Tech Report 2:

Electrical System Existing Conditions

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14 October, 2013
University of Maryland: Prince Frederick Hall

Executive Summary

This document contains three sections to: formulate criteria for the future re-design of Prince Frederick Hall, provide details on the existing electrical system, and evaluate that system. As a university building, the systems designed for it need to have the durability to last a long time. They need to be easily maintained and renovated as future changes occur. The current design of the building reflects that idea. The distribution system is simple and functional.

Where the current design falls short is in its effort to promote sustainability. Prince Frederick Hall is designed to be a LEED Gold building, but not much is done by the electrical systems that indicates this. My future studies of the building will involve consideration of different ways that sustainability can be incorporated into this design.

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Introduction

Prince Frederick Hall is an 8 storey building on the University of Maryland's campus. The first floor has some living quarters for students, but mostly classrooms and university common space. The 2nd-7th floors are entirely dormitory housing, with amenities such as: two study lounges, a laundry room, and common bathrooms, on each floor. The roof is not accessible to students as it is used for mechanical equipment and the emergency generator. The ground floor has some classroom space, as well as offices for faculty and maintenance staff. The main mechanical and electrical rooms are also located on the ground floor; this is where campus-provided utilities enter the building.

Criteria & Scope

The following section outlines basic criteria for future re-design of this building's electrical system. Important sections from the NEC are addressed, such as: estimated load calculations, special occupancy requirements, and emergency power requirements.

1. Load Calculation

Perform a Preliminary electrical load calculation based on the building type, per square foot NEC lighting and receptacle loads and demand factors, air conditioning and heating fuel sources and special equipment anticipated. Additional per square foot load information for HVAC systems will need to be researched and identified.

dwelling unit load: **452,795 VA**

Electrical Calculations for Dwelling Units						
	No of Units	Total SF	Total Demand Load	*Kitchen*	*Bathroom(s)*	*Laundry*
Apartments	2	2430	63640	*Y*	*Y*	*Y*
Single Suites	3	1121	3149	*N*	*Y*	*N*
Double Suites	42	34350	94346	*N*	*Y*	*N*
Typ. Dorms	162	45282	138270	*N*	*N*	*N*
Common Laundry	21		38850			
HVAC (local)	249		114540			
			452,795	VA		

non-dwelling area load: **2,087,492 VA**

Electrical Calculations for Non-Dwelling			
	note:	Total Demand Load	
Lighting	*this area includes all office, classroom, storage, and mechanical spaces*	471460	
Receptacles		57384	
HVAC		1361082	
Misc. Mechanical		197566	
		2,087,492	VA

Using spreadsheets provided by www.electrical-knowhow.com and the method outlined by the 2011 NEC, I estimated the total building demand for Prince Frederick Hall. A summary of my calculations can be seen above; for full detail calculations, please see appendix page 17.
estimated total building demand load: **2,540,287 VA**

2. Power Company

Identify the power company serving the building location.

Pepco is the power company that supplies power to the University of Maryland, but the university is the provider for this specific building.

3. Rate Schedule

Make a preliminary rate schedule selection and identify the service voltage.

Service voltage to the building is 13,200 V medium voltage from the university's power grid. No rate schedule can be determined for this building.

4. Building Utilization Voltage

Select the preliminary Building Utilization Voltage and what voltage would serve each of the following loads:

- ➔ Lighting: indoor 120V
  outdoor 277V
- ➔ Receptacles: 120V for normal power
  208V for specific equipment like: dryers, kitchen equipment, and server racks, etc.
- ➔ Equipment: most mechanical equipment will be run at 480V

5. Emergency Power Requirements

Identify Emergency Power Requirements based on the IBC and your building use and occupancy, and estimate the loads and preliminary voltage and fuel source selection.

Safety systems in this building are governed by the 2009 IBC and IRC. Emergency power is required for: egress lighting, exit signs, and emergency voice/alarm communication systems in Group A occupancies. And standby power is required for: smoke control systems, and accessible means of egress elevators. Emergency power is easiest to provide with an on-site generator. This could either be diesel or natural gas-fired. Because the generator will have to run some fans and mechanical loads, it should be 277/480V to handle these loads. Some loads it will run are:

➔ the fire pump	23,920 VA
➔ emergency egress lighting	10,500 VA
➔ the elevator controllers	48,000 VA
➔ smoke evacuation fans	38,941 VA
➔ smoke dampers	700 VA
➔ firefighter receptacles	70,000 VA
➔ **estimated required load**	**192,061 VA**

6. Special Occupancy Requirements

Identify any potential Special Occupancy Requirements based on Chapter 5 of the NEC (simply list them based on the table of contents).

Two classrooms on the first floor are considered **assembly** spaces because they are designed to hold over 100 people. No other special occupancies apply.

7. Special Equipment

Identify any potential Special Equipment based on Chapter 6 of the NEC (simply list them based on the table of contents).

➔ electric signs:	maybe used for future design
➔ manufactured wiring systems:	maybe used for future design
➔ elevators:	necessary in 7 storey building
➔ solar photovoltaic systems:	maybe used for future design
➔ fuel cell systems:	maybe used for future design
➔ small wind electric systems:	maybe used for future design

8. Priority Assessment

Based on your building type and use, provide a priority assessment (Low/Med/High) for the following characteristics:

RELIABILITY

Med: Systems will have to withstand many different students using them. While the systems are not critical, they will have to be durable.

POWER QUALITY

Low: There will likely be many computers using the power circuits, but other than that, power quality is not extremely important.

REDUNDANCY

Low: Safety systems must function properly, but the main spaces in this building are classrooms and dorm rooms, neither are essential spaces.

INITIAL COST

Med: Extra costs could possibly be passed onto students, and should be minimized as much as possible, but the building will be around long enough to payback efficient systems.

LONG TERM OWNERSHIP COST

High: As a university building, Prince Frederick Hall is likely to be under operation for a very long period of time.

FLEXIBILITY

Med: The long term nature of this building means that it must be able to adapt to future generations needs.

9. Back-Up Power

Identify loads in the building that may desire Optional Back-up Power and determine if those loads should be provided back-up by a generator (long term) or UPS (short term) or both, and estimate the loads.

Back-up power is not necessary for any areas of this building; however, in the event of a long-term power outage, it might benefit the comfort of the building's residents to have certain non-essential systems on back-up. Some systems to consider for back-up power:

➔ tel/data connectivity	4,000 VA
➔ selected receptacles	37,620 VA (with one/room)
➔ lighting within dormitory rooms	10,868 VA

10. &11. Special Systems

Identify potential special/communications systems from the list below:

TELEPHONE/DATA

Telephone will be necessary for parts of the building, and data will be critical for all areas.

FIRE ALARM

Required throughout the building.

CATV

This will used to supply wired data connections and wireless access points.

INTERCOM

This system will probably not be used.

ACCESS CONTROL

To provide secure housing to the residents of the building, access will be controlled to residential floors and to the rooms themselves.

SECURITY

The primary security system will be access control, but cameras could be used to augment security in some areas.

12. Major Equipment

Identify major equipment that will require space in the building.

Mechanical and electrical equipment will require space in the sub-basement and ground floor. Some mechanical equipment includes: pumps, air handling units, rooftop units, vav boxes and fan coil units. Electrical equipment in the building includes: switchgear, switchboards, transformers, and generator. Some other specialty equipment is: server racks, and fire protection systems.

Existing Conditions

The existing electrical service to Prince Frederick Hall is provided by the University of Maryland. This section will further discuss this service, along with more detailed building loads, emergency systems, and other special systems.

