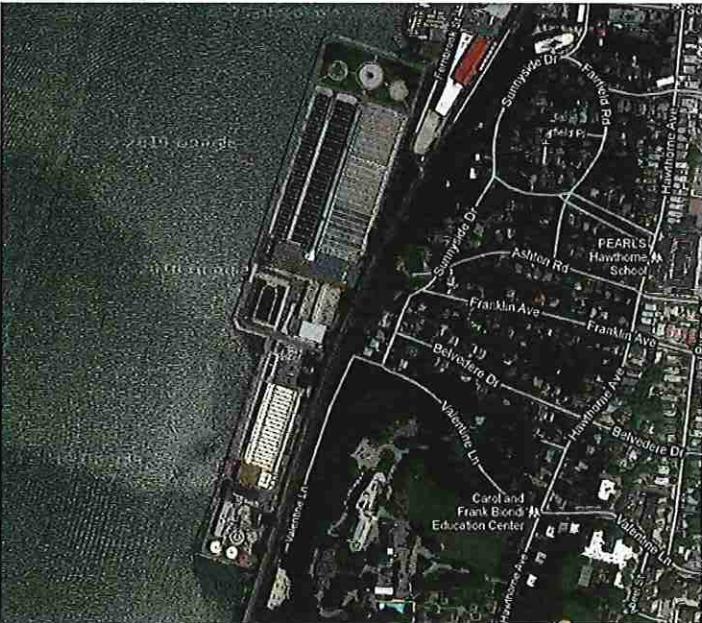


FINAL DESIGN REPORT

Westchester County Department of Public Works

Yonkers JWWTP Engine Replacement Program
Phase IV - Engine Upgrades

NYPA WBS No. ES-GSN-0853



February 2024



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Executive Summary

Program Description and Objectives

As part of the New York Power Authority's (NYPA) Energy Services Program (ESP), CDM Smith is serving as the design engineer and construction manager for an Engine Replacement Program at the Westchester County Department of Environmental Facilities (WCDEF) Yonkers Joint Wastewater Treatment Plant (WWTP), located in Yonkers, New York. The primary goals of the Engine Replacement Program are to:

- install a high pressure, high volume natural gas service for connection to all engines and the Secondary Boilers;
- optimize the aeration system through rehabilitation and rerate of existing centrifugal blowers, installation of new magnetic bearing turbo blowers and improvements to the associated blower and master aeration controls; and
- the phased replacement of engine-blowers no. 2 and 3, while optimizing the utilization of the digester gas as fuel for the engine generators that will power the new magnetic bearing turbo blowers.

The Engine Replacement Program is being executed in four (4) phases. "Phase I" covered the cost for the design services for Phase II and III. "Phase II" is the 'Natural Gas and Aeration System Upgrades' component of the program. "Phase III" is the 'Turbo Blower and Electrical System Upgrades' component of the program and "Phase IV" is the 'Engine Upgrades' component. Phase II and III construction was completed March 2022. The pre-purchase of the combined heat and power (CHP) systems for Phase IV was initiated in November 2022.

The purpose of this design report is to outline the basis of design for Phase IV of the engine replacement program.

The "Phase IV, Engine Upgrades" scope includes the following:

- Removal of existing engine driven blowers No. 2 and No. 3 and all ancillary heat recovery equipment;
- Installation of two (2) digester gas/natural gas fueled cogeneration engines and associated heat recovery equipment including steam generating boilers.

The primary benefits of this project include:

- Electrical energy savings by powering the process air turbo blowers directly from a dual fuel (ADG/natural gas) cogeneration engine;
- Thermal energy savings by recovering heat from the cogeneration engine to offset building and process heat demand;

- Replacement of inefficient equipment that has reached the end of its useful life;
- Increased efficiency using new and improved technology;
- Improved reliability and resilience, as the ADG/natural gas cogeneration engine will operate in island mode and will be able to power the process air blowers during an extended utility outage;
- Improved energy monitoring; and
- Improved process control and operational performance.

The following sections describe the details of the design:

- Section 1 includes a description of the existing facilities
- Section 2 includes a basis of design for the above referenced improvements
- Section 3 includes the Engineer’s Opinion of Probable Cost
- Section 4 includes the Energy Savings for the Proposed Improvements

Contracting Strategy

To reduce construction duration and minimize disruption to plant operations, Phase IV – Engine Upgrades will be implemented in two contracts as follows:

- **Equipment Pre-Purchase** – the dual fuel combined heat and power (CHP) systems, including the engine generators, gas trains, heat recovery equipment and all associated appurtenances will be pre-purchased as a separate contract. This is done to allow for the 12 month fabrication timeline to occur while the details of the installation contract are finalized around the selected equipment.
- **Installation Contract** – This contract will include all material and labor for the installation and commissioning of the two CHP systems.

Project Timeline

The bid process for the equipment pre-purchase was initiated in October 2021 and awarded in November 2022. This is timed such that the selected manufacturer can develop shop drawings for the CHP systems and the installation contract drawings finalized to reflect the successful bidder of the pre-purchase contract. The benefit of this is that the design drawings and specifications will reflect the specifics of the actual equipment to be installed and the equipment lead time can commence prior to award of the installation contract. The estimated timeline for completion of design, bidding and contract execution is as follows:

- 90% Design of Installation Contract: December 2023
- Westchester Department of Health Approval – May 2024
- Bid Phase of Installation Contract: January – March 2024

- New York Power Authority (NYPA) Customer Project Commitment (CPC) for installation contract: June 2024
- The estimated construction timeline for the installation contract is 12 months.

