CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

ENERGY RESEARCH AND DEVELOPMENT DIVISION

Appendix A: Technology Descriptions

June 2024 | CEC-500-2024-054-AP

APPENDIX A:
Technology Descriptions

Project plan included demonstration of three specific technologies. They are the gas-engine heat pump (GEHP), the evacuated tube collector (ETC), and Energx dual setpoint controller.

The GEHP Technology

While the traditional approach of water heating with a flame remains largely unchanged with incremental improvements in efficiencies up to 85 to 95 percent, natural-gas-engine-driven heat pumps offer an economic alternative to gas water heaters and boilers and an outstanding opportunity to reduce water heating costs and lower greenhouse gas (GHG) emissions. New advances in internal- combustion-engine technology in the automobile industry have led to significant improvements in reliability and efficiency of the GEHP with operating life exceeding 20,000 hours. Additionally, new emissions-control technology has led to cleaner emissions and lower criteria pollutants. However, the GEHP is still considered an emerging and underutilized technology. The most efficient and advanced GEHP is the Ilios HEWS 500-AS.

Figures A-1 and A-2 show the Ilios heat pump. A GEHP heat pump traditionally consists of a vapor-compression refrigeration cycle that includes a condenser, an evaporator, a throttling valve, and a compressor. Compressor-shaft work is provided by a reciprocating engine. A measure of efficiency is the coefficient of performance (COP), which is defined as the useful energy "out" (hot water), divided by the useful energy "in" (fuel). Depending upon operating conditions the Ilios unit's COP is between 1.2 to 2.2. By comparison, a typical gas fired boiler that produces 550,000 British thermal units (Btu)/hr of hot water would consume 687,500 Btu/ hr of gas (80 percent efficiency), or almost twice as much fuel as the Ilios.

Figures A-1 and A-2: Ilios Heat Pump

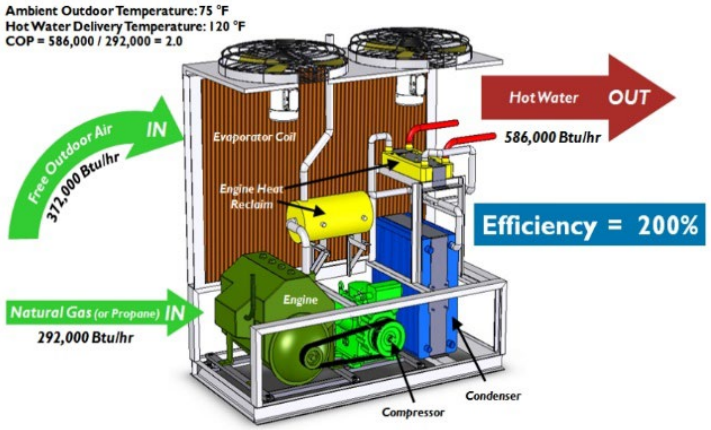


Figure A-1

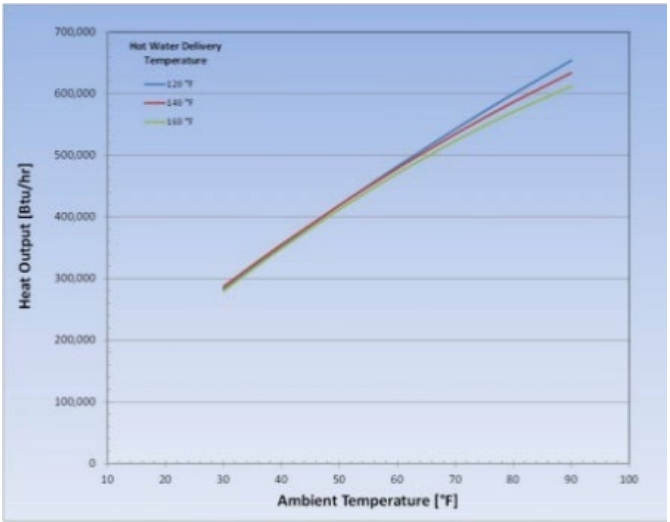
Source: Tecogen

Figure A-2

Source: Tecogen

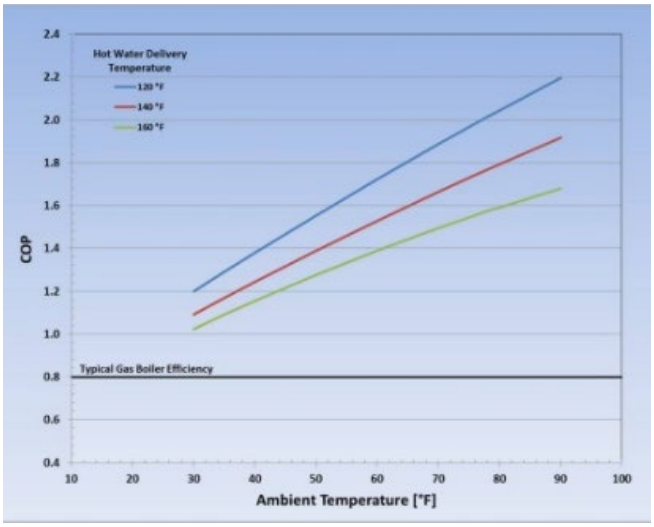
The graphs below illustrate how the capacity (heat output) of the Ilios increases with outdoor air (Figure A-3) resulting higher COPs (Figure A-4). In Southern California climate conditions with milder winters and hot summers, the COP of the Ilios GEHP should be consistently high. With this higher COP there will be significant reduction of fuel use and GHG emissions.

Figure A-3: Outdoor Air Temperature Versus Heat Output



Source: Solar Rating and Certification Corporation (SRCC)

Figure A-4: Outdoor Air Temperature Versus COP



Source: Tecogen

The main features of this technology are:

- 90 kilowatts (kW) to 175 kW of hot water ideal for domestic hot water (DHW), swimming pools, space heating, or process heat.
- Hot water delivery temperature 100°F (38°C) to 160°F (71°C).
- Advanced thermodynamic cycle extracts available energy from the environment, and uses mechanical work from a gas engine (natural or gaseous propane) to pump this heat to a higher useful temperature.
- Highly efficient heat pump with reclaimed engine waste heat resulting in a COP of 1.2 to 2.2.
- Exceeds clean emission standards throughout the United States, including California.
- 50 percent reduction in carbon footprint saving 100 tons of carbon at typical installations.
- Ultra-low emissions with near-zero criteria pollutants.
- Minimal electrical power requirement similar to a household appliance (220 volts [V] alternating current [AC]/50 hertz [Hz]/10 amperes [A] service).

The Evacuated Tube Collector (ETC)

In use since the early 1900s, flat-plate collectors are time-tested, reliable, and currently dominate the market. ETCs are a more recent technology, introduced in the late 1970s. Several types are available, with the common element being a glass tube surrounding an absorber plate. Because the space inside the tube is a vacuum, which is a far superior insulator than air, these collectors have much better heat retention than the glazing/air space (R-7) design of flat-plate collectors, which makes them particularly highly efficient under many circumstances. Frames and manifolds for paralleling multiple tubes are available and can hold 4 to 20 tubes or more. Multiple banks can be plumbed together to increase system capacity. While overall weights and dimensions are similar between the two types, evacuated tubes usually have performance and installation advantages. Sealing and maintaining a vacuum is difficult, and this was a common problem that plagued early designs. Today the majority of ETCs use a continuous piece of glass to minimize the risk of vacuum loss. The ETC is considered an emerging and underutilized technology.

Collectors operate most efficiently when the temperature of the inlet fluid (Ti) is the same as or less than the ambient temperature (Ta) of the air. When Ti equals Ta, flat-plate collectors tend to be about 75 percent efficient, while evacuated tubes have an efficiency of about 50 percent. However, collectors rarely operate under these conditions. Table A-1 illustrates that the ETC performs better for high-temperature DHW application. Figure A-5 illustrates that performance of the ETC is superior in higher outdoor temperatures past 80°F (27°C), which is expected in many California climate zones for many months of the year, including the one for our test building. Figure A-6 is an illustration of the evacuated tube collector.

Table A-1: Comparison Performance

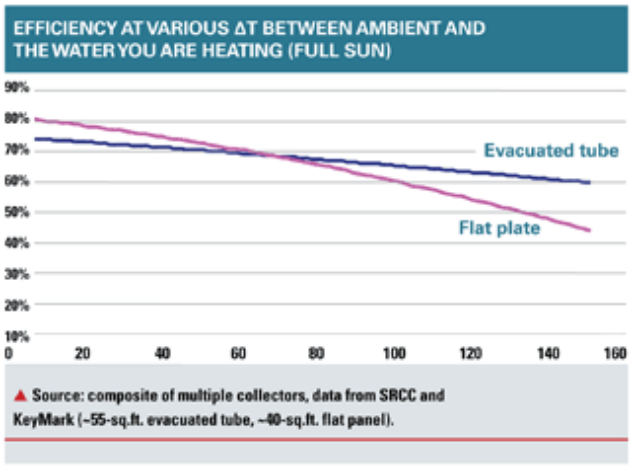
COMPARISON PERFORMANCE: FLAT PLATE TO EVACUATED TUBE (SRCC DATA)						
	BTUS PER PANEL PER DAY					
Temp/ condition	Clear day ~2,000 BTU/f2/day		Partly cloudy ~1,500 BTU/f2/day		Cloudy~1,000 BTU/f2/day	
	Flat plate	Evacuated	Flat plate	Evacuated	Flat plate	Evacuated
A. -9°F (Pool 1)	53,000	43,000	42,000	32,000	28,000	22,000
B. 9°F (Pool 2)	48,000	41,000	36,000	31,000	22,000	20,000
C. 36°F (DHW 1)	40,000	38,000	27,000	28,000	13,000	17,000
D. 90°F (DHW 2)	24,000	32,000	12,000	22,000	2,000	12,000
E. 144°F (A/C)	9,000	26,000	1,000	15,000	0	6,000

Source: SRCC

The project is to study how best to integrate the two technologies in order to maximize energy savings and GHG reduction at the lowest possible cost. Cost will depend on size of the solar collectors, the storage tank size and the ancillary materials and equipment such as storage

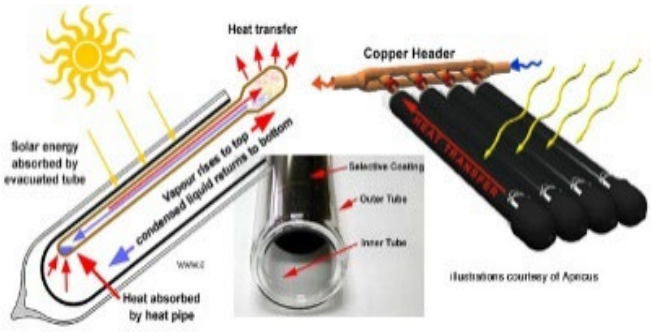
tank, pumps and, trenching, piping and insulation distances. Please see Figure 3 in Chapter 5 for a schematic diagram of the proposed configuration. We will also use the Energx hot water loop controller to reduce line losses during low demand. Testing will be done with either the GEHP operating or the ETC operating to collect performance data for each subsystem.

Figure A-5: Evacuated Tube Performance



Source: SRCC

Figure A-6: Evacuated Tube Collector



Source: Apricus

Energx dual setpoint controller

The Energx dual setpoint controller is an energy savings controller that reduces the water temperature setpoint when hot water is not required. The savings are primarily achieved in two ways, one by controlling the set point temperature of the water in the storage tank and secondly by controlling the firing rate of the boiler, as these boilers typically have three to four burners staged in series to meet various load changes.

Depending on the application and number of boiler stages, one to four original equipment manufacturer Honeywell logic controllers are used to process the temperature(s) in the storage tank and cycle the stages of the boiler on/off. An additional temperature controller and relays are integrated into the control to measure the ambient air temperature and change the water temperature setpoint. Even as the temperature is increased the controller will still optimize the firing rate/stages of the boiler.

Please note that at no time is the system locked out (demand limiting) – hot water is always available to occupants and the Energx control system will cause the boiler to maintain the tank water temperature setpoint. No fuzzy logic is used to automate the temperature set point adjustments. It is expected that the operator only needs to set it once with little if any adjustments throughout the change of seasons.

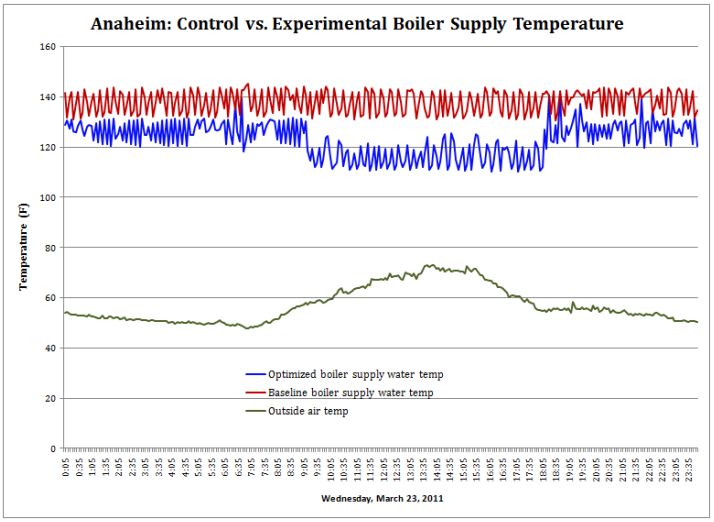
The controller being studied is a dual setpoint controller (Figure A-7), and has two tank water temperature setpoints, referred to here as high temperature and low temperature. When the ambient temperature rises the Energx controller will place the boiler water set point at the low temperature setting to conserve energy. Conversely, if the ambient air temperature is detected

to be below the threshold (such as at night or a cold day) the boiler will be placed on the high-water temperature setpoint in order to be able to provide more heat to the apartment fan coils (Figure A-8). The high-temperature setpoint is typically approximately 140°F (60°C) while the low temperature setpoint is approximately 120°F (49°C). Even with 120°F (49°C) water being supplied to the fan coils, heat is still available from the apartment fan coil units if a resident were to adjust their thermostat to call for heating. Domestic water at 120°F (49°C) is considered sufficient for bathing and washing, etc.

Figure A-7: Energx Raydronics Boiler Controller

Source: Energx Controls

Figure A-8: Monitored Boiler Temperature



Source: Negawatt Consulting

The energy savings are achieved by allowing the system to operate at the low temperature water set point during the mild to hot weather conditions found much of the year throughout the Southern California area. According to Energx, there are hundreds of Raydronics systems within the SoCalGas service territory, each consuming approximately 350 therms per apartment unit per year. The potential market is of significant size.

CALIFORNIA ENERGY COMMISSION

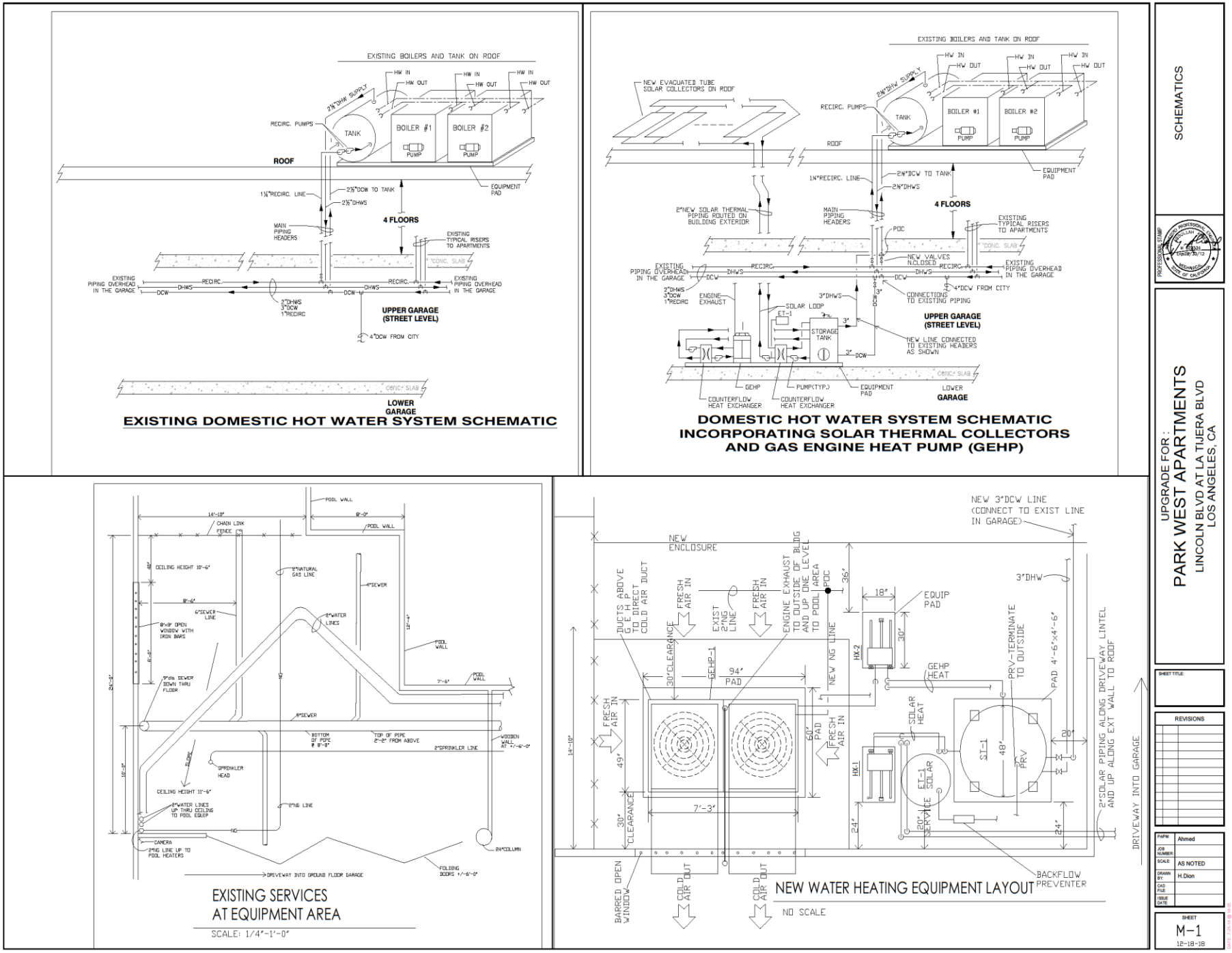
CALIFORNIA NATURAL RESOURCES AGENCY

ENERGY RESEARCH AND DEVELOPMENT DIVISION

Appendix B: Project Plans

June 2024 | CEC-500-2024-054-AP

Figure B-1: Engineering Plans for the Domestic Hot Water System Upgrade at Park West Apartments



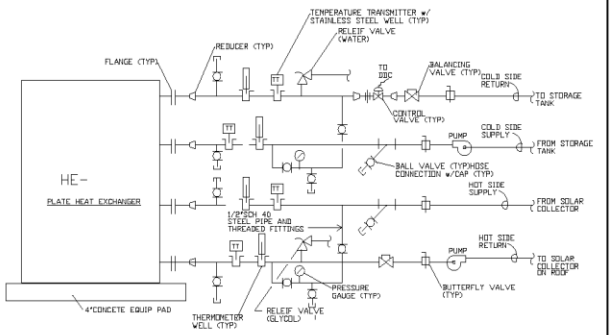
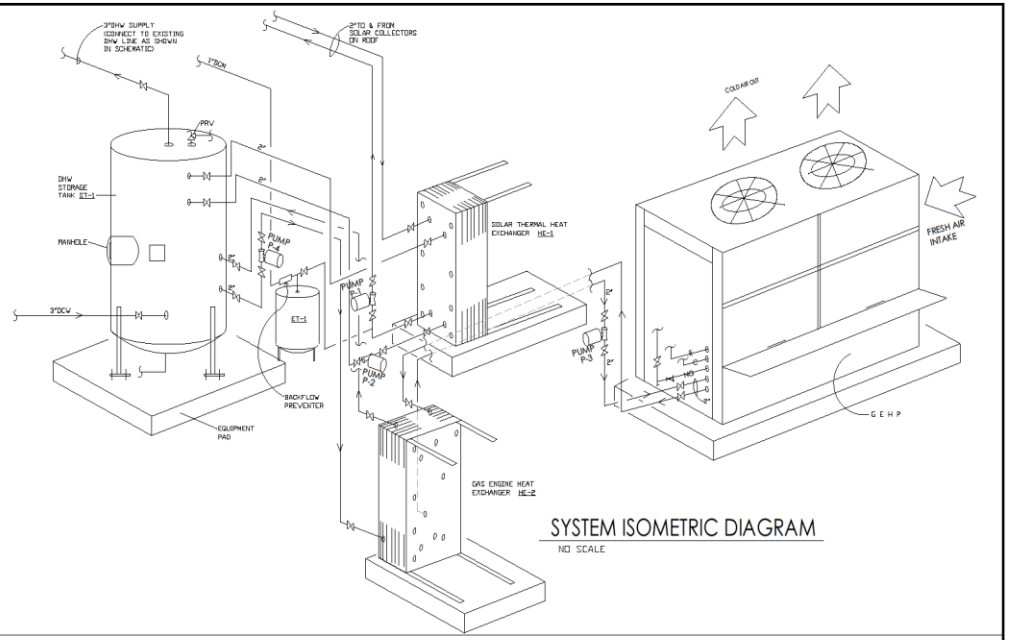


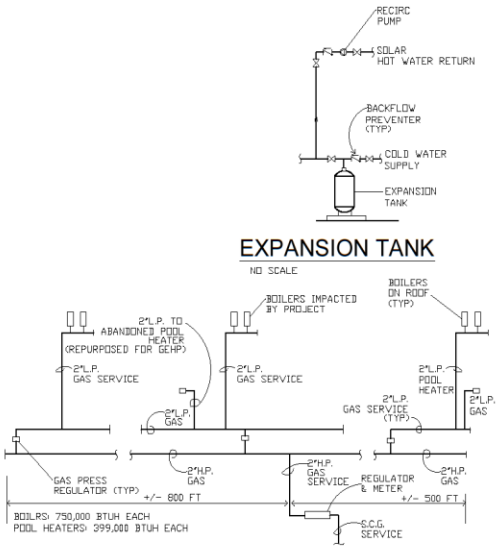
PLATE AND FRAME HEAT EXCHANGER
PIPING DIAGRAM

NO SCALE



SYSTEM ISOMETRIC DIAGRAM

NO SCALE

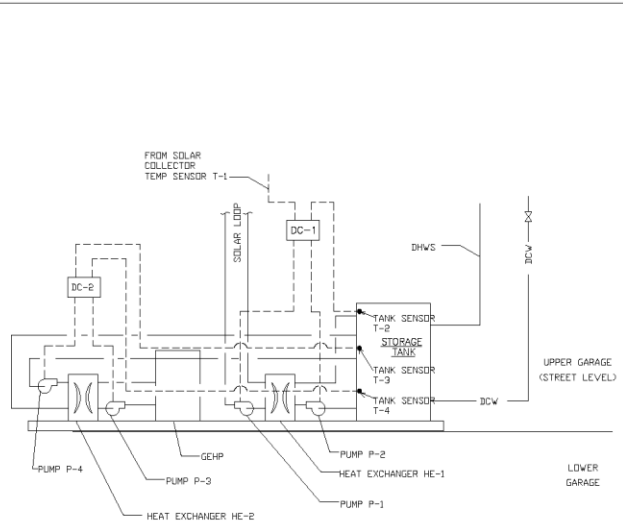


EXPANSION TANK

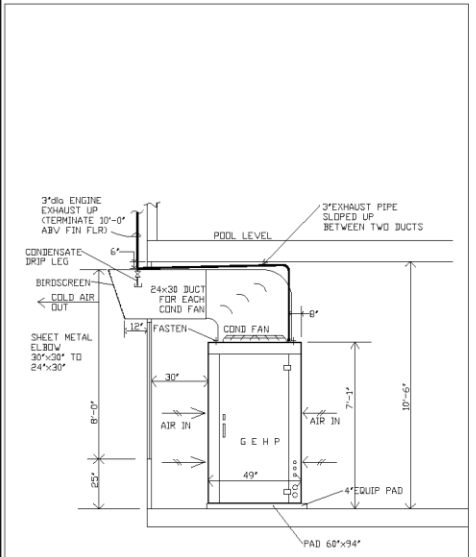
NO SCALE

NATURAL GAS SERVICE PIPING

NO SCALE



DOMESTIC HOT WATER
SYSTEM CONTROL DIAGRAM



GEHP ELEVATION SHOWNING
AIR FLOW MANAGEMENT

SCALE 1/2"=1'-0"

SCHEDULES &
ISOMETRIC DIAGRAM

PROFESSIONAL STAMP

UPGRADE FOR :
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA

SHEET TITLE:

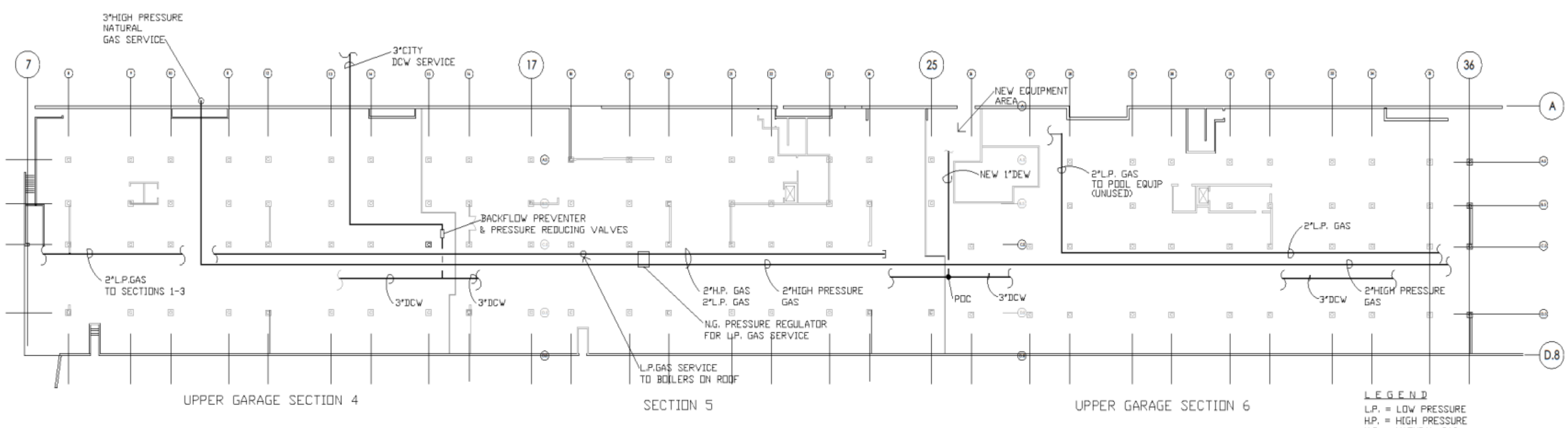
REVISIONS

PA/PM	Ahmed
JOB NUMBER	
SCALE:	AS NOTED
DRAWN BY:	H.Dion
CAD FILE:	
ISSUE DATE:	

SHEET
M-2
12-18-18

GENERAL NOTES:

1. All work must meet State and Local codes.
2. All mechanical equipment must be installed according to manufacturer recommendations.
3. All mechanical equipment and systems shall be guaranteed for a period of one year after acceptance by the Owner.
4. Any walls, floor or ceiling surface that is disturbed during installation of mechanical equipment shall be repaired to match previous condition.
5. Contractor shall field verify exact dimensions, clearances, heights and any interferences before installation of mechanical systems.
6. Check all architectural, structural and plumbing drawings for conflict. Cutting or otherwise altering any structural members shall not be permitted without written permission from the Architect.
7. Contractor shall coordinate with other trades to ensure that installation is done in a smooth manner.
8. For all roof penetration, exhaust and ventilation air, provide weatherproof cap, flashing and bird screen.
9. All ductwork installation shall meet SMACNA recommended practice for ductwork installation.
10. All outside air inlets to be minimum 10 ft from any exhaust or plumbing vent opening.
11. All ductwork shall be constructed of galvanized sheet metal as required by CMC Chapter 6.
12. Fire dampers must be installed in any ductwork that penetrates fire walls and ceilings.
13. All exterior ductwork shall be installed as per SMACNA and UMC standard and painted with coating to prevent corrosion.
14. Engine exhaust pipe shall be insulated and not be in contact with any combustible material
15. Engine exhaust must be terminated at a safe height, at least 10 feet away from building balconies
16. Install engine exhaust as per NFPA and CBC codes
17. Insulate hot water storage tank with minimum two-inch thick foam insulation
18. Insulate all GEHP DHW and solar collector piping with at least one-inch thick insulation
19. All exterior piping installed on exterior walls must be painted to match wall color
20. All work areas must be maintained in a clean and organized manner
21. After each day of work, the work areas must be cleared for any trip, safety and fire hazard and equipment and materials must be stored in an secure manner



UPPER GARAGE FLOOR PLAN-EXISTING PIPING

NO SCALE

GARAGE PLAN
ROOF PLAN

PROFESSIONAL STAMP

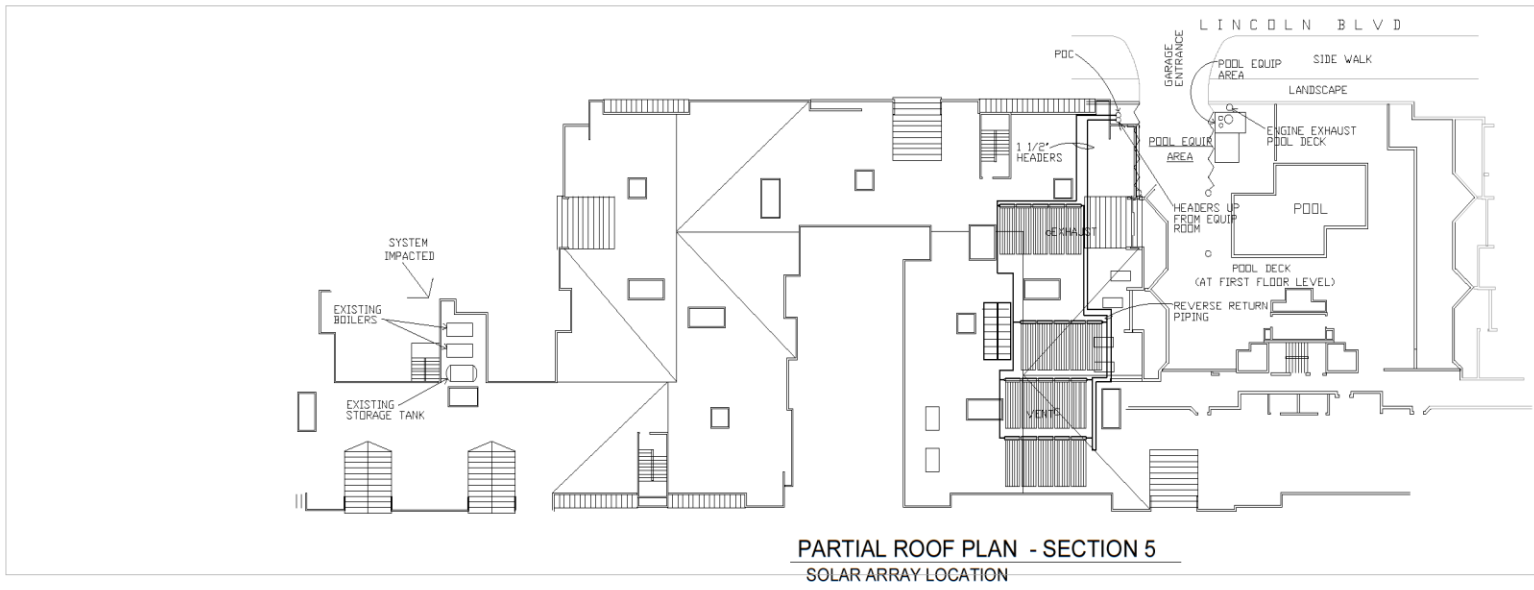
UPGRADE FOR :
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA

