GEORGETOWN, SC, LOAD-SIDE GENERATION FACILITY

SCAMPS

2018 ANNUAL MEETING

PRESENTED BY:

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AND

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GEORGETOWN, SC

TABLE OF CONTENTS

1. INTRODUCTION

The City of Georgetown operates a municipal electric distribution system including two distribution substations. The Georgetown Substation serves 6-12.47 kV distribution circuits and has a current peak demand of 26.4 MW. The Maryville Substation serves 2-12.47 kV distribution circuits and has a current peak demand of 6.1 MW. The total City peak load is currently 32.5 MW.

Utility Technology Engineers-Consultants (UTEC) has worked with the City of Georgetown, SC, to design and construct a 3.6 MW Load-Side diesel-engine generating plant to operate in parallel with the City's primary electric distribution system. The project was substantially completed May 31, 2018, and has been operated several times so far during June 2018. This paper presents the economic basis for the plant, site selection decisions, operating sequences, and construction progress photographs.

2. BACKGROUND

In 2013, Georgetown solicited power supply proposals from several electric utility companies that were considered reasonable options to provide wholesale power to Georgetown. Proposals were received from five potential power suppliers, listed in alphabetical order:

1. Duke Energy
2. Piedmont Municipal Power Agency (PMPA)
3. Santee Cooper
4. South Carolina Electric and Gas (SCE&G)
5. Southern Power.

The Request for Proposal (RFP) specified the key contract terms Georgetown desired. These key terms included:

- Demand portion of the contract to be based on City's metered hourly load <u>coincident</u> with the power suppliers integrated hourly peak demand
- Continuous access to the power supplier's instantaneous load (MW)
- Allowance for Georgetown to install load-side generation assets that could be operated in parallel with the City's electric system when desired by the City
- A 10-year contract term that could be renewed at the end of the term

The proposal evaluations included not only the power supply costs, but also the additional costs for transmission services. After detailed review and evaluation, Georgetown determined that the proposal from Santee Cooper was the best and most economical proposal for its load, both with and without load-side generation, and entered into contract with Santee Cooper May 2014.

Georgetown next performed an economic analysis for costs and expected cost savings if Georgetown were to install load-side generation. The results of the analysis showed considerable economic benefit to the City to install generation. Savings would be achieved for renting temporary generators and well as for constructing permanent facilities. Georgetown decided to lease temporary generators while designing and constructing permanent facilities. Over the lease period, we were able to gain experience in monitoring the power supplier's load and making decisions about running generators. Georgetown contracted with Blanchard Power Systems to rent two 1800 kW mobile Caterpillar engine generators. One unit was installed at the City's Waste Water Treatment Plant January 29, 2015, and one unit was installed at the City's Water Treatment Plant February 26, 2015. Both units were controlled remotely via cell telephone. These two temporary generators have been in service and produced power supply cost savings since early 2015 until the end of May 2018.

3. ECONOMIC FEASIBILITY

UTEC performed a detailed analysis of the economic feasibility for Georgetown to install load side generation to reduce wholesale power costs. We worked with several of the major equipment vendors to develop current cost opinions for major equipment and rental costs for leasing temporary equipment. UTEC also worked with several contractors to develop cost opinions for building and equipment erection.

3.1 Economic Analysis Parameters

The parameters used in the analysis are:

- Annual interest rate for money – 4.00%
- Economic evaluation period and term for capital recovery calculations – 20 years
- Annual insurance cost for capital investment – 0.5% times capital cost
- Maintenance service agreement with major equipment vendor - $48,188 for 5-yr term
- Current fuel cost - $3.50/gallon
- Design engineering and permit applications estimated to be approximately 15% of the capital costs. Engineering field services during installing and startup were estimated to be $200,000.
- The annual inflation rate is estimated to be 2.00%/yr. for variable cost and Consumer Price Indices, both past and projected, were used for future fuel cost estimates.

3.2 Key Study Results

- The cost opinion for the capital investment was $4,789,244. This is an all-in cost for major equipment, site development, permitting, engineering, and commissioning.
- For the permanent installation only, the total power cost savings over 20 years is $19,741,098. The net savings after expenses is $6,463,288. The net present worth of the net savings for 20 years is $5,190,612.

- For both the temporary rental installation and the permanent installation, the total power cost savings over 20 years is $20,700,197. The net savings after expenses is $6,546,134. The net present worth of the net savings for 20 years is $5,274,093.

4. ANALYSIS OF NATURAL GAS VERSUS DIESEL

UTEC performed an economic analysis of natural gas fuel versus diesel fuel. The scope of the evaluation included:

- Installation Cost – Considers equipment and installation cost, peripheral support systems, and impact to required building square footage.
- Maintenance / Overhaul Cost – Evaluates the cost and frequency of normally scheduled maintenance and engine overhauls.
- Operating Cost – Considers cost of fuel and exhaust treatment additives required for operation.
- Fuel Availability and Cost Forecast – Considers the reliability of fuel supply and the present / future cost of fuel.

Summary of the analysis is as follows:

4.1 Installation Costs

Diesel Engine / Generator Units

The cost of installing two diesel engine units breaks down as:

Two Diesel Engine Generators - Equipment and Installation Cost			
Item	Unit Cost	Quantity	Total Cost
Diesel Engine/Generator 1825 kw Prime, 2000 kW Standby, 4.16 kV, 350 gal day tank pump/controls, Exhaust Insulation, Exhaust After-treatment. Check-out / startup	$776,000	2	$1,552,000
Diesel Fuel Storage Tank System, Piping Insulation, Leak Detection, Level Gauge, Steel, double walled tank	$152,200	1	$152,200
Installation – Engine / Generator Set, exhaust piping with insulation, Exhaust After-treatment System, day tank fuel system	$39,750	2	$79,500
Total			**$1,783,700**

Table 1: Diesel Engine Cost Breakdown

The diesel exhaust after treatment system varies among engine manufacturers. However, typical system requirements include an after treatment diesel particulate filter (DPF) module, selective catalyst reduction (SCR) and diesel exhaust fluid (DEF) dosing module, DEF storage tank, DEF dosing control cabinet, required sensors and transducers, and possibly compressed air. The SCR module with DEF dosing converts the harmful NOx emission into nitrogen and water.

The after treatment system can be a significant part of the engine installation, in some case as large as the engine generator set itself

Figure 1 illustrates example diesel engine / generator sets with SCR after treatment technology.

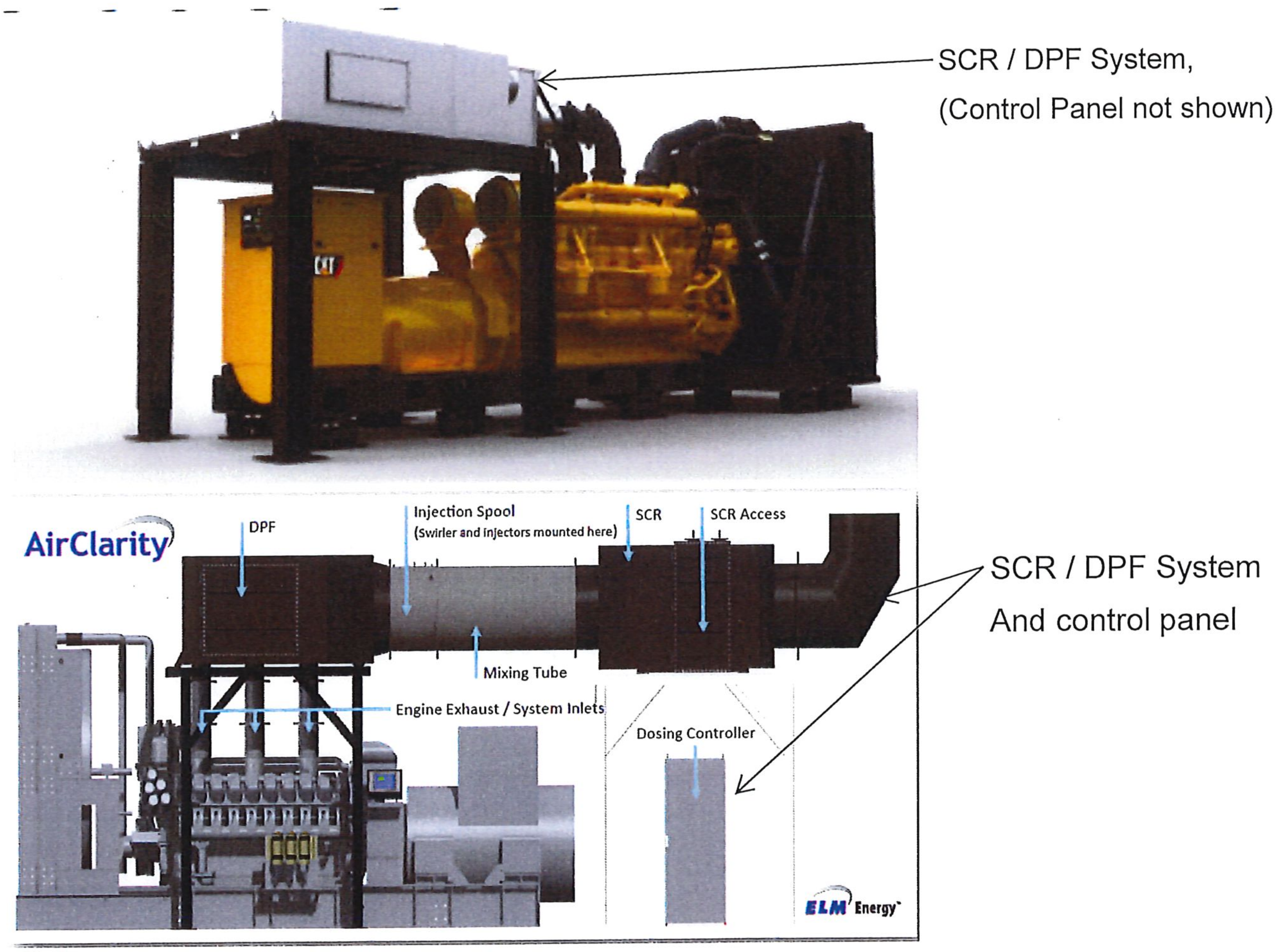


Figure 1: Diesel engine / generator sets with after treatment system

Natural Gas Engine / Generator Units

The cost of installing two natural gas engine units breaks down as:

Two Natural Gas Engine Generators - Equipment and Installation Cost			
Item	Unit Cost	Quantity	Total Cost
Natural Gas Engine/Generator 1964 kW Prime, 1964 kW Standby, 4.16 kV, Check-out / startup services.	$928,000	2	$1,856,000
Natural Gas Leak Detection System	$5,500	2	$11,000
Install exhaust, insulation, silencer	$30,000	2	$60,000
Installation – Engine / Generator Set, Install separately shipped radiator cooling fan	$39,750	2	$79,500
Natural Gas Line (2000 ft) / Meter Installation by SCE&G	$23,600	1	$23,600
Additional building / site preparation	$68,875	1	$68,875
Total			**$2,098,975**

Table 2: Natural Gas Engine Cost Breakdown

Natural Gas engines do not require any exhaust after treatment or external fuel storage tanks. An exhaust silencer is required for noise reduction. The natural gas unit requires an additional 8 ½ linear feet of floor space; necessitating an additional cost for building and site preparation as reflected table 2.

Figure 2 illustrates example natural gas engine / generator sets.

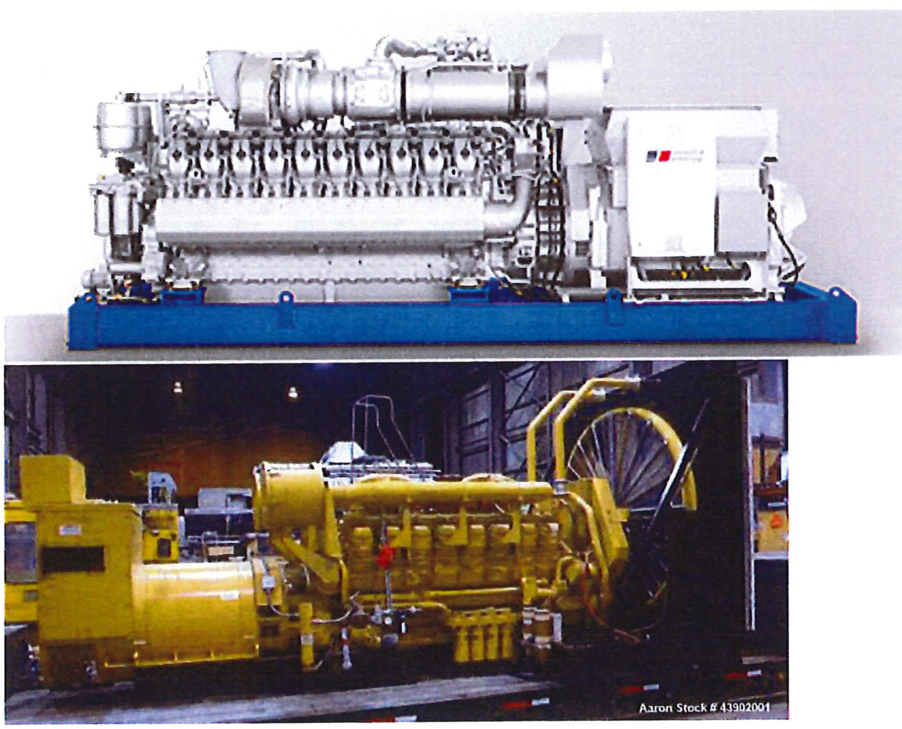


Figure 2: Natural Gas engine / generator examples, (exhaust silencer not shown)

Installing two natural gas engine / generator sets will cost approximately $315,275 more than two diesel engine / generator sets; a 17.67% increase over and above the diesel engine units cost.

4.2 Maintenance/Overhaul Cost

Maintenance / Overhaul cost and interval schedules vary between different engine manufacturers. However, within the same manufacturer, the difference in maintenance cost for either a diesel or natural gas engine is negligible.

Table 3 illustrates the maintenance and overhaul cost and intervals

Caterpillar Engines (Blanchard)		
Task	Diesel Engine Interval / Cost per Engine	Natural Gas Engine Interval and Cost per Engine
Routine Maintenance Replace Engine Oil, Oil Filter, Air Filter, Fuel Water Filter	2000 hours / $2,900	2000 hours / $2,700 (no fuel water filter)
1st Overhaul	7500 hour / $116,000	20,000 hours / $83,000
2nd Overhaul	22,000 hours / $217,000	80,000 hours / $202,000

Detroit Diesel Engines (MTU)		
Task	Diesel Engine Interval / Cost per Engine	Natural Gas Engine Interval and Cost per Engine
Routine Maintenance Replace Engine Oil, Oil Filter, Air Filter, Fuel Water Filter	250 hours / $2,421	250 hours / $1946 (no fuel water filter)
1st Overhaul	24,000 hours / $410,400	65,000 hours / $323,634
2nd Overhaul	48,000 hours / $410,400	130,000 hours / $323,634

Table 3: Maintenance / Overhaul interval and cost

Engine overhaul hours are very large in comparison to expected yearly operating hours. For example, considering operating an engine for 250 hours a year, it would be approximately 30 years for the 1st overhaul of a Caterpillar diesel engine and 80 years for a 1st overhaul of a Caterpillar natural gas engine.

4.3 Operating Cost

Operating Costs are calculated considering both generators operating at a load of 1800 kW. Operation Cost also includes the estimated yearly maintenance cost. For diesel engines, diesel exhaust fluid costs are also considered. For natural gas engines, monthly gas service line facility charges are included.

Operating cost analyses are performed using current diesel prices recently paid by the City of Georgetown and estimated future prices provided by the US Energy Information Administration. Natural gas pricing was obtained from South Carolina Electric & Gas Company. Yearly operating hours is considered to be 167 hours per generator, based on 2015 operating data provided by Georgetown.

The operating cost and savings per year using natural gas units are indicated in table 4

Operating Cost Analysis: Savings per year using Natural Gas Units Operating 167 hrs/yr - 1800kW Load/Generator – 2 Generators Operating			
Fuel Cost	Diesel Engine $ Cost / yr	Natural Gas Engine $ Cost / yr	Natural Gas $ Saved / yr
<u>Current Fuel Cost</u> Diesel = $1.41/ gal DEF = $2.80 / gal Nat Gas = $.81883/therm	$70,089	$52,812	$17,277
<u>2016 Projected Fuel Cost</u> Diesel = $2.22/ gal DEF = $2.80 / gal Nat Gas = $.81883/therm	$104,718	$52,812	$51,906
<u>2017 Projected Fuel Cost</u> Diesel = $2.58/ gal DEF = $3.25 / gal Nat Gas = $.8881/therm	$121,445	$64,581	$56,864
<u>Previous Diesel Prices</u> Diesel = $3.75/ gal DEF = $4.10 / gal Nat Gas = $.8881/therm	$173,992	$56,865	$117,127

Table 4: Operating Cost Comparisons / Projected savings

4.4 Fuel Availability and Cost Forecast

The advantage of diesel fuel is that it is stored on site and ready anytime operation is required.

Natural Gas will be delivered by a gas service line and meter. Though extremely reliable, natural gas supply could be subject to outages resulting from vehicle accidents, storms, or natural disasters. However, SCE&G has reported that it has never lost service, even during hurricane conditions.

The price of natural gas can be compared to the price of diesel fuel by converting the cost of natural gas to diesel gallon equivalent units. Figure 3 illustrates the historical cost of natural gas, converted to diesel gallon equivalent units, compared to other diesel fuel and other alternative fuels.

The price of natural gas tends to be more stable.

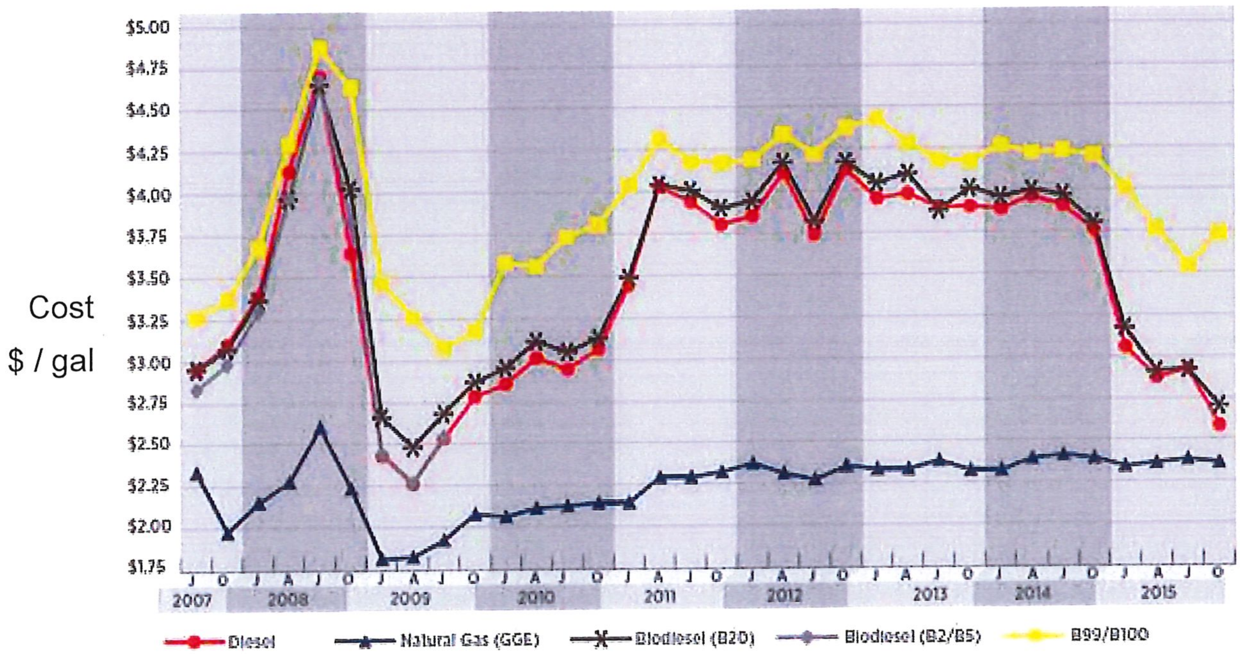


Figure 3: Historical Fuel Cost (Natural Gas Cost at diesel gallon equivalent unit) (Oct 2015 US Dept. of Energy)

4.5 Summary and Recommendation

Natural gas engine / generator sets will cost $315,275 more than diesel engine units.

