RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

ELECTRICAL SAFETY RESEARCH ADVISORY COMMITTEE

Meeting Minutes

RESEARCH PLANNING MEETING

HILTON HEAD, SOUTH CAROLINA

SATURDAY, 13 JANUARY 2018; 8:00 AM – 2:00 PM

1. Call to Order, Agenda, and Attendees. The meeting was called to order at 8:00 AM by Donny Cook, Chair of the Electrical Safety Research Advisory Committee (ESRAC). The meeting agenda was briefly reviewed and this is included as Attachment A. A summary of the attendees is included in Attachment B.

2. Welcome and Meeting Overview: Donny Cook welcomed everyone and provided a brief overview of the ESRAC. It was clarified that the membership of the ESRAC is open. An overview summary of the ESRAC was circulated and this is included as Attachment C. Casey Grant used slides to review additional overview information describing the role of the Foundation. These slides are included as Attachment D, and were used throughout the remainder of the meeting to help focus the meeting discussions.

3. Summary of Previous Research Activities. Casey Grant indicated that the last time the ESRAC compiled their research priorities was in June of 2016, and a summary of the identified research topics is included as Attachment E.

   Meanwhile, all completed research projects conducted by the Foundation are posted on the FPRF web page (see www.nfpa.org/Foundation). Specifically, the Foundation's published reports on electrical topics are posted at: http://www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Research-reports/Electrical-safety.

4. Issue #1 – Branch Circuit Loading: This topic was introduced by Casey Grant with reference to the earlier recent study posted on the Foundation's website at: Evaluation of Electrical Feeder and Branch Circuit Loading: Phase 1 (2016). Larry Ayer, Chair of the NEC Correlating Committee Task Group on this topic provided a detailed presentation, and his slides are included in Attachment F. An effort is underway to consider NEC revisions for the design of branch and feeder circuit loading, recognizing that the electrical loads in today's buildings are much different than in the past, with

significant differences based on occupancy and other factors. Ultimately, more data is needed on actual usage.

A case study application involving health care occupancies has already seen efforts to collect data on this topic. Presentations were made by Walt Vernon and Jason D'Antona, and their presentations are included as Attachments G and H respectively. This provided specific data, and it facilitated the dialogue on clarifying on-going data needs.

This resulted in a discussion by all present that identified several key processing parameters and performance characteristics. It was indicated that we ultimately need to establish a process (with framework and protocols) to address this issue beyond the initial case study topic of healthcare. Further, the time frames need to be clarified for the immediate deliverables that can be realistically addressed in this NEC cycle, and those that should become the focus of future revision cycles.

Based on discussion by the entire group, the key performance characteristics that need to be considered relating to the collection of branch circuit loading data include the following:

- Critical Definitions and terminology (for consistent data collection, such as preferred units of measurement, defining ambient temperature, etc.);
- Equipment performance characteristics (including maintenance);
- Occupancies (and critical features of the occupancy, such as seasonal influences, geographic or regional differences, special loads such as a mass casualty event in healthcare, etc.);
- Methodologies used for data collection (in support of ultimate analytical approaches to be used); and
- Data Characteristics (with statistical validity).

At this time the NEC Correlating Committee Task Group will continue to review the data and related information collected for healthcare occupancies. They will focus on specific possible changes for this cycle of the NEC, and in parallel will consider the optimum approach for extending this to all occupancies in the future. The Foundation will be on standby to assist with addressing this topic, and will stay in touch as the Task Group proceeds.

5. Issue #2 – Power Over the Ethernet: This is seen as an important issue involving emerging technology, and involves the combined use of cables and conductors for both electrical power and communication.

   This has potentially sweeping implications for the NEC, as well as other NFPA codes and standards such as NFPA 72 (National Fire Alarm and Signaling Code, NFPA 730 (Guide for Premises Security, NFPA 731 (Standard for the Installation of Electronic Premises Security Systems), and NFPA 1221 (Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems). Further this involves codes and standards from other organizations, adding to the complexity of this issue. The recent workshop on this topic held in October 2017 in Durham NH was referenced, and the Proceedings for this workshop are posted at Workshop: Power Over the Ethernet.

Discussion indicated that, in general, this comes down to: sending data and some amount of power through cables that aren't necessarily designed or tested to handle both safely and accurately over the long term. The discussion around this focused on needing a framework before more could be done (even definitions are unclear). The following are the primary identified needs:

- Definitions and terminology (e.g., cable, data-lines, wireless, etc.);
- Data (including modelling based on data, adverse outcomes, centralized failure analysis, etc.);
- Clarify and define key stakeholder expectations (enforcers, inspectors, insurers, etc.);
- Training, education and awareness (including simplified mainstream easily understood outreach); and
- Regulatory coordination (including among model code and standards organizations).

A key issue is to consider the establishment on an on-going process and framework to consider this issue across multiple organizations (such as a United Nations type activity focused on PoE). The establishment of such an activity has clear challenges, though this should be considered at upcoming joint meetings.

The Research Foundation will seek to set-up another follow-up planning effort on PoE, if possible in June 2018 at the NFPA C & E in Las Vegas. This will focus on further refining this issue into actionable strategies, and further addressing the outcomes from the Durham workshop. Specific items to address include sub-details such as the regulatory landscape, definitions, terminology, required data, performance issues, stakeholders, training, new vs. retrofit, and other issues. More information on this will be circulated when it becomes available.

6. Issue #3 – AFCI/GFCI: Several Research Fund submittals have been received on AFCIs and GFCIs in this latest round as well as previous rounds, and thus there was a general discussion on these topics. Likewise during the last ESRAC meeting in June 2016 this was considered an important research area. It was acknowledged that these are technically different applications, and have noteworthy differences despite commonalities.

   For both AFCIs and GFCIs, the discussion focused on the need for data, with a two-pronged focus on retrospective data (existing data; looking backward) and prospective data (data not yet collected; looking forward). The challenges of collecting data were identified as existing vs. retrofits, enforcement quality, installation quality, fire vs. shock, investigation quality, etc. Detailed case study comparison would be useful, as well as clear residential electrical fire data (consistent with research fund submittal #1803).

7. Issue #4 – Marina Electrical Safety: The need to address ESD (electric shock drowning) remains a significant concern among the electrical community, though the best next steps to positively impact this issue remains elusive and more work is needed. Late last year the Foundation published the report on Marina Risk Reduction, and this now provides a critical baseline that compares the risk and overall value of the full spectrum of mitigation measures.

   Several specific projects received in the Research Fund relating to this topic were discussed. This includes #1880, which considers a comparison with NFPA 72 that takes a similar approach with

smoke detectors. Submittals #1880 and #1881 are distinctly different though related (e.g., chemical corrosion vs. environmental). It was suggested that we consider future research that is regulatory focused consistent with the concepts of community risk reduction. This could or would clarify:

- The magnitude of applications, with specific sub-details and trends of use
- The regulatory approach by jurisdiction or state
- Summarize the regulatory landscape
- Identify successful jurisdictional case studies

8. Overall Review of Proposed Electrical Projects. Casey Grant provided a summary of the Project Statement Form that was circulated prior to the meeting with a memo to identify possible research projects. Multiple proposed projects were collected, and a summary of the Research Projects under review was circulated earlier to the ESRAC, and likewise a hard copy was made available to meeting attendees. A summary form was provided and attendees were asked to complete and return this to staff by the end of the meeting. A compilation of the results of the most desired research efforts was generated after the meeting, and this is included as Attachment I. This will provide useful guidance on the ultimate direction of the limited resources to address these proposed projects.

9. Concluding Remarks and Adjournment. Donny Cook reminded all interested parties to participate in these activities and let the Research Foundation know about possible sponsors and other important details. Casey Grant indicated that the Foundation will be looking into moving forward on certain issues that are viewed as priorities. It was suggested to repeat this ESRAC meeting later in 2018 at the San Diego NEC Panel meetings, and staff will plan for such a meeting.

   ESRAC attendees were thanked for their participation and contribution to this meeting. A meeting summary will be prepared by staff and circulated. The meeting was adjourned at 2:00 pm.