1. Building Load

Calculate the actual connected building loads, summarized in the following categories:

LIGHTING

➔ **49,379** VA	Switchgear #2	lighting

RECEPTACLE & POWER

+ 1,030,374 VA	Switchgear #1	power
+ 484,119 VA	Switchgear #2	power
+ 212,796 VA	Switchgear #2	receptacle
+ 1,300 VA	Switchgear #2	appliances
➔ **1,728,589** VA		

MECHANICAL

+ 6,048 VA	Switchgear #1	HVAC
+ 61,594 VA	Switchgear #2	HVAC
+ 50 VA	Switchgear #2	motor
+ 17,349 VA	Switchgear #2	cooling

+ 36,000 VA	Switchgear #2	heating
➔ **121,041** VA		

OTHER EQUIPMENT

+ 592,885 VA	Switchgear #1	other
+ 432,539 VA	Switchgear #2	other
+ 55,000 VA	Switchgear #2	fire receptacle
➔ **1,080,424** VA		

TOTAL

➔ **2,979,433** VA

2. Rate Schedule

Identify the actual power company rate schedule in place and service voltage.

There is no specific rate schedule for this building as it is a University campus building; however, Pepco is the power supplier for the University of Maryland.

3. Building Utilization Voltage

Determine the Building Utilization Voltage, describe the fundamental design concept verbally including what voltage serves each of the following loads:

- ➔ Lighting: all indoor 120V
  all outdoor 277V
- ➔ Receptacles: most are 120V
  some 208V for tel/data racks, dryers, kitchen equipment, and fire receptacles
- ➔ Equipment: AHU's at 480V
  pumps at 480V

4. Emergency Power Requirements

Identify and total all loads connected to the Emergency Power System, describe the power source, fuel source, size, voltage and describe the fundamentals of the Emergency Power Distribution System.

Emergency power is supplied by the university. Emergency circuits have their own breakers in the switchgear. Additionally, a 350kW (600 A CB) natural gas generator is located on the roof of the building to power:

- ➔ egress lighting & exit signs
- ➔ smoke evacuation fans & dampers
- ➔ elevator controllers & cab lighting
- ➔ sewage pump
- ➔ fire pump
- ➔ firefighter receptacles
- ➔ tel/data racks

The main feed from the generator is connected to a series of three disconnect switches. One goes to the fire pump. The next goes to an emergency panel that feeds: smoke evacuation fans, smoke dampers, and elevator cab lighting. The third disconnect switch feeds another emergency panel that provides power via a series of distribution panels to residential floor egress lighting, elevator pit receptacles, elevator sump pumps, sewage pump, tel/data racks, and firefighting receptacles.

5. Special Occupancy Requirements

Identify any Special Occupancy Requirements found in the design documents (drawings and specifications) based on Chapter 5 of the NEC (simply list them based on the NEC table of contents) and where you found them (drawings or specifications).

The building is broken into four IBC occupancy types:

- ➔ residential: R-2 1st floor, 2nd-7th floors
- ➔ assembly: A-3 ground floor, 1st floor, 2nd-7th floors
- ➔ business: B ground floor, 1st floor
- ➔ storage: S-2 lower level SCUB, ground floor, 1st floor

The special occupancy types that apply from the NEC are for the assembly spaces. In the case of NEC, assembly spaces are only for the "gathering together of 100 or more persons" (518.1), so this governs 2 classrooms on the first floor.

6. Special Equipment

Identify any Special Equipment found in the design documents (drawings and specifications) based on Chapter 6 of the NEC (simply list them based on the NEC table of contents) and where you found them (drawings or specifications).

- ➔ elevators: 5 located throughout the building

7. Building Equipment

Determine and document the following based on the design documents (drawings and specifications, most of this information will typically be found in the specifications). Include voltage and phase for each.

MAIN SERVICE EQUIPMENT

The building is connected to the University of Maryland's medium voltage (13,200V) power grid. (2) ductbanks serve as the connection from this grid to Prince Frederick Hall:

- ➔ (1) 4 way concrete encased ductbank with 4- 5" PVC conduits, (2) sets of (3) 500kcmil + 2/0G (15KV cable)
- ➔ (1) 2 way concrete encased ductbank with 2- 5" PVC conduits, (1) sets of (3) 500kcmil + 2/0G. (15KV cable)

MAIN SERVICE TRANSFORMERS

(2) 3000kVA (13.8kV - 480/277V) liquid filled transformers, measuring 117" X 91", are located on a concrete pad outside on the north side of the building.

MAIN SERVICE DISTRIBUTION

The main feed into the building, from the main service transformers, is (1) 12 way concrete encased ductbank with 12- 4" PVC conduits, (8) sets of (4) 500kcmil + 2/0G. This provides (480/277V) power to switchgear#1 and switchgear#2, in the basement level, room M0226. Both are 3000A, 480/277V, 3PH, 4W each. Switchgear#1 is primarily for equipment, and switchgear#2 is primarily for lighting and power in occupied spaces. Distribution to the residential floors and mechanical pumps occurs through (4) switchboards.

DISTRIBUTION TRANSFORMERS

(9) transformers are located within the building:

- ➔ (4) are in the main electric room (room M0226), on the ground floor.

- T-3: 480V to 208Y/120V 3φ 30kVA
- T-4: 480V to 208Y/120V 3φ 75kVA
- T-5: 480V to 208Y/120V 3φ 500kVA [this feeds a switchboard]
- T-6: 480V to 208Y/120V 3φ 500kVA [this feeds a 2nd switchboard]

➔ (1) is also on the ground floor (emergency service room M0228), but is for emergency power.
  - T-7: 480V to 208Y/120V 3φ 150kVA

➔ (1) is also on the ground floor (electric room 0102), but located outside the main electric room.
  - T-8: 480V to 208Y/120V 3φ 112.5kVA

➔ (3) are on the roof (electric room 8212), (1) of those is for emergency power only and is connected to the generator.
  - T-9: 480V to 208Y/120V 3φ 45kVA
  - T-10: 480V to 208Y/120V 3φ 15kVA
  - T-11: 480V to 240/120V 1φ 25kVA

PANELBOARDS

On the dormitory floors, 250A panels distribute to (10) 100A panels [MP*floor*A-D and NP*floor*A-D]that provide power to receptacles and lights in the dorm rooms.

MAIN RISERS AND FEEDERS

(2) main risers feed power to the upper floors. Each of these comes from a 1600A panel [MDPNP &MDPMP].

CONDUCTORS

- main building feed: copper 500kcmil
- feeders: All copper. Stranded for No 8 AWG and larger, solid for No 10 AWG and smaller.
- branch circuits: All copper. Stranded for No 8 AWG and larger, solid for No 10 AWG and smaller. (Except VFC cable)

CONDUIT

- ductbanks: schedule 40 PVC
- raceways: ARC (aluminum rigid conduit), GRC (galvanized rigid steel conduit), and IMC (intermediate metal conduit)
- feeders: EMT (electrical metallic conduit), IMC (intermediate metal conduit), and RMC (rigid metal conduit)
- homeruns: EMT (electrical metallic conduit)
- local connections within rooms: MC cable

RECEPTACLES

Types of receptacles used: straight-blade, GFCI, twist-locking, and floor boxes. 1 in 10 receptacles to be hospital-grade TVSS.

SWITCH AND RECEPTACLE FACEPLATES

- finished spaces: stainless steel, satin finish
- unfinished spaces: stainless steel satin finish
- damp locations: cast aluminum
- specialty receptacles: painted to match device color
  - emergency power system receptacles: red
  - TVSS receptacles: blue

- isolated ground receptacles: orange

MOTOR STARTERS

Magnetic motor starters are used for: smoke, exhaust, and stair pressurization fans. Chillers use VSD-type starters.

UPS

Not used for this building.

8. Back-Up Power

Identify loads in the building that are provided with Optional Back-up Power and describe if those loads are connected to a back-up generator or UPS or both, and their loads, voltage and phase.

A 350kW natural gas generator is mounted on the roof. This provides power to required emergency loads, but a few loads are on the generator that are not required, such as the telecom/data racks.

9. & 10. Special Systems

Identify special/communications systems found in the design documents from the list below. Identify any of these systems that are integrated with each other or other special systems such as lighting control, BAS systems, demand shifting or demand management systems.

TELEPHONE/DATA

Telecom service is provided by the university. Main service entered the building on the northwest corner. Most outlets are dual tel/data outlets wired with Cat5e. All classrooms, first floor corridors, and study lounges have their own wireless access point. Data is distributed throughout the upper residential floors through two tel/data rooms on each floor. Dormitory rooms have coax connections and data connections, no telephone connections are provided in these areas.

