DEMYSTIFYING ENGINEERING (JARGON)

Engineering: Accessible and Fun!

Introductions

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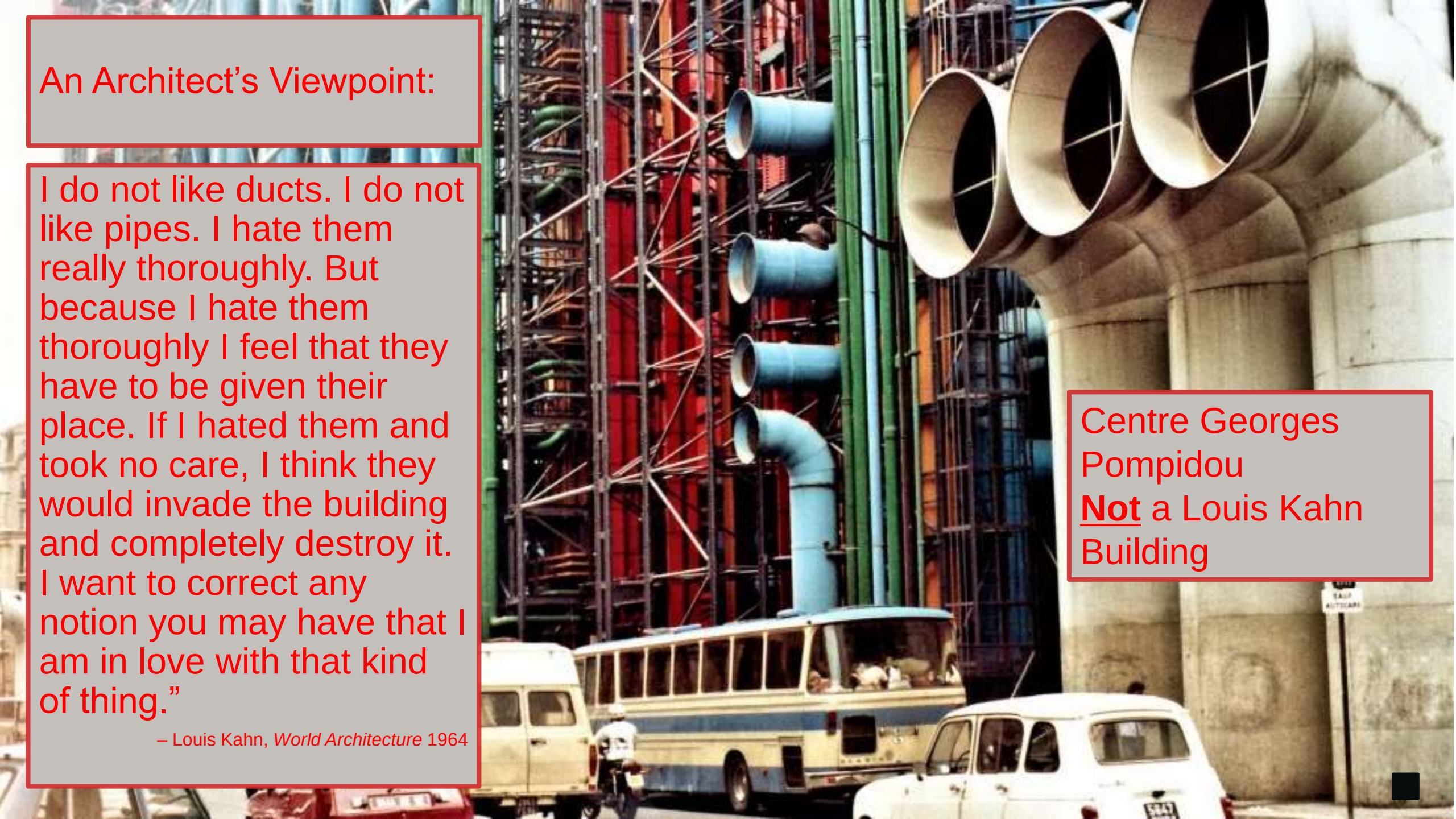
Agenda | Learning Objectives

- Why should I care about engineering?
- Words and Concepts
- More Words and Concepts
- Align Expectations
- System Interactions
- Decision Making Tools

CAUTION
WORKER IN
CONFINED SPACE
DANGER
CONFINED SPACE
ENTER BY
PERMIT ONLY

Why | Engineering Jargon

- At some point in your career, you will need to understand and interpret engineering “speak”
- Engineering Design Decisions have an impact on
  - Cost
  - Maintenance
  - Space
- Engineering systems need to be integrated into the built environment



An Architect's Viewpoint:

I do not like ducts. I do not like pipes. I hate them really thoroughly. But because I hate them thoroughly I feel that they have to be given their place. If I hated them and took no care, I think they would invade the building and completely destroy it. I want to correct any notion you may have that I am in love with that kind of thing."

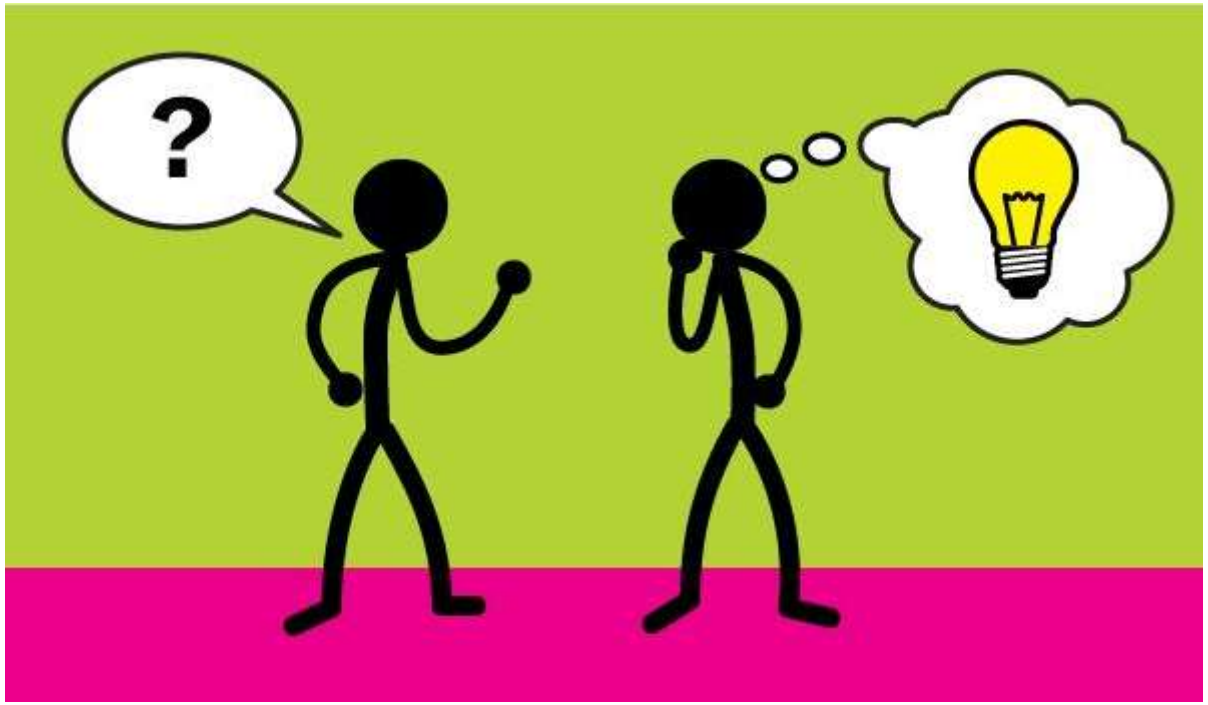
– Louis Kahn, *World Architecture* 1964

Centre Georges Pompidou

Not a Louis Kahn Building

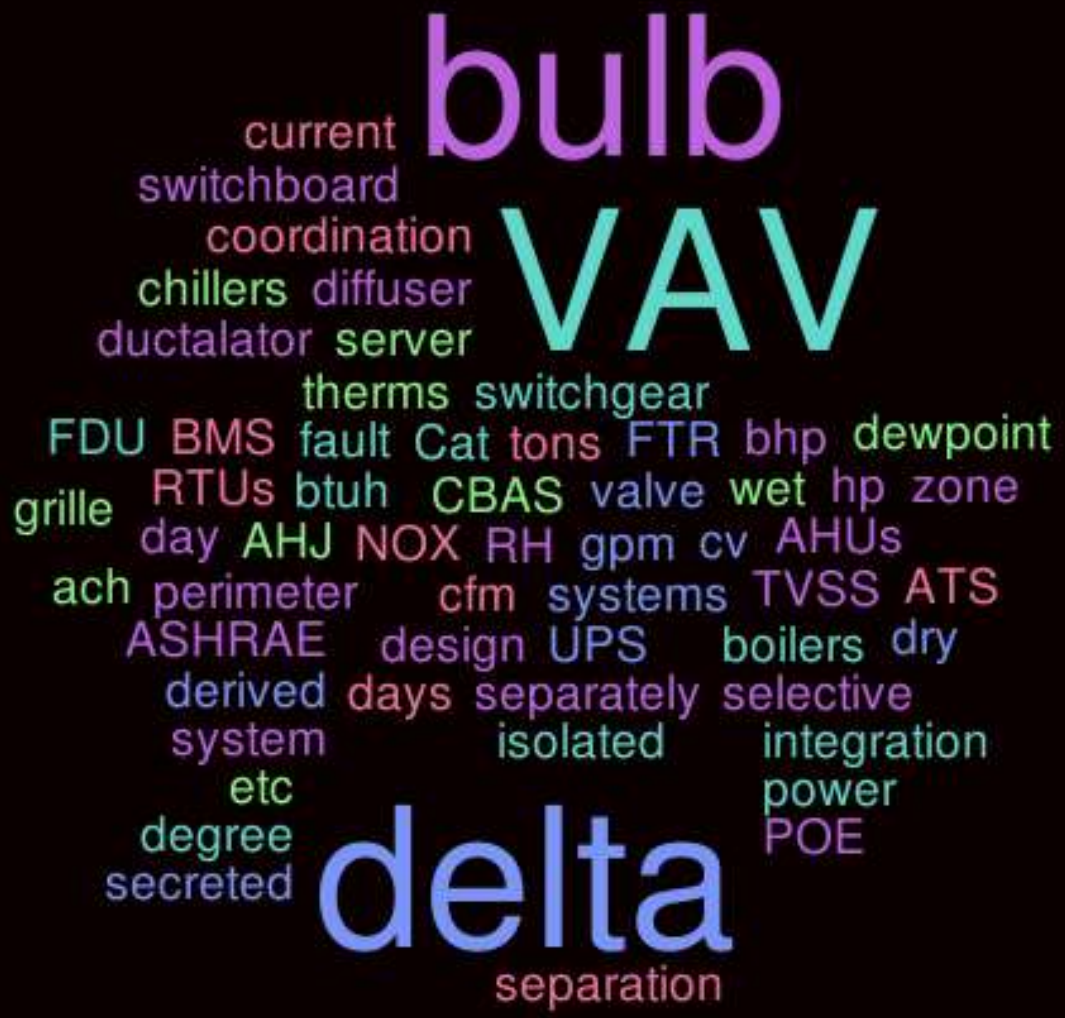
Why | Ask Questions

- Ask questions as you think of them.