(Meeting Summary by C. Grant, 12/Feb/2018)

Attachments

Attachment	Description	No. of Pages
A	Meeting Agenda	1
B	Summary of Meeting Attendees	2
C	ESRAC Overview	2
D	Slides for ERAC Meeting Overview (by Casey Grant)	4
E	Summary of Research Topics from June 2016	2
F	Slides on Branch Circuit Loading (by Larry Ayer)	5
G	Slides on Branch Circuit Loading (by Walt Vernon)	4
H	Slides on Branch Circuit Loading (by Jason D'Antona)	4
I	Summary of Research Fund Electrical Priorities	1

RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

ELECTRICAL SAFETY RESEARCH ADVISORY COMMITTEE

RESEARCH PLANNING MEETING

AGENDA

Last Updated: 17 December 2017
Subject to further updates

Saturday, 13 January 2018

8:00 am – 3:00 pm

Sonesta Resort Hilton Head Island (formerly the Crowne Plaza)

130 Shipyard Drive Hilton Head, SC 29928

(Dress code: business casual)

1.	Welcome, Introductions, Preliminaries & Background	(8:00 am – 8:30 am)
2.	Issue #1: Branch Circuit Loading	(8:30 am – 10:00 am)
	Break	(10:00 am – 10:15 am)
3.	Issue #2: Power Over the Ethernet	(10:15 am – 11:15 am)
4.	Review of Data Collection Efforts (for Issues #1, 2, & 3)	(11:15 am – 12:00 pm)
	Working Buffet Lunch	(12:00 pm – 12:30 pm)
5.	Issue #3: AFCI/GFCI	(12:15 pm – 1:15 pm)
6.	Identification and Prioritization of Other Research	(1:15 pm – 2:45 pm)
7.	Meeting Summary, and Adjournment	(2:45 pm - 3:00 pm)

Note: Information on the venue and related NEC Code Making Panel meetings can be found at:
http://www.nfpa.org/assets/files/AboutTheCodes/70/70_A2019_NEC_FD_meetingnotice_01_18_REV.pdf

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Electrical Safety Research Advisory Committee;
Saturday 13 January 2018 (8 am to 3 pm) ----- Hilton Head, SC

Last Updated: 15 January 2018

Attendees

1	Kevin Arnold	Eaton	kevinsarnold@eaton.com
2	Larry Ayer	IEC & Bizcom Electric	larryayer@bizcomelec.com
3	George Bish	Ring	gjbish@gmail.com
4	Alpesh Bhobe	Cisco	abhobe@cisco.com
5	Dan Buuck	NAHB	DBuuck@nahb.org
6	Greg Clement	Fluor	gregory.clement@fluor.com
7	Dave Clements	IAEI	dclements@iaei.org
8	Terry Coleman	Electrical Training Alliance	terryc@najtc.org
9	Donny Cook	Shelby County AL	dcook@shelbyal.com
10	Dale Crawford	Steel Tube Institute	dcrawford@steeltubeinstitute.org
11	Amy Cronin	Strategic Code Solutions	acronin@codestrategist.com
12	Jason D'Antona	Thompson Consultants, Inc.	jdantona@thompson-consultants.com
13	Vince Dellacroce	Siemens	vincent.dellecroce@seimens.com
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27	David Hittinger	IEC	davidhittinger@gmail.com
28	Mike Holt	Mike Holt Enterprises	mike@mikeholt.com
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RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

Advisory Committee on Electrical Safety Research

Last Updated: 7 August 2017

Goal

To enhance electrical safety through research and education in support of NFPA Electrical Codes and Standards

Reporting Structure

The Committee is a subdivision of the Fire Protection Research Foundation (the Foundation), which is solely responsible for its administration.

Membership

The Committee is open to all individuals who support its mission; membership will be attained by registration with the administrator of the Foundation. The Executive Director of the Foundation will appoint an initial Chair of the Committee, to serve until a Chair and Vice Chair are elected by membership of the Committee for two year terms, or until their successors are elected and qualified.

The staff liaison of the NEC Code Making Panels, the staff liaison of other NFPA electrical codes and standards, appointed liaisons from these committees and from the Fire Protection Research Foundation Board of Trustees will serve by designation as members of the Committee.

Role of the Foundation in General Committee Activities

The Foundation shall oversee and have general charge of the affairs and activities of the Committee. The Foundation shall designate a non-voting secretary to the Council, the secretary shall provide administrative services to its activities, including meeting arrangements, record keeping, and other activities as determined to be appropriate by the Board of Trustees.

Activities of the Committee

The Committee will meet at least annually; additional meetings may be held at the call of the Chair. An annual report of Committee activities will be provided to all members. Regular electronic communication on current activities will be provided through electronic means.

The Chair of the Committee will recommend designated individuals to carry out various activities in support of the mission including: research planning, representation on Foundation Project Technical Panels, and symposia planning committees, etc, as needed.

The primary activity of the Committee will be to plan, oversee, and communicate research programs in support of its mission as follows:

The Committee will engage in a research planning program to identify priority research projects. The scope and preliminary research plan for these priority projects will be developed with guidance from members of the Committee. If appropriate, the Foundation will seek funding support for the project, and, once undertaken, will appoint a Project Technical Panel including members of the Committee to oversee the project and conduct the research in accordance with its procedures. Regular reports on all research projects will be provided to the Committee membership by the Foundation by email, and through presentations at the appropriate Code Making Panel meetings.

A secondary activity of the Committee is to provide the community with updates on the state of the art in electrical safety. The Committee will provide input into symposia planning at the Foundation; symposia will be administered by the Foundation.

All activities of the Committee are subject to the approval of the Foundation Board of Trustees.

Funding

Committee membership is open to all who support its mission and the Foundation will support the general activities of the Committee at no cost to participants. The Foundation will charge for its role in administration of Foundation research projects.

RESEARCH FOUNDATION
RESEARCH FOR THE NFPA MISSION

Electrical Safety Research Advisory Committee

Research Planning Meeting

13 January 2018 | 8:00 am – 3:00 pm | Hilton Head, South Carolina

AGENDA

Electrical Safety Research Advisory Committee

1) Welcome, Introductions, Preliminaries & Background
2) Issue #1: Branch Circuit Loading
3) Issue #2: Power Over the Ethernet
4) Review of Data Collection Efforts (for Issues #1, 2, & 3)
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Understanding the NFPA and FPRF

NFPA – National Fire Protection Association

- Non Profit Membership Association
- Established in 1896; Approximately 65K members
- Headquartered in Quincy, MA, though no geographic boundaries
- Mission: Make the world safer from fire and related hazards
- 300 plus "model Codes & Standards; administered by 8K volunteers

FPRF– Fire Protection Research Foundation

- NFPA's Research Affiliate: Separate non-profit research organization
- Mission: Facilitate research on behalf of the NFPA mission
- Analogy: Hollywood movie producer

www.NFPA.org/Foundation

Foundation Projects… who participates?

- Funding (Sponsors): *Where does it come from?*
  - Manufacturers, trade associations, NFPA, federal agencies, research organizations, nowhere, etc…
- Contractors: *Who Does the Work?*
  - Consultants, research organizations, test labs, universities, NFPA Fire Analysis, volunteers
- Advisory Oversight: *Project Technical Panel*
  - Typically small (6 to 15)
  - Meet at important stages of project (start/end/other)

www.NFPA.org/Foundation

HANDOUT: ESRAC Overview

HANDOUT: Project Statement Form


HANDOUT: ESRAC Research Priorities 2016


HANDOUT: 2018 Electrical Project Review


www.NFPA.org/Foundation

FOUNDATION REPORTS: www.nfpa.org/foundation

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RESEARCH FOUNDATION


Evaluation of Electrical Feeder and Branch Circuit Loading: Phase 1

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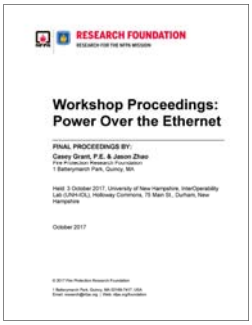
RESEARCH FOUNDATION

Workshop Proceedings: Power Over the Ethernet



Workshop Proceedings: Power Over the Ethernet

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RESEARCH FOUNDATION

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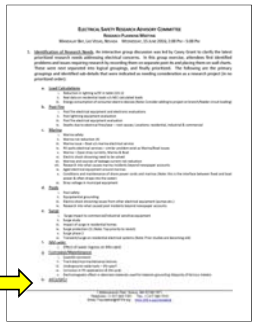
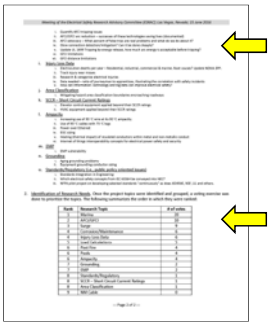
RESEARCH FOUNDATION