SHEET TITLE:

REVISIONS

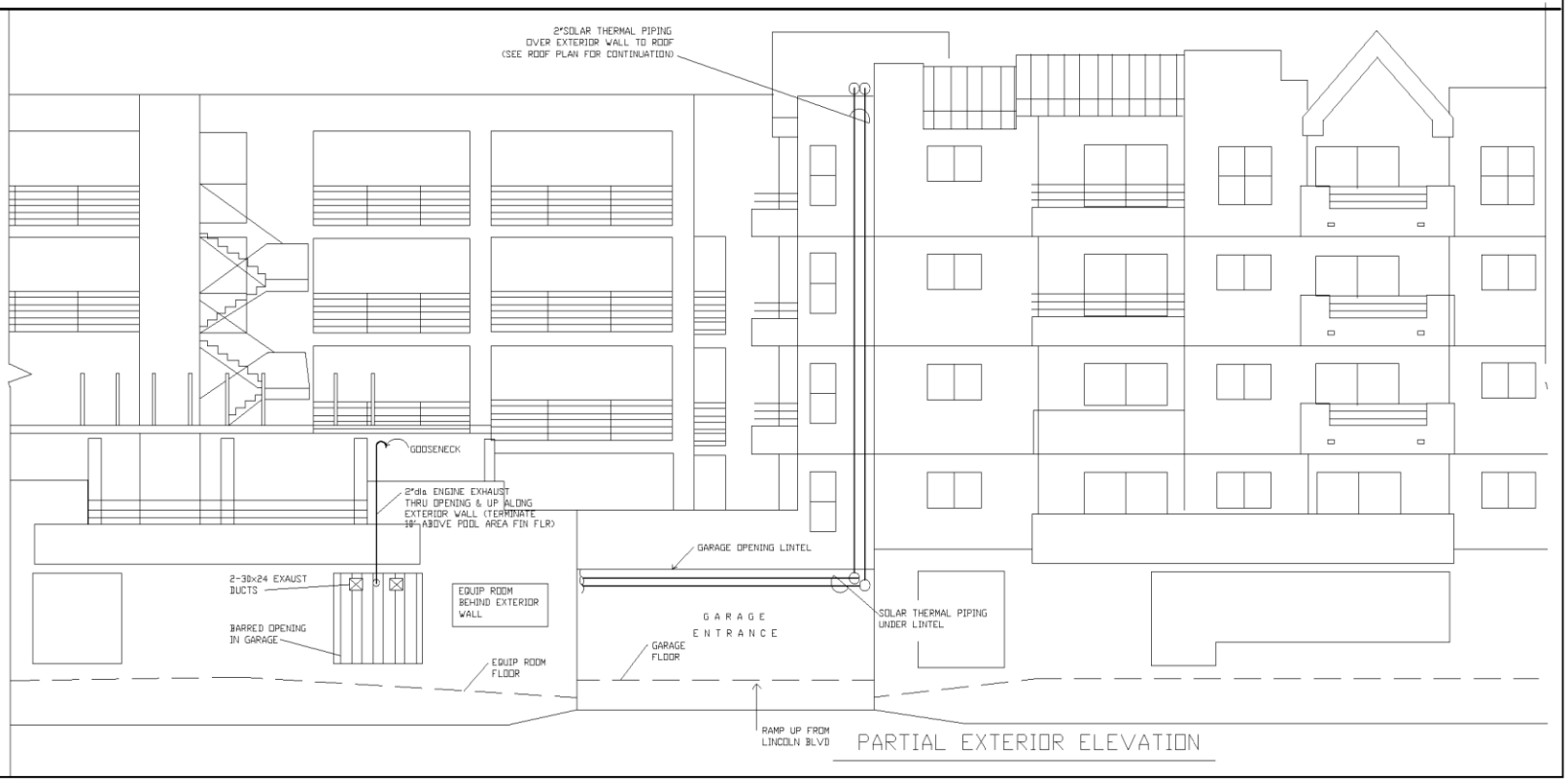
PA/PM	Ahmed
JOB NUMBER	
SCALE	AS NOTED
DRAWN BY	H.Dion
CAD FILE	
ISSUE DATE	

SHEET
M-3
12-18-18



PARTIAL ROOF PLAN - SECTION 5

SOLAR ARRAY LOCATION



PARTIAL EXTERIOR ELEVATION

DETAILS

PROFESSIONAL STAMP

UPGRADE FOR :

PARK WEST APARTMENTS

LINCOLN BLVD AT LA TIJERA BLVD

LOS ANGELES, CA

SHEET TITLE

REVISIONS

PAYNE	Ahmed
JOB NUMBER	
SCALE	AS NOTED
DRAWN BY	H.Dion
CAD FILE	
ISSUE DATE	

SHEET

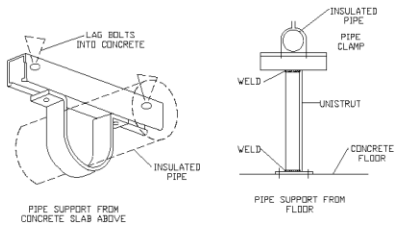
M-4

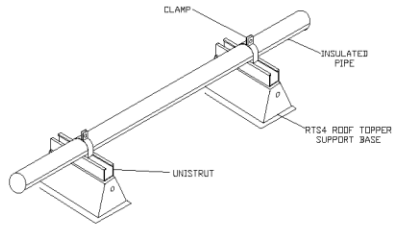
12-18-18

PARK WEST APARTMENTS

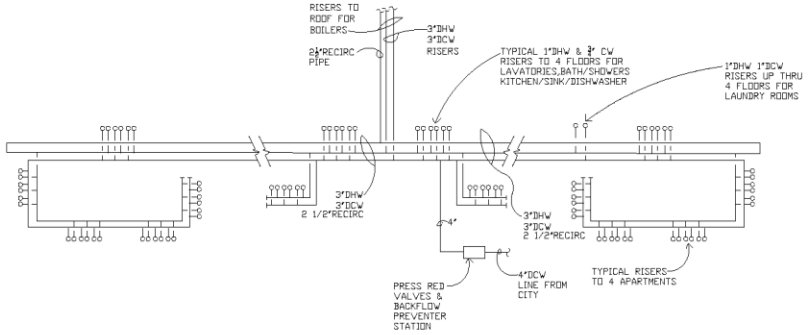
DCW and DHW Water Piping Fixture Unit Calculations for Line Sizing

Typical Apartment Fixtures		
Use	**Fixture Units**	
	Cold	**Hot**
Lavatory	0.5	0.5
Water Closet-Private	2.2	
Shower	1	1
Kitchen Sink	1	1
Dishwasher		1.4
Total/Apartment	**4.7**	**3.9**
		148
Total Fixt Units for Apartments	695.6	577.2
Common Area:		
No of Clothes Washers per floor		4
No of Floors		4
Total no of Washers		16
Fixture Units @ 4/washer		64
Grand Total Fixt Units	695.6	641.2
From LA DOBS website for fixture units and gpm		
For flush tank service		
Flows gpm	150	150
Line Sizes @ 5-8 ft/sec flow	3 inch	3 inch
Friction Loss	2.5 psi/100 ft	2.5 psi/100 ft
Total pipe length added	200 ft	100 ft
Total Pressure drop psi	5.0	2.5



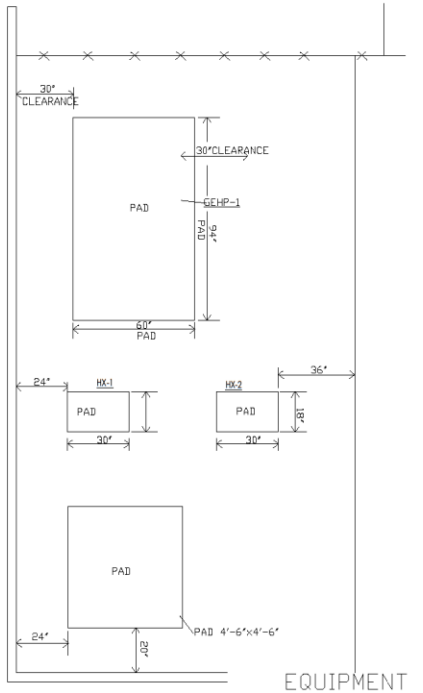


PIPE SUPPORT ON ROOF



PLUMBING RISER DIAGRAM

NOT TO SCALE



EQUIPMENT PADS

DETAILS

PROFESSIONAL STAMP

UPGRADE FOR :

PARK WEST APARTMENTS

LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA

SHEET TITLE:

REVISIONS

PAPM:	Ahmed
JOB NUMBER:	
SCALE:	AS NOTED
DRAWN BY:	H.Dion
CAD FILE:	
ISSUE DATE:	

SHEET
M-5
12-18-18

SYSTEM CONTROL SCHEDULE

Sensors and Controls:

T-1 Temperature Sensor Solar Collectors

T-2 Temperature Sensor at top of Storage Tank (set at 145 degF)

T-3 Temperature Sensor at upper third of Storage Tank (Set at 140 degF)

T-4 Temperature Sensor at bottom of Storage Tank (set at floating temp)

P-1 Solar Collector Loop Pump

P-2 Solar Heat Pump to Tank

P-3 GEHP Heat Pump

P-4 GEHP heat to Tank

FS-1 Flow switch in GEHP piping

DC-1 Differential Controller - Solar Loop

DC-2 Differential Controller - GEHP Loop

Differential Controller: Steca Model TR0603mc+

Control Schema

DC-1 senses solar collector temp T-1 and storage tank water temperature T-2

If T-1 > T-2 turns on pumps P-1 and P-2 to transfer heat from solar to tank through Heat Exchanger HE-1

At T-2 temperature 145 degF, DC-1 shuts down pumps P-1 & P-2 and collector flows goes into stagnation

DC-1 senses tank temperatures T-3 at tank upper location and cold water temperature T-4 at tank bottom

If T-3>T4 turns on pumps P-3 and P-4 to transfer heat from GEHP into storage tank

FS-1 Senses flow and starts up GEHP

When T-3 reaches 140 degF, DC-2 shuts off pumps P-3 and P-4

FS-1 When flow ceases, turns off GEHP

DIFFERENTIAL CONTROLLER - STECA MODEL TR0603mc+

System voltage	230 V AC (± 15 %), 50 Hz
System voltage optional	115 V AC (± 15 %), 60 Hz
Standby	1.57 W
Temperature control class	I
Energy efficiency	1%
Number of inputs	6
Inputs	5 x temperature (Pt1000), 1 x temperature (Pt1000) or pulse
Additional inputs	1 x Grundfos Direct Sensors™ (temperature / flow rate)
Number of outputs	3
Outputs	2 x triac for speed control (R1, R2), max. 250 W (230 V) or PWM control signal for pump speed (PWM R1, PWM R2); 1 x switch output relay (R3), max. 800 W (230 V) or R3 voltage free
Hydraulic schemes	40
Ambient temperature	0 °C ... +45 °C
Interfaces	SD card, RS-232, RS-485 (Steca TPC 1 bus)
Data logging	SD card
Degree of protection	IP 20 / DIN 40050
Dimensions (X x Y x Z)	170 x 170 x 46 mm [0.00 x 0.00 x 0.00 inch]
Weight	450 g [0.00 oz]

ENGINE EXHAUST BACKPRESSURE - CALCULATION

As per Caterpillar Application and Installation Guide

Backpressure is calculated by

$$P = \frac{L \times S \times Q^2 \times 3.6 \times 10^6}{D^5} + P_s$$

OR

$$P = \frac{L \times S \times Q^2}{187 \times D^5} + P_s$$

Where
- P = Back pressure in inchWC
- L = Total equivalent length of pipe
- Q = Exhaust gas flow in cfm
- D = Diameter of pipe
- S = Density of gas
- P_s = Pressure drop of silencer

Equivalent Length of Straight Pipe

Standard Elbow	L =	33x D/12
Long Elbow	L =	20 x D/12
45 deg Elbow	L =	15 x D/12
Square Elbow	L =	66 x D/12

Assume: 2 inch exhaust

1 Standard Elbow	(33 x 2) /12	
2 Long Elbows	(20 x 2 x2)/12	
2 45 deg Elbows	(15 x 2 x 2)/12	
Straight lenth L	30 ft	
TOTAL		

Assume :

P_s = 0 psi since silencer is integral to engine

Diameter D = 2 inches

Exhaust CFM = 89 cfm

Equiv Length = 47

$$P = \frac{37 \times 0.008 \times 89 \times 89}{187 \times 2^5} + 0$$

P = 0.49771 psi

Max Allowable Back Pressure by Manuf 40 In WC

CONTROLS & CALCULATIONS

PROFESSIONAL STAMP

UPGRADE FOR :
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA

SHEET TITLE:

REVISIONS

PM/PM:	Ahmed
JOB NUMBER:	
SCALE:	AS NOTED
DRAWN BY:	H.Dion
CAD FILE:	
ISSUE DATE:	

SHEET
M-6
12-18-18

EVACUATED TUBE SOLAR COLLECTORS ETC-1

Make: ErgSol **Model**: 100-6 df **Fluid**: De-mineralized Water

No of Tubes/Panel: 20 **Gross Area:** 17.11 SqFt **Aperture Area**: 12.26 SqFt

SRCC Rate btu/day: 20,000 btu **SRCC OG 100 Certification**: Yes **No**: 10001807

Heat Pipe: Copper **Outer Tube Dia**: 4 inches **Tube Material**: Glass

Collector Size: 68" x 80" **Weight**: 170 lbs **Collector Flow Rate**: 0.7 gpm

Operating Pressure: 20-70 psi **Maximum Pressure**: 150 psi

Stagnation Temperature: 450 degF

Total Number of Panels: 20 Collector Mounting: For EPDM Roof Deck

Collector Angle: 30 degree **Collector Orientation**: 130 deg South Facing

STORAGE TANK ST-1

Make: Hanson Tank or Equal **Model:** GS-48-585-V **Type**: Vertical

Capacity: 585 gallons, **Application**: Domestic Hot Water

Surface Area: 94.5 SqFt, **Pressure:** 240 psig

Temp: 210 degF **No of Legs:** 4 **Construction**: Steel **Lining**: Glass

Dimension: 48" OD x 87" H with legs **Weight**: 1143 lbs (unfilled)

Standard ASME rated vertical steel tank with connections as shown in drawings

With 84" MAG Anode, 11" x 15" manhole

Factory insulation is a 2 component HCFC blown, polyurethane spray foam system. The foam is rated CLASS I according to ASTM E-84 at two inches, flame spread index 25 with 345 smoke developed.

SOLAR THERMAL EXPANSION TANK ET-1

Make: B&G Xylem or Equal Type: Vertical Bladder Type

Application: Glycol Solution Size: 20 Gallon Construction: Carbon Steel

Bladder Type: Rubber Factory Pre-charge: 36 psig Max Pressure: 150 psig

Max Operating Temp: 260 degF certification: ANSI/ASME

Diameter: 16 inch Length: 30 inch Air tight cushion.

GEHP SYSTEM THERMAL EXPANSION TANK ET-2

Make: B&G Xylem or Equal Type: Vertical Bladder Type

Application: Glycol Solution Size: 10 Gallon Construction: Carbon Steel

Bladder Type: Rubber Factory Pre-charge: 36 psig Max Pressure: 150 psig

Max Operating Temp: 260 degF certification: ANSI/ASME

Diameter: 12 inch Length: 16 inch Air tight cushion

EQUIPMENT SCHEDULE

GAS ENGINE HEAT PUMP GEHP-1

Make: Ilios/Tecogen, **Model**: HEWH-500-AS **Fluid**: Water

Thermal Output: 400,000-600,000 btu/hr **Rated COP**: 1.2-2.2

Water Flow Rate: 50 gpm **Water Delivery Temp**: 100-160 degF

Sound Rating: 72 dba@20 ft **Electrical Power**: 120V/1ph/60Hz

Amps: 15A, **Gas Pressure:** 8-12 inch wc, **Gas Conn**: 1 Inch,

Max Gas Flow: 390 SCFH, **Refrigerant**: HFC-134A **Water Connection**: 2 inch

Dimension: 7'3"L x 4'1" W x 7'1"H **Weight**: 4,200 lbs **Exhaust Conn**: 2 inch

Ultra low-emission natural gas 4-cylinder engine (<50 hp).

Internal 5 kW generator for parasitic loads.

Spark Ignition, 0.5% Oxygen air fuel mixture, electronic ignition, 12V DC Battery

5W-20 Synthetic blend oil, Compact brazed plate condenser.

Integral catalytic converter and silencer. Excluded from SCAQMD source test requirements

PUMP P-1

Make: B&G or Equal **Model:** Series 3530 Quantek **Fluid:** 80% Glycol Solution

Location: Between Solar Collectors and Heat Exchanger HE-1

Flow: 30 gpm **TDH** : 90 ft WC **HP** : 1.50 hp **Volts**: 208/230 **PH:** 1 ph **Hz:** 60 hz

Pump Body: Stainless Steel Impeller: Stainless Steel Shaft: Stainless Steel

Gasket /O-ring : EPDM **Flange**: 1.5 inch **Insulation Class**: F **Weight:** 39.6 lbs

Max Working Press: 175 psi, **Max Working Temperature**: 230 degF

TEFC Motor, In-line Close Coupled pump with VFD accessory

MATERIALS OF CONSTRUCTION

Solar Collector Piping	Corrugated stainless steel tube 1.5 in diameter with temperature range of -450degF-+1112 degF. Recommended pressure at +392 degF 3/4 inch 159 psi
Solar collector pipe insulation	1 inch thickness made of EFDM closed cell synthetic rubber, PVC and CFC free.Meets ASTM D635 Class VO for flammability and smoke density according to UL-94, Meets CA Title-24 Standards
DHW/GEHP piping	Copper tube, hard drawn, type L: to ASTM B88M. Bronze pipe flanges and flangec fittings, Class 150 and 300: to ANS/ASME B16.24.
DHW/GEHP pipe Insulation	1 inch thickness made of EFDM closed cell synthetic rubber, PVC and CFC free.Meets ASTM D635 Class VO for flammability and smoke density according to UL-94, Meets CA Title-24 Standards
DCW piping	Copper tube, hard drawn, type L: to ASTM B88M. Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI/ASME B16.24.
Natural Gas Piping	Steel and wrought-iron pipe shall be not less than standard weight (Schedule 40) and shall comply with ASME B36.10, ASTM A53, ASTM A106 (NFPA 54; 5.6.2.2)
Storage Tank	Vertical 160# ASME (HLW) for potable hot water, glass lined 5-12 mils, Steel construction , angle leg support, handhold. Max temp 210 degF
Storage Tank Insulation	Spray-on polyurethane foam factory insulation with topcoat. Nominal "R" value is R-16 @ 2" thick. This exceeds ASHRAE requirements. With min 2 inches of foam insulation
Engine Exhaust	2 inch carbon steel with wlded joints rated for engine exhaust temperature
Engine Exhaust Insulation	2 inch Calcium Silicate insulation with protective jacket and water proof jacket for pipe extending on outside the building

PLATE AND FRAME HEAT EXCHANGER HE-1

Make: B&G Model: GPX AP20-DW-41-TL Fluids: Water and 80% Glycol

SOLAR SIDE		
Flow - Glycol	30	gpm
Water Temp from Solar	150	degF
Water TEMP to Solar	130	degF
Total BTU Q	300000	btu
DHW SIDE		
Flow Water	20	gpm
Inlet Water Temp from Tank	110	degF
Outlet Water TEMP to Tank	140	degF
Total BTU Q	255000	btu
Approach GEHP Side High Temp-Tank Side High Temp	10	degF

No of Passes: 1, **Channels**: 20, **Rated PSI**: 150 psig, **Max Temp**: 284 degF
Plate Material: 316 SS, **No of Plates**: 49 **Flooded Weight**: 649 lbs
Double Walled Heat Exchanger for Potable Water Application
Interplate space open to air.

PLATE AND FRAME HEAT EXCHANGER HE-2

Make: B&G Model: GPX AP20-DW-41-TL Fluids: Water

GEHP SIDE		
Flow	50	gpm
Water Temp from GEHP	150	degF
Water TEMP to GEHP	130	degF
Total BTU Q	500000	btu
DHW SIDE		
Flow	43	gpm
Inlet Water Temp from Tank	120	degF
Outlet Water TEMP to Tank	140	degF
Total BTU Q	425000	btu
Approach GEHP Side High Temp-Tank Side High Temp	10	degF

No of Passes: 1, **Channels**: 20, **Rated PSI**: 150 psig, **Max Temp**: 284 degF
Plate Material: 316 SS, **No of Plates:** 49 **Flooded Weight**: 649 lbs
Double Walled Heat Exchanger for Potable Water Application
Interplate space open to air.

PUMP P-2

Make: B&G or Equal, **Model**: Ecocirc XL 65-130, **Fluid**: Water

Location: Between Storage Tank and Heat Exchanger HE-1

Flow: 20 gpm, **TDH** : 40 ft WC **HP** : 1.0 hp, **Volts**: 208/230 **PH**: 1 ph **Hz:** 60 hz

Pump Body: Cast Iron, **Impeller**: Poly-phenylene Sulfide **Shaft**: Stainless Steel

Gasket /O-ring : EPDM **Flange**: 1.5 inch **Insulation Class:** F **Weight**: 39.6 lbs

Max Working Press: 125 psi, **Max Working Temperature**: 225 degF

In-Line circulator. Electronically commutated permanent magnet motor

PUMP P-3

Make: B&G or Equal **Model:** Ecocirc XL 65-130 **Fluid**: Water

Location: Between GEHP and Heat Exchanger HE-2

Flow: 50 gpm **TDH** : 45 ft WC **HP** : 1.0 hp **Volts**: 208/230 **PH**: 1 ph **Hz**: 60 hz

Pump Body: Cast Iron **Impeller**: Poly-phenylene Sulfide **Shaft**: Stainless Steel

Gasket /O-ring : EPDM **Flange**: 1.5 inch **Insulation Class**: F **Weight**: 39.6 lbs

Max Working Press: 175 psi, **Max Working Temperature**: 230 degF

In-Line circulator. Electronically commutated permanent magnet motor

PUMP P-4

Make: B&G or Equal **Model**: Ecocirc XL 65-130 **Fluid**: Water

Location: Between Storage Tank and Heat Exchanger HE-2

Flow: 43 gpm **TDH** : 40 ft WC **HP** : 1.0 hp **Volts:** 208/230 **PH**: 1 ph **Hz:** 60 hz

Pump Body: Cast Iron **Impeller**: Poly-phenylene Sulfide Shaft: Stainless Steel

Gasket /O-ring : EPDM **Flange:** 1.5 inch **Insulation Class**: F **Weight**: 39.6 lbs

Max Working Press: 175 psi, **Max Working Temperature**: 230 degF

In-Line circulator. Electronically commutated permanent magnet motor w/VFD

EQUIPMENT SCHEDULES

PROFESSIONAL STAMP

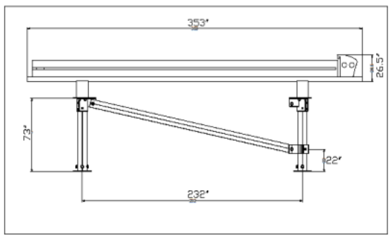
UPGRADE FOR :
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA

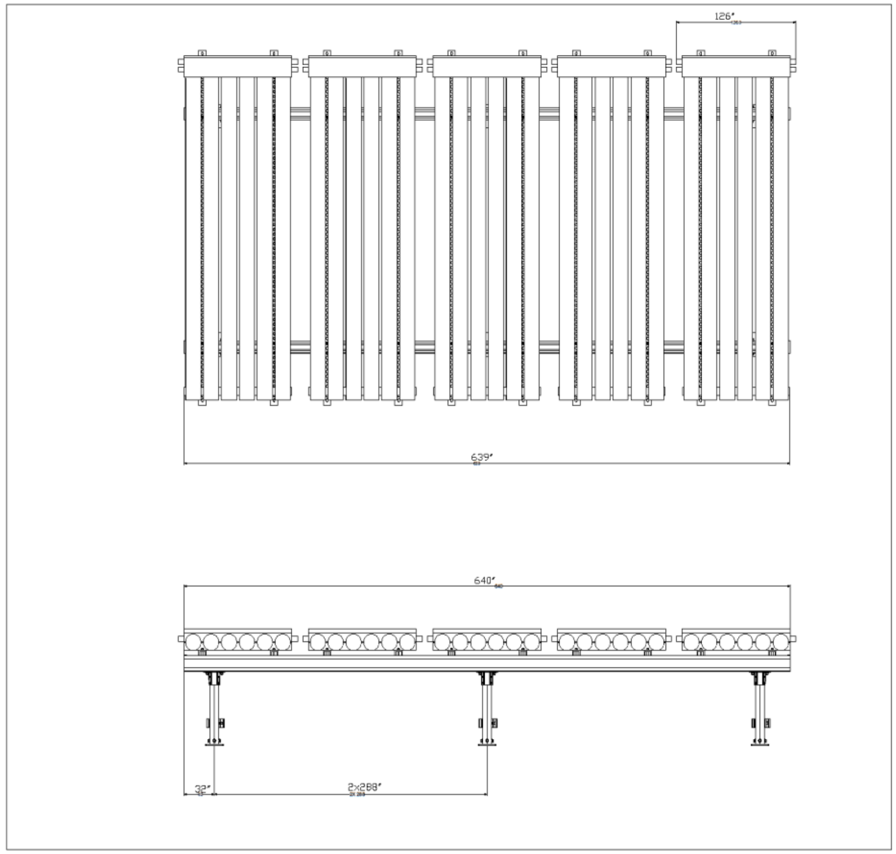
SHEET TITLE:

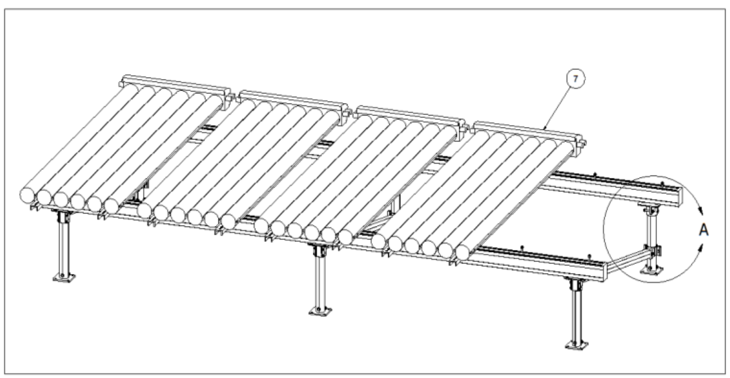
REVISIONS

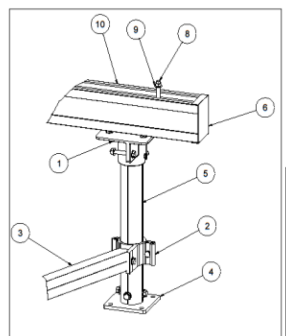
PA/PM:	Ahmed
JOB NUMBER:	
SCALE:	AS NOTED
DRAWN BY:	H.Dion
CAD FILE:	
ISSUE DATE:	

SHEET
M-7
12-18-18









DETAIL A

ITEM	PART NUMBER	DESCRIPTION	QTY
10	A20143-160	I BEAM EXTRUSION, L=160	2
9	B15003-001	FLANGE NUT 3/8-16	20
8	B15018-003	HEX CAP SCREW 3/8-16 X 2	20
7		SOLAR THERMAL COLLECTOR	5
6	A20237-001	SUNBEAM COVER	4
5	A20189-018	2.375" OD POST L=18	6
4	K10237-001	2.0 PIPE STEEL POST BASE KIT	6
3	A20164-055	1.5X2 AL TUBE BRACE, L=55	3
2	K10219-001	2" PIPE CLAMP KIT	3
1	K10218-001	2 AL PIPE CAP KIT WITH T BOLTS	6

MATERIAL: SEE BOM
Third Angle Projection
DRAWN BY: PHQ DATE: 10/09/2018

SunModo Corp.
14800 NE 65TH STREET, VANCOUVER WA 98682

TITLE: 1PX5-0DEG-SB
D DRAWING NUMBER: 181002.ERG.1
SCALE: NONE SHEET 1 of 3

SunMoto Corp
SOLAR PANELS

PROFESSIONAL STAMP

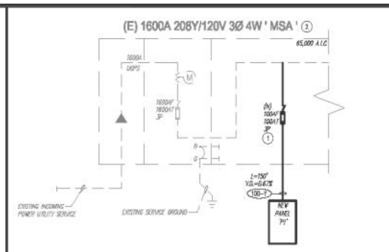
UPGRADE FOR :
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA

SHEET TITLE:

REVISIONS

PA/PM	Ahmed
JOB NUMBER	
SCALE:	AS NOTED
DRAWN BY:	H.Dion
CAD FILE:	
ISSUE DATE:	

SHEET
M-8
10-29-18



SINGLE LINE DIAGRAM 1

600V FEEDER SCHEDULE 3Ø 4W

LABEL	TYPE	SETS	PHASE	NEUTRAL	GROUND	CONDUIT
20-Y	20A-4W	1	3 # 12	1 # 12	1 # 12	3/4"
30-Y	30A-4W	1	3 # 10	1 # 10	1 # 10	3/4"
40-Y	40A-4W	1	3 # 8	1 # 10	1 # 10	1"
50-Y	50A-4W	1	3 # 6	1 # 6	1 # 10	1"
60-Y	60A-4W	1	3 # 6	1 # 6	1 # 10	1"
70-Y	70A-4W	1	3 # 4	1 # 4	1 # 8	1"
80-Y	80A-4W	1	3 # 4	1 # 4	1 # 8	1-1/4"
90-Y	90A-4W	1	3 # 2	1 # 2	1 # 8	1-1/4"
100-Y	100A-4W	1	3 # 1	1 # 1	1 # 8	1-1/2"
125-Y	125A-4W	1	3 # 1	1 # 1	1 # 6	1-1/2"
150-Y	150A-4W	1	3 # 1/0	1 # 1/0	1 # 6	1-1/2"
175-Y	175A-4W	1	3 # 2/0	1 # 2/0	1 # 6	2"
200-Y	200A-4W	1	3 # 3/0	1 # 3/0	1 # 6	2"

NOTE:
ALL CONDUCTOR SIZES ARE BASED ON TYPE THHN COPPER CONDUCTOR UNLESS OTHERWISE NOTED. THE AMPACITY OF CONDUCTORS SHALL BE BASED ON THE TERMINALS NOT TO EXCEED 60°C FOR CONDUCTOR SIZE #14 THROUGH #1 AWG OR 75°C FOR CONDUCTOR SIZE OVER #1 AWG AS PER NEC 110.14(C).

