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A.G. HOLLEY STATE HOSPITAL
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I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH received a request from the State of Florida's Department of Hea Rehabilitative Services (HRS) to evaluate the ventilation system A.G. Holley State Tuberculosis (TB) Hospital in Lantana, Florida Officials from HRS were concerned about the nosocomial transmiss TB, especially since the number of persons with multidrug-resist strains of TB being admitted to the hospital for treatment is increasing. In addition to a ventilation assessment, the hospit use of ultraviolet germicidal radiation and particulate respirat employees was observed. A review of employees' health records a TB surveillance protocol used at the hospital was also completed

On May 19-21, 1992, investigators from NIOSH performed a Health Evaluation (HHE) at Holley Hospital that included industrial hyg and medical components. The industrial hygiene component focuse assessing the effectiveness of the ventilation systems in use at hospital. A visual inspection of the ventilation systems, as we review of the original specifications of the air-handling units, completed by the investigators. Additionally, measurements were of the air flow from supply and exhaust diffusers in patient roo along with temperature and relative humidity measurements. The direction of air flow between patient rooms and hallways, and be hospital wards, was also determined in several locations in the hospital complex. The medical component consisted of a qualitat review of current employee infection control practices. Inadequ in the employee TB skin test screening program precluded a quant analysis of the skin test conversion rate.

The investigation found that the ventilation systems at the hosp did not provide adequate fresh air to all of the patient rooms o second and third floors of the hospital, even when they are clas as "patient rooms" rather than "isolation rooms" according to re evaluation criteria. The airflow direction was from clean areas infected areas, or from drug-sensitive TB wards to drug-resistiv wards. There were no patient rooms that could be classified as isolation areas on the basis of ventilation evaluation criteria. the patient admission room on the first floor of the hospital wa negative pressure relative to the hallway as evidenced by the st flow of air from the hallway into the admission room and out of building through the exhaust ducts.

Some deficiencies were noted in the ventilation systems which co potentially contribute to the transmission of TB bacilli from infectious patients to other patients and hospital staff. Recommendations to modify the ventilation systems so that isolat evaluation criteria are met are offered in Section VIII of the r along with recommendations to strengthen the hospital's employee testing and infection control programs.

KEYWORDS: SIC 8069 [Specialty Hospitals, Except Psychiatric], Tuberculosis (TB), state hospital, ventilation, infection control.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH received a request for a health hazard evaluation (HHE) from the of Florida's Department of Health and Rehabilitative Services (H April 6, 1992. The HRS Tuberculosis (TB) Control Program was co about the ventilation system at the A.G. Holley State Tuberculos Hospital in Lantana, Florida and its ability to adequately contr nosocomial transmission of TB. A recent decision by the Florida Legislature to keep A.G. Holley State Hospital open for multidru resistant TB (MDR-TB) patients and other hard to manage TB patie triggered the concern by Florida health officials. NIOSH invest conducted an industrial hygiene and medical evaluation at the ho on May 19-21, 1992. Preliminary findings were presented to the of the hospital during a closing conference on May 21, 1992.

III. BACKGROUND

The A.G Holley Hospital is part of a 155 acre complex located in Lantana, Florida. Included in the complex are the original hosp nursing quarters, staff cottages, an HRS laboratory, the physica structures, along with a collage of additions, trailers, tempora structures, and a new Palm Beach County Public Health Unit clini tenants of the complex include several HRS social service progra Department of Corrections, and the Palm Beach County Public Heal Department.

The Southeast Florida Tuberculosis Hospital, now known as A.G. H State Hospital, originally opened as a 500 bed hospital for the treatment of TB patients in 1950. By the early 1970s, because o newer, more effective drugs used in the treatment of TB, the res census of the hospital dropped to less than 250 patients for TB therapy. The Department of Corrections began to use a portion o hospital building for prison work release programs, treatment of addicts, and for prisoners in the corrections system who require hospitalization. By 1976, A.G. Holley was the only remaining TB hospital in Florida, with a maximum population of 150 patients, initiated plans to close the hospital.