The maintenance costs for the diesel engine / generator set and the natural gas engine / set are similar and not a factor in the operating cost analysis.

At current fuel prices (diesel - $1.41/gal; natural gas - $.81883/therm), the annual cost savings operating a natural gas unit is $17,277. This represents an 18.25 year payback period.

Diesel fuel is currently at a significantly low cost. The US Dept. of Energy forecasts the cost of diesel fuel will increase at a greater percentage than the cost of natural gas. At estimated 2017 and beyond pricing (diesel – 2.58/gal; natural gas - .8881/therm), the annual cost savings operating a natural gas unit is $56,864. This represents a 5.5 year payback period.

At future estimated fuel prices, natural gas becomes a more viable option. However, without a significant increase in diesel fuel cost, the diesel engine generator plant remains the best option.

5. COINCIDENT PEAK DEMAND CONTRACT

One of the keys to the economic value of load-side generation is having a power supply contract in which Demand Charges are determined at the time, or during the hour of, the power supplier's peak load. Such contracts are referred to as Coincident Peak, or CP, contracts. Some of the power supply proposals based demand charges on the coincident annual hourly peak load, one based demand charges on the average load during the highest 10 hours of the year, and others based the monthly demand charges on the monthly highest CP load. Load-side generators can be operated with any of these type CP contracts and produce cost savings. Each type contract requires a different number of operating hours per year of the generation assets to be sure the generators are operated during the hours that the power supplier's peak demands occur.

Energy produced by diesel engine generators is typically more expensive than energy purchased under a wholesale contract. The cost of energy produced by internal combustion engine generators is proportional to the cost per gallon of diesel fuel and diesel exhaust fluid (DEF). For engines rated 1800 kW, typical full load diesel fuel usage is 128 gallons/hr. and typical full load DEF usage is 8.9 gallons/hr. Recent diesel fuel purchases by Georgetown were $2.69/gallon and recent DEF purchases were $1.49/gallon. At these rates, the production cost of energy is $0.19865/kWh. Current wholesale energy costs from various wholesale providers range from $0.030/kWh to $0.050/kWh. So clearly, the less energy generated and instead purchased under wholesale contracts, the lower the overall energy costs. The objective is to run the generators during the hours of CP only, and purchase wholesale energy during all other hours.

How do we optimize run time? The answer is accurate knowledge of the expected daily load profile each day and the ability to monitor and update the projection throughout the day. Then, operate the load-side generation only during the hours that are the peak loads.

6. DAILY LOAD PROFILE

For most wholesale CP contracts that allow operation of load-side generation, it is the responsibility of the customer to determine when to operate its load-side generation to reduce demand. Therefore, another key to the economic value of load-side generation is having access to the wholesale supplier's instantaneous load. Typically, peak hourly loads occur in the morning between 6 AM and 8 AM during winter and afternoon between 2 PM and 6 PM during summer. During spring and fall months, the hourly peak loads can occur in the morning, afternoon, or evening hours. The instantaneous load, kW, is driven by the customer loads in operation at any particular time, with variation of these loads throughout the day and the seasons primarily driven by outside temperatures and humidity values.

Georgetown has access to the instantaneous load of its wholesale supplier 24 hours a day, seven days a week, 365 days a year. Since February 2015 Georgetown has developed a data base of daily historical instantaneous loads of its wholesale power supplier, temperatures, and humidity values and adds to this data base each day. UTEC developed a spreadsheet program to predict the load profile of each day and to monitor and update the actual profile as the day proceeds. This program is used to determine when Georgetown should run generators and when to shut generators down.

Figure 4-1 is a typical daily load profile chart for a power provided. The chart plots the 24-hours of the day in 5-minute increments on the "X" axis and the instantaneous demand on the "Y" axis.

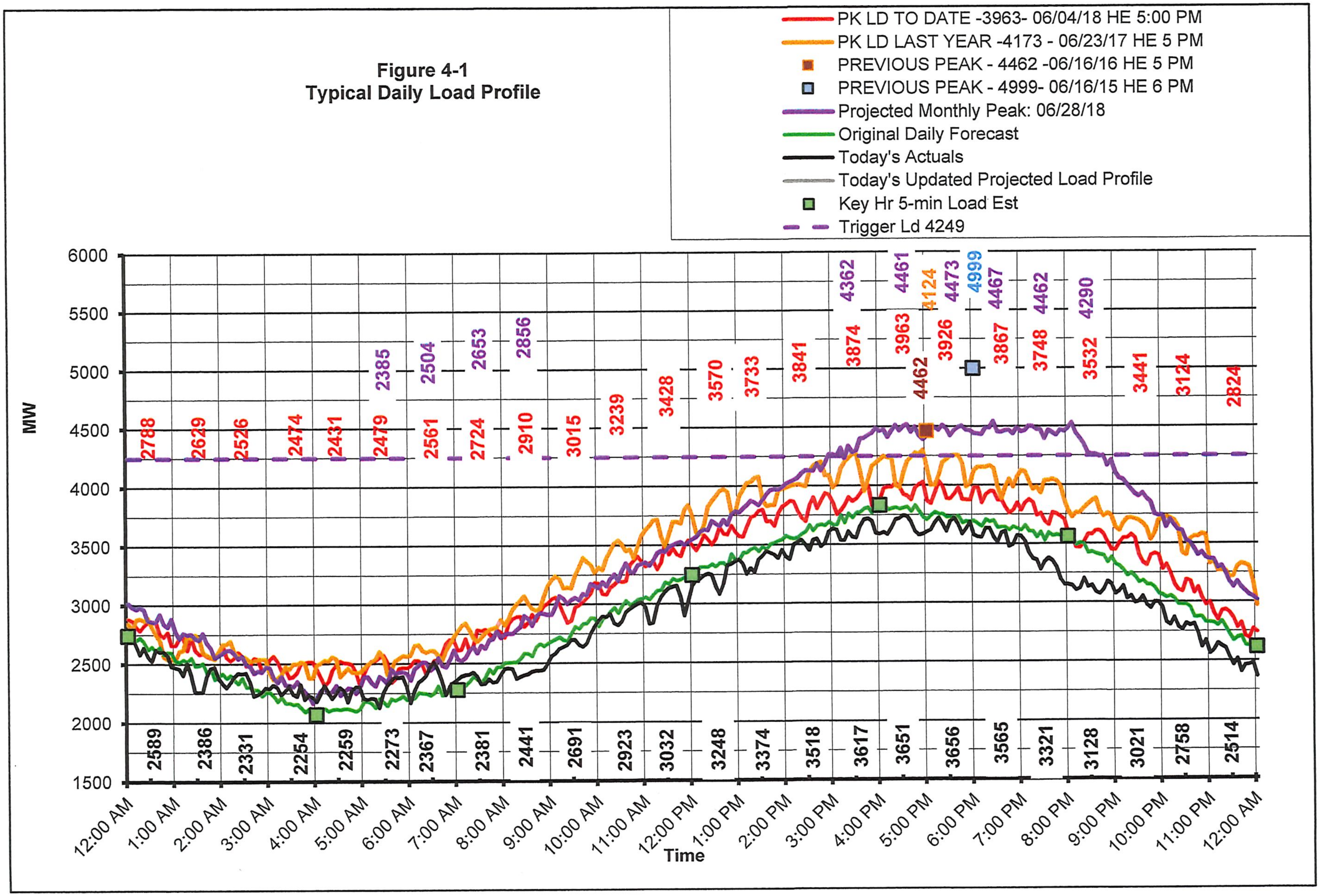
The spreadsheet includes historical load data, historical temperature data, and historical humidity data for major load centers of the wholesale utility, and using this data with regression analyses, develops the least squared error equations of load versus heating degree days, cooling degree days, and humidity. Each day, the projections of temperature and humidity at seven key times are obtained from weather stations. Inputting weather projections into the spreadsheet results in calculations of the projected demands during the seven-key times. The seven key times are:

- 12 AM
- 4 AM
- 7 AM (8 AM during weekends and holidays)
- 12 PM
- 4 PM
- 8 PM
- 12 AM the following day.

These values are the green square data points shown on the chart. In addition to the historical load and temperature data, historical instantaneous load data has been saved for every five minutes of each previous day. Up to five typical daily profiles are input into each daily profile chart to calculate the expected profile between each of the seven key times. The results are the green forecast curve in the chart. We use this green forecast curve to predict in advance if and when we might have a peak load requiring operations. We typically do not change the weather projections during the day, but if we do make updates, the green curve will re-calculate. At the beginning of the next day, we input actual temperature and humidity for the previous day and keep the actual spreadsheet and data for future forecasting.

