Machine Room Ventilation - INTERNATIONAL CODE

June 18, 2015

INPUT

Project Name:	My Project Name
Program User:	My Name Here
Room Floor Area, Sq. Ft.	2,200
Room Height, Ft.	22
ASHRAE Summer 1% DB Temp, ˚F:	92
ASHRAE Winter 99% Design Temp, ˚F:	8
Heating Indoor Design Temp, ˚F:	50
Max Summer Indoor Design Temp, ˚F:	104
Building Code:	INTERNATIONAL CODE
Project Insurance Type:	FM Project
Machine Room Construction Type:	METAL ROOF, METAL WALLS
Refrigerant Type:	AMMONIA
Number of Emergency Exhaust Fans:	3
Total Room Motor Load, HP	2,500
Compressor Motor Efficiency:	95.0%
Refrigerant in Largest System, lbs.	12,000

95.0% Typical for Premium Efficiency Motors

ITEM	TOTAL GROSS AREA SQ FT	R VALUE INSULATION ONLY
ROOF	2,200	19
EXTERIOR WALL - NORTH	1,500	7
EXTERIOR WALL - EAST	1,350	7
EXTERIOR WALL - SOUTH	0	7
EXTERIOR WALL - WEST	1,350	7

OUTPUT

- Winter Envelope Heating Load: Q = U x A x ∆T

  Perimeter = 1500 / 22 + 1350 / 22 + 0 / 22 + 1350 / 22 = 190 Ft.

		BTU/hr
Roof:	0.05 x 2200 x (50 - 8) =	4,620
Walls:	0.12 x 4200 x (50 - 8) =	21,168
Floor:	0.55 x 190 =	105
TOTAL:		25,892

- Summer Envelope Cooling Load: Q = U x A x [CLTD + (78 - Tr) + (To - 85)]

  Tr (Room Temp) limited to 104 F to prevent power wiring de-rating per NEC Article 310

Tr = 104 F

		BTU/hr
Roof:	0.05 x 2200 x [70 + (78 - 104) + (92 - 85)] =	5,610
Wall - North:	0.12 x 1500 x [24 + (78 - 104) + (92 - 85)] =	900
Wall - East:	0.12 x 1350 x [29 + (78 - 104) + (92 - 85)] =	810
Wall - South:	0.12 x 0 x [37 + (78 - 104) + (92 - 85)] =	0
Wall - West:	0.12 x 1350 x [67 + (78 - 104) + (92 - 85)] =	810
Lights:	1.0 W/Sq. Ft. x 2200 Sq. Ft. x 3.413 BTUh/W =	7,509
TOTAL:		15,638

- Motor Heat from Machinery in Room:

Q = 2500 HP x (1 - 0.95) x 2545

= 318,125 BTU/hr

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- Summer Ventilation Rate, continued

Summer Ventilation Rate Required to Limit Room Temperature to 104 F

Summer Envelope Cooling Load:	15,638	BTU/hr
Machinery Room Motor Heat:	318,125	BTU/hr
TOTAL:	333,763	BTU/hr

$$CFM = \frac{Q}{1.1 \times \Delta T} = \frac{333{,}763}{1.1 \times (104 - 92)} = 25{,}285$$

per IIAR Std 2 ¶ 13.3.8.1:

$$Q = 20 \text{ Air Changes per Hour} = \frac{2200 \times 22 \times 20}{60} = 16{,}133 \text{ CFM}$$

Summer Ventilation Rate: 25,285 CFM

- Summer Ventilation Rate air changes per Hour

$$\text{Air Changes per Hour} = \frac{CFM \times 60}{\text{Area} \times \text{Height}} = \frac{25285 \times 60}{2200 \times 22} = 31$$

- Emergency Ventilation Rate
  per IMC ¶ 1105.6.4:

$Q = 100\sqrt{G}$ Where G = Lbs of refrigerant in largest single system

$= 100\sqrt{12{,}000} = 10{,}954$ CFM

per IIAR Std 2 ¶ 13.3.9.1:

$$Q = 30 \text{ Air Changes per Hour} = \frac{2200 \times 22 \times 30}{60} = 24{,}200 \text{ CFM}$$

per FM Std 7-13 ¶ 2.8:

$Q = 10$ CFM/Sq Ft = 10 x 2200 = 22,000 CFM

per IIAR Std 2, ¶ 13.3.2 (see note 1):