Project Cost and Energy Savings

The engineer's Opinion of Probable Total Installed Project Cost for Phase IV – Engine Upgrades as outlined in this report, based on the 90% design, is \$25,155,175. The electrical energy savings associated with this final phase of the Engine Replacement Program is based on displacement of utility power for the three 500 HP (1,119 kW) turbo blowers with power provided by the new cogeneration units that will be fueled by a combination of ADG and natural gas. The fuel oil savings associated with taking engine-blowers no. 2 and no. 3 are not accounted for in this savings as the energy balance is based on plant loads in 2019. The engine-blowers no. 2 and no. 3 that will be replaced under this phase are no longer in operation due to the plant's Title V permit.

This displacement of utility power consumption will result in a 37% savings of electrical energy or an annual electrical cost savings of \$688,051. With supplemental natural gas and maintenance costs the estimated annual savings is \$463,807.

Section 1

Existing Facility Description

1.1 Background

The Yonkers Joint Water Resource Recovery Facility (JWRRF) is a conventional activated sludge wastewater treatment plant located in Yonkers, New York, adjacent to the Hudson River. The permitted monthly average discharge flow is 120 mgd. The Plant services an area of approximately 69,000 acres in the southwestern portion of Westchester County. The liquid process train of the plant consists of four primary settling tanks, six fine bubble aeration tanks, nine final clarifiers for mixed liquor settling and two chlorine contact tanks. The solids processing train consists of primary and secondary digesters, gravity belt thickeners and centrifuges. The Yonkers Joint WRRF utilizes the anaerobic digestion process to reduce sludge volumes, which in turn generates digester gas. The digestion process occurs in the three primary sludge and six waste activated sludge (WAS) digesters.

The plant's monthly electrical consumption ranges from 1,300,000 – 2,700,000 kWh and monthly demand ranges from 2700 – 4500 kW resulting in an annual electrical cost of \$1,800,000.

Historically engine-blowers no. 2 and no. 3 utilized between 5000 to 6000 gallons of fuel oil each annually. These engine-blowers were taken off-line in 2019 due to the plant's Title V requirements which resulted in significant savings in fuel oil consumption. The engines were permitted to only run under emergency conditions. In 2019 the plant utilized 2,700 gallons of fuel oil, a 75% reduction in fuel oil use.

There are three natural gas services. The first service supplies the hot water heaters and the storage building boilers. Two higher pressure natural gas services were installed under Phase II/III of this Engine Program to serve the existing cogeneration engine (Engine No. 1), the existing secondary boilers and the two proposed cogeneration engines. Natural gas would be the back-up fuel to digester gas for Engine No. 1 and the secondary boilers, and natural gas would supplement digester gas for the proposed Engine No. 2 and No. 3, as needed. These services will further reduce the need to burn fuel oil on-site.

The digester gas is currently utilized in the plant boilers and in Cogeneration Engine No. 1. The use of digester gas in the existing cogeneration engine offsets the plant's electrical and thermal demand. There is also unused digester gas that is currently flared. The digester gas primarily consists of methane and carbon dioxide, as well as nitrogen and some trace impurities. The following Table 1-1 summarizes the digester gas quality at Yonkers.

Table 1-1: Yonkers Digester Gas Quality

Yonkers Raw Digester Gas Quality (ppbV)		
Gas	Average	Max
Siloxane	1,129	2,351
H2S	54,019	130,015

A time series of gas production from 2017 to 2020 at the facility is shown in Figure 1-1. The average digester gas production is 720,000 cubic feet per day (cfd). It should be noted that between 2005 –

2008 at the beginning of the engine replacement program the average daily digester gas production was estimated to be 1,000,000 ft³/day. The County attributes this decline in average digester gas production to an overall decline in wastewater flow. The County has considered the addition of food waste, as there is digester capacity which would increase the average digester gas production.