FEEDER SCHEDULE 2

MOUNTING: SURFACE
FED FROM: MAIN SWITCHBOARD 'MSA'
NEMA: 3R
AIC RATING: 10,000

PANEL
P1
(NEW)
LOCATION: HVAC ENCLOSURE

VOLTAGE: 208Y/120V 3PH 4W
BUS: 150 A
MAIN: 150 A
FEEDER: 150 -Y

NOTE	DESCRIPTION	A	B	C	TYPE	POLE	AMP	AWG/PH	LENGTH	V.D.%		PHASE		V.D.%	LENGTH	AWG/PH	AMP	POLE	TYPE	A	B	C	DESCRIPTION	NOTE
	GEN P-1	1800			M	1	20	#12	20	1.00	1	A - -	2	0.34	20	#12	20	2	M	915			PUMP P-1	
	PUMP P-2		915		M	2	20	#12	20	0.34	3	- B -	4		--		--	-	M		915		------	
	------			915	M	-	--		--		5	- - C	6	0.42	20	#12	20	2	M			1144	PUMP P-3	
	PUMP P-4	815			M	2	20	#12	20	0.34	7	A - -	8		--		--	-	M	1144			------	
	------		915		M	-	--		--		9	- B -	10	0.15	20	#12	20	2	M		400		DIFFERENTIAL CONTROLLER	
	SPACE										11	- - C	12		--		--	-	M			400	------	
	SPACE										13	A - -	14										SPACE	
	SPACE										15	- B -	16										SPACE	
	SPACE										17	- - C	18										SPACE	
	SPACE										19	A - -	20										SPACE	
	SPACE										21	- B -	22										SPACE	
	SPACE										23	- - C	24										SPACE	
	SPACE										25	A - -	26										SPACE	
	SPACE										27	- B -	28										SPACE	
	SPACE										29	- - C	30										SPACE	
	SPACE										31	A - -	32										SPACE	
	SPACE										33	- B -	34										SPACE	
	SPACE										35	- - C	36										SPACE	
	SPACE										37	A - -	38										SPACE	
	SPACE										39	- B -	40										SPACE	
	SPACE										41	- - C	42										SPACE	
	SUBTOTALS	2715	1830	915																2059	1315	1544		

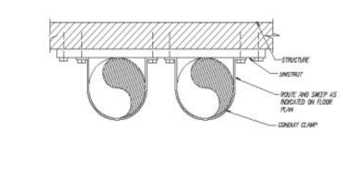
CEC LOAD CALC.	CONNECTED	DEMAND	DEMAND	DEMAND
LOAD TYPE	VA	FACTOR	VA	AMPS
(L) LIGHTING	0	1.25	0	0
(R) RECEPTACLE	0	NEC 220.44	0	0
(M) MOTOR	10379	1.25	12974	36
LARGEST MOTOR		0.25	0	0
(C) CONTINUOUS	0	1.25	0	0
(N) NON-CONTINUOUS	0	1.00	0	0
(K) KITCHEN (NEC 220.56)	0	0.65	0	0
(S) SPECIAL DEMAND	0	1.00	0	0
TOTALS	10379		12974	

TOTAL AMPS CONNECTED AT 208Y/120V 3PH 4W WITH LCL 36 A

SUBTOTALS		PHASE
4774	VA	A
3146	VA	B
2459	VA	C
10379	VA	TOTAL
29		AMPS

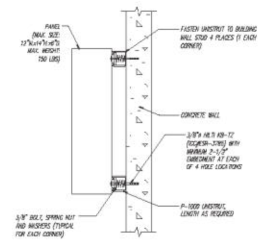
NOTES:

PANEL SCHEDULE 3



GENERAL NOTES:
1. REFER TO FLOOR PLAN FOR CONDUIT SIZE, LOCATION AND QUANTITY.

CONDUIT SUPPORT 6



SURFACE MNTD PANEL CONCRETE FRAMING 4

- 7

5

S.L.D. GENERAL NOTES

1. ALL CIRCUIT BREAKERS, PANELBOARDS AND TRANSFORMERS SHALL BE OF THE SAME MANUFACTURER.
2. ALL GROUND CONNECTIONS SHALL BE CADWELD.
3. AVAILABLE FAULT AT SERVICE POINT SHALL BE CONSIDERED AT 65,000 RMS SYM.
4. ALL PANELBOARDS SHALL BE FULLY RATED FOR THE AVAILABLE FAULT UNLESS OTHERWISE NOTED.
5. THE FEEDER LENGTHS SHOWN ON THESE DRAWINGS ARE FOR CALCULATION PURPOSES ONLY AND ARE NOT VALID FOR BIDDING.
6. CONTRACTOR SHALL UPDATE ALL MODIFIED PANEL DIRECTORIES OR CREATE A NEW TYPED DIRECTORY, IF ONE DOES NOT EXIST, IDENTIFYING EACH CIRCUIT AND INSTALLED CIRCUIT LOADS, MOUNTED IN GLASS OR PLASTIC INSIDE DOOR. THE CONTRACTOR SHALL BE RESPONSIBLE FOR UPDATING DIRECTORIES TO INDICATE ALL NEW CIRCUITS AND ACTUAL AREA SERVED WHICH IS NOT NECESSARILY THE DESCRIPTION INDICATED ON THE BID DOCUMENTS. USE A COMPUTER OR TYPEWRITER TO CREATE DIRECTORY; HANDWRITTEN DIRECTORIES ARE NOT ACCEPTABLE.

S.L.D. CONSTRUCTION NOTES

(1) PROVIDE NEW FUSE IN EXISTING MAIN SWITCHBOARD 'MSA'. FUSE SHALL BE RATED TO WITHSTAND AVAILABLE FAULT CURRENT.

(2) EXISTING MAIN SWITCHGEAR TO BE REUSED.

ABBREVIATIONS

A	AMPERE	NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
AF	AMPERE FRAME RATING (CIRCUIT BREAKER)	NEW (N)	NEW, TO BE FURNISHED AND INSTALLED BY CONTRACTOR
AFF	ABOVE FINISHED FLOOR	NF	NON-FUSED
AFG	ABOVE FINISHED GRADE	NIC	NOT IN CONTRACT
AFU	AMPERE FUSE RATING (FUSE)	N/L	NIGHT LIGHT
AIC	AMPERE INTERRUPTING CAPACITY	NO	NUMBER, NORMALLY OPEN
AS	AMPERE SWITCH RATING (FUSE)	NTS	NOT TO SCALE
AT	AMPERE TRIP RATING (CIRCUIT BREAKER)	OC	ON CENTER
AWG	AMERICAN WIRE GAUGE	OD	OUTSIDE DIAMETER
BKBD	BACKBOARD	P	POLE
BLDG	BUILDING	PB	PULL BOX
BKR	BREAKER	PF	POWER FACTOR
C	CONDUIT	PNL	PANEL
CB	CIRCUIT BREAKER	POC	POINT OF CONNECTION
CKT	CIRCUIT	PP	POWER POLE
CFSD	COMBINATION FIRE SMOKE DAMPER	PWR	POWER
CO	CONDUIT ONLY	PVC	POLYVINYL CHLORIDE
CONC	CONCRETE	QUAD	QUADRUPLEX
CT	CURRENT TRANSFORMER	QTY	QUANTITY
CU	COPPER	REQD	REQUIRED
CL	CENTERLINE	REQMT	REQUIREMENT
DISC	DISCONNECT	RGS	RIGID GALVANIZED STEEL
DSBN	DISTRIBUTION SECTION	RMC	RIGID METALLIC CONDUIT
DN	DOWN	RM	ROOM
DWG	DRAWING	RNC	RIGID NONMETALLIC CONDUIT
EA	EACH	SHT	SHEET
EC	ELECTRICAL CONTRACTOR	SN	SOLID NEUTRAL
EM	EMERGENCY	SPEC	SPECIFICATIONS
EMT	ELECTRICAL METALLIC TUBING	SPDT	SINGLE POLE, DOUBLE THROW
EXIST, (E)	EXISTING	SPST	SINGLE POLE, SINGLE THROW
EXO	EXTERNAL OPERABLE DISCONNECT	SW	SWITCH
F	FUSE	SWBD	SWITCHBOARD
FA	FIRE ALARM	TC	TIME CLOCK
FACP	FIRE ALARM CONTROL PANEL	TEL	TELEPHONE
FF	FINISHED FLOOR	TERM	TERMINAL
FG	FINISHED GRADE	TP	TEMPORARY POLE
FLA	FULL LOAD CURRENT	TYP	TYPICAL
FLUOR	FLUORESCENT	UGPS	UNDERGROUND PULL SECTION
GEN	GENERATOR	UL	UNDERWRITERS LABORATORY
GFCI	GROUND FAULT CIRCUIT INTERRUPTER	UPS	UNINTERRUPTIBLE POWER SUPPLY
GFP	GROUND FAULT PROTECTION	UON	UNLESS OTHERWISE NOTED
GND	GROUND	V	VOLT, VOLTAGE
HOA	HAND-OFF-AUTOMATIC	VA	VOLT-AMPERE
HP	HORSE POWER	VFC	VARIABLE FREQUENCY CONTROLLER
HV	HIGH VOLTAGE	VFD	VARIABLE FREQUENCY DRIVE
IDF	INTERMEDIATE DISTRIBUTION FRAME	W	WATT
IG	ISOLATED/INSULATED GROUND	WH	WATT-HOUR
INCAND	INCANDESCENT	WP	WEATHERPROOF
ISC	SHORT CIRCUIT CURRENT AVAILABLE IN RMS SYMMETRICAL AMPERES	WT	WEATHERTIGHT
J-BOX	JUNCTION BOX	WW	WIREWAY
KCMIL	THOUSAND CIRCULAR MILS	XP	EXPLOSION PROOF
KW	KILOWATT	Z	IMPEDANCE
KV	KILO VOLT		
KVA	KILO VOLT-AMPERE		
LDC	LOCAL DISTRIBUTION CABINET	4W	FOUR-WIRE
LDF	LOCAL DISTRIBUTION FRAME	3W	THREE-WIRE
LCL	LONG CONTINUOUS LOAD	SS	JUNCTION BOX (4 11/16" SQUARED X2 1/8" DEEP)
LTG	LIGHTING		
LV	LOW VOLTAGE	Ø	DIAMETER, PHASE
MFR	MANUFACTURER	#	NUMBER
MAX	MAXIMUM	°C	DEGREE CELSIUS
MCC	MOTOR CONTROL CENTER		
MIN	MINIMUM	(E)	EXISTING DEVICE TO REMAIN
MH	MANHOLE / METAL HALIDE	(R)	REMOVE EXISTING DEVICE AND ASSOCIATED CONDUIT AND WIRE
M/M	METER AND MAIN SECTION		
MULTI	MULTI-METER SECTION	(E)	REMOVE EXISTING DEVICE AND RELOCATE AS SHOWN ON PLAN
MV	MEDIUM VOLTAGE		
NC	NORMALLY CLOSED		
NEC	NATIONAL ELECTRICAL CODE	(NL)	NEW LOCATION OF RELOCATED DEVICE

GENERAL NOTES

1. ALL MATERIALS AND WORKMANSHIP SHALL CONFORM TO THE LATEST CALIFORNIA CODE OF REGULATIONS (CCR), NATIONAL ELECTRICAL CODE EDITION AND ALL APPLICABLE LOCAL CODES AND REGULATIONS.
2. ALL PANELS, SWITCHES, ETC. SHALL HAVE SUFFICIENT GUTTER SPACE AND LUGS IN COMPLIANCE TO UL REQUIREMENTS TO ACCOMMODATE CONDUCTORS SHOWN.
3. WHERE WIRE SIZES ARE INDICATED ON PLANS, FOR INDIVIDUAL CIRCUITS, THE WIRE SIZE INDICATED SHALL APPLY TO THE COMPLETE CIRCUIT, UNLESS OTHERWISE NOTED.
4. CONTRACTOR SHALL VERIFY THE EXACT LOCATION OF MECHANICAL, PLUMBING AND OTHER EQUIPMENT REQUIRING ELECTRICAL CONNECTION PRIOR TO ANY WORK.
5. CONTRACTOR SHALL EXTEND WIRING FROM ALL JUNCTION BOXES, SWITCHES, ETC. AND MAKE FINAL CONNECTION AS REQUIRED TO ALL BUILDING EQUIPMENT REQUIRING ELECTRICAL CONNECTIONS.
6. DRAWINGS ARE DIAGRAMMATIC AND INDICATE GENERAL ARRANGEMENT OF SYSTEMS AND WORK INCLUDED. FOLLOW DRAWINGS IN LAYING OUT WORK AND CHECK DRAWINGS OF OTHER TRADES RELATING TO WORK TO VERIFY SPACE IN WHICH WORK WILL BE INSTALLED. MAINTAIN HEADROOM AND MINIMUM CODE REQUIRED WORKING CLEARANCES AT ALL TIMES.
7. CONTRACTOR SHALL COORDINATE THE LOCATION OF ALL WALL OUTLET BOXES FOR SWITCHES, BELL/STROBES, FIRE ALARM PULL STATIONS, RECEPTACLES ETC. WITH CABINETS, FURNITURE, EQUIPMENT ETC., TO AVOID CONFLICT.
8. FURNISH APPROVED EXPANSION FITTINGS WHERE RACEWAY CROSSES BUILDING EXPANSION JOINTS.
9. FURNISH PULL STRING IN EACH RACEWAY RUN OVER 10' IN LENGTH, IN WHICH PERMANENT WIRING IS NOT INSTALLED.
10. PROVIDE PULL BOXES WHEREVER NECESSARY TO FACILITATE PULLING OF CONDUCTORS. COORDINATE LOCATIONS OF BOXES WITH OTHER TRADES TO AVOID CONFLICT. PULL BOXES SHALL BE ACCESSIBLE. THE SIZE OF PULL BOX SHALL COMPLY WITH N.E.C. REQUIREMENTS.
11. SEE MECHANICAL AND PLUMBING DRAWINGS AND SPECIFICATION FOR ADDITIONAL CONNECTION REQUIREMENTS TO CONTROL PANELS, CONTROL TRANSFORMERS, POWER FOR CONTROL SYSTEM EP AND PE SWITCHES, TIME CLOCKS, VALVES, STATS, RELAYS, DUCT SMOKE DETECTOR LOCATIONS, ETC. INDICATED ON CONTROL WIRING DIAGRAMS. ELECTRICAL CONTRACTOR SHALL VERIFY FINAL CONTROL WIRING REQUIREMENTS WITH MECHANICAL AND PLUMBING CONTRACTORS PRIOR TO ANY WORK AND PROVIDE ALL NECESSARY DEVICES AND CONNECTIONS AS REQUIRED.
12. ALL EXTERIOR ELECTRICAL DEVICES AND EQUIPMENT INCLUDING THOSE THAT ARE EXPOSED TO OUTSIDE ENVIRONMENT (UP TO 16') SHALL BE WEATHERPROOF TYPE, NEMA 3R.
13. NO CONDUIT RUNS SHALL BE ALLOWED IN CONCRETE SLABS. ALL CONDUITS WILL BE PLACED ABOVE ACCESSIBLE CEILING SPACES UNLESS SPECIFICALLY INDICATED TO BE UNDERGROUND.
14. DISCONNECT SWITCHES SHALL BE MOUNTED ON INDIVIDUAL SUPPORTS, OR OTHERWISE DIRECTLY ON EQUIPMENT, PROVIDED NO MODIFICATION TO EQUIPMENT IS NECESSARY.
15. ALL ELECTRICAL POWER LIGHTING, TELEPHONE OR SIGNAL WIRING IN FIRE RATED WALL IS TO BE INSTALLED IN A METALLIC CONDUIT SYSTEM.
16. ALL ELECTRIC MATERIAL SHALL BE LISTED BY "UL" FOR THE TYPE OF APPLICATION AND "UL" LABEL SHALL APPEAR ON ALL ELECTRICAL EQUIPMENT.
17. ALL DISTRIBUTION AND CONTROL EQUIPMENT (SUCH AS CB's, SWITCHES, CONTACTORS, ETC.), TERMINATIONS SHALL BE FULLY RATED PER UL AS FOLLOWS:
    a. 125A OR LESS : 60°C OR MORE.
    b. MORE THAN 125A : 75°C OR MORE.
18. CONDUCTORS SHALL HAVE UNDERWRITER'S LABORATORIES, INC.(UL) LISTED, 600 VOLT INSULATION OF TYPE SPECIFIED BELOW OR ELSEWHERE IN THE SPECIFICATIONS. CONDUCTORS SHALL BE COPPER.
    1. BRANCH CIRCUITS – LIGHTING AND POWER.
       a. #10 AWG AND SMALLER, SOLID WIRE TYPE THW OR THWN/THHN, THHN/THWN FOR DRY LOCATION ONLY).
       b. #8 AWG TO #2 AWG, STRANDED TYPE THW OR THWN/THHN.
       c. #1 AWG AND LARGER, STRANDED TYPE XHHW.
    2. FEEDERS : TYPE THW OR THWN/THHN, OR XHHW.
19. PROVIDE GREEN INSULATED GROUNDING CONDUCTOR IN EACH RACEWAY INCLUDING CONDUITS, PLUG STRIPS, WIREMOLD. SIZE OF GROUNDING SHALL BE IN ACCORDANCE WITH NATIONAL ELECTRIC CODE ARTICLE 250.
20. WIRING METHOD SHALL BE EMT ABOVE GROUND AND MOUNTED IN CONCEALED SPACES AND SCHEDULE-40 PVC FOR UNDERGROUND INSTALLATION. USE RIGID WHEN ENCASED IN CONCRETE OR SUSCEPTIBLE TO DAMAGE.
21. USE 10AWG CONDUCTORS FOR 20 AMPERE, 120V BRANCH CIRCUITS LONGER THAN 75 FEET.
    USE 10AWG CONDUCTORS FOR 20 AMPERE, 277V BRANCH CIRCUITS LONGER THAN 200 FEET.

POWER LEGEND AND SYMBOLS

SYMBOL	DESCRIPTION
	DUPLEX RECEPTACLE OUTLET, CONVENIENCE. (20 AMPS, 125 VOLTS) MOUNTED +15" A.F.F. TO BOTTOM OF DEVICE, U.O.N.
	DUPLEX RECEPTACLE OUTLET, CONVENIENCE. (20 AMPS, 125 VOLTS, GFCI TYPE) MOUNTED +15" A.F.F. TO BOTTOM OF DEVICE, U.O.N.
WP	WEATHERPROOF DUPLEX RECEPTACLE OUTLET, CONVENIENCE. (20 AMPS, 125 VOLTS) MOUNTED +15" A.F.F. TO BOTTOM OF DEVICE, U.O.N.
	ABOVE CEILING, CONCEALED, JUNCTION BOX, WITH COVER, PER NATIONAL ELECTRICAL CODE (NEC) TABLE 314.16(A)/(B), 4" SQUARE DEEP, WITH PLASTER RING.
	RECESSED WALL MOUNTED JUNCTION BOX, WITH COVER, PER NATIONAL ELECTRICAL CODE (NEC) TABLE 314.16(A)/(B), 4" SQUARE DEEP, WITH PLASTER RING.
OR	BRANCH PANELBOARD, WALL MOUNTED, SEE PLANS AND SCHEDULE. (SURFACE MOUNTED)
	MAIN SWITCHBOARD, POWER OR LIGHT, FLOOR STANDING ENCLOSURE, (SEE SINGLE LINE DIAGRAM AND LOAD SUMMARY)
	DISCONNECT SWITCH H.P. RATED 600 VOLTS RATED. "F" INDICATES FUSE TYPE. FUSES PER APPROVED MANUFACTURERS SHOP DRAWINGS.
	MAGNETIC MOTOR STARTER H.P. RATED (NUMBER INDICATES NEMA SIZE)
+36" OR 7'-6" AFF	MOUNTING HEIGHT FROM FINISHED FLOOR TO BOTTOM LINE OF OUTLET OR EQUIPMENT. FOR LIGHT FIXTURES, IT IS TO BOTTOM OF FIXTURE.
	CONDUIT TURNED DOWN
	CONDUIT TURNED UP
	CONDUIT STUBBED AND CAPPED
	RACEWAY CONCEALED IN WALLS OR ABOVE CEILING
	CONDUIT CONCEALED IN OR UNDER FLOOR, COORDINATE WITH G.C.; OR, BURIAL CONDUIT UNDERGROUND IN SCHEDULE - 40 PVC, U.O.N. VERIFY DEPTH AND TRENCHING WITH G.C.
DETAIL No. / SHEET No.	DETAIL REFERENCE
EQUIPMENT ID. No.	EQUIPMENT REFERENCE
A-1,3	HOMERUN TO CIRCUITS #1 AND #3 IN PANEL "A". (CROSSMARKS INDICATE NUMBER OF PHASES AND NEUTRAL. PROVIDE GROUND WIRE.)
	3/4" CONDUIT WITH 2 #12 & 1 #12 GND WIRES, U.O.N.
	3/4" CONDUIT WITH 3 #12 & 1 #12 GND WIRES, U.O.N.
	3/4" CONDUIT WITH 4 #12 & 1 #12 GND WIRES, U.O.N.
	3/4" CONDUIT WITH 5 #12 & 1 #12 GND WIRES, U.O.N.
#10	3/4" CONDUIT WITH 2 #10 & 1 #10 GND WIRES (#10 INDICATING WIRE SIZE)
#10	3/4" CONDUIT WITH 3 #10 & 1 #10 GND WIRES (#10 INDICATING WIRE SIZE)
#10	3/4" CONDUIT WITH 4 #10 & 1 #10 GND WIRES (#10 INDICATING WIRE SIZE)
#10	3/4" CONDUIT WITH 5 #10 & 1 #10 GND WIRES (#10 INDICATING WIRE SIZE)
	1" CONDUIT WITH 6 #10 & 1 #10 GND WIRES (#10 INDICATING WIRE SIZE)
	GROUND WELL
	EXISTING (DASH INDICATES) ELECTRICAL EQUIPMENT
	TELEPHONE BACKBOARD 2'X4'X3/4" PLYWOOD. PROVIDE 2" CONDUIT TO TELEPHONE POC.
	SWITCH AND FUSE ASSEMBLY
	UTILITY COMPANY PULL SECTION LUGS
	GROUNDING CONNECTION TO MAIN BUILDING GROUND SYSTEM, U.O.N.
N G	GROUNDING CONNECTION AT SWITCHGEAR/DISTRIBUTION BOARD WITH NEUTRAL BONDING
M	IN-LINE UTILITY COMPANY METER
M	UTILITY METER WITH CIRCUIT TRANSFORMERS (CT'S) METER
200-Y	CONDUIT WIRING DESCRIPTION PER FEEDER SCHEDULE ON OTHER PLAN
PB	CONCRETE ELECTRICAL PULL BOX WITH LID APPROPRIATE FOR INSTALLATION LOCATION. LID SHALL BE LABELED "ELECTRICAL" OR "COMM" ACCORDING TO USE.

(The 3/4" and 1" conduit entries are bracketed: CONCEALED IN WALL OR CEILING)

NOTE TO CONTRACTOR

DO NOT SCALE DRAWINGS

CONTRACTOR SHALL VERIFY PLANS AND EXISTING DIMENSIONS AND CONDITIONS ON THE JOB SITE AND SHALL IMMEDIATELY NOTIFY THE ARCHITECT IN WRITING OF ANY DISCREPANCIES BEFORE PROCEEDING WITH THE WORK OR BE RESPONSIBLE FOR THE SAME.

APPLICABLE CODES

1. 2016 BUILDING STANDARDS ADMINISTRATIVE CODE, PART 1, TITLE 24 C.C.R.
2. 2016 CALIFORNIA BUILDING CODE (CBC),PART 2, TITLE 24 C.C.R. (IBC WITH AMENDMENTS)
3. 2016 CALIFORNIA ELECTRICAL CODE (CEC), PART 3, TITLE 24 C.C.R. (NEC WITH AMENDMENTS)
4. 2016 CALIFORNIA MECHANICAL CODE (CMC), PART 4, TITLE 24 C.C.R. (UMC WITH AMENDMENTS)
5. 2016 CALIFORNIA PLUMBING CODE (CPC), PART 5, TITLE 24 C.C.R. (UPC WITH AMENDMENTS)
6. 2016 CALIFORNIA FIRE CODE, PART 9, TITLE 24 C.C.R. (IFC WITH AMENDMENTS)
7. 2016 CALIFORNIA REFERENCED STANDARDS, PART 12, TITLE 24 C.C.R.
8. 2016 TITLE 19 C.C.R., PUBLIC SAFETY, STATE FIRE MARSHAL REGULATIONS.
9. 2016 CALIFORNIA ENERGY CODE (PART 6, TITLE 24 C.C.R.)
10. 2016 CALIFORNIA GREEN BUILDING STANDARDS CODE (CGBSC), PART 11, TITLE 24 C.C.R.

SHEET INDEX

SHEET NUMBER	SHEET TITLE
E-0.1	ELECTRICAL LEGENDS & NOTES
E-1.1	ELECTRICAL FLOOR PLAN
E-2.1	ELECTRICAL SPECIFICATIONS

DESIGN WEST ENGINEERING
MECHANICAL, ELECTRICAL, ENERGY CONSULTANTS
275 W. Hospitality Lane, Suite #100
San Bernardino, CA 92408

ISSUE DATE:

DATE | BY | ISSUE FOR

REVISION:

NUM. | DATE | BY | REVISION FOR

CONSULTANT

PROJECT TITLE

PROJECT FOR:
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA. 90045

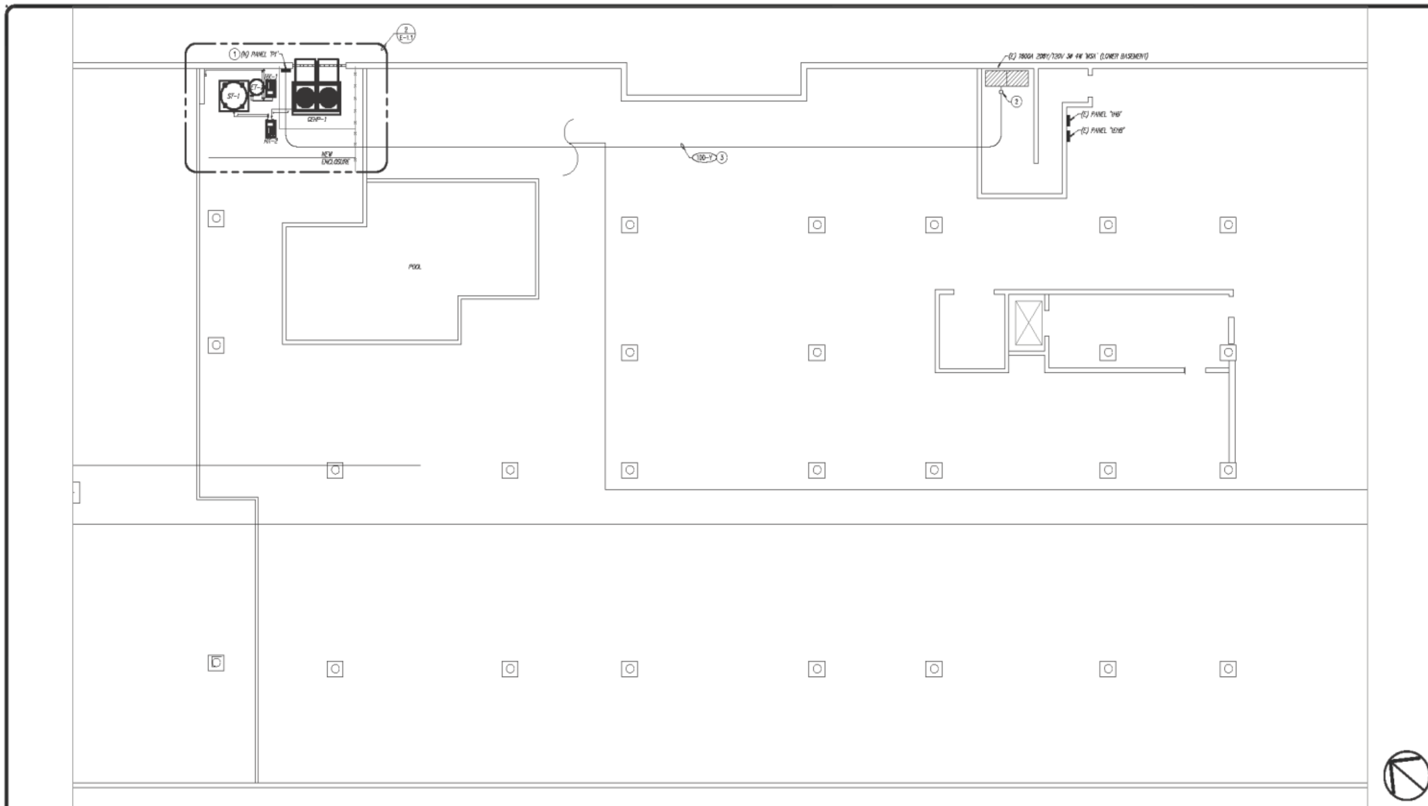
STAMP

SHEET TITLE

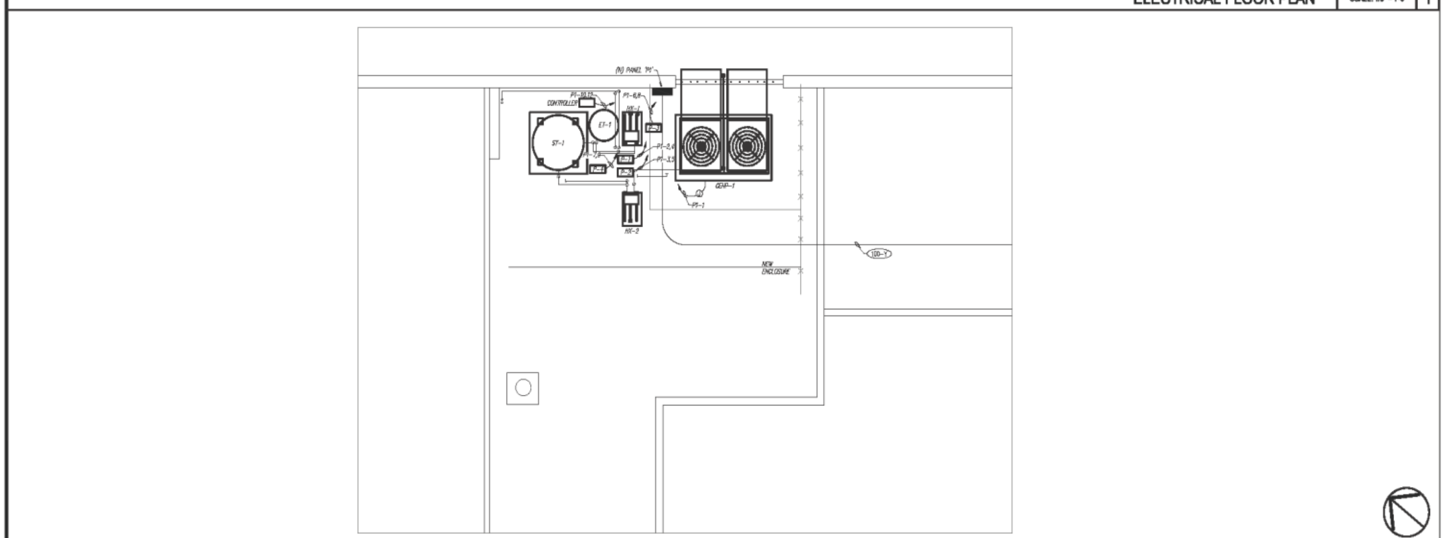
ELECTRICAL LEGENDS & NOTES

DESIGNED BY	MK
DRAWN BY	MK
CHECKED BY	KM
DATE	
SCALE	AS NOTED
JOB NO.	

