MECHANICAL SYSTEMS DESIGN

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Team 2010 - 2

PRESENTATION OVERVIEW

- PROJECT OVERVIEW
- DESIGN GUIDELINES
- DESIGN ASSUMPTIONS
- MECHANICAL DESIGN
- PLUMBING DESIGN
- FIRE PROTECTION DESIGN
- EMERGENCY SYSTEM
- SUSTAINABLE DESIGN/INNOVATION

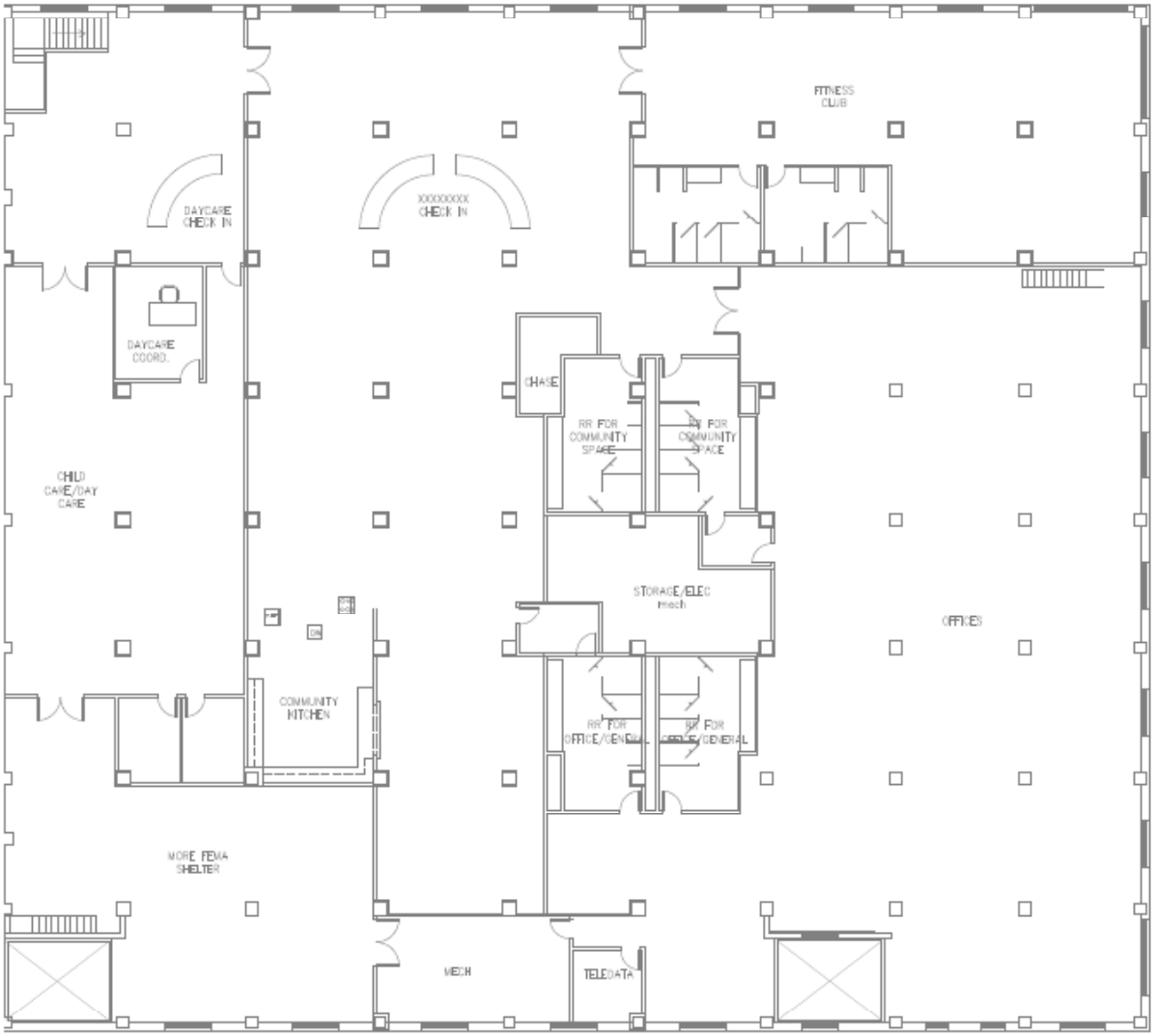
PROJECT OVERVIEW

- Existing 2-story building in urban Tulsa, OK
- First floor:
    - Medical office/outpatient facility
- Second floor:
    - Daycare, fitness center, community center, offices
- Design a feasible, yet innovative facility within reasonable economic constraints
- Design for specified positive and negative pressure rooms
- Provide a FEMA Tornado Shelter and Triage Center in the event of a natural or manmade disaster (minimum 3000 square feet)
- **Focus on sustainable design and innovative technologies**

PROJECT OVERVIEW

First Floor Plan

PROJECT OVERVIEW



Second Floor Plan

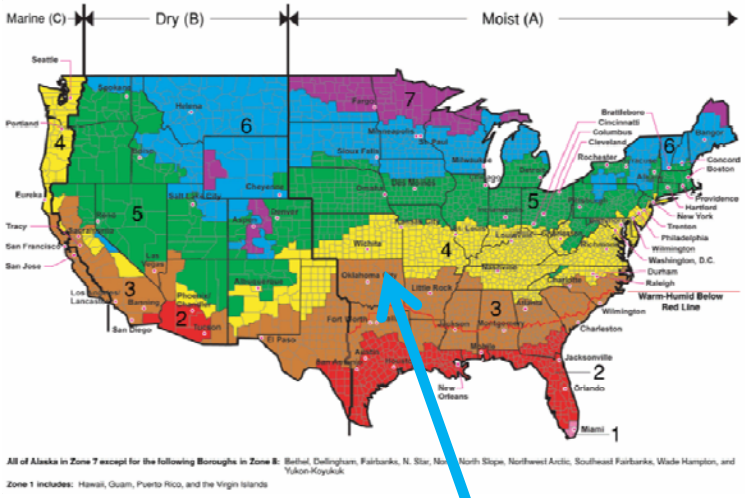
DESIGN GUIDELINES

- Codes and standards
- ASHRAE Advanced Energy Design Guide for Small Hospital and Healthcare Facilities
- 2006 AIA Guidelines for Design and Construction of Healthcare Facilities

