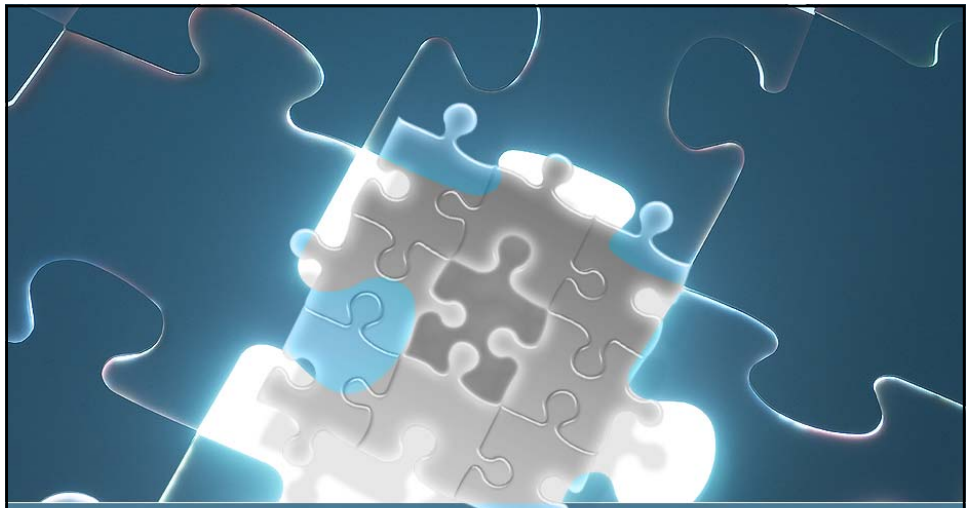

Machinery Room Design

Requirements & Best Practices

Todd Jekel, Assistant Director, IRC

Feb. 8, 2007

Standard Definition

- What is a machinery room?
  - ASHRAE 15-2004 §3 states:

    "a space, meeting the requirements of §8.11 and §8.12, that is designed to house compressors and pressure vessels"
  - §8.11 refers to §7.4, which refers to §7.2
  - §7.2.2.7 states:

    "All refrigerant-containing parts in systems exceeding 100 HP (74.6 kW) compressor drive power, **except** evaporators used for refrigeration or dehumidification, condensers used for heating, control and pressure-relief valves for either, and connecting piping, are located either in a machinery room or outdoors."

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Standard Definition *(cont.)*

- What is a machinery room?
  - IIAR 2-1999

    "a space that is designed to safely house compressors, pressure vessels, or associated refrigeration equipment"

    No further expansion of definition within the body of the standard

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Location & Siting

- Location
  - Ideal
    - Ground floor with multiple outside walls
    - Easy access for emergency response
  - Often found realities in older systems
    - No outside walls due to facility expansion
    - Basement or upper floor location (formerly allowed)

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Egress

- Egress & Doors
  - ASHRAE 15
    - §8.11.2
      - "tight-fitting door(s) opening outward, self-closing if they open into the building, adequate in number to ensure freedom for persons to escape in an emergency"
    - §8.12(b)
      - Same as §8.11.2 but says **fire** doors
    - §8.12(d)
      - "...shall have a door that opens directly to the outside air or through a vestibule equipped with self-closing, tight-fitting doors"
  - IIAR 2 §6.3.1.5 (same)

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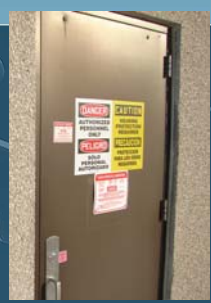
Standard Requirements



- Access
  - ASHRAE §8.11.8 & IIAR §6.1.1.1
    - "Access…shall be restricted to authorized personnel. Doors shall be clearly marked…to indicate this restriction."
- Penetrations
  - ASHRAE 15 §8.12(f) & IIAR §6.3.1.10
    - "All pipes piercing the interior walls, ceiling or floor…shall be tightly sealed to the walls, ceiling or floor through which they pass."