SHEET NO.
E-0.1



ELECTRICAL FLOOR PLAN | SCALE: 1/8" = 1'-0" | 1



ENLARGED ELECTRICAL FLOOR PLAN | SCALE: 1/4" = 1'-0" | 2

GENERAL NOTES

1. COORDINATE POWER AND DATA DEVICE LOCATIONS, AND DEVICE PLATE COLOR WITH ARCHITECT.
2. REFER TO MECHANICAL AND PLUMBING PLANS FOR THE EXACT LOCATION OF HVAC EQUIPMENT AND ADDITIONAL WIRING REQUIREMENTS.
3. PROVIDE DUCT DETECTOR POWER AND CONNECTIONS AS INDICATED ON MECHANICAL DRAWINGS.
4. PROVED FLEXIBLE SEAL TYPE CONDUIT FOR CONNECTION TO ALL HVAC EQUIPMENT.
5. ALL EXTERIOR ELECTRICAL EQUIPMENT SHALL BE NEMA 3R.
6. ALL EXTERIOR RECEPTACLE OUTLETS SHALL BE GFCI TYPE.
7. PROVIDE HEAVY DUTY DISCONNECT SWITCHES WITH DUAL ELEMENT FUSES TO MATCH MOTOR H.P. RATING.

CONSTRUCTION NOTES

(1) PROVIDE MINIMUM 3'-0" LEVEL CLEARANCE IN FRONT OF ELECTRICAL EQUIPMENT, PER NEC 110.26.

(2) CONTRACTOR IS TO EXIT SWITCHGEAR AND RISE UP TO FLOOR ABOVE. CORE DRILL THROUGH EXISTING CONCRETE FLOOR AND SUPPORT AS REQUIRED.

(3) SUPPORT CONDUIT TO CONCRETE DECK EVERY 10' AND WITHIN 3' OF ANY JUNCTION BOXES OR TERMINATIONS.

DESIGN WEST ENGINEERING
MECHANICAL, ELECTRICAL, ENERGY CONSULTANTS
275 W. Hospitality Lane, Suite #100
San Bernardino, CA 92408
Phone: 909-890-3700
Fax: 909-890-3770
Email: cadd@designwesteng.com

ISSUE DATE:

DATE BY ISSUE FOR

REVISION:

NUM. DATE BY REVISION FOR

CONSULTANT

PROJECT TITLE

PROJECT FOR:
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TIJERA BLVD
LOS ANGELES, CA. 90045

STAMP

SHEET TITLE

ELECTRICAL FLOOR PLAN

DESIGNED BY	MK
DRAWN BY	MK
CHECKED BY	RM
DATE	[illegible]
SCALE	AS NOTED
JOB NO.	[illegible]

SHEET NO.

E-1.1

ELECTRICAL SPECIFICATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. WORK COVERED BY THIS SECTION CONSISTS OF FURNISHING ALL LABOR, EQUIPMENT, SUPPLIES, AND MATERIALS, UNLESS OTHERWISE SPECIFIED, AND IN PERFORMING ALL OPERATIONS NECESSARY FOR THE INSTALLATION OF A COMPLETE AND OPERABLE ELECTRICAL SYSTEM AS REQUIRED BY THESE SPECIFICATIONS AND AS INDICATED ON THE DRAWINGS.

B. THE CONTRACTOR SHALL EXAMINE ALL DRAWINGS AND SPECIFICATIONS IN A MANNER TO BE FULLY COGNIZANT OF ALL WORK REQUIRED UNDER THIS SECTION.

C. THE CONTRACTOR SHALL OBTAIN AND PAY FOR ALL REQUIRED PERMITS UNLESS OTHERWISE ARRANGED AND SCHEDULE ALL REQUIRED INSPECTIONS FOR THE EXECUTION OF THE WORK UNDER THIS CONTRACT.

1.02 GENERAL REQUIREMENTS

A. WORK DONE UNDER THIS SECTION SHALL COMPLY WITH THE LATEST EDITION OF THE CALIFORNIA ELECTRICAL CODE, NEC (NATIONAL ELECTRICAL CODE), THE STATE OF CALIFORNIA TITLE 24, THE STATE BUILDING STANDARDS, (OSHA) OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, AND TO ANY APPLICABLE LOCAL JURISDICTIONAL REQUIREMENTS. IN CASE OF CONFLICT BETWEEN REQUIREMENT, THE MOST RESTRICTIVE SHALL APPLY.

1.03 ELECTRICAL CONTRACTOR'S RESPONSIBILITY

A. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN A COMPLETE SET OF DRAWINGS AND SPECIFICATIONS. CONTRACTOR SHALL CHECK THE DRAWINGS OF THE OTHER TRADES AND SHALL CAREFULLY READ THE ENTIRE SPECIFICATIONS AND DETERMINE HIS RESPONSIBILITIES.

B. BEFORE SUBMITTING THE BID, THE ELECTRICAL CONTRACTOR SHALL VISIT THE JOB SITE AND FULLY ACQUAINT HIMSELF WITH EXISTING CONDITIONS. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO INSTALL THE EQUIPMENT AND ASSOCIATED WIRING IN SUCH A MANNER AS TO CONFORM WITH THE EXISTING STRUCTURE OF THE BUILDING, AVOID OBSTRUCTIONS, AND MEET APPLICABLE CODE REQUIREMENTS.

C. THE INTENT OF THESE DRAWINGS IS TO DESCRIBE A COMPLETE AND OPERABLE SYSTEM. WHERE EXISTING CONDITIONS DIFFER FROM DRAWINGS, ADJUSTMENT SHALL BE MADE AND ALLOWANCES INCLUDED FOR ALL NECESSARY EQUIPMENT TO COMPLETE ALL PARTS OF THE DRAWINGS AND SPECIFICATIONS. BRING ANY QUESTIONS TO THE ARCHITECT OR ENGINEER'S ATTENTION PRIOR TO BIDDING.

D. WHEREVER A DISCREPANCY IN QUANTITY OR SIZE OF CONDUIT, WIRE, EQUIPMENT, DEVICES, CIRCUIT BREAKERS, ETC., ARISES ON THE DRAWING AND/OR SPECIFICATION, THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING AND INSTALLING ALL MATERIAL AND SERVICES REQUIRED BY THE STRICTEST CONDITION NOTED ON DRAWINGS AND/OR IN SPECIFICATIONS TO ENSURE COMPLETE AND OPERABLE SYSTEMS AS REQUIRED BY THE OWNER AND ENGINEER.

1.04 WORK NOT INCLUDED

A. CERTAIN LABOR, MATERIALS, OR EQUIPMENT MAY BE FURNISHED UNDER OTHER CONTRACTS BY THE OWNER. WHEN SUCH IS THE CASE, THE EXTENT, SOURCE, AND DESCRIPTION OF THESE ITEMS WILL BE INDICATED ON THE DRAWINGS OR DESCRIBED IN THE SPECIFICATIONS. UNLESS OTHERWISE NOTED, ALL LABOR, MATERIALS AND EQUIPMENT FOR THE COMPLETE INSTALLATION OF THE ELECTRICAL WORK SHALL BE PROVIDED UNDER THIS SECTION OF THESE SPECIFICATIONS.

1.05 SPECIAL REQUIREMENTS

A. THE DRAWINGS INDICATE GENERAL ARRANGEMENT OF CIRCUITS, OUTLETS, LOCATIONS OF MOTOR CONTROLLERS WITH DISCONNECTS, PANELBOARDS, CONDUIT ROUTING, AND OTHER WORK. INFORMATION SHOWN ON THE DRAWINGS IS ESSENTIALLY DIAGRAMMATIC. HOWEVER, RECIRCUITING OR RELOCATING ELECTRICAL EQUIPMENT WILL NOT BE PERMITTED WITHOUT SPECIFIC WRITTEN APPROVAL OF THE ENGINEER.

1.06 SUBMITTALS

A. AFTER AWARD OF THE CONTRACT AND BEFORE ANY MATERIALS ARE DELIVERED TO THE JOB SITE, A COMPLETE LIST OF ALL MATERIALS PROPOSED TO BE FURNISHED AND INSTALLED UNDER THIS SECTION MUST BE PROVIDED.

B. SUBMIT TO THE ENGINEER FOR APPROVAL ONE PRINT AND ONE REPRODUCIBLE OF ALL LIGHTING FIXTURES, SWITCHGEAR, PANELBOARDS, MOTOR CONTROL CENTERS, TRANSFORMERS, AND MOTOR STARTERS. SHOP DRAWINGS SHALL INCLUDE MANUFACTURER'S PRINTED INFORMATION FOR EACH OF THESE ITEMS IDENTIFIED ON THE DRAWINGS. THE INFORMATION SHALL INCLUDE, AS MINIMUM, OVERALL DIMENSIONS, WEIGHT, PHASE, VOLTAGE RATINGS, WIRING DIAGRAMS, AND NAMEPLATE DATA.

1.07 STANDARDS AND MATERIALS

A. ALL MATERIALS SHALL CONFORM WITH THE CURRENT APPLICABLE INDUSTRY STANDARDS, NEMA (NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION), ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE), IPCEA (INSULATED POWER CABLE ENGINEERS ASSOCIATION), IEEE (INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS), NATIONAL ELECTRICAL SAFETY CODE.

B. UNLESS OTHERWISE INDICATED, ALL MATERIALS SHALL BE UNDERWRITERS LABORATORIES LISTED AND LABELED, OR CERTIFIED BY A NATIONALLY RECOGNIZED TESTING LABORATORY.

C. WORKMANSHIP AND NEAT APPEARANCE SHALL BE AS IMPORTANT AS THE ELECTRICAL MECHANICAL EFFICIENCY. DEFECTIVE AND DAMAGED MATERIALS SHALL BE REPLACED OR REPAIRED PRIOR TO FINAL APPROVAL AND ACCEPTANCE. THE DRAWINGS AND SPECIFICATIONS TAKE PRECEDENCE WHEN THEY ARE MORE STRINGENT THAN CODES, STATUTES, OR ORDINANCES IN EFFECT. APPLICABLE CODES, STANDARDS, ORDINANCES, AND STATUTES TAKE PRECEDENCE WHEN THEY ARE MORE STRINGENT OR CONFLICT WITH THE DRAWINGS OR SPECIFICATIONS.

1.08 DELIVERY AND STORAGE OF MATERIALS

A. THE CONTRACTOR SHALL INVESTIGATE EACH SPACE IN THE BUILDING THROUGH WHICH EQUIPMENT MUST PASS TO REACH ITS FINAL LOCATIONS. IF NECESSARY, THE MANUFACTURER SHALL BE REQUIRED TO SHIP HIS MATERIAL IN SECTIONS, SIZED TO PERMIT PASSING THROUGH SUCH RESTRICTED AREAS IN THE BUILDING.

B. THE CONTRACTOR SHALL RETAIN IN HIS POSSESSION AND SHALL BE RESPONSIBLE FOR ALL PORTABLE AND DETACHABLE PARTS OF PORTIONS OF INSTALLATIONS SUCH AS FUSES, KEY LOCKS, ADAPTERS, BLOCKING CLIPS, AND INSERTS UNTIL FINAL COMPLETION OF WORK. THESE PARTS SHALL BE DELIVERED TO THE OWNER UPON COMPLETION OF THE WORK.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. ALL MATERIALS FURNISHED AND INSTALLED UNDER THIS CONTRACT SHALL BE NEW, FREE FROM DEFECTS, AND SHALL BE GUARANTEED FOR A PERIOD OF ONE (1) YEAR FROM DATE OF ACCEPTANCE OF THE WORK. SHOULD ANY TROUBLE DEVELOP DURING THEIR PERIOD DUE TO DEFECTIVE MATERIALS OR FAULTY WORKMANSHIP, THE CONTRACTOR SHALL FURNISH ALL NECESSARY MATERIALS AND LABOR TO CORRECT THE TROUBLE WITHOUT ANY COST TO THE OWNER. ANY DEFECTIVE MATERIAL OR INFERIOR WORKMANSHIP NOTED AT THE TIME OF INSTALLATION SHALL BE CORRECTED IMMEDIATELY TO THE SATISFACTION OF THE OWNER.

B. ALL MAJOR EQUIPMENT COMPONENTS SHALL HAVE THE MANUFACTURER'S NAME, ADDRESS, MODEL NUMBER, AND SERIAL NUMBER PERMANENTLY ATTACHED IN A CONSPICUOUS MANNER.

2.02 CONDUIT

A. PROVIDE RACEWAYS AS INDICATED ON THE DRAWINGS AND AS HEREIN SPECIFIED. CONDUITS SHALL BE RIGID STEEL "GRC" (THICK WALL) GALVANIZED; ELECTRICAL METALLIC TUBING "EMT" (THIN WALL); FLEXIBLE STEEL, GALVANIZED; LIQUID-TIGHT, FLEXIBLE STEEL CONDUIT WITH GROUND BOND; ALUMINUM CONDUIT; OR SCHEDULE 40 PVC.

B. ALL EMPTY CONDUITS (CO) SHALL BE SCHEDULE 40 PVC UNLESS OTHERWISE INDICATED ON THE DRAWING.

C. WHERE CONDUIT CROSSES AN EXPANSION JOINT, PROVIDE APPROVED FITTINGS WHICH ALLOW DEFLECTIONS EQUIVALENT TO TWICE THE MOVEMENT ALLOWED BY THE DESIGN.

2.03 CONDUCTORS

A. PROVIDE A COMPLETE SYSTEM OF CONDUCTORS IN RACEWAY SYSTEMS AS SHOWN ON THE DRAWINGS AND THEN HEREIN SPECIFIED.

B. LIGHTING AND POWER CONDUCTORS SHALL BE COPPER, 600 VOLT, TYPE THWN/THHN, NO. 12 MINIMUM UNLESS OTHERWISE NOTED.

C. CONTROL CONDUCTORS SHALL BE 600V, TYPE THWN/THHN, NO.14 MINIMUM SIZE UNLESS OTHERWISE NOTED.

2.04 FITTINGS

A. CONNECTOR, COUPLING, LOCKNUT, BUSHINGS AND CAPS USED WITH RIGID CONDUIT SHALL BE STEEL, THREADED AND GALVANIZED. BUSHINGS SHALL BE INSULATED.

B. EMT FITTINGS, CONNECTORS AND COUPLINGS SHALL BE STEEL, ZINC, OR CADMIUM PLATED, COMPRESSION TYPE, WITH INSULATED THROAT.

C. FLEXIBLE STEEL CONDUIT CONNECTORS SHALL BE TWIST-IN-TYPE WITH INSULATED THROAT. THE FINISH SHALL BE ZINC OR CADMIUM PLATING.

D. EMT CONDUIT FITTINGS SHALL BE THE COMPRESSION TYPE; SET SCREW FITTINGS SHALL NOT BE USED.

2.05 JUNCTION AND PULL BOXES

A. FOR INTERIOR DRY LOCATIONS, BOXES SHALL BE GALVANIZED ONE-PIECE DRAWN STEEL, KNOCKOUT TYPE WITH REMOVABLE, MACHINE SCREW SECURED COVERS.

B. FOR EXTERIOR WET LOCATIONS, BOXES SHALL BE NEMA 3R OR NEMA 4 RATED, GASKET MACHINE SCREW SECURED COVERS.

C. INGROUND PULLBOXES SHALL BE CONCRETE ELECTRICAL PULL BOX WITH LID APPROPRIATE FOR INSTALLATION LOCATION. SIZE PULLBOX PER NEC REQUIREMENTS.

D. ALL BOXES SHALL BE SIZED FOR THE NUMBER AND SIZES OF CONDUCTORS AND CONDUITS ENTERING THE BOX AND EQUIPPED WITH PLASTER RINGS WHERE REQUIRED.

2.06 OUTLET BOXES

A. FOR FIXTURES, BOXES SHALL BE GALVANIZED, ONE-PIECE DRAWN STEEL, KNOCKOUT TYPE EQUIPPED WITH 3/8" FIXTURE STUDS AND PLASTER RINGS WHERE REQUIRED.

B. FOR CONVENIENCE OUTLETS, WALL SWITCHES, OR OTHER DEVICES, OUTLET BOXES SHALL BE GALVANIZED ONE-PIECE DRAWN STEEL, KNOCKOUT TYPE 4"X4"X1-1/2" MINIMUM.

C. FOR LOCATIONS WHERE STANDARD BOXES ARE NOT SUITABLE, SPECIAL BOXES SHALL BE DESIGNED TO FIT SPACE OR MEET OTHER REQUIREMENTS AND SUBMITTED FOR APPROVAL.

2.07 SWITCHES N/A

2.08 RECEPTACLES

A. DUPLEX RECEPTACLES SHALL BE SPECIFICATION GRADE, 20 AMPS, 125 VOLTS, 3-WIRE, SIDE-WIRED WITH BINDING SCREWS, PARALLEL SLOTS, U-GROUND, PLASTER EARS AND CAPTIVE MOUNTING SCREWS. BODY SHALL BE PHENOLIC, PLASTIC, OR BAKELITE. RECEPTACLES SHALL BE HEAVY-DUTY, 3-BLADE CURRENT CARRYING CONTACT AND DOUBLEWIDE FLAT BLADE GROUND CONTACTS. PROVIDE ARROW HART 5342-I HUBBELL 5342-I OR LEVITON 5242-I.

B. SINGLE RECEPTACLES SHALL BE SPECIFICATION GRADE, GROUNDING TYPE, SIDE-WIRED, WITH BINDING SCREWS AND SHALL HAVE STANDARD SIZE IVORY BAKELITE BASE. FOR CIRCUITS CONSISTING OF ONE SINGLE RECEPTACLE ONLY, AMPERE RATING OF RECEPTACLE SHALL BE THE SAME AS CIRCUIT BREAKER OF FUSE. FOR RECEPTACLES RATED 15 AMPS/125 VOLTS, PROVIDE NEMA 5-15R, ARROW-HART 5351-I, FOR RECEPTACLES RATED 20 AMPS / 125 VOLTS, PROVIDE NEMA 5-20R, ARROW-HART 5721-I, OR EQUAL.

2.09 DEVICE PLATES

1. PROVIDE PLATES FOR ALL SWITCHES, RECEPTACLES, JUNCTION BOXES, TELEPHONE AND OTHER OUTLETS.

2. PROVIDE ENGRAVED OR ETCHED PLATES FOR ALL LOCK SWITCHES, PILOT SWITCHES, SWITCHES FROM WHICH EQUIPMENT OR CIRCUIT CONTROLLED CANNOT BE READILY SEEN, THREE OR MORE SWITCHES UNDER A COMMON PLATE AND FOR SWITCHES AS INDICATED.

3. STAINLESS STEEL PLATES SHALL BE AMERICAN IRON AND STEEL INSTITUTE (AISI) TYPE 302, WITH BEVELED EDGES. 0.040" THICK WITH SATIN SMOOTH FINISH. "SMOOTHIE," HUBBELL #97071 SERIES.

4. PLASTIC COVER PLATE SHALL BE HIGH IMPACT THERMOPLASTIC, HIGH STRENGTH, SCRATCH-RESISTANT, SMOOTH AND SELF-EXTINGUISHING, HUBBELL "PJ" SERIES OR PASS & SEYMOUR RP SERIES.

5. WHERE OUTLETS ARE INDICATED TO BE WEATHERPROOF, PROVIDE AN AISI TYPE 302 STAINLESS WITH DOUBLE HINGED COVERS, PASS & SEYMOUR #WP2-B.

6. GALVANIZED STEEL PLATES SHALL BE SQUARE OR RECTANGULAR AND HOT DIPPED GALVANIZED OR SHERARDIZED, BEVELED EDGES AND 0.040" THICK. GALVANIZED STEEL PLATES SHALL BE USED IN UTILITY AREA.

7. PROVIDE PLATES EQUIPPED WITH CLOSE FITTING OPENINGS FOR THE EXACT DEVICE TO BE USED. PROVIDE PLATES FOR TELEPHONE OUTLETS EQUIPPED WITH BUSHED OPENINGS.

8. REFER TO SECTION 3.08 FOR LABELING OF PLATES.

9. COVER PLATES ON PRESSED STEEL OUTLET BOXES IN FURRED AREAS, ATTICS, ETC., OR EXPOSED IN MECHANICAL EQUIPMENT ROOMS SHALL BE OF THE SAME MATERIAL AS THE OUTLET BOX.

10. COVER PLATES IN LOCATIONS CONCEALED FROM PUBLIC VIEW SHALL HAVE THE CIRCUIT NUMBERS AND SOURCE FEED POINT HAND LABELED WITH MARKING BLACK PEN (PERMANENT MARKER). SEE SECTION 3.08 FOR LABELING.

11. PROVIDE PLASTIC COVER PLATES UNLESS NOTED OTHERWISE.

2.10 PANELBOARDS

A. FURNISH AND INSTALL ALL BRANCH CIRCUIT PANELBOARDS AS HEREINAFTER SPECIFIED AND AS SHOWN ON THE DRAWINGS. PANELBOARDS SHALL BE OF THE DEAD FRONT SAFETY TYPE EQUIPPED WITH THE THERMAL MAGNETIC 40°C CIRCUIT BREAKERS.

B. CIRCUIT BREAKERS SHALL BE RATED MINIMUM 10,000 AMPS RMS SYMMETRICAL INTERRUPTING CAPACITY AND SHALL BE THE NUMBER OF POLES AND CURRENT CAPACITY AS INDICATED ON THE PANEL SCHEDULE. BRANCH CIRCUIT PANELBOARDS SHALL BE SQUARE-D OR EATON/CUTLER HAMMER WITH LUGS UL LISTED FOR USE WITH 75°C WIRE.

C. DOOR SHALL HAVE A PLASTIC COVERED DIRECTORY FRAME WITH A TYPED IDENTIFICATION CARD OR ALL CIRCUIT AND PANEL NUMBERS FOR BRANCH CIRCUIT PANELBOARDS.

D. PROVIDE NAMEPLATE FOR ALL PANELBOARDS, ENGRAVED WHITE LETTERS ON BLACK BACKGROUND INSTALL NAME PLATES ON THE TRIM ABOVE DOOR.

E. ALL WIRING SHALL BE NEATLY ARRANGED AND LACED TOGETHER.

F. ALL CIRCUIT BREAKERS USED FOR HVAC LOADS SHALL BE RATED "HACR".

G. BUS BARS SHALL BE RECTANGULAR IN CROSS SECTION CONSTRUCTED OF COPPER. NEUTRAL AND GROUND BUSES SHALL BE FULL SIZE.

2.11a INTERIOR LIGHTING FIXTURES N/A

2.11b EXTERIOR LIGHTING FIXTURES N/A

2.12 LOW VOLTAGE SWITCHGEAR N/A

2.13 CIRCUIT AND MOTOR DISCONNECTS

A. DISCONNECT (SAFETY) SWITCHES SHALL BE FUSED, HEAVY DUTY TYPE SWITCHES MEETING NEMA SPECIFICATIONS. SWITCHES SHALL BE PROVIDED WITH REJECTION TYPE FUSE BLOCKS. PROVIDE SWITCHES WITH THE NUMBER OF POLES, THE VOLTAGE, CURRENT AND HORSEPOWER RATINGS AS REQUIRED. PROVIDE EXTERNALLY OPERABLE QUICK-MAKE, QUICK-BREAK TYPE MECHANISM WITH COVER INTERLOCK AND PADLOCKABLE IN EITHER THE OPEN OR CLOSED POSITION.

B. SWITCHES SHALL BE NEMA 3R (RAIN TIGHT ENCLOSURE) WHERE INDICATED TO BE OUTDOORS WEATHERPROOF.

C. PROVIDE NAMEPLATE INDICATING EQUIPMENT SERVED. ALL GENERAL SNAP SWITCHES OPERATING MOTOR LOADS SHALL BE HORSEPOWER RATED OR BE RATED AT LEAST 125% OF THE FULL LOAD CURRENT.

2.14 TRANSFORMERS N/A

2.15 ELECTRICAL CONNECTIONS

A. UNLESS OTHERWISE NOTED, ALL WIRING FOR MOTORS, STARTERS, CONTROLS, AND EQUIPMENT SHALL BE PROVIDED BY THE ELECTRICAL CONTRACTOR. WHERE MOTORS FOR MECHANICAL EQUIPMENT ARE FURNISHED BY OTHER DIVISIONS, WIRING SHALL BE THE RESPONSIBILITY OF THE ELECTRICAL CONTRACTOR, EXCEPT WHERE WIRED INTEGRALLY WITH THE EQUIPMENT.

B. CONNECTION AND CONTROL DIAGRAMS FOR ALL MECHANICAL AND CONTROL EQUIPMENT SHALL BE FURNISHED UNDER OTHER DIVISIONS, AND BE APPROVED BY THE OWNER FOR CONNECTION BY THE ELECTRICAL CONTRACTOR.

2.16 SUPPORTING DEVICES

A. ALL EQUIPMENT CONDUITS SHALL BE SUPPORTED, ANCHORED AND BRACED IN ACCORDANCE WITH THE MOST STRINGENT CODES AND REQUIREMENTS. COMPLY WITH CHAPTER 23 OF THE LATEST CBC (CALIFORNIA BUILDING CODE).

PART 3 EXECUTION

3.01 WORKMANSHIP AND COMPLETION OF INSTALLATION

A. WORKMANSHIP AND NEAT APPEARANCE SHALL BE AS IMPORTANT AS THE ELECTRICAL AND MECHANICAL EFFICIENCY. DEFECTIVE AND DAMAGED MATERIALS SHALL BE REPLACED OR REPAIRED PRIOR TO FINAL INTERPRETATIONS INCLUDED. ANY DEFICIENCY PERTAINING TO EITHER WORKMANSHIP OR MATERIALS FOUND BY THE INSPECTOR SHALL BE CORRECTED WITHOUT ADDITIONAL COST TO THE OWNER.

B. THE CONTRACTOR SHALL MAINTAIN ON JOB SITE A SET OF THE WORKING DRAWINGS WHICH SHALL BE UPDATED DAILY IN DETAIL FOR WORK ACCOMPLISHED. UPON COMPLETION OF THE WORK, A SET OF REPRODUCIBLE CONTRACT DRAWINGS SHALL BE OBTAINED FROM THE GENERAL CONTRACTOR AND ALL CHANGES AS NOTED ON THE RECORD SET OF PRINTS SHALL BE INCORPORATED THEREON WITH RED INK IN A NEAT, LEGIBLE, UNDERSTANDABLE AND PROFESSIONAL MANNER.

C. ALL EQUIPMENT AND MATERIAL CONNECTED WITH THIS PROJECT SHALL BE INSTALLED COMPLETE, THOROUGHLY CLEANED, AND ALL RESIDUE REMOVED FROM INSIDE SURFACES. EXTERIOR SURFACES OF ALL MATERIAL AND EQUIPMENT SHALL BE CLEANED AND DELIVERED IN A PERFECT, UNBLEMISHED CONDITION.

D. UPON COMPLETION OF THE INSTALLATION AND AS A CONDITION OF ITS ACCEPTANCE FURNISH ONE COPY OF THE FINAL INSPECTION CERTIFICATE TO THE OWNER.

3.02 PREPARATION COORDINATION.

A. THE CONTRACTOR SHALL COORDINATE THIS WORK WITH ALL OTHER CONTRACTORS FURNISHING LABOR, MATERIALS AND WORK, SO THAT THE WORK AS WHOLE SHALL BE EXECUTED AND COMPLETED WITHOUT CONFLICT OR DELAY.

B. EXAMINE THE DRAWINGS AND SPECIFICATIONS AND DETERMINE THE WORK TO BE PERFORMED BY THE ELECTRICAL, MECHANICAL AND OTHER TRADES. PROVIDE THE TYPE AND AMOUNT OF ELECTRICAL MATERIALS AND EQUIPMENT NECESSARY TO PLACE THIS WORK IN PROPER OPERATION, COMPLETELY WIRED TESTED AND READY FOR USE. THIS SHALL INCLUDE ALL CONDUIT, WIRE, DISCONNECTS, RELAYS, AND OTHER DEVICES FOR THE REQUIRED OPERATION SEQUENCE OF ALL ELECTRICAL, MECHANICAL, AND OTHER SYSTEMS OR EQUIPMENT.

C. PERFORM ALL WORK IN A MANNER WHICH WILL NOT CAUSE UNNECESSARY INCONVENIENCE OR DANGER TO THE OCCUPANTS, NOR INTERFERE WITH THE ACTIVITIES IN THE BUILDING.

D. THE CONTRACTOR SHALL COORDINATE AND SCHEDULE EACH POWER INTERRUPTION WITH OWNER, AND SHALL PROVIDE AT LEAST TWO WEEKS NOTICE OF PROPOSED INTERRUPTION AND WORK TO BE ACCOMPLISHED.

3.04 CORE CUTTING, DRILLING, AND PATCHING

A. NO HOLES WILL BE ALLOWED IN ANY STRUCTURAL MEMBERS WITHOUT THE WRITTEN APPROVAL OF THE ARCHITECT OR STRUCTURAL ENGINEER AND GENERAL CONTRACTOR.

3.05 INSTALLATION

A. WORKMANSHIP IS TO BE NEAT, BY EXPERIENCED WORKMEN WITH ADEQUATE SUPERVISION, AND IN LINE WITH NORMAL INDUSTRY WORK PRACTICES.

B. MAINTAIN WORKING CLEARANCE AROUND ELECTRICAL EQUIPMENT, IN ACCORDANCE WITH CODE REQUIREMENTS AS A MINIMUM.

C. WHERE LIGHTING FIXTURES AND OTHER ELECTRICAL ITEMS ARE SHOWN IN CONFLICT WITH LOCATIONS OF STRUCTURAL MEMBERS AND MECHANICAL OR OTHER EQUIPMENT, FURNISH AND INSTALL ALL REQUIRED SUPPORTS AND WIRING TO CLEAR THE ENCROACHMENT.

D. VERIFY LOCATION OF EACH OUTLET FOR POWER, SIGNAL, TELEPHONE/DATA, AND EACH LIGHTING FIXTURE WITH ARCHITECT PRIOR TO ROUGH-IN. INCLUDE IN BID COST OF RELOCATING EACH ITEM WITHIN TEN-FEET RADIUS OF ITS INDICATED LOCATION.

E. ALL CONDUIT TO BE RUN CONCEALED UNLESS OTHERWISE NOTED. ALL CONDUITS SHALL BE ROUTED OVERHEAD IN CEILING SPACES. NO CONDUITS SHALL BE PERMITTED IN CONCRETE SLAB, MASONRY WALLS UNLESS SPECIFICALLY SO INDICATED. CONDUIT SHALL BE RUN SO AS NOT TO INTERFERE WITH OTHER PIPING FIXTURES OR EQUIPMENT.

F. WHERE ALLOWED, EXPOSED CONDUIT RUNS SHALL BE INSTALLED PARALLEL OR PERPENDICULAR TO WALLS, STRUCTURAL MEMBERS, OR INTERSECTION OF VERTICAL PLANES AND CEILINGS.

G. ALL ELECTRICAL CONDUITS AND OTHER ELECTRICAL RACEWAYS PASSING THROUGH FIRE RATED CEILINGS, SLABS, CABLE TRAYS, WALLS AND PARTITIONS SHALL BE SEALED TO PREVENT THE SPREAD OF FIRE, SMOKE, AND GASSES. USE A UL LISTED AND APPROVED FIRE-STOP MATERIAL EQUAL TO RATING OF A WALL OR A FLOOR SLAB PENETRATED; INSTALLATION OF FIRE-STOP MATERIAL SHALL BE IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.

H. UNLESS WRITTEN PERMISSION IS GRANTED BY THE ARCHITECT, NO MATERIAL SHALL BE MOUNTED ON THE EXTERIOR WALLS OR PARAPET TOP OF THE BUILDING.

