Technical Report 2

The Electrical Systems Report

Xiaoyin Wu
Penn State University
Architectural Engineering | L/E
Electrical Adviser: Leslie Beahm
Thesis Adviser: Shawn Good

Executive Summary

In this report, there is an analysis of the electrical system of the Fraunhofer CSE building. The report has three parts. In the first part, the electrical system criteria and scope of work is developed to give an estimation of the electrical system of the building. The second part is to describe the electrical system as currently designed. Detailed current electrical system is presented in this part including building utilization voltage, building loads, special equipment and power distribution. The third part is the evaluation of the as-designed systems against the criteria developed in Part 1 and suggestion of potential changes.

The criteria and requirement are according to NEC, IBC and ASHRAE national codes. And all the calculations are performed based on the actual building drawing and information provided by the owners.

Basic Building Stats

- Building Name: Fraunhofer CSE Project http://cse.fraunhofer.org/
- Location: 5 Channel Center Street, Boston, MA
- Occupancy Type: Offices and research laboratories (Group B) and conference room (Group A-3)
- Size: 42150SF
- Number of Stories above Grade: 6
- Project Teams:
  - Owner: Fraunhofer USA
  - General Contractor/Construction Manager: Gilbane Building Co. www.gilbaneco.com
  - Architects: DiMella Shaffer www.dimellashaffer.com
  - Structural Engineer: McNamara/Salvia, Inc. www.mcsal.com
  - MEP/FP/Tel Data Engineer: BR+A Consulting Engineers www.brplusa.com
  - Lighting Consultant: Lam Partners www.lampartners.com
  - Plumbing/HVAC Services: Northeastern Mechanical www.northeasternmech.com
  - Civil Engineer: VHB, Inc. www.vhb.com
  - Geotechnical Engineer: Haley & Aldrich, Inc. www.haleyaldrich.com
- Dates of Construction: Jan 2012— Apr 2013
- Actual Cost Information: Not clear
  - This renovation project is designed for Fraunhofer Building Technology Show Case (http://cse.fraunhofer.org/5cc/). For this specialness of the project, almost all the products and materials are donated by manufacturers. Therefore cost is hard to be estimated.
- Project Delivery Method: Base building—Tenant Fit-Up

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Develop the Electrical Systems Criteria and Scope of Work

1. Preliminary Electrical Load Calculation

The building type of Fraunhofer Building is office and research laboratories (Group B). Based on that the building type, the suggested building load from NEC (2011) is:

Lighting: 3.5VA/sf

Receptacle: 1VA/sf (what is that in 220.14(I)?)

HVAC: 7VA/sf

Demand factors are used as follows: (NEC 2011 Article 220)

Lighting: 100%

Receptacles: 100% for first 100kVA or less and remainder over 10kVA at 50%

HVAC: 100%

Other: 100%

Based on the assumptions made above with the total building area of 42150sf, the preliminary total building loads in kVA are calculated as below:

Lighting: 147.5 kVA

Receptacles: 42.2kVA

HVAC: 295kVA

2. Power Company

NSTAR
http://www.nstar.com/business/
800 Boylston St
Boston, MA
(617) 424-2000

3. Rate Schedule and Service Voltage

See tables on the next page.

Delivery Service Charges (October - May)

Customer (per month) $18.19	**Distribution Energy** First 2,000 kWh (per kWh) $0.02419	**Distribution Energy** Next 150 hours of kW (per kWh) $0.01914
Distribution Energy Each additional kWh (per kWh) $0.01727	**Distribution Demand** Greater than 10 kW (per kW) $9.43	**Transition Energy** First 2,000 kWh (per kWh) $0.00783
Transition Energy Next 150 hours of kW (per kWh) $0.00783	**Transition Energy** Each additional kWh (per kWh) $0.00783	**Transition Demand** (per kW) No Charge
Transmission Demand Greater than 10kW (per kW) $5.54	**Transmission Energy** First 2,000 kWh (per kWh) No Charge	**Transmission Energy** Next 150 hours of kW (per kWh) No Charge
Transmission Energy Each additional kWh (per kWh) No Charge	**Energy Conservation** (per kWh) $0.00250	**Renewable Energy** (per kWh) $0.00050

Delivery Service Charges (June - September)

Customer (per month) $18.19	**Distribution Energy** First 2,000 kWh (per kWh) $0.03412	**Distribution Energy** Next 150 hours of kW (per kWh) $0.02087
Distribution Energy Each additional kWh (per kWh) $0.01776	**Distribution Demand** Greater than 10 kW (per kW) $20.22	**Transition Energy** First 2,000 kWh (per kWh) $0.00783
Transition Energy Next 150 hours of kW (per kWh) $0.00783	**Transition Energy** Each additional kWh (per kWh) $0.00783	**Transition Demand** (per kW) No Charge
Transmission Demand Greater than 10kW (per kW) $14.68	**Transmission Energy** First 2,000 kWh (per kWh) No Charge	**Transmission Energy** Next 150 hours of kW (per kWh) No Charge
Transmission Energy Each additional kWh (per kWh) No Charge	**Energy Conservation** (per kWh) $0.00250	**Renewable Energy** (per kWh) $0.00050

4. Building Utilization Voltage

The building should work on 480Y/277V, 3-phase with lighting mainly on 277V, receptacle 120V, HVAC on 208V or 480V as needed by specific equipment. Most special equipment including elevator will work on 208V.

5. Emergency Power Requirements

In the event of failure of normal supply to the building, emergency lighting, emergency power, or both shall be available within the time required by application but not exceed 10 seconds. The selection of emergency source of power is decided by the occupancy type. The Fraunhofer building type is Type B. According to International Building Codes, the following the requirements shall apply to the building:

Power Supply: The primary and secondary power supply for the fire alarm system shall be provided in accordance with NFPA 72.

Smoke control systems: Standby power shall be provided for smoke control systems in accordance with Section 909.11.

Exit sign. Emergency power shall be provided for exit signs in accordance with sections 1011.6.3.

Emergency power for illumination: the power supply for means of egress illumination shall normally be provided by the premises' electrical supply.

Means of egress illumination: Emergency power shall be provided for means of egress illumination in accordance with Section 1006.3.

Elevators: Standby power for elevators shall be provided as set forth in Sections 3003.1, 3007.9 and 3008.9.

In National Electrical Code (2011) standby power is required in Article 701.

6. Special Occupancy Requirements

The building is not classified in hazardous occupant and does not apply to special occupancy requirement in NEC (2011).

7. Potential Special Equipment

Special equipment in this building should follow the requirement by NEC (2011) is listed below:

- Elevator/Stairway Chairlifts [620]
- Solar photovoltaic system (this system is applied due to the company profession) [690]
- Fire pumps [695]

8. Priority Assessment of the Electrical Design Characteristics

The priority list of assessment is listed in the order from **high to low**:

- Reliability | HIGHEST
- Long term ownership cost
- Power quality
- Flexibility
- Redundancy
- Initial cost | LOWEST

The priority is decided in such ways: the building is dedicated in developing high end building technology with photovoltaic labs in it, so the reliability is the most important assessment of all. And as to run a company like this, reduce the long term means a lot, especially a lot of new building technology is used in the building partly to reduce the cost and save energy. Power quality is somewhat important as well because much especial lab equipment is based on the performance of the power. Flexibility is not as important in an office building because not a lot of changes will be made during the usage of the company. The initial cost is the least important factor in this special case is because, for the building renovation project, all the equipment and fixtures are donated by different manufacturers as part of the building technology showcase. So the manufacturers have donated their most advanced HVAC system, material, and lighting fixtures. Therefore the initial cost is not considered to be an important issue.

