Surgery Air Handler Upgrades to Meet Indiana State Department of Health (ISDH) Requirements

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Learning Objectives

- Learn how to efficiently upgrade existing mechanical systems to meet ISDH operating room requirements
- Understand how to apply new technology to existing equipment
- Discuss complexities and logistics of working in surgery environments

Problems With Meeting ISDH 60% Maximum Humidity Limit

- Surgery staff wants to lower temperature in ORs
- Protective clothing and hot lights

Capability of Older HVAC Equipment

- Outdoor air requirements
  - Problems controlling outdoor air – old dampers, worn seals, loose linkage, worn actuators
- Ventilation required over the years
  - 1970s – 20 AC/hr with 20% OA Ratio
  - 1980s-90s – 15 AC/hr with 20% OA Ratio
  - 2000s – 15 AC/hr with 20% OA Ratio
  - 2015 – 20 AC/hr with 20% OA Ratio

Capability of Older HVAC Equipment

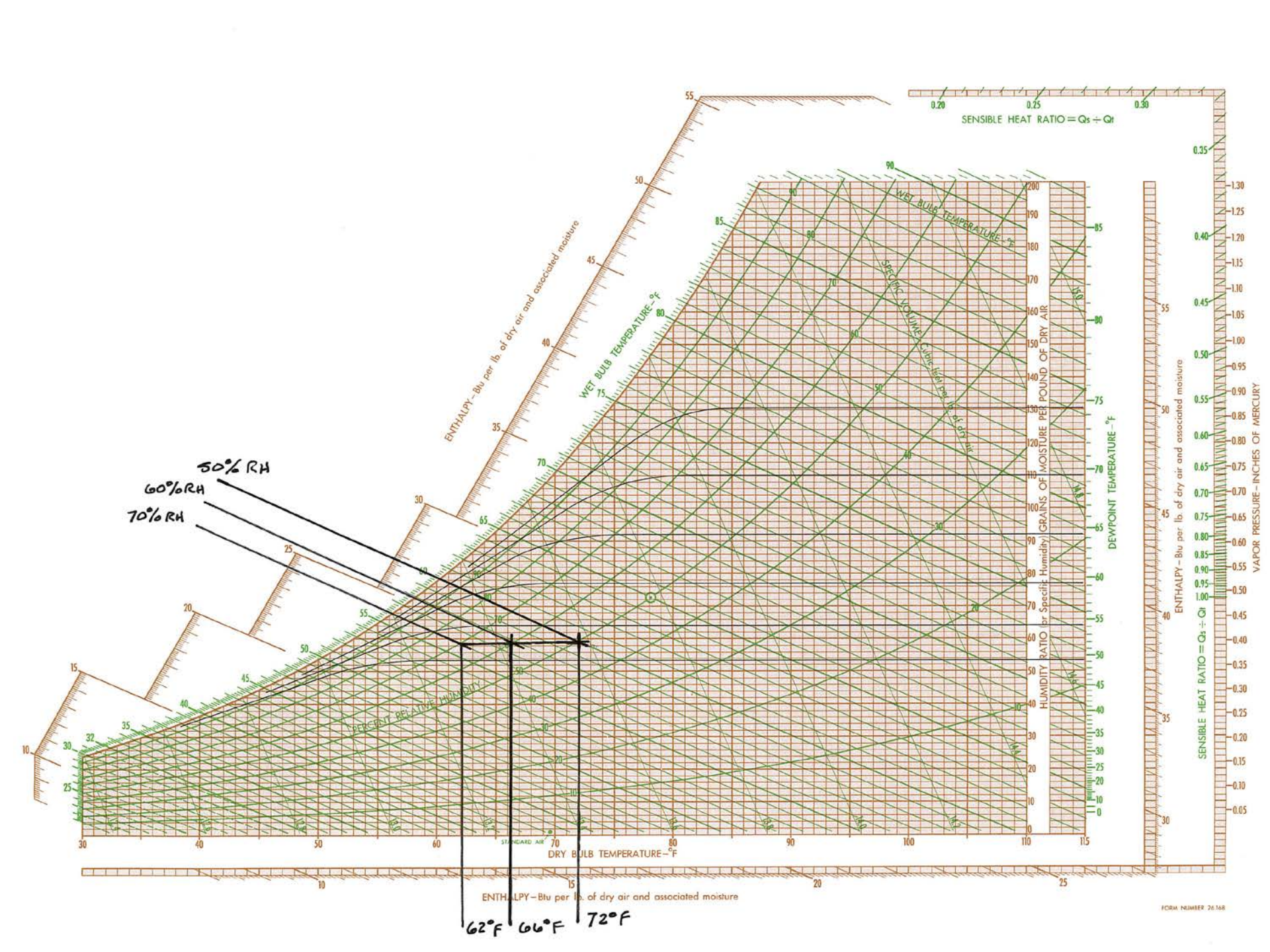
- Deterioration with age and operational hours
  - Most ORs run 24 hr/day, 365 days/yr = 8,760 hr/yr
  - Temperature swings of -20˚F to 100˚F
  - Extremely hard service
- Reduce capital exposure and downtime
  - Repair and upgrade only parts needed
  - Address ISDH requirements for ventilation and humidity

ISDH Requirements

- Current Guidelines – AIA 2001
  - Ventilation for ORs is 15 AC/hr
  - Outdoor air for ORs is 3 AC/hr = 20% OA Mix
  - RH Range = 30%-60%
  - Temperature = 68˚F-73˚F
- Future Guidelines – FGI 2014
  - Ventilation for ORs is 20 AC/hr
  - Outdoor air for ORs is 4 AC/hr = 20% OA Mix
  - RH Range = 20%-60%
  - Temperature = 68˚F-75˚F

Temperature and Humidity Relationship

- RH is inverse to room temperature
  - Not intuitive – one would think the lower the temperature, the lower the humidity
- The lower the room temperature, the higher the relative humidity
  - To have lower temperatures, you need lower dry bulb and wet bulb temperatures off the cooling coil