Other hospitals in southern Florida were reluctant to accept TB patients for treatment. Thus, A.G. Holley was forced to remain An increase in Cuban and Haitian immigrants infected with TB dur 1977 to 1981 also contributed to the need for the facility to re open. Additional attempts to close the hospital were unsuccessf later years because there were few community-based alternatives management of TB patients. In 1991, a state TB Task Force deter that there was a need for a comprehensive program of medical and psychosocial care for persons with TB, and that the need was lik increase throughout the 1990s, because of an increasing number o

people with acquired immunodeficiency syndrome (AIDS) and human immunodeficiency virus (HIV) infections, substance abuse, and MD The Florida legislature concurred with the TB Task Force and det that A.G. Holley State Hospital should remain open, but with the of beds reduced to 50 in Fiscal Year 1992-93 for patients requir long-term care.

Tuberculosis care activities are located on the first three floo the basement of the east and central wings of the original hospi building. The west wing of the hospital building currently hous female prisoners from the Department of Corrections. Patients receiving treatment for MDR-TB are roomed on the east end of the floor, separated from patients infected with drug-sensitive TB o same floor by double doors in the hallway. Patients who have be TB drug therapy for the longest time are housed in rooms on the floor, along with any patients who are placed under locked custo the hospital by the courts. During periods of low patient censu patients may be housed on the third floor. The first floor of t hospital is comprised of the patient admissions office, patient services offices, kitchen, cafeteria, chapel, and conference roo basement houses the hospital support staff and an activities are the patients. The TB hospital is staffed by approximately 200 p with two-thirds of the staff dedicated to the direct care of TB patients. The remaining staff is dedicated to administration se housekeeping, engineering, and physical plant activities.

There are two different air handling systems that supply ventila the TB hospital. The original building design had no mechanical ventilation system; air was delivered to the hospital through op windows. The first mechanical heating, ventilation, and air conditioning (HVAC) unit was installed at the hospital in 1968. HVAC system still supplies ventilation to portions of the third of the hospital, including the MDR-TB ward. A second HVAC syste installed in 1981, supplies air through individual room fan-coil to the rest of the hospital. This system passes exhaust air and incoming outdoor air through a rotary air-to-air heat exchanger, located on the roof, to transfer sensible and latent heat, usual the incoming air to the exhaust air, in order to conserve energy conditioning for the hospital is accomplished using a chilled wa system, and heating is done using steam from the boiler plant.

The employee health unit is located on the first floor of the ho next to the patient admitting office, and across the hall from t patient social services office. The health unit includes an exa area and a record-keeping area. Radiographic equipment is locat the third floor; patient and employee x-rays are taken with the equipment.

All employee health records are maintained in individual file fo in the employee health unit. When the employee health nurse bec aware that an employee has terminated employment, his or her hea record is moved to a separate file drawer. Additionally, some information is summarized by date in spiral-bound notebooks. No these records are computerized.

The health unit is supposedly staffed on the day shift by a lice practical nurse. In actuality, the nurse is reassigned to the p floors on an as-needed basis and may only be in the employee hea unit one day each week. The current employee health nurse has h this position for two years. For those shifts that the health u not staffed, the nursing supervisor on duty has oversight responsibility for employee health.

All A.G. Holley employees receive new employee physical examinat and initial care for work-related injuries and illnesses through health unit. The employee tuberculosis surveillance program inc periodic purified protein derivative (PPD) skin tests and chest Details of the program are discussed below in section IV.D.

Laboratory services for A.G. Holley Hospital are contracted thro State Health Office Branch Laboratory which is located in a sepa building on the A.G. Holley grounds. Laboratory workers, even t they are not directly employed by A. G. Holley, are covered unde A. G. Holley employee tuberculosis surveillance program but do n routinely receive any other care through the A.G. Holley health

IV. EVALUATION CRITERIA

In the hospital setting, primary importance should be placed on identification, treatment, and isolation of infectious TB patien correct application of principles of ventilation (both local and general). The use of germicidal ultraviolet radiation and perso protective equipment (respirators) should be viewed as ancillary control measures.[1]

The risk of TB transmission in any setting is proportional to th number of viable TB bacilli in the air. All suggested control m may reduce a worker's exposure to TB to some extent; however, th no currently-available methods to quantify the degree of reducti may be achieved by each control measure.