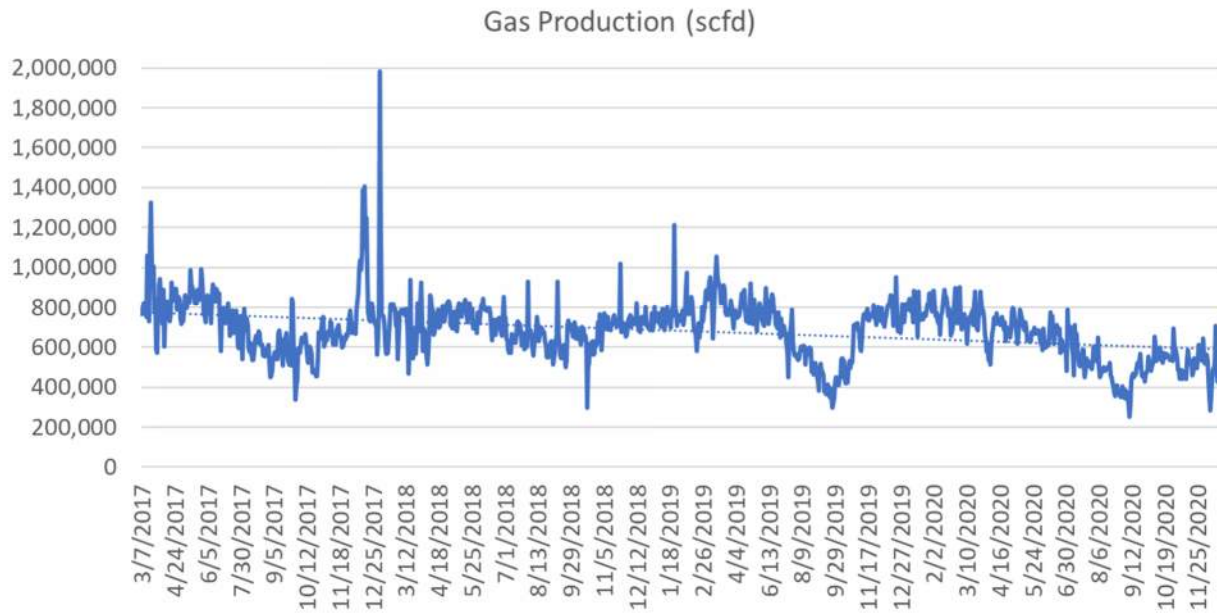


Figure 1-1: Digester Gas Production 2017-2020.

Currently, the digester gas is utilized in the plant's primary and secondary boilers to generate heat for building and process loads and in engine generator No.1 which operates in parallel with the utility grid. The excess digester gas that is not utilized is burned in the plant's waste gas flares. Table 1-2 provides a summary of the gas production and end use as annual daily average flows.

Table 1-2: Yonkers gas production and distribution.

Yonkers Gas System Distribution					
Annual Daily Average	2017	2018	2019	2020	2017 2020
Gas Flow to Engine Generator [cfd]	273,257	292,154	273,743	44,578 ¹	210,077
Primary Flare Gas Flow [cfd]	101,148	97,732	68,340	31,513	72,247
Primary Gas Flow to Boiler [cfd]	37,716	68,199	67,707	66,809	61,007
Secondary Flare #1 Gas Flow [cfd]	43,640	79,658	94,897	121,928	87,590
Secondary Flare #2 Gas Flow [cfd]	121,863	107,671	113,616	153,462	125,487
Secondary Flare #3 Gas Flow [cfd]	44,815	32,333	39,161	123,138	63,069
Secondary Gas Flow to Boiler [cfd]	118,213	70,751	114,803	101,818	100,466
Total Gas Used (Engines + Boilers)	429,187	431,103	456,253	213,205	371,551
Total Gas Flared	311,465	317,394	316,013	430,041	348,394
Total Gas Production	740,653	748,498	772,266	643,246	719,945

- ADG Engine No. 1 was out of service for 8 months of 2020. The outage of ADG Engine No. 1 was exaggerated due to delayed availability of replacement parts during the start of the pandemic.

1.1.1 Facility Location

The Yonkers Joint WRRF is located on Fernbrook Street in Yonkers, NY. The following figure is an aerial of the plant locating the Blower and Admin Building where the engine generators and associated heat recovery equipment is located.



Figure 1-2: Aerial view of Yonkers Joint WRRF

1.2 Existing System Descriptions

1.2.1 Existing Aeration Blowers and Control

Filtered air is supplied to the aeration tanks, the aeration tank influent channels, the final and primary tank channels and the grit tanks by the process air blowers.

There are currently four (4) constant speed Howden Roots blowers and five (5) variable speed Sulzer magnetic bearing turbo blowers. The Howden Roots blowers are either electric driven or dual-fuel engine driven (ADG and no. 2 fuel oil). Blower no.'s 1 and 2 are electric motor driven and blower no.'s 2 and 3 are the dual-fuel engine-driven. Diesel fuel is used as the pilot for ignition of the engine driven blowers and then continues to be used in conjunction with digester gas to sustain combustion. The resulting fuel mix in the engine driven blowers no. 2 and 3 (i.e. the Enterprise engines) is 7% fuel oil and 93% ADG. As such, the plant's Title V air permit, prohibits the extended use of these engine-driven blowers. These are the two engine-driven blowers which will be removed and replaced with cogeneration engines under the proposed Phase IV – Engine Upgrades. As summarized in Section 1.1, the plant not running engine-blowers no. 2 and no. 3 in 2019 resulted in a 75% savings of fuel oil use.

The Howden Roots electric motor driven blower's no's 1 and 2 were recently upgraded under Phase II of this Engine Program. They are 36" OIB model with 1750 hp motors and a design capacity of 40,000

acfm. A Howden Roots blower (old blower no. 6) was removed and replaced under Phase III of this program, with the five (5) Sulzer 500 hp magnetic bearing turbo blowers with a design capacity of 9,570 scfm each.

Air output is controlled by the new master aeration panel installed under Phase III of this program. The master control panel provides flow based most-open valve logic to control the number of blowers and speed or inlet guide vane position for the turbo blowers and Howden Roots blowers respectively.

The seasonal average and maximum process air demand is summarized in Table 1-3. Under average conditions it is anticipated that the plant will meet the air demand with the operation of the five 500 hp turbo blowers. Under max conditions, it is anticipated that one of the electric motor driven Howden Roots blowers will operate in parallel with the turbo blowers. The turbo blowers are supplied with VFDs and would be turned down or the number in operation reduced while a Howden Roots blower is in operation. The average process air demand of the system is approximately 45,000 scfm of air or 2,140 HP.

Table 1-3: Blower seasonal and maximum air demands.