FIRE ALARM

The main FACP is located on the first floor, in the fire alarm control room. The fire alarm control room is within the envelope of the building, but separated by a firewall and only accessible from a door on the outside. A FATC is located on each dormitory floor, and on the ground floor, in an electrical closet. Each dorm room is equipped with a alarm speaker, strobe, and smoke alarm.

INTERCOM

No system in this building.

ACCESS CONTROL

The main form of access control is through magnetic door contacts and card readers. Areas protected with this system are: mechanical and electrical rooms, tel/data rooms, all elevators, all access points on the first and ground floors, and all dormitory rooms. Residential floors have RF readers installed above the ceiling.

SECURITY

Three blue-light emergency phones are located around the outside of the building, not more than 600 feet away. Six exterior CCTV cameras are mounted around the perimeter, on the roof level, of the building; signal is provided to these cameras via 6-strand fibre.

EMERGENCY RADIO COVERAGE

An in-building radio amplification system will be installed to boost radio signals for emergency responders. This system is not yet designed, and is specified to be installed after building construction by a certified professional.

11. Systems Square Footage

Identify each of the dedicated electrical and communications systems spaces in the building, the total SF of those spaces, and calculate the percentage of the total building SF.

TELEPHONE/DATA

The only part of the building that doesn't have tel/data service is a few parts of the ground floor mechanical/electrical rooms. So many wireless access points mean that even rooms without wired connections, have data regardless. This means that approximately 90% of the building has access to telephone and/or data.

FIRE ALARM

All 100% of the building is protected by a fire alarm system.

INTERCOM

None.

ACCESS CONTROL

All access points into the building are secured with card readers, thus 100% of the building is protected with access control.

SECURITY

All grounds outside the building are monitored via security cameras.

EMERGENCY RADIO COVERAGE

TBD after building construction.

12. Energy Reduction

Identify any Energy Cost Savings or Energy Reduction techniques designed into the building electrical systems such as PV Arrays, Fuel Cells, Cogeneration, Demand Reduction, Demand Shifting, Wind Generation, etc. Is the Building LEED Certified.

This building planned to achieve LEED Gold. The electrical systems credits outlined in the specifications are:

- ➔ Credit EQ 4.1: VOC content of sealants
- ➔ Credit EQ 4: products must comply with requirements of the California Department of Health Services' VOC testing standard practice
- ➔ Credit EA 5: continuous metering of equipment for energy consumption data (for all VFD's)

13. Single Line Diagram

Provide a complete single line/riser diagram of the existing distribution system.

See appendix, page 16, for single line diagram.

System Evaluation

The current systems in the building are sufficient to provide safety and comfort to the occupants. Systems used in Prince Frederick Hall represent a standard for university building design that very much based on durability and longevity. However, this building is targeting a LEED Gold certification, and it seems like more could be done by the electrical systems to accomplish this.

1. Estimated vs Actual Loads

Compare your estimated and actual connected building loads and explain any differences and discrepancies.

LIGHTING
- ➔ actual: **49,379** VA

RECEPTACLE & POWER
- ➔ actual: **1,728,589** VA

MECHANICAL
- ➔ actual: **121,041** VA

OTHER EQUIPMENT
- ➔ actual: **1,080,424** VA

TOTAL
- ➔ actual: **2,979,433** VA

DWELLING UNITS
- estimated: **452,795** VA

NON-DWELLING AREAS
- estimated: **2,087,492** VA

TOTAL
- estimated: **2,540,287** VA

Two different methods were used to break down the different types of loads for each of the actual loads and estimated loads. The actual loads are based on the VA demand listed at the switchgear level. This was originally divided into categories (lighting, receptacle, mechanical and other) by the electrical engineer. My estimations are based on the NEC's method for calculating demand load. Because my building contains dwelling and non-dwelling spaces, I chose to divide my calculations in this way.

2. Power Company Rate Schedule

Power Company Rate Schedule – are other alternatives to the one in place available, and would you suggest investigating any changes to the rate schedule or service voltage and discuss why and how you would evaluate the alternatives and make a choice. Are there optional riders that could be taken advantage of to provide cost savings.

As power is supplied to this building via the University, rates are fixed.

3. Building Utilization Voltage

Building Utilization Voltage and fundamental distribution concepts – Would you suggest any changes and why you might suggest those changes. Describe how you would evaluate the options and make a choice. Look for design alternatives that, without changing the quality of materials, might provide cost savings, improve flexibility, improve reliability, or improve power quality. Address any effects those changes might have on the dedicated spaces required, mechanical systems, structural systems, etc.

I wouldn't suggest any changes to the building utilization voltages at this time. If changes occur in regards to equipment selection that require a different voltage, then I may need to revisit this aspect of design. However, I do not intend to change the voltage of any equipment that is already in place.

4. Emergency Power System

Emergency Power System- Are there any noted discrepancies between identified code requirements in Part 1 with the as-designed conditions. Would you suggest any changes, particularly to the power source or fuels source, describe why you might suggest those changes. Describe how you would evaluate the options and make a choice. Address any effects those changes might have on the dedicated spaces required, mechanical systems, structural systems, etc.

There is additional room on the roof of the building, where the current generator is located, if I should want to add capacity. This would potentially require a re-evaluation of the structural support in this area. The University of Maryland is also in the process of researching expanded use of fuel cells, so this might be a good option to look into as well. If this turns out to be a viable option, I would evaluate the two systems based on reliability, operation time, and maintenance costs.

5. Building Equipment

Based on your assessment in Part 1, Item 8, compared to your as-designed conditions, would you suggest any changes to the following items, and explain why you would suggest those changes. Address any effects those changes might have on the dedicated spaces required, mechanical systems, structural systems, etc.

MAIN SERVICE EQUIPMENT

I believe that the main electrical room could be organized better to streamline equipment locations. With the large voltages in this space, it is unlikely that any noticeable voltage drop would affect the system, but I would like to determine the reasoning for the current placement of equipment. This will help me decide if re-organization of the electrical room would produce any benefit.

DISTRIBUTION SYSTEM

There is not a need to change the distribution system at this time. As I make other changes throughout the building, this may need to be re-evaluated.

CONDUCTORS

Due to the long-term nature of this building, it was a good decision to use all copper wiring. I intend to continue this trend for any changes I make to the design.

CONDUIT

I do not intend to make any changes to existing conduit; any redesign I do will conform with the current design.

RECEPTACLES

Current specifications call for 1 in 10 normal power receptacles to be TVSS type receptacles

SWITCH AND RECEPTACLE FACEPLATES

These are specified to match university standards, I will not make any changes to these.

MOTOR STARTERS

If more efficient options seem reasonable, I would consider estimating a ROI for this component of the building; however, this will most likely fall outside my scope.

UPS

The occupancies in this building are such that a UPS system would not be very beneficial, and it would add a lot of extra expense.

6. Back-Up Power

Optional Back-up Power and UPS systems – Describe any changes you might suggest and explain why.

Internet connectivity is currently provided on the back-up generator. That the the only non-required system that is on the generator, and it seems like this would be the most important to the residents of the building. As it is unlikely that power would be down for very long, I would not suggest additional changes to this system.

7. Cost of Ownership

Identify changes that could reduce the cost of ownership – more efficient transformers, UPS systems, VSD's, higher quality equipment. Describe how you would evaluate those changes.

As reliability is the most important aspect of the systems, I would like to research the use of more efficient equipment for this building. This could include components like transformers, motors, or generators. Since the building will potentially have many years to recoup the costs of more efficient equipment, I will use ROI calculations to evaluate if something is worth the university's investment. Additionally, I believe that optimized lighting controls would reduce the cost of ownership for the university.

8. Additional Systems

Identify any potential systems integration you might suggest that is not already incorporated into the design. Discuss what the advantages and disadvantages would be and how it would affect other systems.