DESIGN ASSUMPTIONS

Space	Lighting Load	Plug Load	Occupant Load	Ventilation Load	Vent. Load from:
Call Center	1 W/sq ft	2000 W	10 People	20 CFM/person	IMC 2006
Clean Supply	0.9 W/sq ft	0 W	0 People	4 ACH	AIA Guidelines
Entries/Halls	1 W/sq ft	0 W	0 People	0.05 CFM/SF	IMC 2006
Offices/Workrooms	1.1 W/sq ft	200 W	7 People/ 1000 SF	20 CFM/person	IMC 2006
Procedure Rooms	1.5 W/sq ft	0 W	4 People	15 ACH	AIA Guidelines
Break Room	1 W/sq ft	753 W	15 People	10 CFM/person	ASHRAE 62-07
Loading Dock	1 W/sq ft	0 W	0 People	0.15 CFM/SF	IMC 2006
Toilets	0.9 W/sq ft	0 W	0 People	Exhaust Air	IMC 2006

Example loading scenarios



ASHRAE Climate Zone Map
Courtesy of ASHRAE

Tulsa, OK
Zone 3A

ELECTIRCAL / LIGHTING

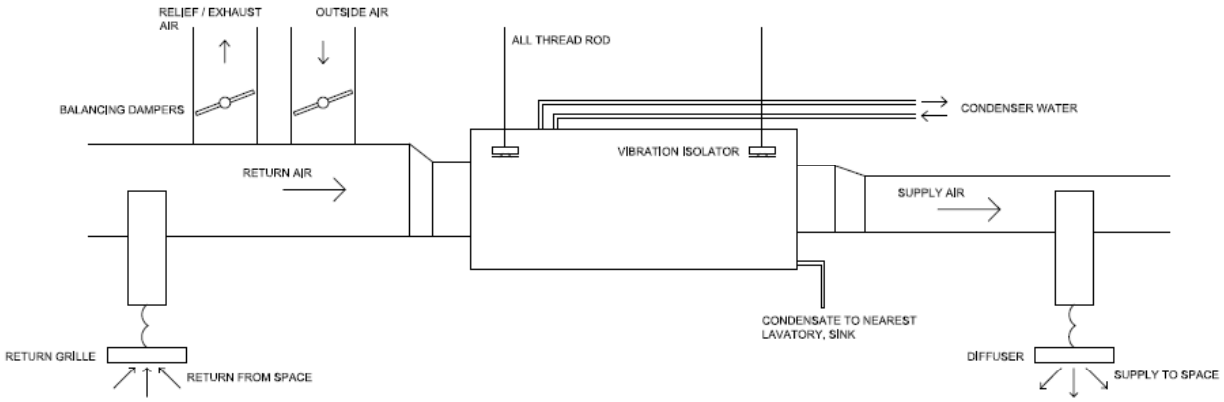
- Generator for emergency power
- Lighting does not exceed 1.2 W/sq. ft.
- Incoming power at 120/208V 3P 4W

MECHANICAL

- Trace 700 skin loads are based off of ASHRAE AEDG
- Outdoor summer design: 98/75 (ASHRAE 1%)
- Outdoor winter design: 13 db (ASHRAE 99%)
- Indoor design:
  - 75 db / 50% RH cooling
  - 70 db heating
- Plug loads based on research of probable loading scenarios
- City Water Main pressure: 80 psi
- Minimum pressure required: 15 psi