I. ALL ROTATING ELECTRICAL EQUIPMENT SHALL BE SUPPLIED WITH A FLEXIBLE, LIQUID-TIGHT CONDUIT WITH APPROPRIATE SLACK AND SHALL NOT EXCEED THIRTY-SIX (36) INCHES.

J. ALL POWER WIRING SHALL BE INSTALLED IN CONDUIT.

K. TELEPHONE WIRES SHALL BE PLENUM RATED CABLE FOR MOUNTING IN CEILING SPACES WITHOUT CONDUIT UNLESS OTHERWISE NOTED.

L. ALL WIRES FOR ALL SYSTEMS SHALL BE CONTINUOUS FROM SWITCH TO TERMINAL OR FURTHEST OUTLET. NO JOINTS SHALL BE MADE EXCEPT IN PULL, JUNCTION OR OUTLET BOXES, OR IN PANEL OR SWITCHBOARD GUTTERS.

M. ALL RECEPTACLE, CONTROL DEVICE, AND SWITCH MOUNTING HEIGHTS SHALL BE COORDINATED WITH ARCHITECTURAL ELEVATIONS PRIOR TO ROUGH-IN.

3.06 GROUNDING

A. ALL EQUIPMENT SHALL BE PROPERLY GROUNDED AS INDICATED ON DRAWINGS AND AS REQUIRED BY THE LATEST EDITION OF APPLICABLE CODES.

B. FURNISH AND INSTALL ALL GROUNDING CONDUCTORS, CONDUIT AND CLAMPS. THE SIZE OF THE GROUNDING CONDUCTORS SHALL BE NOT LESS THAN THAT SPECIFIED IN THE NEC.

C. BUILDING GROUNDING SYSTEM RESISTANCE TO GROUND SHALL NOT EXCEED 25 OHMS.

D. EACH BRANCH CIRCUIT SHALL BE EQUIPPED WITH CODE SIZE GREEN GROUND, EQUIPMENT WIRE (PER NEC 250-95) (NOT INDICATED ON DRAWINGS) WITHIN THE SAME CONDUIT FOR ALL CIRCUITS OF PANELBOARDS.

3.07 BRANCH CIRCUITS

A. NO MORE THAN THREE BRANCH CIRCUITS PERMITTED IN ONE CONDUIT UNLESS INDICATED OTHERWISE.

3.08 IDENTIFICATION

A. THE FOLLOWING ITEMS SHALL BE EQUIPPED WITH NAMEPLATES:

1. ALL MOTORS, MOTOR STARTERS, CONTROL PANELS, MOTORS CONTROL REMOTE STATIONS.

2. ALL DISCONNECT AND SAFETY SWITCHES, MAIN DISTRIBUTION PANEL FEEDER OVERCURRENT DEVICES AND SPARES, CIRCUIT EQUIPMENT IN SEPARATE ENCLOSURES.

3. SPECIAL ELECTRICAL SYSTEMS SHALL BE PROPERLY IDENTIFIED AT JUNCTION AND PULL BOXES.

4. ALL BRANCH CIRCUIT PANEL BOARDS SHALL HAVE IDENTIFYING ENGRAVED PLASTIC NAMEPLATES. ALSO, PROVIDE A TYPED DIRECTORY CARD FOR EACH BRANCH CIRCUIT PANELBOARD. THE CARD IS TO BE PLACED ON THE INTERIOR SIDE OF THE PANELBOARD DOOR BEHIND A CLEAR PLASTIC SHIELD. THE CARD SHALL IDENTIFY EACH CIRCUIT BY NUMBER, LOAD, AND LOCATION.

5. IN GENERAL, EQUIPMENT SHALL BE IDENTIFIED AS DESIGNATED ON THE ELECTRICAL DRAWINGS. NAMEPLATES FOR PANELBOARDS AND SWITCHBOARDS SHALL INCLUDE THE PANEL DESIGNATION, VOLTAGE AND PHASE OF THE SUPPLY. THE NAME OF THE MACHINE SHALL BE THE SAME AS THE NAME USED ON ALL MOTOR STARTERS, DISCONNECTS, AND P.B STATION NAMEPLATES FOR THAT MACHINE.

B. NAMEPLATES SHALL BE FABRICATED AS FOLLOWS:

1. NAMEPLATE MATERIALS SHALL CONSIST OF 3-PLY, 1/16" LAMINATED PLASTIC WITH WHITE CORE FOR LETTERING AND BLACK BACKGROUND.

2. CAPITAL LETTERS SHALL BE USED.

3. NAMEPLATES SHALL BE FASTENED WITH CADMIUM-PLATED SELF-TAPPING NO. 6 SCREWS 1/4" LONG

4. THE MINIMUM SIZE OF ALL NAME PLATES AND LETTERING SHALL BE 3/4" HIGH BY 3" LONG WITH 1/4" LETTERS.

3.09 PROTECTION

A. USE ALL MEANS NECESSARY TO PROTECT THE WORK AND MATERIALS FROM LOSS DURING AND AFTER INSTALLATION, AND PROVIDE ADEQUATE AND PROPER STORAGE FACILITIES DURING THE PROGRESS OF THE WORK. PROVIDE FOR THE SAFETY AND GOOD CONDITION OF ALL WORK UNTIL FINAL ACCEPTANCE OF THE WORK BY THE OWNER. REPLACE ALL DAMAGE OR DEFECTIVE WORK, MATERIAL, AND EQUIPMENT AT NO EXPENSE TO THE OWNER BEFORE REQUESTING FINAL ACCEPTANCE.

3.10 CLEANING OF EQUIPMENT, MATERIAL, AND PREMISES

A. SITE SHALL BE LEFT BROOM CLEAN AFTER COMPLETION OF WORK EACH DAY. UPON COMPLETION OF THE WORK, LEAVE THE PREMISES CLEAN OF ALL DIRT AND DEBRIS.

B. ALL EQUIPMENT AND MATERIAL CONNECTED WITH THIS PROJECT SHALL BE INSTALLED COMPLETE, THOROUGHLY CLEANED, AND ALL RESIDUE REMOVED FROM INSIDE SURFACES. EXTERIOR SURFACES OF ALL MATERIAL AND EQUIPMENT SHALL BE CLEANED AND DELIVERED IN A PERFECT, UNBLEMISHED CONDITION.

3.11 HANDLING OF WIRE AND CABLE

A. HANDLE WIRE AND CABLE SO AS TO AVOID DAMAGE TO CONDUCTORS AND TAKE EVERY PRECAUTION TO AVOID SHARP BENDING OR SCORING OF THE CABLE. CABLE SHALL NOT BE LAID NOR DRAGGED UPON THE GROUND.

B. THE CONTRACTOR SHALL BE REQUIRED TO REMOVE AND REPLACE AT HIS OWN EXPENSE ALL WIRE AND CABLE DAMAGED DUE TO IMPROPER HANDLING, AND SHALL PAY FOR THE NEW WIRE OR CABLE.

3.12 TESTING AND INSPECTIONS

A. THE CONTRACTOR SHALL OBTAIN AND PAY FOR ALL REQUIRED PERMITS AND ARRANGE ALL REQUIRED INSPECTIONS FOR THE EXECUTION OF THE WORK UNDER THIS CONTRACT.

B. THE CONTRACTOR SHALL REPLACE ALL DAMAGED OR DEFECTIVE EQUIPMENT OR WORK.

C. ALL CIRCUITS SHALL BE TESTED FOR CONTINUITY AND CIRCUIT INTEGRITY BY THE CONTRACTOR. ADJUSTMENTS SHALL BE MADE FOR CIRCUITS NOT COMPLYING WITH TESTING CRITERIA.

D. THE CONTRACTOR SHALL FURNISH ALL INSTRUMENTS AND PERFORM ANY ADDITIONAL TESTS REQUIRED BY THE AUTHORITY HAVING JURISDICTION. CONTRACTOR SHALL ALSO CORRECT ALL FAILURES AND REPLACE ANY DAMAGED PORTIONS OF THE WORK RESULTING FROM THOSE TESTS. THE COST OF THE FOREGOING ITEMS SHALL BE PAID BY THE CONTRACTOR.

E. THE CONTRACTOR SHALL FURNISH THE OWNER CERTIFICATES OF INSPECTION AND APPROVAL BY THE ELECTRICAL INSPECTION AUTHORITY ON ALL WORK COMPETED AS REQUIRED.

F. TITLE 24 REQUIRES THE COMPLETION OF ALL APPLICABLE CERTIFICATES OF INSTALLATION AND CERTIFICATES OF ACCEPTANCE FOR LIGHTING SYSTEMS. THIS SHALL INCLUDE INDOOR AND OUTDOOR LIGHTING SYSTEMS.

G. CONTRACT DRAWINGS AND SPECIFICATIONS, GENERAL PROVISIONS OF THE CONTRACT, INCLUDING GENERAL AND SUPPLEMENTARY CONDITIONS, ELECTRICAL PROVISIONS AND DIVISION-1 SPECIFICATION SECTIONS APPLY TO WORK OF THIS SECTION.

H. COMPLETE ALL TITLE 24 REQUIRED CERTIFICATE(S) OF INSTALLATION (NRCI) AND CERTIFICATE(S) OF ACCEPTANCE (NRCA) TO BE COMPLETED PER THE CONTRACT DOCUMENTS.

I. RESPONSIBILITIES OF INSTALLING CONTRACTORS

A.A. GENERAL CONTRACTOR (GC)

a. ENSURE THAT ALL CONTRACTORS IDENTIFIED AS THE CONTRACTOR RESPONSIBLE FOR ACCEPTANCE TESTING AND COMPLETION OF THE TITLE 24 CERTIFICATE(S) OF ACCEPTANCE ARE CERTIFIED BY THE STATE OF CALIFORNIA OR ITS DESIGNATED BODY TO CONDUCT EACH RESPECTIVE TEST.

A.A. ELECTRICAL CONTRACTOR (EC)

a. VERIFY PROPER INSTALLATION AND PERFORMANCE OF ALL ELECTRICAL SERVICES PROVIDED.

b. COMPLETE TITLE 24 CERTIFICATE(S) OF INSTALLATION AND MANUFACTURER'S PRE-START CHECKLISTS PRIOR TO SCHEDULING STARTUP/PROGRAMMING OF LIGHTING CONTROL EQUIPMENT.

i. RETAIN CERTIFICATE(S) OF INSTALLATION IN A 3-RING BINDER IN AN ORGANIZED FASHION. BINDER IS TO REMAIN ON THE JOB SITE

ii. MAKE CERTIFICATE(S) OF INSTALLATION AVAILABLE FOR BUILDING INSPECTOR'S REVIEW.

iii. RETAIN CALIBRATION RECORDS FOR EQUIPMENT PROVIDED WITH MANUFACTURER CALIBRATED SENSORS IN THE CERTIFICATE(S) OF INSTALLATION BINDER.

iv. CORRECT LABELING OF ALL CIRCUITS WITH CONNECTED EQUIPMENT.

c. COMPLETE THE CERTIFICATE(S) OF ACCEPTANCE PER THE CONTRACT DOCUMENTS.

i. THE COMPANY INSTALLING THE LIGHTING SYSTEMS MUST BE AN AUTHORIZED LIGHTING CONTROLS ACCEPTANCE TEST EMPLOYER CERTIFIED BY A LIGHTING CONTROLS ACCEPTANCE TEST TECHNICIAN CERTIFICATION PROVIDER OR INCLUDE IN THEIR BID THE COST OF RETAINING AND OVERSEEING A CONTRACTOR WHO IS AN AUTHORIZED LIGHTING CONTROLS ACCEPTANCE TEST EMPLOYER TO COMPLETE THE ACCEPTANCE TESTING.

ii. ALL REQUIRED ACCEPTANCE TESTING MUST BE COMPLETED BY A LIGHTING CONTROLS ACCEPTANCE TEST TECHNICIAN EMPLOYED BY THE LIGHTING CONTROLS ACCEPTANCE TEST EMPLOYER.

iii. RETAIN CERTIFICATE(S) OF ACCEPTANCE IN A 3-RING BINDER IN AN ORGANIZED FASHION. BINDER IS TO REMAIN ON THE JOB SITE

iv. UPLOAD ALL CERTIFICATE(S) OF ACCEPTANCE TO THE CALIFORNIA TITLE 24 CERTIFICATES OF ACCEPTANCE DATABASE, IF, AT THE TIME OF PROJECT COMPLETION, THE DATABASE IS AVAILABLE TO THE PUBLIC.

d. SUCCESSFUL COMPLETION OF THE REQUIRED ACCEPTANCE TESTS IS THE RESPONSIBILITY OF THE INSTALLING CONTRACTOR. ANY COSTS ASSOCIATED WITH MODIFICATIONS NECESSARY TO OBTAIN COMPLIANCE AND RE-TESTING OF SYSTEMS SHALL BE INCLUDED IN THE BASE BID OF THIS PROJECT.

DESIGN WEST ENGINEERING
MECHANICAL, ELECTRICAL, ENERGY CONSULTANTS
275 W. Hospitality Lane, Suite #100
San Bernardino, CA 92408
Phone: 909-890-3700
Fax: 909-890-3770

ISSUE DATE:

DATE | BY | ISSUE FOR

REVISION:

NUM. | DATE | BY | REVISION FOR

CONSULTANT

PROJECT TITLE

PROJECT FOR:
PARK WEST APARTMENTS
LINCOLN BLVD AT LA TUERA BLVD
LOS ANGELES, CA. 90045

STAMP

SHEET TITLE

ELECTRICAL SPECIFICATIONS

DESIGNED BY MK
DRAWN BY MK
CHECKED BY KM
DATE
SCALE AS NOTED
JOB NO.

SHEET NO.
E-2.1

Figure B-2: Los Angeles Department of Building and Safety Application for Building Permit and Certificate of Occupancy

9400 S La Tijera Blvd

19044 - 10000 - 15652

k X19LA22989 Printed: 12/20/19 10:23 AM

e:

LA DBS

DEPARTMENT OF BUILDING AND SAFETY

LA Department of Bui Xdä.ng and Safety
LA 104172449 12/20/2019 10:23:22 AM

Htg/REY PMT cota	490. 00
DEV CENTER SURCH	*2. 70
SYSTEMS DEVT	
FEE $5.40	
HTG/REF PMT COb4M	$0. 00
HTG/B..DF PMT cow:	0.00
sub Total:	$98. 10

Permit # : 190441000015652
Reoe±pt # ; 0104132547

Safety Issued On: 12/20/2019

Last Status: Issued

Status Date: 12/20/2019

GO IL 60680

(714)256-2136

5, PPLICATION COMMENTS. EW Receipt Section
Structural plan check is required Application Label: CAPITAL ONE VISA when supported by a building and FD861229DD943547 weight of the old one. LAMC Sec TVR: 0080008000
AID: A0000000031010

f.)ESCRIPTION OF WORK
INSTALL 2 EXHAUST FANS IN OARAGE

COUNCW PISTRJCT: 1 I

9. PPLICATION PROCESSING INFORMATION -Plan Check
By:
OK for Cashier: Nicole Ltface

Signature: Date: 12/20/2019

NOTICE,
The work included in this permit shall not be construed as establishing the legal number of dwelling units or guest rooms, That number is established by a Building Permit or a Certificate of Occupancy. In the event that any box (i.e. I- 10) is filled to its capacity, it is possible that additional information has been captured electronically and could not be printed due to space restrictions. Nevertheless, the information printed exceeds that required by Section 19825 of the Health and Safety Code ofthe State of California.

Permit # : Receipt # :

92821

CLASS LICENSE #	PHONE
C20 967408	(714)256-2136

9400 S La Tijera Blvd

For inspection requests, call toll-free (888) LA4BUILD (524-2845), or request inspections via www.ladbs.org. To speak to a Call Center agent, call 311. Outside LA County, call (213) 473-3231.

Reference No: 14106

tshier's Use Only W/O 94415652

HVAC

Apartment

Express Permit

No Plan Check

1. PROPERTY OWNER

EQR BETHANY VILLAGE VIS'

2. APPLICANT INFQRMATION (Relationship: Conti

WILLIAM BEESON -

3. TENANT INFORMATIQN

4. CONTRACTOR, ARCHITECT & ENGR

(C) ENETECH INCORP(

HVAC

X19LA22989

HTG/REF PMT cond	$90.00
DEV SERV CENTER SURCH	$2.70
SYSTEMS DEVT FEE	$5.40
HTG/REE' PMT co»a.f	$0.00
HCG/REF co»n'l	$0.00
Sub Total:	$98.10

LA ESTE 104172449 12/20/2019 10:23:22 AM

190441000015652

0104132547

P190441000015652IN

19044 - 10000 - 15652

LA DBS

DEPARTMENT OF BUILDING AND SAFETY

:k #: X19LA22989 Printed: 12/20/19 10:23 AM

de:

IAA Department of Building and Safety

LA ESTE 104172449 12/20/2019 10:23:22 AM

Safety	Issued On:	12/20/2019	
	Last Status:	Issued	
	Status Date:	12/20/2019	

HTG/RE PMT COMM $90. 00 DEV $2. 70

SYSTEMS DEVO

$5. 40

HTG/REF PMT

$0. 00

HTG/R.EF PMT coua $0. 00

)AGO IL 60680

(714)256-2136

Sub Total : $98.10

Permit # ; 190441000015652

Receipt # ; 0104132547

9400 S La Tijera Blvd

19044 - 10000 - 15652

Permit # : Receipt # :

9400 S La Tijera Blvd

92821 CLASS LICENSE # PHONE

C20 967408 (714)256-2136

Reference No: 14106

EMVReaeipt Section

' Cashier's Use Only W/O 94415652

Application Label: CAPITAL ONE VISA TC: FD861229DD943547 'rva: 0080008000
AID; A0000000031010

HVAC
Apartment
Express Permit
No Plan Check

1. PROPPRTY OWNER

EQR BETHANY VILLAGE VI APPLICANT.

WEQRMATION (Relationship:

WILLIAM BEESON -

3. TENANT INFORMATION

6. DESCRIPTION OF WORK

INSTALL 2 EXHAUST FANS IN GARAGE

E KLIST ITE

PISTRICT: I I

(C) ENETECH INCO

.PPLICATIONPROCESSING INFORMATION -Plan Check

By:

OK for Cashier: Nicole L•aface

Signature: Date: 12/20/2019

X19LA22989

5. APPLICATION COMMENTS

Structural plan check is requi when supported by a building weight ofthe old one-1AMC

NOTICE,

The work included in this permit shall not be construed as establishing the legal number of dwelling units or guest rooms. That number is established by a Building Permit or a Certificate of Occupancy. In the event that any box (i.e. 1-10) is filled to its capacity, it is possible that additional information has been captured electronically and could not be printed due to space restrictions. Nevertheless, the information printed exceeds that required by Section 19825 of the Health and Safety Code ofthe State of California.

For inspection requests, call toll-free (888) LA4BUILD (524-2845), or request inspections via www.ladbs.org. To speak to a Call Center agent, call 311. Outside LA County, call (213) 473-3231.

72449 12/20/2019 10:23:22AM HTG/REF PMT COMM $90.00 DEV SERV CENTER SURCH $2.70 SYSTEMS DEVT FEE HTG/REF PMT COMM $5.40
HTG/REF PM'E COMM $0.00
$0.00

Sub Total :

$98.10

P190441000015652IN

190441000015652

0104132547

Permit #:

Plan 4: X19LA09099

Event Code;

19041 - 10000 - 19552

Printed: 05/23/19 09:30 AM

Electrical
Apartment
Express Permit
o Plan Check

City of Los Angeles Department of Building and Spfety

APPLICATION FOR ELECTRICAL

PLAN CHECK AND INSPECTION

Issued On: 05/23/2019

Last Status: Issued

Status Date: 05/23/2019

9400 S La Tijera Blvd
19044 - 10000 - 15652

Permit # : Receipt # :

9400 S La Tijera Blvd

PROPERTY O PR

F,QR BETHANY VILLAGE VISTAS INC O PO BOX 87407 CHICAGO IL 60680

APPLICANT, NEQRMATEON (Relationship: Contractor}

ABDULLAH AHMED -(951)768-0719

TENANT INFORMATION

CONTRACTOR,ARCHITZCT & ENGINEER NAME	ADDRESS		CLASS	LICENSE #	PHONE #
(C) ENETECH INCORPORATED 92821	420 W LAMBER'F RD (K,	BREA, CA 92821	B	967408	(951)768-0719

S. PPLICATION CC COMMENTS

For Cashier's Use Only

W/O 94119552

6. DESCRIPTION OF WORK

ELECTRICAL, FOR PUMPS ADVANCED DOMESTIC WATER HEATING SYSTEM

7. CHECKLIST ITEMS:

8. COUNCIL DISTRICT:

9. APPLICATION PROCESSING INFORMATION

Plan Check By:

OK for Cashier: Monique Perez

Signature: Date: 05/23/2019

NOTICE•

nte work included in this permit shall not be construed as establishing the legal number of dwelling units or guest rooms. That number is established by a Building Permit or a Certificate of Occupancy. In the event that any box (i.e. 1-10) is filled to its capacity. it is possible that additional information has becn captured electronically and could not be printed due to space restrictions. Nevertheless, the information printed exceeds that requited by Section [9825 of_ the Hcalth and Safety Code of the State of California,

For inspection requests, cal 4BUILD (524-2845), request inspections via www.ladbs.org. To k toa Call Cente a nt, call 3". Outside LA County catt (213) 413-3231.

0 S La Tijera Blvd
41 - 10000 - 19552

T6

AM
$196.00
$6.57
$13.14
$23.00

LA HENR 106123619 5/23/2019
ELECTRICAL PERMIT-COMM
DEV SERV CENTER SURCH

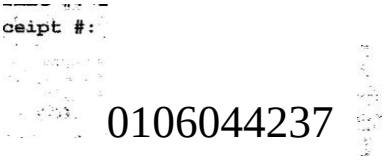
SYSTm4S DEVT FEE ..
ELECTRICAL PERMI'1'-COßßf ELECTRICAL PERMIT-CQN

* P 1 9 0 4 1 I IIIIi IIII IIII IIiII IIIII IIIII Il IIIII IIII IIIII IIIII III II II IIII

190411000019552Sub Total : $238.71

Permit # : Receipt # :

9400 S La Tijera Blvd



Permit # : Receipt # :

9400 S La Tijera Blvd

19016 10000 - 11459

LA DBS

:k #:

le:

Bldg-Alter/Repair GREEN .NONE Apartment
Plan Check at Counter Pian Check

B19LA07875 Printed: 05/10/19 09:27 AM

DEPARTMENT OF BUILDING AND SAFETY

Saf Safety Issued on: 05/10/2019

RM1f Last Status: Issued

NCY Status Date: 05/10/2019

TRACI
TR 19445

Building and Safety
LA 104156122

44/87 096B161 831

2. ASSESSOR PARCEL #
4119 - 039 - 004

LA Department: of

5/10/2019 : 27 :AM

BUILDING

PERMIT COMM *920.00
BUI'LDINå PLAN CHECK $0.00
EIRESIDENTIAL $42.00 DEV SERV CENTER SURCH
$28. 86 . sys 'rmag DEVT E $57.72 CITY
LINKAGE FEE PLANNING SURCH 55 .20
MISCELLANEOUS $10. oo
Pl..aANNING GEN PLAN MAINT SURCH $64 . 40 CA BLDG STD
Sub Total: $1,1

Permit #: 190161000011459
Building Card #: 2019LA24574
Receipt #: 0104038465

AID: A0000000041010

Airport Hazard Area i 50' Height Limit
Abi Airpoit Hazard Area - Transitional Surface
Area Planning Commiqgion West Los Ang
LADBS Blanch Office WLA
Council District - Il

District Map - 096B
Energy Zone - 6
Fire District 2
.Hiflside Grading Area - YES
Near Source Zone Distance - 6.3

ZONE(S): [QIC4-l-CDO

4. DOCUMENTS
ZI - ZI-2374 LOS ANGELES STATE
ZI - ZI-2404 Loyola Village
ZI - ZI-2452 Transit Priority Area in tl
ZA - ZA-1987-1490-SM

ORD - ORD-180797
CPC. - CPC-i956-70S8
CPC • CPC.1984-226-SP
CPC - CPC-1986-292-ZC

5. CHECKLIST ITEMS
Special Inspect - Anchor Bolts
Special Inspect - Concrete>2.5ksi
Special Inspect - Epoxy Bolts

r's Use Only W/O #: 91611459

6. PROPERTY OWNER, TENANT, APPLICAN
Owner(s):
EQR BETHANY VILLAGE VISTAS
0 PO BOX 87407, CHICAGO IL 6068
Tenant:

COt'NISSION SURCHARGE $6. 00 BUILDING PLAN CHECK 90.00

gub Total: $1,184.18

Applicant: (Relationship: Other)
WILLIAM B. - ENETECH
920 W. LAMBERT RD. SUITE J, BREA, CA 92821 -- (714) 255-2939

Struck

Struck

7. EXISTING USE
(05) Apartment

PROPOSED USE

Receipt #

9400 S La Tijera Blvd

Permit 190161000011459.

8. DESCRIPTION OF WORK
New concrete pad and anchorages for (N) solar water heating and GEHP storage tanks on ground level.

9. # Bldgs on Site & Use:

go. PROCESSING

BLDG. pc By: Nguyen DAS pc By: OK ti)r Cashier: Michael Lopez Coord. OK;

Signature: Date: 05/10/2019

11. PROJECT VALUATION Final Fee Period

Permit Valuation: $150,000 PC Valuation:

Sewer Cap ID: Total Bond(s). Due:

12. ATTACHMENTS

Plot Plan

For inspection requests. call toil-free (888) LA4BUILD (524-2845), or request inspections via www.ladbs.org. To speak to a Call Center agent, cau 311. Oatside LA County, (2*3) 473-3231.

LA ESTE 104156122 5/10/2019 9:27:38 AM

BUILDING PERMIT cowna $920.00.
BUILDING PIAN CEECK
El RESIDENTIAL . $42 , 00
DEV SERV CENTER SURCH $28,86 . SYSTEMS
DEVE FEE $57.72 CITY PLANNING SURCH $55.20.
MISCELLANEOUS
PLANNING . . . . . GEN PLAN MAINE' SURCH $64.40 ca BLDG s[r]iD COBNISSION SURCHARGE $6, 00
BUILDING CHECK $0.00 LINKAGE ——— FEE $0.00

Tot-al: $1,184.18

* P 1 9 0 1 6 1 0 0 0 0 1 1 4 5 9 E N *

Permit #: 190161000011459
Building Card #: 2019
Receipt #: 0104038465 2019LA24574

Application Plan Che

ckB1911.A07887SEv

e d
n e
t :
19016 10000 11459
o Printed: 04/19/19 10:18 AM

.Bldg.A1ter/Repair GREEN NONE Apartment
Ptan Check at Counter Plan Check

City of Los Angcies• Depattntentof Building and Safety

APPLICATION FOR BUILDING PERMIT AND CERTIFICATE OF OCCUPANCY

Last Status: PC in Progrßs
Status Date: 04/19/2019

	bOT(si				4119 039 — 004
TR 19445	10	3	M B 628-84/87	096B161 01	

Airport Hazard Area 150' Elcight Limit Above Elevation 1.26
Airport Hazard Area - fransitional Surface Area
Ätea Planning Cotnmission - West Los Angeles
LADBS Branch Office - WI,A Coundil
District-

Community Design Overlay District - Loyola Village
Certified Neighborhood Council Westchester/Ptaya dc! Rey
Community Noise Equiv, Level - 65 db < dB
Community Plan Area - Westchester Playa def Rey
Census Tract 2766.04

096B 16 t
Energy Zone -6
Fire District 2
Hillside Grading Area - 'VES
Near Source Zonc Distance 6.3

IQ]C4-l-CDO

Zi-2374 LOS ANGELES STATE ZA - z.Aa9S8-315%V
ENTER 42404 Loyota Village - ZA-2000-2494-CU
Area in Cit ORD^AIOt823
- ZA-i987- t490-SM ORD ORO-I t 006

ORD - ORD. 129279
ORD - ORD- 161650
ORD - 00-168999
ORD ORD.J759S1-SA500

ORD ORD. t*0797
CPC - CPC-19S6-fi058
CPC 984-226-SP
CPC CPC-1986-292-ZC

For Cashier's Use Only W/0 4: 91611459.

EQR BETHANY VILLAGE VSTAS INC O
PO BOX CHICAGO IL 60680 Tenant:

App%canc (Relationship: Other)
WILLIAM
920 W. LAMBERTRD, SUITE J, BREA, CA 92821 (7M) 235-2939

SOLAR WATER HEATING & GEMP STORAGE TANK & GEHPANCHOR& CONCRETE.
CONCRETE INSPECTION.

?.ROCESSING

BLDG. pc By: DAS PC. By:
OK Cashier: Coord. OK:

Signature: Date:

it. Submittal ftePeriod M50.000

Sewer Cap ID: Total Bond(s) Due:

IA ESTE 104154804 4/19/2019
BUILDING PLAN CHECK $828.00
DEV SERV CENTER $24.84
SURCH SYSTEMS DEVT $49.68
PEE ctTY PLANNING $49.68
SURCH MISCELLANEOtJS $10.00
PLANNING MAINT St.JRCX

9400 S La Tijera Blvd

Fnrinspacüon requests, can (888) LA4BiJILD (524-2845). Outside LA County, cali (213) 482-0000 or request inspections via To gpeak to a Call Center agent, can 311. Outside LA County, (213) *73-3231.

$57 96

Sub Total ;

Permit 190161000011459

6 1 0 0 -O 0104029377

1 9 G

@DBS Pennit Y: k 19042 10000 02461

Plan Check X19LA01839 Printed: 01/3 i/19 09:16 AM

A

DEPARTMENT OF BUILDING AND SAFETY Event Code:

.A DeparExnent of Bu±lding and DAVI 307033750 1/31/2019	$55.00	Angeles Department of Building and Safety	Issued On: 01131/2019
	$1.65		
'LUbBJNGPbRMIT,„CüMM	$3.30	PPLICÅTION FOR PLUMBING	1st Status: Issued
)EV SERV CENTER SURCH ;YSTEMS DEVI[S] 'LUMBINGPERMIT-COEN	$0, 00	AN CHECK AND INSPECTION	Date: 01/31/2019
	95	87407 CHICAGO IL 60680	

gub (951)768-0719

190421000002461

(C) ENETECHINCORPORATED 420 W LAMBERT RD BREA, CA 92821 C33 967408 (950768-0719

SOLAR WATER HEATING SYSTEM

Il

Plan Check By:
OK for Cashier: Trevia Hodge

Signature: Date: 01/31/2019

The work included in this permit Shau not be construed as establishing the. legal number of dwelling units or guest rooms, That number is established by a Building Permit Of a Certificate ofOeeupancy. fntheeventthat any box (i.e. {"10) -is lilied to itscgpaeitY* itis possible {hat additional information has been captured electronically md could not be printed due s»aee Nevertheless, the. information printed-exceeds that rcquircd by Section 19825 of the Code Of the State ofCalifornia.