The red curve is very important. This is the actual instantaneous load profile for the peak-hour day so far in the month. The vertical red values are the average hourly loads, kWh/hr., for each hour of the peak load curve thus far in the month. The idea is

Figure 4-1
Typical Daily Load Profile



that if actual loads during the day exceed the highest hourly load of the red curve, we consider running the generators during that hour.

The black curve is the actual instantaneous load thus far in the current day. The gray curve is the updated projection of the instantaneous load profile for the day based on the actual black loads for the day and historical data. The black vertical values are the actual integrated hourly loads for each hour that has passed or for the gray updated profile. If the updated hourly projections appear that loads will exceed the red peak hourly loads for any hour, we consider running the generators.

The purple curve is also very important. This is the expected instantaneous profile for the peak day of the month. If all plays out as projected, this purple curve will be the peak for the month.

The problem is, weather conditions do change from predictions. So, this purple curve provides the expected peak, but we must monitor actual loads (black and gray) and decide if the developing loads do in fact tell us to run.

Table 4-1 shows the actual generator run hours each month since January 2016. The total annual run hours were 203, 208, and 47 for 2016, 2017, and 2018 to date through May 31, 2018, respectively.

6.1 Typical Seasonal Peak Day Profiles

Figure 4-2 is a typical winter peak day load profile chart. During the winter, the peak hourly load is typically hour-ending (HE) 7 AM or HE 8 AM. Loads typically taper off after 8 AM but will increase during the evening between 6 PM and 9 PM. While the load profile needs to be checked during the evening, the evening loads rarely exceed the morning loads.

Figure 4-3 is a typical summer peak day load profile chart. During the summer, the peak hourly load is typically HE 4 PM to HE 6 PM. Loads typically taper off after 6 PM.

Figure 4-4 is a typical spring peak day load profile chart. During the early spring season the peak hourly load is typically HE 7 AM or HE 8 AM. Loads typically taper off after 8 AM but will increase during the evening between 6 PM and 9 PM. During late spring season, the peak hourly load is typically HE 4 PM to HE 6 PM. While the load profile needs to be checked during the evening, the evening loads rarely exceed the afternoon loads.

Figure 4-5 is a typical fall peak day load profile chart. During the early fall season, the peak hourly load is typically HE 4 PM to HE 6 PM and loads typically taper off after 6 PM. During late fall season, the peak hourly load is typically HE 7 AM or HE 8 AM. Loads typically taper off after 8 AM but will increase during the evening between 6 PM and 9 PM. While the load profile needs to be checked during the evening, the evening loads rarely exceed the morning loads

TABLE 4-1
GEORGETOWN, SC
MONTHLY OPERATING HRS

Date:	Time:	# of Hrs Run:	Day/Time Hourly Peak	Annual # of Hours
January-16				
5-Jan	7am-9am	2		
6-Jan	6am-9am	3		
12-Jan	7am-9am	2		
19-Jan	7am-9am	2	1/19/16 8:00am	
February-16				
8-Feb	6am-9am	3		
10-Feb	6am-10am	4		
11-Feb	7am-9am	2		
14-Feb	8am-10am	2	2/14/2016 9:00am	
March-16				
3-Mar	6am-9am	3		
5-Mar	7am-9am	2		
7-Mar	7am-9am	2		
22-Mar	7am-9am	2	3/22/16 8:00am	
April-16				
6-Apr	6am-9am	3		
19-Apr	5pm-7pm	2		
24-Apr	6pm-8pm	2		
25-Apr	6pm-8pm	2		
26-Apr	4pm-8pm	4		
27-Apr	3pm-7pm	4		
29-Apr	3pm-6pm	3	4/29/16 5:00pm	
May-16				
12-May	4pm-6pm	2		
25-May	4pm-8pm	4		
26-May	3pm-7pm	4	5/26/2016 5:00pm	
27-May	3pm-7pm	4		
June-16				
3-Jun	3pm-7pm	4		
4-Jun	3pm-7pm	4		
11-Jun	3pm-6pm	3		
12-Jun	3pm-7pm	4		
13-Jun	3pm-6pm	3		
14-Jun	3pm-6pm	3		
16-Jun	3pm-8pm	5	6/16/16 5:00pm	
23-Jun	3pm-6pm	3		
24-Jun	3pm-5pm	2		

TABLE 4-1
GEORGETOWN, SC
MONTHLY OPERATING HRS

Date:	Time:	# of Hrs Run:	Day/Time Hourly Peak	Annual # of Hours
July-16				
3-Jul	3pm-6pm	3		
5-Jul	3pm-7pm	4		
8-Jul	3pm-8pm	5		
13-Jul	3pm-5pm	2		
25-Jul	3pm-5pm	2		
26-Jul	3pm-6pm	3		
27-Jul	3pm-7pm	4	7/27/16 6:00pm	
29-Jul	3pm-5pm	2		
August-16				
13-Aug	3pm-7pm	4		
14-Aug	4pm-7pm	3		
15-Aug	3pm-7pm	4	8/15/2016 5:00pm	
16-Aug	4pm-6pm	2		
September-16				
1-Sep	3pm-5pm	2		
7-Sep	4pm-7pm	3		
8-Sep	3pm-7pm	4		
9-Sep	3pm-7pm	4		
10-Sep	4pm-7pm	3		
11-Sep	3pm-6pm	3	9/11/16 4:00pm	
October-16				
2-Oct	3pm-6pm	3		
3-Oct	3pm-6pm	3		
17-Oct	3pm-6pm	3		
19-Oct	3pm-7pm	4	10/19/16 5:00pm	
20-Oct	4pm-6pm	2		
November-16				
2-Nov	4pm-6pm	2		
3-Nov	4pm-9pm	5		
16-Nov	6am-9am	3		
17-Nov	6am-8am	2		
20-Nov	7am-10am	3		
21-Nov	6am-9am	3	11/21/16 8:00am	
22-Nov	6am-8am	2		
December-16				
9-Dec	6am-10am	4		
9-Dec	9pm-1am	4		
10-Dec	6am-10am	4	12/10/16 8:00am	
11-Dec	6am-8am	2		
16-Dec	6am-9am	3		
				203

TABLE 4-1
GEORGETOWN, SC
MONTHLY OPERATING HRS

Date:	Time:	# of Hrs Run:	Day/Time Hourly Peak	Annual # of Hours
January-17				
8-Jan	6am-10am	4		
9-Jan	6am-9am	3	1/9/16 8:00am	
February-17				
4-Feb	7am-11am	4		
10-Feb	5am-9am	4	2/10/17 8:00am	
March-17				
3-Mar	6am-9am	3		
4-Mar	6am-9am	3		
5-Mar	6am-9am	3		
12-Mar	2pm-3pm	1		
12-Mar	9pm-11pm	2		
13-Mar	6am-9am	3		
15-Mar	6am-10am	4		
16-Mar	6am-9am	3	3/16/17 8:00am	
17-Mar	7am-8am	1		
April-17				
17-Apr	5pm-8pm	3		
20-Apr	3pm-8pm	5		
21-Apr	3pm-8pm	5		
22-Apr	3pm-7pm	4		
28-Apr	2pm-7pm	5	4/28/17 5:00pm	
29-Apr	3pm-6pm	3		
May-17				
10-May	3pm-8pm	5		
11-May	3pm-8pm	5		
15-May	4pm-8pm	4		
16-May	3pm-8pm	5		
19-May	4pm-6pm	2		
20-May	3pm-7pm	4		
27-May	4pm-7pm	3		
28-May	3pm-7pm	4		
29-May	2pm-7pm	5	5/29/17 4:00pm	
June-17				
15-Jun	3pm-5pm	2		
23-Jun	3pm-7pm	4	6/23/17 5:00pm	
24-Jun	3pm-4pm	1		
July-17				
5-Jul	3pm-5pm	2		
6-Jul	3pm-7pm	4	7/6/17 5:00pm	
7-Jul	3pm-5pm	2		
8-Jul	3pm-5pm	2		
14-Jul	3pm-5pm	2		
21-Jul	3pm-4pm	1		
22-Jul	3pm-5pm	2		

TABLE 4-1
GEORGETOWN, SC
MONTHLY OPERATING HRS

Date:	Time:	# of Hrs Run:	Day/Time Hourly Peak	Annual # of Hours
August-17				
12-Aug	3pm-6pm	3		
15-Aug	3pm-8pm	5		
16-Aug	3pm-6pm	3		
17-Aug	3pm-4pm	1		
18-Aug	2pm-8pm	6	8/18/17 6:00pm	
19-Aug	3pm-5pm	2		
23-Aug	3pm-7pm	4		
September-17				
1-Sep	4pm-6pm	2		
5-Sep	4pm-5pm	1		
21-Sep	3pm-5pm	2		
26-Sep	3pm-6pm	3		
27-Sep	3pm-7pm	4		
28-Sep	3pm-7pm	4	9/28/17 5:00pm	
October-17				
5-Oct	4pm-6pm	2		
6-Oct	3pm-6pm	3		
7-Oct	3pm-7pm	4		
8-Oct	2pm-5pm	3	10/8/17 2:00pm	
November-17				
11-Nov	7am-10am	3		
15-Nov	6am-9am	3		
16-Nov	6am-9am	3		
17-Nov	6am-8am	2		
20-Nov	6am-9am	3	11/20/17 8:00am	
27-Nov	7am-8am	1		
28-Nov	6am-8am	2		
December-17				
8-Dec	6am-8am	2		
10-Dec	6am-10am	4		
11-Dec	6am-9am	3		
28-Dec	7pm-9pm	2		
29-Dec	6am-10am	3	12/29/17 9:00am	
30-Dec	6am-9am	3		
				208

