



Fundamentals of Chiller Plant Design

Mechanical Room Design and Safety



What you will Learn in this Lesson

- Outdoor equipment layout
- Indoor equipment layout
- Pre engineered solutions
- Refrigerant safety
- Mechanical room safety

Outdoor Equipment Layout

- Often roof mounted
- Can be slab on grade
- Stay far enough away from edge to avoid safety issues
- Observe chiller spacing issues regarding air recirculation
- Consider sound generated by chillers
 - Especially in residential neighborhoods
 - It is better to buy a chiller with low sound levels than try to abate sound with enclosures

Outdoor Equipment Layout

- Sight line enclosures may be required
 - Will help with sound
 - Does not have to be on all four sides
- Consider cold weather issues
- Consider seismic and hurricane requirements
- Consider service access
 - Control panel
 - Watch for chillers on raised structures
- Chillers on grade should be secured
 - Fence

Outdoor Equipment Placement

- Air recirculation is major issue for AC chillers and cooling towers
 - Watch enclosures
- NEC requires 3 feet in front of control panel
- Must have disconnect with line of sight of unit
- Consider major repairs
 - Compressor removal

Pre-Engineered Solutions

- Small AC chillers can include pump packages
 - Pumps, expansion tank, controls all provided with chiller
- Larger chillers can have pump packages in an enclosure
- Avoids mechanical room space

Mechanical Room Layout

- Indoor (water cooled) chillers require mechanical room
- Houses
 - Chillers
 - Pumps
 - Expansion tank
 - Controls
 - Remote sumps (if used)

Mechanical Room Layout

- Good mechanical room design includes:
 - Access for proper maintenance
 - Operation of facility
 - Efficient layout that maximizes use of space
 - Future growth needs
 - Proper adherence to safety codes
- Require line of sight disconnect
- Consider two mirror image chillers

Chiller Placement

- Most indoor chillers require access on all sides
- Control panel requires 3 feet in front
- Space for tube cleaning and replacement
 - Need length between tube sheets on one end or the other
- End cap removal
 - For two pass try to use end opposite connections
 - Standard cap with Vic connections
 - Marine Water Box
 - Expensive so just do MWB

Other Equipment Placement

- Pumps are often in mechanical room with chillers
- Piping is usually at ceiling height and dropped from headers to pumps
- Headers can be capped at end for future expansion
- Manual valves up high should have chain operators
- Expansion tanks
- Chemical treatment
- Water make up

Gas Fired Equipment

- Most refrigerants when burned create toxic fumes
- Most safety standards restrict gas fired equipment from chiller mechanical rooms
- Solutions include:
 - Separate boilers from chillers with a wall
 - Direct duct combustion inlet and exhaust air to boilers
 - Interlock refrigerant monitor with boiler controls
 - Shut down boiler if there is an alarm



Check Local Codes!

Planning For Growth

- Mechanical room should include space for future equipment
 - Pumps and chillers
 - Pipe headers sized for increased flow
 - Structural design for additional weight
- Access to space
- Good approach is to keep chillers in a line
 - Add one on to the line
- Electrical power distribution

Very Large Plants

- Typically have dedicated buildings
- Full time staff
- Industrial feel
- Medium to high voltage
- Pump room is separate from chillers
 - Maybe on a different floor
- Campus or district cooling applications

Pre-Engineered Chiller Plants

- Can include everything
 - Chillers
 - Towers
 - Pumps
 - Switch gear
- Can be engineered fabricated and delivered to site
- Factory quality control
- Very good for fast track projects
 - Server rooms
- Typically an owner sell

Refrigerant Safety

- Safety based on toxicity and flammability
- Most refrigerants are A1 but some new types are A2L
- Refrigerant properties impact mechanical room safety
- Typical flooded chiller has 3 lb/ton
 - 1000 ton chiller has a 3000 lbs refrigerant
- Fluorine based refrigerants are clear, odorless and heavier than air
 - Asphyxiation is a risk