50% RH
60% RH
70% RH
62°F
66°F
72°F
SENSIBLE HEAT RATIO = Qs ÷ Qt
ENTHALPY – Btu per lb. of dry air and associated moisture
WET BULB TEMPERATURE – °F
SPECIFIC VOLUME Cubic feet per lb. of dry air
GRAINS OF MOISTURE PER POUND OF DRY AIR
DEWPOINT TEMPERATURE – °F
HUMIDITY RATIO or Specific Humidity
PERCENT RELATIVE HUMIDITY
STANDARD AIR
DRY BULB TEMPERATURE – °F
ENTHALPY – Btu per lb. of dry air and associated moisture
SENSIBLE HEAT RATIO = Qs ÷ Qt
VAPOR PRESSURE – INCHES OF MERCURY
FORM NUMBER 26168

How did we make it happen?

- We knew what we needed to achieve – what were the options to achieve the goal?
- Considerations
  - 15 existing operating rooms
  - Lost revenue ($75,000 per OR, or $1.1M each day)
  - Budget constraints – fixed budget
  - Schedule constraints – surgery schedule
  - Constructability & existing conditions
  - Logistics
  - Surgical staff and administration influence

Options Considered

- Complete replacement in the same location
- New mechanical room in a different location
- Split existing AHU and do ½ at a time
- Re-build

Evaluation of Existing Equipment

- Unit structurally sound and able to be rebuilt
- Rust and deterioration, Installed 1987
- Physical space for up-grades
  - Deeper coils for added ventilation and humidity control
  - Space for filters
  - Added reheat coil
  - Location for humidifiers and ISDH rules

Evaluation of Existing Equipment – The Good

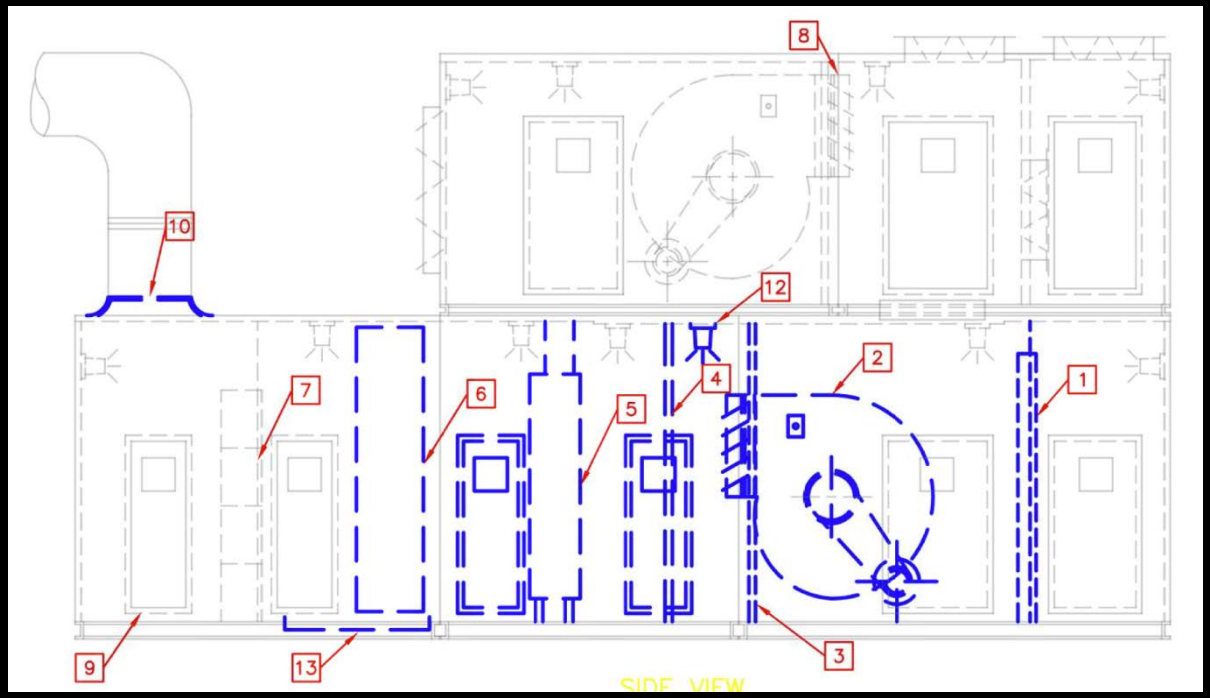
Evaluation of Existing Equipment – The Bad