Blower in Operation	Summer Average Air Demand (scfm)	Summer Max Air Demand (scfm)	Winter Average Air Demand (scfm)	Winter Max Air Demand (scfm)
Blower No. 1	Stand-by	35,000 (1,770 HP)	Stand-by	35,000 (1,770 HP)
Blower No. 2	Stand-by	Stand-by	Stand-by	Stand-by
Turbo Blower No. 1	9,570 (500 HP)	9,460 (475 HP)	9,570 (500 HP)	8,750 (412 HP)
Turbo Blower No. 2	9,570 (500 HP)	9,460 (475 HP)	9,570 (500 HP)	8,750 (412 HP)
Turbo Blower No. 3	9,570 (500 HP)	9,460 (475 HP)	9,570 (500 HP)	8,750 (412 HP)
Turbo Blower No. 4	9,570 (500 HP)	9,460 (475 HP)	9,570 (500 HP)	8,750 (412 HP)
Turbo Blower No. 5	7,150 (315 HP)	9,460 (475 HP)	7,295 (320 HP)	8,750 (412 HP)
Turbo Blower No. 6	7,150 (315 HP)	9,460 (475 HP)	7,295 (320 HP)	Stand-by
Process Air Demand at Blower Inlet (SCFM)	33752	75274	34383	62973
Channel Air Demand (SCFM)	8900	7000	8900	7000
Total Air Demand (SCFM)	42650	82300	43300	70000
Total Stand-by Capacity (SCFM)	75,000 - 80,000	40,000	75,000 - 80,000	49570
Total Operating Horsepower	2130	4150	2140	3418

1.2.2 Existing Engine Generator No. 1

The ADG fueled cogeneration engine no. 1 is continuous rated at 1400kw, 1750 kVA with an output voltage of 480V. A 2000 kVA transformer is provided to step-up the generator output voltage to 13.2kV to match the medium voltage distribution within the facility. Additionally, an AC/ AC converter unit is connected on the 480 volt side of the transformer to provided fault mitigation. This generator

is connected to the medium voltage switchgear bus 1 through breaker 105 on the 10W85 side of the gear. The cogeneration engine generator runs in parallel with the utility to offset a portion of the plant load.

The cogeneration engine generator has protective relaying included to prevent power from flowing back to the utility. Additional relaying is installed to protect from under or overvoltage, under or over frequency and ground faults. Synchronizing relaying prevents the cogeneration engine generator from paralleling with the utility unless it is within the acceptable range of frequency and phase shift. The cogeneration engine generator has a 2000A, 480V circuit breaker that is used to disconnect it from the system with a lockout relay on any of the trip conditions mentioned above. The lockout relay has to be manually reclosed after the fault condition has been removed. The controls and protective relaying are housed in the 480V breaker switchgear.

1.2.3 Existing Gas Conditioning System

The existing gas conditioning system includes one hydrogen sulfide scrubber, two gas blowers, a gas cooling heat exchanger with refrigeration system, moisture removal separator, two siloxane scrubber treatment vessels, four particulate filters, valves, piping, instruments and controls. The gas conditioning system is designed for outdoor operation in a Class I, Division 1 Group D area. The iron sponge regeneration blower, glycol chiller, and control panel with variable speed drives are designed for outdoor operation in a non-classified area. The existing gas conditioning system is sized to treat 680 scfm of digester gas. This is adequate capacity to treat the digester gas flow to ADG engine no. 1 and a second ADG engine. As summarized in Table 1-4, the gas conditioning skid is designed to remove siloxanes to 500 ppbv and H₂S to 5,000 ppbv.

Table 1-4: Design Effluent through Gas Treatment Skid

Design Effluent through Gas Treatment Skid (ppbV)	
Siloxanes	500
H ₂ S	5,000

1.2.4 Existing Electrical Equipment

Under Phase III of this program, a 480V switchgear was installed to serve the turbo blowers. The switchgear is configured in a double-ended arrangement with a single utility power source powering one side of the switchgear and the ability for the new digester gas/natural gas generators to power the other side of the switchgear.

The double-ended switchgear is configured in a Main-Tie-Main arrangement allowing each side of the bus to be powered from either the utility power source or the ADG generators no. 2 and 3 through the bus tie breaker. Both the utility and generator main circuit breakers, as well as the bus tie breaker, are fitted with Kirk-key interlocks to prevent paralleling of the two voltage sources. In this configuration one of the two main circuit breakers needs to be manually opened prior to closing the bus tie breaker allowing the entire switchgear to be fed from either utility power or the digester gas generators which will be installed under this phase of the program.

As configured, both utility power supplies are available to power the blower switchgear through the automatic transfer scheme in the Primary Switchgear. The loss of utility power will initiate transfer control logic in the Primary Switchgear powering the Turbo Blower Switchgear through either the second utility power supply or the standby generator.



Figure 1-3: Turbo Blowers- 1st Floor of Blower Building.



Figure 1-4: Turbo Blowers- 1st Floor of Blower Building.



Figure 1-5: Blower 2 – 1st Floor of Blower Building.



Figure 1-6: Blower 2 and Control panel – 1st Floor of Blower Building.

Section 2

Basis of Design

2.1 Scope of Work

Phase IV – Engine Upgrades, the final phase of the Yonkers Engine Program, will replace the two Enterprise engine driven blowers that can no longer be operated for extended periods under the plant’s current Title V air permit. These engine-driven blowers are compression ignition engines that use diesel fuel as the pilot for ignition and then continue to use diesel in conjunction with digester gas to sustain combustion. During the feasibility study, several options were evaluated including a second paralleling spark-ignition cogeneration engine and replacement engine-driven blowers. The spark-ignition engine uses a spark from a spark plug in the combustion process of the air-fuel mixture. These engines deliver a high-intensity spark of timed ignition and duration to ignite the compressed fuel-air mixture within the cylinder. This results in high efficiency and low exhaust gas emissions and a long life of the spark plugs. Additionally, the engine controls can adjust to gas of varying methane content.