HANDOUT: ESRAC Research Priorities 2016





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Other Research: Identification & Prioritization

ID #	Title	Technical Relevance[1]	Problem Magnitude[2]	Sense of Urgency[3]	Likelihood of Success[4]	OVERALL RANK	Comments
1	1601 Modeling Shock in Water						
2	1602 Low Voltage Cable Impedance						
3	1603 GFCI Limitations						
4	1604 GFCIs in Marinas						
5	1623 Interoperability						
6	1718 Elec Grounding in O2 Atmosphere						
7	1719 Fire Resistance Rating of Concrete						
8	1803 Residential Electrical Fire Data						
9	1813 Arc Flash Modelling						
10	1821 Power Transmission Anti-Icing						
11	1880 Marina Elec Equip Harvesting						
12	1881 Pool Corrosion						

Footnotes:
1) Value added from a technical and scientific standpoint
2) Problem magnitude as compared to overall mission (of NFPA, the respective document, etc)
3) Criticality of timing issues
4) Feasibility

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RESEARCH FOUNDATION
RESEARCH FOR THE NFPA MISSION

Thank You

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ELECTRICAL SAFETY RESEARCH ADVISORY COMMITTEE

RESEARCH PLANNING MEETING

MANDALAY BAY, LAS VEGAS, NEVADA WEDNESDAY, 15 JUNE 2016; 2:00 PM – 5:00 PM

1. Identification of Research Needs. An interactive group discussion was led by Casey Grant to clarify the latest prioritized research needs addressing electrical concerns. In this group exercise, attendees first identified problems and issues requiring research by recording them on separate post-its and placing them on wall charts. These were next separated into logical groupings, and finally prioritized. The following are the primary groupings and identified sub-details that were indicated as needing consideration as a research project (in no prioritized order):

    a. Load Calculations
        i. Reduction in lighting w/SF in table 220.12
        ii. Real data on residential loads v/s NEC calculated loads
        iii. Energy consumption of consumer electric devices (Note: Consider adding to project on branch/feeder circuit loading)
    b. Post Fire
        i. Post fire electrical equipment and electronic evaluations
        ii. Post lightning equipment evaluation
        iii. Post fire electrical equipment evaluation
        iv. Deaths due to electrical fires/year – root causes; Locations: residential, industrial & commercial
    c. Marina
        i. Marina safety
        ii. Marina risk reduction (4)
        iii. Marina issue – Boat v/s marina electrical service
        iv. RV parks electrical services – similar problem exist as Marina/Boat issues
        v. Marina – Zipse stray currents, Marina & Boat
        vi. Electric shock drowning need to be solved
        vii. Marinas and sources of leakage current risk reduction
        viii. Research into what causes marina incidents beyond newspaper accounts
        ix. Aged electrical equipment around marinas
        x. Conditions and maintenance of shore power cords and marinas (Note: this is the interface between fixed and boat power & often drape into the water)
        xi. Stray voltage in municipal equipment
    d. Pools
        i. Pool safety
        ii. Equipotential grounding
        iii. Electro-shock drowning issues from other electrical equipment (pumps etc.)
        iv. Research into what caused pool incidents beyond newspaper accounts
    e. Surge
        i. Surge impact to commercial/industrial sensitive equipment
        ii. Surge study
        iii. Impact of surge in residential homes
        iv. Surge protection (3) (Note: Top priority to revisit)
        v. Surge phase 2
        vi. Transient/surge on residential electrical systems (Note: Prior studies are becoming old)
    f. NM cable
        i. Effect of water ingress on NM cable
    g. Corrosion/Maintenance
        i. Quantify corrosion
        ii. Track electrical maintenance failures
        iii. Underground cable tasks – life span?
        iv. Corrosion in PV applications & life cycle
        v. Electromagnetic effect in alternate materials used for telecom grounding (Majority of ferrous metals)
    h. AFCI/GFCI

i. Quantify AFCI tripping issues
ii. AFCI/GFCI arc reduction – successes of these technologies saving lives (documented)
iii. AFCI advocacy – What percent of false trips are real problems and what do we do about it?
iv. Glow connection detection/mitigation? Can it be done cheaply?
v. Update UL 1699 Tripping by energy release, how much arc energy is acceptable before tripping?
vi. GFCI limitations
vii. GFCI distance limitations

i. Injury Loss Data
   i. Electrocution deaths per year – Residential, industrial, commercial & marine. Root causes? Update NEMA 5PP.
   ii. Track injury near misses
   iii. Research & categorize electrical injuries
   iv. Data needed – ratio of journeyman to apprentices, illustrating the correlation with safety incidents
   v. How can Information Technology and big data can improve electrical safety?

j. Area Classification
   i. Mitigating hazard area classification boundaries encroaching roadways

k. SCCR – Short Circuit Current Ratings
   i. Elevator control equipment applied beyond their SCCR ratings
   ii. HVAC equipment applied beyond their SCCR ratings

l. Ampacity
   i. Increasing use of 90 °C wire at its 90 °C ampacity.
   ii. Use of 90 °C cables with 75 °C logs
   iii. Power over Ethernet
   iv. EGC sizing
   v. Heating (thermal impact) of insulated conductors within metal and non-metallic conduit
   vi. Internet of things interoperability concepts for electrical power safety and security

m. EMP
   i. EMP vulnerability

n. Grounding
   i. Aging grounding problems
   ii. Equipment grounding conductor sizing

o. Standards/Regulatory (i.e., public policy oriented issues)
   i. Standards Integration in Engineering
   ii. Which electrical safety concepts from IEC 60364 be conveyed into NEC?
   iii. NFPA pilot project on developing selected standards "continuously" as does ASHRAE, NSF, UL and others.

2. Identification of Research Needs. Once the project topics were identified and grouped, a voting exercise was done to prioritize the topics. The following summarizes the order in which they were ranked:

Rank	Research Topic	# of votes
1	Marina	20
2	AFCI/GFCI	10
3	Surge	9
4	Corrosion/Maintenance	6
4	Injury Loss Data	6
5	Load Calculations	5
6	Post Fire	4
6	Pools	4
6	Ampacity	4
7	Grounding	2
7	EMP	2
8	Standards/Regulatory	1
8	SCCR – Short Circuit Current Ratings	1
8	Area Classification	1
9	NM Cable	0

CC Energy Task Group

- Where we are…
- Review important proposed changes to Table 220.12.
- What we need to be successful moving forward
- Consolidate energy in specific direction
- Where we want to go

Energy Task Group

Larry Ayer (Co-Chair), IEC
Alan Manche (Co-Chair), Schneider Electric
Donny Cook, IAEI
Eric Richman, Ashrae 90.1
John McCamish, IBEW
Ken Boyce, UL
Mike Weaver, NECA
Richard Holub, American Chemistry Council
Steve Douglas, CSA
Tom Domitrovich, NEMA
Tim Croushore, Edison Electric Institute
Tim Pope, CSA

Office Bldg

HVAC load for Office Bldg	6
Lighting Allowance	3.5
Outlets	2.7
Other	??
Total	12.2 Watts/s.f. + other??

