Fuel	Nameplate Capacity (MW)	Status (As of April 2020)
Vega Baja Unit 1-1	1971	Simple-Cycle Gas Turbine	Oil No. 2	21	Operational
Vega Baja Unit 1-2	1971	Simple-Cycle Gas Turbine	Oil No. 2	21	Non-Operational; forced outage due to a failure in the second stage of the GT; projected return to service in Q4 of 2021

1. **Operational**—Functioning and suitable for power generation
2. **Non-Operational**—Out of service temporarily and not generating power

2.1. MECHANICAL SYSTEMS

The mechanical systems of Vega Baja include the two simple-cycle gas turbine (GT) units with their ancillary cooling and lube oil systems, a fuel oil storage tank, a fuel forwarding system, a CO_2 fire protection system, a potable water system, and drainage systems. The technical details of these systems and their comprising equipment are provided below.

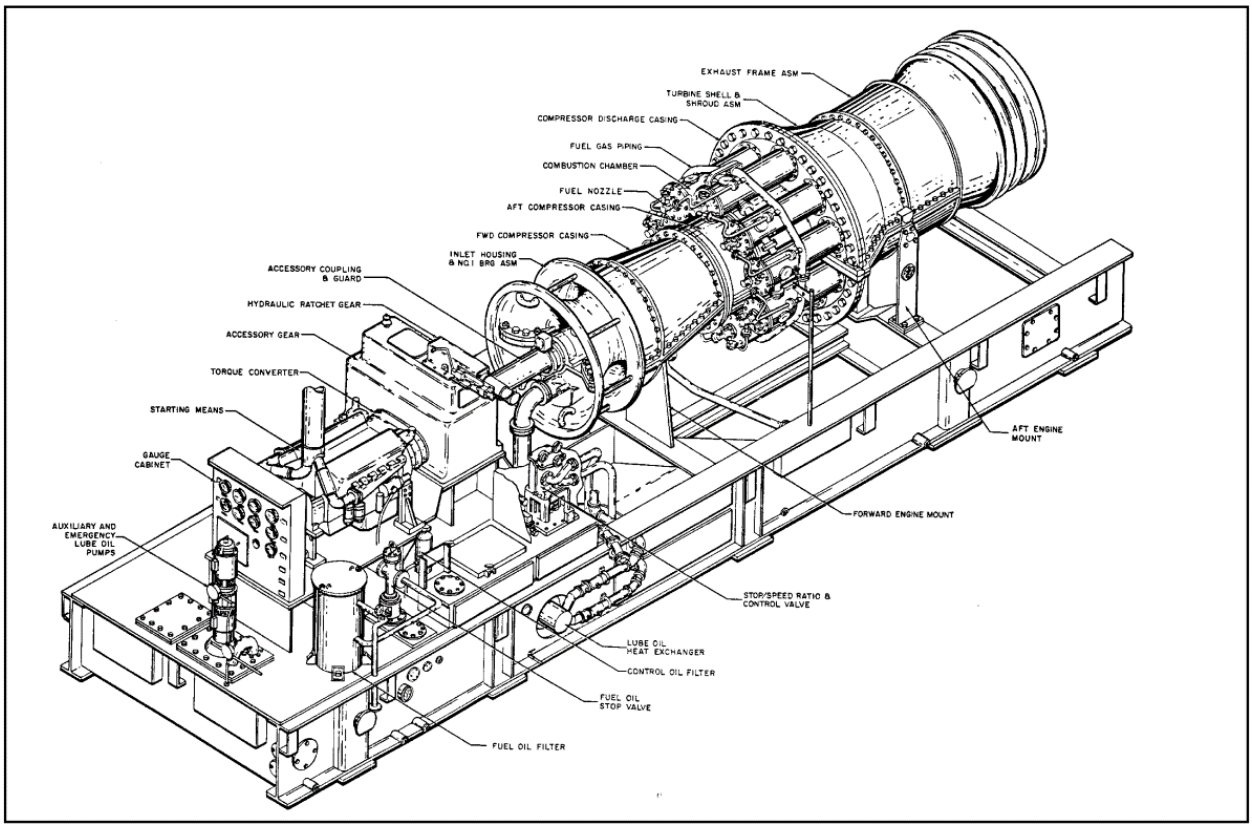
2.1.1. Combustion Turbines

Vega Baja Units 1-1 and 1-2 are simple-cycle GT units arranged in a parallel configuration, each of which includes a John Brown Engineering Frame 5000[4] single-shaft GT coupled to a BRUSH generator via a gearbox.

[4] The John Brown Frame 5000 was manufactured under a licensing agreement with GE and is based on the GE Frame 5 Model MS5001. Much of the information in this report pertaining to the combustion turbines is referenced from published GE data for the MS5001, which was found to be more readily available than historical John Brown documentation, as the facility design drawings were not available for review.

The GE Frame 5 is a robust combustion turbine design with a lengthy history in power generation and utility service dating back to the 1950s when GE shipped the first 12-MW Model MS5001A. Over the years, the Frame 5 designs were continuously improved with advances in materials and manufacturing processes, leading to the 21-MW units installed at Vega Baja in 1971. The John Brown Engineering turbines were manufactured under a licensing agreement with GE and are similar to GE's Model MS5001R, with a nominal[5] firing temperature of 1720°F, an exhaust temperature of 955°F, and a heat rate of 13,260 Btu/kWh.[6] Each unit includes a 16-stage axial flow compressor and a two-stage rotor.

Figure 2-1 — GE MS5001 Gas Turbine



Source: GE reliability improvements publication GER-4196.

The combustion system features 10 individual combustors capable of firing a variety of fuels including natural gas, light and heavy distillates, and crude and residual oil. The Vega Baja units run on No. 2 fuel oil, the only fuel available at the site. The combustion air intake includes two-stage static filtration with pre- and post-filters mounted in a filter house enclosure located at grade on the south end of each unit. Unit

[5] Nominal values are based on NEMA standard conditions firing natural gas fuel at the fuel's lower heating value.
[6] British thermal units per kilowatt hour

cooling is achieved by a self-contained closed cooling water system that exchanges heat with the lube oil and generator heat exchangers and rejects heat via radiators mounted on the accessory enclosure wall.

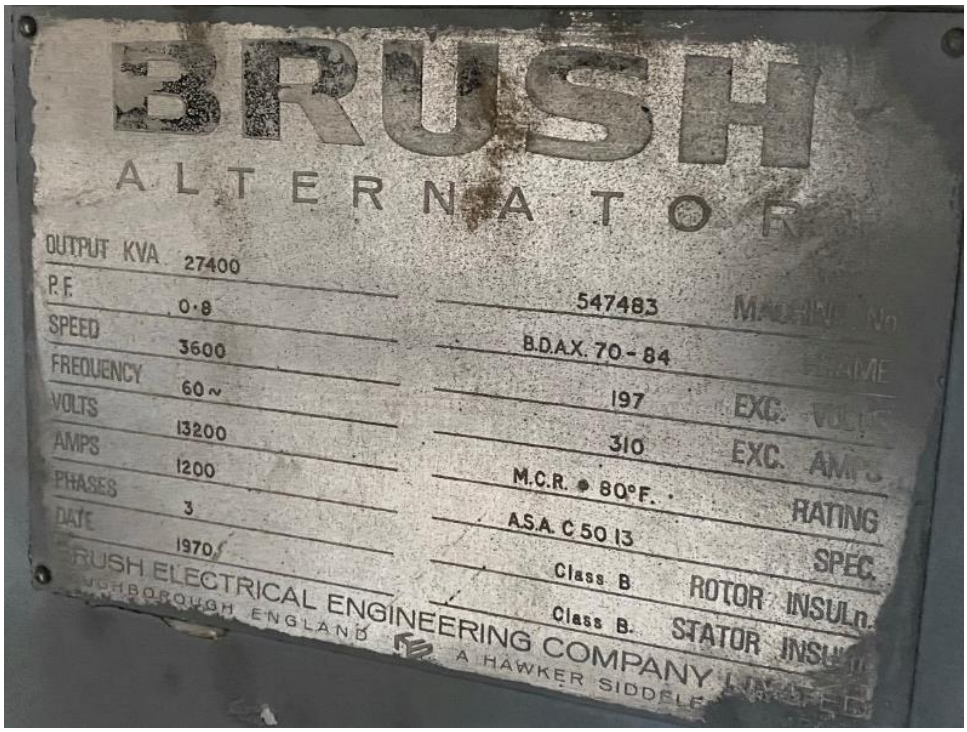
Figure 2-2 provides a panoramic view of Unit 1-1 with the generator enclosure on the left, the GT enclosure, and the stack (vertical GT exhaust duct) toward the center of the photo. The accessory enclosure—which houses the starter motor, torque converter, accessory gear, fuel oil final filter, cooling system radiators (visible on the exterior) and other accessories—is in the right side of the photo underneath the combustion air intake duct that draws air from the grade-mounted filter house on the far right.

Figure 2-2 — Vega Baja Gas Turbine Unit 1-1

2.1.2. Generators

Each GT unit is coupled via gearbox to a 27,400-kVA, 60-Hz, air-cooled BRUSH generator with a 0.8 power factor. Figure 2-3 shows the nameplate for the Unit 1-1 generator, the same make and model as the Unit 1-2 generator.

Figure 2-3 — Unit 1-2 Generator Nameplate



2.1.3. Water Systems

2.1.3.1. Potable Water

Potable water is delivered to site by a connection to the PRASA municipal water system and provides water for facility plumbing, emergency eyewash and shower stations, fire protection hose cabinets, and various service water hose spigots on site. The connection to the PRASA supply header and much of the potable water piping on site is underground.

2.1.3.2. Cooling Water

Each unit is equipped with a self-contained closed cooling water system that cools the accessory gearbox and generator and rejects heat via radiators mounted on the exterior wall of the accessory enclosure. The cooling water reservoir tank is approximately 600 gallons and is refilled with potable water from a service water hose as needed.

2.1.3.3. Site Drainage System

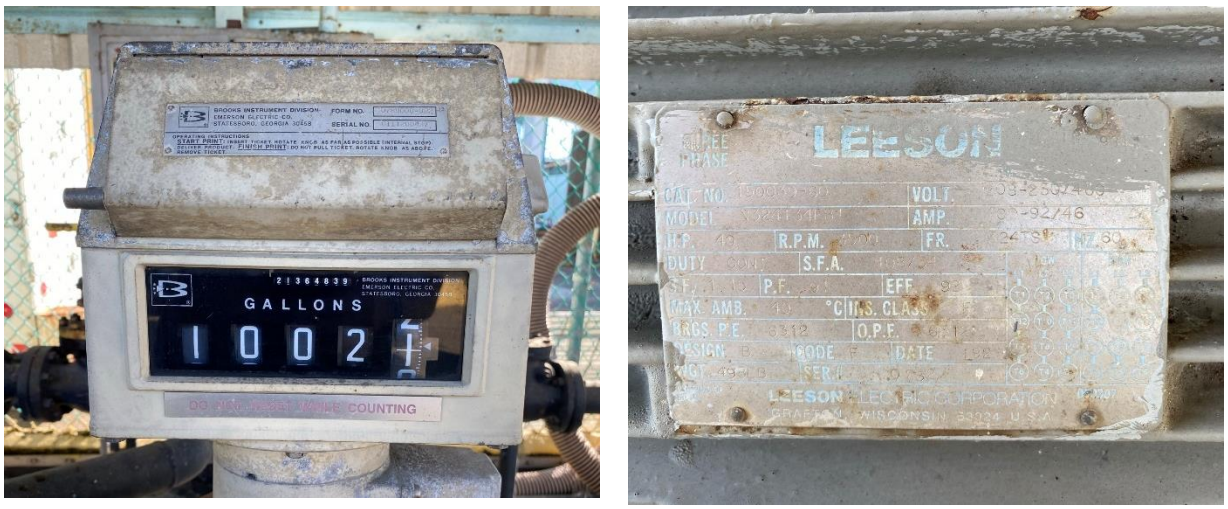
Drainage from the units, fuel oil storage tank containment, and various other curbed containments on site is delivered to an open-air, oil-water separator (pit) via underground piping. Containments that are too

distant to gravity drain directly to the oil-water separator are collected in an underground sump near the fuel oil forwarding system. This sump is outfitted with a single vertical immersion vortex sump pump that can be operated manually at the nearby control panel to deliver the sump contents to the oil-water separator. Collected oil is manually pumped from the top of the separator using a vacuum truck, and water effluent from the separator returns to the PRASA municipal sewer system. The plant staff notes that none of the underground piping is outfitted with cathodic protection.

2.1.4. Fuel Systems

While the John Brown Engineering GTs are capable of operating on a variety of fuels, Vega Baja only includes fuel systems for No. 2 fuel oil. The site includes a truck unloading station with a single 40-hp, 3500-rpm centrifugal pump and analog Brooks BiRotor flow meter (see Figure 2-4) inside a curbed containment and underneath a protective awning. Fuel is pumped from a delivery truck at the unloading station to the shared Fuel Storage Tank S-1, which has a nominal capacity of 6,581 bbls,[7] or approximately 276,400 gallons.