The best option from a capital cost and energy savings perspective was to provide new spark-ignition engine generators that would operate in ‘island’ mode powering the switchgear and three of the five process air turbo blowers provided under Phase II/III. The initial construction phase, Phase II/III, provided the infrastructure upgrades to the aeration blower system (increased blower capacity, new turbo blowers, and associated local and master control) to allow for the demolition of the engine-driven back-up blowers in this final phase of the Yonkers Engine Program.

The project scope and associated energy savings will be discussed in greater detail, but in general this phase of the program includes:

1. Two (2) dual-fuel spark-ignition combined heat and power (CHP) engine generators.
2. Heat recovery system to capture heat from the spark-ignition engines for building and process heat.
3. Modifications to two (2) 480V switchgears
4. One (1) load bank and associated cable bus.
5. Mechanical interlocking of electrical distribution equipment
6. Tie into existing lube oil waste tank

Yonkers Phase IV work will be located in the following areas:

1. Blower and Admin Building:
 - a. Basement, Elevation -6.00

- b. Engine Room, Elevation 9.00
2. Dewatering Building

Demolition

- Engine-Blowers
 - 2 engine driven blowers and associated piping and exhaust stacks.
 - 2 engine driven blower local instruments, control panels, cable, conduit, and circuit breakers.
- Partial demolition of 480V switchgear
- (2) Portable generator connection boxes

2.2 General

2.2.1 Spark Ignition Combined Heat and Power Engine Generators

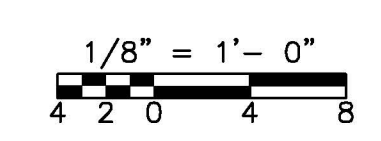
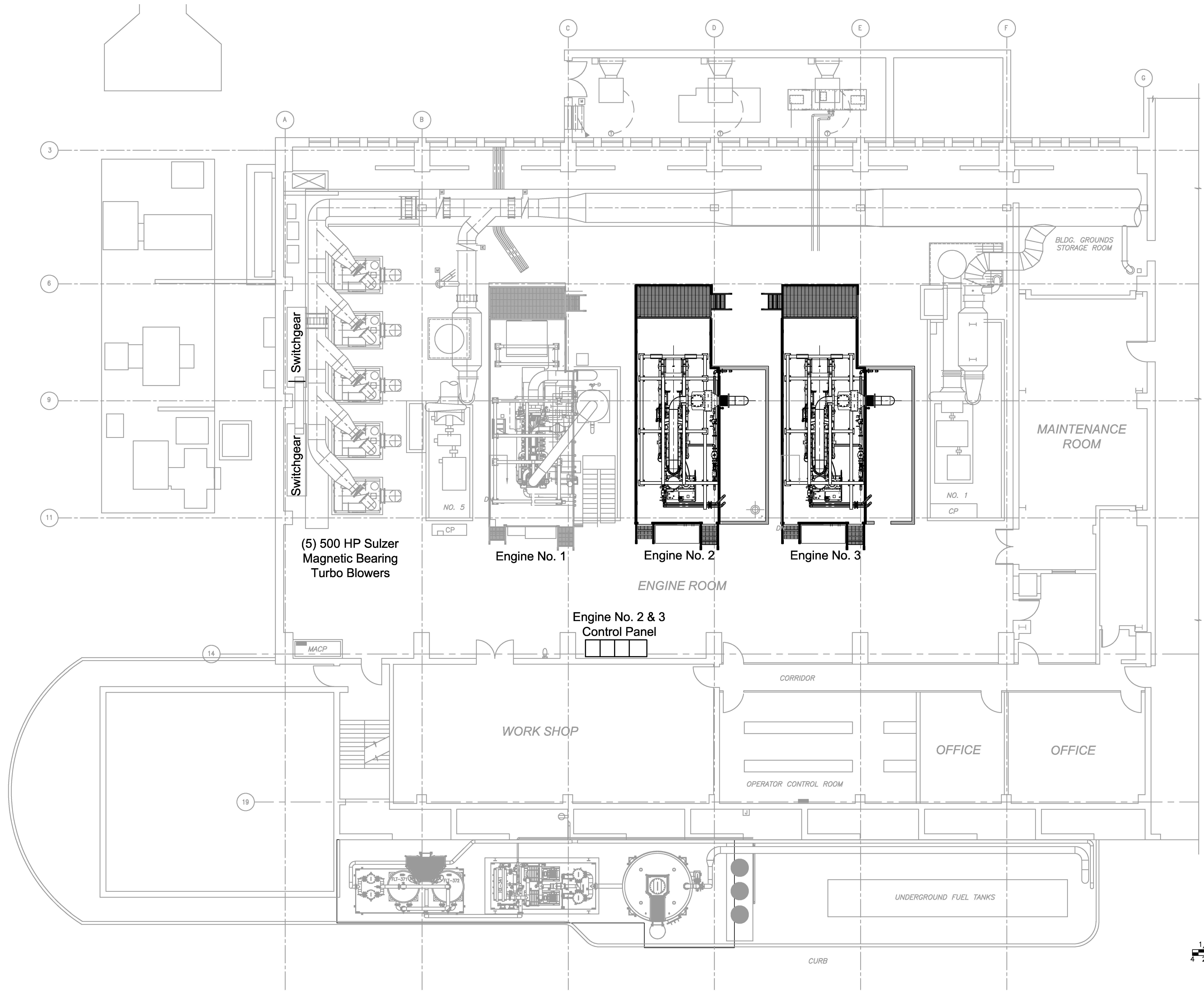
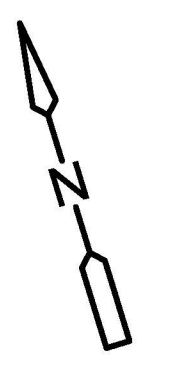
The design includes removal of the two Enterprise engine-driven blowers and replacement with two spark-ignition CHP engine generators. Engine Generators No. 2 and 3 will operate in island mode, isolated from a utility power source, and will be sized to run up to three (3) 500-HP turbo blowers each. Synchronizing controls will be provided with the pre-purchased generator control panels to parallel the two engine generators to accommodate generator load step limitations as necessary. With the two engines operating in parallel the combined generator capacity will be capable of starting and supporting up to five 500 HP turbo blowers. This will afford the County the flexibility to run both engines to power all five turbo blowers during an extended power outage on digester gas and/or natural gas. The plant's existing diesel standby generator would power the gas conditioning skid in the event of a utility power failure.