Figure 19. Austin Energy - Commercial Building Average Electric Power Intensity
(Data Source: [6])

Table 13. Measured Power Consumption of Common Office Devices in Various States*

Device	Number	Active (W)	Idle (W)	Sleep (W)	Standby (W)
Desktop computer	61	78.9	45.6	3.2	2.2
Notebook computer	20	74.7	30.3	1.6	1.6
LCD display	84	34.2	26.4	6.2	0.9
Laser MFD	18	75.7	26.1	5.4	5.5
Laser printer	33	130.1	19.0		11.4
Inkjet printer	13	64.0	6.8	4.7	2.7
Computer speakers	18	6.0	2.4		1.7
External drive	2	28.4		10.7	1.0
Ethernet hub or switch	9	17.0	8.0	5.9	1.3
USB hub or switch	2	26.0	14.1	5.9	0.6
LCD television	2	58.2			3.1
Video projector	4	181.9		9.8	4.6
Portable CD player	7	18.0	3.0		1.3
Speakers (audio)	6	32.0	10.0		1
Coffee maker	10	464.0	40.3		1.8
Shredder	4	78.4			0.8
Space heater	4	937.7			1.0
Toaster oven	1	1057.9			0.0

*Devices and data selected from Table 11 in [14]

Fire Research Foundation Study

- Good synopsis of research papers and the issues but …..
- We need NEC type data.
- Section 8.5 – Data Analysis
  - ✓Evaluation of Lighting Load
  - Evaluation of Receptacle Load (NEC 2023)
  - Evaluation of Other Loads (NEC 2023)
  - Evaluation of In-House Feeder Sizing and Transformer Loading
  - Evaluation of Main Feeder Size and Service Transformer Loading
  - General Evaluation of Power Quality

Comparison of NEC 2017 vs ASHRAE 90.1-2013				
NEC Occupancy Type	Building Area Type	NEC (watts/sf)	ASHRAE 90.1-2013 (watts/sf)	Percentage Difference
Office	Office	3.5	0.82	327%
Garages - commercial (storage)	Parking Garage	0.5	0.21	138%
	Pententiary		0.81	
	Performing arts theater		1.39	
	Police Station		0.87	
	Post Office		0.87	
Churches	Religious building	1	1	0%
Stores	Retail	3	1.26	138%
Schools	School/university	3	0.87	245%
Armories and auditoriums	Sports Arena	1	0.91	10%
	Town Hall		0.89	
	Transportation		0.7	
Warehouse/Storage	Warehouse	0.25	0.66	-164%
	Workshop		1.19	

NEC 2017 Table 220.12 Occupancies	ASHRAE 90.1	NEC 2020 Table 220.12 Occupancies
	Automotive Facility	Automotive Facility
	Convention Center	Convention Center
Court rooms	Courthouse	Courthouse
Clubs	DINING: BAR LOUNGE/LEISURE	Restaurants
Restaurants	DINING: CAFETERIA/FAST FOOD	
	DINING: FAMILY	
	Dormitory	Dormitory
	Exercise Center	Exercise Center
	Fire Stations	Fire Stations
Armories and Auditoriums	Gymnasium	Gymnasium
	Healthcare	Healthcare
Hospitals	Hospital	Hospital
Hotels and motels, including apartment houses without provisions for cooking by tenants	Hotel	Hotels and motels, including apartment houses without provisions for cooking by tenants
	Library	Library
	Manufacturing	Manufacturing
	Motel	
	MOTION PICTURE THEATRE	MOTION PICTURE THEATRE
Dwelling	MULTI-FAMILY	
	MUSEUM	MUSEUM

1/13/2018 8

NEC 2017 Table 220.12 Occupancies	ASHRAE 90.1	NEC 2020 Table 220.12 Occupancies
Office Building Banks	OFFICE	OFFICE
Garages - commercial (storage)	PARKING GARAGE	PARKING GARAGE
	PENITENTIARY	PENITENTIARY
	PERFORMING ARTS THEATER	PERFORMING ARTS THEATER
	POLICE STATIONS	POLICE STATIONS
	POST OFFICE	POST OFFICE
Churches	RELIGIOUS BUILDINGS	RELIGIOUS BUILDINGS
Stores Barber shops and beauty parlors	RETAIL	RETAIL
Schools	SCHOOL/UNIVERSITY	SCHOOL/UNIVERSITY
	SPORTS ARENA	SPORTS ARENA
	TOWN HALL	TOWN HALL
	TRANSPORTATION	TRANSPORTATION
Warehouse	WAREHOUSE	WAREHOUSE
	WORKSHOP	WORKSHOP

9

Historical ASHRAE 90.1 Comparison of Building LPD over time

	Bldg Type	2016	2013	2010	2007 2004	2000 1999	1989*	1980*
1	AUTOMOTIVE FACILITY	0.71	0.80	0.8	0.9	1.5	1.7	3.7
2	CONVENTION CENTER	0.76	1.01	1.1	1.2	1.4	1.9	1.5
3	COURTHOUSE	0.90	1.01	1.1	1.2	1.4	2.0	1.3
4	DINING: BAR LOUNGE/LEISURE	0.90	1.01	1.0	1.3	1.5	2.4	1.6
5	DINING: CAFETERIA/FAST FOOD	0.79	0.90	0.9	1.4	1.8	2.2	2.0
6	DINING: FAMILY	0.78	0.95	0.9	1.6	1.9	2.3	2.2
7	DORMITORY	0.61	0.57	0.6	1	1.5	1.6	1.6
8	EXERCISE CENTER	0.65	0.84	0.9	1	1.4	1.2	1.0
9	FIRE STATIONS	0.53	0.67	0.7	1	1.3		1.3
10	GYMNASIUM	0.68	0.94	1.0	1.1	1.7	1.1	0.9

1/13/2018 ADD A FOOTER 10

220.12 Lighting Load for Non-Dwelling Occupancies.

A) General. A unit load of not less than that specified in Table 220.12 for non-dwelling occupancies and the floor area determined in 220.11 shall be used to calculate the minimum lighting load. Motors rated less than 1/8 HP and connected to a lighting circuit shall be considered general lighting load.

Informational Note: The unit values of Table 220.12 are based on minimum load conditions and 100 percent power factor and may not provide sufficient capacity for the installation contemplated.

(B) Energy Code. *Where the building is designed and constructed to comply with an energy code adopted by the local authority, the lighting load shall be permitted to be calculated using the unit values specified in the energy code where the following conditions are met:*

1. A power monitoring system is installed that will provide continuous information regarding the total general lighting load of the building.

2. The power monitoring system will be set with alarm values to alert the building owner or manager if the lighting load exceeds the values set by the energy code. Automatic means to take action to reduce the connected load shall be permitted.

3. The demand factors specified in 220.42 are not applied to the general lighting load.

4. The continuous load multiplier of 125 percent shall be applied.

Cross references for the 2017 NEC occupancies are provided in the notes to Table 220.12.

Type of Occupancy	Unit Load	
	Volt-amperes/m²	Volt-amperes/ft²
Automotive facility	16	1.5
Convention center	15	1.4
Courthouse	15	1.4
Restaurants[4]	16	1.5
Dormitory	16	1.5
Exercise center	15	1.4
Fire station	14	1.3
Gymnasium[3]	18	1.7
Health-care clinic	17	1.6
Hospital	17	1.6
Hotels and motels, including apartment houses without provision for cooking by tenants[6]	18	1.7
Library	16	1.5
Manufacturing facility	24	2.2
Motion picture theater	17	1.6

Museum	17	1.6
Office[1]	14	1.3
Parking garage[8]	3	0.3
Penitentiary	13	1.2
Performing arts theater	16	1.5
Police station	14	1.3
Post office	17	1.6
Religious facility	24	2.2
Retail[5, 7]	20	1.9
School/university	16	1.5
Sports arena	16	1.5
Town hall	15	1.4
Transportation	13	1.2
Warehouse	13	1.2
Workshop	18	1.7

Notes:

1. Banks are office type occupancies.
2. Industrial Commercial loft buildings are considered manufacturing type occupancies.
3. Armories and Auditoriums are considered Gymnasium type occupancies.
4. Clubs are considered restaurant occupancies.
5. Barber shops and beauty parlors are considered retail occupancies.
6. Lodge rooms are similar to hotel and motel
7. Stores are considered retail occupancies.
8. Garages – Commercial (storage) are considered Parking Garage occupancies.

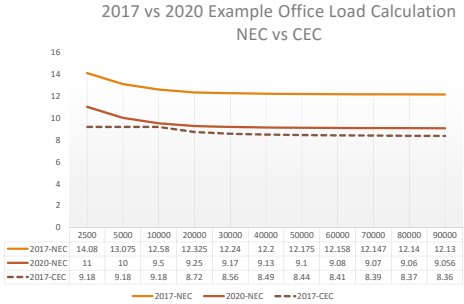
220.42 Demand Factors

PI-3153

Table 220.42 Lighting Load Demand Factors

Hospitals	First 50,000 or less at	40
	Remainder over 50,000 at	20

500,0000 ft² Hospital Example	
Designed NEC Load @ 2 watts/ft²	1,000,000
Using Demand Table 220.42	
First 50,000 watts @ 40%	
Over 50,000 watts @ 20%	
Total Unit Lighting Load after applied Demand Factors	210000
Actual Lighting Load using ASHRAE 90.1-2016	500000
Percentage of lighting assumed off at any given time	58.00%



	2500	5000	10000	20000	30000	40000	50000	60000	70000	80000	90000
2017-NEC	14.08	13.075	12.58	12.325	12.24	12.2	12.175	12.158	12.147	12.14	12.13
2020-NEC	11	10	9.5	9.25	9.17	9.13	9.1	9.08	9.07	9.06	9.056
2017-CEC	9.18	9.18	9.18	8.72	8.56	8.49	8.44	8.41	8.39	8.37	8.36

Determine severity of the gap

WHERE DO WE WANT TO GO?