Principal efforts should be directed towards preventing infectio However, in those individuals who become infected, efforts shoul directed towards preventing disease. Methods and procedures whi reduce the chance of worker infection with *M. tuberculosis* are considered *primary prevention* strategies. Interventions which s progression of infection to disease are considered *secondary pre*

strategies. Local and general ventilation, as well as germicida ultraviolet radiation and personal protective equipment, are *pri prevention* strategies. Employee skin testing programs using pur protein derivative (PPD) identify infected workers. An employee testing program, together with the follow-up of infected individ is a *secondary prevention* strategy. An employee skin testing pr which is well designed and adhered to can lead to a reduction of disease among workers.

A. Ventilation

Although ventilation is frequently relied upon to control TB health-care setting, ventilation systems sometimes can be com and difficult to evaluate. Satisfactory performance of venti systems requires oversight by engineers or industrial hygieni Incorrect design applications or inadequate maintenance can, fact, increase the risk of TB transmission.[2,3] Consensus guidelines for ventilation and ancillary measures (e.g., germ UV radiation, respirators) of worker protection have been formulated and are based on what are believed to be the most effective combination of feasible control strategies.[4,5]

There are two types of ventilation used for control of airbor transmission of TB; general dilution ventilation and local e ventilation. General dilution ventilation provides an exchan contaminated indoor air with uncontaminated air, thereby dilu the airborne concentration of the infectious agent and reduci potential exposures for workers and other susceptible persons (i.e., patients and visitors). Each of these types of ventil is explained more fully below.

1. General Dilution Ventilation

General dilution ventilation performs two functions. The is to provide sufficient outside air to maintain comfort. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends for hospitals a range of 15 to 30 cubic feet per minute (cfm) per person o outdoor air.[6] The second function of general dilution ventilation is to provide sufficient exchange of potential contaminated air with clean air to minimize the risk of infection. ASHRAE and the American Institute of Architect (AIA) suggest airflow ranging from 4 to 25 air changes per (ACH), depending on the functional area of the hospital.[5,6] These guidelines are provided in terms of pressure relationships to adjacent areas, minimum outdoor air and t air changes, exhaust location, and recirculation restricti

In addition to supplying the specified airflow, ventilatic systems should also provide satisfactory airflow patterns from area to area and within each room. Air flow should from "clean" to "less clean" areas, such as from hallways treatment rooms. This can be accomplished by creating neg (lower) pressure in the area into which flow is desired relative to adjacent areas. Negative pressure is attained exhausting more air from the area than is being supplied. large areas this will require careful balancing of the ventilation system.

Within a room or small area, a ventilation system should b designed to: 1) circulate air to all areas of the room (prevent stagnation of the air), 2) prevent short circuiti the supply to the exhaust (i.e., passage of air directly f the supply site to the exhaust point without mixing of roo air), and 3) direct the clean air past the worker without recirculation within the room. These conditions are not a achievable but should be attempted to the fullest extent feasible. One way to accomplish this is to supply low vel air at one end of a room and exhaust it from the opposite Another method is to supply low velocity air near the ceil and exhaust it near the floor. However, air flow patterns also affected by air temperature, the precise location of supply vents and exhaust vents, diffuser design, the locat of furniture, movement of workers, and the physical configuration of the space. Each room or space must be evaluated individually.

Ideally, ventilation systems used in areas where *Mycobacte tuberculosis* may be present should supply non-contaminated (a portion should be outside air), discharge exhaust air t outside, and should not recirculate air back into the faci In no case should a room or area without mechanical exhaus ventilation be used for patients with *M. tuberculosis*.

