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Generator Capacity Analysis for Existing and New Generators

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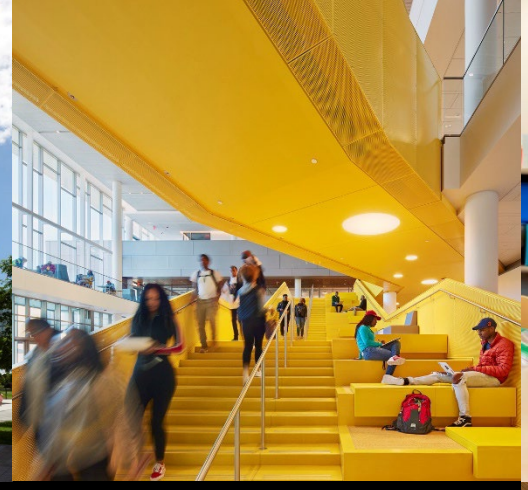

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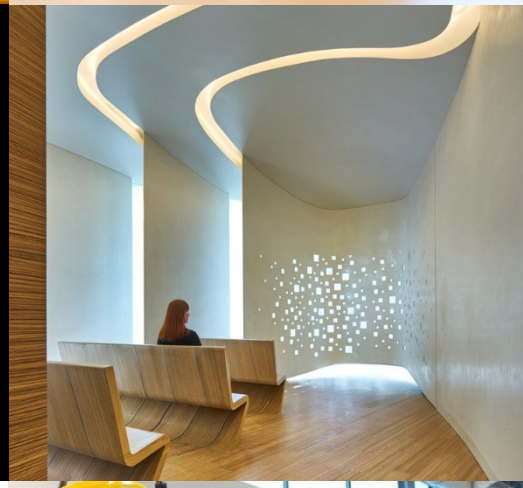




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Programming

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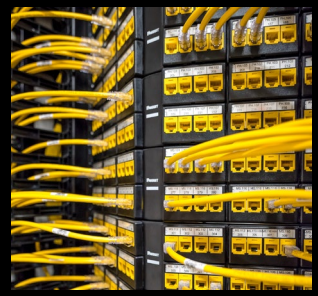
Workplace Strategy

Technology Solutions



Transition Planning

Agenda

1 Why Proper Sizing Is Important

2 Existing Generators

3 New Generators & New Loads

4 Solutions If Under/Over Loaded

5 Summary / Q&A

Why do we need generators?

Why do we need generators?

Why do we need generators?

Why is proper generator sizing important?

Undersized Generator = Load Shedding + Power Outages + Patient Fatalities

Oversized Generator = Wet Stacking + Power Outages + Patient Fatalities + Wasted Money

Can sizing a generator really be that difficult?

NFPA 70 (National Electrical Code, NEC) Guidance

- NEC understands generators shouldn't be oversized.
- NEC is implying that they know the NEC load calculations are designed to be conservative and would oversize the generators.
- NEC doesn't provide any specific demand factors.
- The EOR's engineering judgement must be used to take all the requirements into account.

2017 - 2023 NEC 517.31.D:

(D) Capacity of Systems. The essential electrical system shall have the capacity and rating to meet the maximum actual demand likely to be produced by the connected load.

Feeders shall be sized in accordance with 215.2 and Part III of Article 220. The alternate power source(s) required in 517.30 shall have the capacity and rating to meet the demand produced by the load at any given time.

Demand calculations for sizing of the alternate power source(s) shall be based on any of the following:

(1) Prudent demand factors and historical data
(2) Connected load
(3) Feeder calculations
(4) Any combination of the above

The sizing requirements in 700.4 and 701.4 shall not apply to alternate sources.

NFPA Research

- Minimal studies have been published on actual electrical usage versus NEC demand loads.
- NFPA released this report in 2022 which collected data during the peak of Covid in 2020.
- Data showed that plug load systems are between 100% and 700% oversized.
- NFPA has updated the 2023 NEC to allow higher demand factors for receptacle loads.

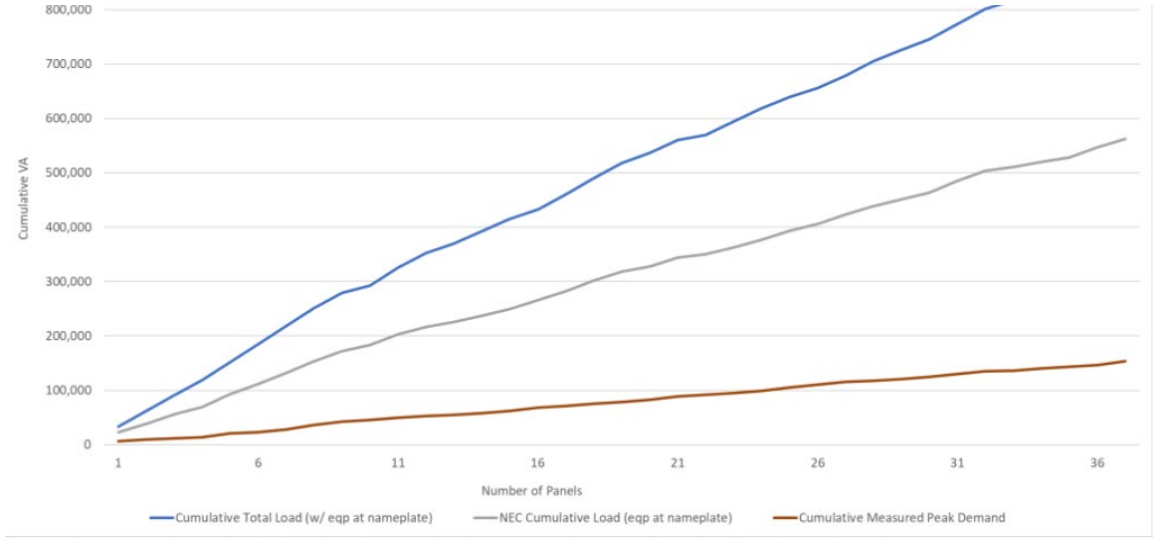
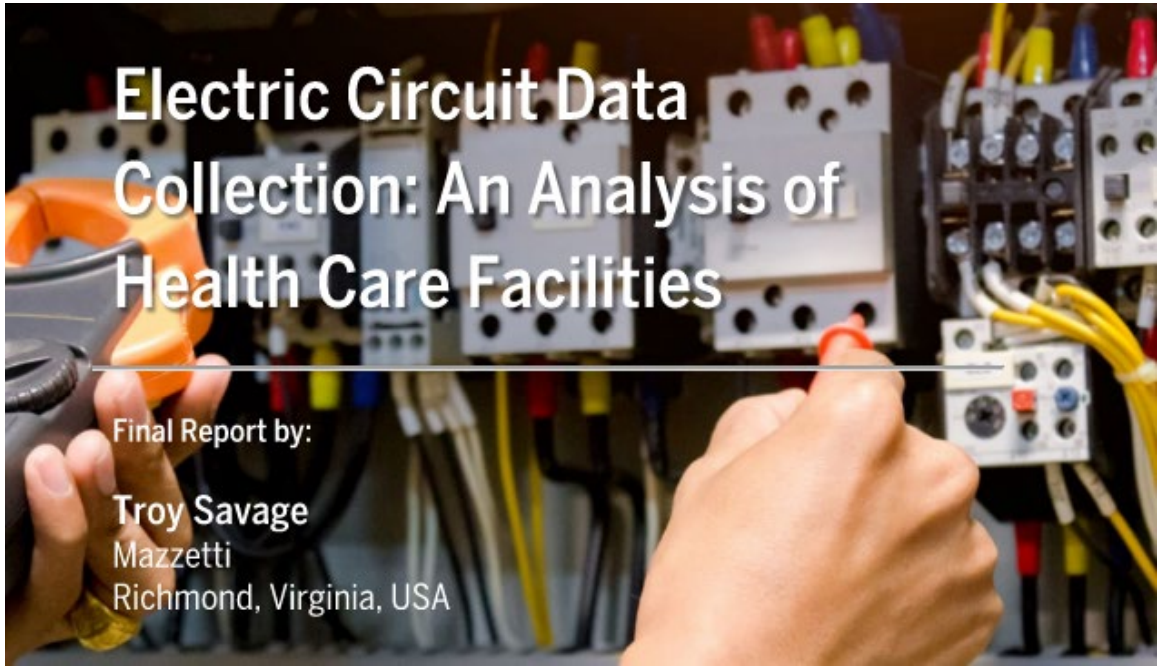