Determine severity of gap

Canadian Standards Association Provided Data

Building Type	Building Area (sq ft)	Building Area (sq m)	Calculated load (kW)	Calculated (W/sf)	Maximum measured demand (kW)	Measured (W / sq m)	Measured (W / sf)	Measured as a Percentage of Connected
Retail Warehouse	142,000	13199	1210	8.52	550	40.6	3.79	45.45%
Warehouse Distribution	500,000	46475	7800	15.60	2100	44.1	4.12	26.92%
Office Building	80,000	7436	880	11.00	700	91.8	8.58	79.55%
Church	50,000	4648	500	10.00	250	52.5	4.91	50.00%
Retail Store	123,000	11433	1110	9.02	500	42.6	3.98	45.05%
Office Space	20,000	1859	400	20.00	150	78.7	7.36	37.50%
Restaurant	30,000	2789	700	23.33	450	157.3	14.70	64.29%
Grocery Bulk Food Retail A	4,600	428	96.065	20.88	35.78	83.68164174	7.82	37.25%
Grocery Bulk Food Retail B	4,819	448	93.579	19.42	43.2	96.44384312	9.01	46.16%
Quick Service Restaurant	2,400	223	185.112	77.13	55.4	248.3397333	23.21	29.93%

NEC Example Data

Description	Location	ft²	HVAC system	Actual Demand	Demand kW/ft2	Calculated Load	Connected Loac kW/ft2	Measured as a Percentage of Connected
Police Station	KY	22,400	VRF	76,300	3.4	277330	12.38	27.46%
Office Building	NJ	250,000	Chiller	1,550,000	6.2	3,706,000	14.82	41.84%
Bank	KY	42,535	VRF	161,800	3.8	453,990	10.63	35.75%
Bank	OH	3,500	Split Systems	20,250	5.79	88,000	24.65	23.49%
Office Building	OH	160,000	Water Source Heat Pump	680,000	4.25	2,135,000	13.34	31.86%
Bank	In	3282	Split Systems	12,800	3.9	54,000	16.45	23.71%

Data Collection Issues

Table 8. New Buildings Institute Receptacle and Lighting Load Office Study [11]

Office Location	Irvine CA Site 1	Irvine CA Site 2	Rosemead CA	Los Angeles CA	Vancouver BC
Square feet (ft²)	8,328	1,500	16,500	8,024	9,000
Lighting Average Daytime W/ft²	0.2	0.4	0.5	0.3	0.5
Plug Load Weekdays					
Average Daytime W/ft²	0.8	0.8	0.5	1.5	0.6
Peak W/ft²	1.6	1.8	0.7	2.1	0.8
Average Night W/ft²	0.4	0.6	0.3	1.46	0.3

Table 11. Plug and Process Load Power Densities of Ten Office Buildings

Office Building Type	Area (square feet)	Average (W/ft²)
Multi-tenant with data center	50,725	1.17
Multi-tenant with data center	365,000	0.19
Multi-tenant with data center	191,799	0.37
Multi-tenant	173,302	0.49
Municipal	172,000	0.40
Single tenant with warehouse	94,621	0.19
Single Corporate tenant with data center	97,500	0.58
Single Corporate tenant with data center	195,721	0.36
Single Corporate tenant with kitchen	91,980	0.64
Single Corporate tenant with laboratories	222,616	2.27

Idaho study is benchmark

Table 7. Summary of Results in University of Idaho's Receptacle Load Study*

Office type	Land records	World wide logistics	Architect	Elections office	Regulatory agency	Investment analytics
Square feet (ft²)	4,544	13,688	1,288	1,550	13,072	13,688
FT employees*	31	94	6	7	49	100
FTE* / ft²	147	146	215	221	267	137
Total plug devices	216	359	50	67	275	392
Devices / 100 ft²	4.8	2.6	3.9	4.3	2.1	2.9
Devices / FTE	7.0	3.8	8.3	9.6	5.6	3.9
Weekdays						
Average W/ft²	0.87	0.36	0.84	0.36	0.48	1.75
Peak Hours	6am-6pm	7am-6pm	8am-5pm	7am-5pm	8am-5pm	7am-6pm
Peak kW	6.25	10.5	1.5	1.25	9.5	28
Unoccupied kW	2.75	2.0	0.75	0.25	4.75	22
Peak* W/ft²	1.38	0.77	1.16	0.81	0.73	2.05
Unoccupied* W/ft²	0.61	0.15	0.58	0.16	0.36	1.61

*FTE is full-time employees. Data found in [10]. Peak and unoccupied W/ft² have been calculated from the peak and unoccupied kW provided in the University of Idaho report.

Column1	Land Records	World Wide Logistics	Architect	Election Office	Regulatory Agency	Investment analytics
Square Footage	4544	13688	1288	1550	13072	13688
No of Receptacles	216	359	50	67	275	392
NEC Calculation	38880	64620	9000	12060	49500	70560
NEC Demand Calc	24440	37310	9000	11030	29750	40280
Receptacle watt/sf	5.38	2.73	6.99	7.12	2.28	2.94
Actual Peak Loading	1.38	0.77	1.16	0.81	0.73	2.05
Percentage Difference	290%	254%	502%	779%	212%	44%

Patient Care

517.18(B) Patient Bed Location Receptacles. Each patient bed location shall be provided with a minimum of eight receptacles. …….

Critical Care

517.19(B) Patient Bed Location Receptacles.

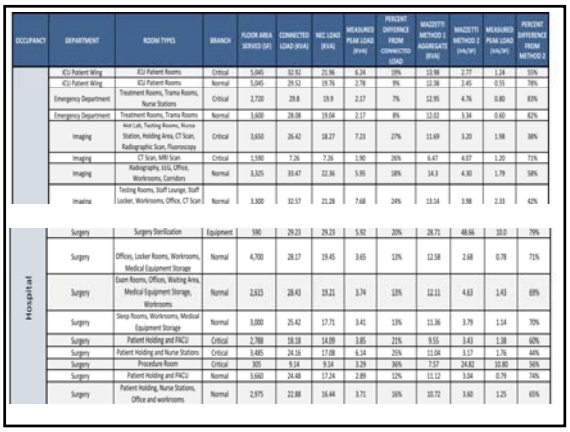
(1) Minimum Number and Supply. Each patient bed location shall be provided with a minimum of 14 receptacles, at least one….

517.19(C) Operating Room Receptacles.

(1) Minimum Number and Supply. Each operating room shall be provided with a minimum of 36 receptacles divided between at least two branch circuits. At least……

Canadian Standards Association Provided Data

Hospital ID	Building Area (sq ft)	Building Area (sq m)	Calculated load (kW)	Maximum measured demand (kW)	Measured (W / sq m)	Meaured (W / sf)
Hospital Site A	720,000	66924	4000	3817	57.03	5.29
Hospital Site B	312,000	29001	1792	2100	72.41	6.71
Hospital Site C	1,200,000	111541	N/A	8,515	76.34	7.08
Hospital Site D	710,000	65995	N/A	4,112.40	62.31	5.78
Hospital Site E	864,918	80395	N/A	4,279	53.22	4.93
Hospital Site F	148,229	13778	N/A	903	65.54	6.07
Hospital Site G	2,757,178	256281	N/A	14,728	57.47	5.33
Hospital Site H	1,022,084	95003.34622	N/A	6,835	71.94	6.67
Hospital Site I	1,351,390	125612.5446	N/A	7,083	56.39	5.23
Hospital Site J	680,581	63260.42906	N/A	3478.098	54.98	5.10