Recommended ventilation rates in hospitals are frequently expressed in terms of air changes per hour (ACH). An ACH defined by the theoretical number of times that the air vo of a given space will be replaced in a one-hour period. Assuming perfect mixing, a rate of six ACH would require 46 minutes to remove 99.0% of contaminants from a room.[1] Hence, the air is not actually "changed" six times per hou The amount of air required to maintain six ACH in a smalle room will be less than a larger room.

For purposes of general ventilation, all supplied air does have to be outside air. For example, AIA recommends that operating rooms be ventilated with a minimum of three ACH

outside air with a minimum total of fifteen ACH. The rema twelve air changes only need be "clean" air (often referre as "transfer air"), not necessarily outside air. It is al advisable, however, to use the most stringent and protecti alternative possible.

The AIA ventilation recommendations are presented in Table Hospital isolation rooms should provide six ACH with all a exhausted directly to the outside. Exhaust locations shou not be near areas that may be populated (e.g., sidewalks c windows that may be opened). Exhaust points should also b away from air intakes, so that exhaust air is not recircul into the facility. The rooms should be under negative pre with respect to adjacent areas.[5,7] For isolation rooms, AS has similar recommendations, with the addition of a recommendation that two of the six ACH should be outside a ASHRAE also recommends a minimum of 25 cubic feet per minute/person (cfm/person) of outside air for patient room Finally, ASHRAE recommends a summertime temperature and relative humidity (RH) guideline for patient rooms of 75°F 50% relative humidity (RH).[6]

2. Local Exhaust Ventilation

Local exhaust ventilation captures the infectious agent ir immediate field of an infectious patient (i.e., scavenging booths or tents) without exposing other persons in the are therefore, it is the preferred type of control strategy be the TB organisms are removed before they can disperse throughout the work area. Local exhaust ventilation is us most effectively in a fixed location. The hood portion of local exhaust system may be of exterior design, where the infection source is near but outside the hood, or enclosir where the infectious source is within the hood. Enclosure (booths) are available for aerosol-generating activities, as sputum collection and aerosol therapy. These devices m exhausted directly to the outside, or they can exhaust thr a HEPA filter back into the room.

B. Germicidal Ultraviolet (UV) Radiation

The value of germicidal UV light in the prevention of TB transmission is still being debated.[8,9,10] The efficacy of UV radiation in clinical settings has not been demonstrated unde controlled conditions, but there is a theoretical and experie basis for believing that it is effective.[11,12,13] The Centers f Disease Control and Prevention (CDC) has continued to recomme germicidal UV lamps (with appropriate safeguards to prevent

overexposure to health-care-facility personnel) as a suppleme
ventilation in settings where the risk of TB transmission is

One concern in the use of UV radiation is the occupational ex
to workers who must work near the UV radiation. Short-term
overexposure can cause keratoconjunctivitis and erythema of t
skin.[14] Long-term exposure to UV radiation is associated with
increased risk of basal cell carcinoma of the skin and with
cataracts.[15] However, with proper installation and maintenanc
the UV lamps, the risk of overexposure is low.

C. Personal Respiratory Protection

In 1990, the CDC produced Guidelines for Preventing the
Transmission of Tuberculosis in Health-Care Settings, with Sp
Focus on HIV-Related Issues.[1] In this document, CDC recommen
that disposable particulate respirators be used by workers ex
to TB patients in certain situations. The use of respiratory
protection is required to help minimize the risk of exposure
droplet nuclei for health-care-facility workers performing ce
high-risk procedures or entering specific areas in hospitals,
correctional facilities, and other environments where there a
persons with infectious TB or potential TB transmitters. New
guidelines on respirator use for workers in health-care facil
potentially exposed to TB have recently been issued by NIOSH.
the guidelines, varying levels of risk for worker exposure to
are delineated from high risk procedures and locations to
indeterminant potential for exposure situations. The guideli
specify that positive-pressure, air-line, halfmask respirator
used in high potential locations. In medium and possible exp
conditions, a powered, high-efficiency particulate air (HEPA)
filter, halfmask respirator is suggested. In areas where no
possibility of exposure to TB occurs, or in areas where effec
infectious-source controls are in use, no respirator is neede
according to the guidelines.