Figure 2-4 — Truck Unloading System



Left: Truck unloading rotary flowmeter. **Right:** Nameplate on the truck unloading pump motor.

The fuel delivery process is a completely manual operation. The truck unloading pump is started with a switch adjacent to the pump, and manual valves are opened and shut to direct flow to Tank S-1 during unloading. Tank S-1's fuel level is monitored with a differential-pressure level transmitter that displays the tank level locally and at the controls enclosure workstation. Two additional fuel oil storage tanks were observed at the site: a 15,000-gallon and a 10,000-gallon tank inside the northern portion of Tank S-1's

[7] Barrel of oil equal to 42 U.S. gallons by volume.

containment. The plant staff notes that these were used as backup storage during the refurbishing of Tank S-1, but they are not certified for regular usage and are no longer used for operations at Vega Baja. The staff noted that these tanks will likely be relocated to another PREPA site to serve as backup storage for another tank refurbishment, but the timing of this is unknown.

Figure 2-5 — Fuel Storage Tanks

Left: Fuel Storage Tank S-1 supplies fuel for both units. **Right:** One of the two smaller auxiliary storage tanks previously used while Tank S-1 was out of service for refurbishment; it is not in service at the site.

Storage Tank S-1 supplies both units via a single suction header to the fuel forwarding system. Located beneath a protective awning and inside a curbed containment, the 3 x 100% fuel forwarding pumps are each able to supply sufficient fuel pressure and flow to operate both Units 1-1 and 1-2. These forwarding pumps are each 15-hp, 90-gpm pumps that generate 215 TDH and operate at 3510 rpm. The two pumps, which provide fuel for normal unit operation with 2 x 100% redundancy, are powered by AC motors, and the third pump is connected to a DC motor for startup or emergency operation.

The discharges of the fuel forwarding pumps combine in a common header that then splits into two valve trains, one for each unit. The valve trains include control valves, isolation valves, and pressure instrumentation for each unit.

2.1.5. Fire Protection

The Vega Baja units were originally equipped with a CO_2 fire protection system with CO_2 piping and nozzles in each of the turbine enclosures fed from a fire protection enclosure that houses an array of 330-ft^3 capacity CO_2 tanks, a tank connection manifold, and emergency hand release valves. Plant staff notes that this CO_2 system is no longer in service, and the enclosure appears to be currently used for the storage of CO_2 tanks and miscellaneous insulation materials. Fire protection for the units is now achieved with portable hand extinguishers and larger 125-lb. rechargeable handcart-mounted dry-pressure transfer extinguisher assemblies next to the combustion turbines. For increased safety, Sargent & Lundy recommends a consultation with the local fire marshal, as discussed in Section 3.1.7.

2.1.6. Compressed Air

The Vega Baja site does not have a station compressed-air system. During the site walkdown, Sargent & Lundy noted a portable air compressor trailer on site, which the plant staff identified as their only source of compressed air. This compressed air is used for pneumatically powered tools in maintenance functions and is not integral to plant operation.

2.2. ELECTRICAL SYSTEMS

2.2.1. Conceptual Design

The two combustion turbine generators are connected to a single main power transformer (MPT) that steps up the voltage from 13.2 kV to 38 kV to be delivered to the substation. The MPT was manufactured by Westinghouse in 1970 and is rated 30/40/50 MVA (OA/FA/FOA) at 55°C average rise. The high-voltage connection to the switchyard is made via overhead cables. The low-voltage connection to the generators is made via non-segregated bus. There is oil containment around the transformer.

Each unit's 480-V loads are powered by a motor control center (MCC). There is one MCC per unit, and each MCC has two vertical sections. Request for information on what loads are powered by the MCC was submitted to PREPA, but it has not been provided as of the writing of this report. The MCC manufacturer and ratings are unknown, as no nameplate or tag was found on either lineup. Sargent & Lundy requested the information, but it was unavailable.

A single diesel generator is connected to both units to provide a backup power source for their auxiliary loads. The diesel generator is manufactured by MTU Onsite Energy and has a rated output of 100 kW/125 kVA at 120/208 V. The connection to the units is made via underground cable. Sargent & Lundy was not provided documentation indicating which loads are powered by the backup generator.

The Plant's batteries are housed in the battery room and provide a backup power source for both units' auxiliary loads. Request for information on what loads are powered has been sent to PREPA. The batteries are manufactured by Lorica; they are lead-acid and operate at 125 V_{dc}. The amp-hour rating is unknown. The batteries are connected to each unit via aboveground cable. There was no containment around the batteries. The battery room has one exhaust fan.

Figure 2-6 — Battery Room

There is one generator electrical enclosure that contains the 13.2-kV generator breakers and potential transformers (PTs) for both units. In the electrical system, the generator breakers are located at the output of the generators and can isolate the generators. The PTs are used to monitor the generator voltage.

PREPA maintains records of electrical tests performed, but they were not provided for review.

2.2.2. Switchyard and Interconnection

The high side (38 kV) of the MPT is connected to the switchyard through overhead conductors and a short run of below-grade cable. The switchyards, 38 kV and 115 kV, are east of the gas turbine plant, across the

street. Revenue metering presently uses the current transformers (CTs) and PTs on the generator side of the MPT; the accuracy class of the CTs and PTs is not known. Switchyard metering is located in the switchyard control room; meters are not metering grade. The existing point of separation between generation and transmission (i.e., the demarcation point) is the low side of the MPT due to the division of PREPA responsibility on the maintenance of the MPT by transmission personnel. All maintenance on the large power transformers is performed by the conservation group within PREPA's substation group; however, this is expected to become the responsibility of the Plant operator. Engineering design is planned to identify and further separate the Plant from the PREPA transmission and distribution (T&D) system. The new point of separation will be at the disconnect switch in the switchyard. A high-level review of the separation required work is included in Sargent & Lundy's Report TD-0003, "Demarcation of PREPA Generation Assets from the Transmission and Distribution System" [Reference 1].

2.3. CONTROL SYSTEMS

The control system is centralized within the main controls enclosure and consists of MARK VI generator control cabinets, a Powerblock Station control cabinet, an operator console, a network cabinet, a relay, and metering cabinets. The system monitors, logs, alarms, and trends the Plant equipment. There are two MARK VI generator control cabinets to control the combustion turbines. The MARK VI cabinets are manufactured by GE and control one generator each. There is one operator console/control station that is used to control both units. The human-machine interface screen displays plant data and system status. There is a phone adjacent to the operator console for plant communications. There is one network cabinet for the site's communications and networking equipment. The relay and metering cabinets contain instruments and relays used to monitor the plant's electrical system.

2.4. STRUCTURES

There are several structures on site, including the controls enclosure that houses the controls equipment for both units, a fire suppression system enclosure, a battery enclosure, a telecommunications building, and a two-story structure with office space on the upper level and an open-air storage area beneath. Plant staff noted that the latter-mentioned two-story structure (shown in Figure 2-7) is only used on occasion, and Sargent & Lundy observed the doors to the office area were padlocked for security.

Figure 2-7 — Structures

Left: Two-story structure with office space above and open-air storage below. **Right:** Fire protection enclosure used for miscellaneous storage and housing tanks for the CO_2 fire suppression system (no longer in service at the site).

Other structures include the awnings over the fuel oil truck unloading equipment, fuel forwarding pumps, and used oil storage area.

3. EQUIPMENT CONDITION

The condition assessment of the Plant is a descriptive summary of the main equipment, facilities, balance of plant, and site-specific items of interest. The units are discussed individually, as a group where reasonable, or as a combined facility for common infrastructure assessment where applicable.

3.1. CONDITION ASSESSMENT

3.1.1. Methodology

Based on interviews, walkdowns, and data gathered on site and sent by PREPA, Sargent & Lundy developed a high-level overall condition assessment for each of the units using a scoring matrix. The matrix is comprised of six major categories: safety hazards, corrosion control, mechanical assessment, electrical assessment, instrumentation and controls assessment, and civil and structural assessment. A short description of each category is as follows:

- **Safety Hazards**—Based on visual observations during walkdowns from experienced engineering staff
- **Corrosion Control**—In consideration of the proximity to the coast and with respect to maintenance planning, capital costs, safety, and reliability
- **Mechanical Assessment**—A high-level review of all major mechanical equipment and systems
- **Electrical Assessment**—A high-level review of all major electrical equipment and systems
- **Instrumentation and Controls Assessment**—A high-level review of all major instrumentation and controls equipment and systems
- **Civil and Structural Assessment**—A high-level review of all major civil and structural equipment and systems

Each of the above categories was scored after Sargent & Lundy's site visits and includes a combination of visual assessment, interviewing, and data review, as indicated in the scoring tables. The color-coded scoring system for this assessment is defined in Table 3-1.

Table 3-1 — High-Level Condition Assessment Point Scoring System

	Like new (replaced or refurbished within the past five years)
	Maintained with general O&M on a routine basis; no major issues noted
	Deficiency noted or components out of service
	Major issues noted, causing a safety, reliability, or unit output issue
	Not in operation due to end of life

3.1.2. Overall Condition

The two Vega Baja units are in a condition expected of their age and vintage. Unit 1-1 was not running during the December 2020 site visit, but Plant staff noted that it was operational and available for dispatch at the full rated 21 MW; however, Unit 1-2 has experienced a recent failure in the second stage of the GT, which has rendered the unit inoperable since July of 2020.

3.1.2.1. Unit 1-1

Unit 1-1 generally scored well compared to other units of this vintage, most of which have been retired from service. The unit was not running during the December 2020 site visit, but Plant staff noted that it was operational and available for dispatch at the full rated 21 MW. Records of recent inspections were not available, but Plant staff noted that the unit was still subjected to regular combustion inspections performed by PREPA personnel. A summary of the Unit 1-1 and common equipment condition assessment is included in Table 3-2. More detailed assessments of both unit systems are discussed in the sections that follow.

Table 3-2 — Unit 1-1 and Common Equipment Overall Condition Assessment (As of Q1 2021)

Item	System	Assessment Method			Scoring Category				Notes
		Visual	Interview	Data	End of Life	Reliability	Unit Output	Subtotal	
1	**Safety Hazards**	yes	yes	no			*n/a*		No issues noted.
2	**Corrosion Control**	yes	yes	no			*n/a*		Rust observed in several areas.
3	**Overall Cleanliness & Housekeeping**	yes	yes	no	*n/a*		*n/a*		Insufficient vegetation control near the oil/water separator may clog equipment or piping and cause an environmental incident.
4	**Mechanical Assessment**								
4.1	Combustion Turbine	yes	yes	no					Unit 1-1 turbine was available for dispatch but was not operating during Dec. 2020 site visit. Surface rust observed on turbine casing and components.
4.2	Station Air System	yes	yes	no	*n/a*	*n/a*	*n/a*	*n/a*	No station air system, portable trailer-mounted compressor used for pneumatic tools and maintenance operations.
4.3	Emission controls	no	yes	no	*n/a*	*n/a*	*n/a*	*n/a*	The units do not include any emissions controls or monitoring equipment.
4.4	Fuel Systems	yes	yes	no					Some rust noted on piping, fittings and valves, one of the 2 x 100% AC fuel forwarding pumps was out of service.
4.5	Water Treatment	yes	yes	no	*n/a*	*n/a*	*n/a*	*n/a*	No water treatment performed at the plant, all water users fed by potable water from municipal PRASA supply.
4.6	Underground Piping	no	yes	no			*n/a*		The plant noted that there was no cathodic protection for underground piping, but no issues or leaks were reported during Dec. 2020 site walkdown.
4.7	Fire Protection Systems	yes	yes	no			*n/a*		The CO_2 fire suppression system was out of service. Hose stations, cart-mounted and hand chemical extinguishers were located in critical locations around the site.
5	**Electrical Assessment**								
5.1	Generator	yes	yes	no					No issues noted.
5.2	Transformers	yes	yes	no					No issues noted.
5.3	Switchgear	yes	yes	no					No issues noted.
5.4	Protective Relays	yes	yes	no			*n/a*		No issues noted.
5.5	Black Start Engines	yes	yes	no					The plant's single 100kW black start diesel generator is operational and is tested for 15-20 min every 2 weeks. BSDG overheats if run for more than 30 min.
6	**Instrument and Controls Assessment**								
6.1	Plant Controls	yes	yes	no					No issues noted.
6.2	Turbine Controls	yes	yes	no					Units operate on Mark VI controls system. No plans for upgrades were noted.
7	**Civil / Structural Assessment**						*n/a*		
7.1	Buildings	yes	yes	no			*n/a*		Control enclosure was serviceable, other buildings were generally unused and had fallen into disrepair.
7.2	Structural Steel	yes	yes	no			*n/a*		Some corrosion noted at the bases of several structural columns.
7.3	Tanks / Containment	yes	yes	no			*n/a*		Fuel storage tank S-1 was refurbished in 2017 and returned to service. Smaller tanks are not used for operation and will be relocated. Tank containment appeared to be in good condition.
7.4	Cranes	no	yes	no	*n/a*	*n/a*	*n/a*	*n/a*	Site has no permanent cranes. PREPA hires a third party contractor to provide cranes for maintenance as needed.
8	**Overall Condition Assessment**								Major issues were noted.