9. Optional Back-Up Power Loads

Lighting for mechanical rooms and control rooms are potential loads that may need optional back-up power. And those loads should be provided with a short term back-up device such as UPS system.

10. Potential Special/Communication Systems

- ✓ Telephone/data
- ✓ Fire alarm
- ✓ Access Control
- ✓ Security—intrusion detection, video surveillance

11. Other Building Services for Special/Communication System

Not enough information is provided at this point that indicates if other building services required for the special/communication systems. Assumptions are made at this stage, according to the usage of the building that no building services are applied for the special/communication system.

12. Other Major Equipment in the Building

- Panel boards
- Distribution switch boards
- Photovoltaic panels

Current Design of Electrical Systems

1. Actual Connected Building Loads Calculation

According to the panel board schedule, three kinds of loads are categorized in summarizing the total loads. It is hard to distinguish HVAC loads from the equipment loads category. So in this part, all the mechanical and related equipment loads are sum up as "equipment loads" in this calculation.

Penal Board	Lighting (VA)	Receptacle (VA)	Equipment (VA)	
P2B	0	27000	4576	
P22	770	31000	15476	
P23	883	21140	24400	
P21B	7354	12140	12504	
P24	0	800	0	
P25	800	0	2400	
P26	1800	36500	21080	
L42	20492	0	0	
L44	4299	0	0	
P32	0	0	11200	
P22A	0	0	40292	
EP4B	12033	0	92520	
P21A	0	0	600	
P2P	0	1800	8700	
EP2B	1128	1500	6584	
Total (kVA)	**49.559**	**131.88**	**240.332**	**421.771**

2. Actual Power Company

NSTAR
http://www.nstar.com/business/
800 Boylston St, Boston, MA
(617) 424-2000

Peak Demand Rate = $28.62/kW (per month)
Electric Rate: $0.08145/kWh
Delivery Charge = $115/month (flat rate)

3. Building Utilization Voltage

As designed, the existing electrical system utilizes a building voltage of 480/277V. The existing design utilizes different voltage for the electrical systems. Due to the fact that variety kinds of equipment are used in the building, different utilization voltages are used.

Lighting – 120V and 277V
Receptacle – 120V
Mechanical and Other Equipment – 120V and 277V, 3 phase
Roof stairwell pressurization fan, elevator pressurization fan and hot water pumps – 460V

4. Emergency Power System Connected Loads

The emergency power system is powered by a 350KW, diesel filled, 480/277V, 3 phase, 4W standby emergency generator located on the rooftop. The generator provides 50% rated integral in-line load bank, three unit mounted circuit breakers serving ATS-700, fire pump, and load bank. It provides with 120V normal power for load bank control circuit, battery charger, and battery pad warmer, and 208V for jacket heater. It also provides with 120V emergency power for lighting and receptacles. EP4B and EP2B are the two emergency panelboards distributing loads into the building. (Detail panelboards information can be found the later sections)

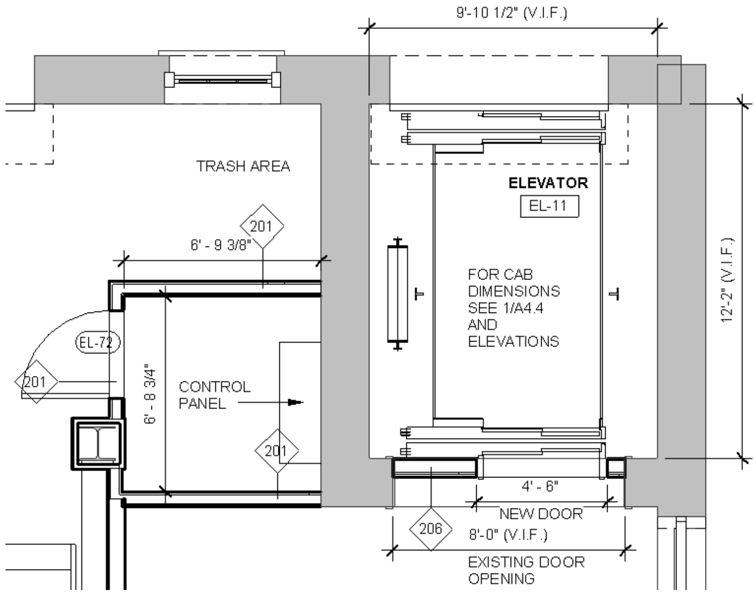
5. Special Occupancy Requirements

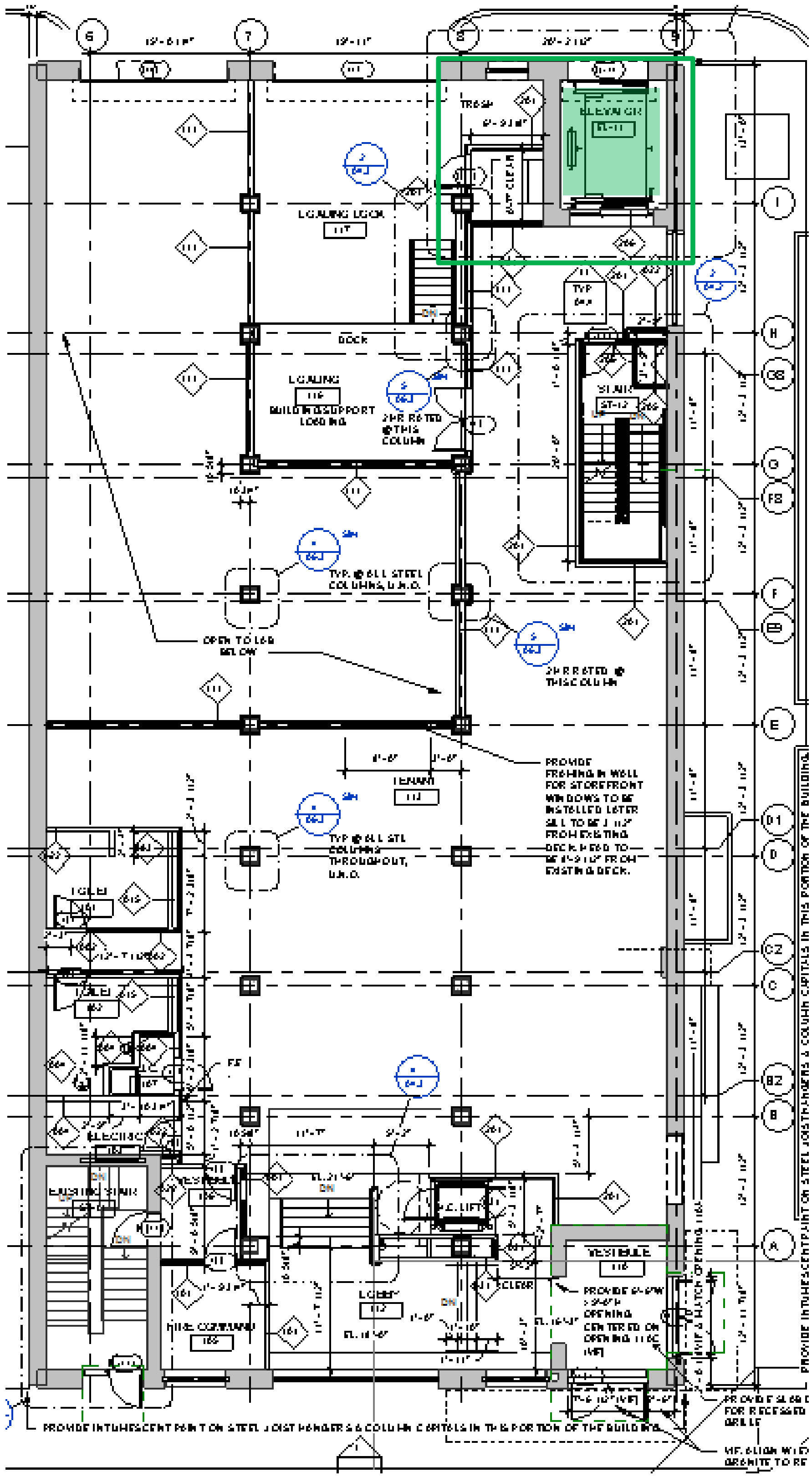
Not applicable to this project, for there is no special occupant in the building.