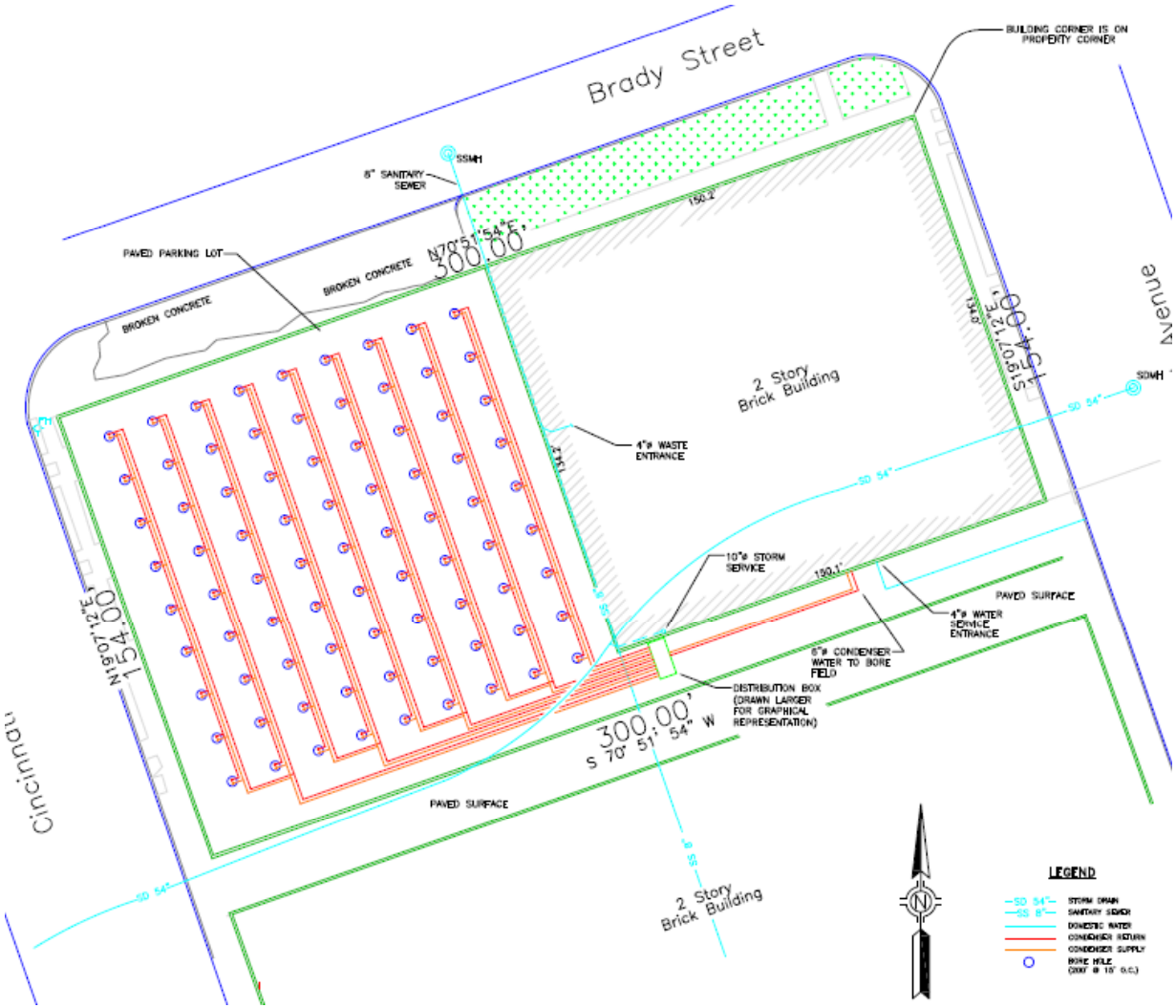
MECHANICAL DESIGN

- Selected HVAC System:
  - Zone Heating and Cooling: 40 Horizontal Geothermal Plenum Heat Pumps
  - Ventilation/Exhaust: 2 Dedicated Outside Air (DOAS) Heat Pumps with Energy Recovery Wheels
  - Vertical Geothermal Well Loop (81 bores)
  - Primary well field pumps (constant flow), secondary zone pumps (variable flow)
- Ventilation and exhaust air delivered/extracted from return air ductwork
- Reverse return hydronic piping
- Hydronic crossover loop