Figure 14: Comparison of calculated and actual load values at the panel level at West Coast hospital 2

Table 220.110(1) Demand Factors for Receptacles Supplied by General-Purpose Branch Circuits in Category 1 and Category 2 Patient Care Spaces

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 5000 or less	100
From 5001 to 10,000	50
Remainder over 10,000	25



Existing Generators and Existing Loads

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NEC Requirements on Existing Loads

- NEC Article 220 discusses requirements on evaluating existing loads.
- Maximum Demand over 1 year (Typically not available for a generator)
- 30 day Meter Reading(Metering Duration) w/ minimum 15min Metering intervals
  - Smaller metering intervals though allow more accurate calculations for example 1min or 5min intervals.
  - Recommend all the readings are done at the same time.
- Existing load at 125% plus new load

2017 - 2023 NEC:

220.87 Determining Existing Loads. The calculation of a feeder or service load for existing installations shall be permitted to use actual maximum demand to determine the existing load under all of the following conditions:

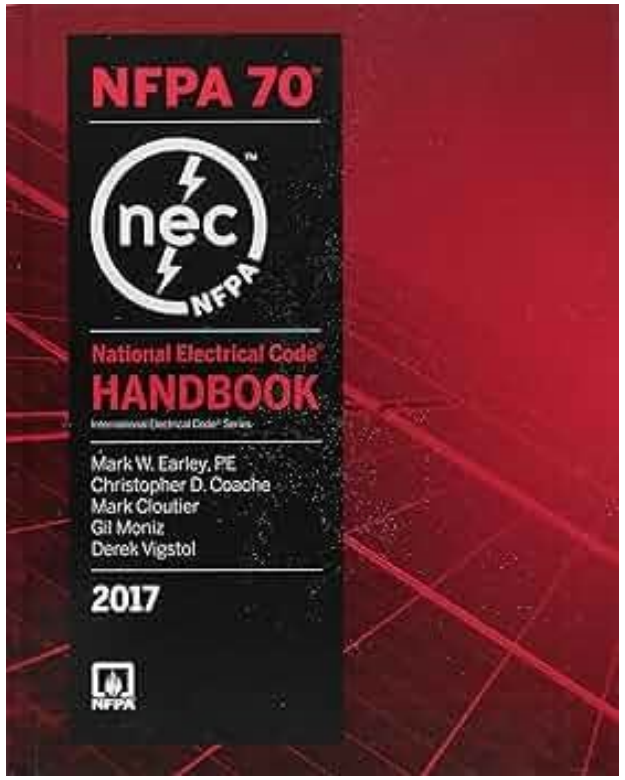
(1) The maximum demand data is available for a 1-year period.

Exception: If the maximum demand data for a 1-year period is not available, the calculated load shall be permitted to be based on the maximum demand (the highest average kilowatts reached and maintained for a 15-minute interval) continuously recorded over a minimum 30-day period using a recording ammeter or power meter connected to the highest loaded phase of the feeder or service, based on the initial loading at the start of the recording. The recording shall reflect the maximum demand of the feeder or service by being taken when the building or space is occupied and shall include by measurement or calculation the larger of the heating or cooling equipment load, and other loads that might be periodic in nature due to seasonal or similar conditions. This exception shall not be permitted if the feeder or service has a renewable energy system (i.e., solar photovoltaic or wind electric) or employs any form of peak load shaving.

(2) The maximum demand at 125 percent plus the new load does not exceed the ampacity of the feeder or rating of the service.

(3) The feeder has overcurrent protection in accordance with 240.4, and the service has overload protection in accordance with 230.90.

NEC – Electrical Branches



LIFE SAFETY

- Illumination of means of egress
- Exit signs
- Alarms/Communication systems
- Generator set accessories
- Elevator accessories
- Power operated doors for egress

CRITICAL

- Task illumination, fixed equipment and select receptacles for spaces as defined by NEC
- Additional items not defined but required for effective facility operation