I don't anticipate adding any additional mechanical or electrical distribution systems. However, I would like to further investigate better lighting control systems. This would affect individual lighting circuits, and if optimizing lighting controls reduces overall power usage, the university would benefit from this change.

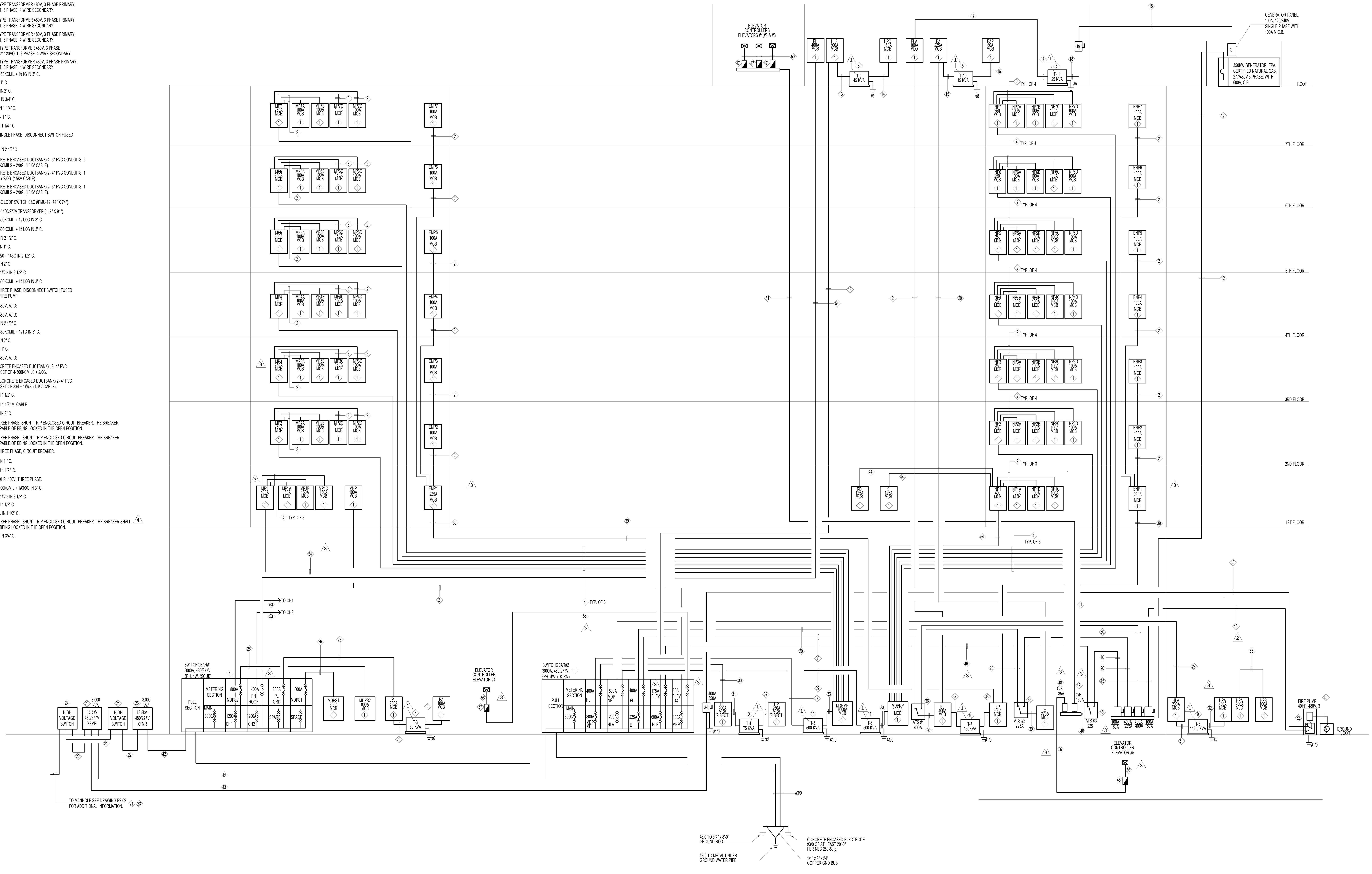
9. Energy Savings

Identify any Energy Cost Savings or Energy Reduction techniques that could be designed into the building electrical systems such as PV Arrays, Fuel Cells, Cogeneration, Demand Reduction, Demand Shifting, Wind Generation, etc. What effect would LEED Certification have on the electrical systems design (if it is not already LEED Certified).

The current design does not utilize any kind of PV arrays or wind turbines on the building. I would like to complete a return on investment analysis of some renewable electricity generation systems. Similarly, the high frequency use of the elevators in a dormitory building make it a prime application for regenerative braking. I would also like to study more on this topic.

RISER NOTES:

1. REFER TO SWITCHGEAR, AND PANEL SCHEDULES DRAWINGS E6.01 THROUGH E6.07 FOR ADDITIONAL INFORMATION
2. 4#1 + 1#8G. IN 1-1/2" C.
3. 4#1/0 + 1#6G. IN 2" C.
4. 4-250KCMIL + 1#4G IN 3" C.
5. 15KVA DRY TYPE TRANSFORMER 480V, 3 PHASE PRIMARY, 208Y-120VOLT, 3 PHASE, 4 WIRE SECONDARY.
6. 25KVA DRY TYPE TRANSFORMER 480V, SINGLE PHASE PRIMARY, 240-120VOLT, SINGLE PHASE, 3 WIRE SECONDARY.
7. 30KVA DRY TYPE TRANSFORMER 480V, 3 PHASE PRIMARY, 208Y-120VOLT, 3 PHASE, 4 WIRE SECONDARY.
8. 45KVA DRY TYPE TRANSFORMER 480V, 3 PHASE PRIMARY, 208Y-120VOLT, 3 PHASE, 4 WIRE SECONDARY.
9. 75KVA DRY TYPE TRANSFORMER 480V, 3 PHASE PRIMARY, 208Y-120VOLT, 3 PHASE, 4 WIRE SECONDARY.
10. (3) 150KVA DRY TYPE TRANSFORMER 480V, 3 PHASE PRIMARY, 208Y-120VOLT, 3 PHASE, 4 WIRE SECONDARY.
11. 500KVA DRY TYPE TRANSFORMER 480V, 3 PHASE PRIMARY, 208Y-120VOLT, 3 PHASE, 4 WIRE SECONDARY.
12. 2 SETS OF 4-350KCMIL + 1#1G IN 3" C.
13. 3#4 + 1#8G IN 1" C.
14. 4#1/0 + 1#6G. IN 2" C.
15. 3#10 + 1#10G. IN 3/4" C.
16. 4#4 + 1#10G. IN 1 1/4" C.
17. 2#4 + 1#8G. IN 1 " C.
18. 3#1 + 1#8G. IN 1 1/4 " C.
19. 100A, 240V, SINGLE PHASE, DISCONNECT SWITCH FUSED @ 100A.
20. 4#4/0 + 1#4G. IN 2 1/2" C.
21. (4 WAY CONCRETE ENCASED DUCTBANK) 4- 5" PVC CONDUITS, 2 SET OF 3-500KCMILS + 2/0G. (15KV CABLE).
22. (2 WAY CONCRETE ENCASED DUCTBANK) 2- 4" PVC CONDUITS, 1 SET OF 3#4/0 + 2/0G. (15KV CABLE).
23. (2 WAY CONCRETE ENCASED DUCTBANK) 2- 5" PVC CONDUITS, 1 SET OF 3-500KCMILS + 2/0G. (15KV CABLE).
24. HIGH VOLTAGE LOOP SWITCH S&C #PMU-19 (74" X 74").
25. 3000KVA 13.8 / 480/277V TRANSFORMER (117" X 91").
26. 2 SETS OF 4-500KCMIL + 1#1/0G IN 3" C.
27. 2 SETS OF 3-500KCMIL + 1#1/0G IN 3" C.
28. 4#4/0 + 1#6G. IN 2 1/2" C.
29. 3#6 + 1#10G. IN 1" C.
30. 2 SETS OF 4#3/0 + 1#3G IN 2 1/2" C.
31. (3) 3#2/0 + 1#6G. IN 2" C.
32. 4-500KCMIL + 1#2G IN 3 1/2" C.
33. 4 SETS OF 4-500KCMIL + 1#4/0G IN 3" C.
34. 400A, 480V, THREE PHASE, DISCONNECT SWITCH FUSED @ 350A FOR FIRE PUMP.
35. 3P-225A, 277/480V, A.T.S
36. 3P-400A, 277/480V, A.T.S
37. (3) 3#4/0 + 1#4G. IN 2 1/2" C.
38. 2 SETS OF 4-350KCMIL + 1#1G IN 3" C.
39. 4#4/0 + 1#4G. IN 2" C.
40. 3#4 + 1#8G. IN 1" C.
41. 3P-150A, 277/480V, A.T.S
42. (12 WAY CONCRETE ENCASED DUCTBANK) 12- 4" PVC CONDUITS, 8 SET OF 4-500KCMILS + 2/0G.
43. NEW (2 WAY CONCRETE ENCASED DUCTBANK) 2- 4" PVC CONDUITS, 1 SET OF 3#4 + 1#6G. (15KV CABLE).
44. 4#1 + 1#6G. IN 1 1/2" C.
45. 3#4 + 1#6G. IN 1 1/2" MI CABLE.
46. (3) 3#2/0 + 1#4G. IN 2" C.
47. 70A, 480V, THREE PHASE, SHUNT TRIP ENCLOSED CIRCUIT BREAKER. THE BREAKER SHALL BE CAPABLE OF BEING LOCKED IN THE OPEN POSITION.
48. (4) 35A, 480V, THREE PHASE, SHUNT TRIP ENCLOSED CIRCUIT BREAKER. THE BREAKER SHALL BE CAPABLE OF BEING LOCKED IN THE OPEN POSITION.
49. 150A, 480V, THREE PHASE, CIRCUIT BREAKER.
50. 3#4 + 1#10G. IN 1 " C.
51. 3#1 + 1#6G. IN 1 1/2 " C.
52. FIRE PUMP 40HP, 480V, THREE PHASE.
53. 3 SETS OF 3-500KCMIL + 1#3/0G IN 3" C.
54. 4-500KCMIL + 1#2G IN 3 1/2" C.
55. (2) 4#1 + 1#8G. IN 1 1/2" C.
56. 3#12 + 1#12G. IN 1 1/2" C.
57. (3) 80A, 480V, THREE PHASE, SHUNT TRIP ENCLOSED CIRCUIT BREAKER. THE BREAKER SHALL CAPABLE OF BEING LOCKED IN THE OPEN POSITION. (4)
58. 3#6 + 1#10G. IN 3/4" C.