For inspeeåon requestss cali ton-free (213) 482-0000 or requestius ns Via OuGideLACounty. 4BULLD (514-2845). Outside LA COImty, b org, To speak to Catt Center agent,

For Cashier's Use Only

W/O 94202461

r..A bÄVt 107033750 1/31/2019

DEV SERV CENTER SURCE	$55.00
DEV'? FEE	65
sub	$S9,95

190421000002461

Receipt 0107996927

10/15/18 Supervisor Sameh Williams 213 482-6524

9400 S La Tijera Blvd

Application #: 18042 - 10000 - 25924

Plan Check #: M18LA06406

Printed: 10/25/18 03:33 PM

Event Code:

Plumbing GREEN -MANDATORY | City of Los Angeles - Department of Building and Safety

Apartment

APPLICATION FOR PLUMBING | Last Status: Submitted

Regular Plan Check

Plan Check | PLAN CHECK AND INSPECTION | StatusDate•. 10/25/2018

L PROPERTY

EQR BETHANY VILLAGE VISTAS INC OPO BOX 87407 CHICAGO IL 60680

2. APPLICANT INFORMATION (Relationship: Engineer)

ABDULLAH YACOB AHMED OCCIDEh 4862 GRAPHITE CREEK RD JURUPA VALLEY, CA 91752 (951)768-0719

3. TENANT INFORMATION

M18LA06406FO

4. CONTRACTOR, ARCHITECT & ENGINEER NAME | LICENSE # | PHONE #

(E) , D 4862 GRAPHITE CREEK RD, JURUPA VALLEY, CA 91752 M2354

5. APPLICATION COMMENTS

For Cashier's Use Only W/O 84225924

6. DESCRIPTION OF WORK

ADDITION OF SUPPLEMTAL WATER HEATING EQUIPMENT (EVACUATED TUBE SOLAR SYS1EM AND GAS ENGINE HEAT PUMP) ON EXISTING DOMESTIC HOT WATER SYSTEM OF AN APPARTMENT BUILDING.

Plumbing

1. CHECKLIST ITEMS:

COUNCW 11

9. APPLICATION PROCESSING INFORMATION

man Check By:

OK for Cashier:

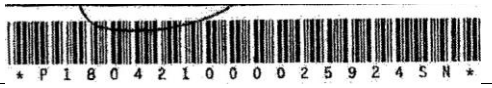
Signature: Date:

9400 S La Tijera Blvd
18042 - 10000 - 25924

NOTICE: work included in this permit shall not be construed as establishing the legai number of dwelling units or guest rooms. That number is established by a Building Permit or a Certificate ofOccupancy. In thc event.that any box (i.e. t- 10) is •filled to its eapaeity. it is possible that additional information has been captured electronically and conid not be printed due to space restrictions. Nevertheless, the infonnation printed exoeedS that required by Section 19825 of the Healdt and Safety Code ofthe State of California.

LA ESTE 104144314 10/25/2018 3:33:06 PM

MECHANICAL pc $99* 00



For inspection reqüests, call toll- (524-2845). Outside LA County, call (213) 482-0000 ortequostins tions via www. adbs rg. Tospeaktoa Call Center agent; 311. OutsideLACo . (213>473-323.1.

DEV SERV CENTER SURCH	$4.46
SYSTEMS bEVT	$8.91
BECEANICAI.$ PC	$49.50
Sub Total :	$161.87

Permit # : 180421000025924

Receipt # : 0104960576

INSPECTION RECORD

Your feedback is important, please visit our website to convtete customer survey at www.iadbs.oqlLADBSWeblcustométsurvey.isf

If you would like to provide additional' feedback' need clarification, or have any question regarding plan check or inspectiori matters, please Gall our Customer Hotline at (213) 482-0056

2019LA24574

5/10/2019

LA ESTE 0104038465

19016-10000-11459 F

PERMIT NO : 19016-10000-11459

ADDRESS : 9400 S LA TIJERA BLVD

WORK DESC : NEW CONCRETE PAD AND ANCHORAGES FOR (N) SOLAR STORAGE TANKS ON GROUND LEVEL.

INSPECTION RECORDS AND. PLANS MUST BE AVAILABLE DURING INSPECTION

DATEINSPECTOR initial

Grading

Toe or Bottom

Soils Report Approved

DO NOT PLACE FILL UNTIL ABOVE IS SIGNED

Backfill

Fill

Excavation

Drainage Devices

Rough Grading

Approved Compaction Repott

Footin Excavation

Forms

Reinforcing Steel

OK to place concrete

Electrical

Plumbing

Plumbing N'Ethane

Gas Piping

Heating & Refrigeration

Fire Sprinklers

Disabted Access

Methane

OK to Place Floor

DO NOT PLACE FLOOR UNTIL ABOVE IS SIGNED

Green Code

Electrical

Plumbing

Fire Sprinkler

Heating & Refrigeration Roof

Sheathing

Disabled Access

Framing

Insulation

Suspended Ceiling OK to Cover

FOR INSPECTION REQUESTS, PLEASE CALL 3-1-1 OR OUTSIDE CITY OF LOS ANGELES 888-LA4-BUtLD (888)524-2845 or

B-B Card rev. 411811

TYPE	DATE	INSPECTOR
Exterior Lathing		
Interior Lathing		
Drywall		
DO NOT COVER UNTIL ABOVE ts SIGNED		
Electrical Underground		
Gas		
H6ating & Refrigeration		
Sewer		
Disabled Access		
Excavation		
Reinforcing Steel		
Bonding		
Pre-Gunite		
Deck		
Enclosure/Fence		
PooVSpa Cover		
DO NOT FILL POOL UNTIL ABOVE IS SIGNED		
Grading		
Etectricai		
Plumbing		
Gas Test		
Gas		
Heating & Refrigeration		
Pressure Vessels		
Elevator		
Fire Sprinkler		
Disabled Access		
Green Building		
I-AFD (Title 19 only)		
LAFD Fire Life safety		
Pool Final		
AQM'sign-off provided		
Public Works		
Building		

Certificate of Occupancy Required YES NO

SUPPLEMENTAL NOTES:

12/6/19 - Concrete work complete - need plumbing + electrical prior to final - OK

NEED HVAC PERMIT
NEED GAS SHUT OFF VALVE

IMPORTANT NOTICE

Prior to the start of any construction work adjacent to any public way, pedestrian protection shall be provided. (Sec. 91.3303 L.A.M.C.).

* Inspections may be requested Monday through Friday by calling 1-888-LA4-BUILD, When requesting an inspection, the following information is required: (1) The job address, (2) Type of inspection, (3) use of Building, (4) Permit number, (5) Phone number of a contact person should the department need to reach someone.
* Inspection requests received before 4:00 p.m. Monday through Friday (excluding holidays) witl normally be made the next business day, Requests received after 4:00 p.m. will be made following the next business day. The Automated Inspection Call Back System (AICBS) will phone the contact person to confirm the inspection.

Permit fees provide for a limited number of inspections. A reinspection fee may be assessed when the work for which an inspection was requested is not complete, when the inspection record or plans are not availabfe, or when here is failure to provide site access to department staff.

No person shall perform any construction or repair work between the hours of 9:00 p.m. (6:00 p.m. grading) and 7:00 a.m. the following day which results in loud noises to the disturbance of persons occupying sleeping quarters in any dwelling, hotel, motel, apartment, or other place of residence(Sec. 41.40 L.A.M.C.).

No person, other than an individual homeowner engaged in the repair or construction of his/her single-family dwelling, shall perform any construction or repair work of any kind upon any building or structure located on land developed with residential buildings or perform work within 500 feet of land so occupied, before 8:00 a.m. or after 6:00 p.m. on any Saturday or at any time on Sunday (Sec. 41.40 L.A.M.C.).

Dust control measures to prevent dust from being blown or deposited over or upon any private property in any residential area must be implemented during any excavation or earth-moving phase of construction, sand blasting, or demolition.

A separate permit from the State of California Division of Industrial Safety is required prior to starting certain work involving substantial risk to workers such as: construction or demolition exceeding 3 stories or 36 feet in height, or excavations or trenches over 5 feet in depth involving entry by workers.

Building permits are valid for Wvo years or expire on the 180th day from the date of issuance if the work permitted has not commenced. The department reserves the right to expire any permit where work has been suspended for a period of 180 days or more.

* Inspection services will not be provided when there is an unleashed dog on the premises.

BUILDING AND SAFETY PERMIT AND PLAN CHECK OFFICE LOCATIONS

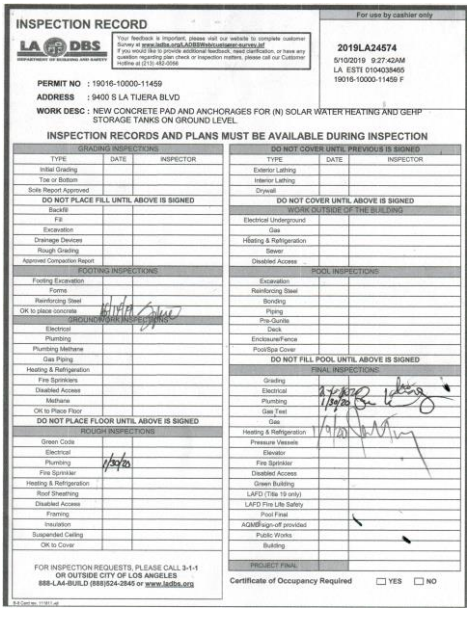
Downtown Los Angeles
201 N. Figueroa st., 4th Fl. Los Angeles, CA 90012 Van Nuys West Los Angeles

San Pedro
638 S. Beacon St., 2nd Fl.
San Pedro, CA 90731

South Los Angeles
8475 S. Vermont Aver, 2nd Fl.
Los Angeles, CA 90044

6262 Van Nuys Blvd., 2nd Fl.
Van Nuys, CA 91401

1828 Sawtelle Blvd., 2nd Fl.
Los Angeles, CA 90025



INSPECTION RECORD

For use by cashier only

LA DBS DEPARTMENT OF BUILDING AND SAFETY

Your feedback is important, please visit our website to complete customer Survey at www.ladbs.org/LADBSWeb/customer-survey.jsf If you would like to speak with someone regarding this application, or have any question regarding plan check or inspection matters, please call our Customer Hotline at (213) 482-0066

2019LA24574
5/10/2019 9:27:42AM
LA ESTI 0104033465
19015-10000-11459 F

PERMIT NO : 19016-10000-11459
ADDRESS : 9400 S LA TIJERA BLVD
WORK DESC : NEW CONCRETE PAD AND ANCHORAGES FOR (N) SOLAR WATER HEATING AND GEHP STORAGE TANKS ON GROUND LEVEL.

INSPECTION RECORDS AND PLANS MUST BE AVAILABLE DURING INSPECTION

GRADING INSPECTIONS		
TYPE	DATE	INSPECTOR
Initial Grading		
Toe or Bottom		
Soils Report Approved		
DO NOT PLACE FILL UNTIL ABOVE IS SIGNED		
Backfill		
Fill		
Excavation		
Drainage Devices		
Rough Grading		
Approved Compaction Report		
FOOTING INSPECTIONS		
Footing Excavation		
Forms		
Reinforcing Steel		
OK to place concrete		
GROUNDWORK INSPECTIONS		
Electrical		
Plumbing		
Plumbing Methane		
Gas Piping		
Heating & Refrigeration		
Fire Sprinklers		
Disabled Access		
Methane		
OK to Place Floor		
DO NOT PLACE FLOOR UNTIL ABOVE IS SIGNED		
ROUGH INSPECTIONS		
Green Code		
Electrical		
Plumbing	1/30/20	
Fire Sprinkler		
Heating & Refrigeration		
Roof Sheathing		
Disabled Access		
Framing		
Insulation		
Suspended Ceiling		
OK to Cover		

FOR INSPECTION REQUESTS, PLEASE CALL 3-1-1
OR OUTSIDE CITY OF LOS ANGELES
888-LA4-BUILD (888)524-2845 or www.ladbs.org

DO NOT COVER UNTIL PREVIOUS IS SIGNED		
TYPE	DATE	INSPECTOR
Exterior Lathing		
Interior Lathing		
Drywall		
DO NOT COVER UNTIL ABOVE IS SIGNED		
WORK OUTSIDE OF THE BUILDING		
Electrical Underground		
Gas		
Heating & Refrigeration		
Sewer		
Disabled Access		
POOL INSPECTIONS		
Excavation		
Reinforcing Steel		
Bonding		
Piping		
Pre-Gunite		
Deck		
Enclosure/Fence		
Pool/Spa Cover		
DO NOT FILL POOL UNTIL ABOVE IS SIGNED		
FINAL INSPECTIONS		
Grading		
Electrical		
Plumbing		
Gas Test		
Gas		
Heating & Refrigeration		
Pressure Vessels		
Elevator		
Fire Sprinkler		
Disabled Access		
Green Building		
LAFD (Title 19 only)		
LAFD Fire Life Safety		
Pool Final		
AQMD sign-off provided		
Public Works		
Building		
PROJECT FINAL		

Certificate of Occupancy Required ☐ YES ☐ NO

CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

ENERGY RESEARCH AND DEVELOPMENT DIVISION

Appendix C: Measurement and Verification (M&V) Report

June 2024 | CEC-500-2024-054-AP

APPENDIX C:
Measurement and Verification (M&V) Report

Overall Measurement & Verification Approach

The goal of this measurement and verification (M&V) project is to assess the overall energy savings potential of the retrofitted equipment, controls hardware, and controls strategies as compared to the baseline domestic hot water (DHW) system at the test site.

The existing DHW system that was retrofitted serves 148 residential units across four stories of the building and is located on the roof. It consists of two central gas-fired boilers (one of which is redundant) with an integral pump each, a storage tank, and two return water pumps in series in the recirculation loop. The make-up water feeds into the storage tank. The boilers are controlled by one aquastat set to approximately 130 degrees Fahrenheit (°F) (54 degrees Celsius [°C]) whose thermowell is mounted in the bottom half of the storage tank. One boiler and at least one return water pump occasionally failed or were disabled intentionally by the facility staff.

The retrofit equipment consists of a gas-engine heat pump (GEHP) plant located in the first-floor parking lot and a solar thermal system located on the roof. Both systems intercept and preheat the make-up water to the existing DHW system, and the existing system is otherwise left intact and not modified by the project team.

The gas into the existing boilers and new GEHP were measured by diaphragm gas meters with pulse output. Pump power for the new pumps was measured with three-phase power meters. Heat energy into and out of the existing storage tank and out of the GEHP was measured with British thermal unit (Btu) meters. Data was typically sampled at 1-second intervals and saved at 1-minute intervals.

The two boiler gas meters and the one Btu meter between the boilers and the existing storage tank were used to estimate the coefficient of performance (COP) of the pair of existing boilers at an hourly interval for time periods of consistent data. The GEHP gas meter and Btu meter were used to estimate the COP of the GEHP at hourly intervals for time periods of consistent data.

For each measurement period, gas usage was aggregated to daily intervals and scatter plotted versus daily National Oceanic and Atmospheric Administration (NOAA) weather station dry bulb temperature to search for linear correlation. Normalization for other factors such as occupancy was not conducted, and pump energy was not scatter plotted against any factors.

Correlation was not great for either period, but both gas versus dry bulb temperature trendline equation were nevertheless applied to California Climate Zone typical weather data. This yielded estimated annual energy usage for the baseline and retrofit periods as well as estimated annual savings.

Data Points

Data points are shown in Table C-1 below.

Data Sampling, Recording, and Collection Intervals

Data point information is also shown in Table C-2 below.

Table C-1: Data Points, Intervals, Resolution, and Accuracy

Data Point	Qty.	Units	Recording Interval	Resolution
Boiler Gas Usage	2	ft^3	1 min.	1 pulse = 1 ft^3
GEHP Gas Usage	1	kBtu/hr	1 min.	1 Btu/hr
Boiler Pump Power	2	kW (via kVA)	1 min.	~0.01 kW
GEHP Pump Power	2	kW	1 min.	0.001 kW
GEHP Other Power	1	kW	1 min.	0.001 kW
Solar Thermal Pump Power	1	kW	1 min.	0.001 kW
Boiler Supply Water Temp.	1	°F	1 min.	0.018°F
Boiler Return Water Temp.	1	°F	1 min.	0.018°F
Hot Water Supply Temp.	2	°F	1 min.	0.018°F
Hot Water Return Temp.	1	°F	1 min.	0.018°F
Make-up Cold & Pre-heated Water Temp.	2	°F	1 min.	0.018°F
GEHP Outlet Temp.	1	°F	1 min.	0.01°F
GEHP Inlet Temp.	1	°F	1 min.	0.01°F
Outside Air Dry Bulb Temperature	1	°C	~ 1hr.	0.1°C
Boiler Water Flow Rate	1	gpm	1 min.	0.001 gpm
Hot Water Return Flow Rate	1	gpm	1 min.	0.001 gpm
Hot Water Supply Flow Rate	1	gpm	1 min.	0.001 gpm
Make-up Water Flow Rate	1	gpm (via (2) gpm)	1 min.	0.001 gpm
GEHP Water Flow Rate	1	gpm	1 min.	0.01 gpm
Boiler Heat Rate	1	Btu/min	1 min.	0.001 Btu/min
Hot Water Return Heat Rate (against Hot Supply Temp.)	1	Btu/min	1 min.	0.001 Btu/min
Make-up Water Heat Rate (against Hot Supply Temp.)	1	Btu/min (via (2) gpm & (2) °F)	1 min.	0.001 Btu/min
GEHP Heat Rate	1	kBtu/hr	1 min.	1 Btu/hr

Source: NegaWatt Consulting

Instrumentation

M&V instrumentation is shown in Table C-2 below.

Table C-2: M&V Instrumentation

Make, Model, Name, URL	Specifications	Notes
MultiTech Cellular Modem MTR-LAT1. https://www.multitech.com/models/92507399LF.	LTE Cat 3 Router with Fallback, w/o Accessories (AT&T). Operating Temp.: -40°F (-40°C) to 176°F (80°C)	Purchased new in 2018.
T-Mobile Unlimited data plan for 2 years. http://www.egauge.net/eos/accessories/CR100MT.	Network Speed: 3G.	Purchased new in 2018.
RS-485 to Ethernet converter. http://www.egauge.net/eos/accessories/bf430.	Operating Temp.: -17°F (0°C) ~ 131°F (55°C).	Purchased new in 2018.
RS485-USB Converter. http://www.egauge.net/eos/accessories/usb485.	Operating Temp.: -34°F (-30°C) to 140°F (60°C).	Purchased new in 2018. Quantity: 2.
ControlByWeb X-420 Web-Enabled Data Acquisition. https://www.controlbyweb.com/x420/.	Digital Inputs Number of Inputs: 2 (configurable). Analog Inputs Number of Inputs: 4. Resolution: 16-bit, SAR. Temperature Sensors Maximum Number of Sensors: 16. Type: Dallas Semiconductor DS18B20. Temp. Range: -67°F to 257°F (-55°C to 125°C). Accuracy: ±32.9°F (0.5°C) (from -18°F [-10°C] to 185°F [85°C]).	Purchased new in 2018. Quantity: 2
ControlByWeb X-WR-1R12-1I-I WebRelay. https://www.controlbyweb.com/webrelay/partnumbers.html	Outputs Relays: 1. Current: 12A 240VAC, 30VDC. Inputs Digital: 1. Range: 4-26 VDC.	Purchased new in 2018.
Elster American Meter AC-800 with PulseMaster Pulse Output Module. https://mcsmeters.com/collections/diaphragm-gas-meters/products/american-meter-ac800-diaphragm-meter.	Capacity: 800 SCFH (22.7 m^3/h) (0.60 specific gravity gas) at 1/2-inch w.c. differential. Pulse Rate: 1 pulse/1 ft^3. Performance: Meets ANSI B109.2.	Purchased new in 2018. Quantity: 2.
Pulse output gas meter (make/model TBD)	TBD	Provided by GEHP manufacturer

Make, Model, Name, URL	Specifications	Notes
Onset Temperature (6') Sensor TMC6-HE. https://www.onsetcomp.com/products/sensors/tmc6-he.	Measurement range: -40°F (-40°C) to 212°F (100°C). Drift: <32°F (0.1°C) (<0.2°F [-17°C]) per year. Response time in air: 3 min. typical to 90% in air moving 1 m/sec (2.2 mph).	Purchased new in ~ 2017. Quantity: 2
Sierra Instruments Ultrasonic Liquid Flow Meter with Thermal Energy/Btu Capability, InnovaSonic®207i. http://www.sierrainstruments.com/products/207iprod.html	Performance Specifications Pipe Size: 2 to 236 inches (50 to 6000 mm). Accuracy: ± 0.5% of reading from 0.16 to 40 ft/s (0.05 to 12 m/s). Repeatability: ± 0.15% of reading >0.16 ft/s (0.05 m/s). Resolution: 0.01 ft/s (0.00025 m/s). Response Time: 150 m/s measuring cycle. Operating Specifications Flow Velocity Range Bi-directional flows: 0.16 to 40 ft/s (0.05 to 12 m/s). Note: 0.08 ft/s (0.025 m/s) is the default low flow cut-off. Temperature Ambient electronics: -4°F (-20°C) to 140°F (60°C). Clamp-on transducer: 14°F (-10°C) to 176°F (80°C). Clamp-On RTD Accuracy: ±0.12% at 32°F (0°C).	Purchased new in 2018. Quantity: 5 4.
Omega Flow Meter	--	Provided by GEHP manufacturer
Temperature sensors	--	Provided by GEHP manufacturer
eGauge Core Energy Meter. http://www.egauge.net/eos/energy-meters/EG4115.	Operating Temp.: -34°F (30°C) to 158°F (70°C). Power Draw: 12W max, 2W typical. Measurement Voltage: Up to 277 Vrms per line. 3 lines. Measurement Current: 15 sensor ports, 6900A max/ea. Accuracy: ANSI C12.2 – 0.5% Compliant.	Purchased new in 2018. Quantity: 2.

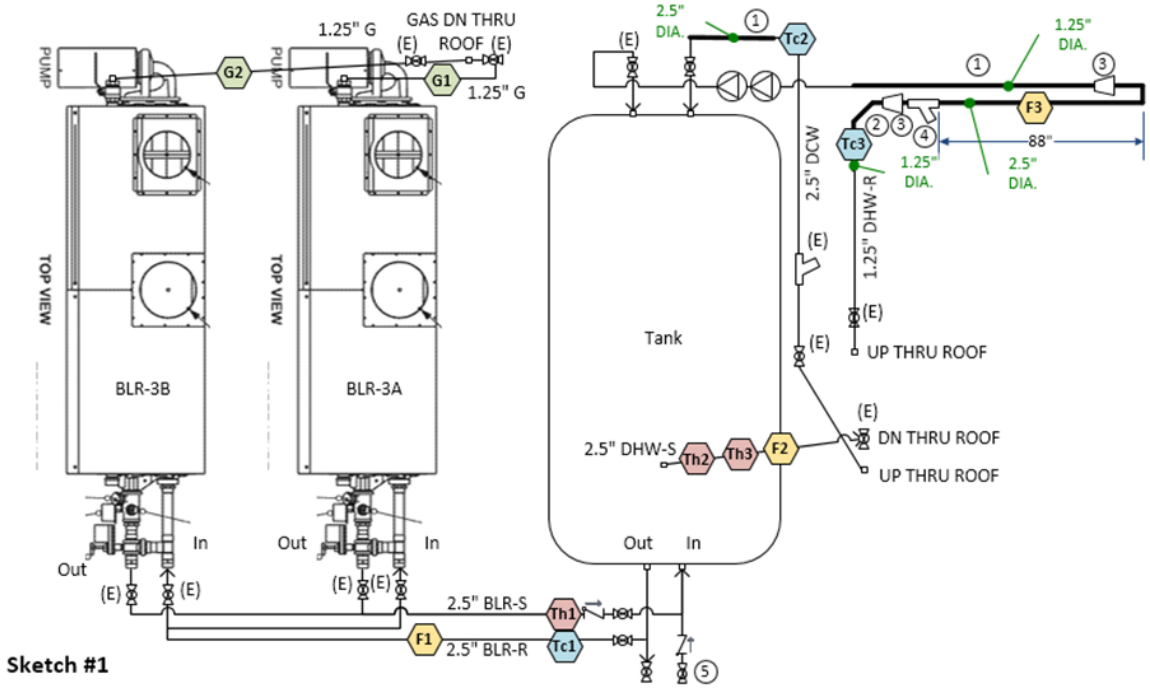
Make, Model, Name, URL	Specifications	Notes
	Register Count (data storage points): 64. Granularity (duration/avg): 1 hour/1 second, 1 year/1 minute, 10 years/15 minutes, Device Lifetime/1 Day. Data Communication: Modbus RTU, Modbus TCP, BACnet/IP, XML.	
Magnelab SCT-0400 Split-core AC Current Sensor, https://www.egauge.net/docs/sct_0400.pdf	Output: 0.333V at rated AC current. Accuracy: ±1%. Range: 10% to 130% of rated current. Frequency: 50Hz – 400Hz.	Purchased new in Fall 2013. Multiple sizes from 10 to 50 amps.
Extech 380976 1-phase/3-phase 1000 Amp True RMS Power Clamp-On Meter, http://www.extech.com/instruments/product.asp?catid=27&prodid=705	Function: Max Range/Resolution, Basic Accuracy. True Power (W): 600kW/10W, ±5%. Apparent Power(kVA): 600kVA/100VA, ±2%. Reactive Power (kVAR): 600kVAR/10VAR, ±5%. Phase Angle (f): -60 to +60° / 0.1°, ±6°. AC Current (Trms): 1000A/10mA, ±2%. µA Current (AC+DC) (Trms): 1000µA/10nA, ±1%. AC/DC Voltage (Trms): 600V/0.1mV, ±1%. Temperature (Type K): -58°F (-50°C), to 1000°F (538°C) / 0.1°F (-17°C), ±1%.	Calibrated on 10/11/2012. Used for spot checking only as needed.

Source: NegaWatt Consulting

Instrumentation Layout

Figure C-1 below shows the baseline instrumentation installation guidance diagram. The hexagons labeled "F" are flow meters, those with "T" are temperature sensors, and those with "G" are gas meters.

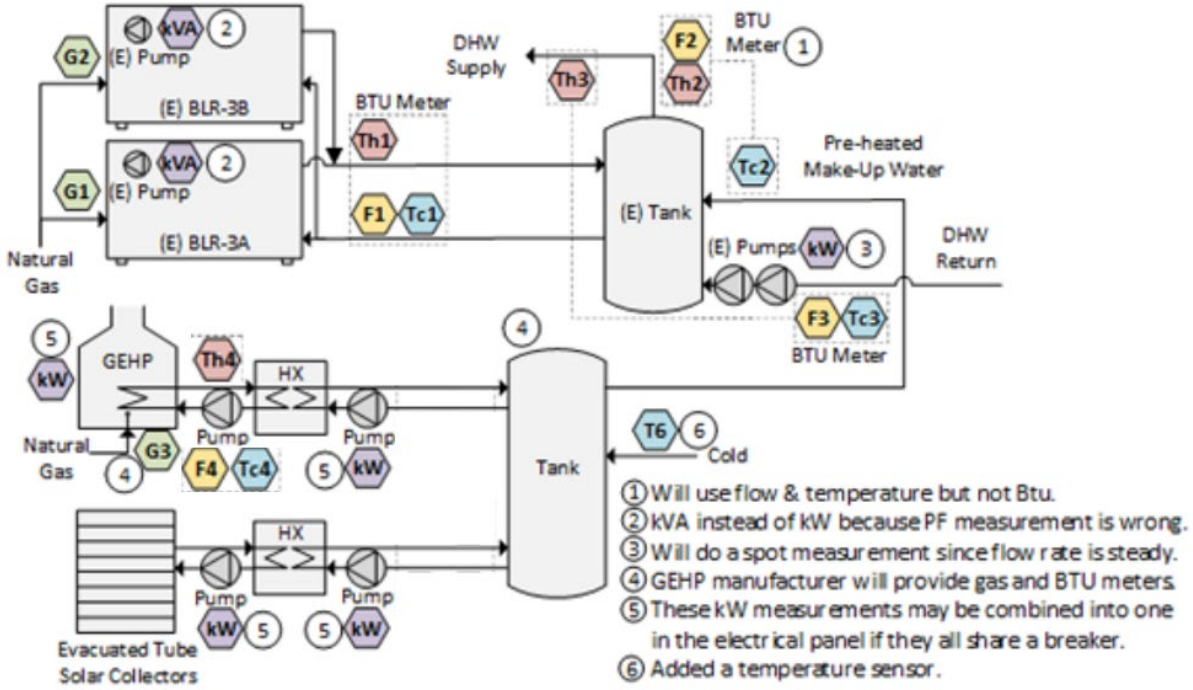
Figure C-1: Baseline M&V Instrumentation Installation Guidance Diagram



Source: NegaWatt Consulting

An instrumentation installation guidance diagram was not created for the retrofit equipment. However, Figure C-2 is a schematic M&V instrumentation diagram showing both the baseline and retrofit equipment.

Figure C-2: Baseline & Retrofit M&V Instrumentation Diagram



Source: NegaWatt Consulting

Data Analysis Procedures

Data analysis procedures are summarized in the following list:

1. Remotely download data from all sensors regularly and troubleshoot irregularities.
2. For the existing boilers in the baseline period and the GEHP in the retrofit period, aggregate the data to daily intervals and compare heat output to gas usage to calculate equipment efficiency or COP:
    a. Q_{out} / E_{in}
3. For the baseline and retrofit periods at the daily interval only, look for correlation between E_{in} and daily NOAA weather station dry bulb.
4. If correlation is high enough for E_{in} for both baseline and retrofit, calculate annual savings against each of the California climate zone weather files first aggregated to daily intervals. If only one correlation is high enough, then only calculate adjusted savings for the respective measurement period (i.e. baseline adjusted to retrofit conditions or vice versa).
5. Calculate cost savings using blended electricity and gas rates.
6. Identify and discuss system loss mechanisms, and opportunities for optimization and improvements.
7. Data analysis will be performed periodically on an interim basis upon request by the PI, and for final reporting at project end.

Baseline System

Existing Domestic Hot Water Plant Conditions

The overall system are shown in Figure C-3 and C-4. The left photo in Figure C-4 shows the hot water supply line, hot water return line and two inline pumps mounted in series, and the make-up cold water line. The right photo shows the gas piping into the boilers and the integral boiler pumps. Figure C-5 shows the nameplate for one of the two identical boilers.