EQUIPMENT BRANCH

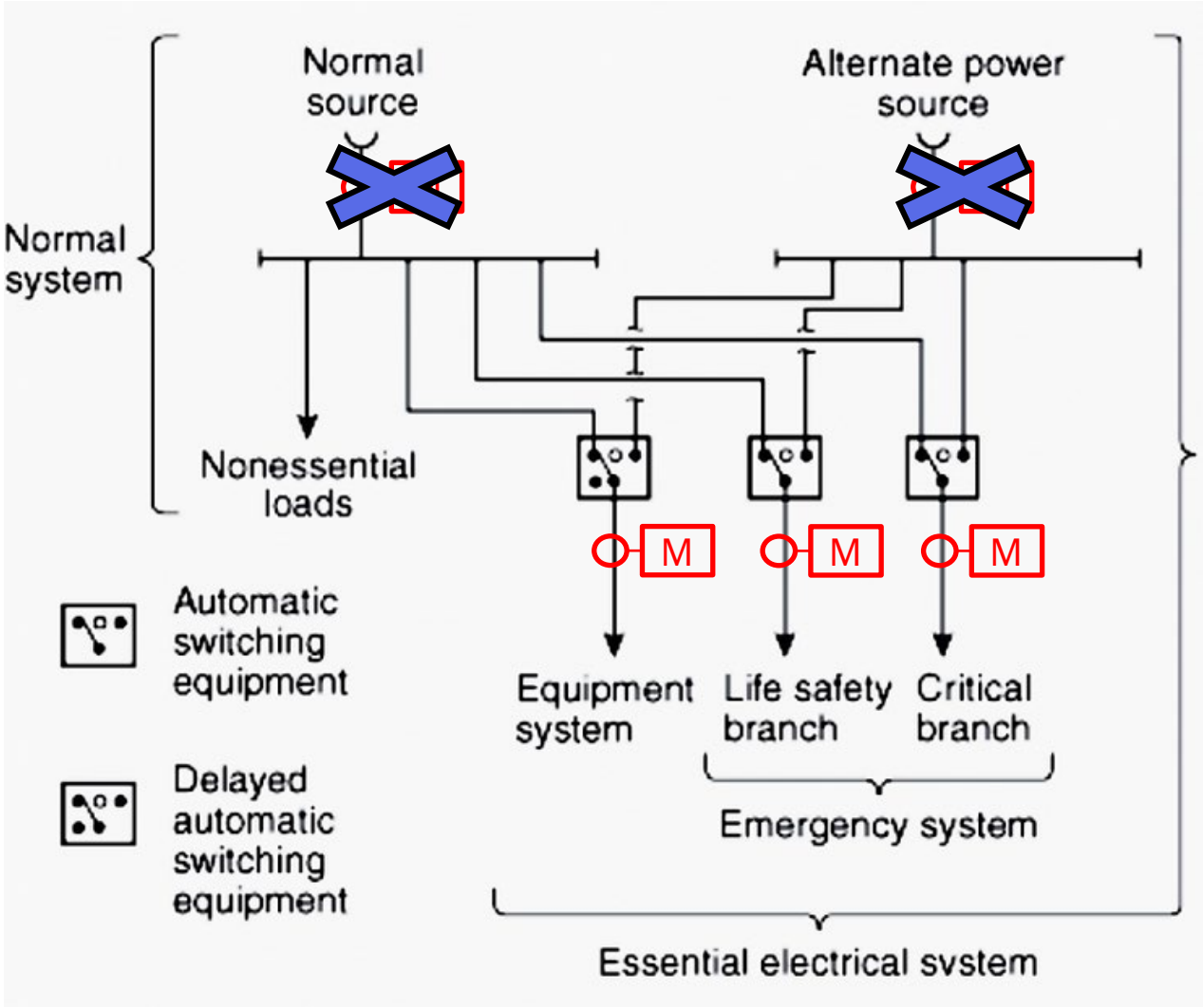
- Med Gas / Vacuum Systems* (Non Shedable)
- Sump Pumps
- Smoke Control
- Kitchen Exhaust
- Ventilation systems for specific rooms

DELAYED or MANUAL EQUIPMENT

- Heating Equipment
- Elevators
- Hyperbaric/Hypobaric Facilities
- Automatic Doors
- Autoclaving Equipment
- Other selected equipment

Metering 101 – Where to Meter??

- Can’t meter at generator as the loads are normally served from Normal source.
- Can’t meter at Normal source as other nonessential loads are fed from it.
- Need to meter each ATS individually.



STEP ONE

Background Info

- Request the utility data to understand max demand over the previous year(s) for a point of reference.
- Gather all the generator load data from the monthly tests over the previous year(s).
- Review the one-line to determine all ATS’s which would be fed from the generator.
- Install meters.

STEP TWO

Gathering the Meter Data (Where it gets complicated)

Data to request:

- PDF report with graphs and summary
- Excel File with all data
- Meters proprietary data file

Definitions - Metering

Metering Interval	The setting on the meter at which the meter reports data at each interval. I.e. 15min or shorter.
Metering Duration	The length the meter reading was taken over. I.e. 30 days.
INTERVAL Average	The Average of all the data collected of the Metering INTERVAL.
INTERVAL Maximum	The Maximum value collected of the Metering INTERVAL.
DURATION Average	The Average of all the data collected over the Metering DURATION.
DURATION Maximum	The Maximum Interval AVERAGE over the Metering DURATION.

Definitions - Generators

Demand Factors	The ratio of maximum demand of a system to the connected load of a system.
Load Shedding	Temporarily turning off or removing load from the electrical system to ensure the system isn’t overloaded.
Wet Stacking	“Wet stacking” is a phenomenon that occurs when unburned diesel fuel builds up within the exhaust side of the engine, which fouls fuel injectors and builds carbon on valves and within the turbocharger.

Lots of Data....

Interval vs Duration

- INTERVAL average is the average value over that specific 15min interval.
- Values in the summary table are showing the DURATION maximum/average/minimum of the averages. These are the values typically given by the reports.

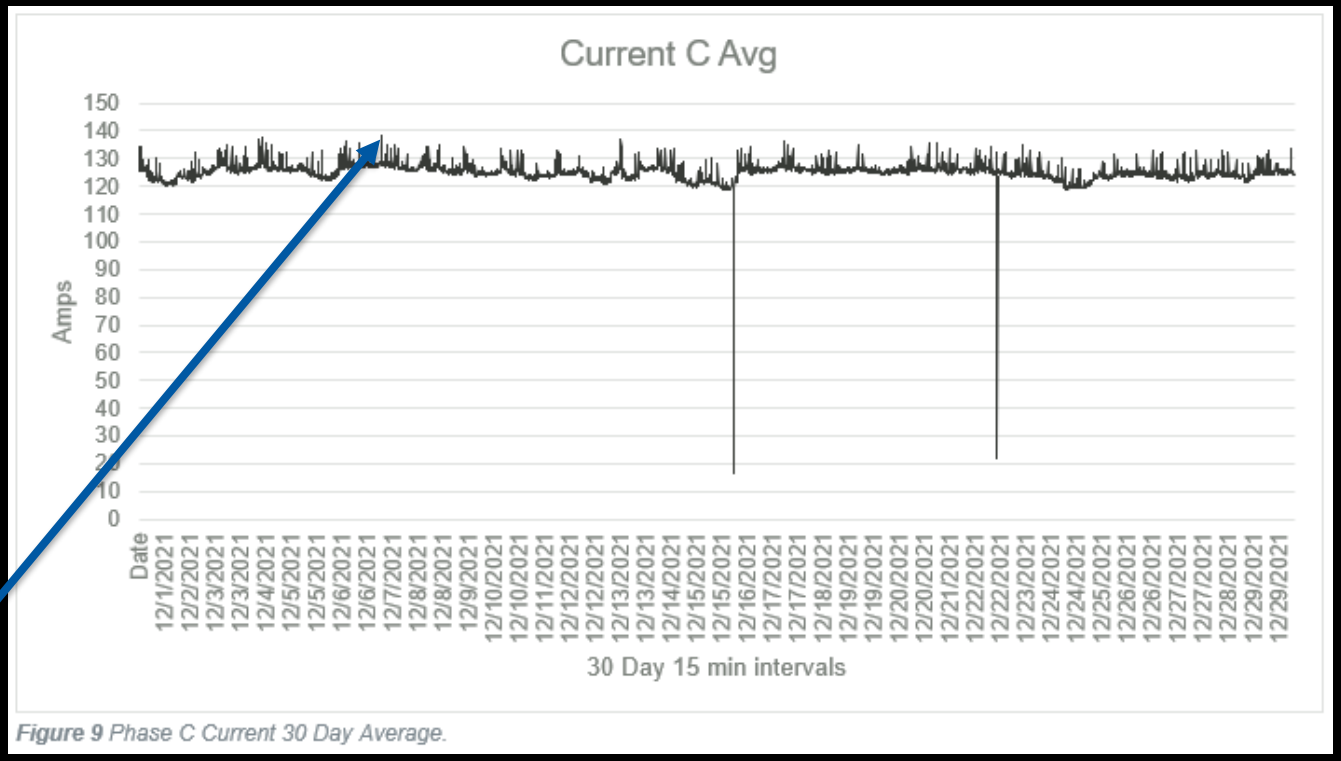


Figure 9 Phase C Current 30 Day Average.

