WALK-THROUGH SURVEY REPORT:

CONTROL TECHNOLOGY FOR NEGATIVE PRESSURE ROOMS

AT

Community East Hospital
Indianapolis, Indiana

REPORT WRITTEN BY:
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PLANT SURVEY:	Community East Hospital 1500 North Ritter Avenue Indianapolis, Indiana 46219
SIC CODE:	8062
SURVEY DATE:	November 16, 1993
SURVEY CONDUCTED BY:	Charles S. Hayden II Ova Johnston
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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal organization engaged in occupational safety and health research. Located in the Department of Health and Human Services, it was established by the Occupational Safety and Health Act of 1970. This legislation mandated NIOSH to conduct a number of research and education programs separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards. The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study the engineering aspects of health-hazard prevention and control.

The risk of nosocomial transmission of tuberculosis to health-care workers and patients alike is well documented.[1-6] Among the many commonalities in the case studies cited were that many of the isolation rooms used for acid-fast bacilli (AFB) isolation were not at a negative pressure (NP) to the surrounding areas. The overall purpose of this study is to evaluate effective ways of maintaining NP in AFB isolation rooms, to quantify the parameters associated with NP isolation rooms, and to evaluate the effectiveness of those parameters.

Fluids, which by definition includes airflow along a path of least resistance; thus air will travel from a higher pressure to a lower pressure area. The lower pressure area is at a "negative pressure" relative to the higher pressure area. In negative pressure isolation room operation, the difference in the amount of air exhausted from the room and the amount of air supplied to the room sets up a difference in pressure (DP) between the isolation room and surrounding area. This DP should prevent the escape of potentially infectious droplet nuclei[7] (which might carry tubercle bacilli) from the isolation room. To achieve and maintain negative pressure in an isolation room, it is currently recommended that exhaust flow rate be 10 percent greater than supply flow rate, but no less than 50 cubic feet per minute (cfm). The actual level of DP achieved will be dependant on the flow area into the room (i.e., under-door opening, cracks, electrical and plumbing pass-throughs etc.). It should not, however, be less than 0.001" H_2O.[8]

A variety of factors aside from ventilation flow rates affect the DP. One factor is the airtightness of the isolation room. Variables which effect this factor are opening of room doors/windows, construction joints, cracks, and, to a lesser extent, the degradation of airtight seals over time. When the isolation room door is opened, the level of directional control provided by negative pressure is significantly diminished.[9] Workers (visitors, etc.) passing through the door, will further agitate the air currents at the doorway and create turbulence, causing an exchange of air between the isolation room and the area outside of the isolation room door. Variables outside of the isolation room can also effect the DP between the isolation room and surrounding areas. Changes in barometric pressure and wind loads on the building can effect the DP as the pressure in areas surrounding isolation rooms could vary in response to these external forces. Variable air volume

(VAV) systems serving areas surrounding isolation rooms can also have an unpredictable effect on isolation room DP as the system adjusts flow rates to those areas in response to temperature changes.[10]

In November of 1993, a survey was conducted at Community East Hospital to examine characteristics and parameters associated with isolation rooms and treatment rooms used to house and care for suspected or confirmed infectious tuberculosis (TB) patients. This survey is one part of a larger project, "Evaluation of Ventilation Parameters in Negative Pressure Rooms," whose objective is to evaluate the parameters necessary to effectively achieve and maintain NP in isolation rooms. The results of the survey will be compiled with results from other hospital negative pressure isolation room surveys. The compiled results will be used in the experimental design for the larger project. The results of this research will enable HVAC designers and technicians to construct, operate, and maintain effective negative pressure rooms with a definitive degree of reliability.

METHODS

Flow rate measurements were obtained using a TSI, Inc., AccuBalance™ Model 8370 flow measuring hood. Using this instrument, airflow from an exhaust grill or supply diffuser can be read directly in cfm. The number of air changes per hour (ACH) were then calculated from Equation 1.

$$ACH = Q * 60 / V \quad (1)$$

Where: ACH = Air Changes per hour
Q = Exhaust Flow Rate (cfm)
V = Volume of Room (ft^3)

The exhaust flow rate (ducted directly to the outside) was used in the ACH calculations since it was the predominate flow in the negative pressure room. Make up air to the room was provided through open areas under and around the doors and the ventilation supply. Pressure differentials between areas were measured using an Air Neotronics Model MP20SR digital micrometer. These pressure differentials were also visually verified using Sensidyne® smoke tubes.

DISCUSSION AND RESULTS

Data from the survey is shown in Table I. Three NP isolation rooms were examined. There were five other isolation rooms in the facility which were not evaluated. Four of those were under construction and the ventilation systems from those areas were not yet operating. One room (Room #3408) was inaccessible due to patient/medical equipment.

Room #2201 (built in 1980) was being readied for refurbishment and was unoccupied and unfurnished on the day of our visit. Room #2201 was surveyed however, to gain comparison data with newer construction. One hundred percent outside air (OA) was supplied to the isolation room via two induction units.

Table I. Ventilation data collected at Community East Hospital in Indianapolis, Indiana on November 16, 1993.

Negative Pressure Room/Treatment Area Survey					Air Changes Per Hour (ACH)	Differential Pressure (H_2O)
Room Number		Supply (cfm)	Exhaust (cfm)	Room Volume (ft^3)		
2201[d]	isolation	100	140	1644	5.1	
	bathroom	100	90	536	10.10	0,0[c]
2223	isolation	500	440	1760[a]	17.0	0
	bathroom		60			
3508	isolation	475	380	1008[a]	37.8	
	bathroom		255			
	anteroom	54	160	416	23.1	+0.004, -0.01[c]

[a] - Includes isolation room and bathroom volume.
[b] - Indicates isolation room to corridor pressure relationship (0 implies neutral pressure difference).
[c] - First number indicates anteroom to isolation room pressure relationship, the second number indicates anteroom to corridor pressure relationship.
[d] - Unoccupied and scheduled for refurbishment.

Air was exhausted from the isolation room through a 6" x 6" register mounted on a side wall of the room. The bottom of the exhaust register was located 8" above the finished floor. The anteroom was supplied 100 percent OA through a dual duct box mounted in the ceiling. Exhaust was provided from the anteroom, directly to outdoors, through a 8" x 8" exhaust register in the ceiling of the anteroom.

Construction of Room #2223 was recently completed and the room occupied. The isolation room can be used as either a positive or negative pressure room. Exhaust flow rate is controlled by a two-speed blower. A two position switch outside of the room can be positioned to provide either a high exhaust rate (negative pressure) or a low exhaust rate (positive pressure) from the isolation room and bathroom. The room was supplied a constant volume of OA, with partial return, through two diffusers in the ceiling of the room. While the measured DP was neutral, it was understood in conversations with the facilities engineer that the contractor who installed the ventilation system would be properly balancing the system in the very near future.

Room #3508 was constructed in 1972. The isolation room was supplied 100 percent OA through a HEPA filter and reheat box. Exhaust, directly to outdoors was provided by a 16" x 10" grill in the isolation room and a 10" x 8" grill in the bathroom. One hundred percent OA was supplied to the anteroom through a 24" x 1" slot located above the anteroom to corridor door. Exhaust from the anteroom was provided by a 8" x 8" grill located in the ceiling of the anteroom.

CONCLUSIONS

One of three rooms examined had a minimum of 0.001" H_2O negative pressure to surrounding areas. Two of the three rooms provided at least six ACH. The exhaust from all rooms went directly to the outdoors.

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