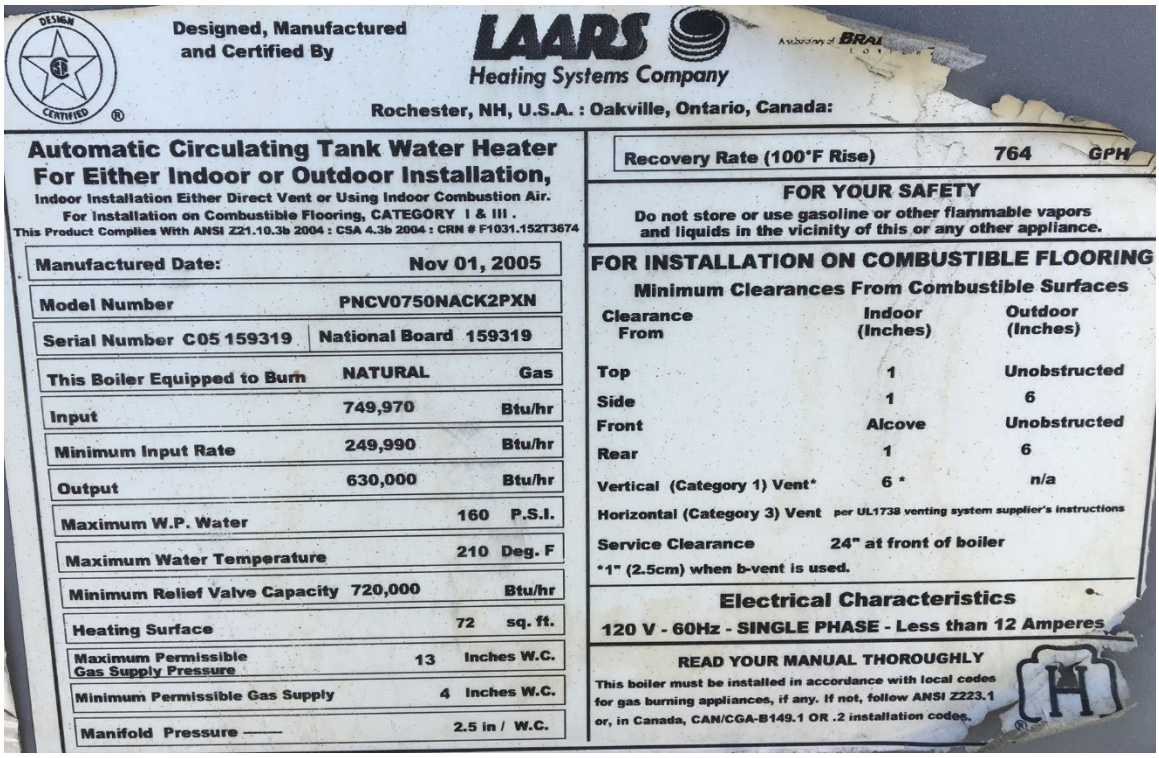
Figure C-3: Existing Boilers and Storage Tank

Source: NegaWatt Consulting

Figure C-4: Existing Storage Tank Water Piping and Boiler Gas Piping

Source: NegaWatt Consulting

Figure C-5: Boiler Nameplate



Source: NegaWatt Consulting

Our various measurements gave us insight into plant operation. The integral boiler pumps run constantly at a steady combined flow rate of approximately 90 gallons per minute (gpm); the boiler supply to return water temperature difference is typically less than 6°F (-14°C); and the tank supply temperature setpoint is easily met. This indicates that cycling the pumps with a call for heat would be more efficient and that one boiler is redundant (i.e., one boiler has sufficient capacity to satisfy the load).

The hot water supply temperature is approximately 130°F (54°C) and the return water temperature is typically about 6°F (-14°C) colder. The return water pumps run constantly at a steady combined flow rate of approximately 19 gpm. The average minutely hot water draws are typically less than 10 gpm and often less than 5 gpm. This indicates that the return water pump flow rate could be reduced without impacting hot water wait time at the fixtures, and that the return water loop heat loss is a substantial portion of the current load.

Natural Gas Utility Data

We reviewed the natural gas utility data, but it is of limited value since one gas meter serves the whole building which includes three DHW plants, a pool, and other gas-fired equipment and appliances. See Figure C-6 for an excerpt of the October 2018 gas utility bill.

Figure C-6: October 2018 Gas Utility Bill

Account Activity

Date of Bill	10/09/2018			Previous Balance	$4813.89
				Total Amount of Payments	$4813.89
				Balance Forward	$0.00
				+ Current Bill	$4665.29
				Current Balance	$4665.29

Gas Service - Account Summary

Invoice Number	[redacted]			Customer Charge -- 30 Days X 0.16438	$4.93
Premise Number				Baseline -- 4299 Therms X 0.88972	$3824.91
Meter No.	[redacted]			**Subtotal**	$3829.84
Rate	GM-E		
Current Reading	70484	Actual	10/05/2018
Previous Reading	67024	Actual	09/05/2018
Measured CCF Usage	3460		
Multiplier	1.0320		
Therm Factor	1.2040		
Therms	4299		

Summary Charges

Baseline -- 4299 Therms X 0.88972	$7.14
Baseline -- 4299 Therms X 0.88972	$404.19
Nat Gas Utility Tax	$424.12
Subtotal	$835.45

Source: SoCalGas; obtained from building owner

During this bill period, the building used 3,460 centum cubic feet (CCF) (or, 346,000 cubic feet) of natural gas. The "multiplier" of 1.032 is used to convert to therms while accounting for the elevation of the site, which is approximately 150 feet, and the heat value of gas delivered that month to the given Btu district, which is 11 (SoCalGas 2018). The "Therm Factor" accounts for elevated delivery gas pressure using Boyle's Law as compared to atmospheric pressure (14.73 pounds per square inch absolute [psia]) (SoCalGas 2010). So, 1.204 equals delivery pressure divided by 14.73, giving a delivery pressure of 17.73 psia or 3 pounds per square inch gauge [psig]) (SoCalGas 2010).

There is a gas regulator in the garage that reduces the gas pressure in the line serving the boilers. We have not measured the pressure at our gas meters on the roof, but we know from the boiler nameplate that the acceptable pressure range is 4 inches water column (w.c.)

(0.144 psig) to 13 w.c. (0.469 psig). This gives a "Therm Factor" range of 1.0098 to 1.0318. We will use the midpoint of 1.02.

For the "multiplier," we will use the average of the most recent 11 months from January to November 2018 which gives 1.033.

Our diaphragm gas meters are not temperature compensating because such meters were not available from our distributor during M&V installation. We mounted a temperature sensor on the outside of the gas header pipe on the roof to attempt the temperature compensation calculation ourselves. For the time being, we will not attempt to correct for temperature since that data seems higher than expected.

The pulse rate of our gas meter is 1 cubic foot per pulse. Therefore, to convert our gas measurements at the boilers:

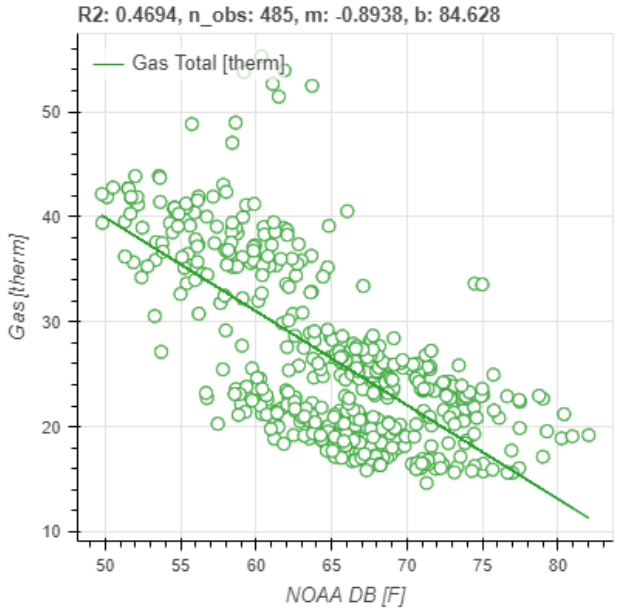
$$Gas\ Usage\ in\ therms = x\ pulses \cdot \left(1\frac{ft^3}{pulse}\right) \cdot (1.02 \cdot 1.033)\frac{therms}{100\ ft^3}$$

To convert this to Btu, we multiply by 100,000 (U.S. EIA 2018).

Estimated Baseline Annual Domestic Hot Water Gas Usage & Emissions

The cumulative minutely gas pulse data was resampled to daily intervals and the above equation was used to convert to therms. The date range was June 8, 2018 to December 1, 2019, anomalous data was removed, and some days of data were missing. There were 485 usable observations. In Figure C-7 below, this data was scatter plotted against average daily dry bulb temperature from the NOAA weather station at Los Angeles International Airport and a linear trendline is shown. The coefficient of determination (R^2) is not as high as we prefer, but our baseline measurement period was long.

Figure C-7: Gas Usage versus Dry Bulb Temperature



Source: NegaWatt Consulting

Applying the trendline equation to daily outside air temperature data for California Climate Zone 6, this yields 10,837 therms per year per Table C-3. Associated greenhouse gas (GHG) emissions are shown using the California Energy Commission's (CEC's) emissions factor of 11.7pounds (lbs.) of carbon dioxide equivalent (CO_2e). Gas cost is shown using CEC's statewide average residential rate of $1/therm.

Table C-3: Estimated Baseline Annual Values

Baseline Annual DHW Gas Usage [therms]	Baseline Annual DHW Gas Usage [MMBtu]	Baseline Annual DHW Gas Cost [$, Statewide Average]	Baseline Annual CO_2e from DHW Gas Usage [lbs.]	Date Range
10,837	1,084	$10,837	126,792	6/8/18-12/1/19

Source: NegaWatt Consulting

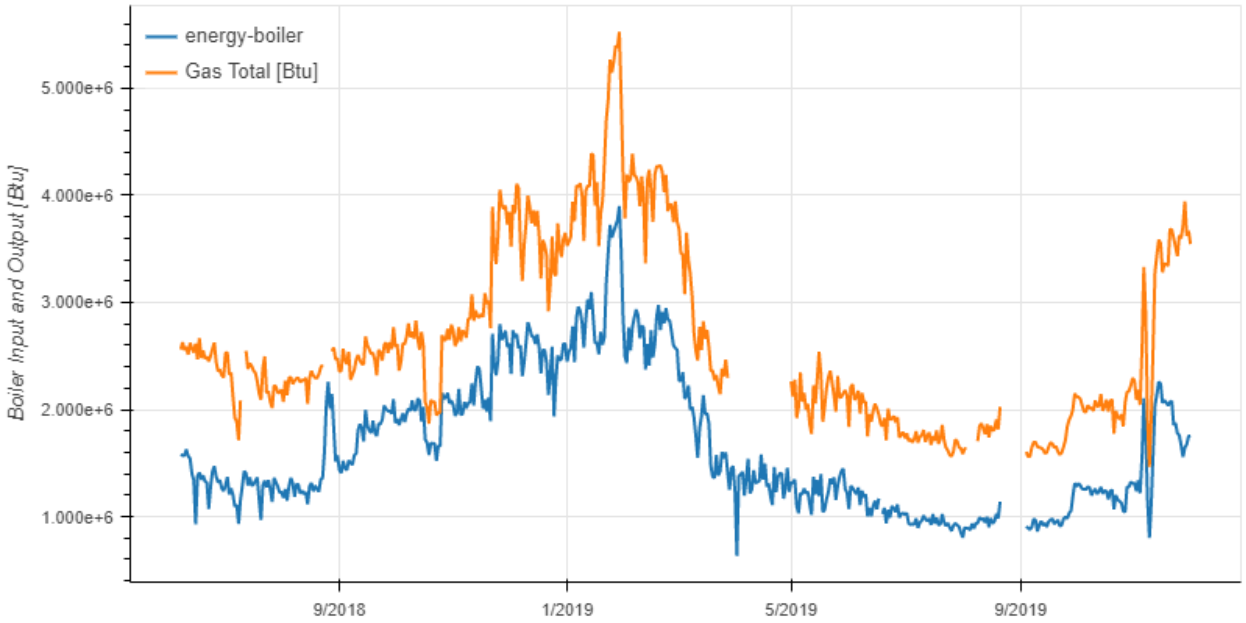
Additional Baseline M&V Results

We measured, plotted, and analyzed numerous additional data points, both at the raw minutely interval and aggregated to daily intervals. Before aggregating to daily intervals, we removed anomalous spikes and corrected small issues such as energy measurements that were consistently negative instead of positive cumulative values. We also ignored days where 60 minutes or more of measurements (congruous or not) were missing. Below are some of our daily interval timeline plots for the full baseline measurement period, along with some observations.

Figure C-8 below shows *net* boiler output (i.e., "energy-boiler") and boiler gas input (i.e., "Gas Total [Btu]"), both in units of Btu. Figure C-9 shows average boiler efficiency, which is net boiler output divided by boiler gas input. The net output data is from the Btu meter across the boiler supply and return pipes between the boilers and the storage tank, and the input data is from our gas pulse measurements. We say *net* because the boiler pumps run constantly at constant flow regardless of heating calls. When there are no heating calls, the loop takes some energy out of the tank.

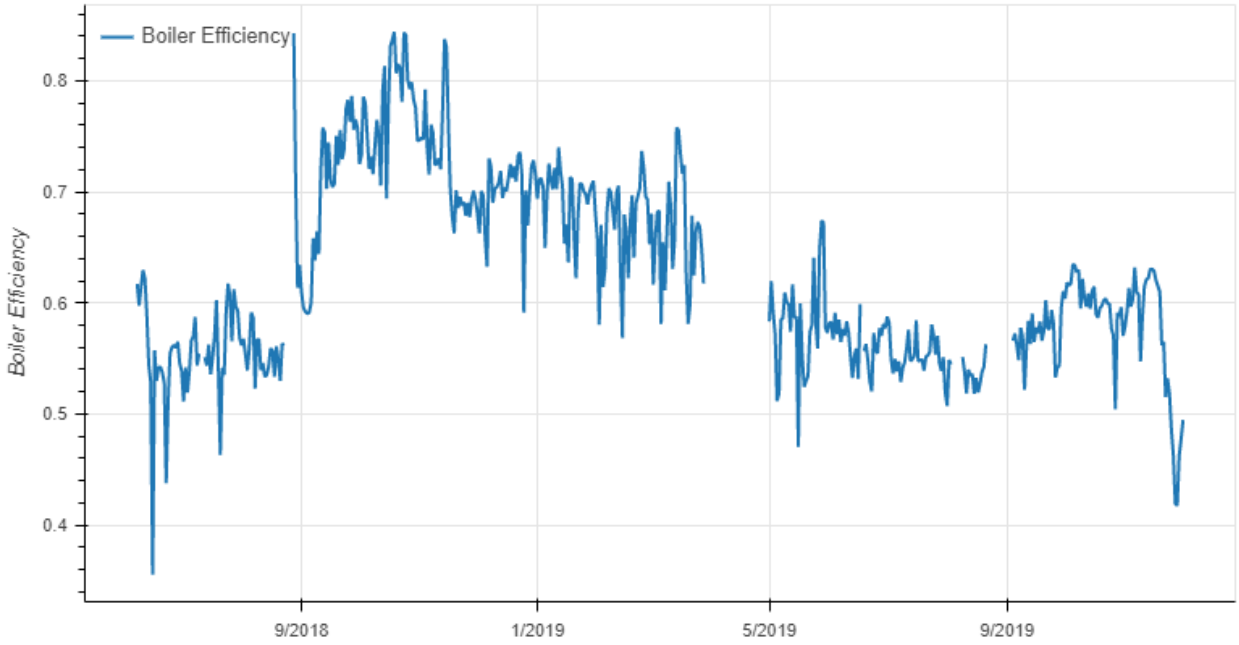
It is not clear what caused the spike in boiler output in late August 2018 or whether it should be omitted. The drop boiler output in late October 2018 coincides with a drop in hot water draws, which we will see later. The gradual increase from September 2018 to early 2019 correlates with colder ambient temperatures which increases boiler load during water draws. The improved efficiency seems to indicate that the boilers are oversized.

Figure C-8: Daily Boiler Gas Usage and Boiler Net Heat Output to Tank



Source: NegaWatt Consulting

Figure C-9: Daily Average Boiler Efficiency



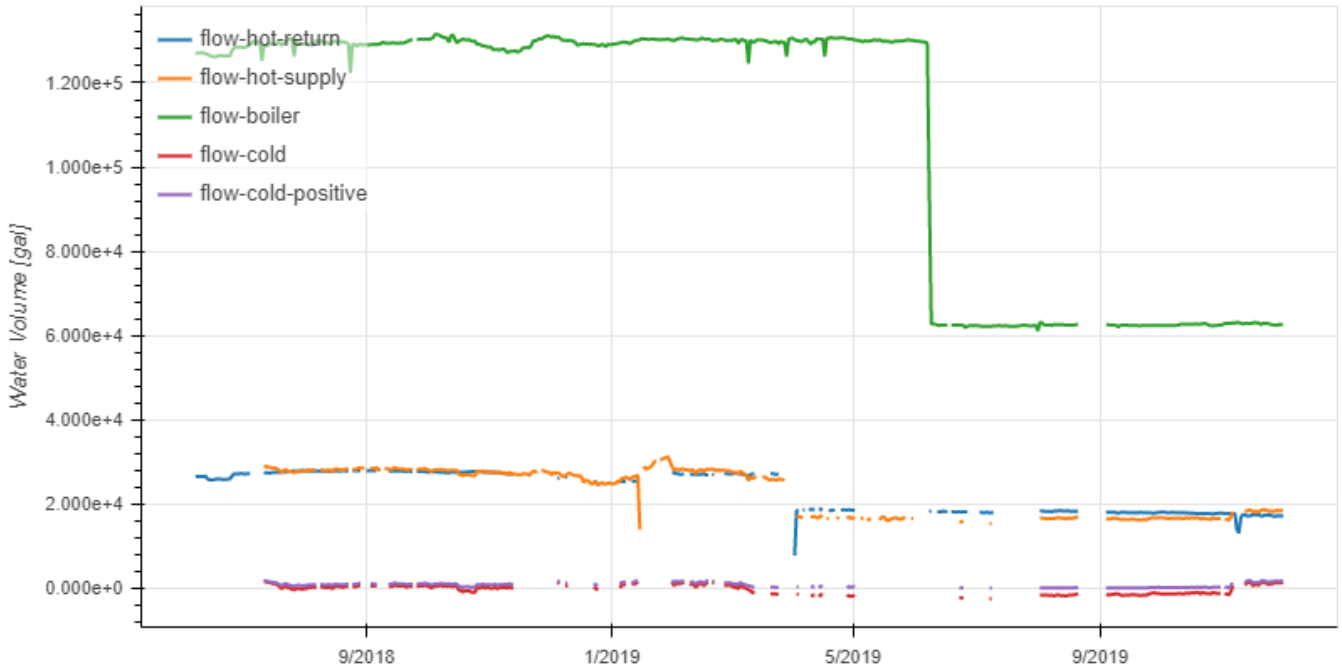
Source: NegaWatt Consulting

Figure C-10 shows cumulative daily water volume readings from the flow meters that are part of the Btu meters. Here is the meaning of each data series:

1. "flow-hot-return" is measured at the return line into the storage tank.
2. "flow-hot-supply" is measured at the supply line exiting the tank to serve the building.

3. "flow-boiler" is not shown in order to zoom into the other data series.
4. "flow-cold" is the difference between "flow-hot-supply" and "flow-hot-return" because the flow at the cold water line was too low to get good readings. This data series was subsequently ignored in favor of "flow-cold-positive."
5. "flow-cold-positive" is also the difference "flow-hot-supply" and "flow-hot-return," but negative minutely values (due to sensor inaccuracy) were excluded before aggregating to daily intervals. The modified minutely data was also used for the cold water Btu calculations. The accuracy of the cold water data is worse than the other data series due to the combined inaccuracy of two Btu meters.

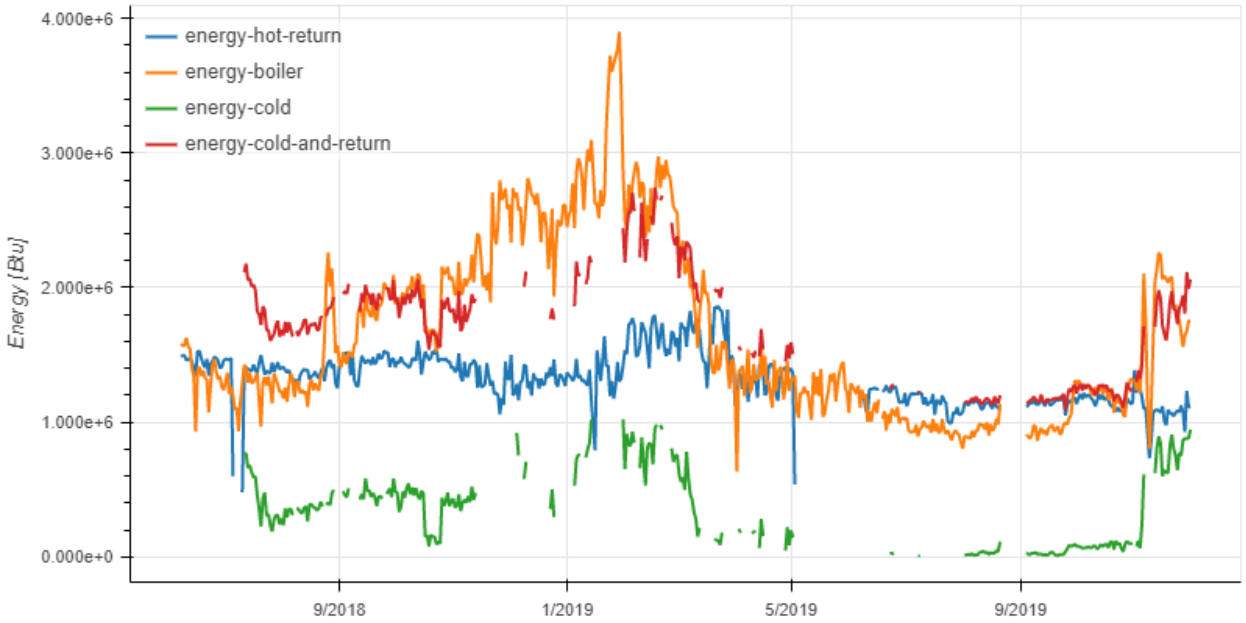
Figure C-10: Daily Water Volumes



Source: NegaWatt Consulting

Figure C-11 shows the thermal energy in Btu from each Btu meters, with the caveat that the "cold" data is calculated. Note that the calculation is automatically performed every second by our eGauge data logger before it is saved as minutely data in the logger. The data series "energy-cold-and-return" is the sum of "energy-cold" and "energy-hot-return." It should always be slightly lower than "energy-boiler," but that is sometimes not the case which makes that data suspect. An unrelated observation is that the dip in "energy-cold" in late October 2018 lines up with the boiler input and output dips in Figure C-11.

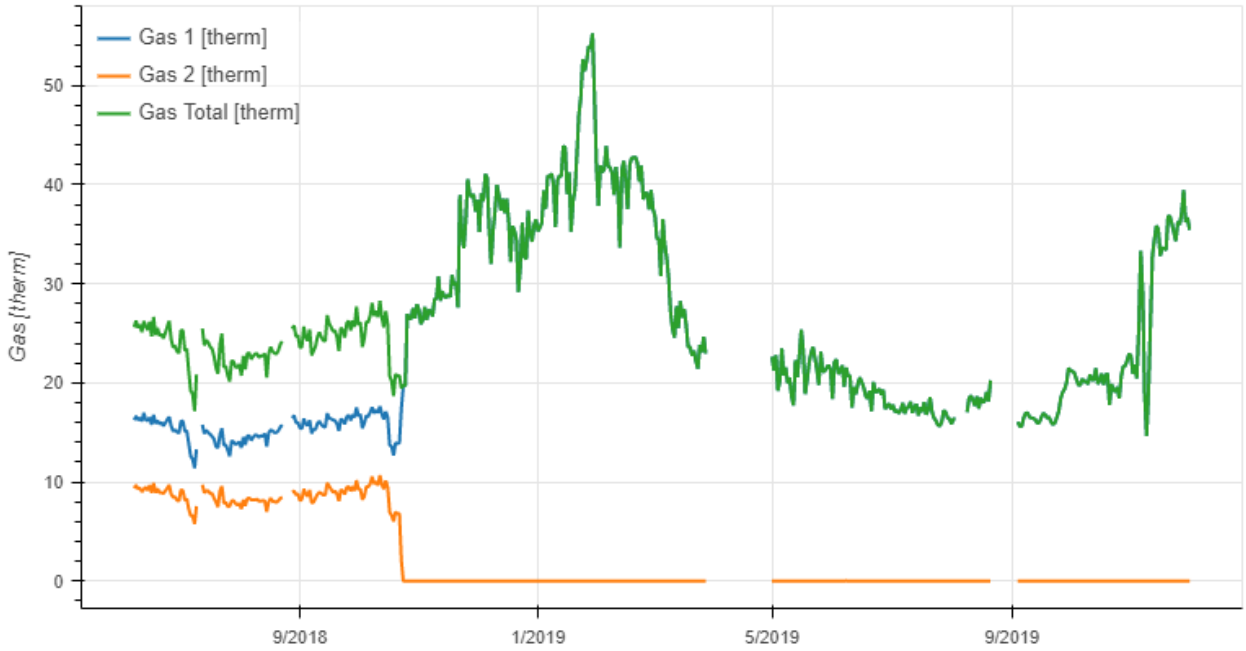
Figure C-11: Daily Thermal Energy



Source: NegaWatt Consulting

Figure C-12 shows the boiler gas input in therms for each individual boiler and for both combined. It shows that boiler "1" consistently handles more of the load, and that boiler "2" stopped firing in late October 2018 for some reason and did not come back online for the rest of the baseline period.

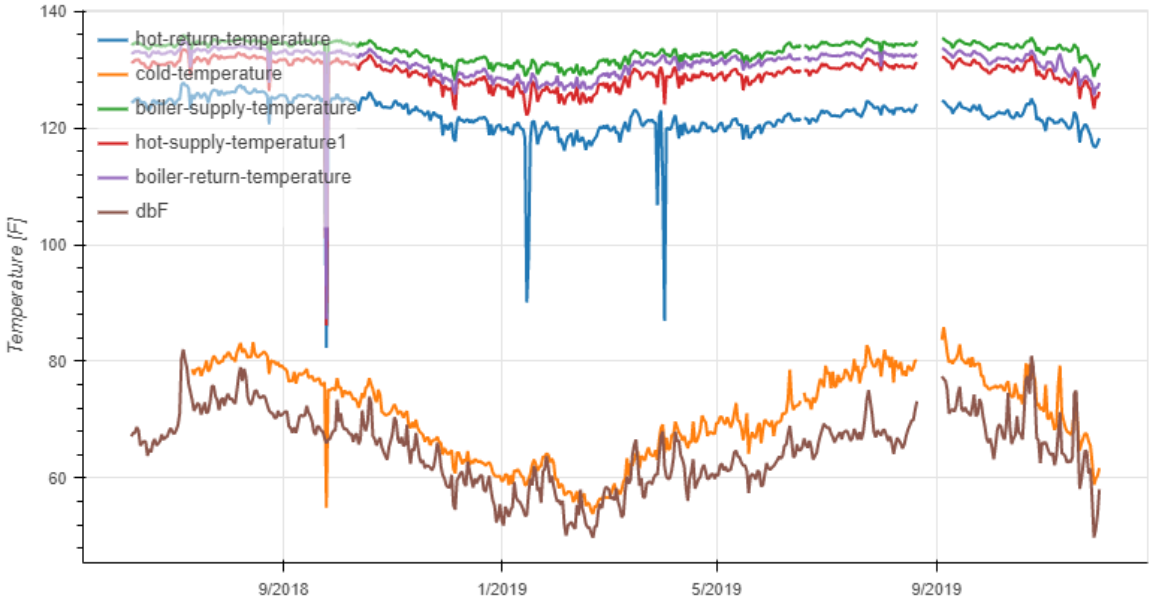
Figure C-12: Daily Boiler Gas Usage



Source: NegaWatt Consulting

Figure C-13 shows the temperature measurements. Note that the cold water temperature is around 80°F in the summer.

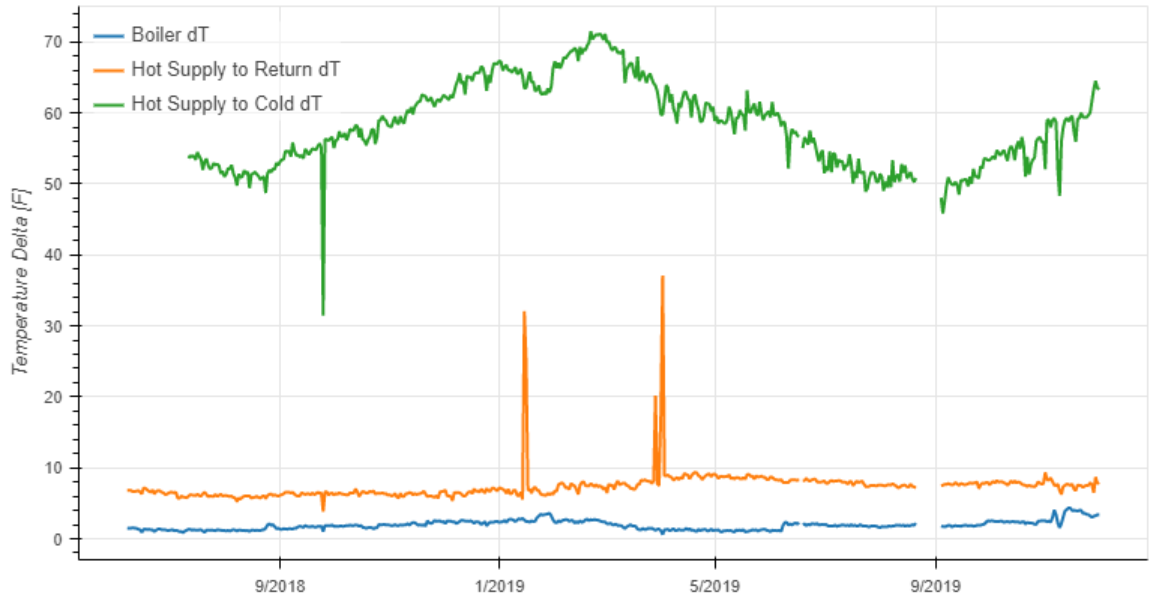
Figure C-13: Daily Average Temperatures



Source: NegaWatt Consulting

Figure C-14 shows the average temperature deltas associated with each Btu measurement. "Boiler dT" is much lower than optimal. The constant pump operation is a contributing factor, and the boilers also seem oversized for the load. As expected, "Hot Supply to Cold dT" show that the load of hot water draws generally increases with lower ambient and cold water temperatures, assuming temperature setpoint is fixed.

Figure C-14: Daily Average Temperature Deltas



Source: NegaWatt Consulting

Retrofit System

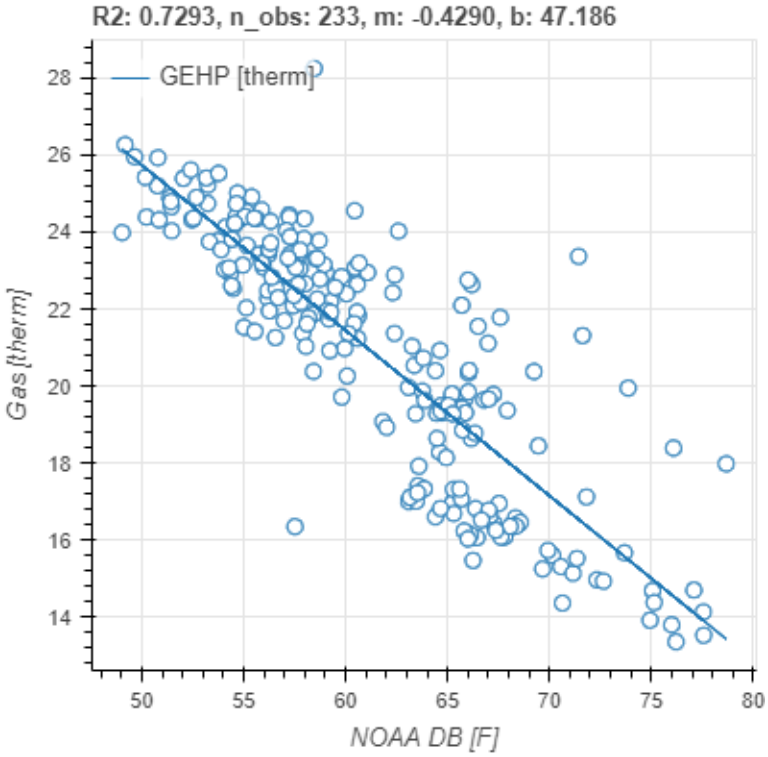
Retrofit System Conditions

The retrofit system consists of the GEHP and solar thermal systems which both pre-heat the cold-water makeup water going to the existing DHW system. The project team did not otherwise modify the existing DHW system whereas the site staff did make seasonal control changes and deal with some pump and perhaps boiler failures. As far as the retrofit equipment, the GEHP system had much lower equipment COP system than expected, but functioned properly otherwise.