Standard Graphs

CURRENT MEASUREMENT SUMMARY			
ARMS PHASE A 30 DAY AVG			
MAXIMUM	138.7	12/7/2021	7:51:00 AM
AVERAGE	123.45		
MINIMUM	14.8	12/16/2021	4:38:30 AM
ARMS PHASE B 30 DAY AVG			
MAXIMUM	141	12/7/2021	7:51:00 AM
AVERAGE	124.55		
MINIMUM	14.8	12/16/2021	4:38:30 AM
ARMS PHASE C 30 DAY AVG			
MAXIMUM	142.4	12/7/2021	7:51:00 AM
AVERAGE	125.29		
MINIMUM	15	12/12/2021	2:55:35 AM

Summary Tables

Even More Data....

Every time interval has a time stamp which can be used to overlay all the meter data on top of each other.

A	B	C	D	E	G	H	I	K	L	M	O	P	Q	S
Date	Time	Vrms ph-n AN Mi	Vrms ph-n AN Av	Vrms ph-n AN Ma	Vrms ph-n BN Mi	Vrms ph-n BN Av	Vrms ph-n BN Ma	Vrms ph-n CN Mi	Vrms ph-n CN Av	Vrms ph-n CN Ma	Vrms ph-n NG Mi	Vrms ph-n NG Av	Vrms ph-n NG Ma	Vrms ph-ph AB
12/1/2021	6:52:04 AM.702	273.86	274.46	274.84	274.26	274.84	275.24	274.44	275.06	275.46	0.42	0.44	0.44	
12/1/2021	6:52:34 AM.702	274.26	274.54	274.76	274.66	274.92	275.2	274.86	275.18	275.44	0.44	0.44	0.44	
12/1/2021	6:53:04 AM.702	273.68	274.38	274.72	274.06	274.8	275.1	274.3	275.02	275.38	0.42	0.44	0.46	
12/1/2021	6:53:34 AM.702	274.16	274.58	274.88	274.5	274.96	275.24	274.74	275.18	275.52	0.42	0.44	0.44	
12/1/2021	6:54:04 AM.702	274.04	274.62	275.04	274.48	275.04	275.38	274.8	275.3	275.68	0.42	0.44	0.44	
12/1/2021	6:54:34 AM.702	274.3	274.72	275.14	274.78	275.14	275.5	274.94	275.36	275.76	0.44	0.44	0.44	
12/1/2021	6:55:04 AM.702	274.4	274.62	274.82	274.82	275.08	275.28	275.1	275.32	275.46	0.44	0.44	0.44	
12/1/2021	6:55:34 AM.702	274.06	274.48	274.7	274.5	274.92	275.14	274.72	275.18	275.44	0.42	0.44	0.54	
12/1/2021	6:56:04 AM.702	273.9	274.38	274.74	274.32	274.76	275.16	274.64	275.08	275.38	0.44	0.44	0.48	
12/1/2021	6:56:34 AM.702	273.5	274.26	274.6	274.06	274.7	274.98	274.26	274.96	275.24	0.44	0.44	0.44	
12/1/2021	6:57:04 AM.702	274.04	274.32	274.54	274.44	274.76	275	274.64	274.96	275.2	0.44	0.44	0.46	
12/1/2021	6:57:34 AM.702	273.76	274.08	274.34	274.14	274.54	274.82	274.42	274.78	275	0.44	0.44	0.46	
12/1/2021	6:58:04 AM.702	273.56	274.06	274.44	274	274.46	274.86	274.18	274.64	274.96	0.42	0.44	0.62	
12/1/2021	6:58:34 AM.702	274.04	274.32	274.68	274.4	274.68	275.06	274.6	274.86	275.18	0.44	0.44	0.46	
12/1/2021	6:59:04 AM.702	273.8	274.42	274.66	274.1	274.74	275	274.4	274.92	275.14	0.42	0.44	0.44	
12/1/2021	6:59:34 AM.702	273.68	274.2	274.5	273.94	274.5	274.8	274.16	274.74	275.06	0.42	0.42	0.44	
12/1/2021	7:00:04 AM.702	273.94	274.22	274.42	274.3	274.56	274.7	274.46	274.72	274.9	0.42	0.44	0.44	
12/1/2021	7:00:34 AM.702	274.06	274.26	274.5	274.28	274.52	274.7	274.58	274.78	275.08	0.42	0.44	0.88	
12/1/2021	7:01:04 AM.702	273.24	274.36	274.74	273.56	274.6	274.94	273.98	274.98	275.32	0.44	0.44	0.46	
12/1/2021	7:01:34 AM.702	273.68	274.1	274.46	273.94	274.32	274.64	274.26	274.74	275.08	0.44	0.44	0.6	
12/1/2021	7:02:04 AM.702	273.96	274.16	274.34	274.22	274.46	274.7	274.48	274.74	274.88	0.42	0.44	0.54	
12/1/2021	7:02:34 AM.702	273.52	273.92	274.3	273.76	274.22	274.6	274.1	274.54	274.88	0.42	0.44	0.44	
12/1/2021	7:03:04 AM.702	273.76	274.18	274.5	273.94	274.4	274.7	274.36	274.74	274.98	0.42	0.44	0.46	
12/1/2021	7:03:34 AM.702	273.56	274.18	274.5	273.86	274.42	274.74	274.22	274.72	275	0.42	0.44	0.44	
12/1/2021	7:04:04 AM.702	273.62	273.98	274.18	273.88	274.26	274.48	274.1	274.42	274.66	0.44	0.44	0.46	
12/1/2021	7:04:34 AM.702	273.48	273.86	274.12	273.76	274.14	274.4	273.88	274.32	274.6	0.42	0.44	0.46	
12/1/2021	7:05:04 AM.702	273.54	273.94	274.24	273.86	274.22	274.5	274.14	274.46	274.7	0.44	0.44	0.44	
12/1/2021	7:05:34 AM.702	273.04	273.88	274.26	273.38	274.2	274.56	273.58	274.42	274.76	0.42	0.44	0.5	
12/1/2021	7:06:04 AM.702	273.54	273.96	274.18	273.84	274.24	274.48	274.02	274.4	274.62	0.42	0.44	0.46	
12/1/2021	7:06:34 AM.702	273.48	273.82	274.14	273.74	274.08	274.36	273.94	274.3	274.54	0.42	0.44	0.44	
12/1/2021	7:07:04 AM.702	273.28	273.9	274.18	273.7	274.3	274.64	273.86	274.42	274.72	0.42	0.44	0.46	
12/1/2021	7:07:34 AM.702	273.78	274	274.26	274.16	274.38	274.62	274.26	274.5	274.76	0.42	0.44	0.44	
12/1/2021	7:08:04 AM.702	273.9	274.26	274.62	274.3	274.64	274.98	274.4	274.76	275.12	0.42	0.44	0.44	
12/1/2021	7:08:34 AM.702	274.04	274.3	274.56	274.34	274.68	274.98	274.54	274.86	275.08	0.42	0.44	0.44	
12/1/2021	7:09:04 AM.702	273.8	274.08	274.28	274.18	274.48	274.74	274.34	274.64	274.88	0.42	0.44	0.44	
12/1/2021	7:09:34 AM.702	273.7	274.14	274.42	274.1	274.56	274.82	274.32	274.72	274.96	0.42	0.44	0.46	
12/1/2021	7:10:04 AM.702	274.04	274.32	274.5	274.5	274.72	274.88	274.62	274.88	275.12	0.42	0.44	0.44	
12/1/2021	7:10:34 AM.702	273.72	274.12	274.5	274.26	274.58	274.98	274.36	274.7	275.04	0.42	0.44	0.44	
12/1/2021	7:11:04 AM.702	273.44	273.94	274.26	273.9	274.48	274.78	274.14	274.62	274.84	0.42	0.44	0.44	
12/1/2021	7:11:34 AM.702	273.5	273.96	274.22	273.98	274.48	274.74	274.26	274.7	274.92	0.42	0.44	0.44	
12/1/2021	7:12:04 AM.702	273.58	273.94	274.3	274.06	274.4	274.72	274.24	274.56	274.88	0.44	0.44	0.44	
12/1/2021	7:12:34 AM.702	273.16	273.82	274.36	273.62	274.26	274.82	273.78	274.4	274.88	0.42	0.44	0.44	
12/1/2021	7:13:04 AM.702	273.52	273.82	274.06	274	274.28	274.5	274.16	274.46	274.7	0.42	0.44	0.44	
12/1/2021	7:13:34 AM.702	273.64	273.94	274.18	274.06	274.38	274.62	274.24	274.56	274.76	0.44	0.44	0.44	
12/1/2021	7:14:04 AM.702	273.74	274.14	274.42	274.22	274.58	274.86	274.34	274.72	274.96	0.44	0.44	0.46	
12/1/2021	7:14:34 AM.702	272.2	273.96	274.34	272.62	274.32	274.68	272.9	274.56	274.9	0.42	0.44	0.46	