Evaluation of Existing Equipment – The Ugly

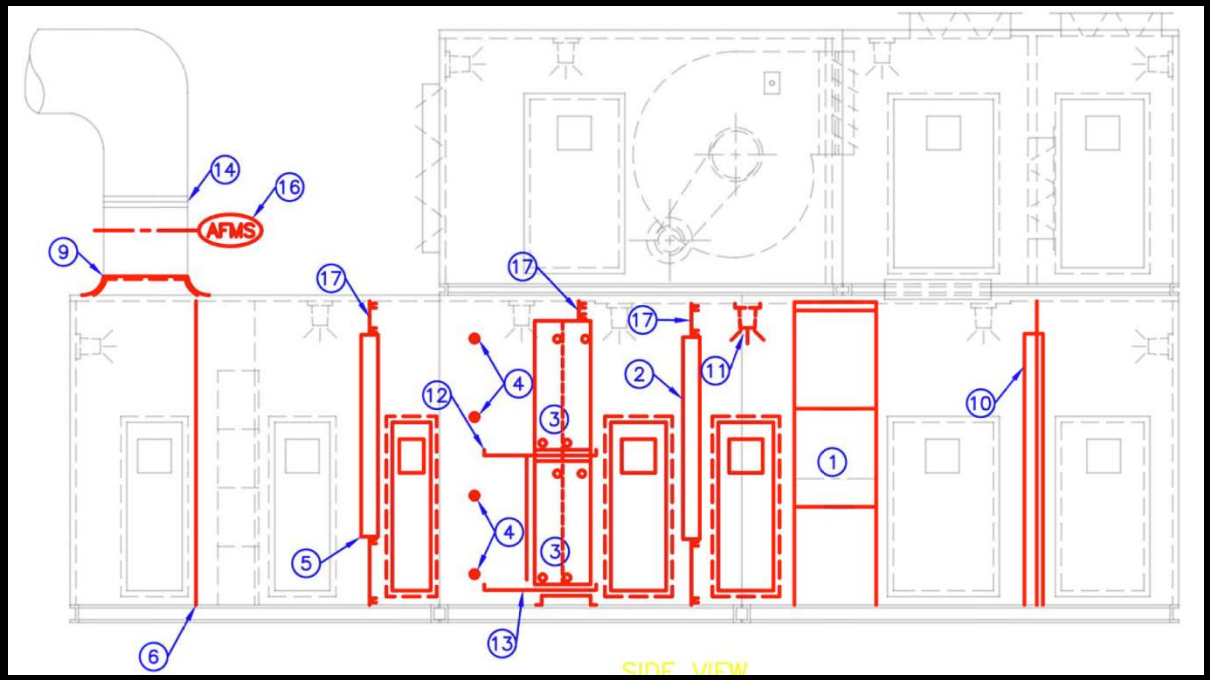
Changes and Improvements

- Low temperature supply air
- Dehumidification
- Humidification
- UV
- Multiple small fans
- Upgrade controls from pneumatic to DDC