OCCUPANCY	DEPARTMENT	ROOM TYPES	BRANCH	FLOOR AREA SERVED (SF)	CONNECTED LOAD (KVA)	NEC LOAD (KVA)	MEASURED PEAK LOAD (KVA)	PERCENT DIFFERNCE FROM CONNECTED LOAD	MAZZETTI METHOD 1 AGGREGATE (KVA)	MAZZETTI METHOD 2 (VA/SF)	MEASURED PEAK LOAD (VA/SF)	PERCENT DIFFERENCE FROM METHOD 2
	ICU Patient Wing	ICU Patient Rooms	Critical	5,045	32.92	21.96	6.24	19%	13.98	2.77	1.24	55%
	ICU Patient Wing	ICU Patient Rooms	Normal	5,045	29.52	19.76	2.78	9%	12.38	2.45	0.55	78%
	Emergency Department	Treatment Rooms, Trama Rooms, Nurse Stations	Critical	2,720	29.8	19.9	2.17	7%	12.95	4.76	0.80	83%
	Emergency Department	Treatment Rooms, Trama Rooms	Normal	1,600	28.08	19.04	2.17	8%	12.02	3.34	0.60	82%
	Imaging	Anti Lab, Testing Rooms, Nurse Station, Holding Area, CT Scan, Radiographic Scan, Fluoroscopy	Critical	3,650	26.42	18.27	7.23	27%	11.69	3.20	1.98	38%
	Imaging	CT Scan, MRI Scan	Critical	1,590	7.26	7.26	1.90	26%	6.47	4.07	1.20	71%
	Imaging	Radiography, ULL Office, Workrooms, Corridors	Normal	3,325	33.47	22.36	5.95	18%	14.3	4.30	1.79	58%
	Imaging	Testing Rooms, Staff Lounge, Staff Locker, Workrooms, Office, CT Scan	Normal	3,300	32.57	21.28	7.68	24%	13.14	3.98	2.33	42%
Hospital	Surgery	Surgery Sterilization	Equipment	590	29.23	29.23	5.92	20%	28.71	48.66	10.0	79%
	Surgery	Offices, Locker Rooms, Workrooms, Medical Equipment Storage	Normal	4,700	28.17	19.45	3.65	13%	12.58	2.68	0.78	71%
	Surgery	Exam Rooms, Offices, Waiting Area, Medical Equipment Storage, Workrooms	Normal	2,615	28.43	19.21	3.74	13%	12.11	4.63	1.43	69%
	Surgery	Sleep Rooms, Workrooms, Medical Equipment Storage	Normal	3,000	25.42	17.71	3.41	13%	11.36	3.79	1.14	70%
	Surgery	Patient Holding and PACU	Critical	2,788	18.18	14.09	3.85	21%	9.55	3.43	1.38	60%
	Surgery	Patient Holding and Nurse Stations	Critical	3,485	24.16	17.08	6.14	25%	11.04	3.17	1.76	44%
	Surgery	Procedure Room	Critical	305	9.14	9.14	3.29	36%	7.57	24.82	10.80	56%
	Surgery	Patient Holding and PACU	Normal	3,660	24.48	17.24	2.89	12%	11.12	3.04	0.79	74%
	Surgery	Patient Holding, Nurse Stations, Office and workrooms	Normal	2,975	22.88	16.44	3.71	16%	10.72	3.60	1.25	65%

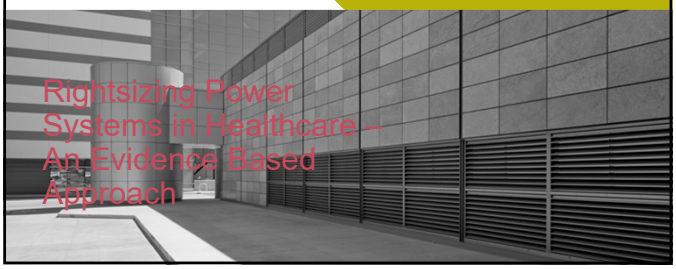
Task Group additions

- Kevin Van Den Wymelenberg, Univ of Oregon, Director of Energy Studies in Buildings Lab
- Sean Denniston, Senior Project manager, New Buildings Institute
- Paul Torcellini, National Renewable Energy Laboratory
- Eric Richman, Chairman of ASHRAE 90.1 Lighting and Power

Other Areas of Review

- Smaller homes. Provisions for homes less than 800 s.f.
- Clean up nomenclature in Article 220
- Possible grouping of load calculations by occupancy categories for usability. I.E. office buildings, hospitals, hotels/motels, etc.
- Should 125% be used for continuous loads for service conductors
- Table for receptacle loading based on Watts/sf for services.
- Removal of show-window and track-load requirement
- Net Zero Buildings

Rightsizing Power Systems in Healthcare – An Evidence Based Approach



Team Recognition

MAZZETTI + GBA

TCI THOMPSON CONSULTANTS, INC.

Stantec

UNIVERSITY OF MICHIGAN

KAISER PERMANENTE

PARTNERS HEALTHCARE

Submitted Methodologies

- Receptacles and cord-connected equipment only
- % of connected kva (similar to existing receptacles)
- w/sf (similar to lighting)
- % based on number of pieces of equipment (similar to elevators, motors, laundry, etc)

Submitted Methodologies

- Receptacles and cord-connected equipment only
- % of connected kva (similar to existing receptacles)
- ~~w/sf (similar to lighting)~~
- ~~% based on number of pieces of equipment (similar to elevators, motors, laundry, etc)~~

- IEEE White Book 602 (2007)
- IEEE Gray Book 241 (1990)
- ASHE Monograph (2014)
- CEC Study (2013)
- NREL (2014)
- LBNL (2012)
- AEDG/T100 (2012-14)

Scatter Chart of Hospital Size and EUI

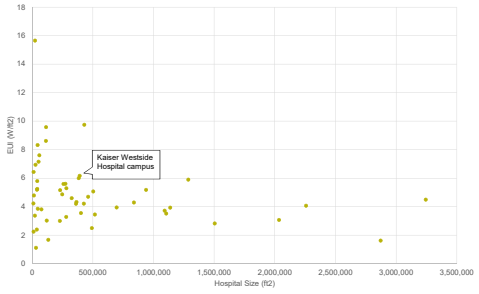
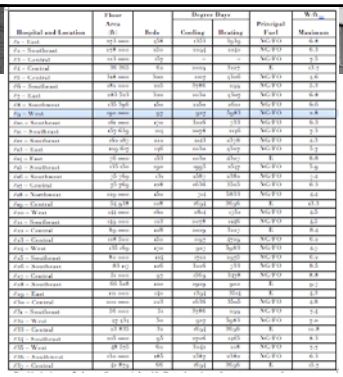


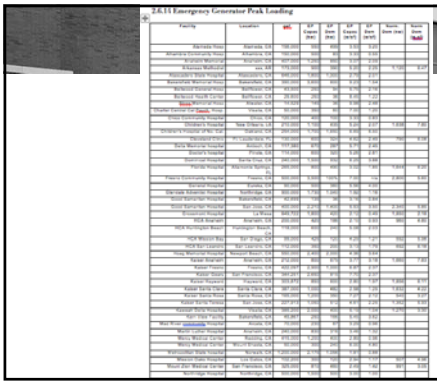
Table 2-3 – Service entrance peak demand (Department of Veterans Affairs)

Hospital	Floor Area (ft^2)	Beds[a]	Degree Days[b] Cooling	Degree Days[b] Heating	Principal[c] Fuel	W/ft^2 [d] Maximum	W/ft^2 [d] Average
V.A. Hospital #1	821 000	922	234	3536	NG/FO	4.5	3.5
V.A. Hospital #2	334 000	500	863	5713	NG/FO	5.2	3.9
V.A. Hospital #3	645 995	670	3488	1488	NG/FO	3.8	2.8
V.A. Hospital #4	681 000	600	1016	654	NG/FO	6.1	4.0
V.A. Hospital #5	503 500	697	3495	841	NG/FO	7.2	5.5
V.A. Hospital #6	800 000	1050	600	7400	NG/FO	5.9	4.2



2.6.9 Kaiser Service entrance peak demand table (1998-2001)

Location	gsf	Peak Demand, 1998 - 2001 kw	w/sf
Vallejo, CA	217,839	1,935	8.88
Richmond, CA	95,100	762	8.01
South San Francisco, CA	114,436	1,295	11.32
Santa Clara, CA	385,790	1,632	4.23
San Jose, CA	226,041	1,352	5.98
South Sacramento, CA	214,253	1,896	8.85
Sacramento, CA	309,499	2,380	7.69
Roseville, CA	282,016	2,350	8.33
Walnut Creek, CA	345,420	3,109	9.00