Sheet1

Raw Data in Excel

STEP THREE

Analyzing the Data (Where it gets more complicated)

Depending what data you have, there are two ways to calculate the load:

1. Add each ATS readings DURATION Maximum together.
2. Do a time stamp overlay of the data and add all the INTERVAL Maximum at each time interval. (Preferred)

It is NOT recommended to add all the INTERVAL Averages.

Duration Maximums

Looking at these three ATS recordings on a common generator the data starts to come together.

- The DURATION Maximums all occur on different days and times.
- The graphs show how variable the current is over the course of the 30 days.
- Adding these together would artificially inflate the generator loading as all the peaks didn't happen at the same time.

BUT… what if we only have access to DURATION Maximums?

- The EOR needs to analysis the data to determine what demand factors or safety factors need to be considered to get an accurate value.

CURRENT MEASUREMENT SUMMARY			
ARMS PHASE A 30 DAY AVG			
MAXIMUM	138.7	12/7/2021	7:51:00 AM
AVERAGE	123.45		
MINIMUM	14.8	12/16/2021	4:38:30 AM
ARMS PHASE B 30 DAY AVG			
MAXIMUM	141	12/7/2021	7:51:00 AM
AVERAGE	124.55		
MINIMUM	14.8	12/16/2021	4:38:30 AM
ARMS PHASE C 30 DAY AVG			
MAXIMUM	142.4	12/7/2021	7:51:00 AM
AVERAGE	125.29		
MINIMUM	15	12/12/2021	2:55:35 AM

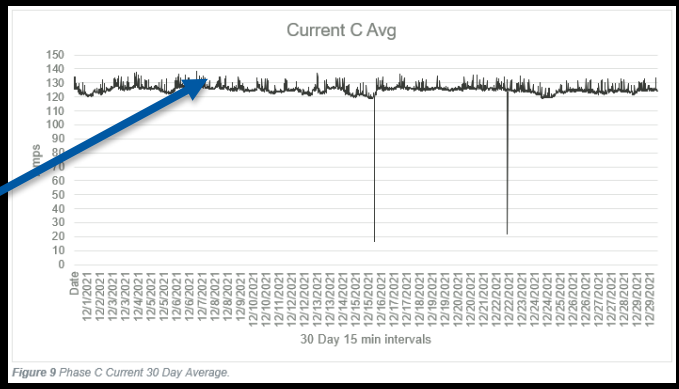


Figure 9 Phase C Current 30 Day Average.

CURRENT MEASUREMENT SUMMARY			
ARMS PHASE A 30 DAY AVG			
MAXIMUM	104.6	12/21/2021	7:12:58 PM
AVERAGE	80.03		
MINIMUM	38.6	12/16/2021	4:37:58 AM
ARMS PHASE B 30 DAY AVG			
MAXIMUM	107.7	12/29/2021	9:04:58 AM
AVERAGE	81.04		
MINIMUM	39	12/16/2021	4:37:58 AM
ARMS PHASE C 30 DAY AVG			
MAXIMUM	105.6	12/21/2021	7:12:58 PM
AVERAGE	81.9		
MINIMUM	39.2	12/16/2021	4:37:58 AM

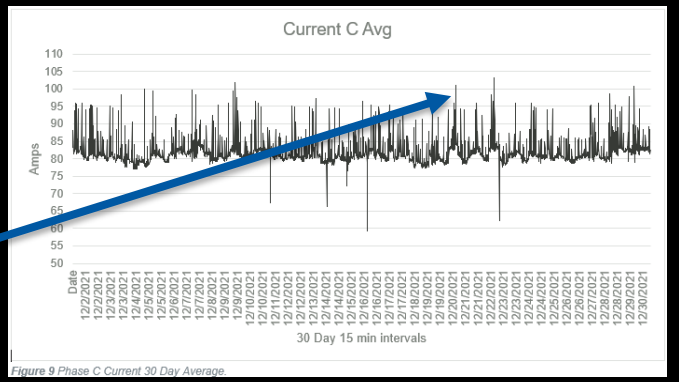


Figure 9 Phase C Current 30 Day Average.