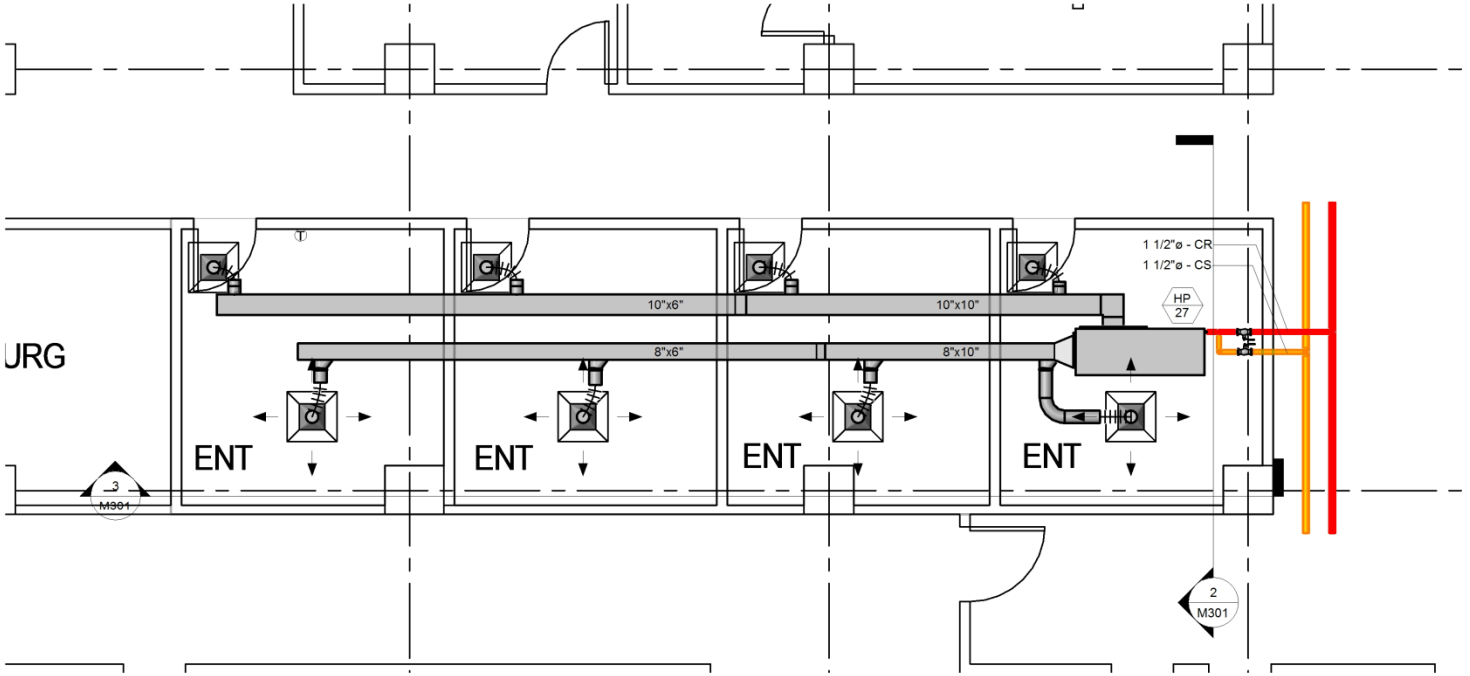
Typical heat pump detail

MECHANICAL DESIGN



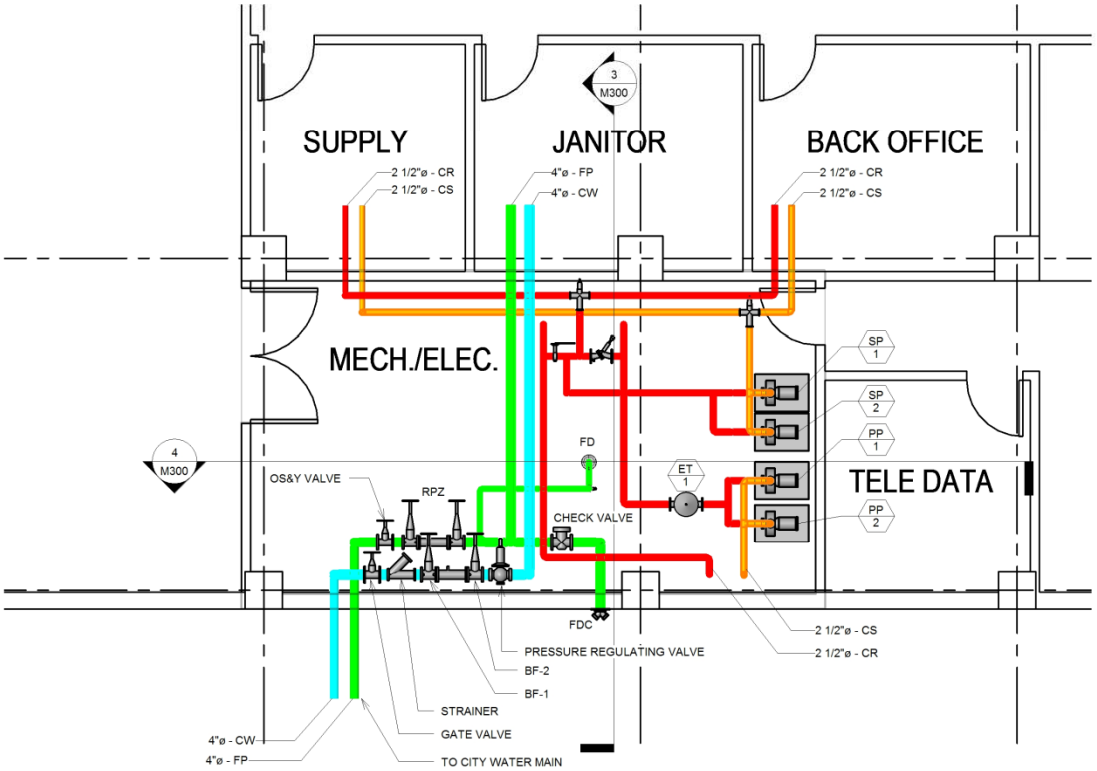
Hydronic Piping Site Plan

MECHANICAL DESIGN



Typical heat pump zone plan

MECHANICAL DESIGN



First floor mechanical room plan

MECHANICAL DESIGN

Room #	Name	Area (SF)	Ceiling (FT)	Cooling			
				Sensible BTUh	Latent BTUh	Total BTUh	Design SA CFM
1	Call Center	371.6	9	20570 btuh	1000 btuh	21570 btuh	955 cfm
2	Supply/Clean	215.3	9	8072 btuh	0 btuh	8072 btuh	375 cfm
3	Staff Entry	252.6	9	8296 btuh	0 btuh	8296 btuh	385 cfm
4	Plaster Cast Suite	587.8	9	26859 btuh	1250 btuh	28109 btuh	1245 cfm
5	Special Entry	983.8	9	44102 btuh	1750 btuh	45852 btuh	2045 cfm
6	Resident Workroom	286.4	9	16181 btuh	500 btuh	16681 btuh	750 cfm
7	Resident Workroom	318.5	9	17696 btuh	500 btuh	18196 btuh	820 cfm
8	Surgery Scheduling	246	9	14849 btuh	500 btuh	15349 btuh	690 cfm

Sample load spreadsheet

Calced from Trane Trace 700

Calced based on cooling load

- Heat gain/loss calculations determined room and zone airflows
  - Office and healthcare equipment was researched and used for internal loads
- Careful airflow analysis was performed
  - Ensure overall positive internal pressure
  - Enough pressure to overcome the potential for infiltration
  - Provided (2) positive pressure & (2) negative pressure rooms
-

