WALK-THROUGH SURVEY REPORT:

CONTROL TECHNOLOGY FOR NEGATIVE PRESSURE ROOMS

AT

Community North Hospital
Indianapolis, Indiana

REPORT WRITTEN BY:
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National Institute for Occupational Safety and Health
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PLANT SURVEY:	Community North 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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DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention (CDC).

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 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 act to prevent the escape of potentially infectious droplet nuclei[7] (which might carry tubercle bacilli) from the isolation room. To achieve and maintain a 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 North 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 whose objective is to evaluate the parameters necessary to effectively achieve and maintain NP in isolation rooms and also to evaluate anteroom parameters. 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

Data from the survey is shown in Table I. A detailed description of the facilities will not be attempted, as a review of engineering drawings was not accomplished. The survey team met with a technician who escorted us on the survey. The facilities engineer was on vacation the day of our visit.
Six isolation rooms were examined. In addition to the data provided it should be noted that rooms B216 and B320 each had two-position (negative and positive) switches which controlled the exhaust flow rate by positioning dampers in the exhaust duct. Markings on the switch cover plate should be examined for accuracy and clarity. Ensure the position markings (negative or positive) on the plate in Room #B320 are switched. On the day of our survey the switch position denoted by the negative marking created a positive pressure condition in the isolation room and vice versa for the positive position/marking (created negative pressure). NOTE: The switch labeling has been corrected since our visit.

Table I. Ventilation data collected at Community North 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^2)[a]		
D101	isolation	125	183	880	12.5	-0.015[b]
D221	isolation	95	135	752	10.8	-0.004[b]
D301	isolation	205	285	1302	13.1	-0.02[b]
B216	isolation	235	227	1036[a]	13.1	
	bathroom					
	anteroom	98	96	416	13.8	0, 0.004[c]
B320	isolation	285	255	1036[a]	16.9	-0.05[b]
	bathroom		36			
B325	isolation	270	240	1664[a]	12.3	-0.03[b]
	bathroom		100			

[a] - Includes isolation room and bathroom volume.
[b] - Indicates isolation room to corridor pressure relationship (neg. # implies air moves from the corridor into the isolation room).
[c] - First number indicates anteroom to isolation room pressure relationship, the second number indicates anteroom to corridor pressure relationship.

CONCLUSIONS

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

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