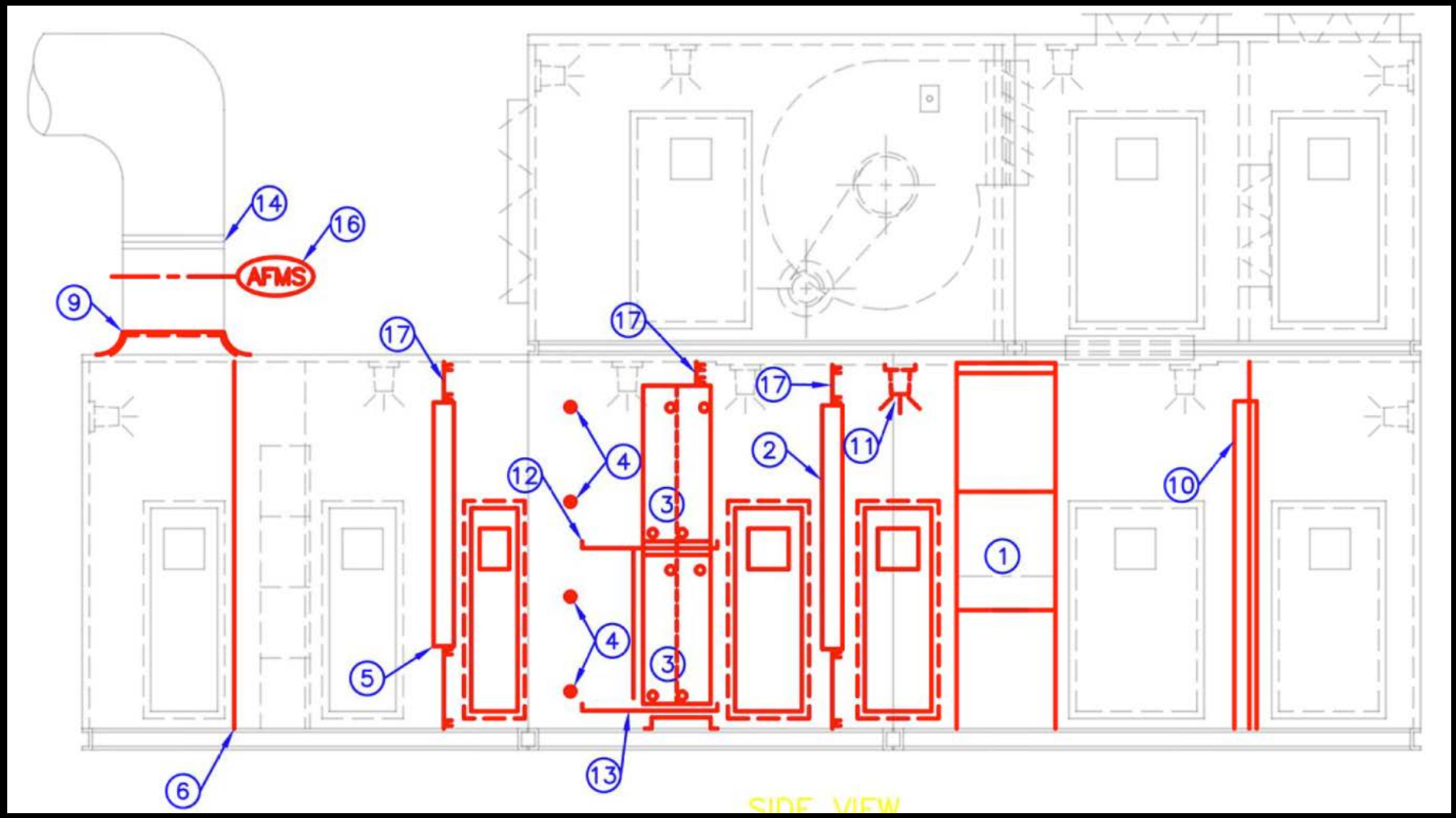
Demolition



New



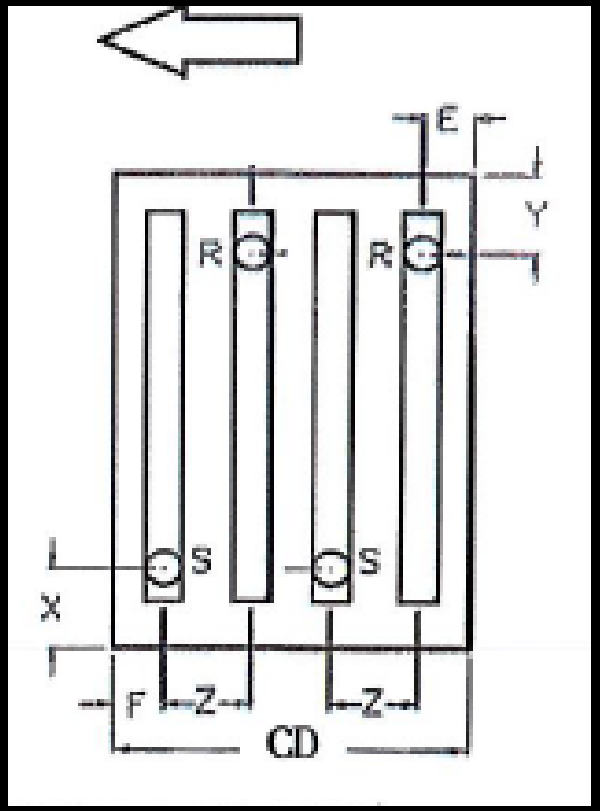
Efficient Space Utilization



Humidity Control

- Typical chilled water temp = 44˚F
  - Lowest room temp w/ 60% RH and 44˚F water = 68˚F
- “Super Cooling” water temp = 29˚F
  - Lowest room temp w/ 60% RH and 29˚F water = 62˚F
- Adding cooling coils for “Super Cool”
  - 12 row vertical split cooling coil
  - Effect on fan static pressure = 0.6” W.C. @ 400 FPM

Vertical Split Cooling Coil

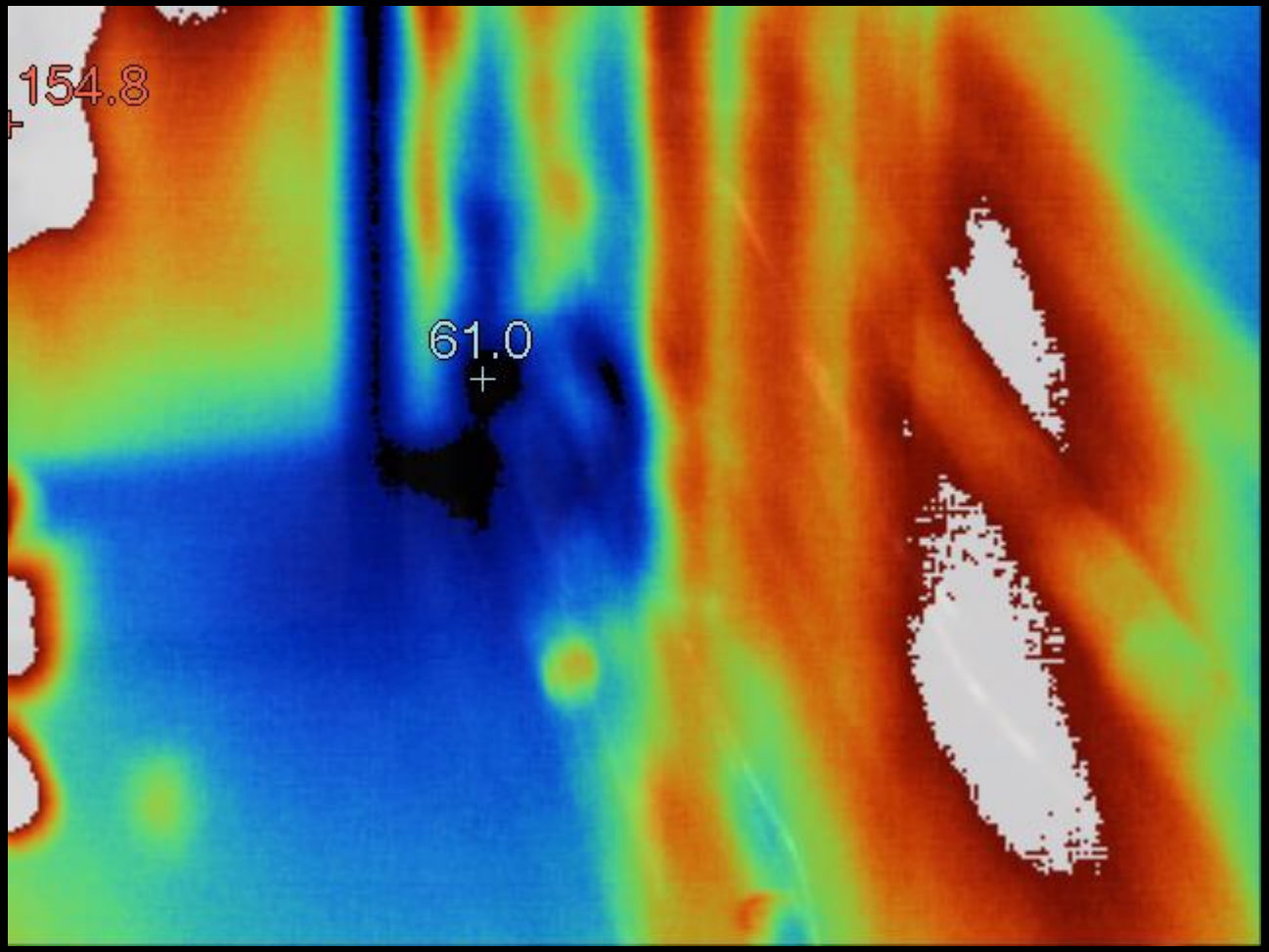


Evaluating the Fan

- Two large centrifugal fans vs. 18 small fans
- Reduced CFM 84,000 vs. 65,000
  - 200 HP to 125 HP
- Fan walls – efficiency and save space
- Redundancy
- Fan failure indication and service