6. Special Equipment

Special equipment found in the building is elevator, stairway chairlift, and photovoltaic systems.

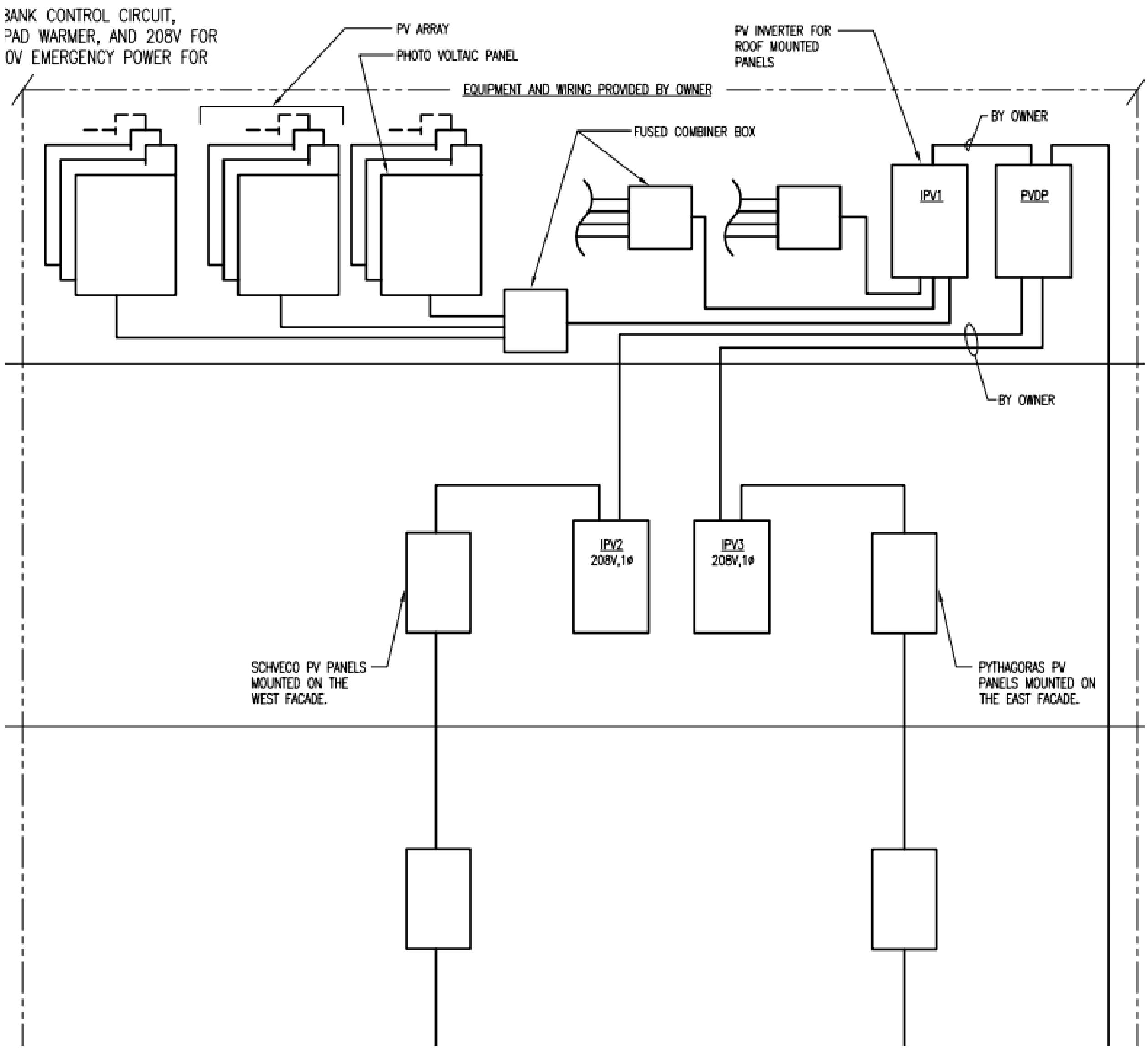
Elevators – NEC Article 620
There is one elevator in the building located on the building west, see the figure below.





Solar Photovoltaic System – NEC Article 650

Three photovoltaic arrays are located on the rooftop, and Schveco Photovoltaic Panels are mounted on the west façade, Pythagoras Photovoltaic panels mounted on the East façade. The photovoltaic system is installed by owner, so it’s not shown on the architectural drawing. But it can be found on the single line diagram.



7. Electrical Equipment

There is one switchboard distribute power to the building to 5 distribution panels. The distribution panels connect 15 panel boards locate in the entire building serving the electric system in each floor.