Kaiser Westside Hospital Loads

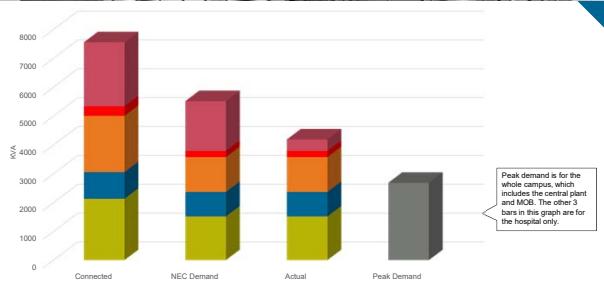
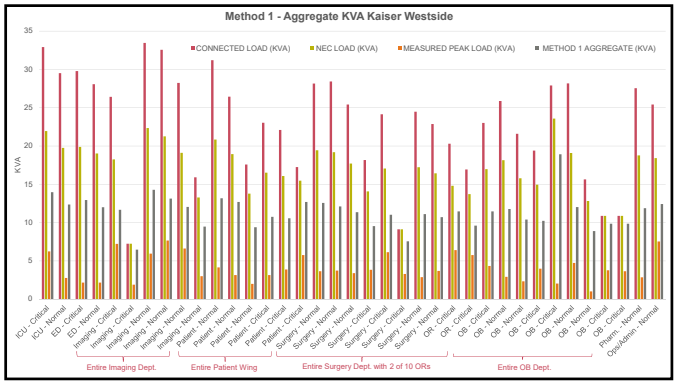


Table 2-1, Sample MOB Load/circuit data

MOB	sf	480 v poles	480 V spares	480 V spaces	480 V Poles/sf	208 V poles	208 V spares	208 V spaces	208 V poles/sf
1	54,000	258	91	66	0.004778	848	161	98	0.015704
2	32,430	54	9	12	0.001665	394	72	27	0.012149
ave	43,215	156	50	39	0.003221	621	116.5	62.5	0.013926

MOB	sf	Ltg (va)	Ltg (va/sf)	receps (va)	receps (va/sf)	equip (va)	equip (va/sf)	HVAC (va)	HVAC (va/sf)
1	54,000	144,725	2.68	429,371	7.9513	283,600	5.2519	197,670	3.6606
2	32,430	33,010	1.02	117,800	3.6324	159,010	4.9032	89,560	2.7616
ave	43,215	88,867	1.85	273,586	5.7919	221,305	5.0775	143,615	3.2111



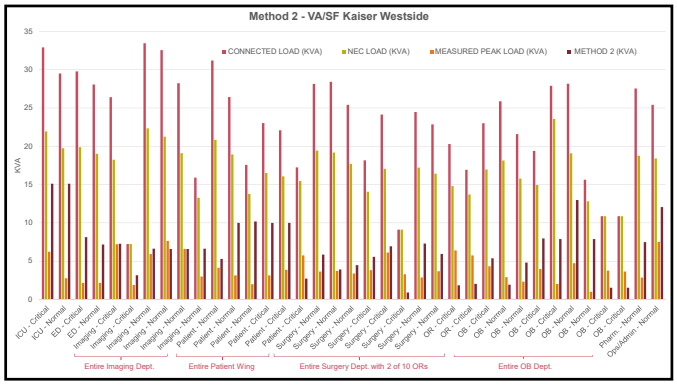
NFPA 70 Article Modifications Submission – Method 1

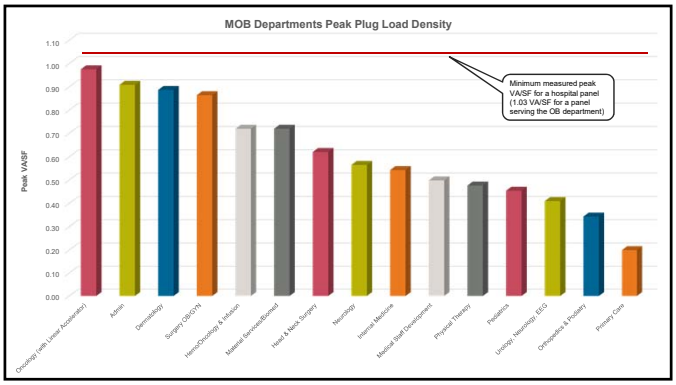
New Section

517.22 **Health Care Facilities.** Rating of feeders, busses, transformers, generators, and services shall be calculated in accordance with Table 517.22, with respect to receptacles and cord-connected equipment.

Table 517.22 Receptacle Outlet and Cord Connected Equipment Demand Factors for Health Care Facilities

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 5.0 kVA or less at	100
Second 5.0 kVA to 10 kVA at	50
Remainder over 10 kVA at	25





NFPA 70 Article Modifications Submission – Method 2

New Section

517.23 (A) **Health Care Facilities,** Rating of feeders, busses, transformers, generators, and services shall be calculated in accordance with Table 517.23(A), with respect to receptacles and cord-connected equipment.

Table 517.23(A) Receptacle Outlet Loads and Cord Connected Equipment for Health Care Facilities

A unit load of not less that the specified in Table 517.23 for health care facility occupancies shall constitute the minimum receptacle load. The floor area for each floor shall be calculated from the outside dimensions of the building, or other area involved, the calculated floor area shall not include atriums, or unfinished spaces not adaptable for future use.

Table 517.23 Health Care Facility Receptacle Outlet and Cord Connected Loads by Occupancy

Type of Occupancy	Unit Load	
	Volt-amperes/m^2	Volt-amperes/ft^2
Category 1 (Critical Care)	32.30	3.00
Category 2 (General Care)	21.50	2.00
Category 3 (Basic Care)	16.10	1.50
Category 4 (Support Space)	13.50	1.25

Summary

Space	TCI Max VA/SF	Mazzetti Max VA/SF	Proposed NEC VA/SF
ICU	1.88	1.79	3.00
General Inpatient	1.07	1.23	2.00


MAZZETTI + GBA
foursight meets TECH
Questions?
Jason D'Antonia at jdantonia@thompson-consultants.com

PLUG LOADING

IN INPATIENT SPACES

- Jason D'Antona, PE, LEED® AP

DISCUSSION TOPICS

- TCI / PHS Study
  - Approach
  - Findings
- Code Drivers
  - NEC
  - FGI / 99
- Implications
- Alignment with Mazzetti
- Conclusions

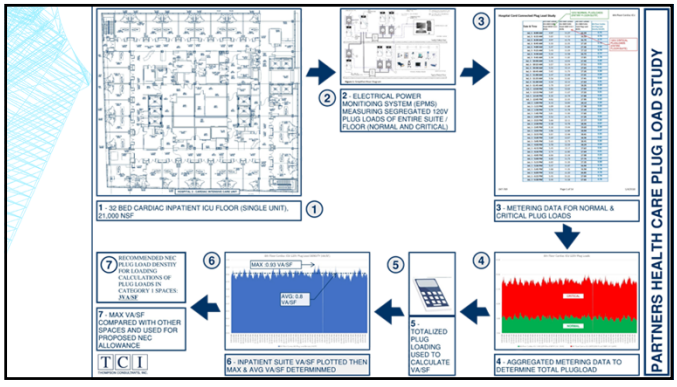
RACU PATIENT ICU ROOM – MGH, BOSTON

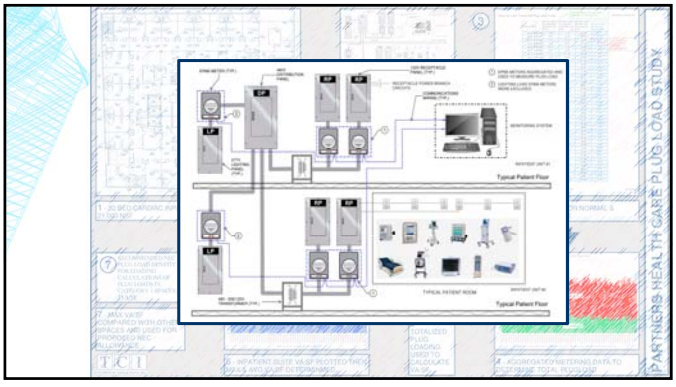
PLUG LOAD STUDY

Approach & Methodology

PARTNERS HEALTHCARE

- PHS – BOSTON BASED
- 16M SF HOSPITALS
- 14 MEMBER HOSPITAL SYSTEMS
- TWO 'TOP 10' ACADEMIC MEDICAL CENTERS
- FOUNDING HOSPITALS MGH, BWH
- STAFF: 73,000