WORDS AND CONCEPTS

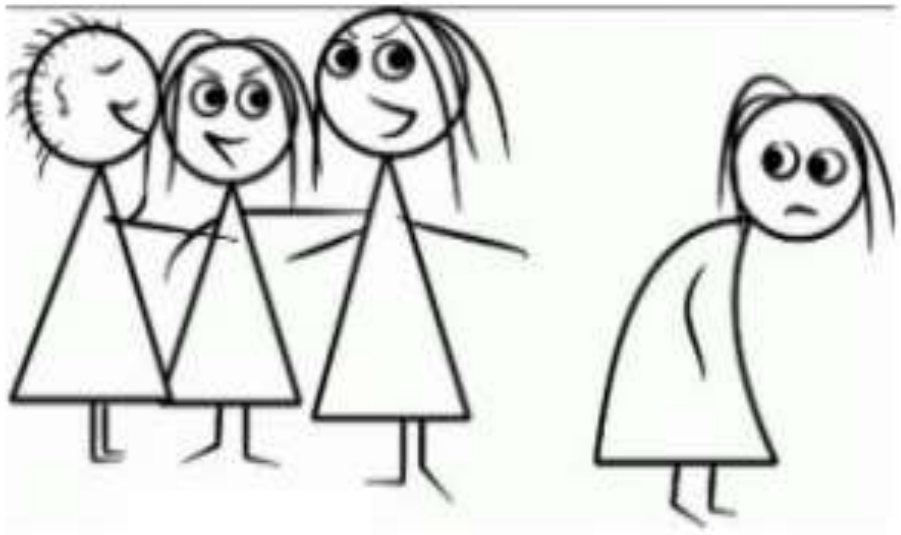
Words | Concepts | Acronyms and Jargon



Words | Concepts | The Words We Use

Jargon is understood by a select few

Jargon is exclusive



Words | Concepts | General

- Engineer- Responsible for the design and construction documents
- Contractor- Installs what is on the contract documents and specifications
- Design Build- Engineers create a schematic program and it is designed and implemented by contracting team
- Design Assist- Engineers and Contractors work together to create design
- AHJ- Authority having jurisdiction. Reviews installation, design and enforces codes
- Governing Body of the Facility – Designated persons from the facility (not the Engineer)

Words | Concepts | General

- Risk Assessment – Determination by the FACILITY on a topic or issue
- N+1 – One “extra” device, beyond minimum required
- Resiliency – Ability to recover after a disruption
- Redundancy – Ability for systems to operate without disruption
- Sustainability – Reduce use of energy and resources, lessening environmental impact while reducing operating costs
- Optimization – Assuring engineering systems are functioning as designed and at maximum energy efficiency

Graphics | Properties | Alarms | Trends | Logic | Reports | Privileges

DAVIS LAB BUILDING CHILLER PLANT MANAGER

74.90 °F
41 %rh

Current Outside Conditions
DAVIS BLDG 76.20 °F
THALIANS BLDG 74.90 °F
AVERAGE TEMP. 75.96 °F

Outside Air Low Temp. Cut out switch
ON OAT CONTROL / OFF OAT CONTROL
Cut-in temp. setpoint is 65.00 °F
Cut-out temp. setpoint is 58.00 °F

Heartbeat from Generator Panel

chwp vfd speed cmd 82.96
CHP-6 OFF
CHP-4 ON E-POWERED
CHP-12 ON
CHP-5 OFF
CHP-11 OFF

Chiller Rotation Sequence

ROTATION ORDER	1	2	3	4	5	6
CH-1	1	3	2	1	2	3
CH-2	2	1	3	3	1	2
CH-3	3	2	1	2	3	1

Manual Select
Number of chillers requsted to run 1
Number of chillers locked out 0

Building Load

Phase 1 378.96 tons
Phase 2 188.91 tons
Total 565.53 tons
System Flow
Phase 1 866.20 gpm
Phase 2 467.40 gpm
Total flow 1333.60 gpm
Load Capacity 39 %

Biasing valve 13 %

43.20 °F CH-1 ON 99 %
LINK TO BACNET CARD
rotation order 1 39 % LOAD

48.60 °F LINK TO BACNET CARD -0 %
CH-2 OFF
rotation order 2 0 % LOAD

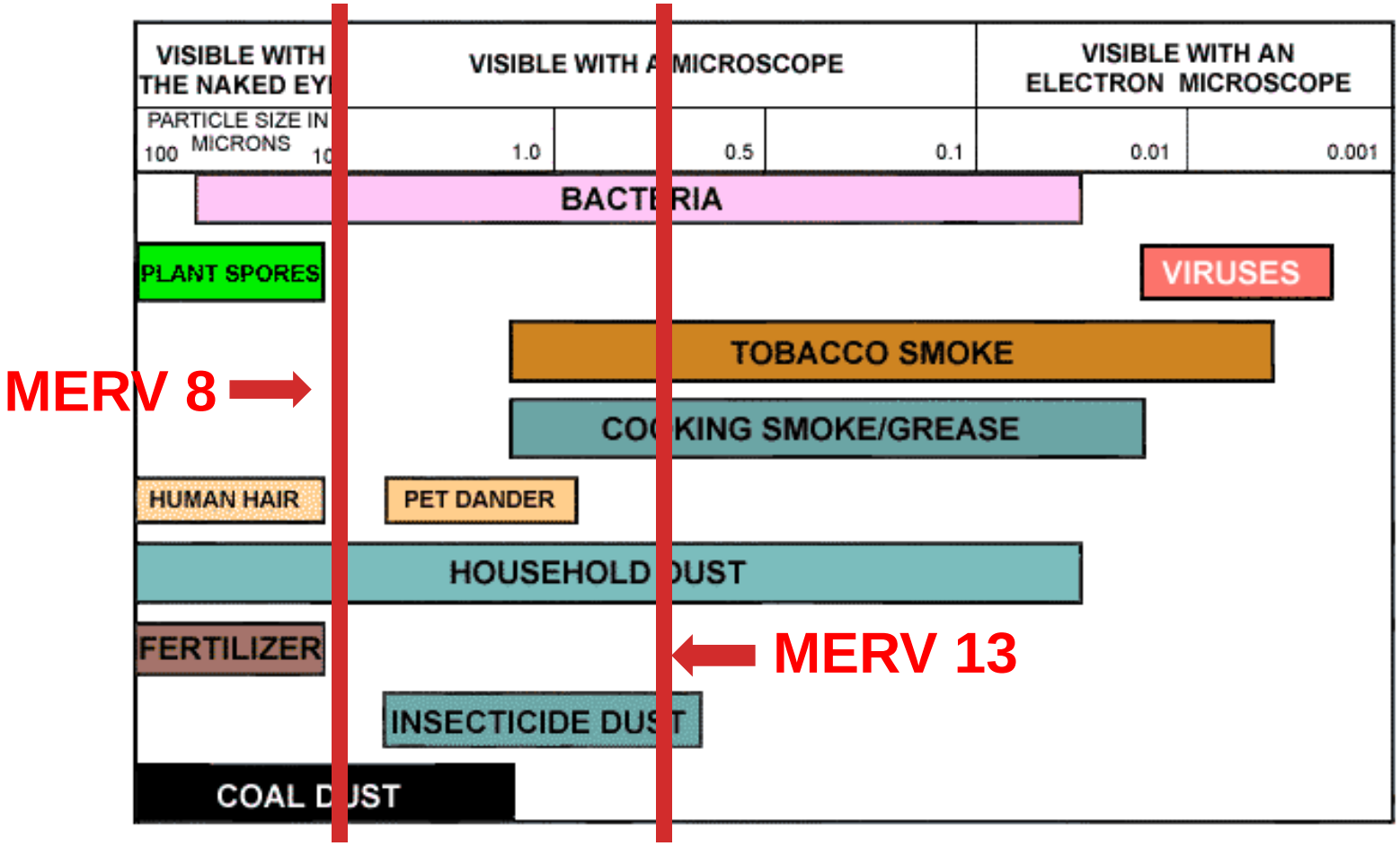
47.70 °F LINK TO BACNET CARD -0 %
CH-3 OFF
rotation order 3 0 % LOAD

CHILLER-1 CONTROL	CHILLER-1 STATUS	CHILLER-2 CONTROL	CHILLER-2 STATUS	CHILLER-3 CONTROL	CHILLER-3 STATUS
AUTO MANUAL	STOPPED ENABLED	AUTO MANUAL	STOPPED ENABLED	AUTO MANUAL	STOPPED ENABLED
	RUN STATUS ON		RUN STATUS OFF		RUN STATUS OFF
MANUAL MODE CONTROL	CH-1 LOGIC ALARM	MANUAL MODE CONTROL	FAILED RUN STATUS	MANUAL MODE CONTROL	CH-3 LOGIC ALARM
ON OFF	CLEAR LOGIC ALARM	ON OFF	CH-2 LOGIC ALARM	ON OFF	CLEAR LOGIC ALARM
			CLEAR LOGIC ALARM		
EVAPORATOR FLOW	CH-1 INTERNAL ALARM POINT	EVAPORATOR FLOW	CH-2 INTERNAL ALARM POINT	EVAPORATOR FLOW	CH-3 INTERNAL ALARM POINT
1912 GPM	CH-1 SAFETY ALARM	0 GPM	** THIS ALARM IS RELATED TO	0 GPM	CH-3 SAFETY ALARM

Words | Concepts | Mechanical

- CRC Valve- Critical Room Control Air Valve
- TCP – Temperature Control Panel
- AII Room – Airborne Infectious Isolation Room
- FFU – Fan Filter Units, Typically used in Chemo Hood & IV Prep rooms
- BAS – Building Automation System
- DDC – Direct Digital Control
- HEPA- High-efficiency particulate arrestance
- MERV- Minimum Efficiency Reporting Value
  - MERV 8- Filter Bank #1, MERV 14- Filter Bank #2
- ACH – Air Changes per Hour
- O.A. – Outside Air

Words | Concepts | Mechanical



Words | Concepts | Mechanical

- BTUH- British Thermal Units per Hour
- Tons- 12,000 BTUH is one ton of cooling
- AHU- Air Handling Unit- with hydronic coils
- RTU- Rooftop Unit- with refrigerant cooling
- RH - relative humidity
- LAT - Leaving air temp
- EAT - Entering air temp
- MAT- mixed air temp
- GPM- Gallons per minute- hydronic
- CFM- cubic feet per minute- air

Words | Concepts | Mechanical

Rooftop Unit

Air Handling Unit (AHU)

Words | Concepts | Mechanical

Rooftop Units

- Composed of supply fan(s), return fan(s) , prefilter, final filters, gas fired heating, DX coils, humidifier, dampers, valves, and controls, inside an insulated casing.
- Benefits: lower first cost
- Benefit: faster and easier construction- due to fewer piping connections

Air Handling Units

- Composed of supply fan(s), return fan(s) , prefilter, final filters, heating coils, cooling coils, humidifier, dampers, valves, and controls, inside an insulated casing.
- Semi-custom air handling units can be configured for various height, width and length
- Components can be individually selected for each project, for increased performance related to noise, vibration, turndown.
- Benefits: accurate degree of temperature control, and a wider range of accurate modulation
- Benefit: Hydronic systems tend to be more energy efficient