Switchboard

SWBD-1: 480/277V, 3 phase, 4 Wire, 1600A

SWITCHBOARD "SWBD-1" SCHEDULE

HORZ. BUS: 1600A	VERT. BUS: 1600A	S.C.R.: *	NEUT. BUS: 1600A
GROUND BUS: FULL	NEMA CLASS: *	VOLTAGE: 480/277V, 3ø, 4W	ENCL. NEMA TYPE: *

COMPT. NO.	EQUIPMENT DESIGNATION	DISCONNECT DEVICE				FEEDER						REMARKS
						WIRE		GROUND		CONDUIT		
		POLES	FRAME	TRIP	TYPE	NO.	SIZE	NO.	SIZE	NO.	SIZE	
1	INCOMING LINE					36						
2	UTILITY METERING											
3	MAIN CIRCUIT BREAKER	3	1600	1600	–							–
4	CH-1 (200 TONS)	3	400	350	–	3	#250	1	#4	1	2-1/2"	1
5	DISTRIBUTION PANEL 'DP41A'	3	400	400	–	24						–
6	DISTRIBUTION PANEL 'DP41B'	3	400	400	–	24						–
7	'DP21A' VIA XFMR	3	400	300	–	REFER TO TRANSFORMER SCHEDULE						–
8	'DP21B' VIA XFMR	3	400	300	–	REFER TO TRANSFORMER SCHEDULE						–
9	DISTRIBUTION PANEL 'DP4P'	3	400	400	–	24						–
10	ATS-700	3	400	400	–	24						–
11	PENTHOUSE PANEL "DP2P"	3	400	300	–	REFER TO TRANSFORMER SCHEDULE						
12	SPARE	3	400	350	–	21						
13	SPARE											
14	SPARE											

Distribution Panel boards

DP41B: 277/480V, 3 phase, 4 Wire, 400A, MLO, surface mounting

DISTRIBUTION PANEL "DPL41B" SCHEDULE — LEVEL 1

277/480 VOLTS	3 PHASE	4 WIRE	* AIC
MAIN BUS SIZE: 400 AMPS	NEUTRAL: 100%	GROUND BUS: FULL	
MAIN DEVICE: MLO	MOUNTING: SURFACE		

CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	PANEL 'L42'	150	100	3	6	1
2	PANEL 'L44'	150	100	3	6	1
3	SPARE	150	100	3	–	–
4	SPARE	150	100	3	–	–
5	SPACE	150	–	3	–	BUS & HARDWARE
6	SPACE	150	–	3	–	BUS & HARDWARE
7	SPACE	150	–	3	–	BUS & HARDWARE
8	SPACE	225	–	3	–	BUS & HARDWARE

DP21A: 120/208V, 3 phase, 4 Wire, 600A, surface mounting

DISTRIBUTION PANEL "DP21A" SCHEDULE						LEVEL 1
120/208 VOLTS	3 PHASE	4 WIRE				* AIC
MAIN BUS SIZE: 600 AMPS	NEUTRAL: 100%			GROUND BUS: FULL		
MAIN DEVICE: 500 AMPS	MOUNTING: SURFACE					
CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	PANEL 'P2B'	250	225	3	16	1
2	PANEL 'P21B'	250	225	3	16	1
3	PANEL 'P22'	250	225	3	16	1
4	PANEL 'P23'	250	225	3	16	1
5	ENVIRONMENTAL TEST CHAMBER 02	100	100	3	6	–
6	PANEL "P22A"	250	225	3	–	–
7	SPARE	250	225	3	–	–
8	SPARE	250	225	3	–	–

DP21B: 120/208V, 3 phase, 4 Wire, surface mounting

DISTRIBUTION PANEL "DP21B" SCHEDULE						LEVEL 1
120/208 VOLTS	3 PHASE	4 WIRE				* AIC
MAIN BUS SIZE: 600 AMPS	NEUTRAL: 100%			GROUND BUS: FULL		
MAIN DEVICE: 500 AMPS	MOUNTING: SURFACE					
CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	PANEL 'P24'	250	225	3	16	1
2	PANEL 'P25'	250	225	3	16	1
3	PANEL 'P26'	250	225	3	16	1
4	SPARE	250	225	3	–	–
5	SPARE	250	225	3	–	–
6	SPACE	250	–	3	–	BUS & HARDWARE
7	SPACE	250	–	3	–	BUS & HARDWARE
8	SPACE	250	–	3	–	BUS & HARDWARE

DP4P: 277/480V, 3 phase, 4 Wire, MLO, surface mounting

DISTRIBUTION PANEL "DP4P" SECTION 1 SCHEDULE						PENTHOUSE
277/480 VOLTS	3 PHASE	4 WIRE				* AIC
MAIN BUS SIZE: 400 AMPS	NEUTRAL: 100%				GROUND BUS: FULL	
MAIN DEVICE: MLO	MOUNTING: SURFACE					
CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	PANEL 'P2P' VIA XFMR (EXISTING)	100	80	3	REFER TO TRANSFORMER SCHEDULE	1
2	HWP-1 (EXISTING) (5HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD 1
3	HWP-2, STANDBY (EXISTING) (5HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD 1

DISTRIBUTION PANEL "DP4P" SECTION 2 SCHEDULE						PENTHOUSE
277/480 VOLTS	3 PHASE	4 WIRE				* AIC
MAIN BUS SIZE: 400 AMPS	NEUTRAL: 100%				GROUND BUS: FULL	
MAIN DEVICE: MLO	MOUNTING: SURFACE				NOTE: FED THRU LUGS FROM DP4P SECTION 1 INSTALLED UNDER SHELL AND CORE PHASE	
CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
9	AHU-1 (64FLA)	100	100	3	3#4 & 1#6G - 1 1/4"C	VIA VFD
10	EAHU-1 (50FLA)	100	100	3	3#4 & 1#6G - 1 1/4"C	VIA VFD
11	CT-1 (20HP)	100	60	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD
12	HEAT TRACE	100	20	3		-
13	AC-1 (1.5HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	-
14	SPARE	100	30	3		
15	SPARE	100	30	3		
16	HRW (1/2HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD
17	CBWP-7 (1.5HP)	100	15	3	REFER TO MOTOR WIRING SCHEDULE	-
18	CBWP-5 (1HP)	100	15	3	3#10 & 1#10G - 3/4"C	-
19	CBWP-6 (1HP)	100	15	3	3#10 & 1#10G - 3/4"C	-
20	SPACE	100	-	3		