Min per fan based on 20 ACH rule:	16,133	CFM	÷ 2	emergency exhaust fans =	8,067	CFM
	8,067	CFM	x 3	emergency exhaust fans =	24,200	CFM

Emergency Ventilation Rate: 24,200 CFM

- Emergency Ventilation Rate air changes per Hour

$$\text{Air Changes per Hour} = \frac{CFM \times 60}{\text{Area} \times \text{Height}} = \frac{24200 \times 60}{2200 \times 22} = 30$$

- Minimum Continuous Ventilation Rate
  per IMC ¶ 1105.6.3.1:

$Q =$ 0.5 CFM/Sq. Ft. x 2200 Sq. Ft. = 1,100 CFM

per FM Std 7-13 ¶ 2.8:

$Q = 1$ CFM/Sq Ft = 1 x 2200 = 2,200 CFM

Continuous Ventilation Rate: 2,200 CFM

- Intake Wall Louver Area, Summer Ventilation Rate

$$\text{Intake Louver Free Area, Sq Ft} = \frac{Q}{V} = \frac{25{,}285}{700} = 36.1$$

Intake Wall Louver Area, Sq Ft = 36.1 x 2 (50% free area louver) = 72.2 Sq Ft

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- Intake Wall Louver Area, Emergency Ventilation Rate

  Intake Louver Free Area, Sq Ft = $\frac{Q}{V}$ = $\frac{24{,}200}{700}$ = 34.6

  Intake Wall Louver Area, Sq Ft = 34.6 x 2 (50% free area louver) = 69.1 Sq Ft

- Intake Wall Louver Area, Continuous Ventilation Rate

  Intake Louver Free Area, Sq Ft = $\frac{Q}{V}$ = $\frac{2{,}200}{700}$ = 3.1

  Intake Wall Louver Area, Sq Ft = 3.1 x 2 (50% free area louver) = 6.3 Sq Ft

- Winter Heating Requirements

		BTU/hr	
Winter Envelope Heating Load:		25,892	
Minimum Ventilation Heating:	Q = 1.1 x CFM x $\triangle$T		
	= 1.1 x 2200 x (50 - 8) =	101,640	
TOTAL:		127,532	BTU/hr
		37.4	KW

MACHINE ROOM VENTILATION RESULTS

CONTINUOUS EXHAUST RATE:	2,200 CFM
CONTINUOUS RATE WALL LOUVER SIZE:	6.3 SQ FT
WINTER HEAT:	37 KW
SUMMER EXHAUST RATE:	25,285 CFM
SUMMER RATE WALL LOUVER SIZE:	72.2 SQ FT
SUMMER AIR CHANGES PER HOUR:	31
EMERGENCY EXHAUST RATE (see note 1):	24,200 CFM
EMERGENCY RATE WALL LOUVER SIZE:	69.1 SQ FT
EMERGENCY AIR CHANGES PER HOUR:	30

- Consider using the larger of the summer and emergency ventilation rates as a combined summer/emergency ventilation rate.
- Per the mechanical code, unit heater cannot have coil temperature higher than 800 F. Use hazardous location explosion-proof heater such as Trane model UHXA.
- Per IIAR Std 2, ¶ 13.1.6.1, provide an emergency eyewash shower external to the machine room readily accessible via an exit.
- Per IIAR Std 2, ¶ 13.3.3.3, machine room intakes must be provided with corrosion-resistant insect screens.
- Per IIAR Std 2, ¶ 13.3.3.4, any motor-operated dampers used in the machine room ventilation scheme must be power-to-close, fail-open.
- Per IIAR Std 2, ¶ 13.3.7.1, all machine room exhaust fans shall discharge vertically with a minimum discharge velocity of 2,500 FPM.
- Per IIAR Std 2, ¶ 13.3.7.2, all machine room exhaust fans shall have non-sparking blades.
- Per IIAR Std 2, ¶ 13.3.7.3, all machine room exhaust fan motors located in the airstream or inside the building shall be TEFC (totally enclosed, fan cooled).

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- Note 1
  Per IIAR Std 2, ¶ 13.3.2, if more than one fan is used to achieve the emergency ventilation rate, the fans must be selected such that the failure of any single fan does not diminish the total ventilation rate to less than 20 air changes per hour.