The blowers will be operated on VFDs and will start sequentially. The blower manufacturer has confirmed that the start time can be slowed down from the standard 50 second duration. The start time ramp-up can be as much as 5 minutes to accommodate loading limitations on the generator. This was observed during factory testing of the Sulzer turbo blowers. Engines 2 and 3 may be used simultaneously to bring blowers online if needed.

A plan view of the Engine/Blower Room is shown in Figure 2-1. The energy balance utilized to calculate the energy savings is presented in Appendix A. The energy balance is based on the normal operation of engine generation no. 2 powering three 500 hp turbo blowers.

2.2.2 Fuel Gas System Operation

The fuel gas system will consist of both the treated digester gas service and a utility grade natural gas (NG) supply. A dedicated natural gas service was installed under Phase II/III. The engines will be designed to operate on digester gas, natural gas, or on a blend of digester gas and natural gas. Normal operation will be fueled by a blend of digester gas and natural gas. The engine will have the ability to supplement the digester gas fuel with blended natural gas up to 100%. The dual fuel gas trains will operate automatically.



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2.2.3 Hazardous Materials

Previous sampling indicates that the blowers may have lead paint. Additional sampling will be conducted to confirm.

2.2.4 Electrical

The design includes modifications to the existing 480V Turbo Blower Switchgear to prepare for the future installation of four (4) new turbo blowers raising the total from five (5) to nine (9). Additional switchgear modifications allow for connection of the two (2) new engine generators (ADG-2 and ADG-3) to the tie breakers of each switchgear bus. A load bank will be installed in parallel with the two (2) generators. The load bank is configured to absorb load from ADG-2 and/or ADG-3 in the event of a turbo blower failure, ensuring the engines are adequately loaded. A cable bus system sized for operation of five (5) turbo blowers will be installed connecting ADG-2, ADG-3, and the load bank to the two tie breakers of the switchgear.

The last switchgear modification allows the existing generator ADG-1 to connect to the B-bus of the Turbo Blower Switchgear. A cable bus system sized for operation of three (3) turbo blowers will be installed for this connection.

The resulting Turbo Blower Switchgear configuration gives the switchgear the ability to be fed from utility power, ADG-1, ADG-2, ADG-3, or a combination thereof. Considering the differing capacity of the varying power sources, the turbo blower master aeration control panel (MACP) will be responsible for limiting the number of turbo blowers available under each operating scenario. Table 2-1 illustrates the various scenarios and the number of turbo blowers available under each. Note that the future condition of all nine (9) turbo blowers operating at once is reliant on either the installation of a transformer to feed the A bus of the turbo blower switchgear, or the combination of utility and generator power.