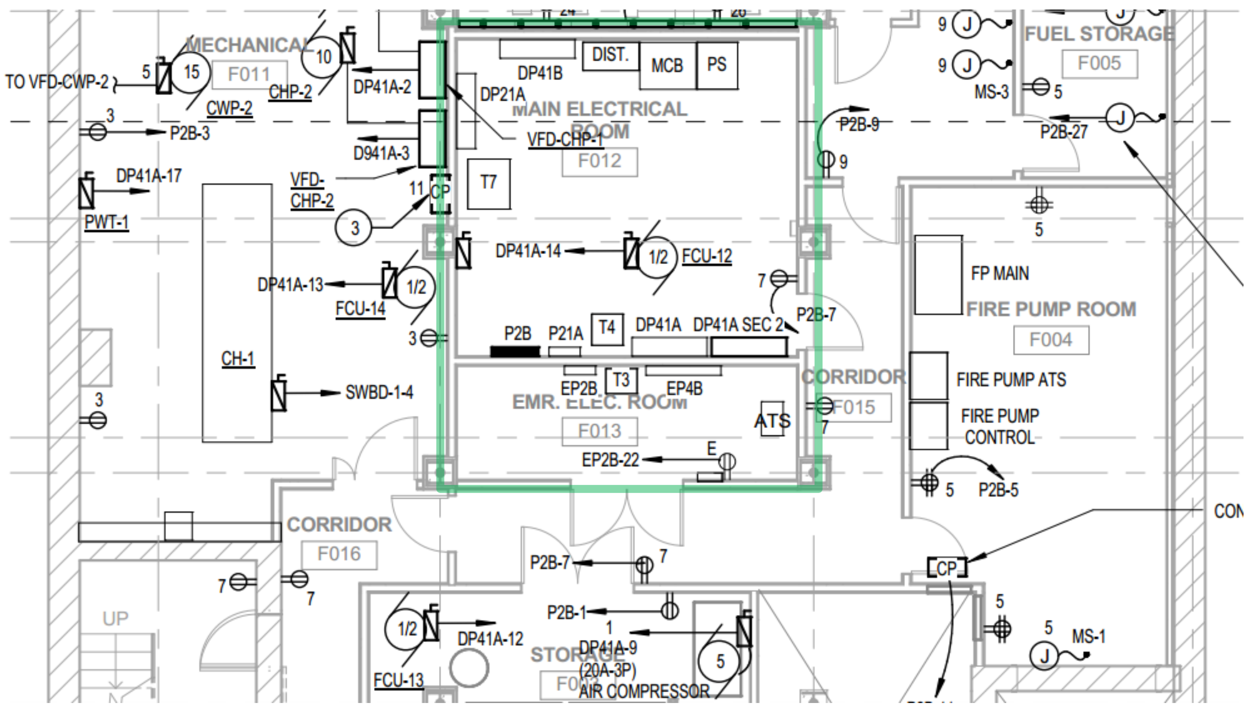
DP2P: 120/208V, 3 phase, 4 Wire, surface mounting

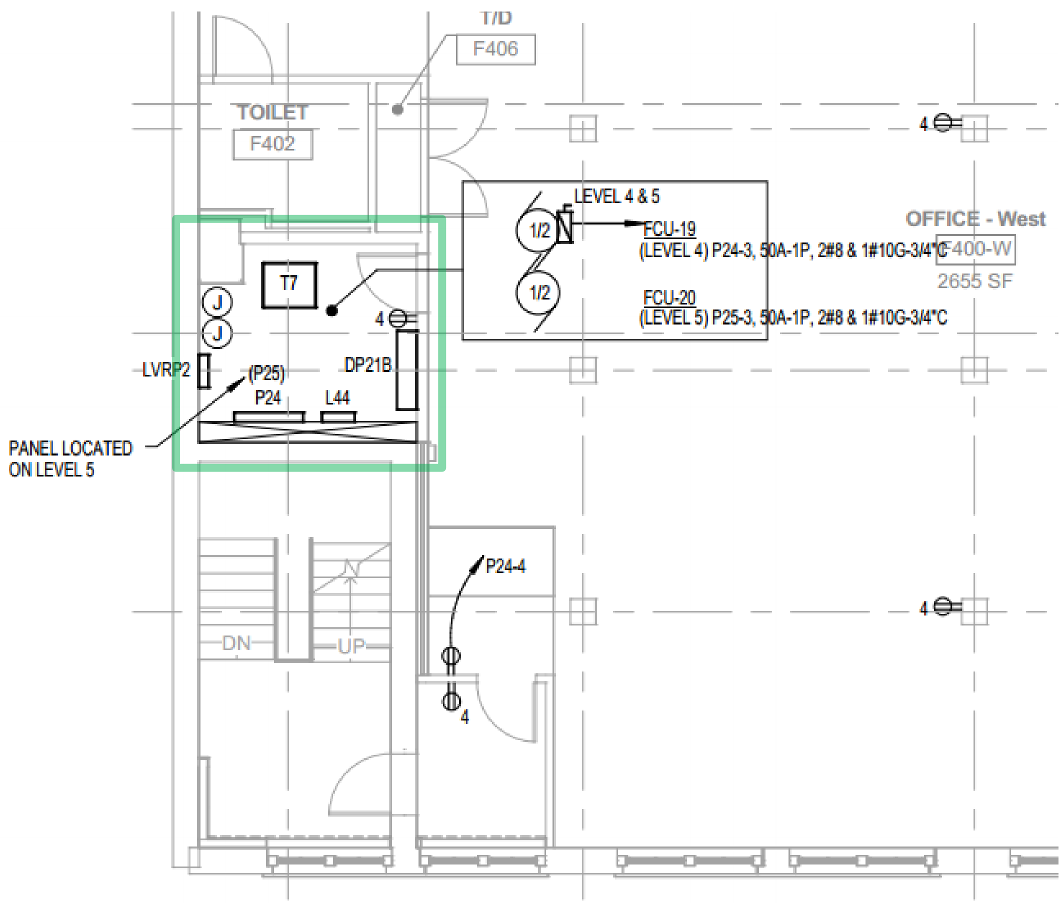
DISTRIBUTION PANEL "DP2P" SCHEDULE						PENTHOUSE
120/208 VOLTS	3 PHASE	4 WIRE				* AIC
MAIN BUS SIZE: 800 AMPS	NEUTRAL: 100%				GROUND BUS: FULL	
MAIN DEVICE: 500 AMPS	MOUNTING: SURFACE					
CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	CLIMATIC CHAMBER	100	100	3	6	
2	HYGROTHERMAL ENV. TEST	100	100	3	6	
3	SPARE	100	100	3		
4	SPACE AND HARDWARE	100	-	3		
5	SPACE AND HARDWARE	100	-	3		
6	SPACE AND HARDWARE	100	-	3		

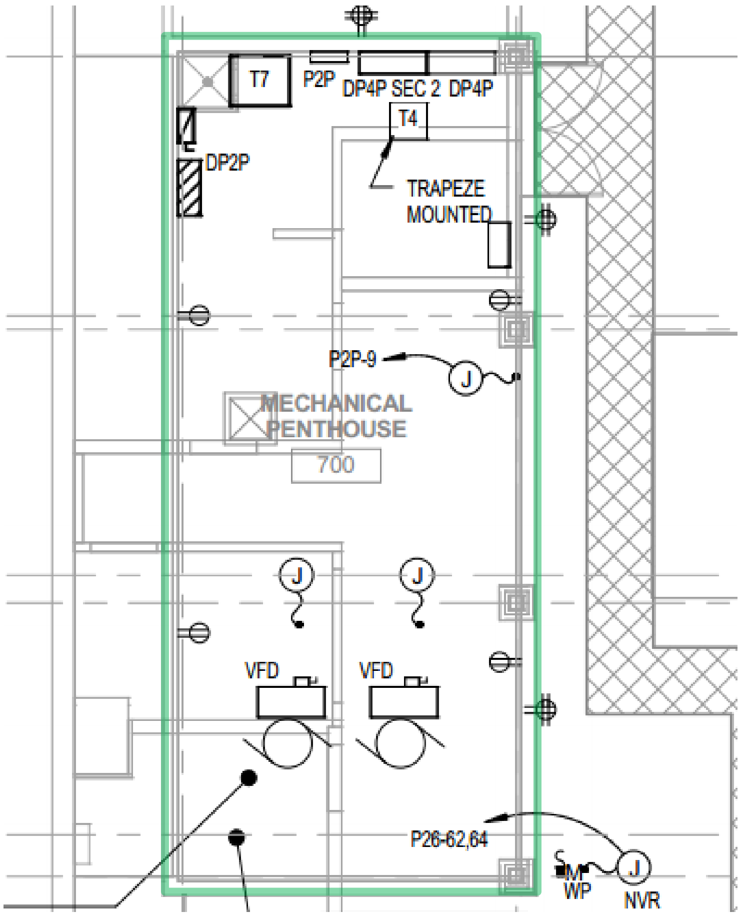
DP41A: 277/480V, 3 phase, 4 Wire, MLO, surface mounting