Estimated Retrofit Annual Domestic Hot Water Gas Usage & Emissions

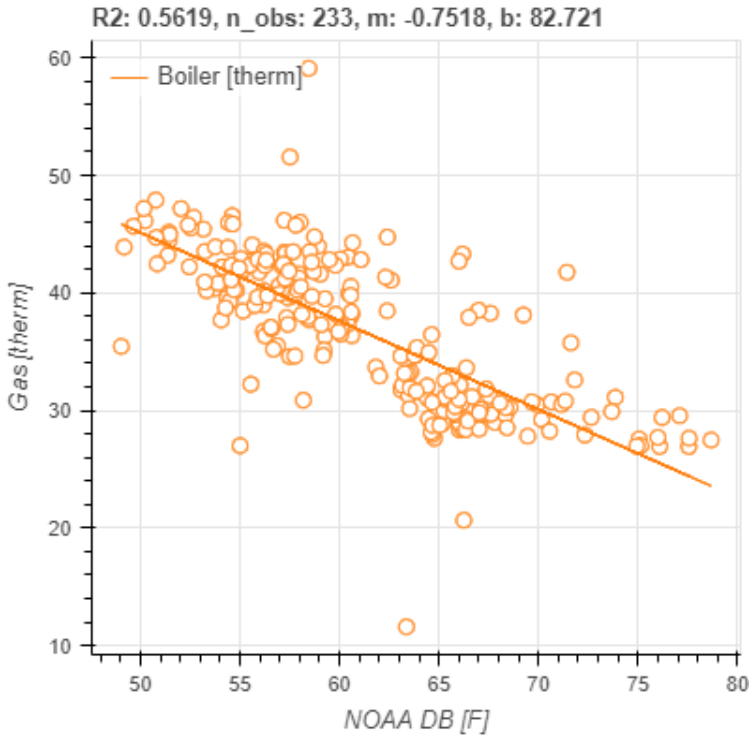
The below three figures (Figures C-15, C-16 and C-17) show the daily gas usage versus daily ambient dry bulb temperature during the retrofit period after anomalous data was removed. The date range was from June 1, 2020 to April 11, 2021 and there were 233 usable observations. Figure C-15 is for the GEHP, Figure C-16 is for the existing boilers during the same dates, and the Figure C-17 is the combined gas usage. Trendline information is shown above each plot. Pump power was not evaluated. Gas usage increased compared to the baseline period. Perhaps the domestic hot water load in the building was higher during this time period versus the baseline period due to more people being at home during the COVID19 pandemic. The pandemic began in early 2020, which was after the end of our baseline M&V period and before our retrofit M&V period.

Figure C-15: GEHP Gas Usage versus Dry Bulb Temperature (Retrofit Period)



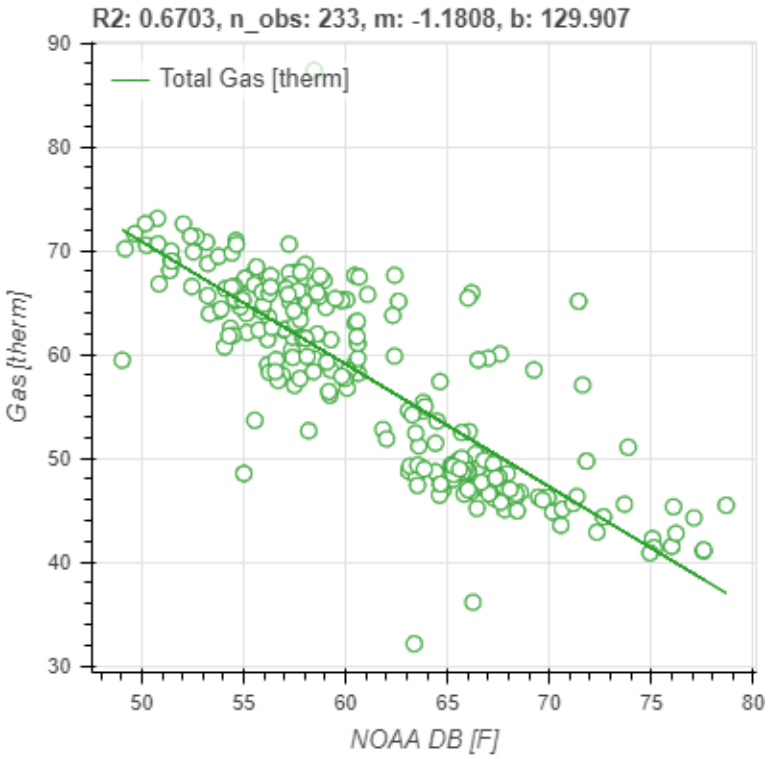
Source: NegaWatt Consulting

Figure C-16: Boiler Gas Usage versus Dry Bulb Temperature (Retrofit Period)



Source: NegaWatt Consulting

Figure C-17: Total Gas Usage versus Dry Bulb Temperature (Retrofit Period)



Source: NegaWatt Consulting

Applying the trendline equation to daily outside air temperature data for California Climate Zone 6, this yields 20,926 therms per year per Table C-4. Associated GHG emissions are shown using CEC's emissions factor of 11.7 pounds of CO_2e per therm. Gas cost is shown using CEC's statewide average residential rate of $1/therm.

Table C-4: Estimated Retrofit Annual Values

Retrofit Annual DHW Gas Usage [therms]	Retrofit Annual DHW Gas Usage [MMBtu]	Retrofit Annual DHW Gas Cost [$, Statewide Average]	Retrofit Annual CO_2e from DHW Gas Usage [lbs.]	Date Range
20,926	2,093	$20,926	244,837	6/1/20-4/11/21

Includes GEHP and Boiler Gas Usage. Additional electrical usage for new pumps not addressed.

Source: NegaWatt Consulting

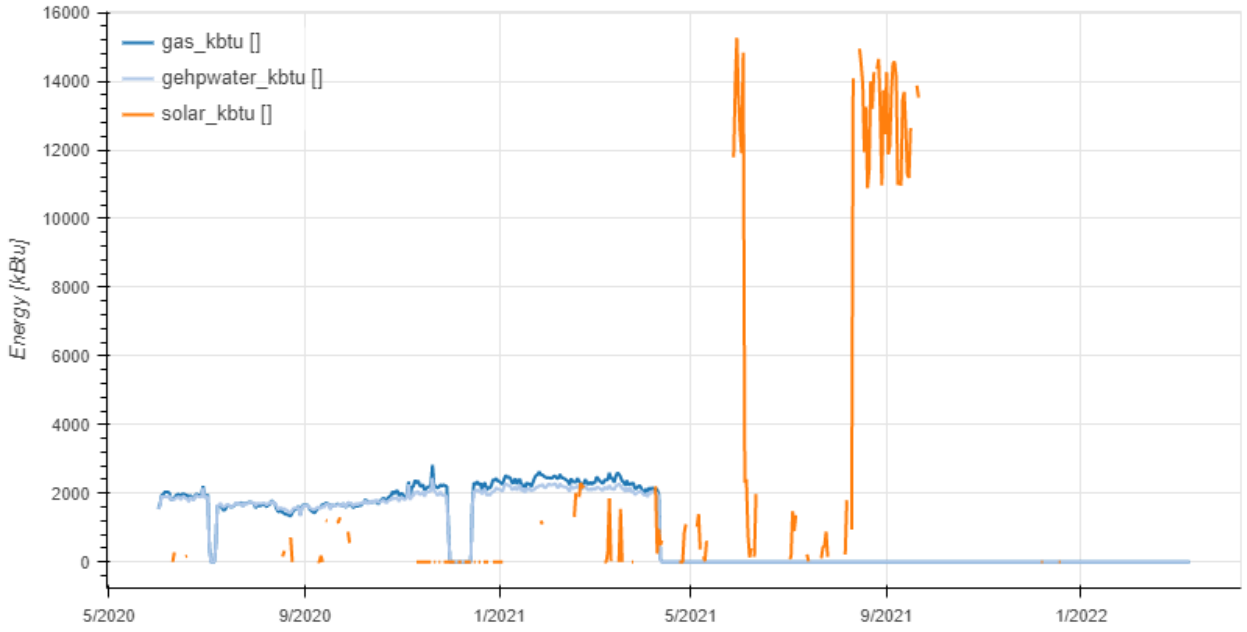
Additional Retrofit M&V Results

The figures below (Figures C-18 through C-26) show the primary data collected during the retrofit period at the new GEHP plant and the existing boiler plant. Note that although we have been collecting most M&V data to date, we lost Modbus communication with the GEHP equipment and related sensors in mid-April 2021. That is why the date range in the above table is shorter than the date range of the below timeline plots. In any case, an important finding during the retrofit period was that the GEHP COP was lower than expected (Figure C-19). The manufacturer and project team have attempted multiple fixes and will continue to attempt additional fixes.

Another important finding is that the retrofit energy usage was much higher than the baseline energy usage. However, it is clear from the temperature data that the GEHP and solar thermal system preheated the supply water as designed (see "tank_supply_F" and "citywater_F" in Figure C-20). We expect that at least some of the gas usage increase was due to COVID-19 impacts. Surprisingly, gas bills from the project site indicate that overall yearly site gas usage was steady from 2018 through 2020.

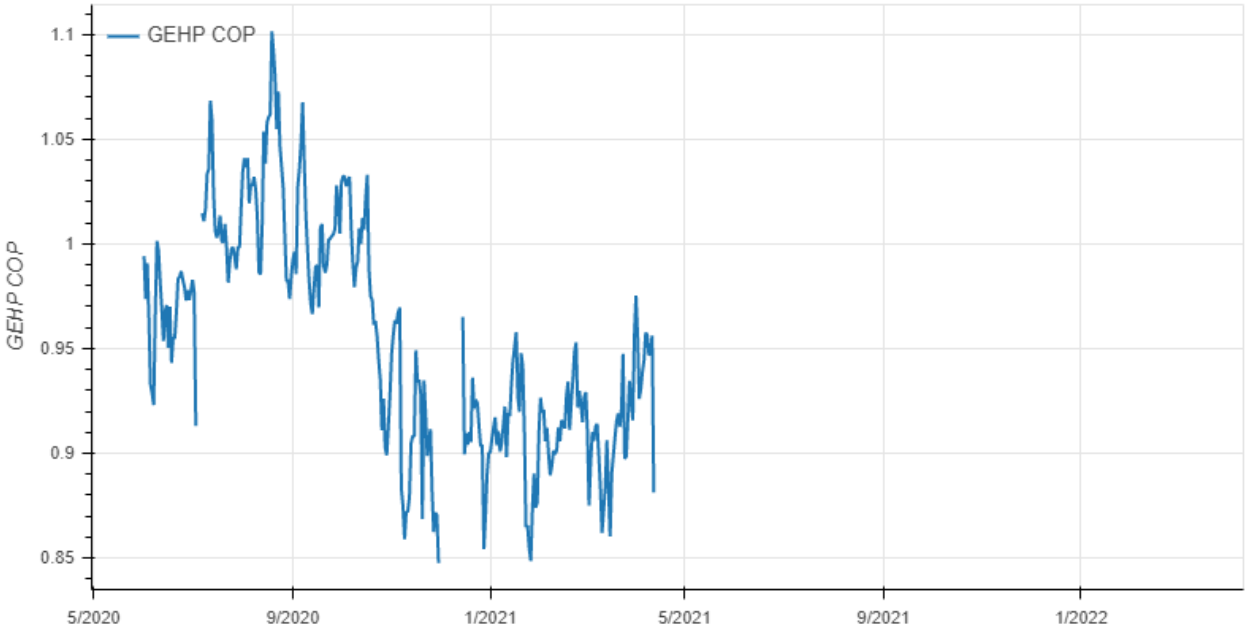
The solar thermal system heat output is compared to the GEHP heat output in Figure C-18. There are only a few data points for the solar thermal system because anomalous temperature data was removed. The average ratio of solar thermal system heat output to GEHP heat output for days where there was useable *non-zero* data for each was 66 percent (i.e., the solar thermal system provided 66 percent as much heat output as the GEHP system on average when both systems were operational and M&V data was available). There were 47 such observations. Figure C-18 also indicates that the solar thermal system can output significantly more energy when the GEHP system is not running. This is because it works better when the inlet water is colder.

Figure C-18: Daily GEHP Gas Usage, GEHP Heat Output, and Solar Thermal Heat Output (Retrofit Period)



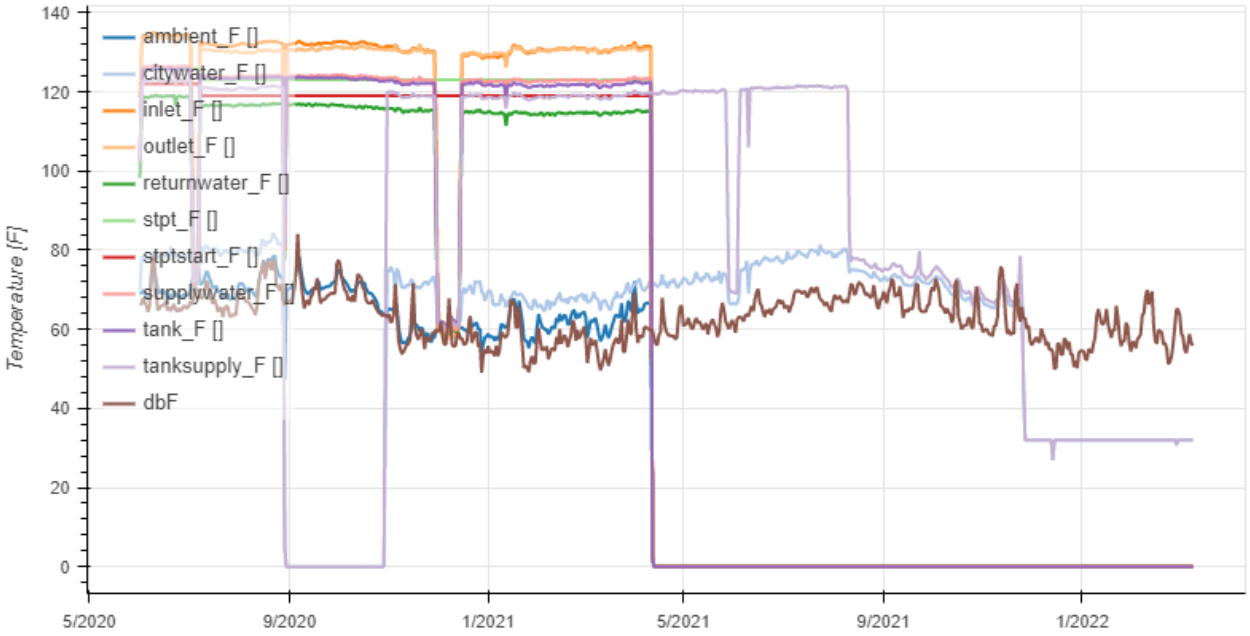
Source: NegaWatt Consulting

Figure C-19: Daily Average GEHP COP (Retrofit Period)



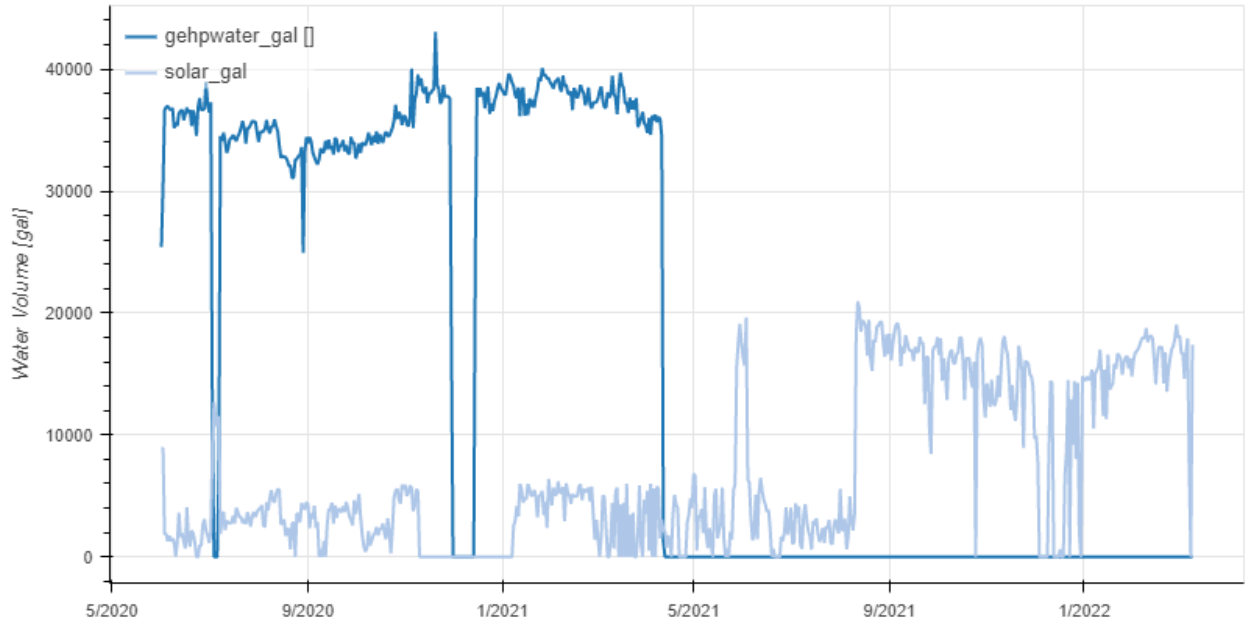
Source: NegaWatt Consulting

Figure C-20: Daily Average Temperatures at the GEHP Plant (Retrofit Period)



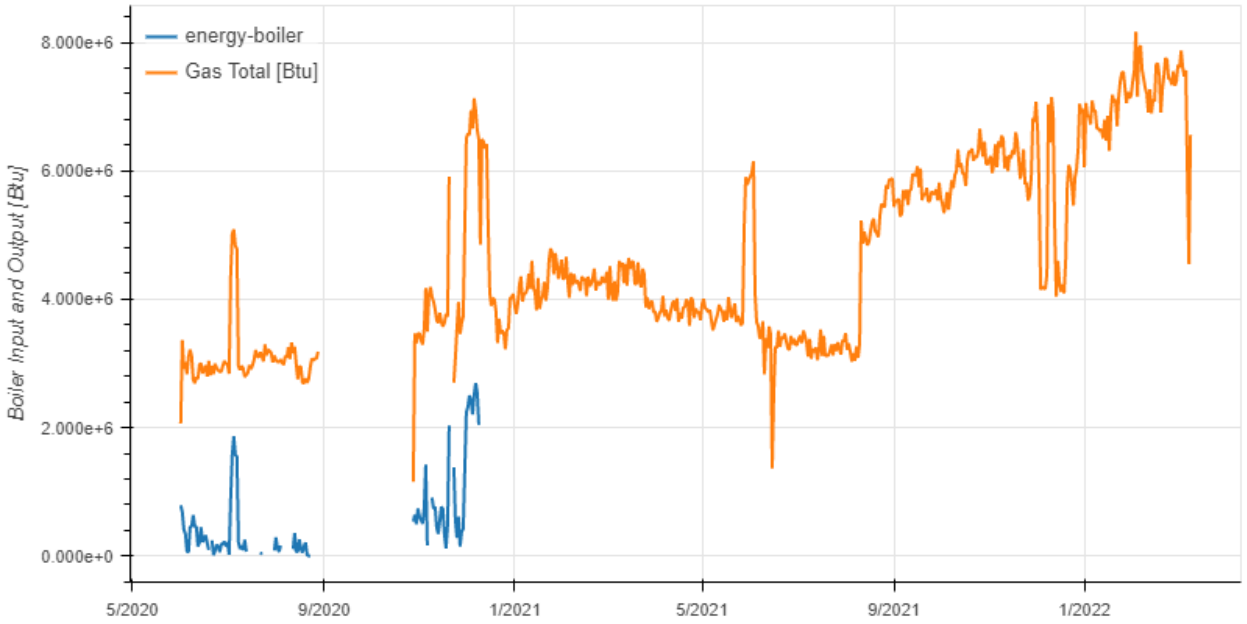
Source: NegaWatt Consulting

Figure C-21: Daily Water Flow through the GEHP and Solar Thermal (Retrofit Period)



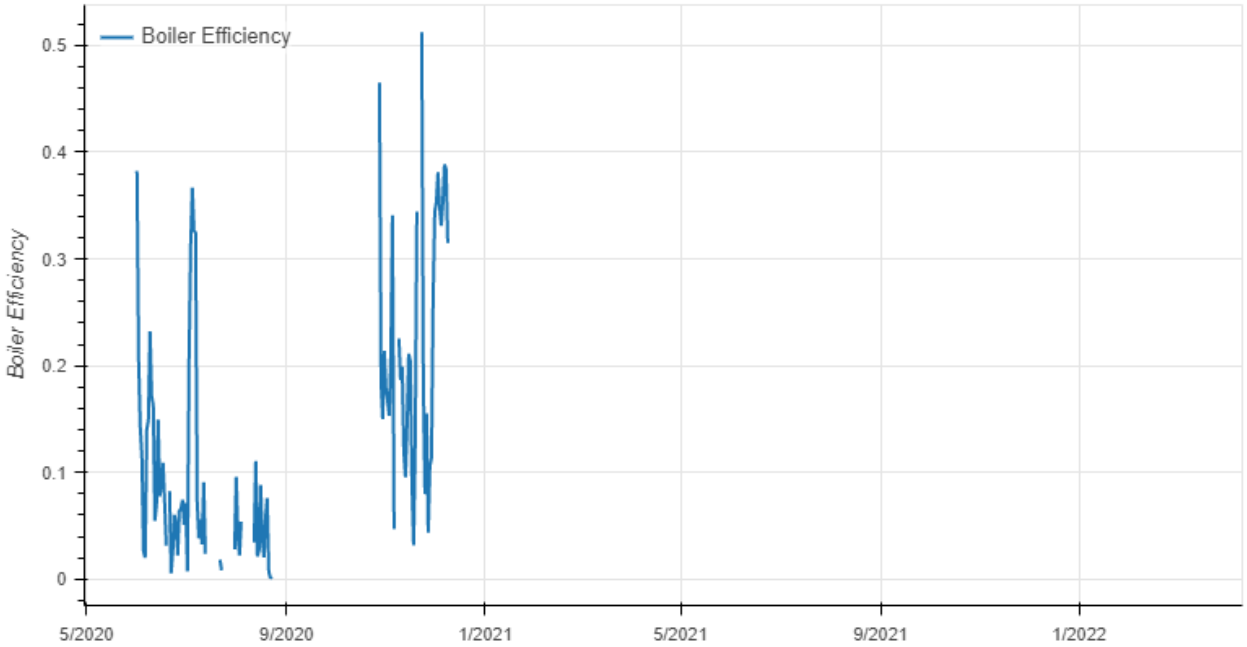
Source: NegaWatt Consulting

Figure C-22: Daily Boiler Gas Usage and Boiler Net Heat Output to Tank (Retrofit Period)



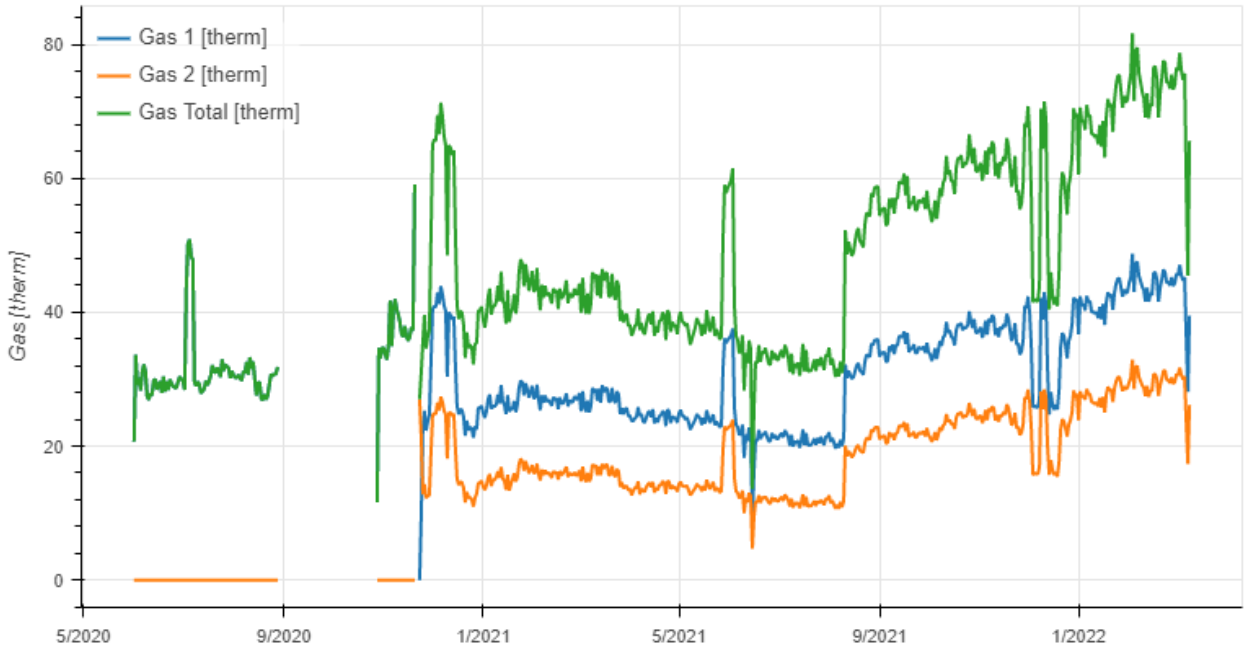
Source: NegaWatt Consulting

Figure C-23: Daily Average Boiler Efficiency (Retrofit Period)



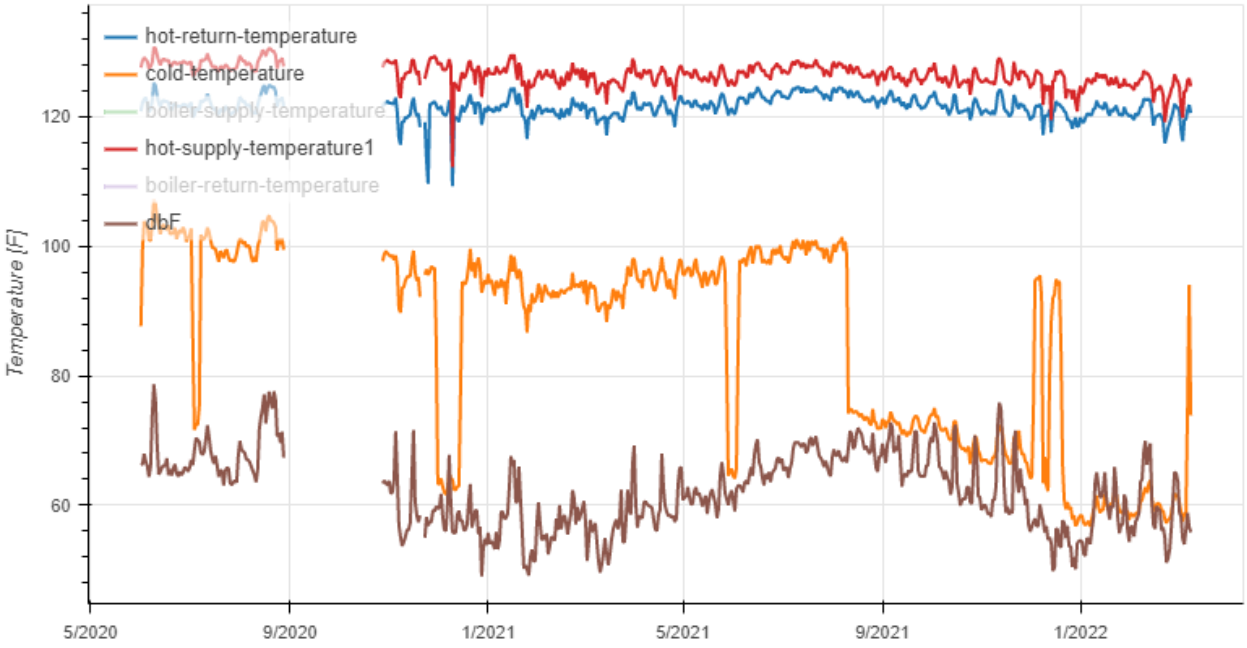
Source: NegaWatt Consulting

Figure C-24: Daily Boiler Gas Usage (Retrofit Period)



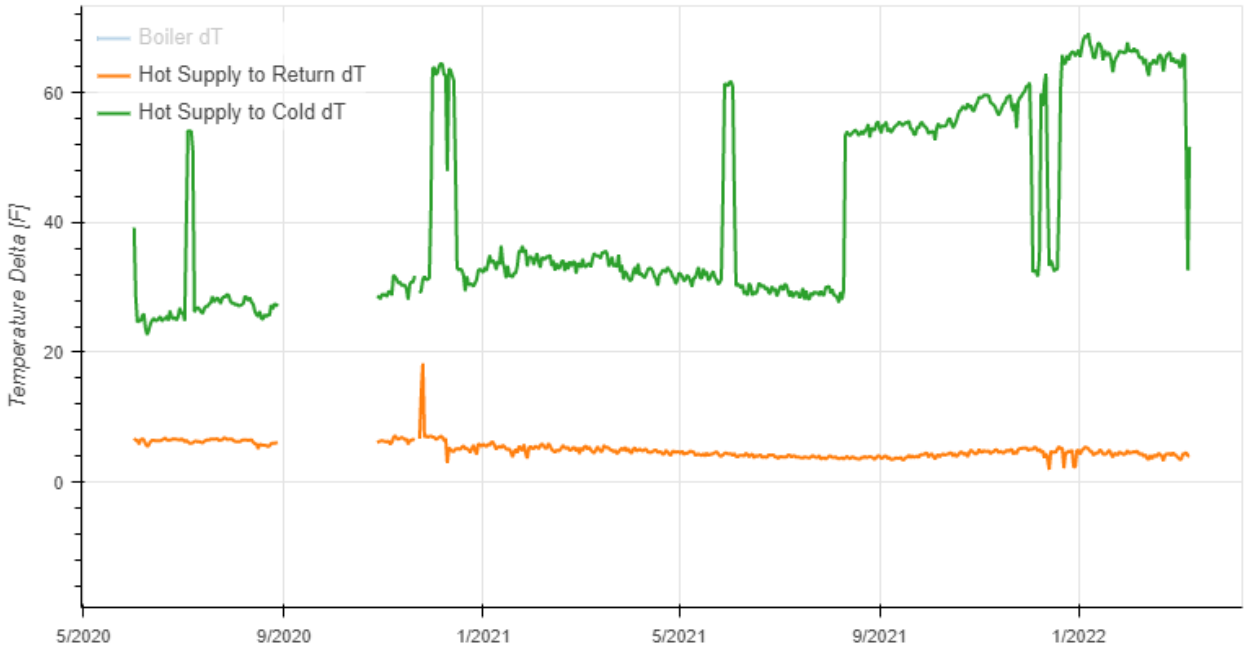
Source: NegaWatt Consulting

Figure C-25: Daily Average Temperatures at Boiler Plant (Retrofit Period)



Source: NegaWatt Consulting

Figure C-26: Daily Average Temperature Deltas at Boiler Plant (Retrofit Period)



Source: NegaWatt Consulting

Savings Estimate

Gas usage was higher during the retrofit period as compared to the baseline period, so savings are not reported.