3.1.2.2. Unit 1-2

Unit 1-2 generally scored comparably to other units of this vintage. The unit was not operational during the December 2020 site visit, and records show that the unit had been forced offline in July of 2020 due to a failure in the second stage of the combustion turbine. The Plant staff noted that Unit 1-2 was expected to be reparable and returned to the full rated 21 MW in Q4 of 2021. Records of recent inspections were not available, but Plant staff noted that the unit was still subjected to regular combustion inspections performed by PREPA personnel, the most recent of which took place in 2019. A summary of the Unit 1-2 condition assessment is included in Table 3-3. More detailed assessments of both unit systems are discussed in the sections that follow.

Table 3-3 — Unit 1-2 Overall Condition Assessment (As of Q1 2021)

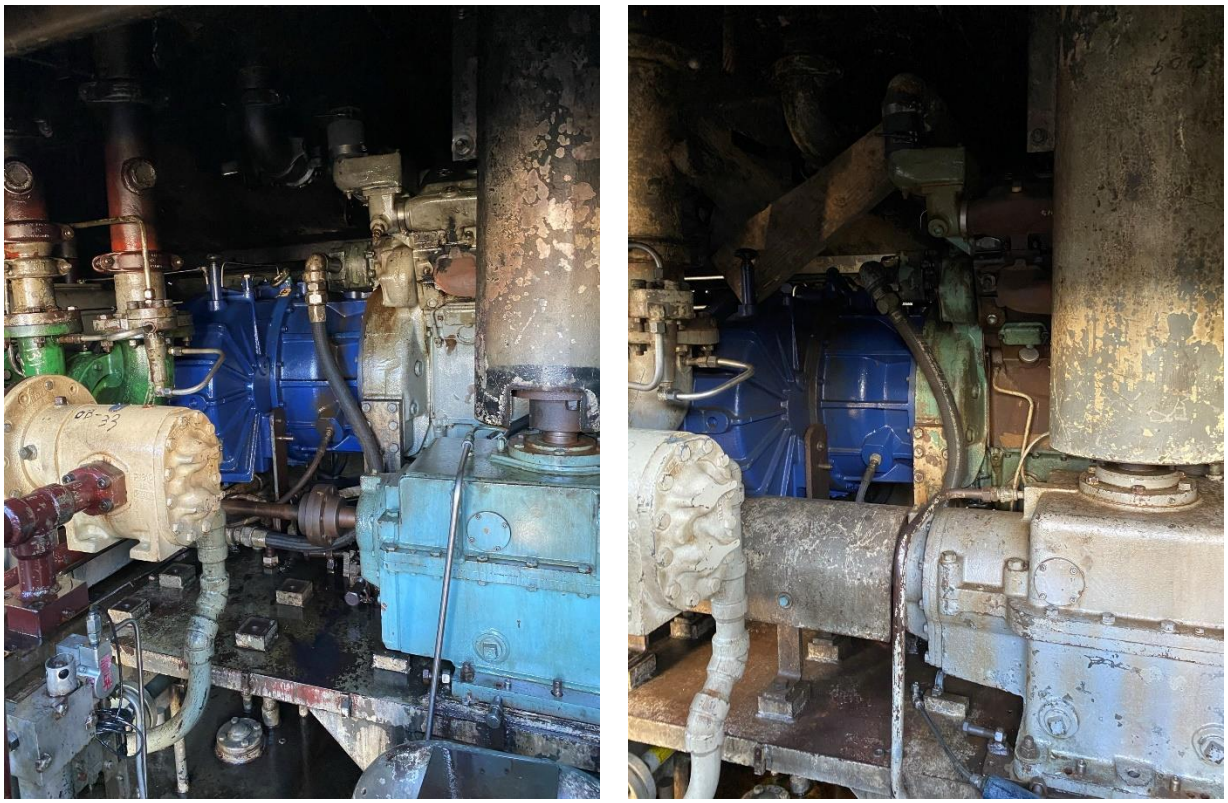
Item	System	Assessment Method			Scoring Category				Notes
		Visual	Interview	Data	End of Life	Reliability	Unit Output	Subtotal	
1	**Safety Hazards**	yes	yes	no			*n/a*		No issues noted.
2	**Corrosion Control**	yes	yes	no			*n/a*		Rust observed in several areas.
3	**Overall Cleanliness & Housekeeping**	yes	yes	no	*n/a*		*n/a*		Insufficient vegetation control near the oil/water separator may clog equipment or piping and cause an environmental incident.
4	**Mechanical Assessment**								
4.1	Combustion Turbine	yes	yes	no					Unit 1-2 turbine was in a forced outage since July 2020 as of the Dec. 2020 site visit. Outage caused by a failure in the 2nd stage of the turbine, repair and return to service TBD. Surface rust observed on turbine casing and components similar to Unit 1-1.
4.2	Station Air System	yes	yes	no	*n/a*	*n/a*	*n/a*	*n/a*	No station air system, portable trailer-mounted compressor used for pneumatic tools and maintenance operations.
4.3	Emission controls	yes	yes	no	*n/a*	*n/a*	*n/a*	*n/a*	The units do not include any emissions controls or monitoring equipment.
4.4	Fuel Systems	yes	yes	no					Some rust noted on piping, fittings and valves, one of the 2 x 100% AC fuel forwarding pumps was out of service.
4.5	Water Treatment	yes	yes	no	*n/a*	*n/a*	*n/a*	*n/a*	No water treatment performed at the plant, all water users fed by potable water from municipal PRASA supply.
4.6	Underground Piping	no	yes	no			*n/a*		The plant noted that there was no cathodic protection for underground piping, but no issues or leaks were reported during Dec. 2020 site walkdown.
4.7	Fire Protection Systems	no	yes	no			*n/a*		The CO_2 fire suppression system was out of service. Hose stations, cart-mounted and hand chemical extinguishers were located in critical locations around the site.
5	**Electrical Assessment**								
5.1	Generator	yes	yes	no					No issues noted.
5.2	Transformers	yes	yes	no					No issues noted.
5.3	Switchgear	yes	yes	no					No issues noted.
5.4	Protective Relays	yes	yes	no			*n/a*		No issues noted.
6	**Instrument and Controls Assessment**				*n/a*	*n/a*	*n/a*	*n/a*	
6.1	Turbine Controls	no	no	no	*n/a*	*n/a*	*n/a*	*n/a*	
7	**Civil / Structural Assessment**						*n/a*		
7.1	Structural Steel	no	no	no			*n/a*		Some corrosion noted at the bases of several structural columns.
8	**Overall Condition Assessment**								Major issues were noted.

3.1.3. Combustion Turbines

The simple-cycle GTs at Vega Baja are serviceable but advanced in age and do not have the heat rates that would be expected of newer units built with modern technological advances. Plant staff notes that the GTs are regularly inspected with the equivalent operating hour (EOH) periodicity recommended by the original equipment manufacturer (OEM) and that these inspections are performed by PREPA staff. Also due to their age and approaching retirement horizon, the peaker facilities are given low priority among PREPA generators for operational and maintenance funding. The limited maintenance budgets afford minimal preventative care, and only the most critical repairs and replacements are approved.

The GT casings and components housed in the GT enclosures showed coating degradation and some surface rust, as would be expected on units of this vintage. The Plant staff notes that budgetary constraints limit maintenance activities, which for many subsystems now includes only the replacement of failed components as necessary to maintain unit operability. Newer-looking coatings on several components within the accessory enclosure provide evidence of such replacements being made recently, and the nameplate on the Unit 1-2 Lufkin accessory gearbox indicates that it was rebuilt in 2019. Figure 3-1 through Figure 3-4 are provided to characterize the general condition of the Unit 1-1 and Unit 1-2 GT units.

Figure 3-1 — GT Accessory Enclosure

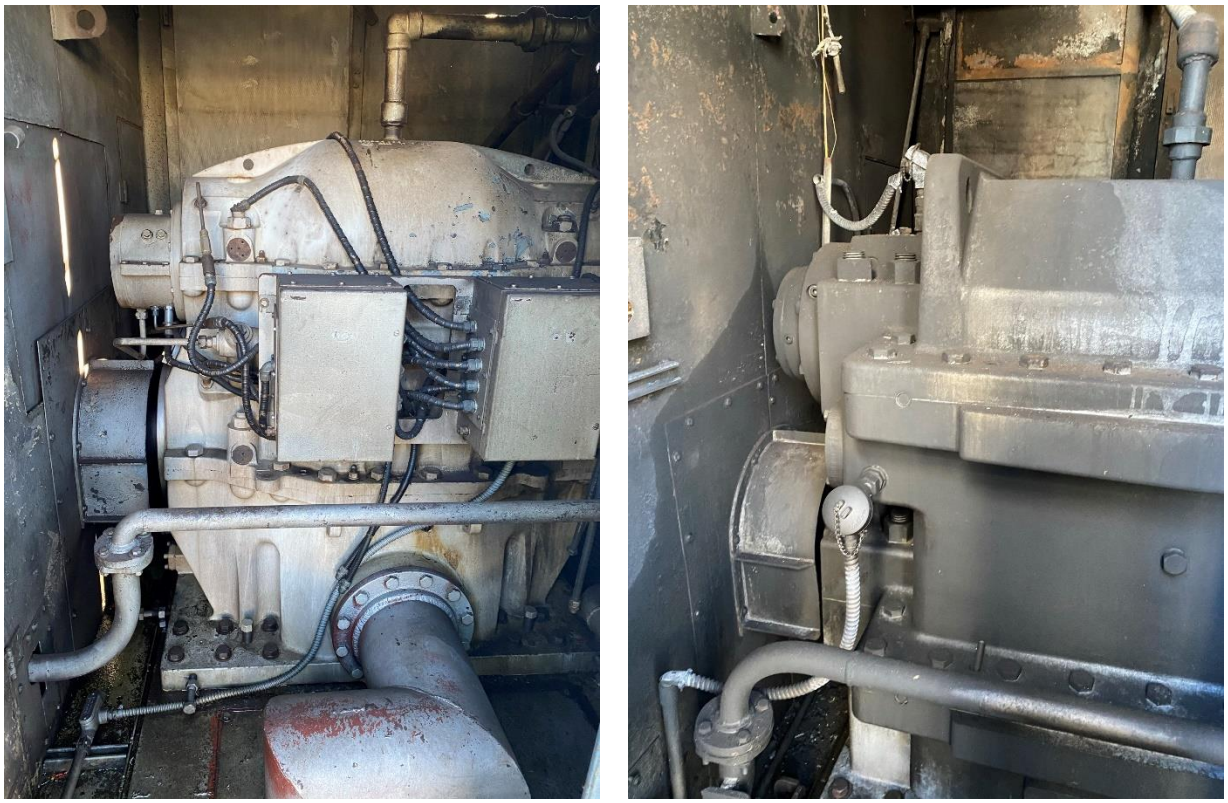


Left: Unit 1-1 accessory enclosure. Note the varying apparent ages of accessory equipment and missing guard on the rotating shaft. **Right:** Unit 1-2 accessory enclosure, similar to Unit 1-1 but guard is installed over rotating shaft and coupling.

Figure 3-2 — Turbine Compressor Discharge Casings

Left: Unit 1-1 turbine casing. Note the pervasive surface rust. **Right:** Unit 1-2 turbine casing. Note the superior coating coverage to Unit 1-1.

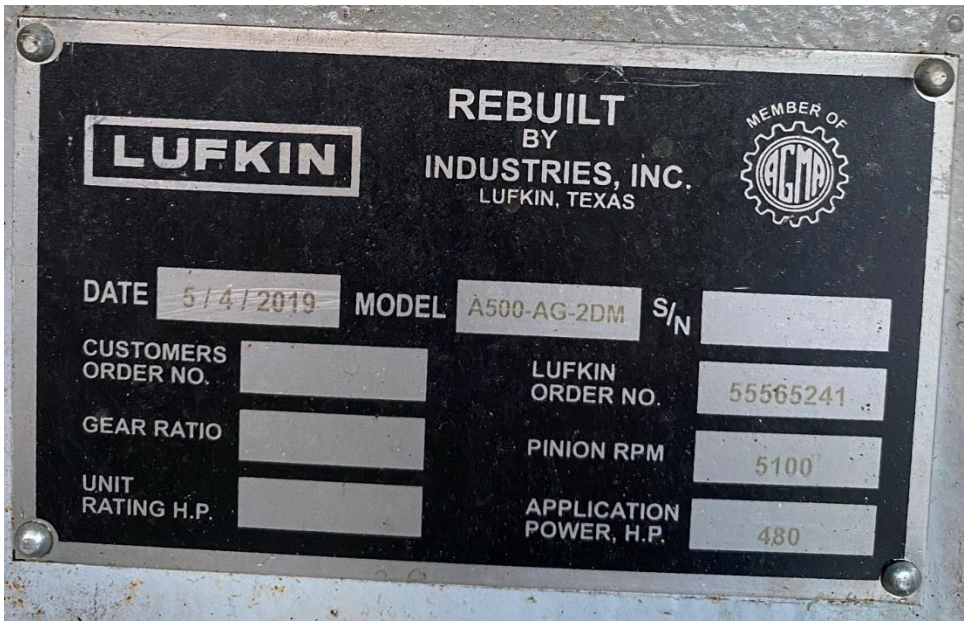
Figure 3-3 — GT/Turbine Gearbox



Left: Unit 1-1 gearbox. Note the newer casing design and more robust thermocouple array compared to the Unit 1-2 gearbox (right).