DISTRIBUTION PANEL "DP41A" SECTION 1 SCHEDULE						LEVEL 1
277/480 VOLTS	3 PHASE	4 WIRE				* AIC
MAIN BUS SIZE: 400 AMPS	NEUTRAL: 100%			GROUND BUS: FULL		
MAIN DEVICE: MLO	MOUNTING: SURFACE					
CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	PANEL 'P21A' VIA XFMR	100	80	3	REFER TO TRANSFORMER SCHEDULE	1
2	CHP-1 (10HP)	100	30	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD
3	CHP-2 (10HP)	100	30	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD
4	CWP-1 (15HP)	100	60	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD
5	CWP-2 (15HP)	100	60	3	REFER TO MOTOR WIRING SCHEDULE	VIA VFD
6	ENVIRONMENTAL TEST CHAMBER 03	100	100	3	6	–

DISTRIBUTION PANEL "DP41A" SECTION 2 SCHEDULE						LEVEL 1
277/480 VOLTS	3 PHASE	4 WIRE				* AIC
MAIN BUS SIZE: 400 AMPS	NEUTRAL: 100%			GROUND BUS: FULL		
MAIN DEVICE: MLO	MOUNTING: SURFACE			NOTE: FED THRU LUGS FROM DP4P SECTION 1 INSTALLED UNDER SHELL AND CORE PHASE		
CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
7	ENVIRONMENTAL TEST CHAMBER 04	100	100	3	6	–
8	MODULE LAMINATOR	100	30	3	3#10 & 1#10G – 3/4"C	–
9	AIR COMPRESSOR (5HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	–
10	PV STRINGER-SOMONT	100	20	3	4#12 & 1#12G – 3/4"C	–
11	SPARE	100	30	3		–
12	FCU-13 (1/2HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	–
13	FCU-14 (1/2HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	–
14	FCU-12 (1/2HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	–
15	S-1 (3HP)	100	20	3	REFER TO MOTOR WIRING SCHEDULE	–
16	CBWP-1 (1/2HP)	100	30	3	REFER TO MOTOR WIRING SCHEDULE	–
17	PWT-1	100	20	1	3#12 & 1#12G – 3/4"C	–
18	FCU-2A (3HP)	100	20	3	3#12 & 1#12G – 3/4"C	–
19	FCU-2B (3HP)	100	20	3	3#12 & 1#12G – 3/4"C	–
20	CBWP-3 (1HP)	100	15	3	3#10 & 1#10G – 3/4"C	–
21	CBWP-4 (1HP)	100	15	3	3#10 & 1#10G – 3/4"C	–
22	CBWP-2 (1HP)	100	15	3	REFER TO MOTOR WIRING SCHEDULE	–
23	SPARE	100	20	3		


MECHANICAL
F011
TO VFD-CWP-2
CWP-2
CHP-2
DP41A-2
D941A-3
P2B-3
DP41A-17
PWT-1
VFD-CHP-2
CH-1
DP41A-13
FCU-14
SWBD-1-4
DP41B
DIST.
MCB
PS
DP21A
MAIN ELECTRICAL ROOM
F012
VFD-CHP-1
T7
DP41A-14
FCU-12
P2B
P21A
T4
DP41A
DP41A SEC 2
P2B-7
EP2B
T3
EP4B
EMR. ELEC. ROOM
F013
ATS
EP2B-22
CORRIDOR
F015
FUEL STORAGE
F005
MS-3
P2B-9
P2B-27
FP MAIN
FIRE PUMP ROOM
F004
FIRE PUMP ATS
FIRE PUMP CONTROL
P2B-5
CORRIDOR
F016
UP
P2B-7
P2B-1
DP41A-12
FCU-13
STORAGE
DP41A-9
(20A-3P)
AIR COMPRESSOR
MS-1


T/D
F406
TOILET
F402
T7
LVRP2
(P25)
P24
L44
DP21B
PANEL LOCATED ON LEVEL 5
LEVEL 4 & 5
FCU-19
(LEVEL 4) P24-3, 50A-1P, 2#8 & 1#10G-3/4"C
FCU-20
(LEVEL 5) P25-3, 50A-1P, 2#8 & 1#10G-3/4"C
OFFICE - West
F400-W
2655 SF
P24-4
DN
UP



Panelboards	Volt	Main Breaker
P2B	120/208	MLO
P21B	120/208	MLO
P24	120/208	MLO
P22	120/208	MLO
P23	120/208	MLO
P25	120/208	MLO
P26	120/208	MLO
L42	277/480	MLO
L44	277/480	MLO
P22A	120/208	-
EP4B	277/480	MLO
P21A	120/208	MCB
P2P	120/208	MCB
EP2B	120/208	MCB

Transformer

In the main electrical room in the basement, it provides standard 75kVA, 1-phase, 480V primary, 220V secondary, step-down transformer.

DRY TYPE TRANSFORMER SCHEDULE								
SIZE	KVA	PRIMARY AMPS	SECONDARY AMPS	480 VOLT OVERCURRENT SEE NOTE 2	208 VOLT OVERCURRENT SEE NOTE 3	480V PRIMARY FEEDER	120/208V SECONDARY FEEDER	GROUNDING CONDUCTOR SEE NOTE 4
T1	9	11	25	20A, 3P	30A, 3P	3-#12 & 1-#12G IN 3/4"C	4-#10 & 1-#8G IN 3/4"C	1-#8 IN 3/4"C
T2	15	18	42	30A, 3P	50A, 3P	3-#10 & 1-#10G IN 3/4"C	4-#6 & 1-#8G IN 1"C	1-#8 IN 3/4"C
T3	30	36	83	60A, 3P	100A, 3P	3-#4 & 1-#10G IN 1"C	4-#1 & 1-#6G IN 1 1/2"C	1-#6 IN 3/4"C
T4	45	54	125	80A, 3P	150A, 3P	3-#3 & 1-#8G IN 1 1/4"C	4-#1/0 & 1-#6G IN 2"C	1-#6 IN 3/4"C
T5	75	90	208	150A, 3P	250A, 3P	3-#1/0 & 1-#6G IN 1 1/2"C	4-#250 KCMIL & 1-#2G IN 3"C	1-#2 IN 3/4"C
T6	112.5	135	313	250A, 3P	400A, 3P	3-#250 KCMIL & 1-#4G IN 2 1/2"C	4-#600 KCMIL & 1-#1/0G IN 4"C	1-#1/0 IN 3/4"C
T7	150	181	417	300A, 3P	500A, 3P	3-#350 KCMIL & 1-#4G IN 3"C	8-#250 KCMIL & 2-#1/0G IN 2 - 3"C	1-#1/0 IN 3/4"C
T8	225	270	625	400A, 3P	800A, 3P	3-#500 KCMIL & 1-#3G IN 3 1/2"C	8-#600 KCMIL & 2-#3/0G IN 2 - 4"C	1-#3/0 IN 3/4"C
T9	300	361	834	600A, 3P	1000A, 3P	6-#350 KCMIL & 2-#1G IN 2 - 3"C	12-#400 KCMIL & 3-#3/0G IN 3 - 3"C	1-#3/0 IN 3/4"C
T10	500	600	1400	1000A, 3P	1600A, 3P	9 #400 KCMIL & 3-#2/0G IN 3 - 3"C	16-#600 KCMIL & 4-#300 KCMIL G IN 4 - 4"C	1-#300 KCMIL IN 1"C