1 POWER RISER DIAGRAM
NO SCALE

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UMD Project Number: 02-016-925-00

		#
Schematic Design	12/1/11	
Design Development	3/1/12	
50% Submission	4/12/12	
80% Submission	5/31/12	
Bid Set	6/22/12	
Addendum 1	7/26/12	1
Addendum 2	10/5/12	2
Construction Set	12/13/12	
Addendum 4	03/18/13	3
Addendum 5	06/27/13	4

Professional Seal

WDG Project No: WA11036

Power Riser Diagram

Scale: NONE

E5.01

Appendix

Dwelling Units - NEC Standard Method Calculation

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Note: If a dwelling has more than one feeder, a separate load calculation is needed for each feeder.

Step-1 : Calculating general lighting and general receptacles loads (except for small-appliance and Laundry Receptacles)

Procedure	Note	Calculation		
From NEC Table 220.12, for dwelling units, minimum general lighting load is 3 VA/ft2.	Under any conditions, for dwelling units, don't use value less than 3 VA/ft2, there are no exceptions. While the designer can choose a higher value based on the existing design conditions	The general lighting load is calculated by multiplying the floor area (in ft2) of a dwelling unit by 3 VA/ft2.		
Calculate the floor area for each floor of Dwelling Unit in ft2.	The floor area for each floor shall be calculated from the outside dimensions of the dwelling unit.	Floor area in ft2 =	2430	ft2
	The calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use (like some attics, cellars, and crawl spaces).	General lighting and general receptacles loads =	7290	VA

Step-2: Calculating Small-appliance branch circuits' load

Procedure	Note	Calculation			
Calculate the required number of small-appliance branch ciruits in the dwelling unit	As per NEC 210.1(C)(1), In each dwelling unit, two or more 20-ampere small-appliance branch circuits must be provided.	The Small-appliance branch circuits' load, for dwelling units, is calculated by multiplying number of Small-appliance branch circuits by 1,500 VA.			
	the designer assign the number of small-appliance branch ciruits based on the exisiting condition (space dimension , number of required small appliances, etc.).	As per 210.52(B)(1)Exception.2, An indvidual branch ciruit is permitted for Refrigeration equipment at 1,500 VA. If you will apply this rule,choose Number of Refergiator Circuits from F13			2
	Don't exceed the permissible loading of a 120 V, 20-ampere branch circuit which is 2400 VA	If a dwelling has more than one feeder, a separate load calculation is needed for each feeder. It is not necessary to include small-appliance branch circuit loads for feeders don't supply such load. Does feeder include small-appliance branch circuits?Select answer from F14			Y
As per NEC section 220.52(A), each 2-wire small-appliance branch circuit load is calculated at no less than 1,500 volt-amperes.		Number of Small-appliance branch circuits in the dwelling unit =	12	Ciruit	
		Small-appliance branch circuits' load =	21000	VA	

Step-3: Calculating Laundry branch ciruit load

Procedure	Note	Calculation			
Calculate the required number of laundry branch ciruits in the dwelling unit	As per NEC 210.11(C)(2), In each dwelling unit, At least one 20-ampere branch circuit shall be provided	The Laundry branch circuits' load, for dwelling units, is calculated by multiplying number of Laundry branch circuits by 1,500 VA.			
As per NEC 220.52(B), each 2-wire laundry branch circuit is calculated at no less than 1,500 volt-amperes.		In multifamily dwelling building, if Laundry facilities are provided on the premises and available to all building tenants (as a common usage), Laundry branch circuits load will not be added to each individual dwelling unit and will be added to a separate "house load" panelboard. is Laundry Facility available to all building tenants?Select answer from F21			N
		A combination of clothes washer and clothes dryer will be handled in calculations as it is a clothes dryer, is there a combination? Select answer from F22			N
		Number of Laundry branch circuits in the dwelling unit =	2	Ciruit	
		Laundry branch circuits' load =	3000	VA	

Step-4: Applying Demand Factors from Table 220.42

Sum Loads of Step-1, Step-2 and Step-3	Total Sum =	31290	VA
Calculate the demand of The First 3,000 VA or Less at 100%	demand of The First 3,000 VA or Less =	3,000	VA
Calculate the demand of (120,000 VA - 3,000 VA), if any, at 35%	demand of (120,000 VA - 3,000 VA), if any =	40950	VA
Calculate the demand of the reminder over 120,000 VA, if any, at 25%	demand of the reminder over 120,000 VA, if any =	0	VA
General Load for Lighting, General Receptacles, Small Appliances and Laundry =		43,950	VA

Step-5: Fastened in Place Appliances Load

As per NEC section 220.53, electric ranges, clothes dryers, space-heating equipment or air conditioning equipment must not be included with the number of appliances that are fastened in place. Also, All portable small Appliances for kitchen and others are not Fastened-in-Place Appliances.

Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW)

As per NEC section, 220.53, It shall be permissible to apply a demand factor of 75 % to the nameplate rating load of four or more appliances fastened-in-place, that are served by the same feeder or service in a one-family, two-family, or multifamily dwelling.

In a multifamily dwelling, the four or more fastened-in-place appliances do not have to be on the same feeder for each dwelling unit. In this case, the 75% demand factor will not apply to the feeder for each dwelling unit but it must be applied to the multifamily dwelling service.