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Standard Req'ts (*cont.*)

- Building materials
  - ASHRAE §8.12(c)
    - "Walls, floor, and ceiling shall be tight and of non-combustible construction. Walls, floor, and ceiling separating the refrigeration machinery room from other occupied spaces shall be of at least one-hour fire-resistive construction."

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Ventilation

- ASHRAE 15 §8.11.3-5
  - "vented to the outdoors utilizing mechanical ventilation… "
  - "one or more power-driven fans... To obtain reduced airflow for normal ventilation, multiple or multispeed fans shall be used. Openings for inlet air shall be positioned to avoid recirculation. Air supply & exhaust ducts...shall serve no other area. The discharge of air shall be to the outdoors in such a manner as not to cause a nuisance or danger."

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Ventilation *(cont.)*

- Volume flow rates (§8.11.5)
  - Modes
    - Emergency, Q_E
      - 100 times the system charge
    - Temperature control , Q_T
      - <19°F room temperature rise above ambient
    - Continuous , Q_C
      - 0.5 cfm/ft^2 minimum

$$Q\,[\text{cfm}] = \max\left(Q_E, Q_T, Q_C\right)$$

$$Q_E = 100 \cdot \sqrt{G\,[\text{lb}]}$$

$$Q_T = \frac{H\,[\text{Btu/hr}]}{1.08 \cdot \left(19\,[^\circ\text{F}]\right)}$$

$$Q_C = 0.5 \cdot A_{MR}\,[\text{ft}^2]$$

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Ventilation Layout Considerations

- Exhaust near potential release sources
- Fresh air dampers near ignition sources (i.e. motors)
  - Low on side wall(s)
  - Fail-open type
- Access doors (roll-up)
  - Don't short circuit the ventilation!
- Ammonia detection near sources & near continuous exhaust location

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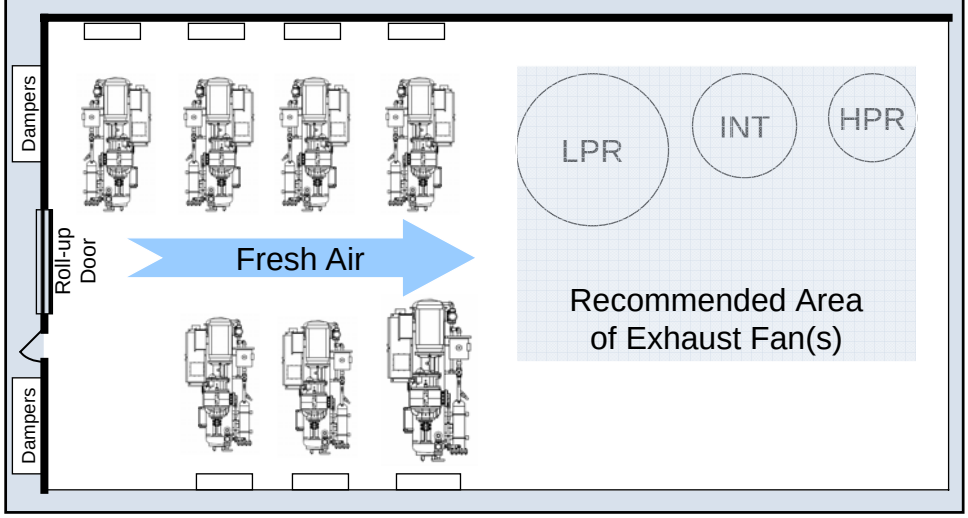
Ventilation Layout



Ventilation Equipment Considerations

- Consider system effects
  - Balance of system pressure drop & fan pressure rise
- Consider location of exhaust & prevailing weather
  - Recirculation
  - Impact makeup air units?
  - Offsite impacts?