PROJECT OVERVIEW

Positive Pressure

Negative Pressure

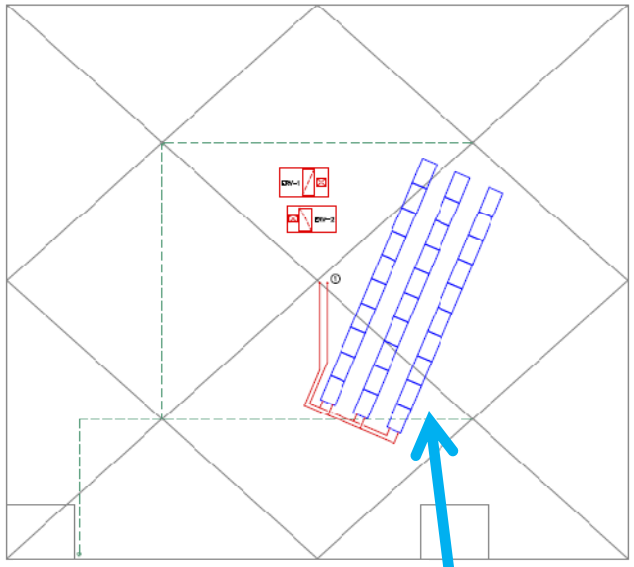
Pressurization Map

MECHANICAL SYSTEMS DESIGN

PLUMBING DESIGN

- 3” domestic water service entrance from city main
- Low flow fixtures were included for each space:
  - Water Closets
  - Urinals
  - Lavatory Faucets
- Hot water provided by solar water heat exchanger
- Water heater has integral electric backup heating
  - Thermocouple to monitor hot water supply temperature
- Solar hot water tanks located in second floor mechanical room

- Standard waste and vent system
- Standard roof drainage system with overflow downspout nozzles.



Roof plan

Solar water panels

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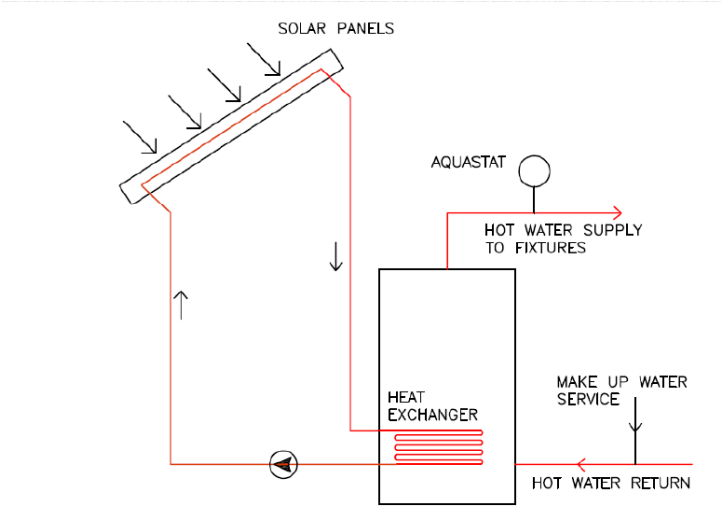


5 SOLAR WATER HEATING DIAGRAM
SCALE: NTS

PLUMBING DESIGN

Low Flow Fixture Selection

"The Pint" Ultra Low Consumption Urinal

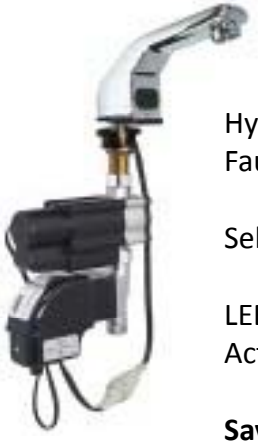
LEED 3.0 Baseline = 1.0 GPM
Actual = 0.125 GPM