ASHRAE Std 34 Refrigerant Safety Classification

	Lower Toxicity	Higher Toxicity
Higher Flammability	A3	B3
Lower Flammability	A2 A2L*	B2 B2L*
No Flame Propagation	A1	B1

* A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 10 cm/s (3.9 in/s)

Refrigerant Safety

- RCL is concentration of refrigerant in air intended to reduce risk of acute toxicity, asphyxiation and flammability
- Used to calculate amount of refrigerant allowed in occupied space
- Most refrigerants under pressure so there are safety concerns with pressure vessels
 - ASME

ASHRAE Std 34 Refrigerant Safety Classification

Refrigerant	ASHRAE Std 34 Safety Classification	Occupational Exposure Limit (OEL) ppm	Refrigeration Concentration Limit (RCL) Lb/1000 ft ³
R-11	A1	1000	0.39
R-12	A1	1000	5.6
R-22	A1	1000	13
R-32	A2	1000	4.8
R-123	B1	50	3.5
R-134a	A1	1000	13
R-290 (Propane)	A3	1000	0.56
R-245 fa	B1	300	12
R-600 (Butane)	A3	1000	-
R-717 (ammonia)	B2	25	0.014
R-744 (CO ₂)	A1	5000	4.5
R-1234 yf	A2L	400	4.7
R-404A	A1	1000	31
R-407C	A1	1000	17
R-410A	A1	1000	25
R-500	A1	1000	7.6

Mechanical Room Safety

- Mechanical rooms that house chillers require special safety considerations
- Standard 15 focuses on
 - Occupancy
 - Refrigeration system
 - Refrigerant safety

Building Occupancy

- Addresses how quickly occupants could exit building in an emergency
 - Institutional (health care)
 - Public assembly
 - Residential occupancy
 - Commercial occupancy
 - Large mercantile (multi-level shopping centers)
 - Industrial
 - Mixed occupancy
- Restrictions for institutional are higher than for industrial spaces
- To avoid impacting occupancy, refrigeration equipment must be 20ft from building opening
- Refrigeration machinery rooms have no occupancy classification (only equipment)

Refrigeration System

- Addresses likelihood that a system leak will enter occupied space
- Focuses on what fluid is adding or removing heat from space air
- Direct systems add/remove heat with refrigerant
 - Ex. DX cooling
 - Considered ***high probability systems***
- Indirect systems separate refrigerant from space with secondary fluid
 - Ex. Chilled water system
 - Considered ***low probability systems***

Refrigerant Safety

- Safety classification from Std 34 impacts safety requirements
- Ex. R-123 (B1) has more restrictions than R-134a (A1)

Refrigerant Quantities

- Based on three classifications, Standard 15 established the maximum volume of refrigerant that is allowed in the occupied space
- This is a direct, high probability system
 - Ex. Refrigerator in a kitchen
- Calculation takes into account volume of space
- Once this is exceeded, the refrigeration system must be located in a machinery room or outdoors

Mech. Room Requirements - Alarms

- Once need for mechanical rooms is established (basically any indoor chiller)
- Refrigerant monitor and alarm required
 - Audio and visual warning
 - In and outside of room
 - Sensors near equipment and close to floor
 - Set for OEL
 - Activate emergency ventilation

Mech. Room Requirements - Ventilation

- Mechanical rooms must have general ventilation
 - Around 0.5 cfm/ft²
 - Goes to emergency ventilation based on signal from refrigerant monitor
 - Volume based on Std 15
- Vent ducts should draw near to chillers and close to floor
 - Refrigerant is heavier than air

Mech. Room Requirements – Relief Piping

- Chillers have PRV or rupture disks (R-123)
- Will release at unsafe pressures
- Std 15 requires these be vent outdoors away from building openings
- Sizing pipe is outlined in Std 15

Mech. Room Requirements – Other

- Door signage
- No open flame
- Tight sealing doors that swing outward
- Some refrigerants (ammonia) require class T machinery rooms
 - Very strict safety Standards

End of Lesson

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