TABLE 4-1
GEORGETOWN, SC
MONTHLY OPERATING HRS

Date:	Time:	# of Hrs Run:	Day/Time Hourly Peak	Annual # of Hours
January-18				
2-Jan	6am-9am	3		
5-Jan	6am-9am	3	1/5/18 8:00am	
7-Jan	7pm-9pm	2		
February-18				
1-Feb	6am-9am	3	2/1/18 8:00am	
3-Feb	8am-10am	3		
March-18				
5-Mar	6am-8am	2		
8-Mar	7am-9am	2		
9-Mar	6am-8am	2		
13-Mar	6am-9am	3		
15-Mar	7am-9am	2	3/15/18 8:00am	
April-18				
8-Apr	8am-11am	3		
11-Apr	7am-9am	2		
17-Apr	7am-9am	2	4/17/18 8:00am	
May-18				
10-May	3pm-7pm	4		
11-May	3pm-7pm	4		
12-May	3pm-6pm	3		
13-May	3pm-6pm	3	5/13/18 5:00pm	
26-May	4pm-5pm	1		
				47

Figure 4-2
Typical Winter Load Profile

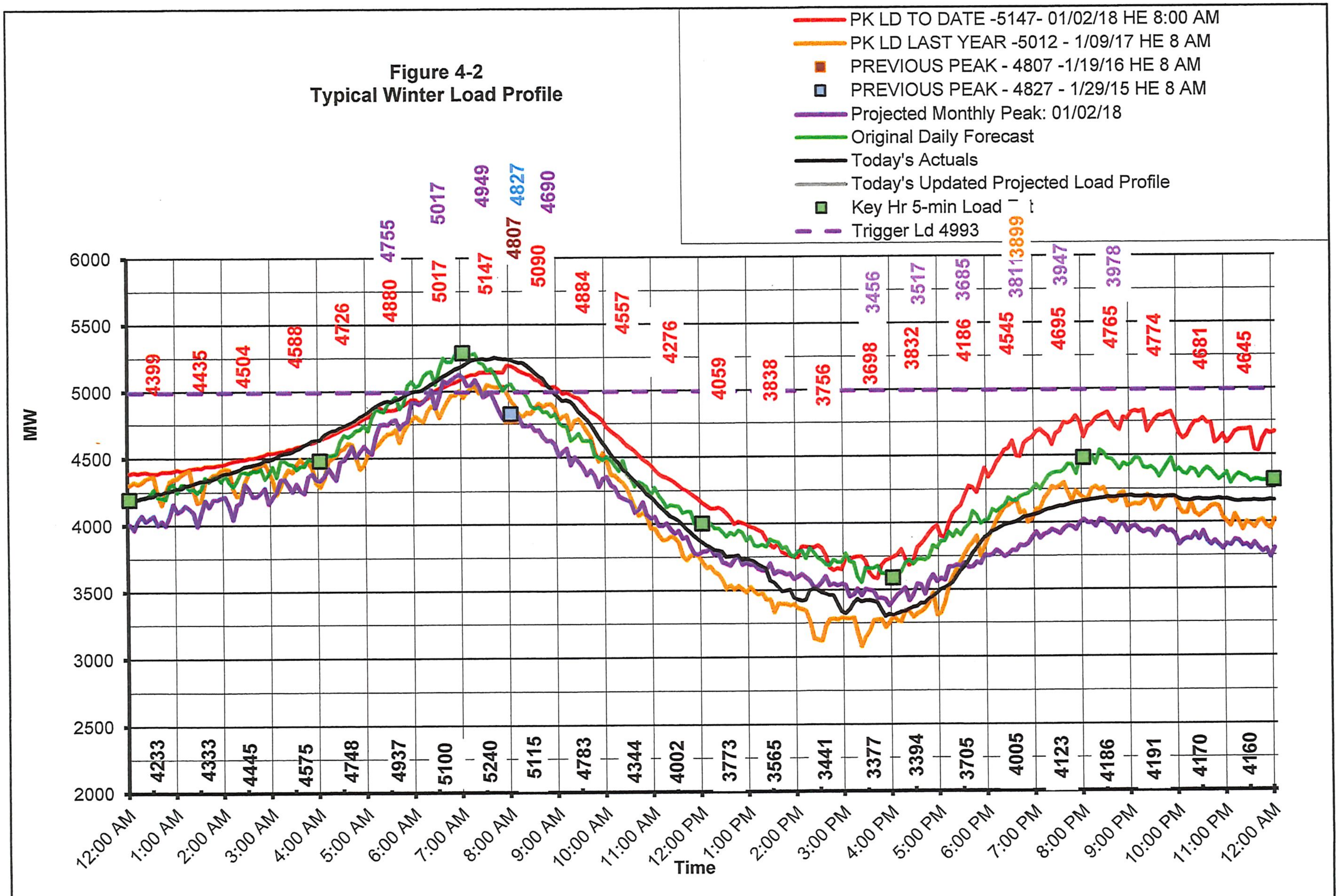


Figure 4-3
Typical Summer Load Profile

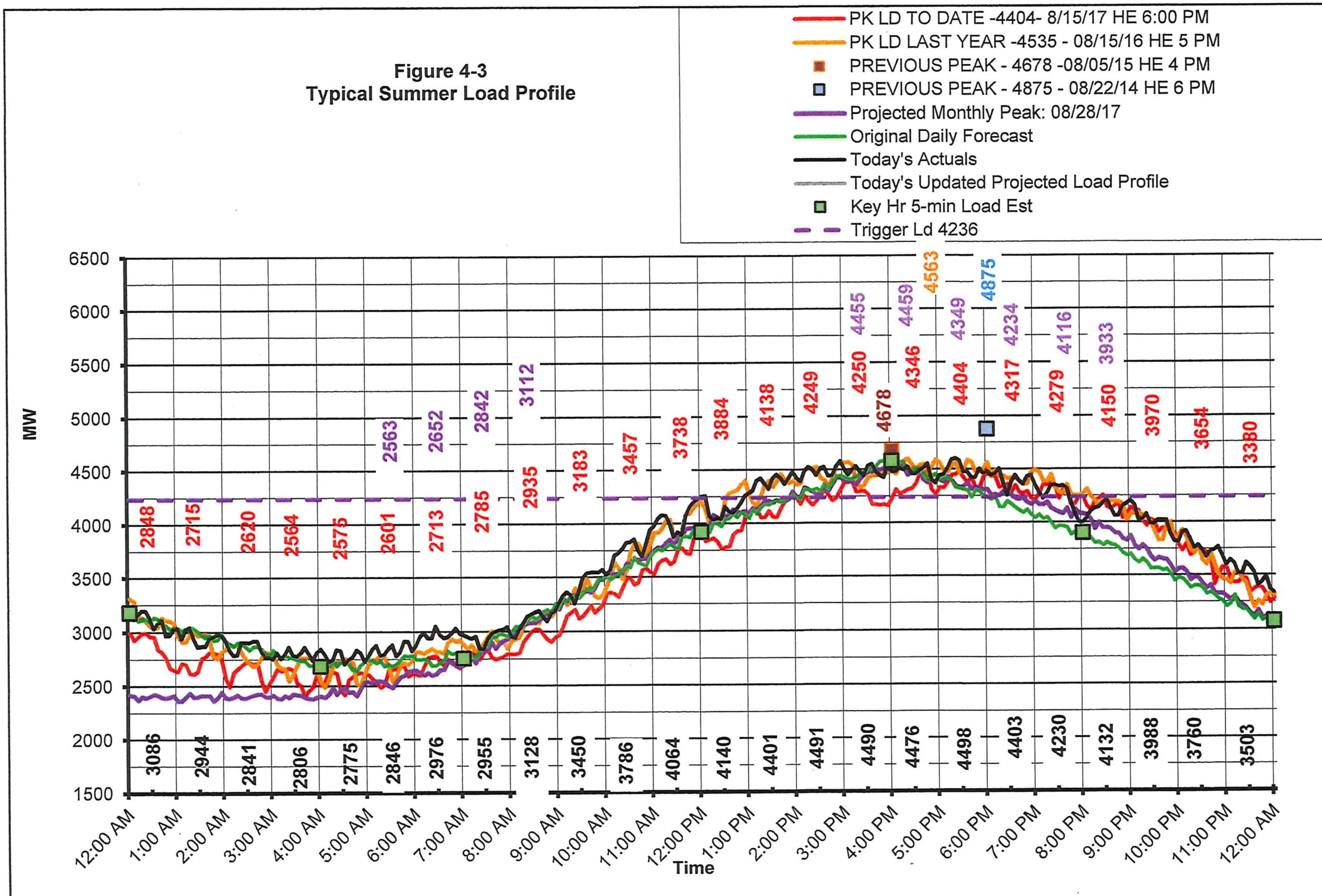
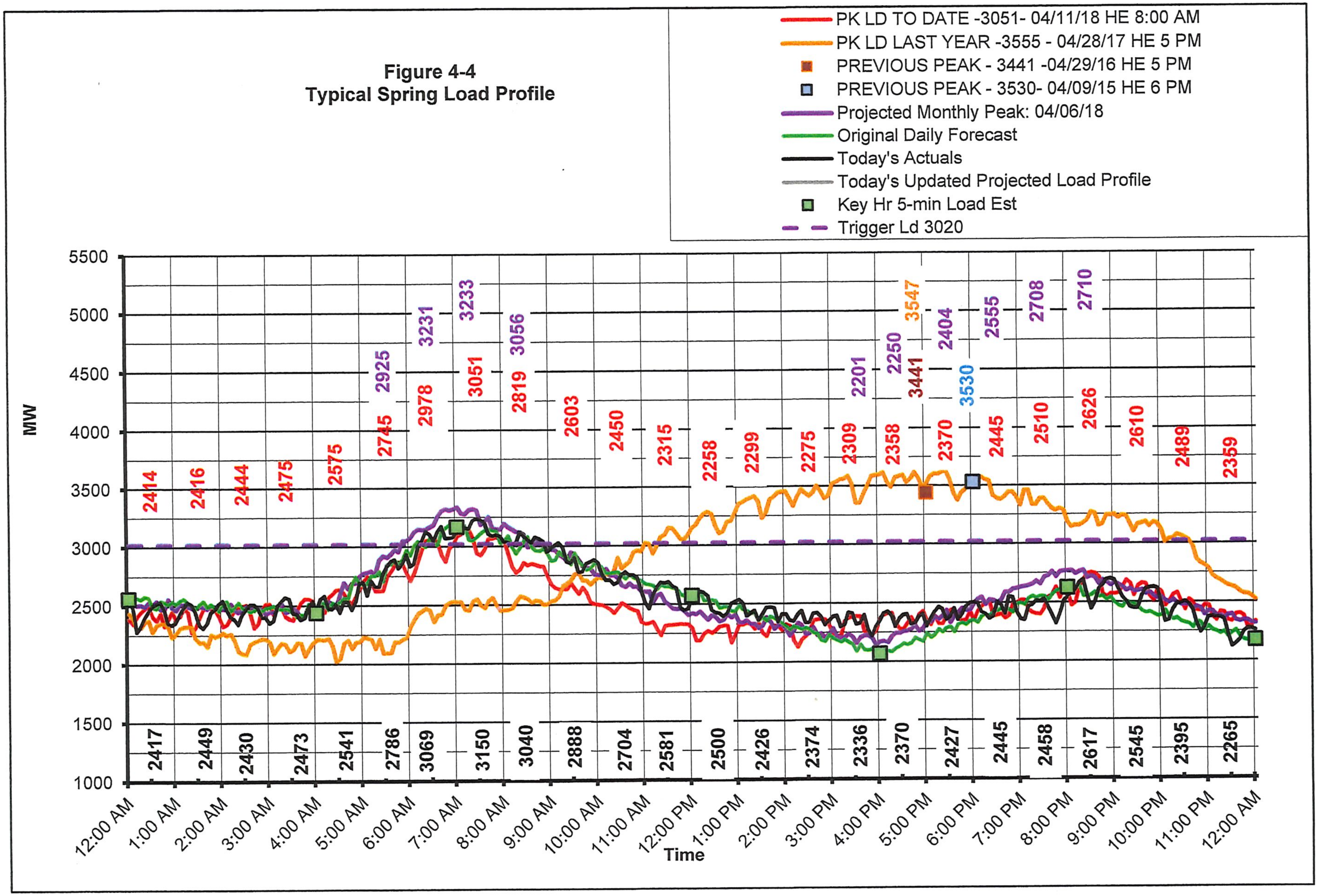