CURRENT MEASUREMENT SUMMARY			
ARMS PHASE A 30 DAY AVG			
MAXIMUM	28.5	12/18/2021	1:47:05 PM
AVERAGE	22.18		
MINIMUM	18.3	12/11/2021	5:48:35 AM
ARMS PHASE B 30 DAY AVG			
MAXIMUM	26.2	12/23/2021	11:31:05 AM
AVERAGE	21.15		
MINIMUM	18.6	12/2/2021	2:14:05 AM
ARMS PHASE C 30 DAY AVG			
MAXIMUM	27.3	12/24/2021	2:32:35 PM
AVERAGE	22.98		
MINIMUM	20.1	12/12/2021	2:55:35 AM

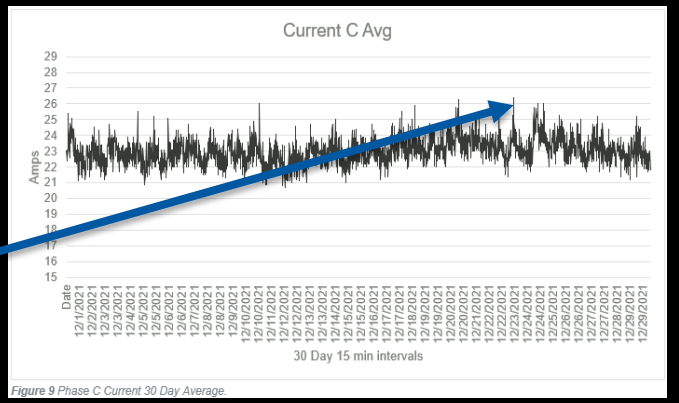
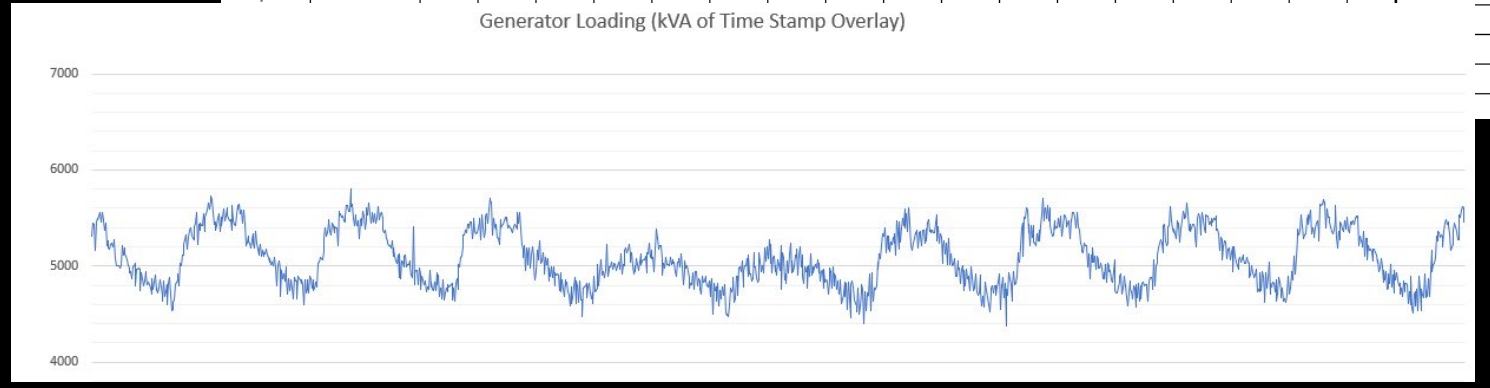


Figure 9 Phase C Current 30 Day Average.

Time Stamp Overlay

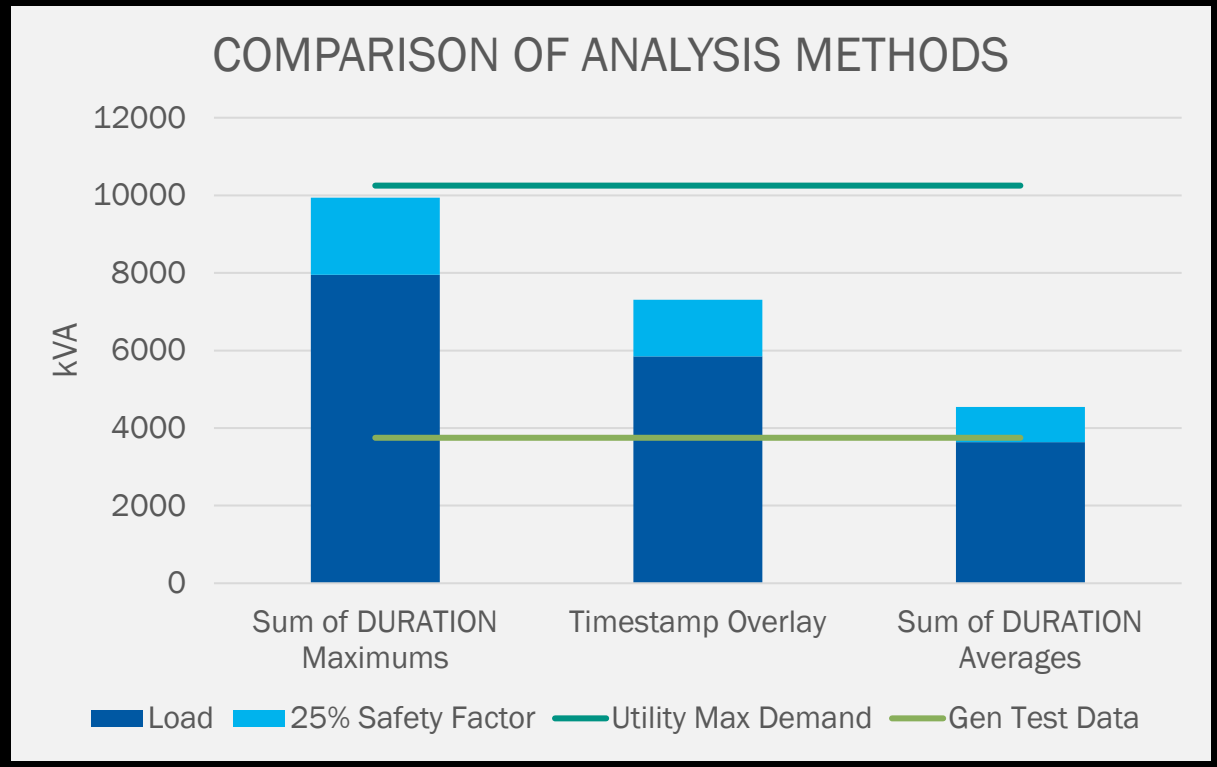
- Aligning the time stamps of each ATS INTERVAL Maximum meter reading gives the most accurate picture of what the generator would actually see.
- Need to ensure you are working with a common unit of measure, ie kVA or kW. If using amps, make sure all the amps are at the same voltage.
- Since the meter data is typically separated by phase, need to either evaluate each phase or just use the maximum of the phases.
- The 125% safety factor from NEC 220.87 should be applied.