The interior of the Unit 1-1 accessory enclosure compartment showed evidence of leaked oil on the floor that could present an elevated fire hazard if the proper ignition conditions were created. Sargent & Lundy recommends that the plant exercise good housekeeping practices within the GT enclosures for as long as the units remain in service.

Figure 3-4 — Unit 1-2 Accessory Gearbox Nameplate



The combustion air intake for each unit includes a length of duct extending over the accessory enclosure to a grade-mounted filter house. Doors on the sides of these filter houses permit access to the filter racks for inspection and replacement. In general, these filter enclosures and the connecting ductwork were in good condition, considering the units' age, and appeared to be regularly maintained. Sargent & Lundy noted pronounced corrosion on the enclosure exterior around the filter access doors; it should be addressed promptly to prevent air and particulate infiltration around the filters. Figure 3-5 and Figure 3-6 illustrate the condition of the Unit 1-1 and 1-2 filters and filter house enclosures.

Figure 3-5 — Unit 1-1 GT Combustion Air Intake Filter House

Left: Exterior of Unit 1-1- filter house and access doors showed significant corrosion. **Center:** Unit 1-1 prefilters were dirty, and Plant staff noted that they were due for replacement. **Right:** Unit 1-1 primary filters appeared to be in good condition. Sargent & Lundy observed that the filter enclosure was also being used for storage of unrelated maintenance components.

Figure 3-6 — Unit 1-2 GT Combustion Air Intake Filter House

Left: Unit 1-2 prefilters looked clean and new; Plant staff noted that they had recently been replaced. **Right:** The Unit 1-2 primary filters and enclosed area were clean and serviceable.

3.1.4. Generators

Both of the BRUSH generators from the Plant's original commissioning remain in service, with nameplates dated in 1970. The generator enclosure's exterior was in good condition with generally adequate coating throughout and minimal corrosion noted. Access inside the generator enclosure was not provided, but a visual inspection of the collector ends of the generators revealed minimal corrosion or cause for concern. Testing on the generator breakers occurs every eighteen months, and testing on the bus bar occurs every three years. PREPA has noted that excessive humidity has caused electrical failures on the bus bar.

Figure 3-7 — Generator Collector End and Enclosure

Left: Collector end of Unit 1-1 BRUSH generator. Note that equipment appears in good condition with minimal corrosion. **Right:** Exterior of Unit 1-2 generator enclosure in good condition with minor corrosion.

3.1.5. Water Systems

3.1.5.1. Potable Water

The potable water connection to the PRASA municipal water system, as well as much of the onsite water piping, is underground; thus, it could not be inspected during the site walkdown. Facility plumbing and service water hose spigots on site were serviceable, and emergency eyewash stations and fire hose stations appeared to be in working condition but were not tested during the walkdown. No issues with the potable water system were noted by the Plant staff.

3.1.5.2. Cooling Water

Plant staff did not report any issues with the self-contained closed cooling water systems on the two units, but the radiator mounting bolts on the exterior wall of the accessory enclosure were rusted. The plant frequently rinses these radiators with water from the potable water system, a practice which appears to be accelerating the corrosion of the radiator hardware and enclosure steel beneath them. Sargent & Lundy also observed a portable ladder that had been left in place to access the roof-mounted AC units for

maintenance. Plant staff indicated that the refilling of the cooling water reservoir was required with some frequency, indicating that water is likely leaking from somewhere in the system when it is operational. Because the unit was not running during the site walkdown, Sargent & Lundy was unable to confirm this suspicion but recommends correcting any leaks to prevent a complete failure of the closed cooling water system.

Figure 3-8 — Closed Cooling Water System

Left: Unit 1-1 accessory enclosure (east side) with closed cooling water radiators. Note that the enclosure doors show corrosion to a greater extent than most enclosure exteriors on site. **Right:** West side of Unit 1-1 accessory enclosure.

3.1.5.3. Site Drainage System

As noted in Section 2.1.3.3, an oil-water separator collects drainage from the units, fuel oil storage tank containment, and various other curbed containments on site. Shown in Figure 3-9, the open-air concrete pit has become somewhat overgrown with vegetation. Plant staff did not note any operational issues with the drainage system; however, Sargent & Lundy recommends more diligent vegetation control in this area, as biological debris introduced into the system from this overgrowth has the potential to clog coalescing media, trash screens, and effluent piping.

Figure 3-9 — Oil-Water Separator

Left: Photographs of the oil-water separator show vegetation encroachment. Oil collected at the surface of this collector is manually pumped out with vacuum trucks, and water effluent is gravity-drained into the PRASA storm sewer system.

Plant staff also noted that none of the underground piping for the water supply and drainage systems is equipped with cathodic protection. Engineered drawings of this system were requested to verify the materials of the underground piping, but these were not made available for review. If the buried piping is metallic and lacks cathodic protection, there is a high risk of accelerated corrosion due to the galvanic interaction with the surrounding soil. Sargent & Lundy recommends that the material of this underground piping be verified and that the integrity be checked periodically, as any leaks of the oily water contents would present an environmental concern.

3.1.6. Fuel Systems

Most equipment in the fuel oil truck unloading area is over 20 years old; elements therein show varying degrees of degradation. The unloading pump and motor were manufactured in 1992 but have robust coatings and exhibit minimal corrosion. The Brooks BiRotor positive displacement flowmeter is functional, but antiquated, designed to record delivery volumes with a mechanical printout. Most piping is adequately coated with minor surface rust observed in high-traffic areas where paint has worn off, and most corrosion

is concentrated at flange bolts and exposed valve shafts and hand wheels. The metal awning and curbed containment appear to be in good condition and serviceable to provide the necessary weather protection and spill containment functions.

Figure 3-10 — Truck Unloading System

Left: An overview of the truck unloading station. **Right:** The switch used to initiate the truck unloading pump. Photos show characteristic signs of aging, with chipped paint and minor surface rust, but the system remains serviceable.

Fuel Oil Storage Tank S-1 at Vega Baja was repaired and recoated in 2017 as a part of PREPA's fleetwide tank maintenance program. During the December 2020 walkdown, the tank was observed to be in good condition, with no signs of leakage in the containment, but some valves and fittings that were recoated during the 2017 refurbishment are showing cracked and chipped coatings with rust blooms (see Figure 3-11). As with all coated steel on site, Sargent & Lundy recommends diligent monitoring of coating systems and recoating as necessary to ward off corrosion and premature failure.

Figure 3-11 — Fuel Storage System Valves

Left: Fuel forwarding pump suction line isolation valve with corrosion around the valve stem and packing gland.
Right: Tank fill line isolation valve with rust blooms on the handwheel, and corrosion on the stem and packing gland.

Plant staff reported that the fuel forwarding system was operational during the December 2020 walkdown, but substantial pooled oil was observed inside the pump containment curbing. In addition, one of the two 15-hp AC motors was found to be removed from its pump, disconnected from its power cabling, and placed in the side of the fuel forwarding skid containment curb. Sargent & Lundy recommends that the oil spill be cleaned and the motor be repaired and reinstalled to reestablish the 2 x 100% redundancy of the fuel forwarding system.

3.1.7. Fire Protection

As noted in Section 2.1.5, the Plant's original CO_2 fire protection system is not operational. The interior of the CO_2 fire suppression enclosure is cluttered, and the cylinders are not properly secured which could present a hazard if one were to fall and incur damage to the nozzle end. A rapid discharge of residual pressure in such an event could make the cylinder a dangerous projectile.

Fire protection for the units is currently provided by handcart-mounted dry-pressure transfer extinguisher assemblies located next to the combustion turbines and, by hose stations, connected to the potable water

system. Other fire risk areas, like the used oil drum storage area and the fuel oil truck unloading station, are equipped with hand extinguishers. All of these extinguishers and hose stations require manual operation in close proximity to the fire, placing the operator at elevated risk. Furthermore, a fire originating inside a closed turbine enclosure may be inaccessible by these means of suppression.

Considering the evidence of oil leakage observed in several areas of the site, and the likelihood of future pressure component failures within the fuel system due the advanced age of the units, the probability of a fire incident at the Vega Baja site appears to be elevated and rising over time. It is unclear whether the legacy CO_2 system could be returned to service, and the present handcart chemical extinguishers and water hose alternatives may not provide sufficient suppression to contain a larger fire incident if one were to occur. For these reasons, Sargent & Lundy recommends a consultation with the local fire marshal to discuss least-cost solutions to improve the site's fire safety capabilities for the next several years of operation.

Figure 3-12 — Plant Fire Protection Hand-Carts

Hand-cart fire extinguishers placed in accessible locations around the site.

3.1.8. Miscellaneous Equipment and Structures

Structural steel on site appears to be generally serviceable, but some pronounced corrosion was noted on and around the base plates of several of the combustion air intake duct support columns; it should be addressed before the structural integrity is compromised (see Figure 3-13). Plant staff notes that these coating issues would typically be addressed by PREPA's ongoing fleetwide coating maintenance program.

Figure 3-13 — Inlet Air Duct Support Column Bases

Extensive corrosion observed around the base of several combustion air intake duct support columns.

The plant security fencing generally appeared to be in functional working order, but there were some areas in which the barbed wire at the top was severely compromised. The Vega Baja plant employs manned security 24 hours a day; however, passive security features like these are valuable to the protection of PREPA's assets housed therein. Sargent & Lundy recommends repair of damaged barbed wire segments and enhancement with more effective concertina wire for added security.

Figure 3-14 — Site Security Fences

Left: Segment of fence with compromised barbed wire fence extensions. **Right:** Section of security fencing with concertina wire enhancement.

The used oil storage structure appeared to be reasonably organized and maintained. The north end of the structure includes a steel rack for storing barrels on their sides to permit gravity drawdown while a drip pan and containment beneath the grating prevents oil spills from contaminating the site (see Figure 3-15).

Figure 3-15 — Used Oil Storage Area

Left: Overview of the used oil storage area. **Right:** The north end of the oil storage structure used to draw oil from the drums. Note the drip pan and grating over the curbed containment to prevent and protect against oil spills.

The two-story structure with office space above and open-air storage below appeared to be in serviceable condition, but Plant staff noted that it was rarely used. Sargent & Lundy was not granted access to the padlocked office area, so the interior condition could not be confirmed. Based on the age and apparent neglect of this structure, substantial renovations would be required if PREPA elected to use it for future operations.

Sargent & Lundy also noted significant rusting on the heating, ventilation, and air conditioning units mounted outside the telecom room. Plant staff indicates that this building is no longer used with any regularity. If PREPA intends to use this building in the future, these units should be replaced to ensure proper climate control and protection of any electronics housed inside it.

3.1.9. Electrical Equipment

3.1.9.1. Transformers

The MPT appeared to be in good working condition. Visual inspection did not reveal any damage to the transformer tank, radiator banks, bushings, or control cabinet. There was some minor rusting on the transformer tank and along its base, which is to be expected for a 50-year-old transformer operated in a tropical environment. PREPA indicated that there are no known operating issues at this time (e.g., gassing) and a dissolved-gas analysis is performed on a yearly basis. It is not known if the MPT has been subjected to through-faults. Maintenance records are kept in the planning and contracts archive in the Monacillos Durotex Building. The overhead cable connections showed no signs of deterioration and were in good condition. The non-segregated bus showed signs of typical wear and tear, including minor rusting, but nothing that would impact operations or maintenance. The transformer pad showed signs of wearing and cracking. The transformer oil containment was free of oil but had vegetation and loose debris. Signs of wearing and cracks were visible in the containment.

3.1.9.2. Battery Room

The station batteries appeared in good condition, and a visual inspection did not reveal any wearing or damage (see Figure 3-16). PREPA indicated that the batteries are regularly maintained and that there are no known issues. The battery room floor did not show any signs of damage due to battery leakage. The cables connected to the batteries were not in good condition, and several had long lengths covered by electrical tape. From the conduit overhear, the cables were “free air” down to the batteries. The exhaust fan was operating and appeared in good condition.

Figure 3-16 — Battery Room

Left: Batteries appear to be in good condition with no signs of corrosion. **Right:** Terminal cabling showed fraying insulation held together by electrical tape in places.

3.1.9.3. Miscellaneous Electrical

Throughout the site, cables (power, control, communications) were hung loosely, including along boundary fences, and were not protected by raceway. No damage to cabling was visible besides that noted elsewhere in this report. The scope of the fiber optic and communications cabling was not known by Plant personnel, as it is handled by a separate group.

Plant staff also noted that there was not a plant-wide alarm system.

3.1.10. Emergency Diesel Generator

The diesel generator enclosure and internals appeared in good condition. A visual inspection showed no signs of rusting or damage to the enclosure or its internals. PREPA stated that the diesel generator is run about every two weeks for approximately 15–20 minutes. PREPA indicated that the diesel generator cannot run for more than 30 minutes due to overheating. It is unknown if the overheating occurs during test mode or with load on the generator. Visual inspection of the underground cables could not be performed.