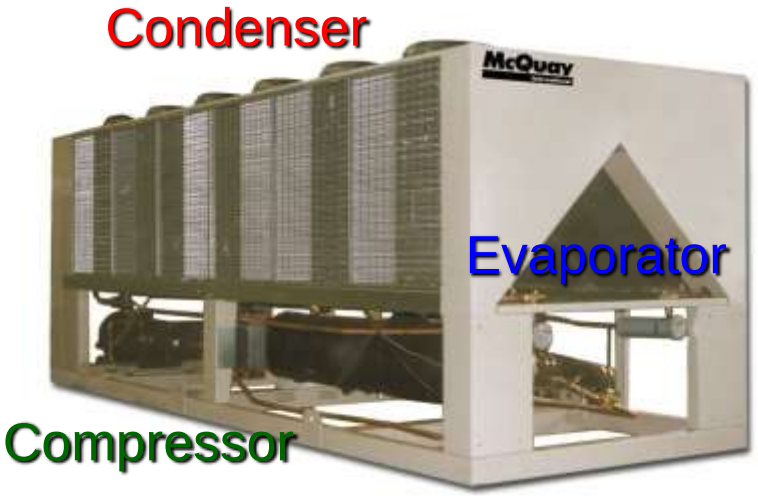
Words | Concepts | Electrical

- Medium Voltage – Greater than 1 KV and less than 1000 KV (Typical utility voltage)
- Voltage – Potential difference between two points in an electric field. 120/208V, 277/480V
- Amp – Ampere. Unit of electrical current
- Switchgear/ Switchboard – Type of distribution equipment from utility or generator
- Distribution Panel – Larger panel serving large loads and/or smaller panelboards
- Lighting Panel – Panel serving descrete loads
- Isolated power panel – Ungrounded service. Typical application is “wet location” Operating Room.
- XFMR – Transformer. Modifies voltage

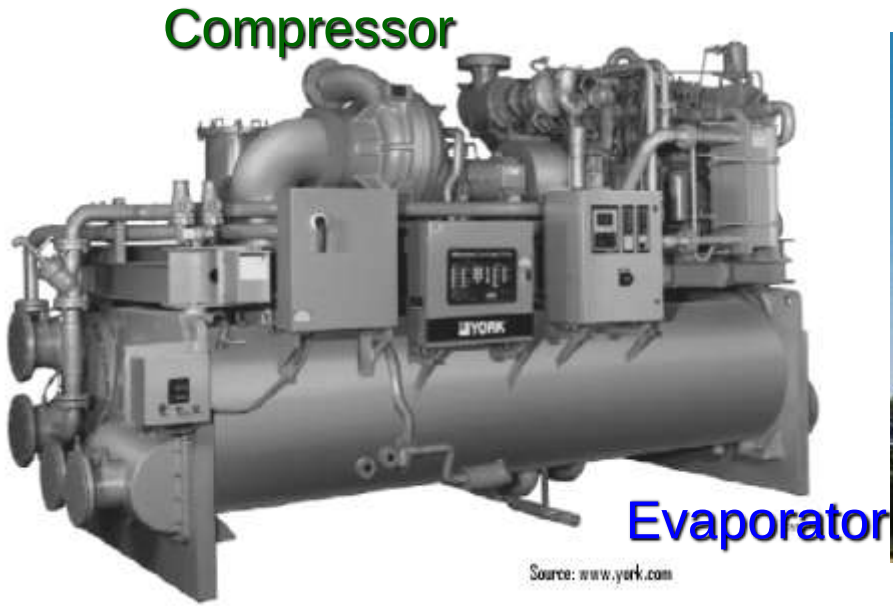
Words | Concepts | Electrical

- LSIG – Long time, Short time, Instantaneous, and Ground Fault Setting (for coordination)
- LSI GF Sensing – For emergency systems. No ground fault tripping just notification of a fault.
- Ground Fault (sensing/tripping)
- AIC – Ampere Interrupting Capacity. AKA, the limit before something blows up.
- Withstand Rating – Similar to AIC but different nomenclature for different equipment
- KVA – Kilovolt Amperes. Apparent Power
- KW – Similar to KVA with power factor
- Power Factor – Power efficiency

Words | Concepts | Mechanical



Air Cooled Chiller



Water Cooled Chiller

Cooling Tower

Words | Concepts | Mechanical

Air Cooled Chillers

- Provides chilled water for the hospital through a stand alone chiller with air cooled condensers.
- Typically screw or scroll compressor
- Lower energy efficiency, but good operation during moderate weather conditions
- Requires freeze protection for the entire chilled water system, typically glycol.
- Benefit: Easier to operate and maintain
- Benefit: Lower cost

Water Cooled Chiller

- Provides chilled water for cooling use in the hospital, coupled with cooling tower located outside
- Cooling towers require maintenance to keep the condenser water clean
- Cooling towers require freeze protection or draining
- Benefit: Large range of operation
- Benefit : Low energy costs
- Benefit: Lower noise- cooling tower versus refrigerant compressor

Words | Concepts | Mechanical

- VAV Zones
- A zone is the space controlled by a thermostat.
- The size of a zone is based on space function and exterior exposure
- Patient rooms typically are a single zone.
- Thermostat location matters- the heat gain in the room and near the thermostat affects the thermostat reading.
- Multiple rooms as a single zone- the thermostat will read the temperature (and heat gain) of that room, the other rooms may not have the same heat gain/loss, and will reach a different temperature equilibrium.
- Typical cost reduction target.
- A typical vav zone consists of a vav box, reheat coil, associated piping and controls, and thermostat.
- Costs range from $2500 to $4000 per zone.
- Benefit of more zones is greater patient comfort and satisfaction
- Benefit of fewer zones is lower cost

Words | Concepts | Mechanical

Words | Concepts | Mechanical

- Room pressure relationships
  - Positive: air flow is out of the room
  - Negative: air flow is into the room- typically exhausted
- Fan array- multiple, smaller fans located in one section of an air handling unit.
- Fan wall- proprietary fan array system
- Ventilation- amount of outside air required
- HVAC- Heating, ventilating, and air conditioning
- VAV- Variable Air Volume- modulate air flow to match room heating/cooling load
- Reheat- heating needed to raise the supply air temperature to match the room load

Words | Concepts | Mechanical

- VFD or VSD- Variable Frequency or Speed Drive- used to efficiently modulate motors
- DOAS- Dedicated Outside Air System- typically sized to match the ventilation requirement
- Chilled Beam- a convective HVAC system, using an integrated heat exchanger
- Economizer (airside vs. waterside)- using outside air temperature to provide heating or cooling, with minimal HVAC energy
- Laminar Flow Air- a column of air moving a low velocity, with little “swirling” or induced air
- Room pressure monitor: Needed for rooms that require a continuous air pressure relationship

Words | Concepts | Electrical

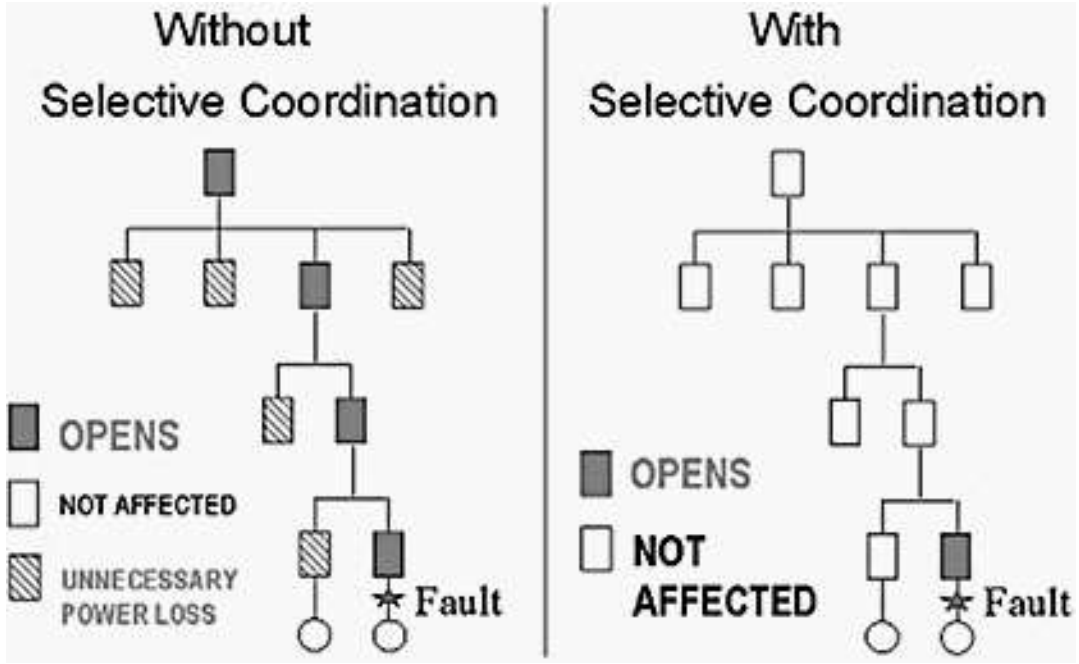
- Separation of systems – Separation of branches of power for specific load types
- EPSS – Emergency Power Supply System; Generator(s), Transfer Switches, and distribution equipment
- Selective Coordination – Overcurrent devices opening in the correct order.
- Parallel Generators – Generators tied to a single distribution
- Paralleling Gear – Distribution equipment for multiple generators
- Peak Shaving – Going “off the grid” and utilizing generators for primary power.
- ATS – Automatic Transfer Switch. The equipment that switches from normal to emergency power.
- UPS – Uninterruptable Power Supply
- Microgrid – Interconnected loads and distributed energy resources that act as a single controllable entity with respect to the grid.

Words | Concepts | Electrical

- EPSS
  - Emergency Power Supply System

Words | Concepts | Electrical

- Selective Coordination
  - Overcurrent devices (breakers or fuses) work in order to assure localization of overcurrent condition.