D. Employee Medical Monitoring

One purpose of a purified protein derivative (PPD) skin testi
program is to identify individuals who have recently become
infected with *M. tuberculosis*. It may be appropriate to trea
newly infected individuals prophylactically with medication t
reduce their likelihood of progressing to frank tubercular di
Because there are side effects of, and medical contraindicati
to, chemoprophylaxis (anti-TB drug treatment), the appropriat
of treatment must be assessed on an individual clinical basis

Without chemoprophylaxis approximately 5%-10% of persons deve
active disease within 2 years of the primary infection. The

estimated relative risk of developing active disease is incre for persons with AIDS (170.0), HIV infection (113.0) or other immunocompromising conditions, such as diabetes mellitus type renal failure (3.6-16.0) when compared to individuals with no factors.[18]

Persons with isoniazid (INH) susceptible *M. tuberculosis* infe treated chemoprophylactically with INH experienced a 30%-93% reduction in the rate of active disease; an 87% reduction was in persons coinfected with HIV. Persons exposed to multidrug resistant *M. tuberculosis* may be offered alternative regimens chemoprophylaxis, dependent on the HIV status of the individu and the drug resistance profile of the organism.[17]

The PPD skin testing programs in the occupational setting hav dual purpose. As above, they identify recently infected pers who may then receive chemoprophylaxis. Additionally, work-ba testing programs serve as a surveillance function, identifyin trends of infection among the workers. Identification of tre can lead to action preventing infection in other workers. Th capability of a program to serve as a surveillance system lar depends on the adherence to an appropriate protocol, as well conscientious maintenance of records.

V. METHODS

On May 19, 1992, NIOSH investigators were taken to the roof of A Holley Hospital in order to visually inspect two of the HVAC sys the original ventilation system and the newer heat-wheel system. Individual fan coil units were observed in patient rooms during walk-through tour. The mechanical diagrams of the ventilation s for the hospital were reviewed with the hospital's maintenance superintendent. A detailed evaluation of the ventilation parame individual rooms in the hospital was undertaken on the next two the survey.

The environmental evaluation included airflow measurements made Shortridge Instruments, Inc. FlowHood® Model CFM 88. Using this instrument, airflow through a supply diffuser or exhaust grille measured directly in cubic feet per meter (cfm). The measured a were compared to the design specifications on the mechanical pla to the AIA and ASHRAE guidelines. Smoke tests were conducted t evaluate (by visual observation) the relative pressures of the r with respect to the corridor, and in the corridors between diffe areas of the hospital, such as between the MDR-TB area and the d sensitive TB patient area. For each of the patient rooms, the direction of smoke movement was observed both near the bottom an top of the door, with the door opened. Smoke tests in the hallw between two different areas of the hospital (e.g., Department of

Correction's prison area versus TB hospital) were conducted with door(s) closed. Temperature and RH measurements were made with Vaisala HM34 Humidity and Temperature meter.

The medical portion of the evaluation consisted of a review of e health records to ascertain the quality of information recorded pertaining to the employee tuberculosis surveillance program. R of employees fitting three categories were reviewed: all employe a reported work-related PPD conversion since 1984 (21 total), al employees with a reported needlestick or related injury (13 tota six randomly selected records. Additional sources of informatio included spiral-bound notebooks summarizing information of each employee's initial hire physical examinations and skin test resu protocol written by the hospital's acting superintendent, dated June 27, 1985, which delineates the procedures of the employee tuberculosis surveillance program, was also provided to NIOSH investigators for review.