3.1.11.Controls Enclosure

The controls enclosure, which houses all the controls equipment critical to the operation of the units, is the only enclosure regularly occupied on a daily basis. The overall enclosure appears to be weather tight and fully functional, but some concerns were noted with the condition and arrangement of the equipment inside.

The MARK VI cabinets look to be in good condition, and visual inspection revealed no signs of wearing or damage. PREPA has indicated that the MARK VI cabinets are maintained and tested by a third-party. The operator console is in good condition and appears to be newer relative to other equipment on site. The network cabinet consists of a loose rack of network and communications equipment that appeared to be in working condition. It does not have any doors of other means to prevent tampering or accidental damage.

The relay and metering cabinets appear in good condition. There is a mix of electromechanical and electrical relays that look to be fully functional; all relays are readily accessible and viewable. There are signs of retrofitting on the front of the cabinets where old equipment was removed and/or replaced. There are also several openings on the front of the cabinets where equipment was removed.

The MCCs for both units appeared to be in working condition. Visual inspection revealed minor rusting on one MCC and signs of wear. Both MCC lineups were dirty, but that does not affect performance. There were several breaker compartment doors that were missing components/instruments, were not covered with a plate, or did not fully close (see Figure 3-17). This poses a serious safety concern to any personnel or equipment in the controls enclosure if there is an arc flash event at the MCCs. Sargent & Lundy recommends providing covers for any openings in the MCCs and fixing or replacing compartment doors that cannot close.

Figure 3-17 — Controls Enclosure

Left: Inside the controls enclosure that houses the Mark VI controls systems and MCCs for both units. **Right:** MCC cabinets inside the controls enclosure. Note the upper compartment door without a control switch or cover plate.

3.2. RECOMMENDATIONS

Recommendations for the Plant focus on two elements of the facility: the two power generation units and the common systems. In the previous sections, the facility's age, condition, and designs have been addressed where appropriate. The discussion in this section will concentrate on what to rectify, upgrade, or replace as applicable.

Understanding that the Vega Baja GTs are expected to be retired in the near future, this report does not include recommendations for large capital investments for improvements to greatly extend the life of these units. Guidance is limited to improvements and maintenance practices that will mitigate life-safety and environmental risks, avoid potential catastrophic failures, or otherwise improve the facility for its continued use when new generation is added to the site.

3.2.1. Recommendations for Units 1-1 and 1-2

Sargent & Lundy noted degraded prefilter elements in the Unit 1-1 filter house and pronounced corrosion on the enclosure exterior around the filter access doors. Sargent & Lundy recommends that the filters be replaced regularly and that corrosion in the housing be addressed promptly to prevent air and particulate infiltration around the filters from reaching the turbine.

The GT accessory enclosure compartments showed evidence of leaked oil on the floor; this could present an elevated fire hazard if the proper ignition conditions were created. Sargent & Lundy recommends that the plant exercise good housekeeping practices and clean up any spilled oil within the GT enclosures for as long as the units remain in service.

Sargent & Lundy recommends that the MPT be inspected and tested on a regular basis. The cracking in the pad and containment should be repaired but does not appear to be significant enough to impact performance; it is recommended that both are repaired when the MPT is replaced. The loose debris and vegetation should be cleared from the oil containment area.

3.2.2. Recommendations for Common Systems

Sargent & Lundy has the following recommendations for the common systems:

- Sargent & Lundy recommends that the compartment doors that cannot close be fixed and any openings in the doors be covered with a plate. If all these items cannot be fixed, then new MCCs should be purchased. Due to the age of the MCCs, maintenance and testing should be performed on a regular basis. It is also recommended that master nameplates or tags be added to each lineup that clearly indicates voltage, amperage, etc.
- For the generator electrical enclosure, the manufacturer-recommended maintenance and testing should be followed per the manuals; PREPA indicated that the manuals are available. Sargent & Lundy recommends that space heaters be added to the enclosure to prevent moisture buildup on the bus bars.
- No changes to the maintenance and testing are recommended for the MARK VI cabinets.
- For the operator console, it is recommended that the security software is kept up to date.
- For the network cabinet, it is recommended to put the network and communications equipment within a lockable cabinet to prevent tampering or damage.
- For the relay and metering cabinets, Sargent & Lundy recommends putting cover plates over any openings. Openings pose a safety concern, as there is the potential for a shock hazard. They also allow for dirt or debris to get in the cabinets, which has the potential to trip the unit(s).
- It is recommended that a plant-wide alarm system be installed to provide audible local alerts for critical events.

- The diesel generator cannot perform its function due to the run-time limitations imposed by the overheating issues. Sargent & Lundy recommends that the source of the issue be determined and fixed. The bi-weekly running of the diesel generator should continue in accordance with manufacturer's recommendations.
- Sargent & Lundy recommends that the current battery maintenance and testing continue. Due to the damaged state of the cables, it is recommended that they be replaced. To prevent future damage to the cables, Sargent & Lundy also recommends that they be routed through the raceway (cable tray, conduit, etc.) all the way to the batteries.
- It is recommended that all aboveground cables be routed through the raceway to prevent damage or destruction from weather, accidents, wildlife, etc. and provide additional safety to Plant personnel.
- Several areas within the site have become overgrown with vegetation. Sargent & Lundy recommends more diligent vegetation control, as biological debris can contribute to fire hazards and the clogging of plant drainage systems.
- Plant staff noted that none of the underground piping for the water supply and drainage systems is equipped with cathodic protection. Sargent & Lundy recommends that this underground piping be checked for leaks, as the oily water contents of the drain piping are an environmental concern.
- Significant corrosion was observed on equipment, enclosures, piping, valves, and structural steel at Vega Baja. Sargent & Lundy recommends diligent monitoring of coating systems and recoating as necessary to ward off corrosion and premature failure.
- Pooled oil was noted in the fuel forwarding pump containment, and one of the two 15-hp AC motors was removed from its pump and disconnected from its power cabling. Sargent & Lundy recommends that this oil be cleaned up and the motor be repaired/replaced and reinstalled to reestablish the 2 x 100% redundancy of the fuel forwarding system.
- It is unclear whether the legacy CO_2 fire suppression system could be returned to service. The present hand-cart chemical extinguishers and water hose alternatives require manual intervention and may not provide sufficient suppression to contain a larger fire incident if one were to occur. For these reasons, Sargent & Lundy recommends a consultation with the local fire marshal to discuss least-cost solutions to improve the site's fire safety capabilities for the next several years of operation.
- Some areas of the barbed wire at the top of the perimeter fencing was severely compromised. The Vega Baja plant employs manned security 24 hours a day; however, passive security features like these are valuable to the protection of PREPA's assets housed therein. Sargent & Lundy recommends repair of damaged barbed wire segments and enhancement with more effective concertina wire for added security.

4. INFRASTRUCTURE AND INTERCONNECTIONS

4.1. FUEL SUPPLY

The units operate on No. 2 fuel oil, stored onsite in a single tank with a nameplate capacity of 6,581 bbls. Fuel is delivered via tanker trucks and unloaded into the storage tank using the onsite truck unloading pump station.

On November 21, 2019, PREPA entered a contract (Contract 902-01-19) with Puma Energy Caribe, LLC for the supply of No. 2 fuel to all the PREPA plants that operate with this fuel. The original term of the contract was for one year, but the contract includes a provision for an automatic extension upon mutual agreement. PREPA and Puma Energy Caribe are currently finalizing details for the extension of the contract until November 20, 2021.

In 2021, PREPA will undergo a competitive process to secure its next No. 2 fuel oil supply agreement.

4.2. WATER SUPPLY AND TREATMENT

The Plant uses a municipal potable water supply from PRASA for domestic use in the facility buildings, firehose stations, service-water hose stations, and the eyewash and safety showers on site. There are no onsite potable water storage tanks or pumps; thus, the station's potable water system is completely dependent upon the municipal service. Plant staff notes that the water received is typically hard, so it is filtered before being used for makeup to the unit cooling water systems.

Drains from the units and curbed containments that may be subject to oil contamination are directed to the plant's oil-water separator. Vacuum trucks periodically remove the oil which settles to the top of the separator, and water effluent is discharged back to the municipal sewer system.

5. OPERATIONS AND MAINTENANCE

The Vega Baja GT units were designed to provide rapid response peaking capacity to complement PREPA's larger base-loaded units connected to the grid. Unlike the base-loaded fossil fuel combustion generation units in PREPA's fleet, the GTs at Vega Baja are not subject to periodic environmental outages. Due to the population density in the area around the Plant, operating hours are limited from 6:00 am to 10:00 pm to limit noise. While the units were originally designed for remote start, the aged equipment has developed issues requiring an operator on site trained to follow special protocols to bring each unit online.

5.1. STAFFING AND TRAINING

At the time of the December 2020 site visit, Vega Baja was staffed with one person operating and performing minor maintenance on the units. The regular shift is Monday through Friday 7:30 am to 4:00 pm. Most maintenance activities are performed by third parties or by staff borrowed from the larger local PREPA generating facilities. Limited budget allocations to the peaker facilities prohibit many of the capital expenditures that would be required for equipment upgrades and typical preventative maintenance activities. Critical fuel oil tank maintenance and re-coating of piping, enclosures, ductwork, structural steel, etc. for corrosion protection is performed under PREPA fleetwide maintenance programs.

5.2. MAINTENANCE PROGRAMS

5.2.1. Overview

As noted above, the Plant lacks sufficient budget for many of the preventative maintenance activities that would normally be performed at a generating facility. Due to the advanced age of the GTs, the OEM no longer provides service for the units at Vega Baja, and the Plant staff procures replacements for critical components from third-party vendors that sell new or refurbished equipment compatible with the Frame 5 design. A third-party contractor provides crane support on site for the larger maintenance activities.

The main objective of PREPA's maintenance plan is to use preventative maintenance in conjunction with predictive techniques developed at the plant level. Maintenance is performed using the OEM's specifications, Plant experience, Plant routine inspections, equipment monitoring, and O&M manuals as applicable. For the Vega Baja units, there is not a standing formal service agreement with the GT manufacturer, and agreements are entered with various third parties as needed to address preventative maintenance and corrective issues with the units. The plant has a limited workshop capability, and major equipment spares, if stocked, are kept in the centralized PREPA warehouse at the Palo Seco facility to limit the budgetary strain on individual peaker facilities.

5.2.2. Preventative Maintenance

Plant staff noted that the preventative maintenance program for PREPA's peaker plants was dismantled between 2010 and 2012. Turbine inspections are now generally limited to combustion (Class A) inspections performed by PREPA mechanics at the manufacturer's recommended equivalent operating hour (EOH) intervals. Major inspections are not regularly performed and require special budget approval. As is typical with units of this vintage, major inspections and work including replacement parts and overhauls are procured and contracted with third party entities, and the turbine OEM is no longer engaged for any of the GT maintenance or inspection activities. The standard inspection types for GE gas turbines of this size are summarized below.

- **Combustion Inspection (Class A)—**The combustion inspection is a relatively short disassembly inspection of fuel nozzles, liners, transition pieces, crossfire tubes and retainers, spark plug assemblies, flame detectors, and combustor flow sleeves. This inspection concentrates on the combustion liners, transition pieces, fuel nozzles, and end caps, which are often the first to require replacement and repair. Proper inspection, maintenance, and repair of these items helps to ensure a longer life of the downstream parts, such as turbine nozzles and buckets

- **Hot-Gas Path Inspection (Class B)—**The purpose of a hot-gas path inspection is to examine those parts exposed to high temperatures from the hot gases discharged from the combustion process. The inspection includes the full scope of the combustion inspection and a detailed inspection of the turbine nozzles, stator shrouds, and turbine buckets. To perform this inspection, the top half of the turbine shell must be removed.

- **Major Inspection (Class C)—**The purpose of the major inspection is to examine all of the internal rotating and stationary components from the inlet of the machine through the exhaust. Major inspections are scheduled in accordance with the recommendations in the owner's O&M manual or as modified by the results of previous borescope and hot-gas path inspections. The work scope involves inspection of all of the major flange-to-flange components of the gas turbine, which are subject to deterioration during normal turbine operation. This inspection includes previous elements of the combustion and hot-gas path inspections and requires laying open the complete flange-to-flange gas turbine to the horizontal joint

The typical order of these inspections will be a repeating sequence of "A-B-A-C" at 4,000 EOH intervals such that a major (Class C) inspection takes place every 16,000 EOH and, between each major, there is a combustion (Class A), minor (Class B), and another combustion inspection at 4,000 EOH intervals. As

noted above, inspections of the peaker facility gas turbines are now typically limited to combustion (Class A) inspections performed by PREPA personnel.

5.2.3. Corrective Maintenance

Corrective maintenance for PREPA's peaker units is conducted on an as-needed basis. Due to the low dispatch of the units, corrective maintenance can generally be performed as required when the unit is not dispatched. Maintenance and operational issues are recorded in a log by the operations staff, prioritized by plant and PREPA corporate management, and dealt with when possible during forced and scheduled outages. To the greatest extent possible, corrective maintenance requiring an outage is performed during the planned outages for the GTs in parallel with the GT inspection and maintenance activities.