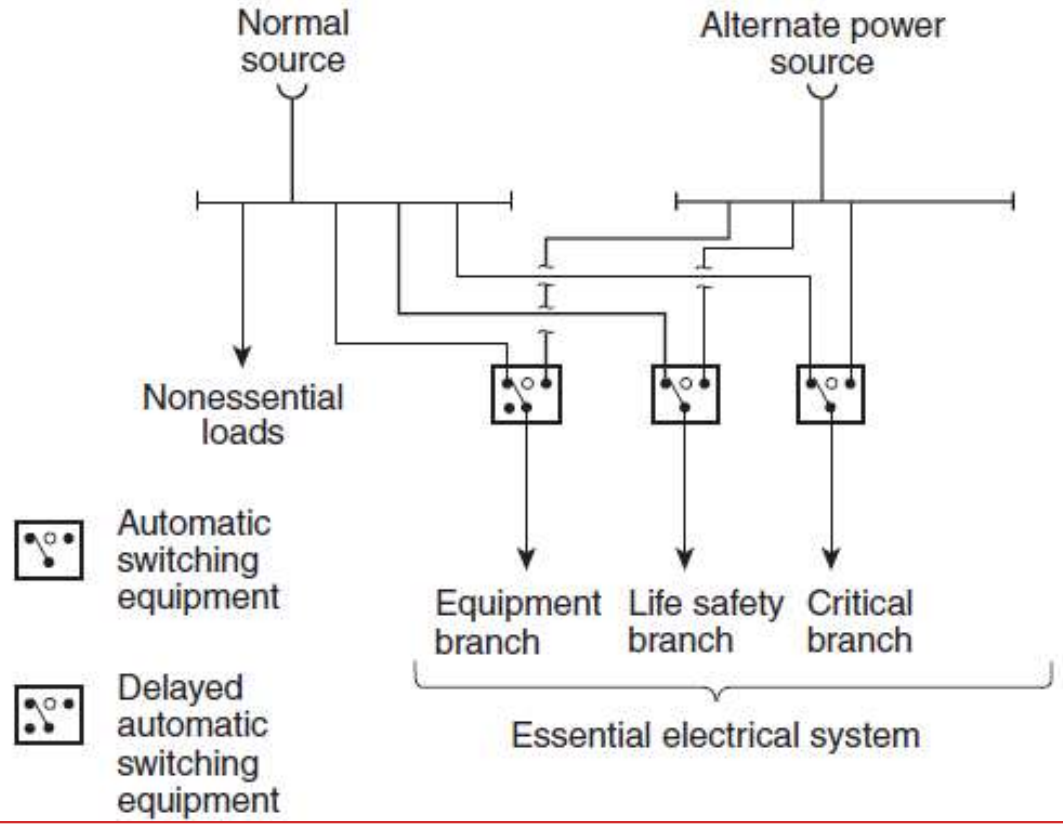


Words | Concepts | Electrical

- Branches of Power
  - Life Safety – Safety of Patients and Personnel in the event of an emergency and to get people out of the building safely
  - Critical Branch – Direct Patient Care (Healthcare Only)
  - Equipment Branch – Power for equipment serving medical and surgical functions, HVAC, MedGas and Kitchen (Healthcare Only)
  - Optional Branch – Not part of the ESS but loads on generator power that do not fit into other categories
  - Normal Branch – Everything else

Words | Concepts | Electrical

- Separation of Systems



Words | Concepts | Plumbing

- AAV – Air Admittance Valve, also called a studor vent
- Downspout Nozzle – Lambs Tongue
- Duplex- two devices in one package
- Triplex- three devices in one package
- Brine – Salty Water
- BFP- backflow preventer
- ASHRAE 188- Legionellosis: Risk Management for Building Water Systems
- Legionella- a bacteria that can cause Legionellosis, a pneumonia-type illness called Legionnaires' disease and flu-like illness called Pontiac fever

Words | Concepts | Lighting

- FC – Footcandles. Measurement of light
- Luminaires – Light fixture
- Lamp – “light bulb”
- LED – Light Emitting Diode
- CCT - correlated color temperature
- CRI - color rendering index
- Ballast – lamp starter
- Driver - Power Supply instead of Ballast

OSRAM

Words | Concepts | Lighting

- Individual Controls
- Lighting Control Systems
- Types of Controls
  - Bi-level Switching
  - Occupancy Sensors
  - Vacancy Sensors
  - Daylight Harvesting
  - Hi/Lo Operations
  - Architectural Dimming Controls
  - Relay System
  - Maximum light output set points
  - Timers
- Energy Payback
- Utility Incentives

Words | Concepts | Lighting

Words | Concepts | Lighting

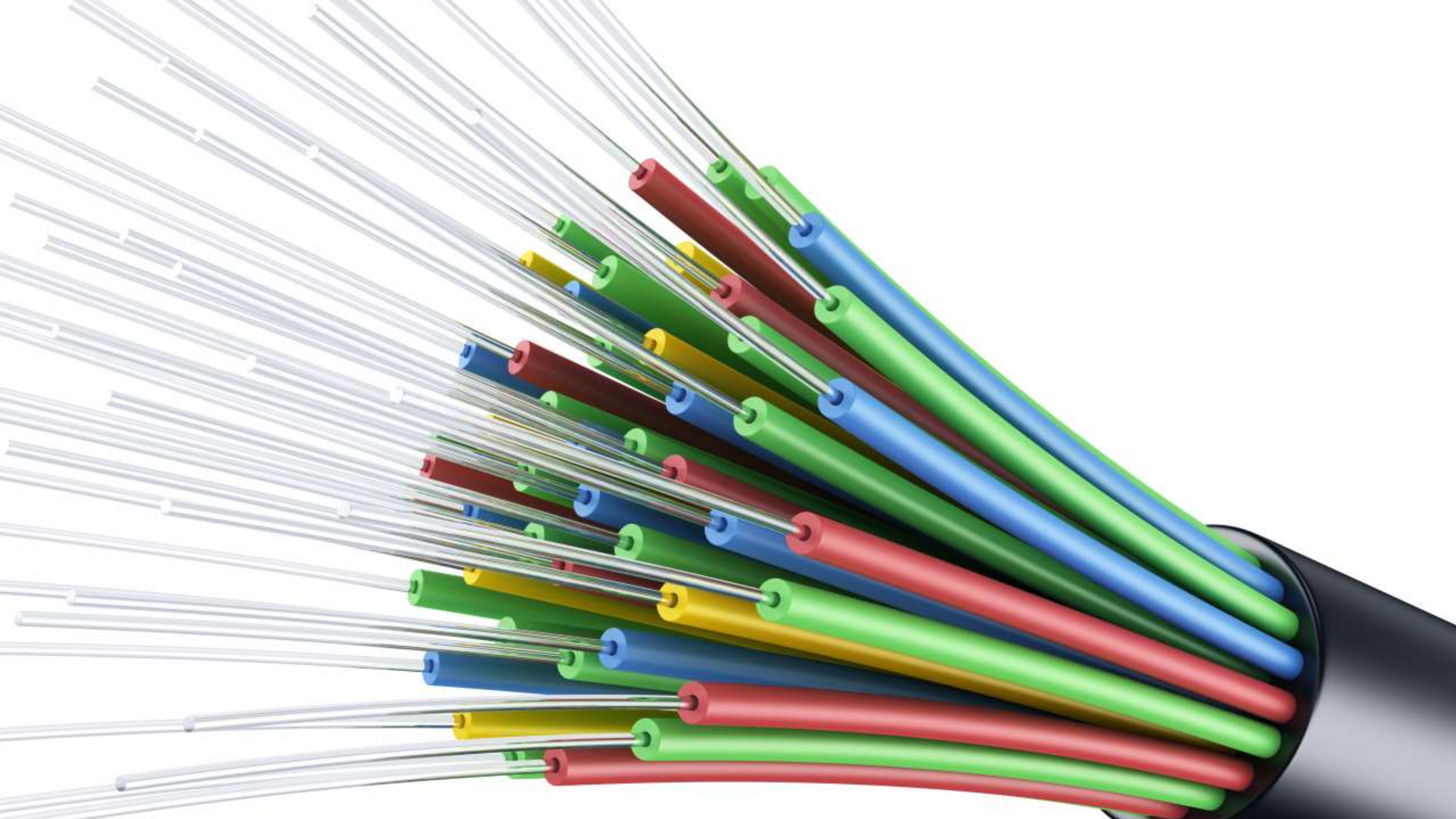
- Daylight Harvesting – Lighting Control
- Ambient Lighting – Not primary lighting source
- Relay – Method of Automatically controlling lighting
- RFI Filter – Required in Operating rooms to not interfere with equipment
- Non-ferrous – Required in MRI rooms (only specific lamp sources work)
- Cove Lighting – light source not visible, part of an architectural solution
- Photometric – Shows how much light is present in a design
- ISENA – Illuminating Society of North America

Words | Concepts | Lighting

- IESNA Lighting Level requirements
- IESNA Controls Recommended practices and associated quality metrics
- Energy and Wellness Programs
  - LEED
  - Living Building Challenge
  - WELL Building
  - Net Zero Building
- Individual State Requirements
  - Title 24 – California
  - B3 – Minnesota
  - Others

Words | Concepts | Technology & Low Voltage

- Server – An application on a host PC that lets other PC's (clients) connect to the host's application
- Backbone – Main distribution for telecom
- Pathway – Conduit, cable tray or J hooks and D rings.
- Structured Cabling – Permanently installed Network/IT Cabling
- CAT 6, CAT 5, CAT 5E, CAT 3, Fiber – Cabling
- UTP – Unshielded Twisted Pair – Cables for communications



Words | Concepts | Technology & Low Voltage

- UI – User Interface - A means of interacting with or controlling a system
- GUI – Graphic User Interface – The graphical controls for a system
- VMS – Video Management System – Software for viewing and recording digital security cameras
- PACs - picture archiving and communication system
- RF – Radio Frequency
- DAS – Digital Antennal System - Boosts cellular coverage
- IDS – Intrusion Detection System – Burglar alarm

TeleTouch 22
vaddio

Words | Concepts | Technology & Low Voltage

- Lexan Guard – Tamper resistant cover that has a local alarm when you lift it
- AOR – Area of Refuge
- FACP – Fire Alarm Control Panel – The brains of the Fire Alarm System
- FAAP – Fire Alarm Annunciator Panel – A panel with a limited readout of the Fire Alarm System status

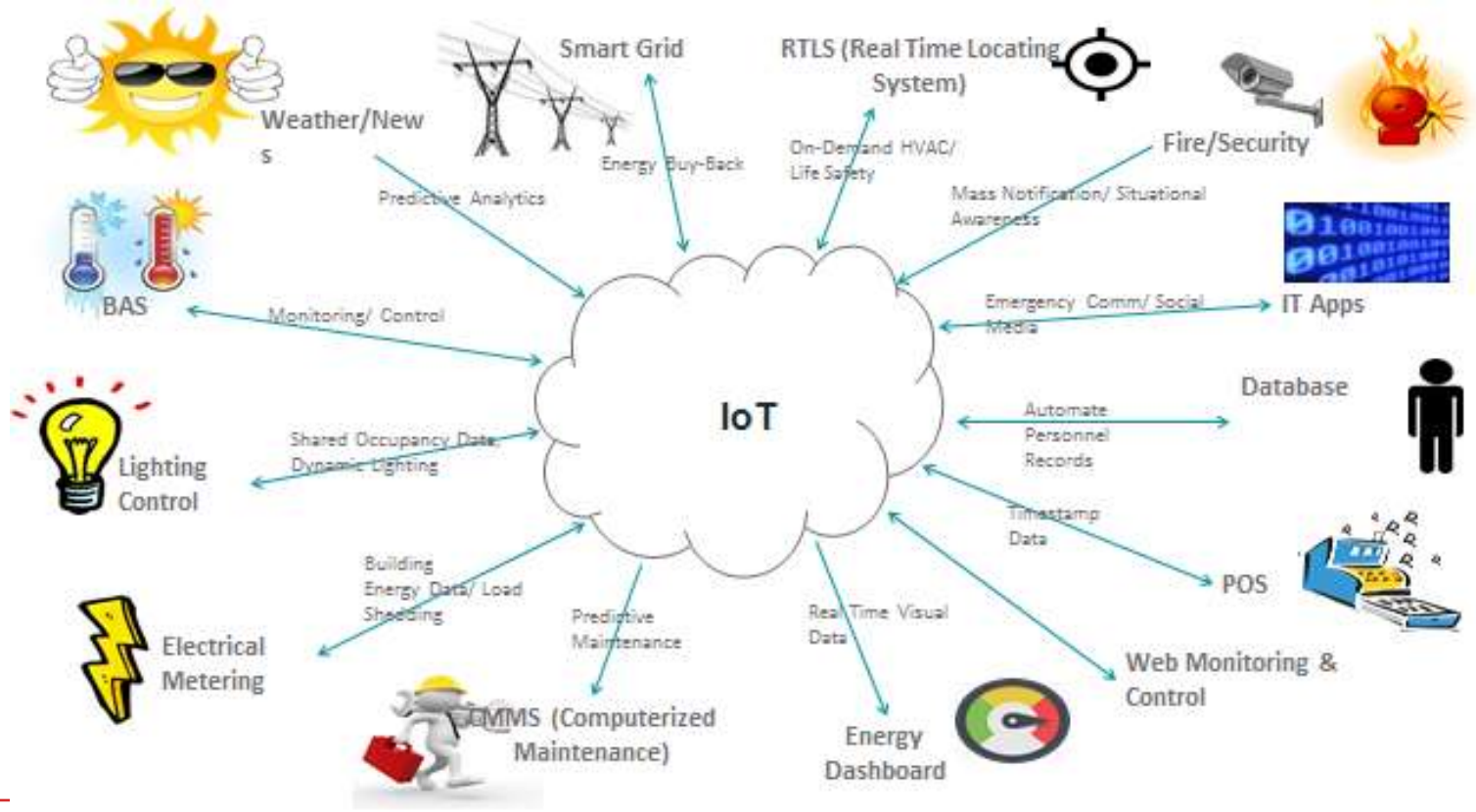
IN CASE OF FIRE - LIFT COVER
PULL FIRE ALARM
PULL
IN CASE OF
FIRE
STOPPER II
PULL STATION PROTECTOR
MODEL STII100
PATENTED
LIFT HERE