Savings = 87%

Dual-Flush Flushometer Valve for all water closets

LEED 3.0 Baseline = 1.6 GPM
Actual = 1.28/1.60 GPM

Potential savings = 20%



Hydroelectric Generator Faucet for all Lavatories

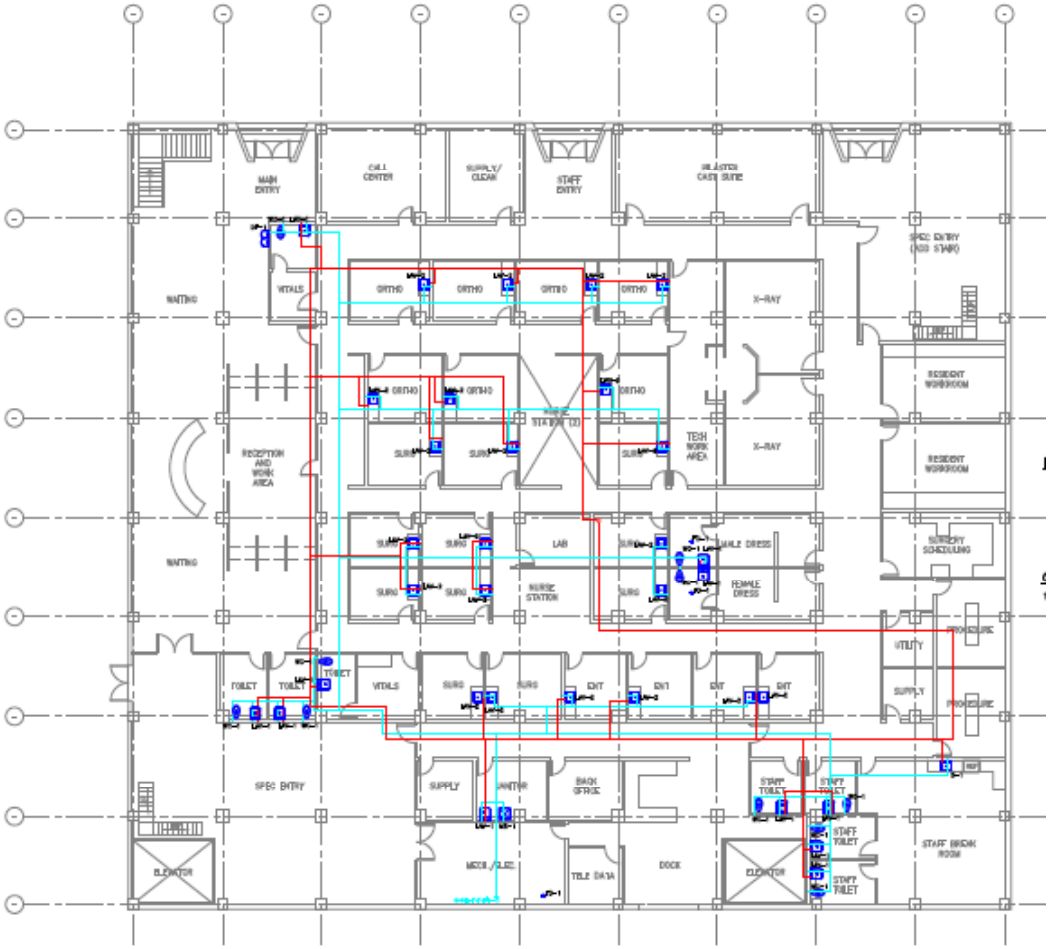
Self sustaining for 10 years

LEED 3.0 Baseline = 0.5 GPM
Actual = 0.25 GPM

Savings = 50%

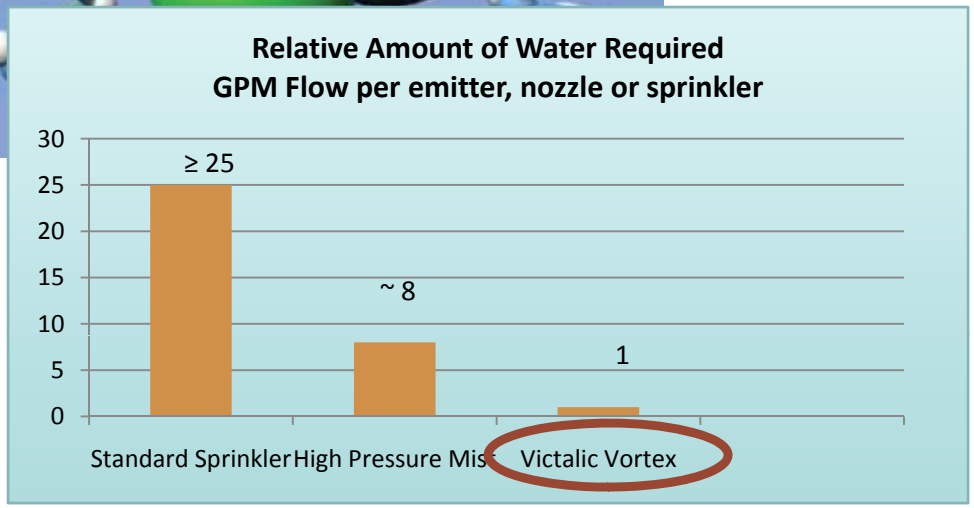
Photos courtesy of Zurn

PLUMBING DESIGN



First floor plumbing plan

FIRE PROTECTION DESIGN



- Victaulic Vortex fire suppression system
  - Zone piping run similar to a standard wet pipe system
  - Use of nitrogen gas – instead of halon gas
  - Nitrogen is a zero ODP and zero GWP substance
  - Normal applications include data center facilities and machine rooms, however implementation within this healthcare facility is applicable
- 4” fire protection service entrance – service will not metered.

Images courtesy of Victaulic

FIRE PROTECTION DESIGN

	Flow, GPM per nozzle	Drop Size, µm	Operating Pressure, PSIG	Velocity
Victaulic Vortex	<=1	<10	25	High
Intermediate Pressure Water Mist	37	400-1000	350	High
High Pressure Water Mist	~8	50-100	1500-2500	Low
Sprinkler Systems	>25	>1000	>20	Moderate
Inert Gases	N/A	N/A	2500	N/A
Halogenated Agents	N/A	N/A	360	N/A

Modified chart from Victaulic

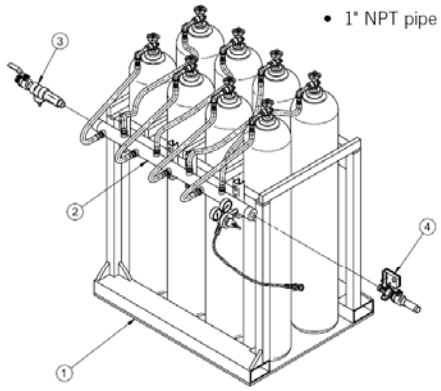
- Water savings even in a fire emergency situation
- "The ozone depletion potential (ODP) and the global warming potential (GWP) of each of the constituents of the Victaulic Vortex System is zero." (EPA 40 CFR Part 82)
- "The Victaulic Vortex System does not contain volatile organic compounds (VOC) as defined under Clean Air Act regulations (see 40 CFR 51.100(s)) addressing the development of State implementation plans (SIPs) to attain and maintain the national ambient air quality standards." (EPA 40 CFR Part 82)