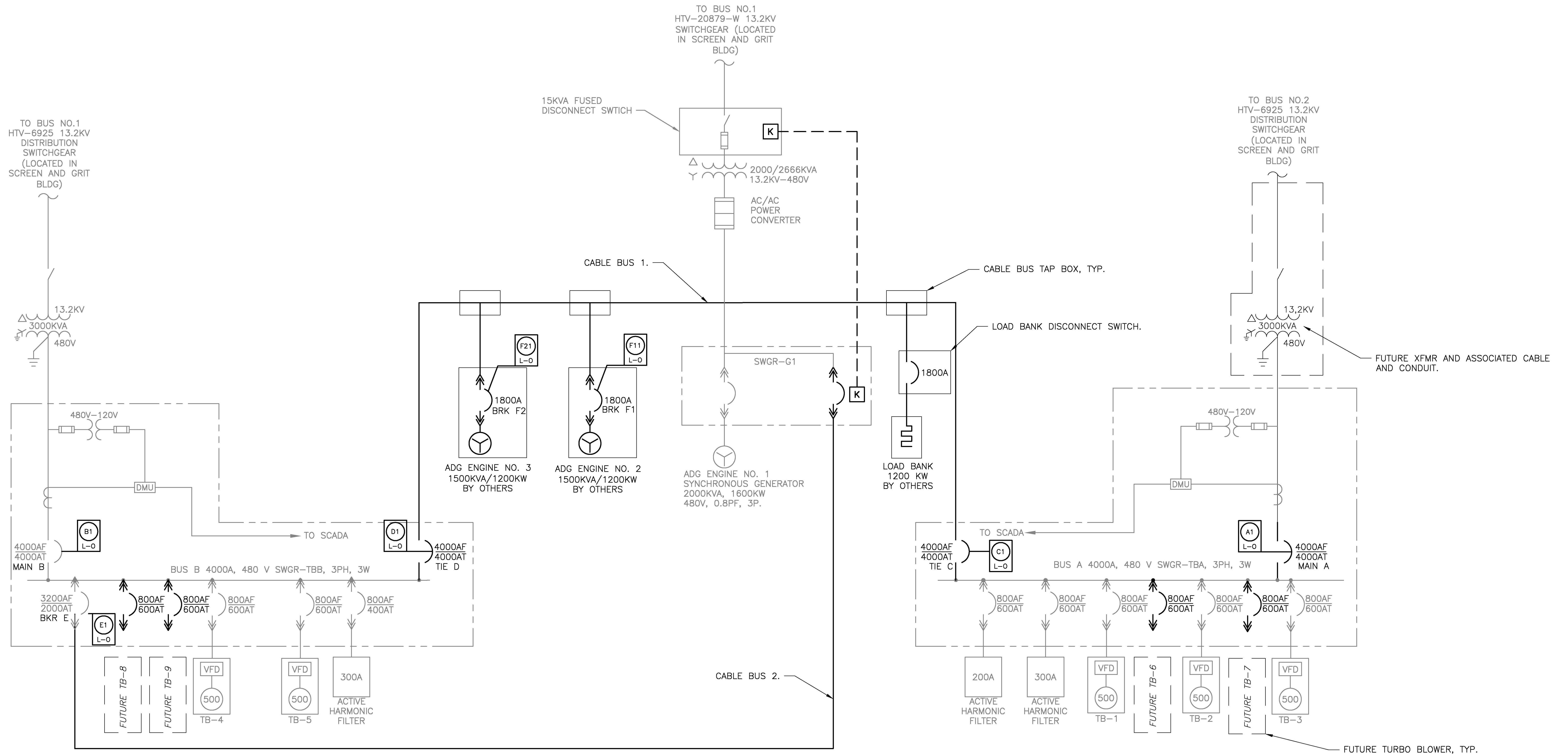
Table 2-1: Turbo Blower Availability

Power Source	Number of Turbo Blowers Available
Utility	5
ADG-1	3
ADG-2	3
ADG-3	3
ADG-2 & ADG-3	5

The turbo blower switchgear main circuit breakers, tie circuit breakers, the ADG-1 switchgear, the ADG-2 circuit breaker, and the ADG-3 circuit breaker will be outfitted with key interlocks configured to prevent the closing of circuit breakers under certain conditions, thus preventing unwanted paralleling. The existing active harmonic filters on the turbo blower switchgear will mitigate (in compliance with IEEE 519) harmonic distortion from the VFDs while operating on generator power.

A new 480V distribution power panel configured with a manual transfer switch will be fed from both the A and B bus of existing Motor Control Center 6. The distribution panel will provide power to the heat recovery equipment and ancillary equipment associated with the two new engine generators. Various new 120V loads associated with the engine and heat recovery

equipment will be powered via existing power panel PP-3A. The manual transfer switch enables one generator to remain operational while the equipment associated with the other generator is safely deenergized. Further, it enables redundancy by allowing the distribution panel to be powered by two independent sources.



2.2.5 Instrumentation and Controls Scope

New control panels will be required in order to ensure proper control of the new cogeneration engines. These will be connected to the plant SCADA system through the Ethernet switch located in the engine auxiliary panel.

2.2.6 Heat Recovery and HVAC Scope

The waste heat from the cogeneration engine would be recovered using a jacket water heat exchanger and an exhaust heat recovery steam generator (HRSG). The recovered jacket heat would be added to the plant's existing hot water heating loop for the secondary digesters. The steam produced by the heat recovery steam generator would be tied into the plant's steam system. Steam can be used at either end of the plant by activating the existing steam main in the tunnel between the Dewatering Building and the Secondary Digester Building. The existing CHP engine only is connected to the secondary digesters. The heat generated by the existing engine combined with the heat recovered from one operating proposed engine will exceed the heat required for the secondary digesters. For this reason, the exhaust heat from the new engines will be recovered by HRSGs. The steam generated in HRSGs can be used anywhere in the plant. Excess heat produced by the engine generators that could not be absorbed by the hot water loop would be directed to an existing heat dump heat exchanger to prevent the generator from overheating. Steam generation will be controlled by an exhaust bypass that will allow excess exhaust heat to be directed directly up the exhaust stacks. This split of the recovered hot water and steam is accounted for in the Energy Balance calculations included in Appendix A.

2.2.7 Sound Attenuation and Architectural Scope

Architectural design scope primarily includes sound attenuation and roll-up door replacement at the Blower Room. Sound attenuation will be accomplished by infilling openings at the eastern wall and replacing storefront at the southern wall with acoustic CMU. Installed doors and borrowed lights will be required to meet STC ratings which minimize sound transmission. Floor and wall repair is anticipated at all wall infill locations. There will be no change/adjustment to egress or occupancy. Additional design scope includes acoustic ceiling tile replacement and waterproofing at and exterior wall. Acoustic ceiling tiles are expected to be damaged due to electrical installations above the ceiling. Tiles will be replaced in like within the existing ceiling grid. New wall penetrations are expected for structural tie-ins and electrical conduit. Wall penetrations will be sealed and flashed as needed to mitigate water infiltration.