Multiple Small Fans

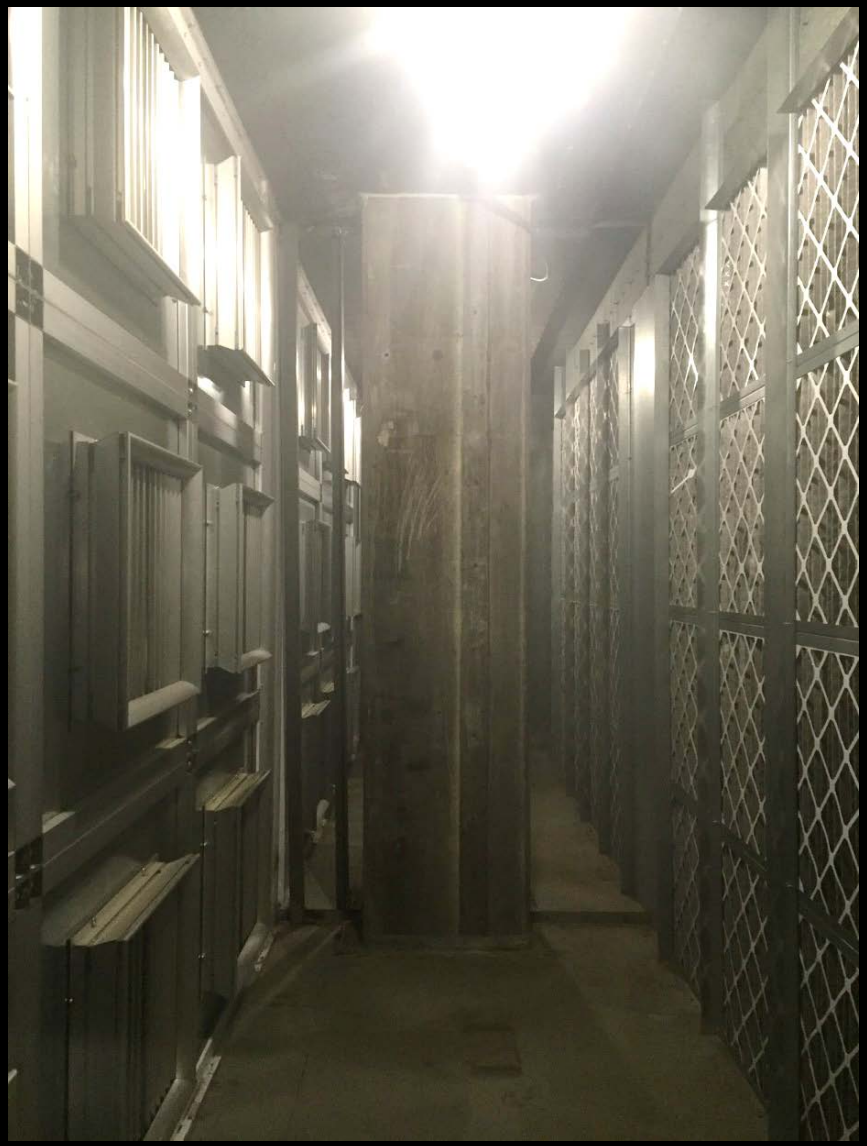
Multiple Fans – No Mixing



Refurbished Unit Exterior

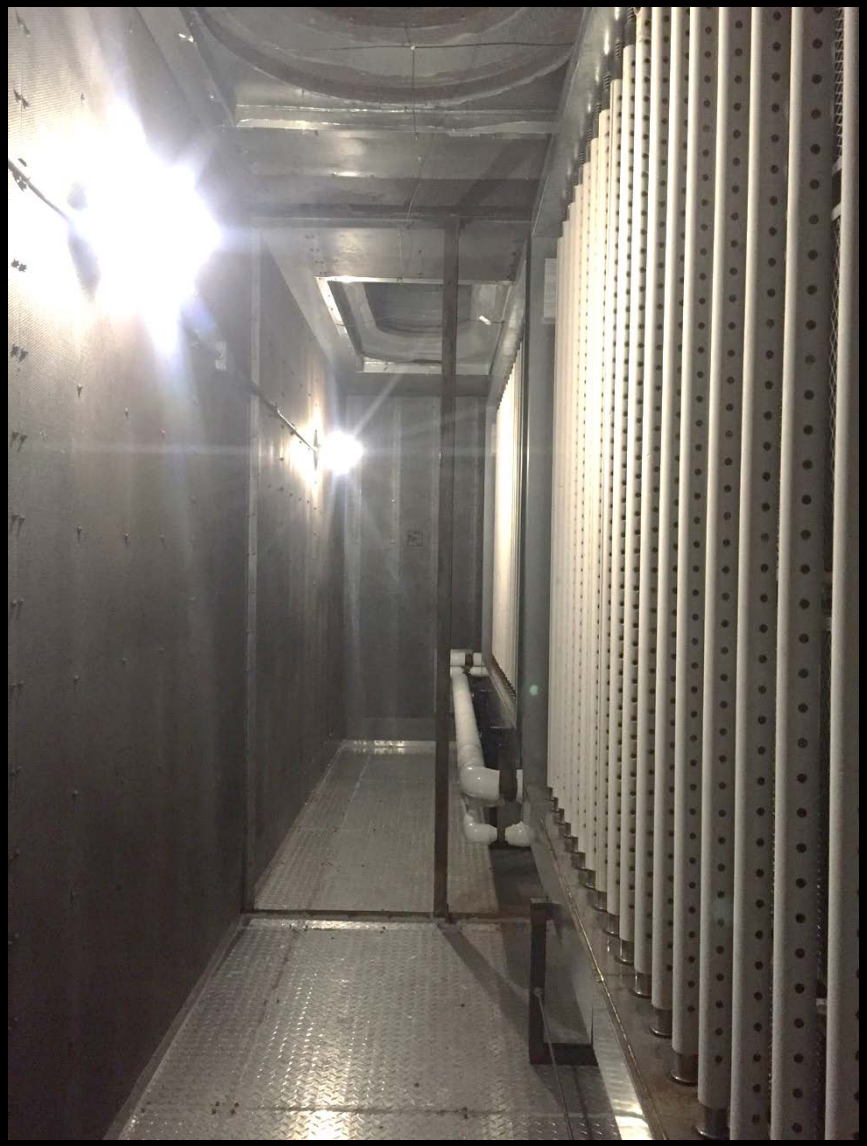
Piping to Coils

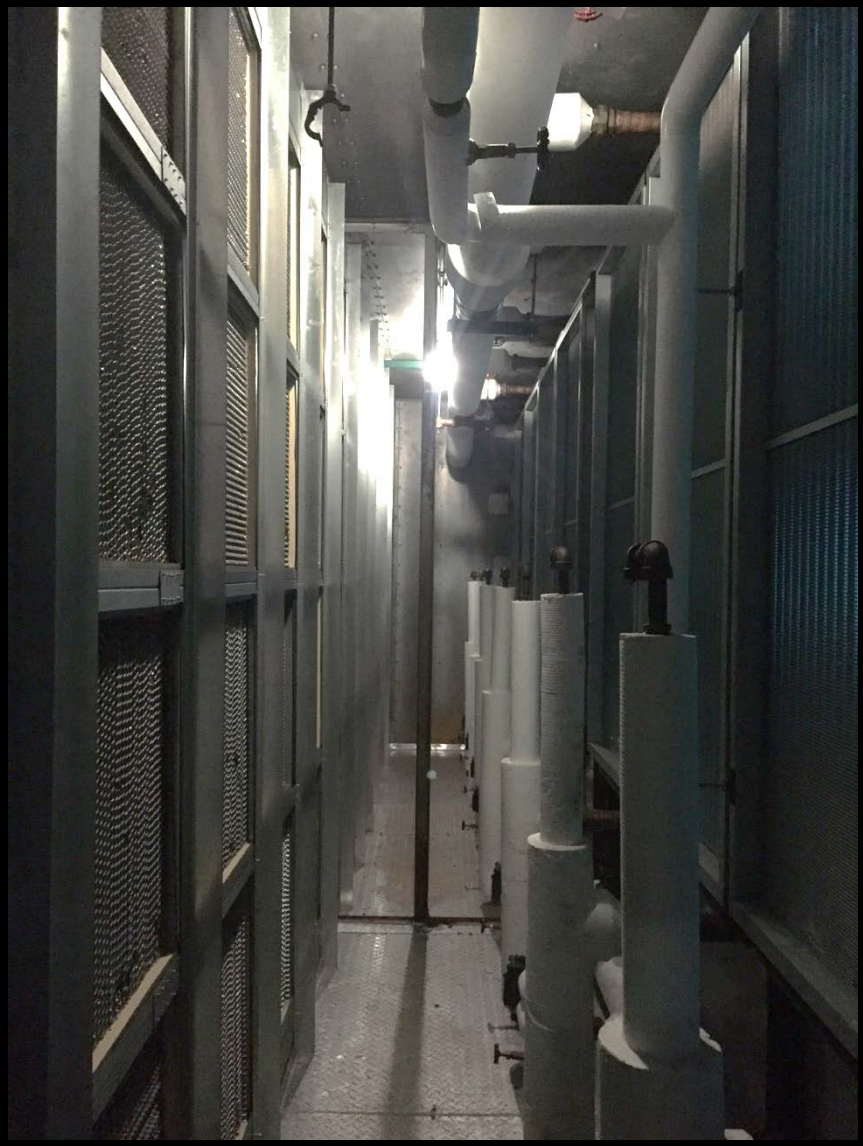