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Equipment Specification

- IIAR Bulletin 111
  - Recommends upblast, high velocity exhaust fans
- Consider
  - Fans that dilute the exhaust with fresh air
    - Often used for laboratory fume hood exhausts
  - Wetted media exhaust systems (scrubbers)

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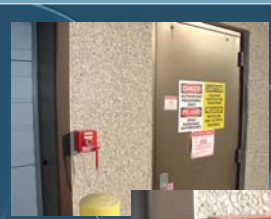
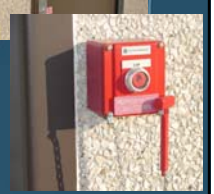
Emergency Controls

- Emergency Controls
  - ASHRAE §8.12(i)
    - "Remote control of the mechanical equipment in the refrigerating machinery room shall be provided immediately outside the machinery room door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical control and have a control switch located immediately outside the machinery room door."





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Ammonia Detection

- ASHRAE §8.11.2.1 exempts ammonia but requires continuous ventilation at the emergency amount (§8.12(h))
  - Despite this exemption, the use of ammonia detectors is common
- Consider using ammonia detectors for both personnel **&** property protection
  - Personnel
    - Low level: Audible & Visual Alarms & Ventilation Control
  - Property
    - High level: Machinery Room Shutdown

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Electrical Shutdown

- Removes power from all non-classified electrical equipment during high ammonia concentrations
  - motors, motor control centers, floats, switches, etc.
- Why? It reduces likelihood of deflagrations in the event of a “non-ventilatable” release
- Consider what equipment should be operational during an emergency situation & specify that equipment with the appropriate classification (NEC Class 1, Div. 2)
  - ventilation fans, emergency lighting, alarms, other equipment

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Safety Systems

- Eye-wash & Shower Station
  - Located outside exit door and another recommended inside machinery room (IIAR 2 §6.3.1.4)
  - Consider what you would need IF you need to use it!
    - Temperature appropriate for 15 minute de-con shower
    - Drench hose
    - Change of clothes

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Safety Systems *(cont.)*

- Passive containment for recirculators/vessels
  - diking
  - drain to temporary holding tank

- Tie ammonia detection and fire protection alarms into auto-paging system
- Machinery room secured 24/7 with key card access

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Conclusions

- Familiarize yourself with the minimum requirements
- Consider moving beyond minimums
  - Emergency shutdown
  - Spill containment
  - Pseudo-classified space

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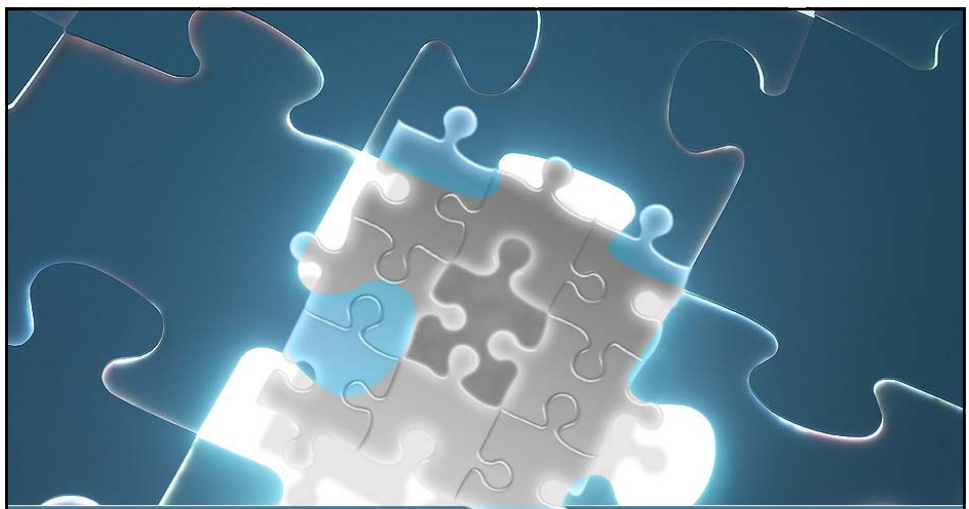

Questions?