Figure 4-4
Typical Spring Load Profile



7. PERMANENT PLANT SITE LOCATION

Three sites were analyzed as candidate locations for the permanent plant. Figure 5-1 is a circuit distribution circuit map that shows the three sites:

1. The Georgetown Substation
2. Water Treatment Plant
3. Waste Water Treatment Plant

The temporary mobile generators included one generator installed at the Waste Water Treatment Plant and one generator installed at the Water Treatment Plant. For economic reasons, the decision was made that the permanent plant would be two generators installed in a building at one of the three locations.

The Georgetown Substation was the best location from a load flow standpoint because the equipment would be installed adjacent to the main delivery substation. However, two concerns about the Substation location were:

1. Potential complaints by local residents regarding noise
2. The substation site would not provide emergency backup for the WWTP during distribution line outages

The Water Treatment Plant site was an option, but available property was somewhat limited for future expansion.

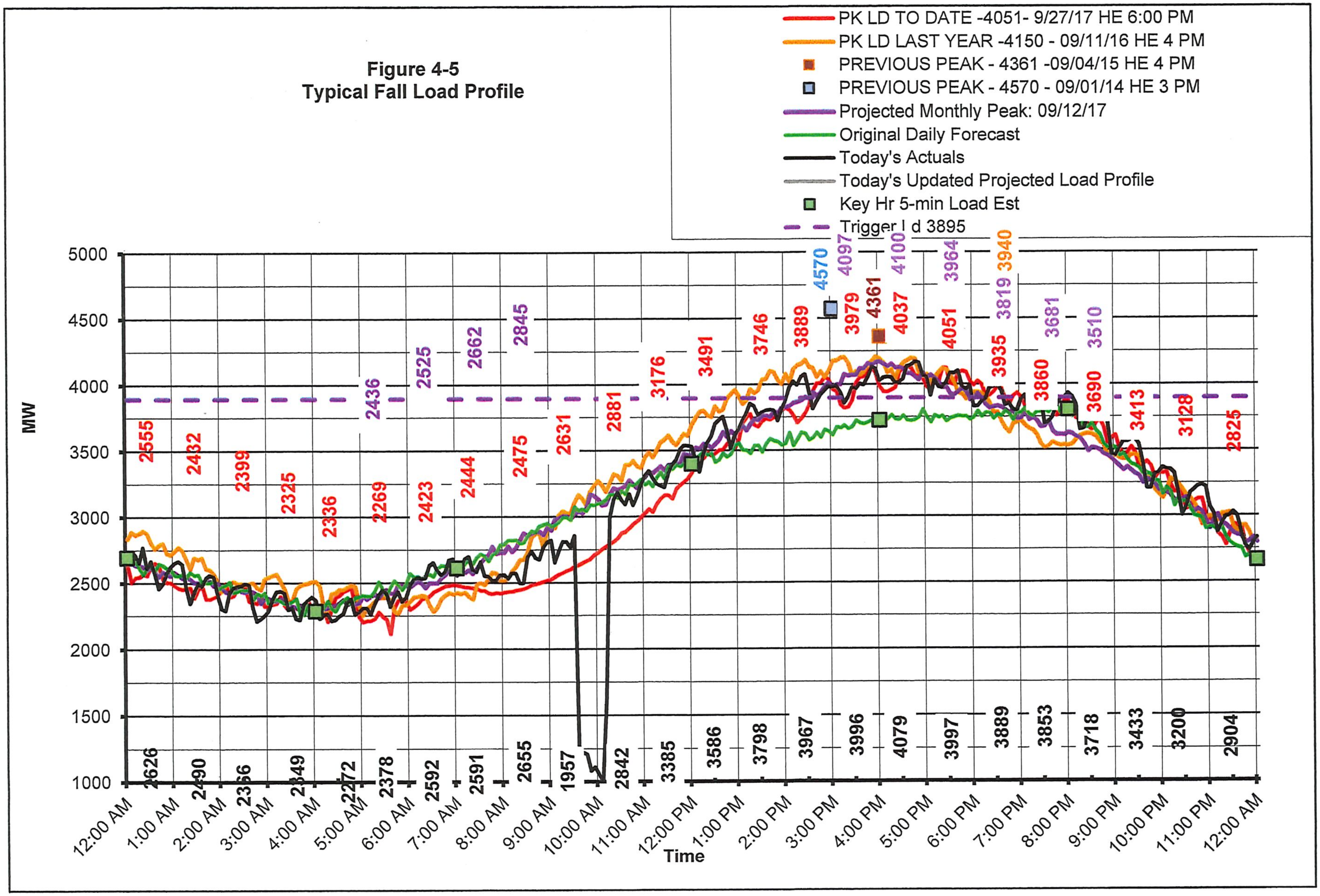
The Waste Water Treatment Plant site offered sufficient property to develop the site which could be expanded for a future third generator. The plant could be designed to provide automatic standby operation for the WWTP during primary distribution line outages and also could be switched to operate during long-term major system outages. The Waste Water Treatment site offered more advantages than the other two sites and became the selected site.

Figure 5-2 is the site plan for the plant. The WWTP is served from the Ridge Street 12.47 kV feeder. An existing overhead circuit existed along Ridge Street and a new under-build circuit was added.

8. FUNCTIONAL ONE-LINE DIAGRAM

Figure 6-1 is a Functional One-Line Diagram for the project. The plant was constructed south of the Waste Water Treatment Plant. The design includes two Kirk Key 12.47 kV overhead switches. The One-Line shows the normal position of the Kirk Key switches. Power flows from the Ridge Street Circuit through Circuit Breaker 52 L to the plant substation 12.47 kV bus, then flows from the substation along the new under-built line to serve the WWTP loads. Breaker 52 P is normally closed, energizing the grounded-wye – delta GSU continuously. The GSU provides a system ground source during normal operations, parallel operating conditions, as well as all operating modes.