Date	Time	ATS-12-LS	ATS-1	ATS-2	ATS-1	ATS-2	ATS-4	ATS-5	ATS-13	ATS-CCH	ATS-N/E	ATS-3	ATS-3	ATS-6	ATS-7	ATS-14	ATS-EQP	Fire Pump	Sum (kVA)
4/8	7:37:26 AM	68.6	923.6	1401.7	110.5	204.6	142.4	278.3	427.7	91.5	381.1	59.7	153.6	339.7	161.4	130.7	321.5	118.9	**5315.6**
4/8	7:47:26 AM	74.8	920.3	1434.4	108.7	198.0	137.9	278.3	429.0	91.3	384.1	59.7	156.4	466.9	151.9	107.7	325.5	118.9	**5443.9**
4/8	7:57:26 AM	78.8	930.1	1370.5	111.7	187.6	143.2	278.3	427.5	94.0	381.4	59.7	154.1	475.4	154.4	141.2	324.5	118.9	**5431.2**
4/8	8:07:26 AM	72.6	912.9	1361.8	113.5	196.9	142.2	278.3	386.8	90.0	384.8	59.7	160.4	324.2	152.1	89.8	321.2	118.9	**5166.2**
4/8	8:17:26 AM	63.1	931.3	1480.8	108.2	204.6	144.7	278.3	416.0	94.0	386.8	59.7	155.1	460.4	151.6	82.3	326.2	118.9	**5462.3**
4/8	8:27:26 AM	60.9	986.9	1413.7	110.7	179.3	185.6	278.3	405.5	95.8	386.8	59.7	186.3	468.9	150.4	82.1	326.2	118.9	**5496.0**
4/8	8:37:26 AM	60.1	927.1	1433.6	112.0	205.3	147.9	278.3	424.3	94.0	386.8	59.7	190.6	472.9	157.4	89.8	321.0	118.9	**5479.7**
4/8	8:47:26 AM	66.8	947.3	1380.3	109.7	179.2	146.2	278.3	436.2	103.8	386.3	59.7	211.8	466.9	156.4	151.9	326.0	118.9	**5525.6**
4/8	8:57:26 AM	64.6	944.8	1386.0	109.5	223.7	145.2	278.3	417.5	98.3	386.1	59.7	230.5	463.2	152.6	157.9	324.0	118.9	**5560.6**
4/8	9:07:26 AM	58.1	945.0	1361.1	109.2	224.3	174.6	278.3	432.5	97.8	384.8	59.7	232.5	324.7	157.1	184.1	318.3	118.9	**5461.0**
4/8	9:17:26 AM	59.9	967.2	1381.3	110.5	217.6	144.7	278.3	395.1	99.3	386.8	59.7	228.0	453.4	153.6	172.3	326.0	118.9	**5552.5**
4/8	9:27:26 AM	62.6	934.1	1366.3	107.0	216.7	148.4	278.3	386.3	101.0	385.8	59.7	209.5	458.4	148.4	178.8	326.7	118.9	**5487.0**
4/8	9:37:26 AM	59.9	931.3	1335.1	105.0	220.0	154.9	278.3	382.4	120.7	387.6	59.7	179.3	454.7	158.4	193.0	326.2	118.9	**5465.4**
4/8	9:47:26 AM	57.9	918.8	1313.4	107.0	209.9	148.9	278.3	411.8	103.0	386.3	59.7	167.4	446.7	155.1	157.4	327.5	118.9	**5368.0**
4/8	9:57:26 AM	57.4	915.9	1387.2	106.8	208.6	168.4	278.3	425.0	100.8	386.8	59.7	158.9	438.5	153.9	157.4	329.0	118.9	**5451.2**
4/8	10:07:26 AM	57.1	895.2	1316.2	108.5	175.2	144.2	278.3	416.0	90.0	385.8	59.7	146.2	447.0	151.6	100.3	323.5	118.9	**5213.6**
4/8	10:17:26 AM	55.6	901.6	1388.7	106.3	174.8	107.2	278.3	412.8	89.3	386.1	59.7	149.6	445.2	147.2	107.0	328.7	118.9	**5257.1**
4/8	10:27:26 AM	64.6	874.5	1326.9	108.5	169.0	139.9	278.3	405.8	89.5	387.8	59.7	150.6	431.2	153.9	107.2	325.0	118.9	**5191.4**
4/8	10:37:26 AM	63.9	893.7	1263.0	109.0	171.3	142.7	278.3	422.5	88.3	388.6	59.7	149.9	442.2	148.9	110.7	321.2	118.9	**5172.8**



Comparison of Methods

- Case study of a large hospital campus with 35+ Automatic Transfer Switches.
- The Sum of DURATION Maximums was approximately 140% more than the Timestamp Overlay of INTERVAL Maximums. For a difference of about 2.1MVA of generator capacity.
- Added cost to meter everything simultaneously was easily covered in savings from:
  - One less generator and gear
  - Reduced generator plant footprint
  - Construction schedule and EOR's time due to everything being complete in 30 days.



- Load data shall also be input into a generator sizing program to ensure generator can handle all the load steps.
- Verify calculated generator load vs utility load data as a gut check.

New Generators With New Load

CANNONDESIGN

New Generator Design

Aurora Medical Center, Fond du Lac

New Generator Design

Froedtert Health, Center for Advanced Care (CFAC)

New Generator Design

ThedaCare, Neenah Campus Modernization

NFPA 70 (National Electrical Code, NEC) Guidance

- NEC understands generators shouldn't be oversized.
- NEC is implying that they know the NEC load calculations are designed to be conservative and would oversize the generators.
- NEC demand factors are very specific and don't apply to all loads.
- The EOR's engineering judgement must be used to take all the requirements into account.

2017 - 2023 NEC 517.31.D:

(D) Capacity of Systems. The essential electrical system shall have the capacity and rating to meet the maximum actual demand likely to be produced by the connected load.

Feeders shall be sized in accordance with 215.2 and Part III of Article 220. The alternate power source(s) required in 517.30 shall have the capacity and rating to meet the demand produced by the load at any given time.

Demand calculations for sizing of the alternate power source(s) shall be based on any of the following:

(1) Prudent demand factors and historical data
(2) Connected load
(3) Feeder calculations
(4) Any combination of the above

The sizing requirements in 700.4 and 701.4 shall not apply to alternate sources.

STEP ONE

Determine the NEC Demand Load

- Do a W/SF calculation based on the new building.
- The NEC gives limited information on sizing loads in hospitals.
- The 2023 NEC does lower the W/SF for lighting and has a more generous demand factor for receptacles in Category 1 & 2 spaces.
- Engineering judgement based on previous projects is needed to determine the load.
- Recommend breaking up the building by space type as each will have different electrical needs.
- Breakout large motors, imagining equipment etc. Subtract redundant equipment or items which won't run at full speed at the same tie, ie hot water pumps vs chilled water pumps.
- Each hospital will have different load profiles.

Table 220.110(1) Demand Factors for Receptacles Supplied by General-Purpose Branch Circuits in Category 1 and Category 2 Patient Care Spaces

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 5000 or less	100
From 5001 to 10,000	50
Remainder over 10,000	25

Table 220.110(2) Demand Factors for Receptacles Supplied by General-Purpose Branch Circuits in Category 3 and Category 4 Patient Care Spaces

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 10,000 or less	100
Remainder over 10,000	50

Table 220.42(A) General Lighting Loads by Non-Dwelling Occupancy

	Unit Load	
Type of Occupancy	Volt-amperes/ m^2	Volt-amperes/ ft^2
Automotive facility	16	1.5
Convention center	15	1.4
Courthouse	15	1.4
Dormitory	16	1.5
Exercise center	15	1.4
Fire station	14	1.3
Gymnasium[1]	18	1.7
Health care clinic	17	1.6
Hospital	17	1.6

STEP TWO

Determine the ACTUAL Load

NEC Demand Load is very conservative which is why the NEC allows historical data and demand factors to be used for generator sizing.