Section 3

Estimated Construction Cost

3.1 Estimated Cost Breakdown

The engineer's Opinion of Probable Total Installed Project Cost for Phase IV – Engine Upgrades as outlined in this report, based on the 90% design, is \$25,155,175.

These costs include the \$5,985,055 pre-purchase of the two CHP systems, all subcontractor overhead and profit, contingency and financing charges. The detailed Project Cost Estimates are included in Appendix B. The total project cost summary table is included on the next page.

Total Project Summary

**New York Power Authority - Energy Efficiency Program
Yonkers Joint WRRF - Blower and Engine Replacement Program**

ES-GSN-0870

February 23, 2024

Project Cost: Final Design		
Construction Material Costs:		\$5,985,055.00
Estimated Labor Costs:		\$14,742,591.00
Asbestos Abatement:		\$100,000.00
Special Inspections:		\$135,000.00
Subtotal:		\$20,962,646.00
Contingency:	20%	\$4,192,529.20
Subtotal:		\$25,155,175.20
Abatement Design & Monitoring:		\$50,000.00
Hazardous Waste Disposal Cost:		\$0.00
Environmental Subtotal:		\$50,000.00
Audit, Feasibility Study, or Design Only Services:		\$56,000.00
Design:		\$1,201,638.08 (See Note # 1)
DSDC:		\$314,439.69 (See Note # 2)
Construction Management:		\$3,018,621.02 (See Note # 3)
Engineering Support Services:		\$323,430.00 (See Note #4)
CMMS Updates:		\$60,000.00 (See Note #5)
NYPA Project Mgt. & Administrative:		\$3,555,371.93 (See Note #6)
NYPA Material Handling Cost:		\$0.00
Project Management Subtotal:		\$8,529,500.73
Project Subtotal:		\$33,734,675.93
Short-Term Financing (STF):		\$432,111.15
Total Project Cost:		\$34,166,787.08
Estimated Grants and Incentives		
NYPA Grants:		\$0.00
Est. 3rd Party Rebates & Incentives Expected to be Paid to NYPA:		\$0.00
Net Project Cost:		\$34,166,787.08

Notes:

- Design fee is 7.75% of 60% thru 100% design based on estimated construction costs, except asbestos abatement. Previous milestones were paid for under prior CPCs. Design fee also includes 7.75% of 6 year service agreement direct contract between WCDEF and Contractor.
 - Design Services During Construction (DSDC) is 1.25% of the estimated construction costs plus contingency. DSDC is not applied to the WCDEF direct purchased extended service.
 - Construction Management (CM) is 12.0% of the estimated construction costs plus contingency. CM is not applied to the WCDEF direct purchased extended service.
 - Estimated \$300,000 allowance for additional engineering support and \$23,430 for ADG-1 support.
 - Estimated \$60,000 allowance for Computerized Maintenance Management System (CMMS).
 - NYPA Project Mgt. & Administrative cost is 11.0% of all project costs, including direct service contract, but not STF.
 - Short-Term Financing (STF) is estimated based on 4.00% interest rate and assumes customer milestone payments during construction.
- *WCDEF Direct Purchase (6 year service) is directly contracted between the County and the Contractor for: \$2,142,259.00
5. Other defined on an as needed basis

Section 4

Energy Savings

4.1 Energy Savings

The Yonkers Engine Program has resulted in significant electric and fuel savings. Phase II/III resulted in electrical savings from new higher efficiency turbo blowers, increased capacity and higher efficiency blower design for the Howden Roots blowers, and blower and master aeration controls. As a result of the Phase II/III upgrades, the plant has gone from the normal operation of running two 1750hp Howden Roots blowers to running five 500 hp turbo blowers. This is a difference of 2000hp. Additionally, as discussed in Section 1, not running the existing engine-blowers no. 2 and no. 3 has resulted in significant fuel oil savings.

The energy savings associated with this final phase of the Engine Replacement Program is based on displacement of utility power for the three 500 HP (1,119 kW) turbo blowers with power provided by the new cogeneration units that will be fueled by a combination of ADG and natural gas. Appendix A contains an electrical and thermal energy balance based on 2019 digester gas production, digester gas usage, and plant thermal loads.

The energy balance reflects Engine No. 2 or No. 3 running 100% of the time. This as there are two engines to serve as back-up should one be down for routine or unexpected maintenance or repair. As summarized in Table 4-1, this displacement of utility power consumption will result in a 37% savings of electrical energy or an annual electrical cost savings of \$688,051. With supplemental natural gas and maintenance costs the annual savings \$463,807.

Table 4-1: Projected Phase IV Energy Savings

Table 4-1: Projected Phase IV Energy Savings		
Annual Electric Consumption (kWh)	26,203,162	kWh/year
Annual CHP Engine No. 2 Output (kWh)	9,829,296	kWh/year
Annual Electrical Energy Savings (%)	37	%

As presented in the energy balance of Appendix A, there are times where natural gas will be necessary to supplement the digester gas to Engine No. 2. Should the ADG production rate increase in the future, the amount of supplemental natural gas will decrease providing an increase in the overall savings.