Feeders: The main feeder uses XHHW/XHHW-2 copper conductors

LEGEND OF FEEDER SIZES COPPER CONDUCTORS - XHHW/XHHW-2					
FEEDER SYMBOL	CONDUCTORS (3 PHASE, 3 WIRE WITH GROUND)	RACEWAY SIZE CONDUIT	CONDUCTORS (3 PHASE, 4 WIRE WITH GROUND)	RACEWAY SIZE CONDUIT	NOMINAL AMPERE RATING
1	3#4 & 1#10G.	1"			60
2			4#4 & 1#10G.	1 1/4"	
3	3#4 & 1#8G.	1"			70
4			4#4 & 1#8G.	1 1/4"	
5	3#1 & 1#8G.	1 1/2"			100
6			4#1 & 1#8G.	1 1/2"	
7	3#1/0 & 1#6G.	1 1/2"			125
8			4#1/0 & 1#6G.	2"	
9	3#1/0 & 1#6G.	2"			150
10			4#1/0 & 1#6G.	2"	
11	3#2/0 & 1#6G.	2"			175
12			4#2/0 & 1#6G.	2"	
13	3#3/0 & 1#6G.	2"			200
14			4#3/0 & 1#6G.	2 1/2"	
15	3#4/0 & 1#4G.	2 1/2"			225
16			4#4/0 & 1#4G.	2 1/2"	
17	3#250 KCMIL & 1#4G.	2 1/2"			250
18			4#250 KCMIL & 1#4G.	2 1/2"	
19	3#350 KCMIL & 1#4G.	3"			300
20			4#350 KCMIL & 1#4G.	3"	
21	3#500 KCMIL & 1#3G.	3"			350
22			4#500 KCMIL & 1#3G.	3 1/2"	
23	3#600 KCMIL & 1#3G.	3 1/2"			400
24			4#600 KCMIL & 1#3G.	4"	
25	6#250 KCMIL & 2#2G.	2-2 1/2"			500
26			8#250 KCMIL & 2#2G.	2-3"	
27	6#350 KCMIL & 2#1G.	2-3"			600
28			8#350 KCMIL & 2#1G.	2-3"	
29	6#600 KCMIL & 2#1/0G.	2-3 1/2"			800
30			8#600 KCMIL & 2#1/0G.	2-4"	
31	9#400 KCMIL & 3#2/0G.	3-3"			1000
32			12#400 KCMIL & 3#2/0G.	3-3 1/2"	
33	9#600 KCMIL & 3#3/0G.	3-3 1/2"			1200
34			12#600 KCMIL & 3#3/0G.	3-4"	
35	12#600 KCMIL & 4#4/0G.	4-3 1/2"			1600
36			16#600 KCMIL & 4#4/0G.	4-4"	
37	15#600 KCMIL & 5#250 KCMIL G.	5-4"			2000
38			20#600 KCMIL & 5#250 KCMIL G.	5-4"	

The conductors and conduit information is cannot be found in for this project because the owner doesn't not provide specification for this project.

8. Optional Back-up Power

This project does not include any other optional back-up power system, according to the single line diagram.

9. Special/Communications Systems

Information on this topic cannot be found in the drawings. Owner can't provide the author with the specification documents. Therefore some information can't be obtained about the communication system.

The building has fire alarm system but not integrated with any other special building control system.

10. Dedicated Electrical and Communication Systems Spaces in Building

The following rooms are dedicated to be the electrical room or building support fire command room.

ROOM	AREA (sf)
F012	306.1
F013	100.5
F103	60.6
F105	96.7
F203	101.4
F303	104.1
F503	107.3
F603	96

11. Energy Cost Saving or Energy Reduction Techniques

The building utilized solar photovoltaic arrays as its main energy reduction techniques. Since the owner company of the building is an organization that dedicates in developing energy saving building technologies, the company has PV labs in the building as well as PV arrays on the rooftop and façade not only for building power distribution but also used as research purposes.

12. Existing Distribution System Single Line Diagram

See Appendix A

Evaluations Of As-Designed System Against The Criteria And Suggestion Of Potential Changes

1. Compare Estimated and Actual Connected Building Loads

The actual lighting load is much lower than the estimated load. This is likely due to that the estimated load is mean to aim a higher load for sizing the feeders. While in the actual design, most lighting fixtures are LED, therefore the actual lighting load is much lower. But the receptacle load is much higher than the estimated load. It is probably because a lot of the lab research equipment is counted into the receptacle load. The actual HVAC load is relatively closed to the estimated value. But this could be off because in the panel board schedule all the equipment load is calculated together as one load and HVAC is not calculated separately. The total actual load is lower than the actual load.

Loads	Estimated (kVA)	Actual (kVA)
Lighting	147.5	49.6
Receptacle	42.2	131.9
HVAC	295	240.3
TOTAL	**487.7**	**421.8**

2. Power Company Rate Schedule

After a simple research about the power supply options in Boston area, there isn't any competitive alternatives for the power company choice other than NSTAR, which serves both residential and business electricity in almost the entire Boston area.

3. Building Utilization Voltage and Fundamental Distribution Concepts

The building works on 277V power is efficient as designed in the actual project. In the actual project the lighting and HVAC system used both 120V and 277V, which provide good flexibility so that a variety of equipment can be used in the building. This design requires good transformer performance and reliable power quality to ensure the load to function properly. It's probably no the more cost efficient design solution.

4. Emergency Power System

The current design fuel and power source for the emergency power supply is diesel. It is a less expensive source and the relatively ease of application. And it is widely used in commercial buildings emergency power sources. So not much suggestion I would made for this system. While there is an alternative option of using turbine generator, typically powered by natural gas. This generator sets are generally lighter weight and run more quietly, with lower installation cost. But the sets is more expensive.

5. Electrical Equipment Suggestion

There is not sufficient information obtained for this project. Due to the fact that most of the equipment of this building fit-out project, there is no documented specifications for the building. Therefore, limited information can only be accessed from electrical drawings.

I suggested the panel boards should be designated into different usages by different kinds of loads. In the current panelboard design, there are two lighting panelboards and one emergency panelboards. HVAC load are calculated together with the entire equipment load distributed in several panelboards. It will be better and clearer to have panelboards just for HVAC loads.