As per NEC section 430.6(A)(1), Do not use the actual current rating marked on the nameplate. When calculating motor loads, use the values given in Tables 430.247 through 430.250.

	Number of appliances	Rating of appliances		

water heater	2	4000		
Refrigerator	2	1000		
Freezer	0	0		
dishwasher	2	1000		
disposal	2	1000		
Range hood	0	0		
microwave	2	720		
mini Refrigerator	0	0		
inst hot	0	0		
ironing center	0	0		
wine Clr	0	0		
Add more Appliances	0	0		
Add more Appliances	0	0		
Add more Appliances	0	0		
total number of appliances =		**10**		
Total ratings of appliances		**7720**		
Total load =			5790	VA

Step-6: Clothes Dryers Load				
A clothes dryer is not a requirement for a load calculation, Skip this step if there is no clothes dryer.				
Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW)				
Procedure	**Note**	**Calculation**		
Write the Nameplate Rating of Cothes dryer	As per NEC section 220.54, the load for household electric clothes dryers in a dwelling unit(s) shall be either 5000 watts (volt-amperes) or the nameplate rating, whichever is larger, for each dryer served.	Write the Nameplate Rating of Cothes dryer	1200	VA
	A combination of clothes washer and clothes dryer (see below image) will be handled in calculations as it is a clothes dryer.	5000 VA or the nameplate rating, whichever is larger	5000	VA
	For single, two-family or multi-family dwelling when each tenant has separate clothes dryer, Table 220.54 Demand Factors for Household Electric Clothes Dryers will be used	Number of Clothes Dryers =	2	
	In a multi-family dwelling where there is a common Laundry area, use the full load of all dryers without applying demand factor.	Total Conneced load of clothes dryers =	10000	VA
		Demand Factor =	1	
Total Demand load of clothes dryers =			10000	VA

Step-7: Household cooking appliances load				
We can skip the calculation of Household Cooking Appliances Load if there are no cooking appliances rated over 1.75 KW. Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW) When the kilowatt rating fraction is 0.5 or more, it must be rounded up to the next whole kilowatt rating i.e. 14.5 KW up to a 15 KW and When the fraction is less than 0.5, it can be dropped i.e. 14.4 KW dropped to 14 KW. The table 220.55 is not applicable for ranges rated more than 27 kW because ranges rated more than 27 kW would not be considered household ranges.				
Case#2: group of Appliances with equal (same) ratings not over 12 KW				
Number of Household cooking appliances =	2			
Household cooking appliances Rating in KW=	3000			
		Put Demand/max. Demand Factor from table 220.55	Calculated demand load	
	Less that 3.5 KW Rating		0	
	3.5-8.5 KW	0.65	3900	3900
	less than 12 KW			
Household cooking appliances Demand load in KW=				3900

Step-8:Heating and air conditioning loads			
the blower motor works with both the heating and air conditioning system, it must be included in both calculations.			
With a heat pump, the compressor (and accompanying motors) and some or all of the electric heat can be on at the same time. The load contribution of a heat pump is the air conditioning system load plus the maximum amount of heat that can be on while the air conditioner compressor is on.			
As per NEC section 430.6(A)(1), Do not use the actual current rating marked on the nameplate. When calculating motor loads, use the values given in Tables 430.247 through 430.250.			
	Noncoincident Loads		**coincident Loads**
Room air conditioners Load in VA at 100%		FALSE	

Fixed electric space-heating Load in VA at 100%		FALSE	
Central air conditioning Load in VA at 100%		FALSE	
Central heating system Load in VA at 100%		FALSE	
Heating and air conditioning load in VA =		0	0

TOTAL DEMAND LOAD =	63,640	VA

Dwelling Units - NEC Standard Method Calculation

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Note: If a dwelling has more than one feeder, a separate load calculation is needed for each feeder.

Step-1 : Calculating general lighting and general receptacles loads (except for small-appliance and Laundry Receptacles)

Procedure	Note	Calculation		
From NEC Table 220.12, for dwelling units, minimum general lighting load is 3 VA/ft2.	Under any conditions, for dwelling units, don't use value less than 3 VA/ft2, there are no exceptions. While the designer can choose a higher value based on the existing design conditions	The general lighting load is calculated by multiplying the floor area (in ft2) of a dwelling unit by 3 VA/ft2.		
Calculate the floor area for each floor of Dwelling Unit in ft2.	The floor area for each floor shall be calculated from the outside dimensions of the dwelling unit.	Floor area in ft2 =	80753	ft2
	The calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use (like some attics, cellars, and crawl spaces).	General lighting and general receptacles loads =	242259	VA

Step-2: Calculating Small-appliance branch circuits' load

Procedure	Note	Calculation			
Calculate the required number of small-appliance branch ciruits in the dwelling unit	As per NEC 210.1(C)(1), In each dwelling unit, two or more 20-ampere small-appliance branch circuits must be provided.	The Small-appliance branch circuits' load, for dwelling units, is calculated by multiplying number of Small-appliance branch circuits by 1,500 VA.			
	the designer assign the number of small-appliance branch ciruits based on the exisiting condition (space dimension , number of required small appliances, etc.).	As per 210.52(B)(1)Exception.2, An indvidual branch ciruit is permitted for Refrigeration equipment at 1,500 VA. If you will apply this rule,choose Number of Refergiator Circuits from F13			0
	Don't exceed the permissible loading of a 120 V, 20-ampere branch circuit which is 2400 VA	If a dwelling has more than one feeder, a separate load calculation is needed for each feeder. It is not necessary to include small-appliance branch circuit loads for feeders don't supply such load. Does feeder include small-appliance branch circuits?Select answer from F14			Y
As per NEC section 220.52(A), each 2-wire small-appliance branch circuit load is calculated at no less than 1,500 volt-amperes.		Number of Small-appliance branch circuits in the dwelling unit =	250	Ciruit	
		Small-appliance branch circuits' load =	375000	VA	

Step-3: Calculating Laundry branch ciruit load

Procedure	Note	Calculation			
Calculate the required number of laundry branch ciruits in the dwelling unit	As per NEC 210.11(C)(2), In each dwelling unit, At least one 20-ampere branch circuit shall be provided	The Laundry branch circuits' load, for dwelling units, is calculated by multiplying number of Laundry branch circuits by 1,500 VA.			
As per NEC 220.52(B), each 2-wire laundry branch circuit is calculated at no less than 1,500 volt-amperes.		In multifamily dwelling building, if Laundry facilities are provided on the premises and available to all building tenants (as a common usage), Laundry branch circuits load will not be added to each individual dwelling unit and will be added to a separate "house load" panelboard. is Laundry Facility available to all building tenants?Select answer from F21			Y
		A combination of clothes washer and clothes dryer will be handled in calculations as it is a clothes dryer, is there a combination? Select answer from F22			N
		Number of Laundry branch circuits in the dwelling unit =	21	Ciruit	
		Laundry branch circuits' load =	0	VA	

Step-4: Applying Demand Factors from Table 220.42

Sum Loads of Step-1, Step-2 and Step-3	Total Sum =	617259	VA
Calculate the demand of The First 3,000 VA or Less at 100%	demand of The First 3,000 VA or Less =	3,000	VA
Calculate the demand of (120,000 VA - 3,000 VA), if any, at 35%	demand of (120,000 VA - 3,000 VA), if any =	40950	VA
Calculate the demand of the reminder over 120,000 VA, if any, at 25%	demand of the reminder over 120,000 VA, if any =	124314.75	VA
General Load for Lighting, General Receptacles, Small Appliances and Laundry =		168,265	VA

Step-5: Fastened in Place Appliances Load

As per NEC section 220.53, electric ranges, clothes dryers, space-heating equipment or air conditioning equipment must not be included with the number of appliances that are fastened in place. Also, All portable small Appliances for kitchen and others are not Fastened-in-Place Appliances.

Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW)

As per NEC section, 220.53, It shall be permissible to apply a demand factor of 75 % to the nameplate rating load of four or more appliances fastened-in-place, that are served by the same feeder or service in a one-family, two-family, or multifamily dwelling.