Part requisitions are routed through PREPA's purchasing department using the Ventyx™ Asset Suite purchasing software. As budgets for the older and less used plants have been prioritized below the other newer plants, maintenance requests, including part and supply requests, have been delayed or deferred as necessary. Plant personnel have been conscientious of this and typically limit their budgetary requests to fund component replacement and maintenance activities most critical to sustaining unit operability.

5.2.4. Predictive Maintenance

Predictive maintenance for Vega Baja is limited to vibration monitoring, which is a standard element of the SPEEDTRONIC™ Mark VI turbine control system. Inputs from the turbine Proximitor®, Velomitor®, and accelerometer probes are fed back to the controls system to provide operations with early indication of misalignment or imbalance issues prior to equipment failure.

5.3. MAINTENANCE AND OUTAGE SCHEDULES

Sargent & Lundy requested, but did not receive, complete historical planned maintenance and outage information for the Plant. A catastrophic failure of the Unit 1-2 combustor nozzle has left the unit in a forced outage since July of 2020. Plant staff notes that a combustion inspection of Unit 1-2 took place in 2019, but an inspection report was unavailable since they did not have the staff or budget to draft one. PREPA currently has a six-year tank inspection program underway to evaluate tanks at all of their facilities per API code and spill prevention, control, and countermeasure (SPCC) compliance and prioritize maintenance. The refurbishing of Fuel Storage Tank S-1 at Vega Baja was completed in 2017; it will not likely need further service under this program.

5.4. SPARE PARTS

No spare parts list was available for review during the December 2020 site visit, and plant staff noted that major equipment spares were not retained on site at Vega Baja. To conserve the modest facility budgets, the peaker plants do not stock many of their own spare parts and depend on the inventory kept at the central PREPA facility in Palo Seco or requisitions directed to PREPA's purchasing department using the Ventyx™ Asset Suite purchasing software as needed for critical repairs.

5.5. ENERGY MANAGEMENT SYSTEM

PREPA, at the corporate level, employs numerous automated control applications to ensure the safe and reliable operation of its system. These applications coordinate with or are integrated into larger systems that support PREPA's routine technical and commercial operations. PREPA uses controls and an energy management system (EMS) to regulate the supply-side generation of electricity to match real-time electric power demand from the users.

In 2012, a supplier provided an updated EMS to replace the older system employed at the time. The 2012 system updated the generation mixture to include intermittent and renewable generation to reflect the new supply-side resources becoming available due to mandated legislation. The EMS also incorporated cybersecurity compliance with the NERC's[8] infrastructure standards. In addition to upgrading the EMS, the supervisory control and data acquisition functionality was also updated to link the central EMS with the generation plants and substations. PREPA's EMS previously included the remote start and stop controls for the peaker facilities, but since the units now require onsite assistance for startup, the EMS only monitors their MW and MVAr outputs.

[8] North American Electric Reliability Corporation (NERC)

6. PERFORMANCE REVIEW

To evaluate the performance of the Plant, Sargent & Lundy reviewed historical operating performance, provided by PREPA, of the units and benchmarked it against a group of industry peer units where data was available. Primary performance indicators reviewed include the following:

- Generation
- Net capacity factor (NCF)
- Equivalent availability factor (EAF)
- Equivalent forced outage rate (EFOR)
- Net heat rate

NCF is the annual net energy production as a fraction of the energy that would be produced if a plant operated at its rated capacity 100% of the time. EAF is a measure of an electric generating unit's availability, where it is a percentage of time that the unit has been available during a specified time period, including the impact of de-ratings (times when the unit is operating at a lower power output). EFOR is a measure of an electric generating unit's unreliability; it is the percentage of time that a unit is in a forced outage during a specified time period, including the impact of forced unit.

Sargent & Lundy reviewed the last six full years of operational data as provided by PREPA (2015–2020). Sargent & Lundy also reviewed data cataloged by NERC within their generating availability database system (GADS)[9] and established a peer group of units comparable to the GTs to compare reliability data.

Sargent & Lundy applied the selection criteria identified in Table 6-1 to the NERC GADS database[10] to establish a reliability peer group for the units. The resulting peer group, which reflects these unit characteristics, includes 204 units owned by 43 different operators, with the dataset including 1,221.25 operating years of annual reporting data. Although the units are similar, the units in the peer group primarily run on natural gas rather than No. 2 fuel oil as the GT units do. Heat rate is not reported to NERC; therefore, peer group data is not presented in this report. Table 6-2 provides a summary of the key performance data for the Plant.

[9] NERC maintains records of reliability information for generating stations within the United States and Canada based on data provided by the station owners and operators. These data are compiled within GADS. Within the GADS, filters can be applied to review reliability data by plant characteristics, such as plant prime mover, nameplate capacity, fuel type, and age. Filters can also be applied for plant generating statistics, such as plant capacity factor. In this way, GADS can report reliability data which are reflective of a peer group of plants with specific characteristics and generating statistics. Sargent & Lundy filtered GADS to obtain reliability statistics that reflect a peer group of units similar to the Plant units.

[10] Accessed via pc-GAR software on November 3, 2020. Version: PC-GAR v4.01.16.

Table 6-1 — Vega Baja Unit Peer Group

Unit Characteristics			Peer Group Characteristics				
Years in Service	COD	Unit Gross Capacity	Years in Service	COD	Unit Gross Capacity	Capacity Factor	Black-Start Capability
50	1971	21 MW	40-60	1965-1980	15-25 MW	0%–20%	Yes

Table 6-2 — Vega Baja Overall Key Performance Data Summary

Key Performance Indicator	2015	2016	2017	2018	2019	2020	Peer Group
Generation (MWh)	1,510	2,234	10,880	5,018	11,755	16,627	-
Equivalent Availability (%)	91.3	59.2	36.8	21.2	37.6	38.3	89.1
Net Capacity Factor (%)	0.4	0.6	3.0	1.0	3.2	4.5	0.48
Equivalent Forced Outage Rate	15.1	43.6	63.6	78.9	62.7	61.9	88.6
Net Heat Rate (Btu/kWh)[1]	16,098	12,624	13,945	13,935	15,334	11,933[2]	-

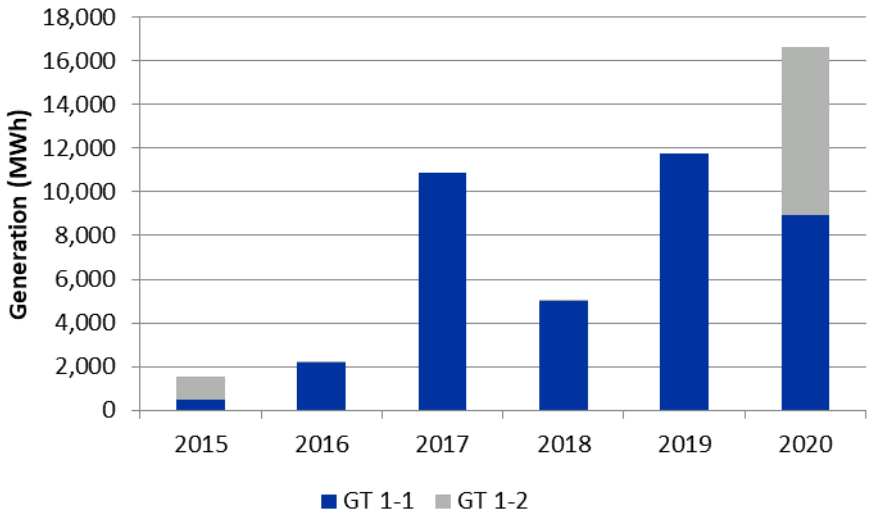
1. Btu/kWh = British thermal unit per kilowatt hour

2. The Puerto Rico Energy Authority's 2020 Annual Generation, Fuel, and Thermal Performance Report shows a heat rate for Vega Baja Unit 1-1 of 7,687 Btu/kWh which is suspected to be inaccurate, thus the average net heat rate of 11,933 Btu/kWh for both units should be confirmed.

6.1. GENERATION

Annual generation for each unit is provided in Figure 6-1. The generation figure provides totalized information for the annual plant generation of power. The plant has operated on a limited basis to provide peaking support, which is evident when reviewing the Plant capacity factor. Notably, the Plant has provided more generation in 2017 after Hurricanes Irma and Maria and in 2020 after the earthquake damaged several plants in the south and during the conversion of San Juan Power Plant to natural gas.

Figure 6-1 — Unit Generation



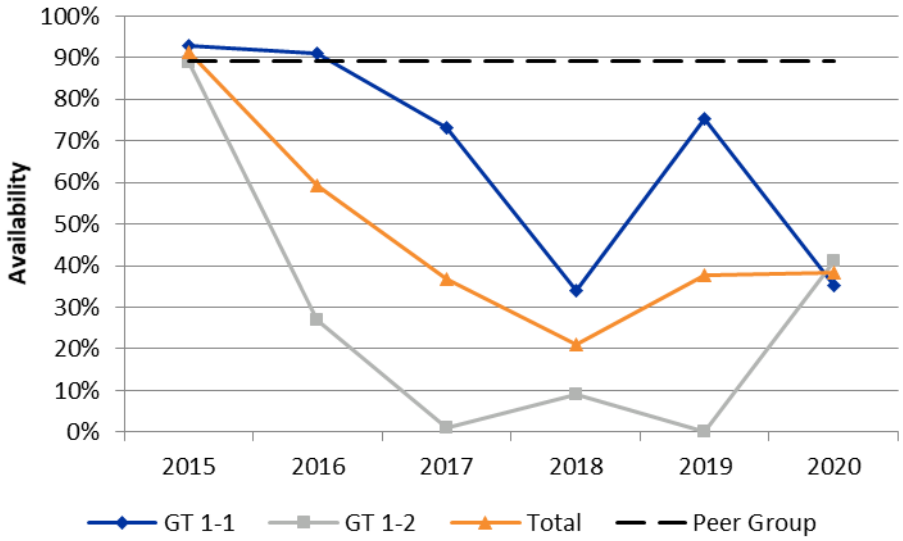
6.2. AVAILABILITY FACTOR

The EAF is the fraction a facility is available to generate electricity at net dependable capacity subtracted by de-rated conditions. EAF is calculated as follows:

EAF = ([Available Hours - (Equivalent Unplanned De-Rated Hours + Equivalent Planned De-Rated Hours + Equivalent Seasonal De-Rated Hours)]/Period Hours) x 100

Vega Baja's EAF has been declining over the last six years, which is indicative of older units with expected maintenance and reliability concerns; however, the availability of the units is less than other similar units in the United States. Unit 1-1 has seen less issues over the last few years than Unit 1-2, which most recently experienced a failure in the second stage of the combustion turbine. Outages tend to extend for longer periods of time as the Plant staff awaits funding for the repairs.

Figure 6-2 — Equivalent Availability Factor



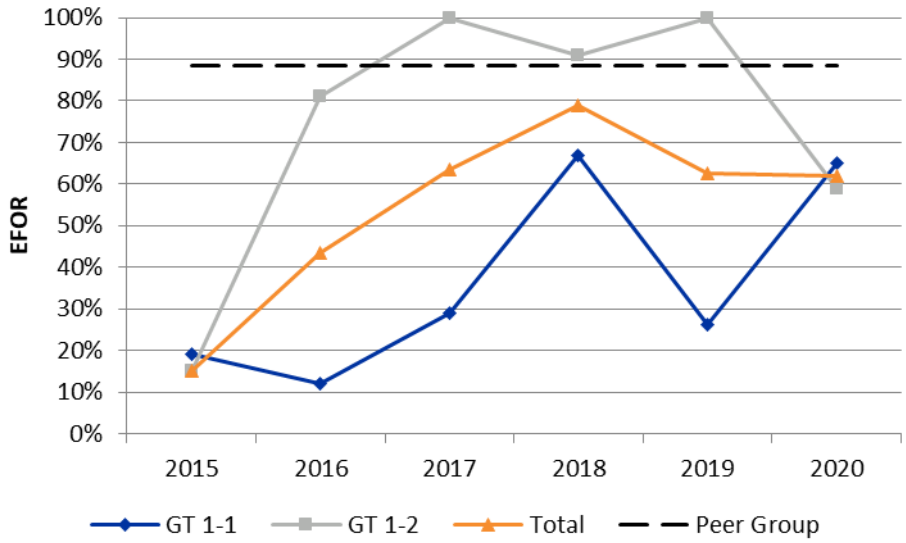
6.3. EQUIVALENT FORCED OUTAGE RATE

EFOR is a measure of the probability that a generating unit will not be available due to forced outages or forced deratings, excluding planned or maintenance outages. In other words, EFOR is a rating to indicate how often the unit is unable to respond, irrespective of system need.

EFOR = (Forced Outage Hours + Equivalent Forced De-Rated Hours)/(Service Hours + Forced Outage Hours + Equivalent Reserve Shutdown Forced De-Rated Hours) x 100

Although the EFOR for Vega Baja is high, the Plant has performed better (i.e., had a lower EFOR) than other plants in its peer group, indicating that many similar units are in a forced outage a significant amount of time. Unit 1-2 has experienced significant outages since 2016.