FIRE PROTECTION DESIGN

SERIES 950 MANIFOLD ASSEMBLY, NITROGEN

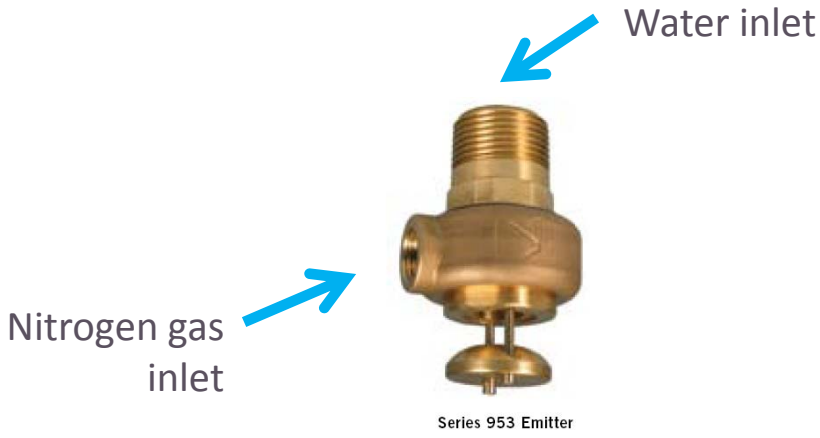
4, 6, 8 and 12 port assemblies available. Includes:

- Manifold
- Impermeable hose assembly with swivel assembly, ¼" NPT bottom, 3000psi
- 1" NPT pipe plug (3000psi rated)



1 - Cylinder Rack
2 - Cylinder Manifold with Regulator Option
3 - Manifold Fill Assembly
4 - Manifold Isolation Switch Assembly

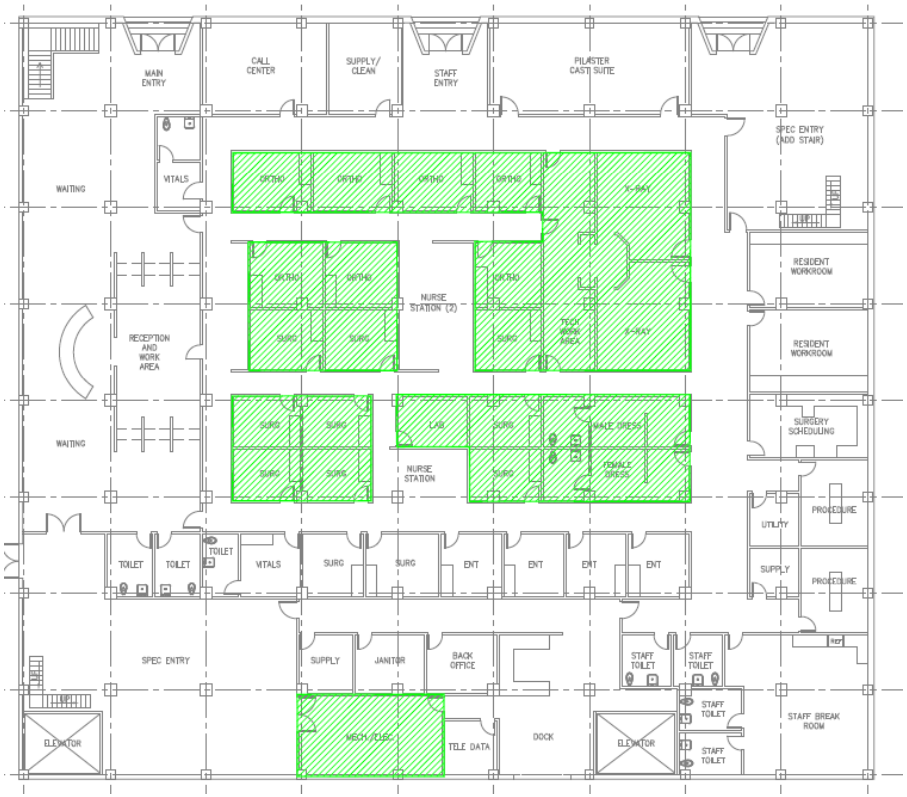
- Nitrogen lines run parallel to water lines
- When fire protection is initiated, nitrogen is released from tanks and dispersed at sprinkler nozzle
- Nitrogen mixes with water at sprinkler nozzles