Words | Concepts | Technology & Low Voltage

- IP – Internet Protocol – Communications used with devices and the internet
- IoT – Internet of Things
- PoE – Power Over Ethernet – Delivers DC power to end-points like phones and IP cameras
- MDF – Main Distribution Frame – Typically the main server/telecom room
- LAN – Local Area Network – The network within a building
- WAN – Wide Area Network – The network between buildings
- WLAN – Wireless Local Area Network – AKA: Wi-Fi network
- WAP – Wireless Access Point – Wi-Fi antennaCATV – Cable TV
- MPOP -Main Point of Presence. Where the main telecom lines come into the building.

Words | Concepts | Technology

- IoT / Smart Buildings



Words | Concepts | Technology

- Integration of previously “siloed” systems
- Utilized “smart” versions of existing technologies and new technologies
- Allows Improved Reporting
- Predictive
- Data transmission and HIPPA concerns (for healthcare)
- Mobile connectivity
- Remote monitoring and control
- Data processing/ analytics/ metrics
- Site selection of Data Center

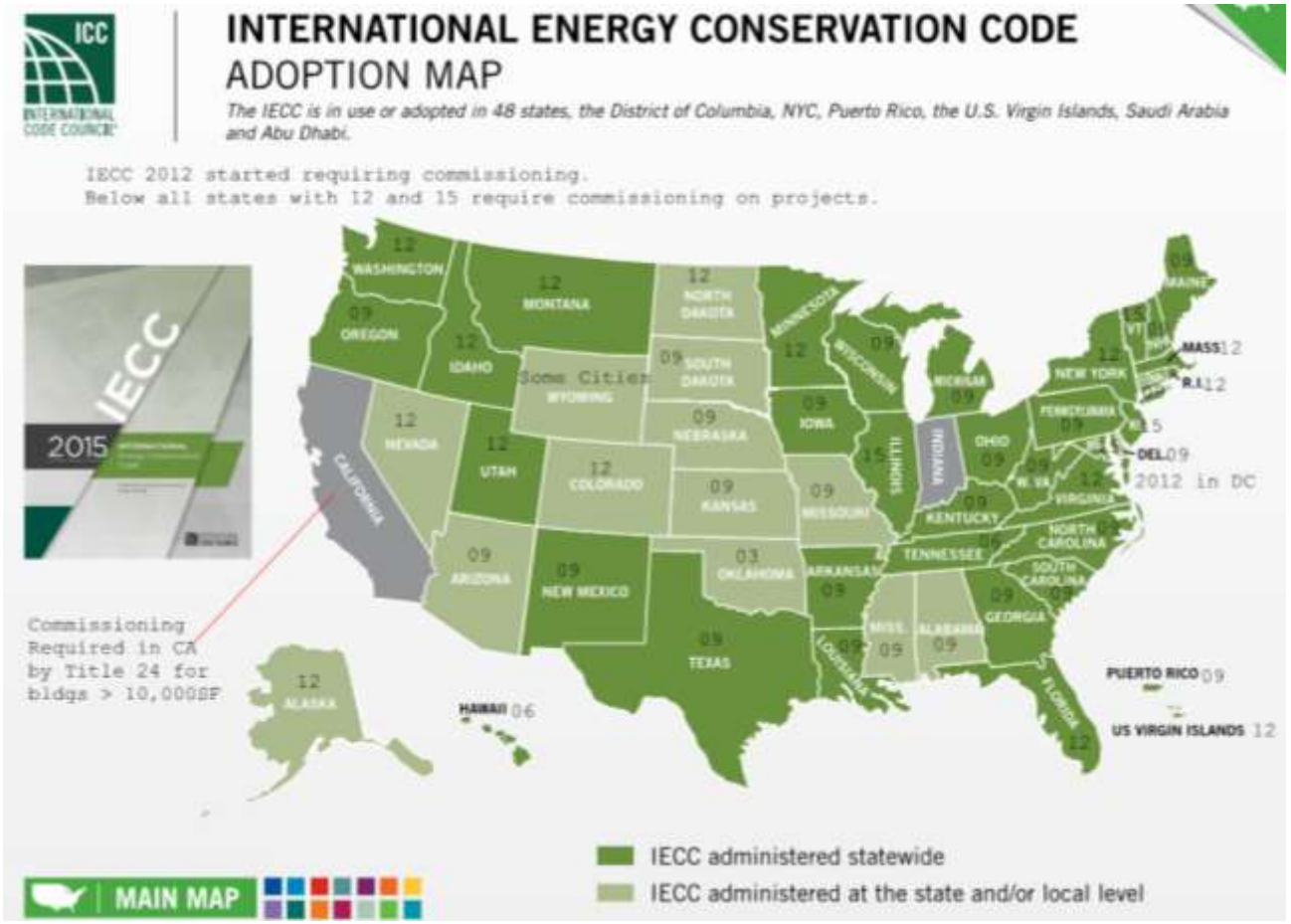
- Things:
  - Temperature control/ On-Demand Ventilation
  - Lighting Control/ Receptacle Control
  - Air Quality monitoring
  - Irrigation
  - Fire Protection
  - Emergency communications/ Mass notification
  - Security
  - Audio/video Systems
  - Smart sensors and actuators
- Integration creates:
  - Energy efficiency
  - Operational efficiency
  - Improved automation

Words | Concepts | Technology

Words | Concepts | Commissioning

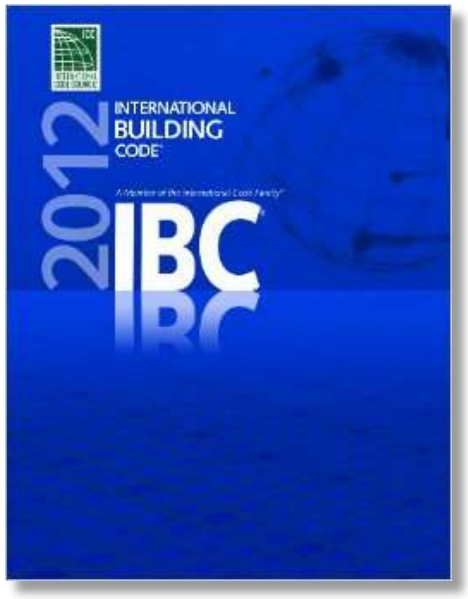
- Cx- Commissioning-process of assuring that the systems of a hospital are designed, installed, tested, operated, and maintained according to the owner's operational requirements
- ReCx: Recommissioning- periodic commissioning of a building that has already been commissioned
- RetroCx – RetroCommissioning- applying the commissioning process to existing buildings
- MBCx – Monitoring-Based Commissioning
- EUI – Energy Use Intensity
- CBECS – Commercial Buildings Energy Consumption Survey

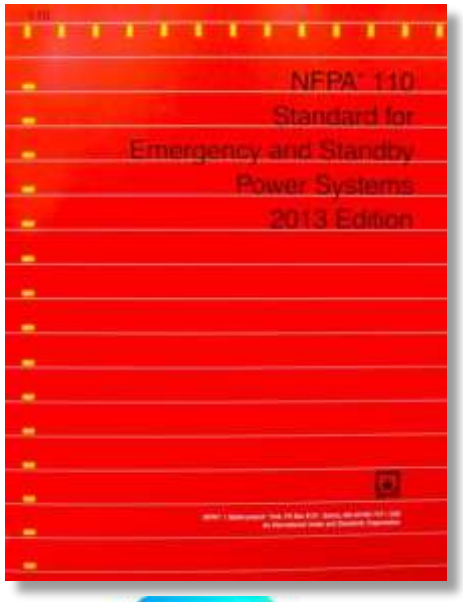
Words | Concepts | Commissioning

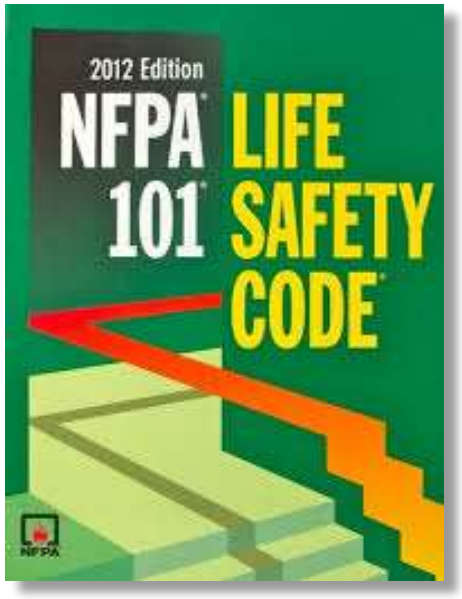


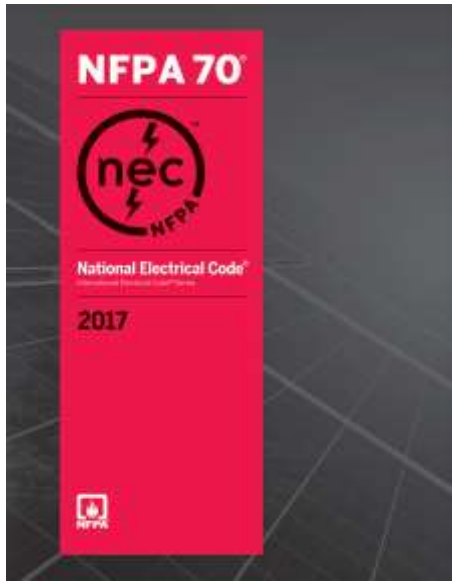
CODES AND GUIDELINES

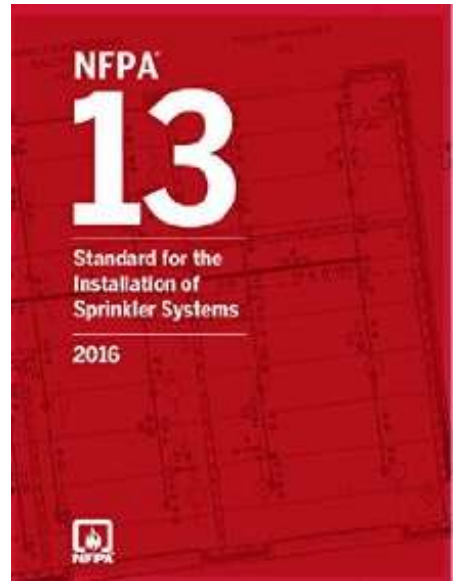
Code | Guideline Considerations











ASHRAE

* Not an all inclusive list and not necessarily the editions adopted by your facility's jurisdiction.