Figure 4-5
Typical Fall Load Profile



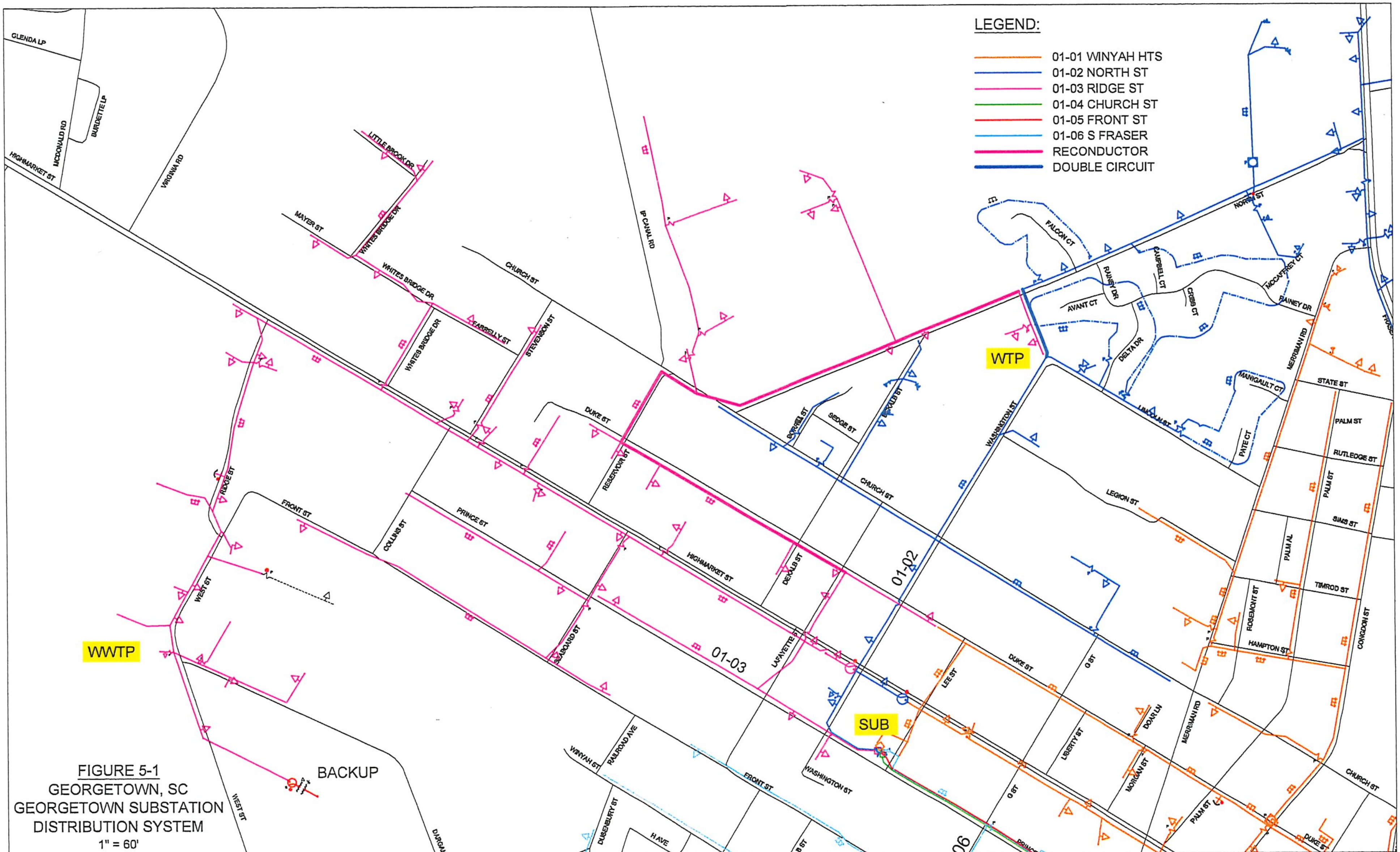


FIGURE 5-1
GEORGETOWN, SC
GEORGETOWN SUBSTATION
DISTRIBUTION SYSTEM
1" = 60'

9. SEQUENCES of OPERATIONS

Prior to operating the generating plant, the 12.47 kV Kirk Key interlocked switches are switched as shown in Figure 6-1. Circuit breakers 52 L and 52 P are closed, the Waste Water Treatment Plant loads are served from the primary distribution line, and the Generator Step-up Transformer is energized. The load-side generation plant is designed to provide four different sequences of operation. The normal operation is the plant in parallel with the primary distribution system and the plant producing full nameplate output. The four sequences of operation are:

9.1 Load Management (Remote and Local)

For normal parallel operations, the generators will be remotely operated by SCADA or cell phones. The generators will synchronize across the 4.16 kV generator breakers. Should a 12.47 kV fault occur on the feeder during parallel operation, the substation recloser will open (initially one-phase only for a single-phase fault) and 52 L will open, disconnecting the generators from the Georgetown electric system and picking up the WWTP loads in a standby mode. When normal power is restored, the plant will synchronize across 52 L and will operate in the peak shaving mode until a shut-down signal is initiated.

9.2 Automatic Standby

For automatic standby operation, loss of normal utility power will (after a time delay) trip the 12.47 kV intertie breaker 52 L, start the generators, close the first 4.16 kV generator breaker to the dead bus and synchronize closing of the second generator breaker. If normal power is restored during the initial time delay, the standby sequence will not be initiated. When normal power is restored, the plant will synchronize across the 52 L and the generators will cycle through a normal shutdown sequence.

9.3 Isolated Standby (Remote and Local)

If Georgetown wishes to operate the plant in isolated standby mode, Georgetown can initiate this operation remotely by SCADA, cell phones, or locally. For this operation, the generators will start, synchronize across the generator breakers, increase load to equal the plant load, and the 12.47 kV intertie breaker 52 L will open. The facilities will remain in this operating mode until a changed operating mode is initiated.

9.4 Emergency (Local)

Georgetown can operate the plant in an Emergency to provide service to the 12.47 kV Ridge St. Feeder. The feeder will be isolated from the Georgetown substation by Kirk Key interlock switches. With the switch operation, the Kirk Key can be retrieved and installed into the Emergency Switch in the switchgear. In Emergency operation the generators are manually started and breakers are manually closed to energize the Ridge St. Feeder. When utility power is available from the Georgetown Substation, plant Emergency Operations will be stopped and Kirk Key switch closed to resume normal operations.

10. CONSTRUCTION PROGRESS

UTEC prepared equipment specifications and bid documents for the following major equipment:

- Engine Generators, Fuel System, and Switchgear
- Generator Step Up Transformers
- 15 kV Circuit Breakers
- Substation Structures and Miscellaneous Equipment

Bids were received and evaluated for each of the major equipment items and recommendations made for direct purchase by Georgetown.

UTEC prepared construction specifications and bid documents for site work, foundations, pre-fabricated metal building, construction, and commissioning services. Bids were received from seven General Contractors. UTEC prepared a detailed bid evaluation and recommended the local firm Coastal Structures Corporation to be awarded the contract as General Contractor. The contract date was August 15, 2017. Construction work started in October 2017 with substantial completion May 31, 2018.

Following are photographs of the chronological construction activities for the project.

11. SUMMARY

- Georgetown solicited, evaluated, and selected its Power Supplier and negotiated a 10-year CP Power Supply contract which allowed Georgetown to install and operate load-side generation.
- An Economic Feasibility study verified that Georgetown could achieve significant power cost savings by operating a load-side parallel operating generation plant intended to operate during the monthly peak hour of the power supplier.
- A detailed analysis of the economics of natural gas versus diesel fuel was performed. Georgetown determined the most economic installation would be a diesel generating plant.
- Georgetown moved forward with the installation of two 1800 kW mobile engine generators and began monitor the power supplier's load and operating the generators during the monthly peak hours. Georgetown also designed and constructed a permanent load-side generating plant.
- Each day, Georgetown prepares the expected daily load profile for its power supplier, and monitors the actual loads to determine if the day is a candidate generation run day.

- Construction of the permanent plant was started in October 2017 and was substantially complete the end of May 2018. Construction activities went smoothly.
- The temporary generators filled their roll of producing power supply savings, provided experience for UTEC and Georgetown monitoring the Power Providers load, and are being returned to Blanchard.

Aerial view shortly before construction started

Bank extension, rip rap, and sub-grade are complete

Formation of pad with the conduit system being installed

Approximately 1 week after pad was poured

Delivery of Gensets

Delivery of Gensets, placement complete

Gensets covered with tarps, erection of building begins, 12,000 gallon fuel tank is placed in right portion of photo