Refurbished Unit Interior



Refurbished Unit Interior

Refurbished Unit Interior

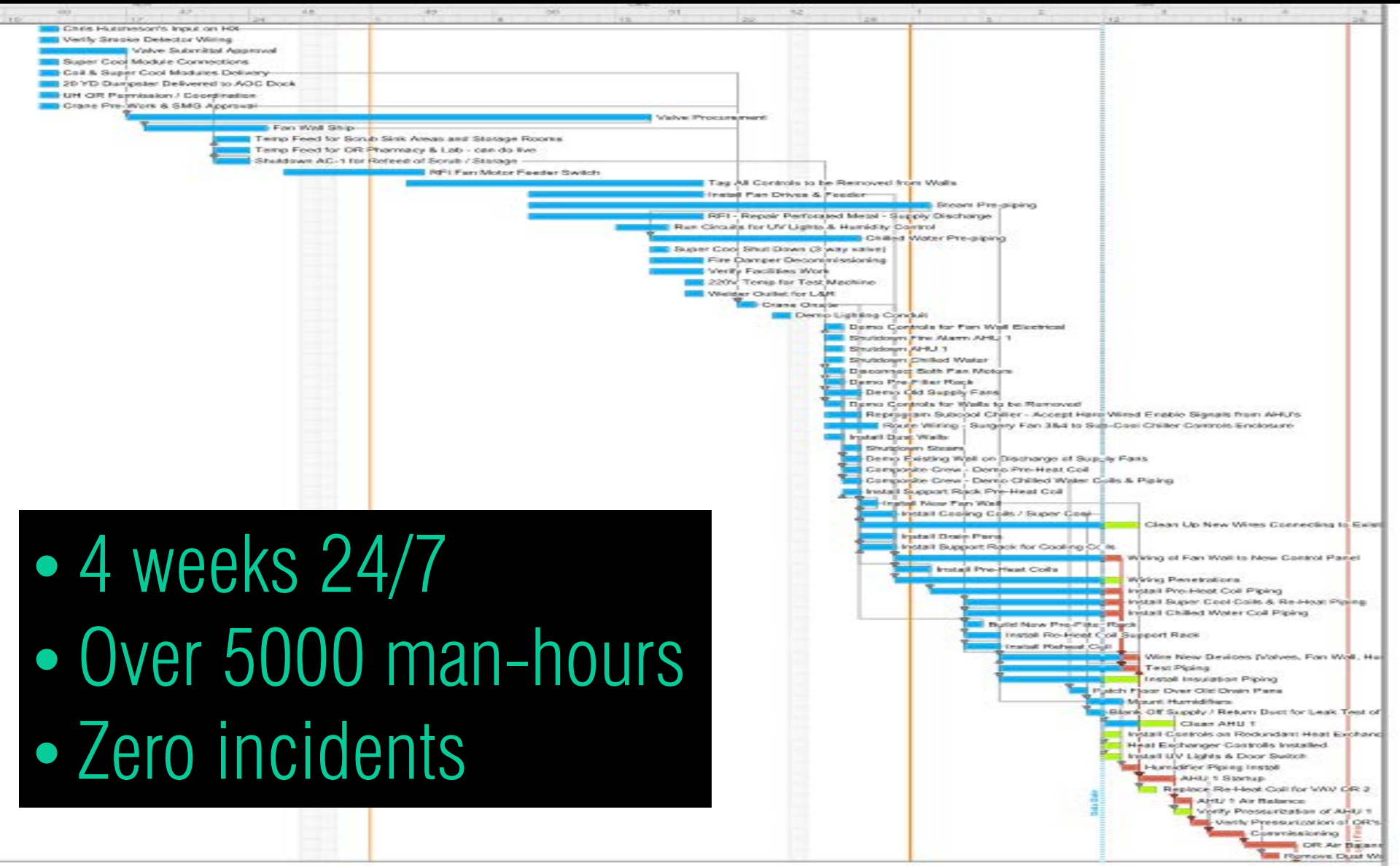




Planning/Execution

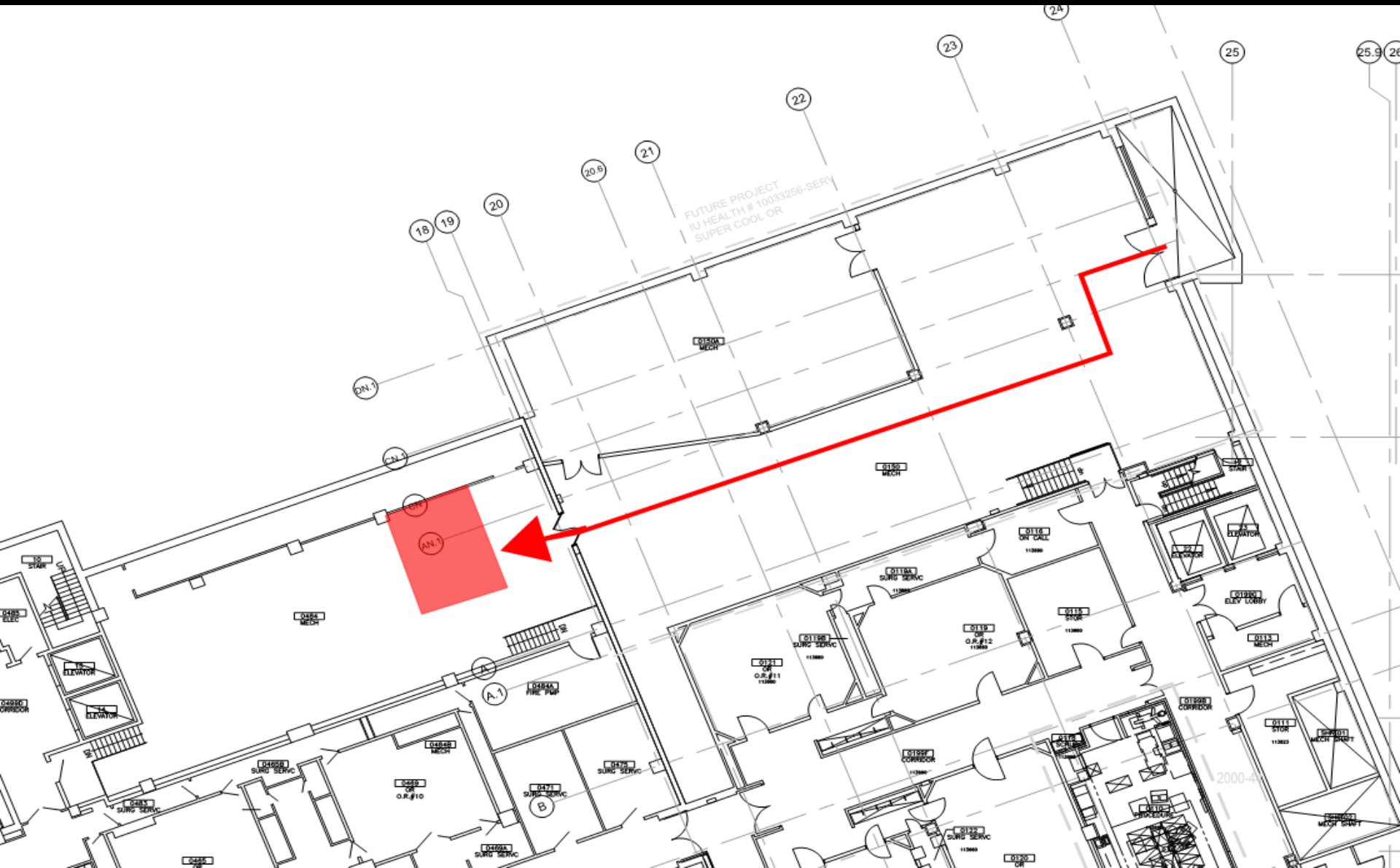
- Scheduling shutdown
  - Timing with surgery schedule
  - 24/7 construction schedule
- Infection control – clean supply storage
- Safety considerations – crane, welding, worker fatigue
- ILSM – temporary partitions
- Procurement of equipment – 10 to 16 weeks
- Delivery of equipment