Codes and Guidelines | Disclaimers

“Code Minimum”

- NFPA Disclaimer: “Anyone using this document should rely on his or her own independent judgement or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.”
- Codes “… Establish minimum criteria.”
- Codes are “Not a design guideline..”
- This Code “… is not intended as a design specification or an instruction manual for untrained persons.”

Codes and Guidelines | Disclaimers

"Code Minimum"

- The Code…. "contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance results in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion…"

- **Code Minimum is the "worst building you can legally build."**

Codes and Guidelines | General

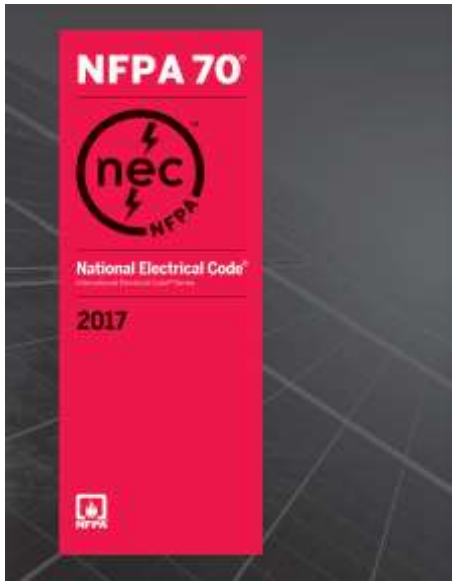
- NFPA 13: Standard for the Installation of Sprinkler Systems
- NFPA 50: Standard for Bulk Oxygen Systems at Consumer Sites
- NFPA 70 aka NEC: National Electrical Code
- NFPA 72: National Fire Alarm and Signaling code
- NFPA 99: Health Care Facilities Code
- NFPA 101: Life Safety Code
- NFPA 110: Standard for Emergency and Standby Power Systems
- ASRAE 170: Ventilation of Health Care Facilities

Code | Guideline Considerations

- NFPA 101 – Life Safety Code
  - Goal: Provide an environment for the occupants that is reasonably safe from fire, safe during emergencies, safe crowd movement
  - Objectives
    - Occupant protection
    - Structural Integrity
    - System Effectiveness

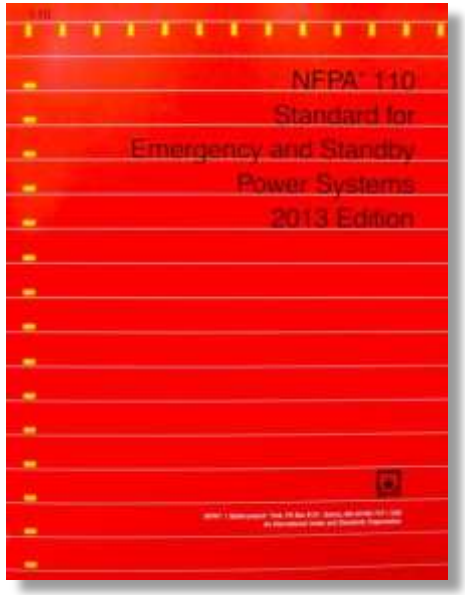
  A healthcare facility (hospital) is defend in place facility

Code | Guideline Considerations



- NFPA 70 – National Electrical Code (NEC)
- Purpose is the practical safeguarding of persons and property from hazards arising from the use of electricity.
  - Article 517 – Health Care Facilities applies to electrical construction and installation in health care facilities that provide services to human beings.
  - Article 701 – Legally Required Standby systems

Code | Guideline Considerations



- NFPA 110 – Standard for Emergency and Standby Power Systems
- Requirements for Emergency and Standby power in the event of primary power loss
- Performance requirements for an EPSS

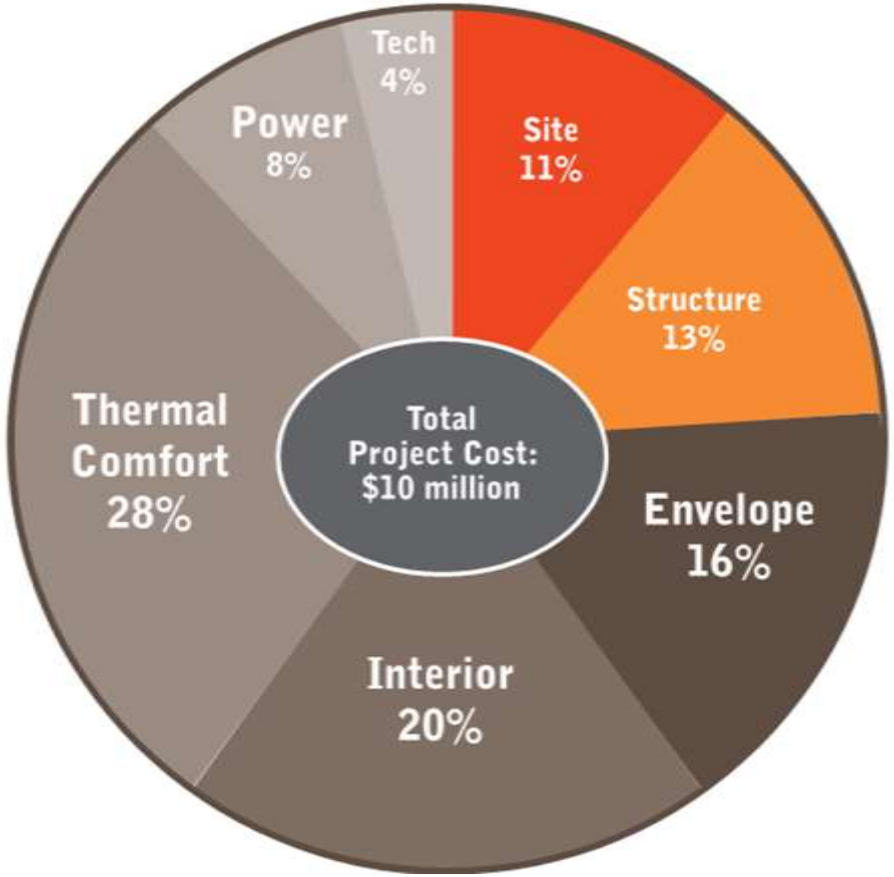
Code | Guideline Considerations

- 2015 Minnesota Mechanical Code (2012 IMC)
- 2015 Minnesota Plumbing Code (2012 UPC with Minnesota Amendments)
- 2015 Minnesota Energy Code (2012 IECC)
- ASHRAE Design Standards

ENGINEERING SCOPE ALIGNMENT

Alignment | Fundamentals

Alignment | Cost



Alignment | Risk

Alignment | Benefit

ENGINEERING SPACE REQUIREMENTS

Words | Concepts | Engineering Systems

Words | Concepts | Infrastructure

Mechanical Rooms and Penthouses

- 7 to 9% of Building Gross Square Feet (BGSF)
- 16 feet clear vertical height
- Access to exterior walls

Shafts

- 0.27% of BGSF- 1 sf per 375 sf
- One shaft per smoke compartment- Aligned vertically
- Coordinated with structural system

Words | Concepts | Infrastructure

Main Electrical Rooms

- 1 to 2% of BGSF

Distribution “Closets”