Figure 6-3 — Equivalent Forced Outage Rate



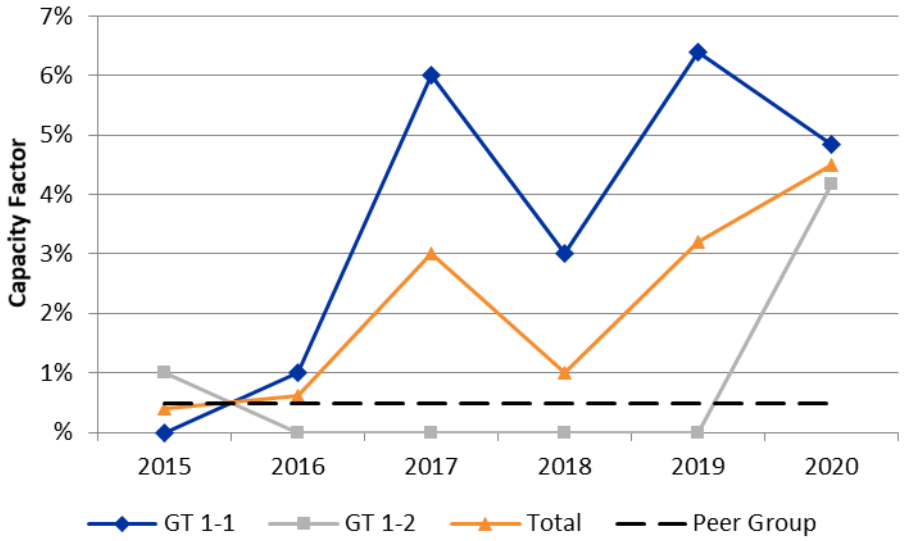
6.4. CAPACITY FACTOR

When reviewing availability and forced outage value changes, it is important to identify if the unit was being dispatched differently. In a gross fashion, the NCF provides insight into this. NCF is a percentage representing the average output of the facility during the time it was active (declared operational). The net capacity factor is calculated as follows:

NCF = (Total Net Generation/[Net Capacity at Mean Ambient Temperature x Period Hours]) x 100

The NCF for Vega Baja is consistent with that of a peaking plant. Vega Baja Unit 1-1 is used more frequently than other similar units. Combined, Vega Baja NCF was highest in 2020 at 4.5%.

Figure 6-4 — Capacity Factor



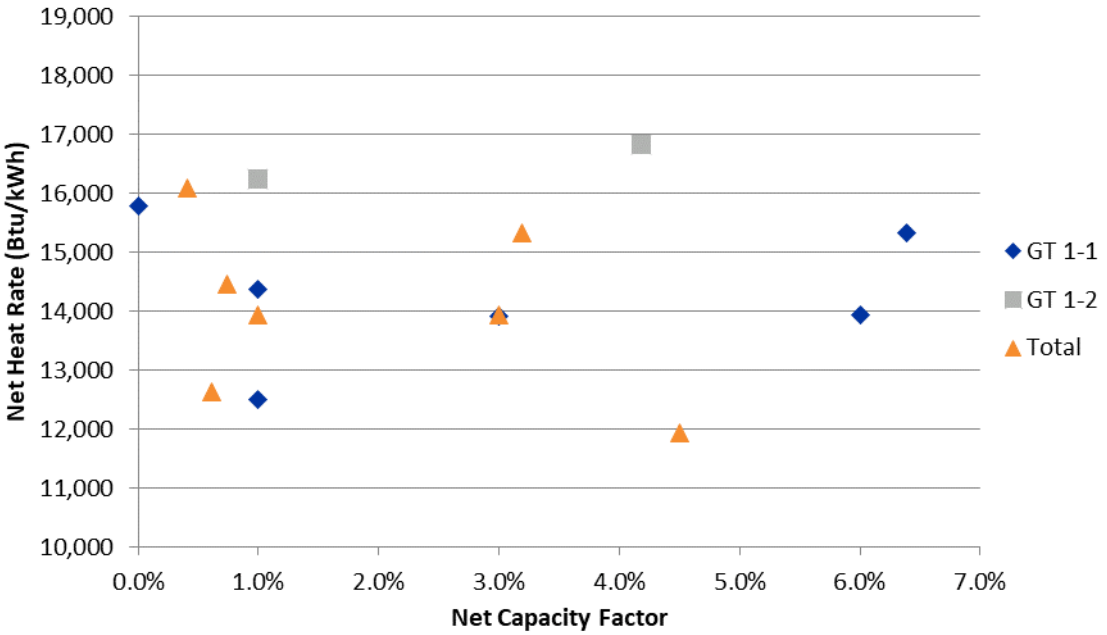
6.5. NET HEAT RATE

The heat rate is the amount of energy used by an electrical generator or power plant to generate 1 kWh of electricity. Heat rate shows, in general, the efficiency of the unit and, to an extent, represents the units to be considered in a dispatch hierarchy. The heat rate is gradually degraded through service.

Heat rate also can be used to determine the expected fuel requirements necessary for generation. As fuel represents the largest variable cost, having a lower heat rate than that of other similar units is a competitive advantage. Lower heat rates are indicative of a generating unit that is efficient at converting fuel into electricity; if two generating units of similar design and vintage are compared, the unit with the lower heat rate will have lower variable fuel costs than the other unit.

Vega Baja's net heat rate is high, as is expected for an older unit used infrequently. Over the last five years, Vega Baja's heat rate has averaged around 14,000 Btu/kWh, which is the lowest heat rate compared to all of PREPA's Frame 5 GTs. Since 2016, The highest heat rate was in 2019 at 15,334 Btu/kWh, and the lowest was in 2020 with 11,933 Btu/kWh. However, the Puerto Rico Energy Authority's 2020 Annual Generation, Fuel, and Thermal Performance Report shows a heat rate for Vega Baja Unit 1-1 of 7,687 Btu/kWh which is suspected to be inaccurate, thus the average net heat rate of 11,933 Btu/kWh for both units should be confirmed.

Figure 6-5 — Heat Rate vs. Capacity Factor



7. FINANCIAL REVIEW

Sargent & Lundy compiled the historical O&M and capital expenditures (CAPEX) for Vega Baja from reported PREPA data and fiscal-plan forecasts for FY 2015 through FY 2020.

Cost data for Vega Baja is reported under the "Generation" directorate, which is one of the five PREPA directorates (Generation, Transmission, Distribution, Customer Service, and Administrative & General). Historical O&M costs were obtained from the following data files and reports:

- *725 OPER-CONST by Resp 2008-2020.xlsx*
- *Generation O&M by RESP.xlsx*
- *PREPA Ex 1.02 Part 1 Economic Analysis Report.pdf*
- *PREPA Ex. 1.02 Part 2 Economic Analysis Report Appendices.pdf*

Summaries of O&M costs and CAPEX for Vega Baja and comparisons with industry values are presented in the subsections below.

7.1. FIXED AND VARIABLE O&M

Fixed O&M costs are independent of the amount of the plant generating output, such as fixed labor, materials, and administrative and general costs. Variable O&M costs are directly proportional to plant generating output, such as chemicals and consumables. The reported fixed and variable O&M costs for Vega Baja are aggregated. The costs for Vega Baja ("Account 307") are combined with costs in the San Juan area, including Palo Seco and Covadonga. It includes the Palo Seco peaker plants (126 MW).[11]

Table 7-1 summarizes the historical O&M costs for the group of facilities that includes Vega Baja, Palo Seco, and Covadonga. The costs are not delineated by plant and exclude corporate costs for the "Generation" directorate that is common with other plants, such as administration, technical support, and fuel contracting.

Table 7-1 — Vega Baja Historical O&M Costs (FY 2015–FY 2020)

Vega Baja (42 MW) - Historical O&M Costs ($)	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020
Operating Labor						
307 - Sub - Area Palo Seco, Vega Baja, Covadonga	$ 697,548.80	$ 632,496.07	$ 475,328.93	$ 370,800.26	$ 584,979.36	$ 885,716.71
Operating Non-Labor						
307 - Sub - Area Palo Seco, Vega Baja, Covadonga	$ 337,456.35	$ 389,389.63	$ 363,973.99	$ 1,083,317.12	$ 341,592.52	$ 644,481.28
Total O&M Costs ($)	$ 1,035,005.15	$ 1,021,885.70	$ 839,302.92	$ 1,454,117.38	$ 926,571.88	$ 1,530,197.99

FY = July 1–June 30

[11] MW capacity values shown in this Section 7 are nominal values reported by PREPA for cost reporting and do not necessarily reflect the latest tested capacity.

The aggregated O&M costs correspond to the fixed and variable components estimated by PREPA in the aforementioned economic analysis report. Table 7-2 summarizes PREPA's estimate of the fixed O&M (in $/kW-year) and variable O&M (in $/MWh) costs for the Vega Baja 21-MW GT units in 2015. Note that variable O&M costs exclude fuel costs and assumes the 2015 generation of 125,000 MWh.

Table 7-2 — Vega Baja Fixed and Variable O&M Cost Breakdown

	Vega Baja Unit 1 (21 MW) | Unit 2 (21 MW)
Fixed O&M (2015 $)	$25.33/kW-year
Variable O&M (2015 $)	$19.27/MWh

Note: Variable O&M costs exclude fuel costs.

The fixed and variable O&M expenses outlined in Table 7-1 are higher than average, but they are within reason, considering the age and remaining useful life of the Vega Baja facility.

7.2. CAPITAL EXPENDITURES

Historical CAPEX reported by PREPA for Vega Baja for FY 2015–FY 2020 are summarized in Table 7-3. As can be seen, there was no reported CAPEX for this period. Little to no reported CAPEX in a year is reasonable, as Vega Baja is nearing the end of its useful life and high dollar investments are not expected. This does not mean, however, that future CAPEX will not be required, and it is possible that Vega Baja CAPEX was reported in line items not presented to Sargent & Lundy.

Table 7-3 — Vega Baja Historical CAPEX (FY 2015–FY 2020)

Vega Baja (216 MW) - Historical CAPEX ($)	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020
Construction/Maintenance Labor						
307 - Sub - Area Palo Seco, Vega Baja, Covadonga	$ -	$ -	$ -	$ -	$ -	$ -
Construction/Maintenance Non-Labor						
307 - Sub - Area Palo Seco, Vega Baja, Covadonga	$ -	$ -	$ -	$ -	$ -	$ -
Total CAPEX ($)	$ -	$ -	$ -	$ -	$ -	$ -

8. ENVIRONMENTAL AND REGULATORY

This section describes certain environmental requirements that currently apply to Vega Baja and includes a limited review station's current environmental compliance status. This section does not include a review of new and proposed regulatory initiatives that may have an impact on future operations at Vega Baja.

Vega Baja operates under the key permits and approvals identified in Table 8-1. Based on review of permits and documentation provided by PREPA or publicly available information, all major environmental permits for the Vega Baja facility are current or in the process of being renewed.

Table 8-1 — Vega Baja Power Plant Key Permits and Approvals

Permit/Approval Description	ID Number	Permit Expiration Date
Title V Operating Permit	PFE-TV-4911-74-0106-0021	November 30, 2015 (renewal application has been filed; see Section 8.1)
National Pollution Discharge Elimination System (NPDES)	N/A	N/A
Resource Conservation and Recovery Act – Hazardous Waste	PRR000023515	N/A
Safe Drinking Water Act	N/A	N/A
Franchise for the Use of Waters of Puerto Rico	R-FA-FAID6-SJ-00165-04062013	N/A

Sargent & Lundy reviewed environmental compliance information provided by PREPA and information obtained from the EPA's ECHO[12] database to determine the current environmental status of the facility. Provided below is a review of the facility's status for the following areas: air emissions, water and wastewater discharge, emergency planning reporting, oil storage spill prevention, and recent enforcement actions.

8.1. AIR EMISSIONS

The Vega Baja Title V Operating Permit includes emission limits and monitoring, recordkeeping, and reporting requirements for Vega Baja. PREPA provided Sargent & Lundy with the facility's Title V operating permit that was issued on November 30, 2010 and expired on November 30, 2015. The facility is required to submit a renewal application to the EQB[13] at least 12 months prior to the expiration date. PREPA applied

[12] Enforcement and Compliance History Online
[13] Puerto Rico Environmental Quality Board

for a renewal on October 20, 2014. On November 4, 2014, PREPA received a letter from the EQB determining that PREPA had submitted an administratively complete renewal application for the purposes of the protective cover of the application. According to PREPA, the permit renewal is pending on EQB approval. The major emission units regulated under the 2015 Title V operating permit include the following:

- Two emission units, VBGT-1 and VBGT-2. Each emission unit is a combustion turbine of simple cycle with a capacity of 301.5 MMBtu/h.

8.1.1. Air Permit Compliance

Sargent & Lundy reviewed air compliance documents supplied by PREPA, including annual emissions reports, semiannual monitoring reports, and annual Title V compliance certifications. Sargent & Lundy also reviewed air compliance information included in EPA's ECHO database.