Series 953 Emitter

Images courtesy of Victaulic

EMERGENCY SYSTEM

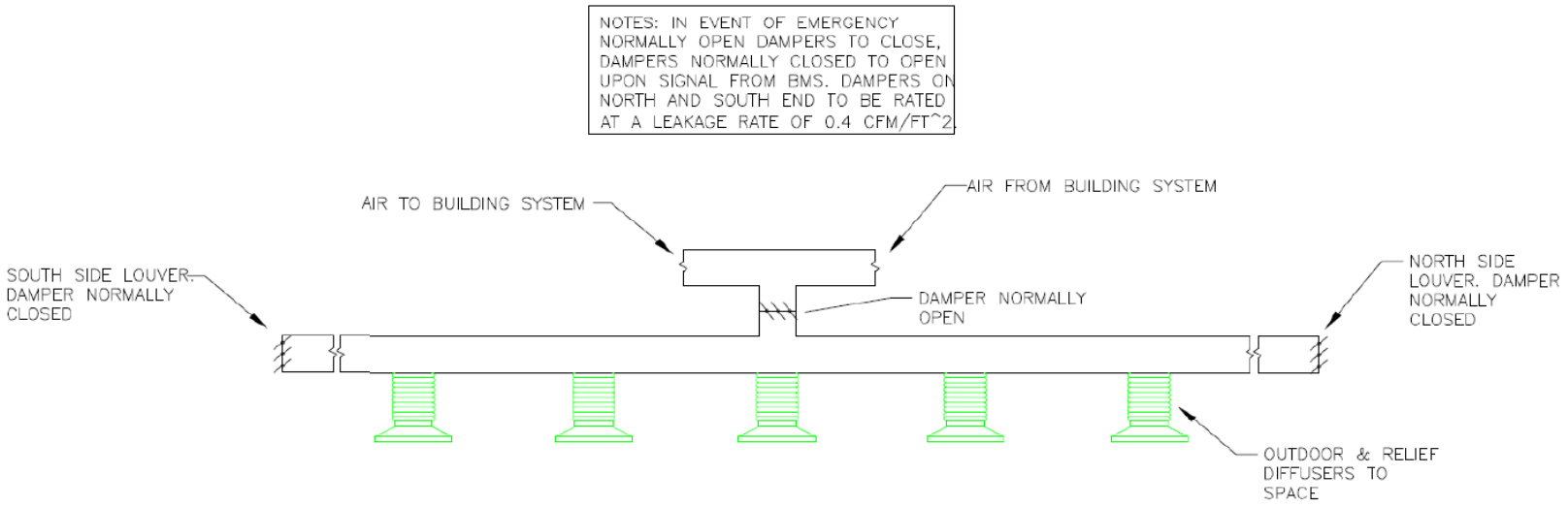


First floor FEMA shelter

- Consists of surgery rooms, x-ray rooms, ENT exam rooms, etc
  - Associated corridors and nurse stations also included
- First floor mechanical room reinforced to serve emergency space
- Hydronic piping run underground to emergency heat pumps
- 3-way valves to isolate emergency loop from rest of building

EMERGENCY SYSTEM

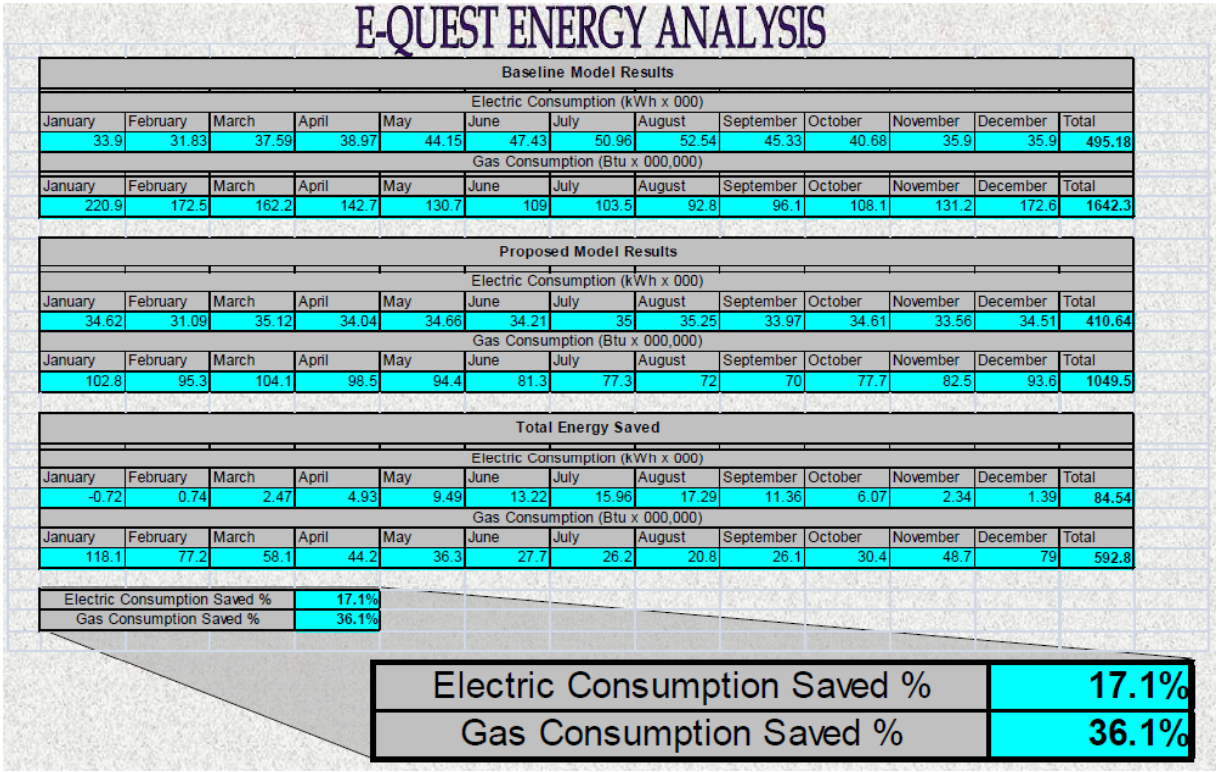
- Redundant outdoor and relief air louvers running north / south in building
- Dampers to close / open to redirect outdoor and relief air in event of emergency



4 OUTDOOR & RELIEF AIR EMERGENCY SCHEMATIC
SCALE: NTS

E-QUEST ENERGY ANALYSIS

- Energy model was created of the building to calculate anticipated energy savings
- Compared baseline building to new proposed design to calculate total energy savings



SUSTAINABLE DESIGN / INNOVATION

MECHANICAL

- Use of non-ozone depleting refrigerant
- Geothermal heat pumps
- Emergency switch-over of HVAC system to FEMA shelter
    - Provision to use existing heat pumps and hydronic piping
- Energy recovery DOAS heat pump

PLUMBING

- Low flow fixtures up to 87% water savings
- All restroom fixtuers are “no touch” fixtures to reduce the transmission of viruses and diseases
    - Overall helps maintain a clean facility
- Solar water heating with electric backup

FIRE PROTECTION

- New Victaulic Vortex system
- Use of Nitrogen instead of Halon 1301
- Only 1 GPM per sprinkler nozzle (dense mist)
- Safe for server rooms or typical office occupancies (virtually no water damage [from Victaulic] to interior surfaces)

QUESTIONS WILL BE TAKEN AT THIS TIME