- 8x10 is good for planning- stacked

Server Room

- 1 sf per 100 of total GSF

Tele/Data Rooms

- Minimum 10’x15’ or Facility standards

Central Plant

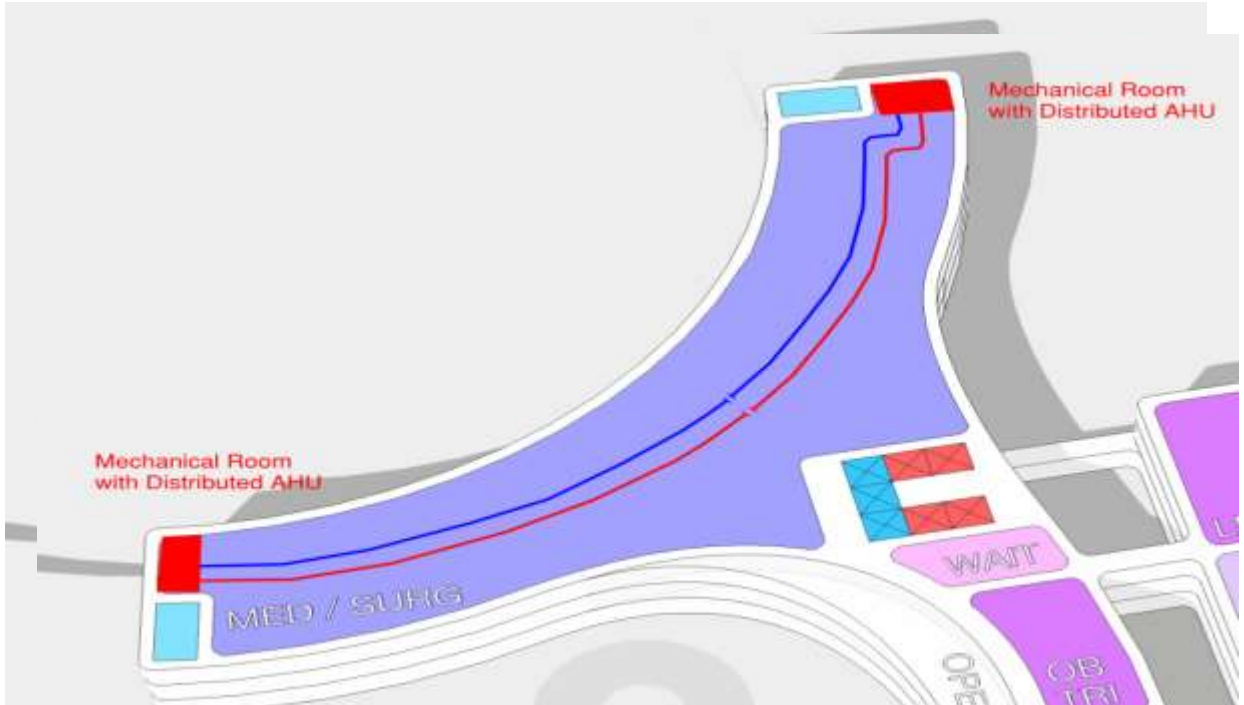
- 2 to 3% of BGSF

SYSTEM INTERACTIONS

Systems Interactions

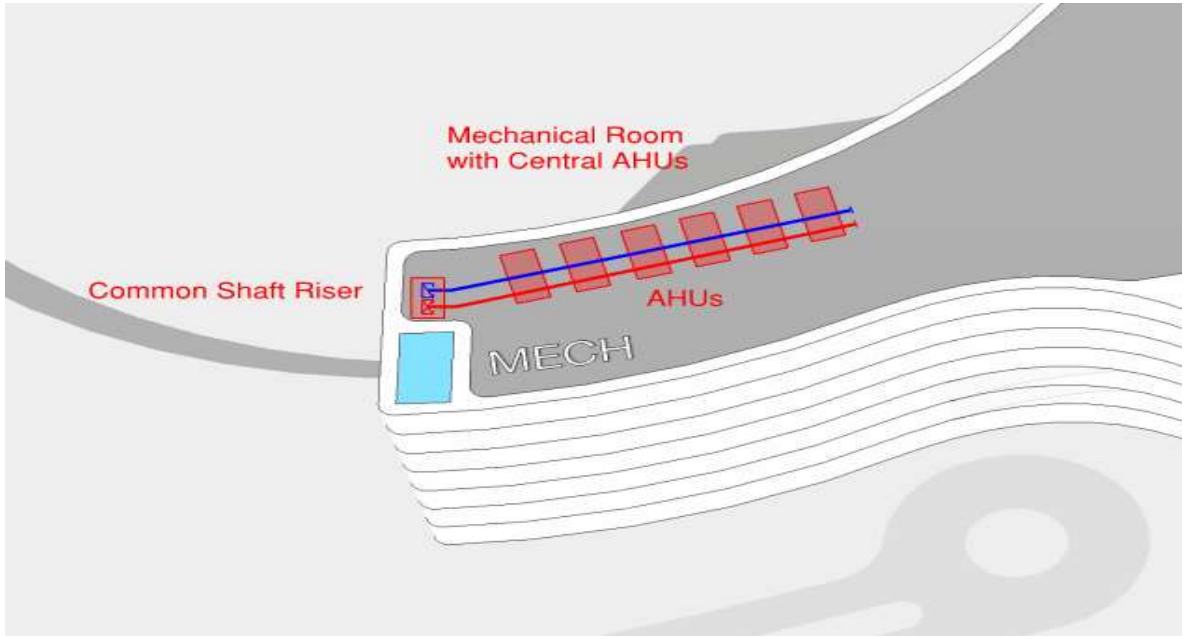
Distributed Air Handling Units

- Packaged Air Handling Unit located close to area of service
- Air capacities up to 20,000 CFM
- Maintenance performed indoors
- Vertical expansion without equipment relocation
- Requires program space with access for outside air and relief air louvers
- Redundancy options

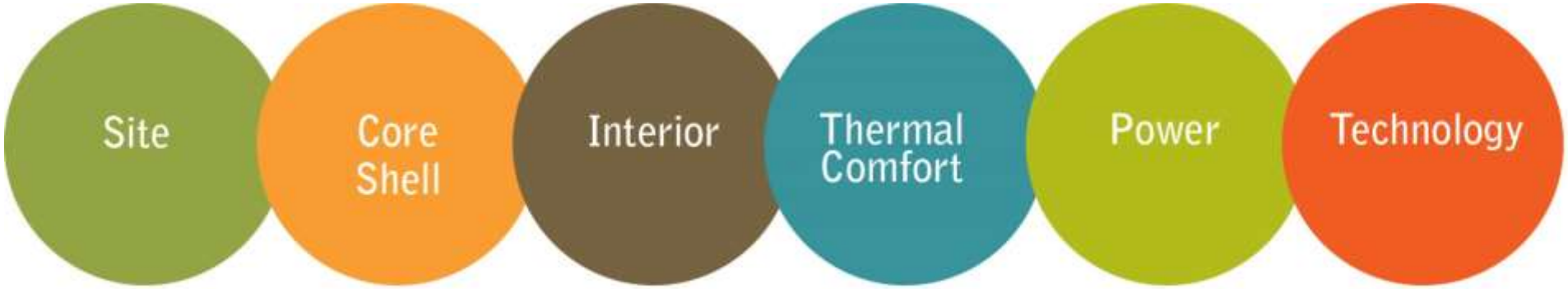


Central Air Handling Units

- Packaged Air Handling Unit located in common location-
- Manifold arrangement for combined air capacities up to 200,000 CFM- redundancy
- Maintenance performed indoors
- Utilize penthouse for multiple AHU location



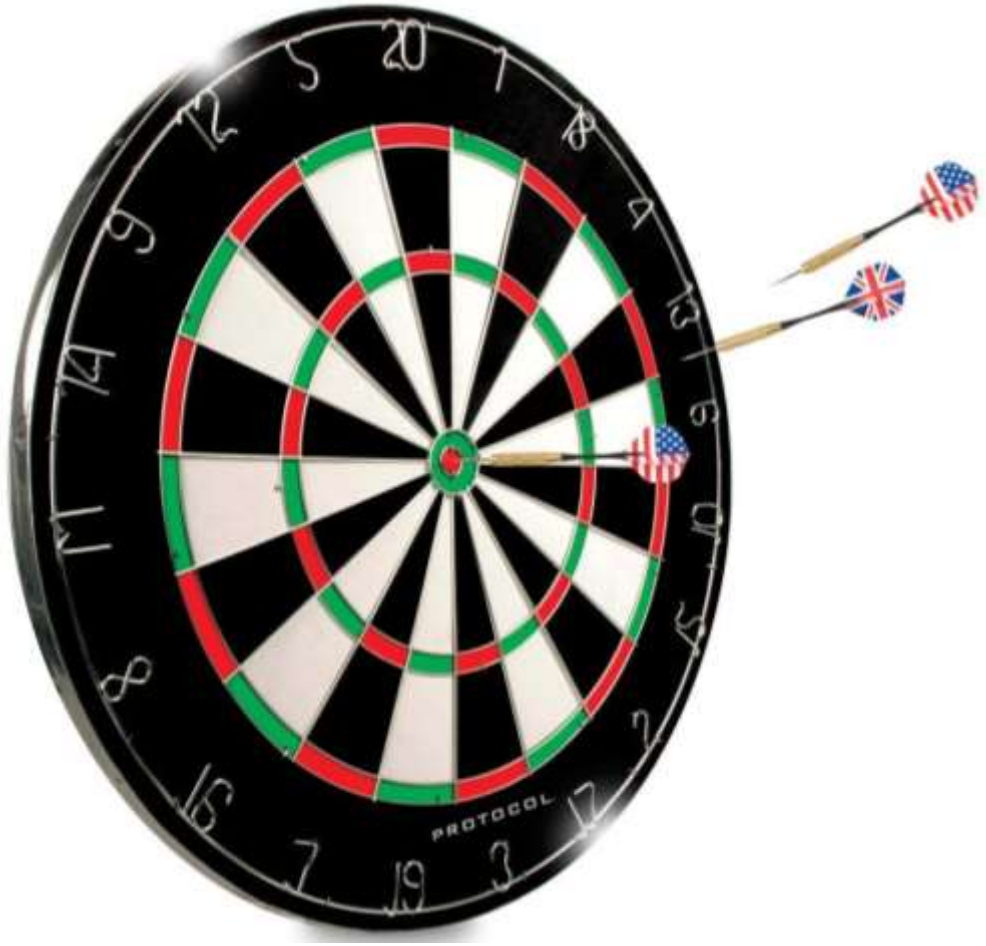
Systems Interactions



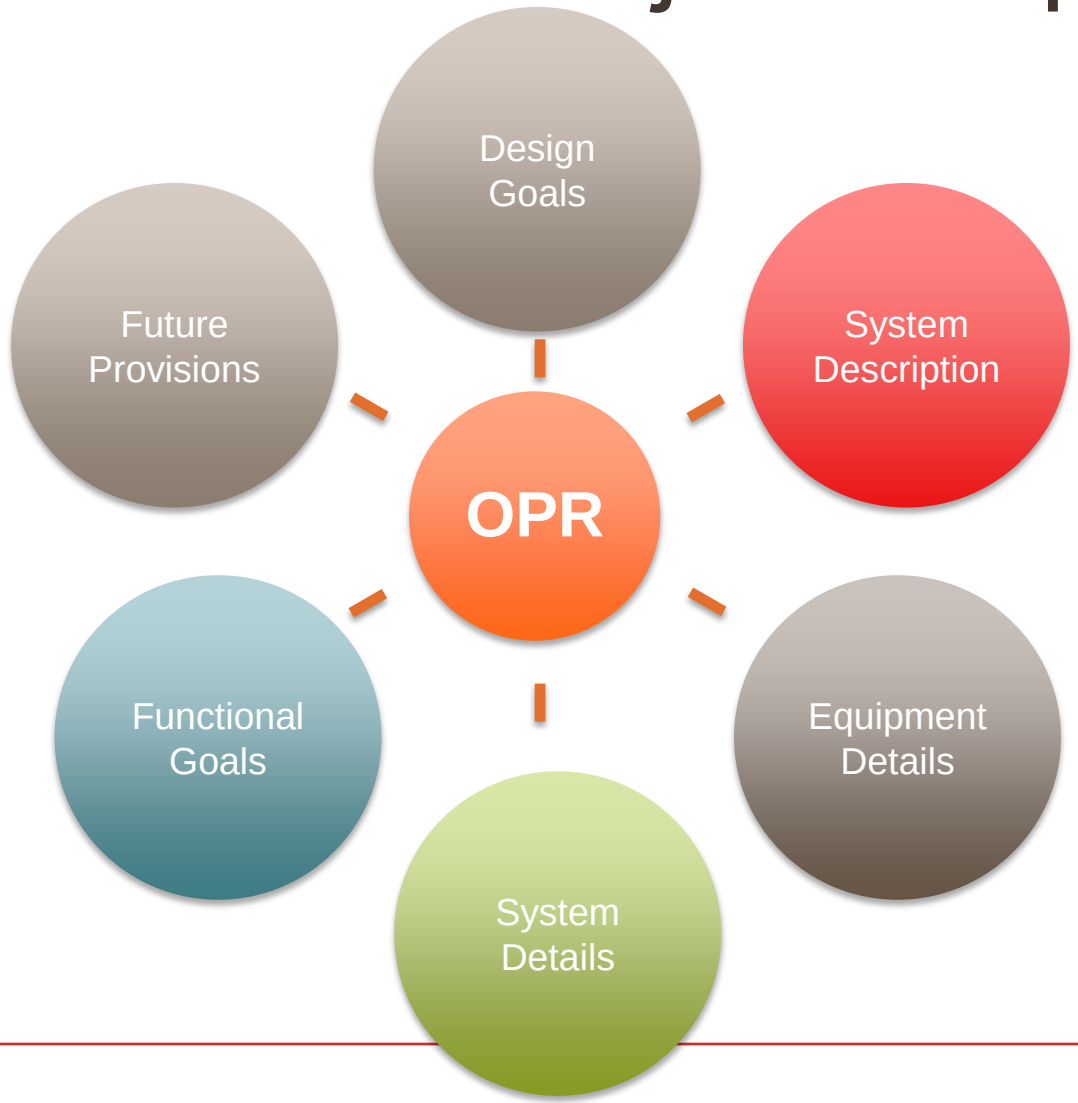
Site	Core Shell	Interior	Thermal Comfort	Power	Technology
Leader:	**Leader:**	**Leader:**	**Leader:**	**Leader:**	**Leader:**
Civil Engineer	Proj. Designer	Proj. Designer	Sr. Engineer	Sr. Engineer	Sr. Engineer
Team:	**Team:**	**Team:**	**Team:**	**Team:**	**Team:**
Owner's Representative	Owner's Representative	Owner's Representative	Owner's Representative	Owner's Representative	Owner's Representative
Project Designer	Project Architect	Project Architect	Mech. Engineer	Electrical Engineer	Electrical Engineer
Project Architects	Architects	Architects	Electrical Engineer	Mech. Engineer	Mech. Engineer
Mech. Engineer	Mech. Engineer	Medical Planners	Project Architect	Project Architect	Project Architect
Elec. Engineer	Structural Engineer	Interior Designers	Structural Engineer	Project Designer	Project Designer
Construction Mgr.	Construction Mgr.	Mech. Engineer	Srvcs. Technical Grp.	Interior Designer	Interior Designer
		Electrical Engineer	Construction Mgr.	Srvcs. Technical Grp.	Srvcs. Technical Grp.
		Construction Mgr.		Construction Mgr.	Construction Mgr.