Placement of clean emissions module just prior to putting roof on building

First CEM in place

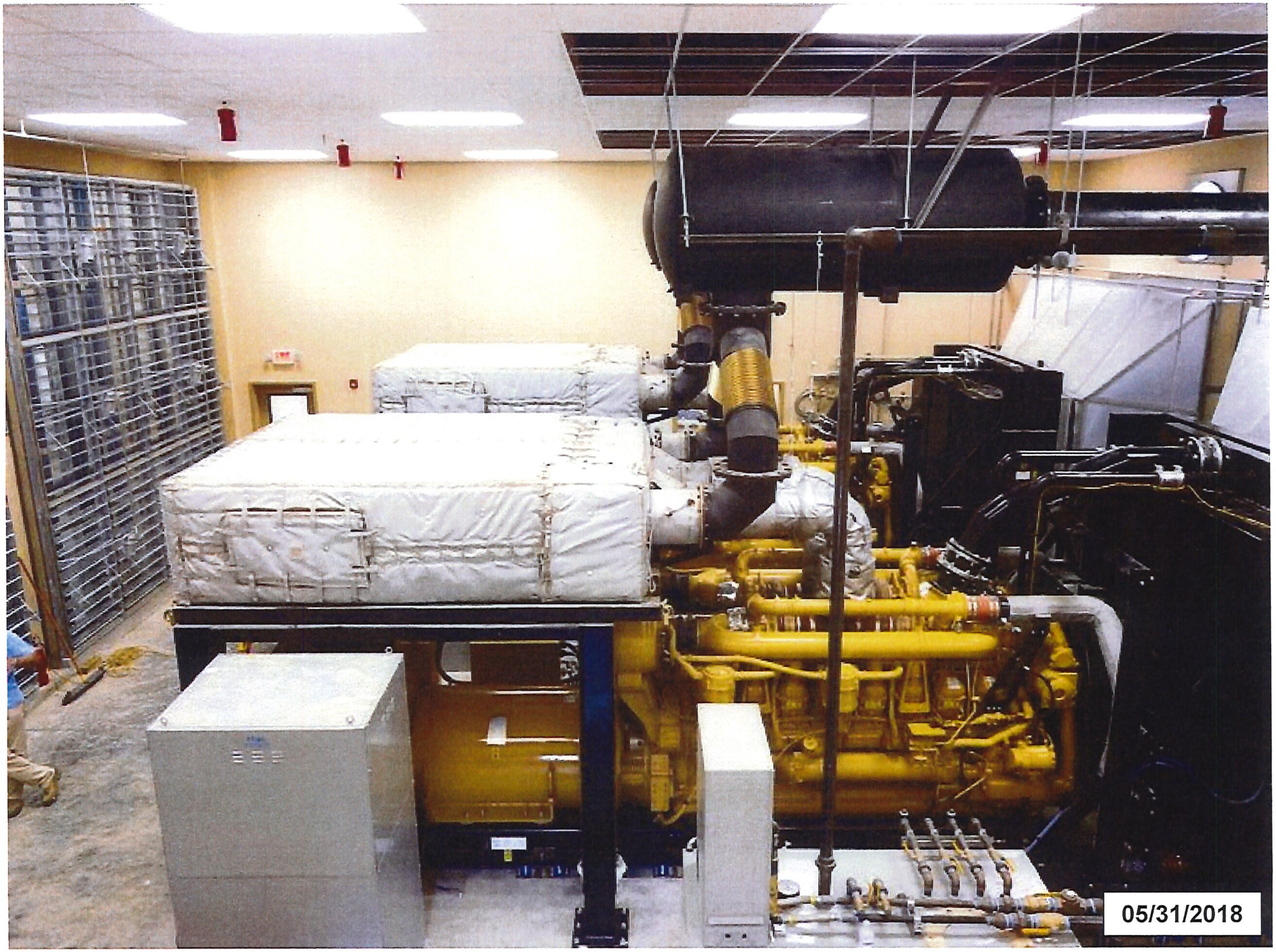
Placement of GSU transformer and spare

Under roof, framed and sheet-rocked

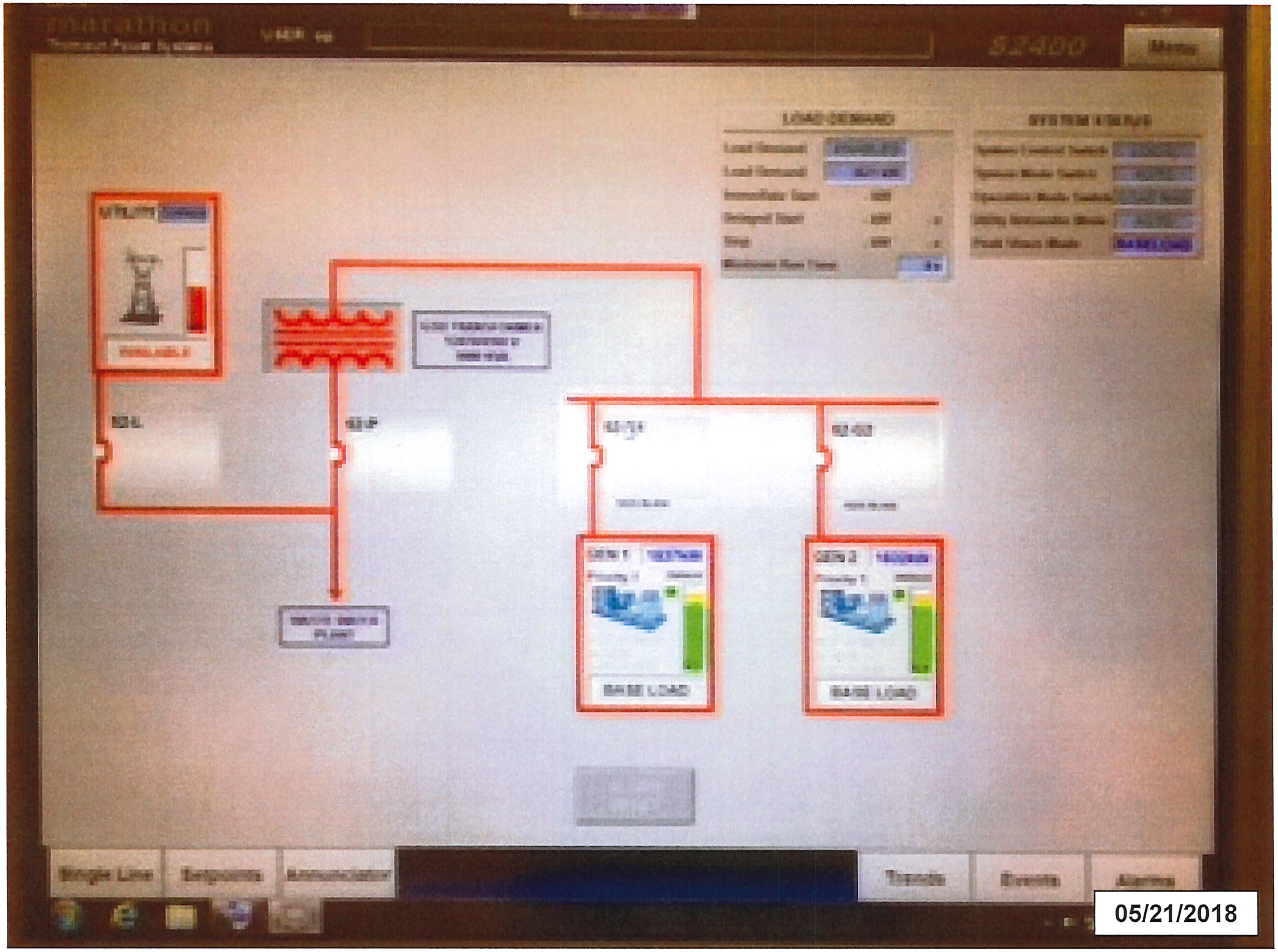
Control and switchgear as it sat in Thompson Electric Shop in Vancouver during factory acceptance testing witnessed by Georgetown, UTEC and Blanchard Staff

Delivery and placement of control and switchgear

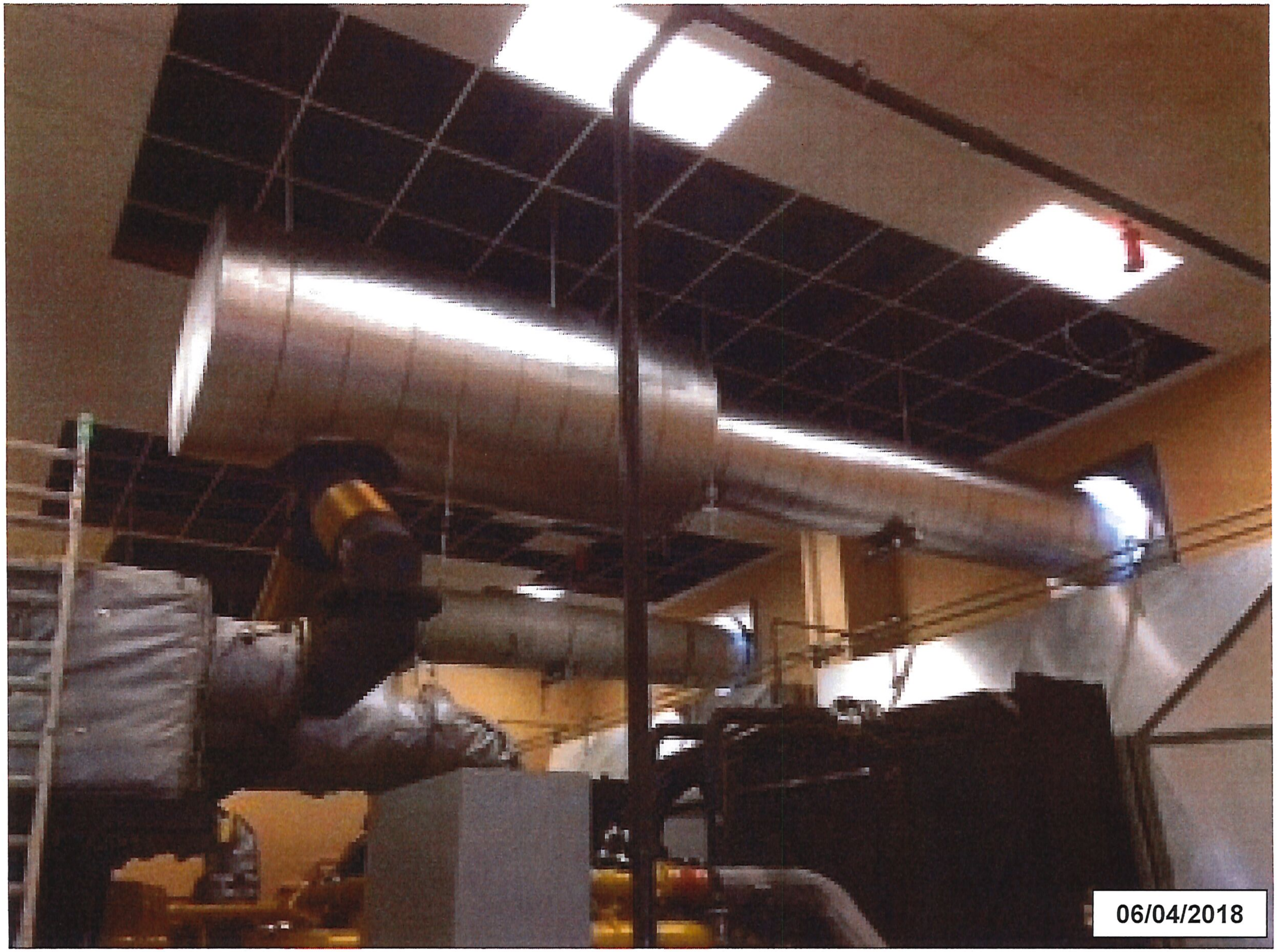
Substation finished and fenced. Breakers required for switching to provide automatic emergency backup for waste water treatment plant



Inside View



HMI display – One-Line shows both units running at full load for first time



Insulation placed around muffler/exhaust

Aerial View from East