Determining what those demand factors are is the difficult part:

- Review previous projects ATS NEC demand vs actual meter readings.
- Review previous projects NEC demand vs Utility Data.
- Review current facility W/SF from utility data.
- Review where central plant functions are located, ie offsite or internal.
- Review planned program. For example an ED will have a much higher electrical usage than a patient floor.
- Analyze overall size of the system. For example a large campus can apply more diversity than a small facility as there’s a higher chance everything could be on at one time.

Demand Factors by Program Space

Low Demand Factor (low load %)

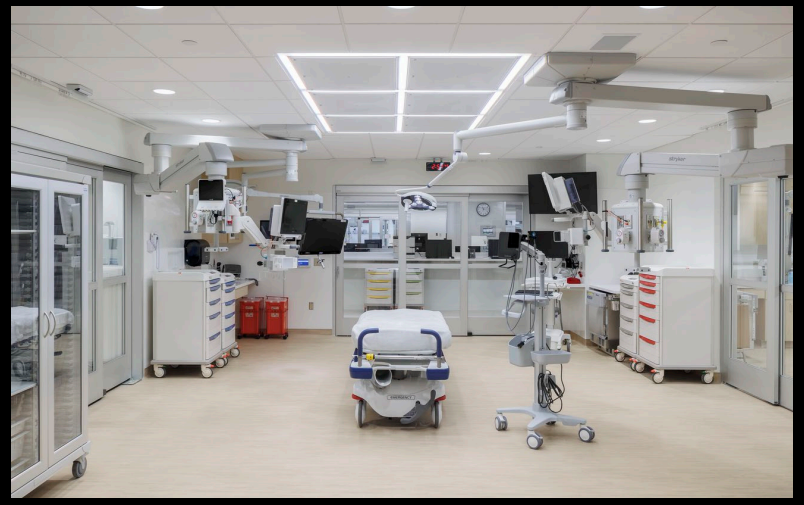
- Patient Rooms
- Operating Rooms
- Outpatient

Medium Demand Factor

- Equipment / Motors

High Demand Factor (high load %)

- Fire Pump
- Life Safety
- Emergency Departments



STEP THREE

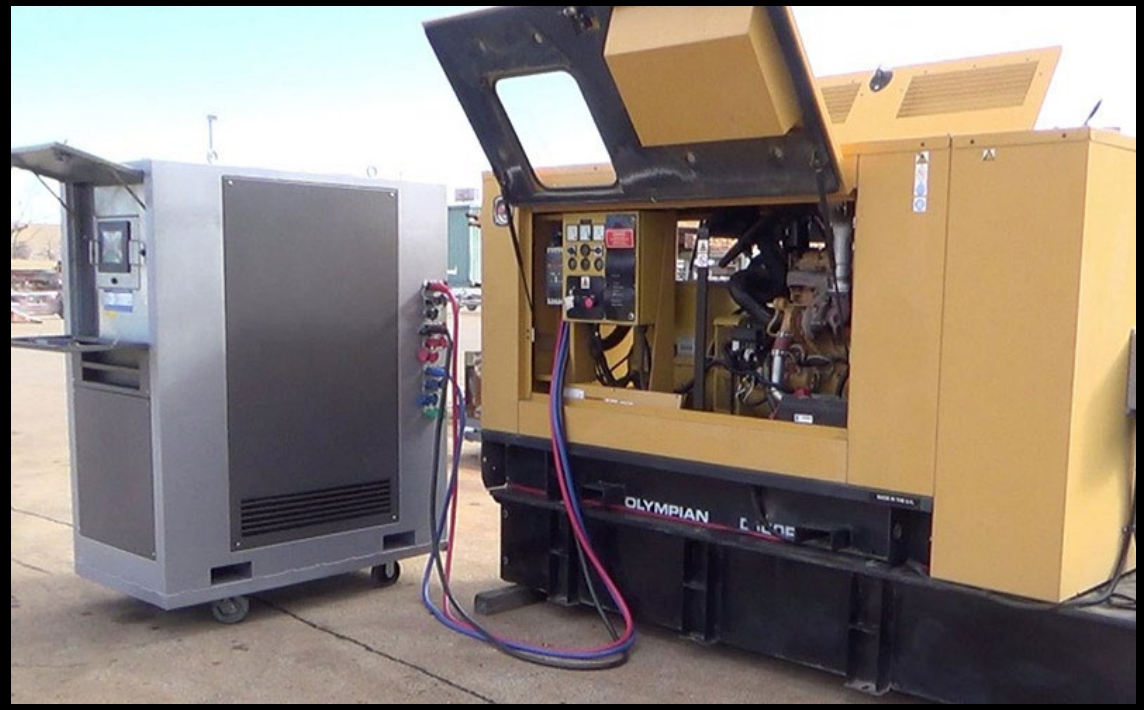
Determining the Generator Size

- Apply the demand factors you determine in Step Two.
- Enter the calculated loads into a generator sizing program to ensure it can handle the loads to determine the final recommended size.
- Also need to look at minimum possible loading to avoid wet stacking.
  - Don’t forget to review phasing of the turn on, if the generator will be online before all loads are turned on.
- If loads are borderline, can review to ensure:
  - Redundant motors have been removed.
  - Is there load shedding available for non code required loads?
  - Fire pumps need to be calculated, but realistically on a campus would multiple be running at the same time while also having all the other loads at an elevated level?
  - How many elevators are planned to run on emergency power?

Other Solutions If Over or Under Loaded

CANNONDESIGN

UNDER-loaded



Loadbanks
(Permanent or Temporary)

BAS Overrides
(Turn motors on/up when generator running)

OVER-loaded

- Load Shedding – Shed ATS's which are not priority 1 when in an overload situation.
- Limit Elevators which run during a power outage.
- BAS Overrides to limit motors/fans to a certain percentage when on generator power

Lessons Learned

- Need to ensure you are working with a common unit of measure, ie kVA or kW. If using amps, make sure all the amps are at the same voltage.
- Make sure seasonal loads are taken into account if not on during metering.
- Review calculations vs utility data as a gut check.
- Review minimum generator loading if there is a single large load or phased turn on/occupancy.
- If the EC doesn’t do metering often, do a test first.
- Make sure all data is good before returning meters.
- Ensure ATS’s which feed other ATS’s are not counted.
- Have a meeting with EOR and EC before install.

Questions to Ask

- Does the Metering Duration truly reflect a maximum demand load, ie seasonal loads.
- What is the facilities Emergency Operations Plan. If on generator power, what program space will still fully function.
  - Does this change if it's a 2 hour outage vs a 2 week outage?
  - Will all operating rooms be used?
  - Will patients be relocated?
- Red outlet usage – Is the facility currently mostly running on red outlets or during a outage loads would probably move from the normal branch to the red critical outlets?
- If there is a surge(ie a pandemic type event), how would that effect the facility/electrical load?
- How much spare capacity is requested? Future expansion plans?

Summary

1 **Why Proper Sizing Is Important**

2 **Existing Generators**

3 **New Generators & New Loads**

4 **Solutions If Under/Over Loaded**

Questions?

Thank you!

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