TOOLS

Decision Making Tools



Tools | Owner's Project Requirements



Tools | Owner's Project Requirements

Owner Project Requirements (OPR) Questionnaire
Abbott Northwestern Hospital
Sixth Floor Heart Hospital Neuro ICU
HGA Commission # 2401-033-00

HVAC

1. Are there published facility design standards for the mechanical systems?
   (YES) If yes, date HGA received a copy: _11 master spec sections, recv'd on 2/26/16; ANW will be sending a more complete set_____.

Energy Efficiency Goals

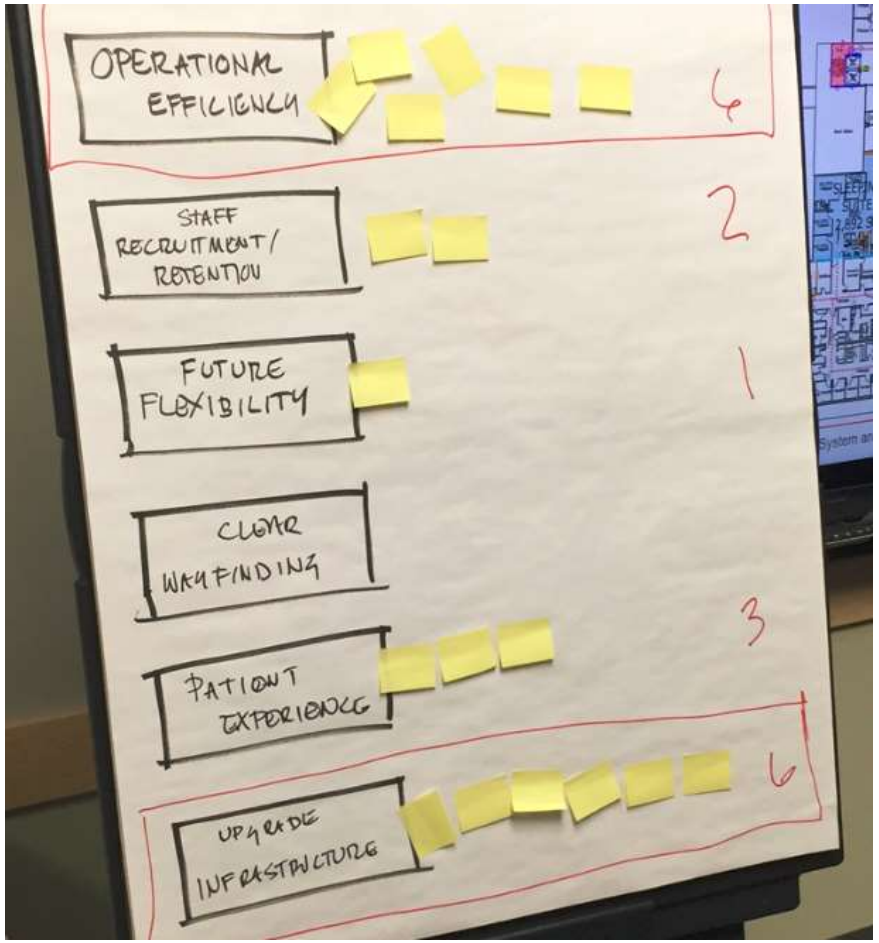
2. Goal is to meet or exceed an EUI (Energy Use Intensity) of ? ___Minimize within reason, but a target EUI is technically not applicable_____.

Sustainability Goals

3. Is it goal of the facility to meet LEED, Energy Star, or other rating system for sustainable design performance? (Yes) **(No)**
   If yes, indicate the rating goal.
   __Design should be in the spirit of LEED, but pragmatic_____

4. Does the data for the rating system chosen need to be documented for application for the award? (Yes) **(No)**

Tools | Forced Ranking of Criteria



Tools | Set Log

					Evaluation Criteria		
	Description	**Energy Cost**	**Capital Cost**	**Flexibility**	**Redundancy**	**Space Needed**	**Maintenance**
	Heating Systems						
Opt A	Steam Boilers with Heat Exchangers	0	0	0	0	0	+
Opt B	**Gas Fired Condensing Water Boilers**	+	0	+	+	+	0
Opt C	Electric Heating	--	+	0	--	+	--

Tools | A3s

TITLE: Emergency Electrical Distribution Modifications
AUTHOR: Krista M. Biason

Health Care Campus

Option 3

OPTION 3 – Executive Summary: Connect existing generator systems together

Original electrical distribution now serves primarily Mechanical Loads, the Fire Pump and normal loads in the facility (ivory outlets). This distribution system is backed up by the original 2 MW generator. Upon loss of utility power all of these loads would be served by the 2 MW generator.

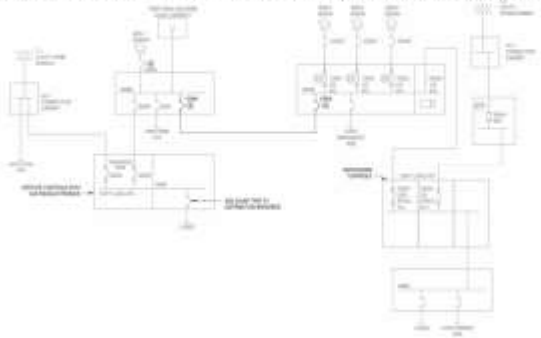
The second electrical distribution system, added in Tower Expansion scope of work, serves primarily code required life safety, critical, and equipment branch loads in addition to select optional loads. The distribution system is backed up by three new 800 KW generators. Upon loss of utility power all of these loads would be served by the generators.

Option 3 Modifications: In normal operation mode, the system would function as currently installed. In the event of a failure of one of the three new distribution generators, the original 2 MW generator could be switched to provide power to code required distribution. If the 2 MW generator fails, one of the 3-800 KW generators could back up the 2 MW generator loads. Note that if one or more of the four generators fail, the entire building may not be fully operational and select loads will still need to be shed.

DESCRIPTION:

Scope: Add output breaker on each switchboard to connect the two busses

1. Add 1200A LSI GF Sensing Breaker to Switchboard MSBE bus.
   a. Switchboard is located within 2 MW generator enclosure.
   b. 1200A breaker is the largest frame breaker that is able to be installed in gear.
2. Utilize spare 1200A LSI GF Sensing Breaker to Paralleling gear GPSB bus.
3. Tie two new breakers together.
4. Add neutral reactor for 2 MW Cummins generator to address pitch difference between Cat generators and Cummins.
5.
6. Replace soft load transfer controls in existing soft load switch for 2 MW Cummins generator.



PROS for Option 3 Design:

1. Provides ability to provide generator power to alternate distribution bus in the event of a catastrophic failure.
2. Utilizes existing distribution equipment.
3. Utilizes existing spare breaker in paralleling gear.
4. No additional physical space required to make modifications.
5. Less outages for modifications and phasing.
6. Allows GPSB load to be served by MSB1 bus to meet minimum loading requirements.

CONS for Option 3 Design:

1. Does not utilize full capacity of generator (sets) due to limited breaker size.
2. Downtime while modifications and terminations are implemented on equipment.
3. Complicated programming to assure code required loads maintain secondary source of power.
4. Longer time duration for each modification and each phase.
5. Transition to migrate generator load to alternate bus not automatic.

Economic Analysis:

1. Allowance is only a high level budget estimate.
2. Budget does not include rental of generators required for phasing.
3. Any additional fees from the utility are not included.
4. Fuel costs are not included.
5. Does not include design or documentation time.

Item	Component	Budget
1.	Material - Electrician	$ 30,000
2.	Supplier Equipment and Labor	$ 90,000
3.	Electrician Labor	$ 35,000
4.	Commissioning and Testing	$ 7,500
	Total Budget:	$ 162, 500

Recommendations:

If redundancy is desired for the two emergency distribution systems Option 3 is the most cost efficient method of achieving this goal.

This option does not allow automatic transitions nor will it allow either distribution load to be solely supported from the alternate distribution but it will be able to fulfil the goal of redundancy and testing.

Tools | A3s

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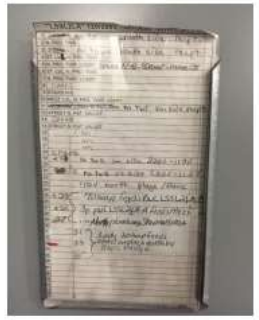
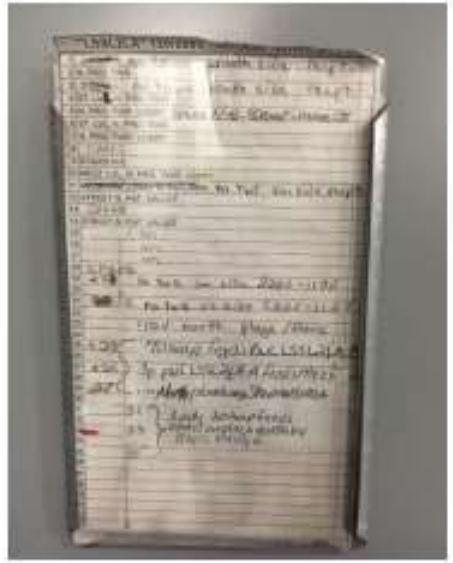
Tools| Engineering Assessment

E2 - EXPOSED BUSSING

Name	Building	Floor	Room
LSSL2LA	Main Building, North Patient Tower	Street Level	A1009/804



Equipment Type	Age	Condition	Comments	
Panelboard	Mar-97	Fair	Panel has exposed bussing, creating a risk of a serious accident.	Blank cover plate should be installed. Typical of ASEA, ASEC, LDA, LSSL2LA, ZLIM, S3P3H, 3LPN, 3DPL, CR3I4LB, CR4I4LB, 4LIA, EC5NG, 6LIB, 6LPMA, CR6I5LA, 6L2M, CR8I2LB, CR8I3LC, 8HPL, 8DPL, and CPH.



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Summary | What you Learned

- **LOTS** of Acronyms and Jargon
- How to align expectations with technical engineering topics
- Engineering Design
  - System Dependencies
- Decision Making Tools
- Engineering is fun!

Questions?

THANK YOU

“Perhaps he was a bit different from other people, but what really sympathetic person is not a little mad?” – Isadora Duncan

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