6. Optional Back-up Power and UPS System

There is no designed optional back-up power or UPS system in the current building electrical design. The building doesn't have data center or telecommunication equipment, so an UPS back-up system is not as necessary.

7. Suggestion to Reduce the Cost of Ownership

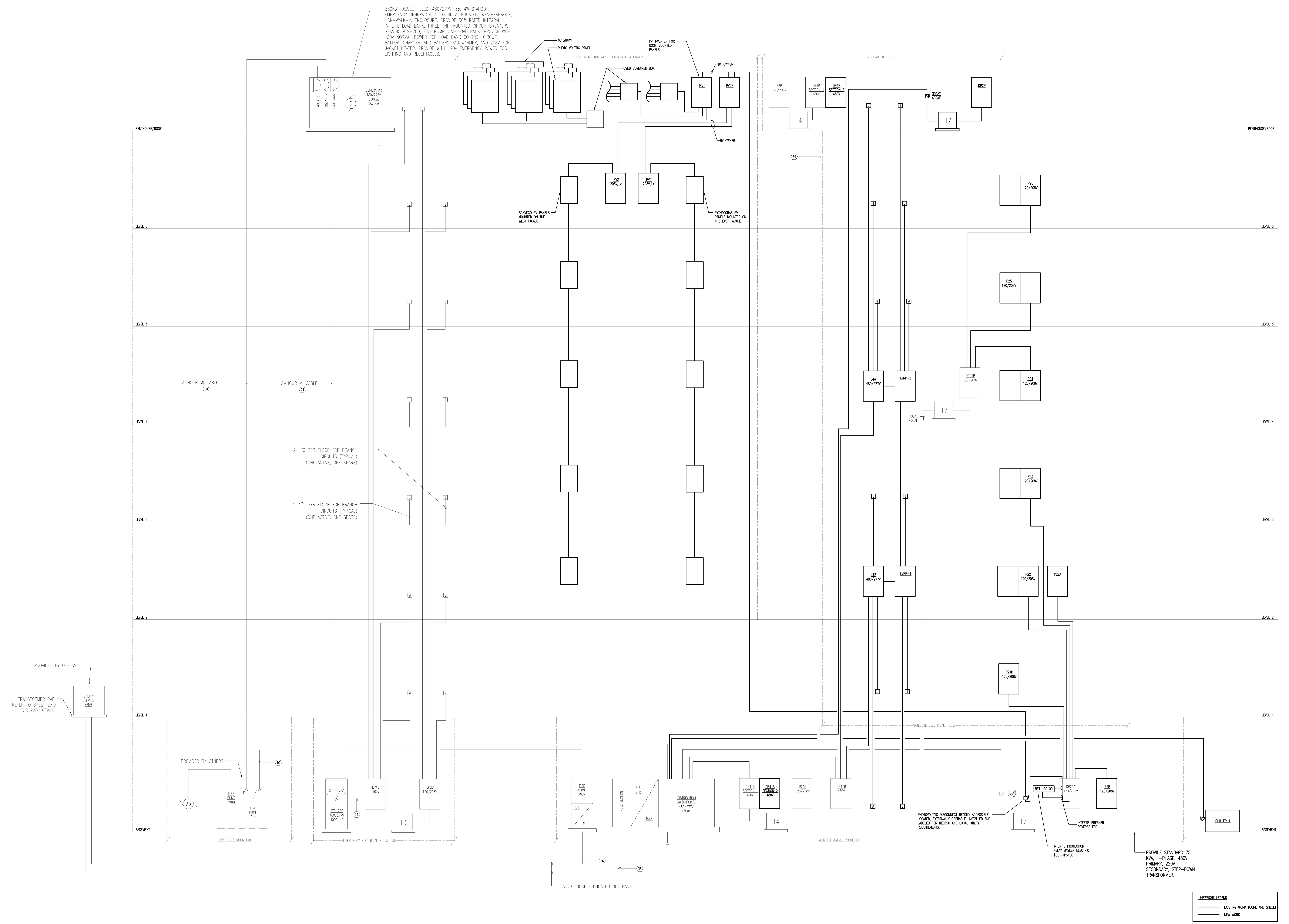
In a tenant fit-out project, make the usage of the existing equipment and condition could save cost in the equipment. And reduce the feeder sizes and number of transformers would reduce the initial cost.

8. Improve Energy Saving Design Technology

The Fraunhofer is an organization that is professional in improving the building design technology. In the building, it already utilizes photovoltaic arrays, and also has PV lab that constantly testing and improving the photovoltaic technology. It can integrate with demand respond into the building system, as to keep record on how my energy is used in the building system, leverage the load and create a smarter building environment to save energy and then save cost eventually. Using the smart automatic building control system, the building can save energy in all kinds of loads. And after all the owner will be able to manage the building energy usage throughout the time and improve the efficiency in the building.

Appendix A

Single line diagram



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Economic Development Authority (EDA)
U.S. DEPARTMENT OF COMMERCE
1401 Constitutuion Avenue NW
Suite 7800
Washington, DC 20230

DiMella Shaffer
Architecture | Interior Design | Planning
281 Summer Street Tel 617.426.5004
Boston, MA 02210 Fax 617.426.0046

OWNER:
FRAUNHOFER CSE 617.575.7250

Structural Engineer
MCNAMARA/SALVIA, INC. 617.737.0040

MEP/FP/Tel Data Engineer
BR+A CONSULTING ENGINEERING 617.254.0016

Code Consultant
C3, INC. 617.330.9390

Lighting Consultant
LAM PARTNERS 617.354.4502

CERTIFICATIONS

KEY PLAN

N

REVISION NOTES

MARK	DATE	DESCRIPTION
	04/29/2011	SCHEMATIC DESIGN
	06/17/2011	DESIGN DEVELOPMENT
	03/30/2012	CONSTRUCTION SET
	04/20/2012	ADDENDUM #1
	07/10/2012	ASI TI 001
	08/10/2012	ADDENDUM #3

GRAPHIC SCALE

CONTRACTORS	A / E CON. NO.	
	A / E TASK NO.	
	CONS. CONSTR.	
	CONS. WORK	
	PRIME A / E	
	SUB A / E	
	CONSTR. CON.	
BUILDING	NAME	FRAUNHOFER
	STREET	5 CHANNEL CENTER STREET
	CITY / ST. / ZIP	BOSTON, MA 02210
	BUILDING NO.	
	OTHER BUILDING NOs	
	FACILITY CODE	
PROJECT	PROJECT TITLE	FRAUNHOFER BOSTON, MA
	PROJECT DESCRIPTION	FRAUNHOFER CSE
	EDA PROJ. NO.	01-01-08808
	D.S. PROJ. NO.	2010003.00
	SUBMISSION	RECORD DRAWINGS
	SUB. DATE	03/25/2013
DRAWING	DRAWING TITLE	ELECTRICAL RISER DIAGRAM
	FILE NAME	
	FLOOR NO.	
	DRAWN BY	NM DATE DRAFTED: 03/30/2012
	CHECKED BY	PC SHEET SIZE 30 X 42
	DRAWING NO.	E3.0TI
		DISCIPLINE SHEET TYPE SEQUENCE
		SHEET OF

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