EPA's ECHO database does not identify any Title V permit deviations as part of the annual compliance certifications for 2013–2019. PREPA's annual emissions reports for 2013–2019 show that the Vega Baja's facility-wide annual emissions have been below allowable levels (see Table 8-2).

Table 8-2 — Vega Baja Gas Turbine Station Annual Emissions

Pollutant	Allowable Emissions (ton/yr.)	Actual Emissions (Ton/Year)						
		2013	2014	2015	2016	2017	2018	2019
PM	9.41	0.0638	0.22	0.15	0.19	0.19	0.19	0.19
SO_x	395.87	0.0537	0.19	0.13	0.32	1.11	0.59	3.02
NO_X	689.83	4.68	16.21	10.96	14.14	71.23	32.23	81.45
VOC	0.32	0.00218	0.01	0.01	0.01	0.03	0.02	0.04
CO	2.59	0.0175	0.06	0.04	0.05	0.27	0.12	0.31
Pb ii	0.011	0.0000745	0.0003	0.00	0.00	0.00	0.00	0.00

PM = particulate matter | NOx = nitrogen oxide | SOx = sulfur oxide | VOC = volatile organic compounds | CO = carbon monoxide | Pb = lead

Sargent & Lundy reviewed annual Title V compliance certifications for 2015–2019. PREPA did not provide Sargent & Lundy with the annual compliance certification for 2020; therefore, it was not reviewed. There were no reported deviations from the facility's Title V permit for the years 2015–2019. Note that during portions of 2017 and 2018, PREPA was operating under a "No Action Assurance" granted by the EPA in the aftermath of Hurricanes Irma and Maria for relief from certain Title V permit requirements, including emission limitations.

Sargent & Lundy also reviewed semiannual monitoring reports for the calendar years 2016–2020. There were no reported deviations from the facility's semiannual monitoring reports in any of the reports reviewed. The "No Action Assurance" granted by the EPA was effective starting October 2017 and extended through April 2018, covering portions of the second half of 2017 and the first half of 2018.

Semiannual monitoring reports for the second half 2017, first and second halves of 2018, and the 2017 Title V compliance certification were not submitted according to the normal reporting schedule. Emergency conditions related to Hurricanes Irma and Maria prevented PREPA from preparing and submitting the required reports on time; therefore, the EPA extended reporting deadlines for all reports covered under the "No Action Assurance" to May 30, 2018. According to PREPA, the EPA gave PREPA until July 30, 2018 to submit the reports, and the EQB informally extended the deadline to be consistent with the "No Action Assurance." According to PREPA, the first-half 2018 semiannual report was submitted in February 2019. In March 2019, PREPA submitted the second-half 2017 semiannual report and the 2017 and 2018 annual Title V compliance certifications.

8.1.2. One-Hour Sulfur Dioxide NAAQS

The Clean Air Act requires the EPA to establish National Ambient Air Quality Standards (NAAQS). Areas that do not meet the NAAQS are designated as "non-attainment areas" for that particular air pollutant, while areas meeting the NAAQS are designated as "attainment areas." NAAQS standards are established by the EPA to be protective of public health and welfare, and the EPA is required to periodically review and update the NAAQS as necessary.

The one-hour sulfur dioxide (SO_2) NAAQS were published on June 2, 2010. The Plant is located in the Municipality of Vega Baja, which is currently designated attainment for the one-hour SO_2 NAAQS. If future revisions of the NAAQS result in more stringent standards, additional emissions reduction could be required.

8.1.3. Hogan Lovells' White Paper

Sargent & Lundy was provided a copy of the "White Paper on Environmental Compliance Issues at Puerto Rico Electric Power Authority Generation Facilities" memorandum dated March 25, 2021 and prepared by Hogan Lovells US LLP for PREPA [Reference 2]. Based on review of the Hogan Lovells' evaluation of the Vega Baja compliance status, the following findings were identified:

- As discussed in Section 8.1.1 of this report, the Hogan Lovells confirms the Title V Permit expired on November 30, 2015 and PREPA submitted a renewal on October 20, 2014. On November 4,

2014, PREPA received a letter from DNER stating the renewal permit submitted was administratively complete for the purposes of protective cover of the application.

- PREPA's generation facilities, including Vega Baja, is subject to Puerto Rico noise pollution control regulations. Based on this information, these facilities do not operate during these nighttime hours, except in emergency situations. In addition, no noise complaints or noise studies were performed in recent years.
- As discussed in Section 8.3 of this report, the Hogan Lovells' white paper states that PREPA is in the process of preparing the spill prevention, control, and countermeasure (SPCC) plan for Vega Baja.
- As discussed in Section 8.1.4 of this report, the Hogan Lovells' white paper states that PREPA has underground injection control (UIC) systems for the disposal of sanitary water at many of its facilities, including Vega Baja; however, no information on the UIC system at Vega Baja was identified in the data room.
- According to the Hogan Lovells' white paper, PREPA's generation facilities must file annual reports under the Emergency Planning and Community Right-to-Know Act (EPCRA), including Tier II reports and toxic release inventory (TRI) reports. Copies of these reports are provided in the data room and summarized in Section 8.2 of this report.
- According to the Hogan Lovells' white paper, PREPA is the potentially responsible party for the Vega Baja Solid Waste Disposal Superfund Site. A summary on why the enforcement actions at the above-reference superfund site were not discussed in the white paper is provided in Section 8.4 of this report.

8.1.4. Water and Wastewater Discharge

According to the Hogan Lovells' white paper reviewed for the Project, PREPA has UIC systems for the disposal of sanitary water at many of its facilities, including Vega Baja; however, no information on the UIC system at Vega Baja was identified in the data room. Sargent & Lundy was not provided a status on the UIC system at Vega Baja from PREPA.

According PREPA, the facility does not have a NPDES or industrial discharge permit.

8.2. EMERGENCY PLANNING REPORTING

The EPCRA provides for nationwide public disclosure of emergency information to protect the public from chemical emergencies and dangers. EPCRA Section 312 (40 CFR Part 370) requires certain facilities that maintain safety data sheets to report the quantity of chemicals that are present on site for the previous year; the submittals are known as Tier 2 reports. EPCRA Section 313 (40 CFR Part 372) requires certain facilities

that manufacture, process, or otherwise use listed toxic chemicals in excess of applicable thresholds to prepare and submit a toxic release inventory to federal and state agencies.

Sargent & Lundy was provided with a Tier 2 report for the reporting period from January 2017 to December 2017, which was prepared for Vega Baja and submitted in 2018. Based on review of the report, it appears that the facility is following the necessary reporting requirements.

TRI reports are due July 1 of each year for each listed TRI chemical that exceeds the manufactured, processed, or otherwise used threshold. PREPA provided Sargent & Lundy with TRI FORM A reports for calendar years 2016–2019 for the chemical naphthalene. Other than the toxic release inventory identifier (00693PRPVGPR2KM), no information was available for review regarding toxic release inventory reports on the EPA's ECHO database.

8.3. OIL STORAGE SPILL PREVENTION

Sargent & Lundy reviewed a copy of Vega Baja's SPCC plan dated October 1999. The SPCC plan, required by 40 CFR Part 112, identifies onsite oil storage containers and provides a plan for preventing the discharge of oil into navigable waters or the adjoining shoreline. The Vega Baja SPCC plan follows the Part 112 requirements; however, the plan is outdated and no longer valid.

According to Part 112.5 requirements, the SPCC plan shall be amended when there is a change in the facility design, construction, operation, or maintenance that materially affects its potential for a discharge or once every five years. Sargent & Lundy was not provided a status on the SPCC update from PREPA; however, the Hogan Lovells' white paper states PREPA is in the process of preparing the SPCC plan for Vega Baja.

8.4. ENFORCEMENT ACTIONS

The EPA has identified PREPA and six other entities as potentially responsible parties under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for using the Vega Baja Solid Waste Disposal Superfund Site, an unlined solid waste disposal and open burning facility owned by the Puerto Rico Land Authority (PRLA), to dispose of commercial, industrial, and domestic waste between the late 1940s until the 1970s. Despite this, the enforcement actions at the above-referenced superfund site are third-party landfills not owned by PREPA and are not deemed necessary to discuss in this limited environmental review.

In addition, the ECHO database does not identify any violations or enforcement actions for the Vega Baja facility.

8.5. SUMMARY

Sargent & Lundy performed a limited environmental review of publicly available information and information provided by PREPA to evaluate the compliance status for Vega Baja. Sargent & Lundy did not find any compliance-related issues that would prevent renewal of the existing permits or impact near-term operation of the facility.

9. RECOMMENDATIONS AND CONCLUSIONS

Overall, Vega Baja is in serviceable condition with the combustion turbines and many of their ancillary systems approaching the end of their useful service lives. Vega Baja's total nameplate capacity is 42 MW; however, the current operating capacity is half of that due to the recent failure in the second stage of the Unit 2-1 GT, which rendered the unit inoperable. The remaining 21 MW are expected to be recoverable, and the unit is projected to return to service in Q4 of 2021. The final resolution and order of PREB in response to PREPA's proposed integrated resource plan (Case No. CEPR-AP-2018-0001) published in August of 2020 supports the planned retirement of the GTs at Vega Baja. Replacement of this peaker capacity is expected to be met by new dual-fuel capable emergency generation peaker units funded through the FEMA 404 hazard mitigation program.

Vega Baja is not located directly on the coast like many other PREPA facilities; however, the Plant is still subject to high chloride deposition from salt-laden coastal winds, presenting corrosive conditions for any equipment exposed to the elements. Care must be taken to ensure that replacements or upgrades to the Plant are suitable for the environmental conditions and properly hardened against potential extreme weather events (e.g., hurricanes). Typically, competitively priced OEM standards for power generation and balance-of-plant equipment are not well-suited for this type of operating environment. Any new equipment must be configured for the challenging conditions at Vega Baja. Failure to make allowances for suitable materials, equipment selection, buildings/enclosures, and other aspects of the facility design to protect the Plant from its operating environment may result in excessive future O&M costs, forced outages, and a shorter plant design life for any new installation. Suitable design specifications appropriate for this operating environment include: (i) corrosion-resistant material specifications; (ii) use of protective equipment enclosures; (iii) proper system selections; and (iv) robust coatings systems. Due to these requirements, tropical power generation sites are inherently more expensive than those installed in less aggressive operating environments.

PREPA continues to study the need for additional grid support and generation throughout Puerto Rico. While both GTs have fully realized their expected useful lives and are soon to be retired, the site is still being considered as a candidate for new peaker units with synchronous condensers that would also offer grid stabilization benefits during the repowering period.

Understanding that the Vega Baja GTs are expected to be retired in the near future, this report does not include recommendations for large capital investments for improvements to greatly extend the life of these units. Guidance is limited to improvements and maintenance practices that will mitigate life-safety and

environmental risks, potential catastrophic failures, or otherwise improve the facility for its continued use if new generation is added to the site.

Recommendations for the Plant focus on two elements of the facility: the two power generation units and the common systems.

Recommendations for Units 1-1 and 1-2 include the following:

- Regularly check and replace air intake prefilters as required.
- Resurface and coat corroded portions of the intake filter housing.
- Clean up any spilled oil within the GT enclosures.
- Continue regular inspections of the MPT and replace if necessary.
- Repair cracking in the MPT foundation pad and containments and clear vegetation.
- Perform the manufacturer-recommended maintenance and testing per the manuals for the generator electrical enclosure.

Recommendations for the common systems include the following:

- Fix or replace the MCC compartment doors that cannot close and provide covers for any vacant openings.
- Perform regular testing of the MCCs and add master nameplates or tags to each lineup that clearly indicate voltage, amperage, etc.
- Add space heaters to the enclosure to prevent moisture buildup on the bus bars.
- Maintain updates to the security software for the operator console.
- Relocate the network and communications equipment within a lockable cabinet to prevent tampering or damage.
- Install cover plates over any openings in the relay and metering cabinets.
- Install a plant-wide alarm system to provide locally audible alerts for critical alarms.
- Troubleshoot and correct the overheating issue with the emergency diesel generator and continue biweekly test runs.
- Continue current battery maintenance and testing, replace cables with damaged insulation, and route cables though raceways to prevent future damage.
- Route all above-ground cables through the raceway (cable tray, conduit, etc.) to prevent damage and increase safety.
- Exercise more diligent vegetation control to prevent fire hazards and clogging of plant drainage systems.

- Regularly check underground drain piping for leaks to prevent oily water from leaking into soil.
- Monitor coating systems for degradation and recoat equipment as necessary to ward off corrosion and premature failure.
- Repair or replace and reinstall the second AC motor for the fuel forwarding pumps to reestablish the 2 x 100% redundancy of the fuel forwarding system.
- Consult with the local fire marshal to discuss least-cost solutions to improve the site's fire safety capabilities for the next several years of operation.
- Repair the damaged barbed wire segments of the perimeter fencing and add more effective concertina wire for improved security.

10. REFERENCES

1. Sargent & Lundy report, “Demarcation of PREPA Generation Assets from the Transmission and Distribution System,” TD-0003, dated May 21, 2021.
2. Hogan Lovells memorandum “White Paper on Environmental Compliance Issues at Puerto Rico Electric Power Authority Generation Facilities,” dated March 25, 2021.