In a multifamily dwelling, the four or more fastened-in-place appliances do not have to be on the same feeder for each dwelling unit. In this case, the 75% demand factor will not apply to the feeder for each dwelling unit but it must be applied to the multifamily dwelling service.

As per NEC section 430.6(A)(1), Do not use the actual current rating marked on the nameplate. When calculating motor loads, use the values given in Tables 430.247 through 430.250.

	Number of appliances	Rating of appliances		

water heater	0	0		
Refrigerator	0	0		
Freezer	0	0		
dishwasher	0	0		
disposal	0	0		
Range hood	0	0		
microwave	250	90000		
mini Refrigerator	0	0		
inst hot	0	0		
ironing center	0	0		
wine Clr	0	0		
Add more Appliances	0	0		
Add more Appliances	0	0		
Add more Appliances	0	0		
total number of appliances =		250		
Total ratings of appliances		90000		
Total load =			67500	VA

Step-6: Clothes Dryers Load

A clothes dryer is not a requirement for a load calculation, Skip this step if there is no clothes dryer.

Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW)

Procedure	Note	Calculation		
Write the Nameplate Rating of Cothes dryer	As per NEC section 220.54, the load for household electric clothes dryers in a dwelling unit(s) shall be either 5000 watts (volt-amperes) or the nameplate rating, whichever is larger, for each dryer served.	Write the Nameplate Rating of Cothes dryer	1200	VA
	A combination of clothes washer and clothes dryer (see below image) will be handled in calculations as it is a clothes dryer.	5000 VA or the nameplate rating, whichever is larger	5000	VA
	For single, two-family or multi-family dwelling when each tenant has separate clothes dryer, Table 220.54 Demand Factors for Household Electric Clothes Dryers will be used	Number of Clothes Dryers =	21	
	In a multi-family dwelling where there is a common Laundry area, use the full load of all dryers without applying demand factor.	Total Conneced load of clothes dryers =	105000	VA
		Demand Factor =	0.37	
Total Demand load of clothes dryers =			38850	VA

Step-7: Household cooking appliances load

We can skip the calculation of Household Cooking Appliances Load if there are no cooking appliances rated over 1.75 KW.

Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW)

When the kilowatt rating fraction is 0.5 or more, it must be rounded up to the next whole kilowatt rating i.e. 14.5 KW up to a 15 KW and When the fraction is less than 0.5, it can be dropped i.e. 14.4 KW dropped to 14 KW.

The table 220.55 is not applicable for ranges rated more than 27 kW because ranges rated more than 27 kW would not be considered household ranges.

Case#2: group of Appliances with equal (same) ratings not over 12 KW

Number of Household cooking appliances =	2			
Household cooking appliances Rating in KW=	3000			
		Put Demand/max. Demand Factor from table 220.55	Calculated demand load	
	Less that 3.5 KW Rating		0	
	3.5-8.5 KW		0	0
	less than 12 KW			
Household cooking appliances Demand load in KW=				0

Step-8:Heating and air conditioning loads

the blower motor works with both the heating and air conditioning system, it must be included in both calculations.

With a heat pump, the compressor (and accompanying motors) and some or all of the electric heat can be on at the same time. The load contribution of a heat pump is the air conditioning system load plus the maximum amount of heat that can be on while the air conditioner compressor is on.

As per NEC section 430.6(A)(1), Do not use the actual current rating marked on the nameplate. When calculating motor loads, use the values given in Tables 430.247 through 430.250.

	Noncoincident Loads		coincident Loads	
Room air conditioners Load in VA at 100%	114540	114540		FCU Load

Fixed electric space-heating Load in VA at 100%	114540	FALSE	
Central air conditioning Load in VA at 100%		FALSE	
Central heating system Load in VA at 100%		FALSE	
Heating and air conditioning load in VA =		114540	0

TOTAL DEMAND LOAD =	389,155	VA

Non-Dwelling Buildings Load Calculation by NEC

All design Calculations for Non-dwelling Buildings will be as per NEC standard calculation method while NEC Optional calculation method can be applied only for the following Non-Dwelling buildings (as permitted by NEC, Part IV. Optional Feeder and Service Load Calculations): a school, an existing installation and a new restaurant.

FIRST: Lighting Loads

1- General lighting

Procedure	Note			
Step#1: determine the general lighting load density (in VA/ft2) for the building occupancy under design by Using Table 220.12.	Don't apply the values of table 220.12 before reviewing the following notes:	The general lighting load unit values specified in table 220.12 for guest rooms or guest suites of hotels and motels includes All general-use receptacle outlets of 20-ampere rating or less, including receptacles connected to Bathroom Branch Circuits, So, no need to add the above outlets in load calculations per NEC method.		
The NEC method and table 220.12 are applied for any Additions to Existing Installations for non-dwelling installations.	1- The unit values herein are based on minimum load conditions and 100 percent power factor (i.e. Load in VA = Load in Watt) and may not provide sufficient lighting for the installation contemplated. So, the designer can choose a higher value based on the existing design conditions.	If the required information for calculating the actual full load for every individual lighting fixture in the circuit is available, the following procedure will be applied: 1- Calculate the actual load for the lighting branch circuit by summing of actual full load for its individual lighting fixtures. 2- Compare the values obtained from NEC method with that obtained from actual load method and select the greater load value to be used in the design.		
As per NEC Section 220.18 (b) states , circuits supplying lighting units that have ballasts, transformers, autotransformers, or LED drivers, the calculated load shall be based on the total ampere ratings of such units and not on the total watts of the lamps.	2- Under any conditions, don't use values less than that specified in table 220.12, there are no exceptions.	Energy saving–type calculations (which used to reduce the connected lighting load and actual power consumption) are not permitted to be used to determine the minimum calculated lighting load if they produce loads less than the load calculated according to 220.12.		
		Calculation		
Step#2: calculate the floor area in (ft2)	The floor area for each floor shall be calculated from the outside dimensions of the building, or other area involved.	general lighting load density =	3.5	VA/ft2
	The calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use (like some attics, cellars, and crawl spaces).	Area =	104769	ft2
Step#3: General lighting load in (VA) = Area of Occupancy in (ft2) X general lighting load density in (VA/ft2)		General lighting load =	471460.5	VA
Step#4: Apply lighting demand factor from table 220.42 for type of building under design.	The demand factors of table 220.42 shall not apply to the calculated load of feeders or services supplying areas in hospitals, hotels, and motels where the entire lighting is likely to be used at one time, as in operating rooms, ballrooms, or dining rooms.	First Part of Demand Load =	471460.5	VA
		Second Part of Demand Load =	0	VA
		Third Part of Demand Load =	0	VA
General Lighting Demand Load =			471460.5	VA
TOTAL LIGHTING LOAD =			**471460.5**	**VA**

Second: Receptacles Loads

1- General-Use Receptacles

Procedure	Note	Calculation		
As per NEC section 220.14(I), Receptacle outlets load shall be calculated at not less than:	if a receptacle is dedicated for a specific device, then the actual load is used and If this dedicated load is continuous, then the 125% overrate is appropriate.	Office Building receptacle load density=	1	VA/ft2
180 volt-amperes for each single receptacle		Area=	104769	Ft 2

180 volt-amperes for each multiple receptacle (duplex or triplex) on one yoke. 90 volt- amperes per receptacle for multiple receptacles (four or more).	The number of receptacle Outlets my not equal to the number of receptacles installed on these outlets. For example, a duplex receptacle has two contact devices on the same receptacle outlet. In this case number of receptacles = 2 while the number of receptacle outlets = 1.	The general lighting load unit values specified in table 220.12 for guest rooms or guest suites of hotels and motels includes All general-use receptacle outlets of 20-ampere rating or less, including receptacles connected to Bathroom Branch Circuits, So, no need to add the above outlets in load calculations per NEC method.
Total General-Use Receptacle Load	104769	VA