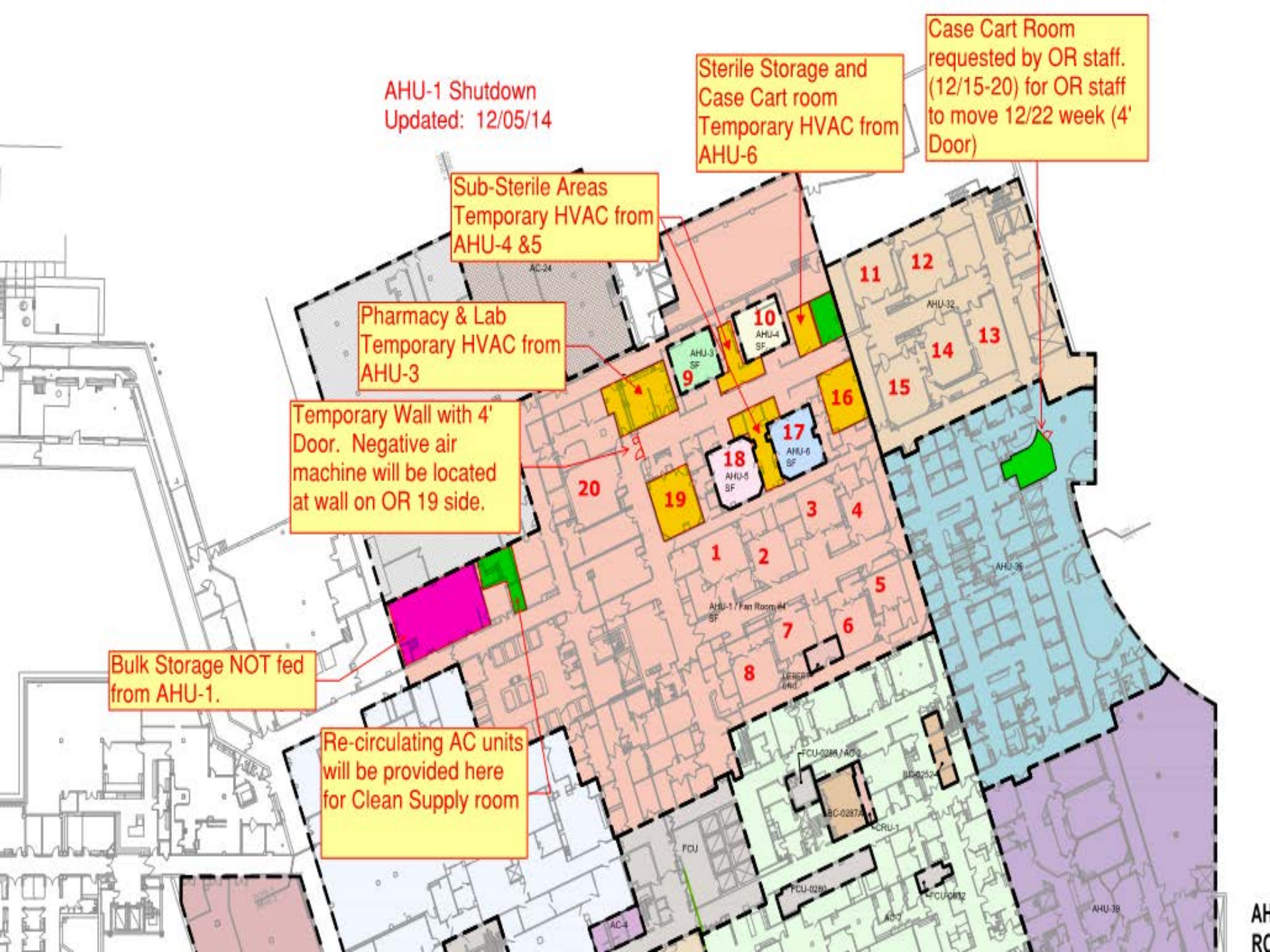
Condensed Schedule



- 4 weeks 24/7
- Over 5000 man-hours
- Zero incidents

Jobsite Access




AHU-1 Shutdown
Updated: 12/05/14
Sterile Storage and Case Cart room Temporary HVAC from AHU-6
Case Cart Room requested by OR staff. (12/15-20) for OR staff to move 12/22 week (4' Door)
Sub-Sterile Areas Temporary HVAC from AHU-4 &5
Pharmacy & Lab Temporary HVAC from AHU-3
Temporary Wall with 4' Door. Negative air machine will be located at wall on OR 19 side.
Bulk Storage NOT fed from AHU-1.
Re-circulating AC units will be provided here for Clean Supply room
AHU-32
AHU-35
AHU-38
AHU-1 / Fan Room #4 SF
AHU-3 SF
AHU-4 SF
AHU-5 SF
AHU-6 SF
FCU
CRU-1
AC-24
AC-4
AC-7
1
2
3
4
5
6
7
8
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19
20

Team Approach

- Coordination with Surgery Staff/Administration
  - Having reliable information to achieve buy-in
- Key players at the table **early** in the process
  - Engineer, CM, Facilities, Trade Contractors, Infection Control, Cx Agent
  - Input from selected vendors on products
  - Budget and schedule reliability
  - Engaging user groups affected by shutdown
  - Eliminate obstacles and surprises

Summary

- Meet ISDH requirements of maximum 60% RH
- Save money and time
  - Utility cost savings = $305,000 per Year
  - Project cost = $1.4 million
  - Project payback = 4.6 years
  - 15 yr. Life Time Savings = $3.175 Million
- Better working environment for doctors and surgery staff

Questions?

Thank you!

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