FINDINGS

- One Month Monitoring
- Two Academic Medical Centers
- 9 Inpatient Care Suites
- 272 Inpatient Rooms
- 144 Category 1 (ICU / CCU)
- 128 Category 2 (General Care)

Space	Number of Rooms	Max VA/SF	Average VA/SF
Cat I (CCU)	144	1.88	0.78
Cat II (IPU)	128	1.07	0.9

SPACE TYPES

ICU & GENERAL CARE

INPATIENT ROOMS

Inpatient Rooms Types

Category I [ICU]

Category II [Gen. Care]

INPATIENT ROOM TYPES

Category I – Critical Care

- Sickest Patient Population
- Major Organs Compromised
- Supplemental Equipment Req'd
  - Ventilators
  - EEG / EKG
  - IABP
  - Many Infusion Pumps
  - Hemodynamic Monitoring
  - HR / Respiratory Monitoring
- High Staff / Patient (1:1 or 1:2)
- More support Equipment (Work Sta)

Category II – General Care

- General Recovery
- Low Acuity
- Minimal Equipment
  - General Monitor
  - Few (if any) Infusion Pumps
- Lower Staff / Patient (1:4 to 1:6)
- Less Support Equipment

CODE DRIVERS

FGI & NEC

FGI

Minimum Receptacle Quantities

- Category 1 ICU - 16
- Category 2 General Care – 12
- Minimum Size 120SF

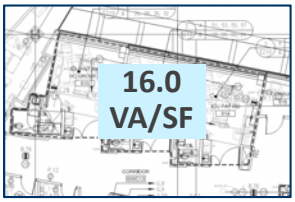
Typical ICU – 18 Receptacles

NEC PLUG LOADING

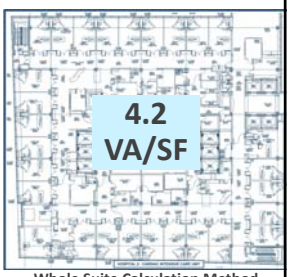
NEC Article 220.44 - Demand Factors for Non-Dwelling Receptacle Loads

- 90VA per outlet (180VA per duplex)
- First 10kVA of load ➔ 100%
- Balance load at 50%

VARYING RESULTS



Small Area Suite Calculation Method

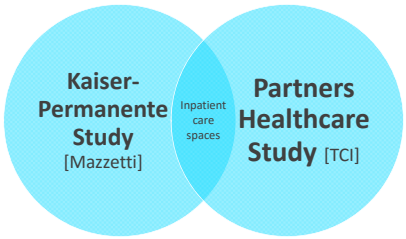


Whole Suite Calculation Method

TCI & MAZZETTI STUDY

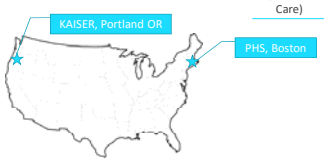
PHS & KAISER

TCI / MAZZETTI STUDY



SIMILAR FINDINGS

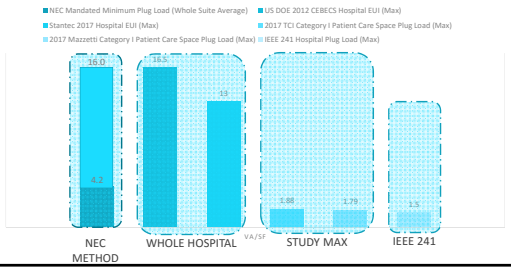
Space	TCI Max VA/SF	Mazzetti VA/SF
Cat I (ICU)	1.88	1.79
Cat II (General Care)	1.07	1.23



CONCLUSION

PLUG LOADS

MINIMUM 'SAFTEY' VS. ACTUAL ENCOUNTERED



EXPANDED RESULTS

Clinical Care Hospital 1	SF	Plug Load (kVA)			Total VA/SF		
		Min	Max	Average	Min	Max	Average
Nero Intensive Care Unit (28 Beds)	22609	16.25	42.5	33.19	0.72	1.88	1.47
General Care Patient Room (32 Beds)	23857	8.75	22.50	16.94	0.37	0.94	0.71
General Care Patient Room (32 Beds)	23423	12.50	25.00	23.06	0.53	1.07	0.98
General Care Patient Room (32 Beds)	23476	8.75	23.75	21.36	0.37	1.01	0.91
General Care Patient Room (32 Beds)	23268	10.00	25.00	23.51	0.43	1.07	1.01

Table 6: Hospital 1 Min, Max, Average metered data summary

Clinical Care Hospital 2	SF	Plug Load (kVA)			Total VA/SF		
		Min	Max	Average	Min	Max	Average
Cardiac Intensive Care Unit (29 Beds)	21691	2.58	20.23	16.75	0.12	0.93	0.77
Cardiac Inpatient Unit (29 Beds)	21544	8.74	13.57	10.42	0.41	0.63	0.48
Cardio Vascular Surgery Suite (29 Beds)	21966	1.18	12.76	9.93	0.05	0.58	0.45
Cardiac Critical Care Unit (29 Beds)	21855	1.77	20.01	15.77	0.08	0.92	0.72

Table 7: Hospital 2 Min, Max, Average metered data summary

2018 NFPA Research Fund Review - Electrical

Reviewer: Combined List

Rating = 1 to 5 (5 is highest); Rank = 1 to 12

	ID#	Title	Technical Relevance	Magnitude	AVERAGE Sense of Urgency	Success Liklihood	Total		OVERALL RANK	
4	**1604**	GFCIs in Marinas	4.9	5.0	4.8	4.6	19.3	✓	**2.6**	✓
11	**1880**	Marina Elec Equip Harvesting	4.6	4.7	4.7	4.5	18.6	✓	**3.5**	✓
1	**1601**	Modelling Shock in Water	4.8	4.8	4.5	4.1	18.1	✓	**3.8**	✓
8	**1803**	Residential Electrical Fire Data	4.5	4.5	4.3	3.9	17.2	✓	**3.9**	✓
3	**1603**	GFCI Limitations	4.6	4.0	4.0	4.6	17.2	✓	**4.0**	✓
12	**1881**	Pool Corrosion	3.8	3.6	3.2	3.9	14.4	!	**5.9**	!
5	**1623**	Interoperability	3.3	3.3	3.3	3.3	13.2	!	**7.0**	!
2	**1602**	Low Voltage Cable Impedence	2.8	3.3	3.0	3.0	12.2	✗	**8.4**	!
7	**1719**	Fire Resistance Rating of Concrete	3.3	2.5	2.1	3.6	11.4	✗	**8.6**	✗
9	**1813**	Arc Flash Modelling	4.4	4.1	4.1	4.1	16.8	!	**8.7**	✗
6	**1718**	Elec Grounding in O2 Atmosphere	3.0	2.7	2.7	3.3	11.8	✗	**9.5**	✗
10	**1821**	Power Transmission Anti Icing	2.6	2.4	2.3	2.5	9.8	✗	**10.1**	✗
		Additions:								
	1819	Hospital Energy Use					0.0			
		Hospital Lighting					0.0			
		Power Over the Ethernet					0.0			
		Adoption Protocol Summary					0.0			
		Equipment Supports for FF Acccess					0.0			

Comments:

Note: Ranking based on review at ESRAC Meeting on 13/Jan/2018, with 21 forms returned.

1601	(1) Applicable to any body of water covered by the NEC; (2) Too many deaths
1602	(1) Questionable outcome impact
1603	(1) Important to expanded requirements
1604	(1) Assess solutions to urgent problem; (2) Too many deaths
1623	(1) Keep NEC/NFA 72 ahead of curve
1718	(1) Not urgent NEC topic
1719	(1) Issue seems to have had reduced discussion
1803	(1) Important to moving AFCI &GFCI protection; (2) Are AFCI's effective? (3) May require longer time frame;
1803	(4) Set-up data acquisition going forward; Have much more granularity; Include AFCI & GFCI information
1813	(1) Scope creep to IEEE/NFPA project
1821	(1) More utility oriented
1880	(1) Related to #1604; (2) Too many deaths;
1880	(3) Most important issue to address, and no one else will; People are dying
1881	(1) Electricity / water interface