4- Demand Load for Receptacle and Fixed Multioutlet Assemblies

Procedure & Note	Calculation		
As per NEC section 220.44, General-Use Receptacles and Fixed Multioutlet Assemblies are subjected to demand factors by either of the following two methods:	Please Select the Calculation Case that you have from the two cases in below Case#1: If Building is not listed in Table 220.42, use Table 220.44		
1- If the occupancy is not one of the types listed in Table 220.42 and receptacle loads greater than 10,000 volt-amperes, The receptacle loads are calculated (without the lighting load) with demand factors from Table 220.44 applied.	Load for Receptacle and Fixed Multioutlet Assemblies for Office Buildings and Banks =	104769	VA
2- If the occupancy is one of the types (other than dwelling units) listed in Table 220.42, the receptacle load could be added to the general lighting load and made subject to the demand factors in Table 220.42.	Load for Receptacle and Fixed Multioutlet Assemblies for Other Buildings =	0	VA
	First 10,000 VA at 100% =	10000	VA
	Reminder Over 10,000 VA at 50% =	47384.5	VA
Demand Receptacle and Fixed Multioutlet Assemblies Load		**57384.5**	**VA**
	Case#2: If Building is listed in Table 220.42, Load will be added to General lighting Load and Table 220.42 will apply to the sum.		
Receptacle and Fixed Multioutlet Assemblies Load for the Building =		104769	VA

Third: Continuous Loads

Procedure	Note	Calculation		
When calculating a feeder or service As per NEC Standard calculation method, the Loads classified as Continuous Loads must be multiplied by 25 percent and add it to the service load calculation.	The loads under the following categories are continuous loads : General Lighting, Track Lighting, Show Window Lighting, Sign and Outline Lighting.	Continous Lighting Loads =	117865.125	VA
if Receptacles and Fixed multioutlet assemblies is dedicated for a specific device, then the actual load is used and If this dedicated load is continuous, then the 125% overrate is appropriate.	While the Loads under the following categories are Non-continuous loads: General-Use Receptacles, Multioutlet Assemblies.	Enter Continuous Other Lighting Loads (if any) =	0	VA
		Enter Sum of Continuous Devices Loads connected to Receptacles and Fixed multioutlet assemblies (If any) =	0	VA
Total Conitnuous Load			**117865.125**	**VA**

Fifth: Heating, Ventilation and Air Conditioning Loads (Non-Coincident Loads)

the blower motor works with both the heating and air conditioning system, it must be included in both calculations.
With a heat pump, the compressor (and accompanying motors) and some or all of the electric heat can be on at the same time. The load contribution of a heat pump is the air conditioning system load plus the maximum amount of heat that can be on while the air conditioner compressor is on.
As per NEC section 430.6(A)(1), Do not use the actual current rating marked on the nameplate. When calculating motor loads, use the values given in Tables 430.247 through 430.250.
Cord and plug space heaters are not a permanent fixed heaters, then it will not be included in load calculation in this step.
Fixed heating equipment, such as central heating systems, boilers, heating cable, and unit heaters (baseboard, panel, and duct heaters) will be included.

Fixed electric space heating shall be considered continuous load.			
	Noncoincident Loads		Coincident Loads
Room air conditioners Load in VA at 100% =		FALSE	
Fixed electric space-heating Load in VA at 100% =		FALSE	
Central air conditioning Load in VA at 100% =	1361082	1361082	10,780
Central heating system Load in VA at 100% =	1361082	FALSE	
Heating and air conditioning load in VA =		1361082	10,780

Total Heating, Ventilation and Air Conditioning Loads (Non-Coincident Loads) =	**1371862**	**VA**

Sixth: The Largest Motor

As per NEC section 430.6(A)(1), Do not use the actual current rating marked on the nameplate. When calculating motor loads, use the values given in Tables 430.247 through 430.250.

Exceptions to 430.6(A)(1) :

1- Motors built for low speeds (less than 1,200 rpm) or high torques for multispeed motors.

2- For equipment that employs a shaded-pole or permanent-split capacitor-type fan or blower motor that is marked with the motor type, use the full load current for such motor marked on the nameplate of the equipment in which the fan or blower motor is employed.

3- For a listed motor-operated appliance that is marked with both motor horsepower and full-load current, use the motor full-load current marked on the nameplate of the appliance.

When calculating a feeder or service As per NEC Standard calculation method, the largest motor must be multiplied by 25 percent and add it to the service load calculation.

If the motor is air conditioning compressor, usually the air conditioning compressor is the largest motor in dwelling units. in this case, multiply the load of one compressor by 25 percent and add it to the service load calculation. But if the heating load is larger than the air conditioning load, and because of 220.60 which states that” it is permissible to use only the larger of the noncoincident loads” the air conditioning load will be omitted and the air conditioning compressor will not be the largest motor in this case.

Enter VA of Largest Motor =	44160	VA
Largest Motor Additional Load =	11040	**VA**

Seventh: All Other Loads

All Other Loads: are the loads that don’t falling under one of the following loads categories:

General lighting,	Show window lighting,	General-use receptacles,
Track lighting,	Sign and outline lighting,	Multioutlet assemblies,
Kitchen equipment,	HVAC loads,	Motor loads.

All other Loads will be calculated as follows:

1- All other Non-Continuous Loads will be added at 100%,	Enter Sum of All other Non-Continuous Loads =	57880	VA
2- All other Continuous Loads will be added at 125%.	Enter Sum of All other Continuous Loads =		VA
Total of All Other Loads =		57880	**VA**

Total Demand Load of The Building =	2087492.	**VA**

HVAC Equipment Loads				
	max Load (KW)	Load (Amps)	Motor Load (FLA)	Total Load (VA)
Chiller (CH-1)	395			395000
Chiller (CH-2)	395			395000
Pump (P-1)		52		23920
Pump (P-2)		52		23920
Pump (P-3)		52		23920
Pump (P-4)		96		44160
Pump (P-5)		96		44160
Pump (P-6)		96		44160
Pump (P-7)		77		35420
Pump (P-8)		77		35420
Pump (P-9)		77		35420
Pump (P-10)		52		23920
Pump (P-11)		52		23920
Pump (P-12)		77		35420
Pump (P-13)		77		35420
Pump (P-14)		77		35420
Pump (P-15)		52		23920
Pump (P-16)		52		23920
FCU-1		4		460
FCU-2		4		460
FCU-3		4		460
FCU-4		4		460
FCU-5		4		460
FCU-6	0.08			80
AC-1			0.43	89.44
AC-2			0.43	89.44
AC-3			0.43	89.44
AC-4			0.43	89.44
AC-5			0.43	89.44
AC-6			0.43	89.44
AC-7			0.43	89.44
AC-8			0.43	89.44
AC-9			0.43	89.44
CUH-1	0.11			110
CUH-2	0.11			110
CUH-3	0.11			110
CUH-4	0.11			110
EUH-1	3			3000
EWH-1	2			2000
EWH-2	4			4000
UH-1		2		230
RTU-1		21		9660
RTU-2		21		9660
BF-1	0.329			329
EEF-1		7.6		3496
EEF-2		7.6		3496
EF-1		4.8		2208
EF-2		9.8		1127
EF-3		14		6440
EF-4A		4.4		506
EF-4B		5.8		667
EF-4C		9.8		1127
EF-5		7.2		828

EF-6		5.8		667
EF-7		5.8		667
EF-8		5.8		667
EF-9		5.8		667
EF-10	0.045			45
EF-11		5.8		667
EF-12		5.8		667
EF-S1		2.1		966
EF-S2		1.1		506
EF-S3		1.1		506
EF-S4		2.1		966
EF-S5		2.1		966
EF-S6		5.8		667
SAF-1		21		9660
SAF-2		14		6440
SAF-3		11		5060
SAF-4		4.8		2208
SAF-5		14		6440
SAF-6		7.6		3496
SF-S1		2.1		966
SF-S2		1.1		506
SPF-1		4.8		2208
SPF-2		4.8		2208
VAV Boxes			10VA each	200
				1,402,855

Other Non-continuous Loads	
SEP-1	18400
SP-1	5060
Fire Pump	23920
Total	47380