VI. RESULTS AND DISCUSSION

A. Industrial Hygiene

1. Ventilation

The environmental evaluation found three different ventila configurations in use in the TB Hospital. On the second f rooms on the south side of the East Wing typically have or two fan coil units on the outside wall which bring outside into the room through an outside grille and duct system attached directly to the unit. The fan coil unit mixes th outside air with recirculated room air. Cooling is provic the chilled water piping. Air is exhausted from the room through 6" x 6" exhaust port that connect to an outside ch along the building. The air in the chase is drawn eastwar along the outside of the building to the end where ductwor leads it up to the roof of the building. An exhaust fan c roof pulls the air through the chase ductwork. There are generally four patient beds in each of the rooms on the so side of the building. When patients occupy the rooms, the to the hallway are consistently kept open. This ventilati arrangement was in place in patient rooms 229, 230, 232, a 243 as well as in the nurses' station in room 237.

Rooms on the north side of the east wing are ventilated by ducted supply and exhaust system that uses the newer heat exchange wheel located on the roof of the hospital. Suppl is brought in through a vent on the roof, passed by the he exchange wheel, and delivered to the second floor by the a handling unit on the south side of the wing. Ducted suppl

enters the rooms through supply grilles near the ceiling i
room. Air is also supplied to the hallway. Room air is
exhausted through the north wall of the room, through a gr
and duct to an exhaust fan on the outside of the building.
Additional air is exhausted out of the hallway, through th
second floor air handling unit and up to the heat exchange
wheel on the roof. Patient rooms 240 and 242 along with t
restroom in room 231 had this ventilation configuration.
additional fan that exhausted air directly outside was fou
a storage room that housed an ice machine next to the rest
(room 231).

Rooms whose airflow was measured on the south side of the
second floor, East Wing had total supply air delivery thro
the fan coil units, ranging from 210 cfm to 530 cfm. Only
portion of this total supply air comes from the outside; t
remainder is recirculated room air drawn through the botto
the fan coil unit. NIOSH investigators were able to measu
the outside air delivered to the fan coil units in three r
on the second floor through the use of the hospital's cher
picker truck. Other rooms on the second floor that had ou
air vents to the fan coil units were inaccessible to the t
because of landscaping or building structures that were in
way. The flowhood was placed over the vent on the outside
the building and the air moving through the vent was measu
The two patient rooms had fresh air supplied at a rate of
115 cfm. The nurses station (Room 237), however, had a fr
air supply of 40-50 cfm. The reduced airflow may be indic
of a damper in the fan coil unit that is partially closed.
of the fan coil units in Room 243 was found to be inoperab
during the survey.

Much of the MDR-TB ward located on the third floor of the
Wing is ventilated by the older HVAC system. Supply air i
ducted from the roof air handling unit to the individual r
on the south side of the wing through ductwork located alo
the hallway wall. The air is delivered to the room throug
mixing box near the ceiling which contains a cooling coil
connected to the chilled-water system. Some air is exhaus
from the rooms through holes drilled into the sheet metal
behind the steam heaters along the outside wall. The air
pulled into the exhaust chase on the outside of the buildi
and then to the roof with the same exhaust fan that serves
second floor, south side rooms. Exhaust fans have also be
placed in the Solarium at the end of the MDR-TB ward which
air down the hallway and from the building through the roo
exhaust or directly from the north side of the building at
third floor level. Five additional patient rooms on the s
side of the East Wing in the drug-sensitive ward on the th

floor have this ventilation arrangement. The remaining ro
near the Center Section have fan coil units on the south s
and ducted systems on the north side similar to the HVAC
systems described for the second floor.

Ventilation parameters in a total of 24 patient rooms, nur
stations, a doctor's office, and restrooms were evaluated
during the survey period. These results are presented in
Tables 2-4. Not all of the ventilation parameters were
measured in all of the rooms either because they were not
applicable, or because they could not be easily measured w
the ventilation equipment available to the NIOSH investiga

Mechanical drawings provided by A.G. Holley Hospital's
mechanical superintendent indicated that the average four-
patient room on the south side of the second floor, East W
was 20.5 ft. x 17.5 ft. x 9.0 ft, resulting in a room volu
3,228 cubic feet. A two-patient room was measured at 10.0
x 17.5 ft. x 9.0 ft. or 1,575 cubic feet. The results of
ventilation measurements for second floor and third floor
patient rooms in the hospital are presented in Table 2 and
respectively. Measurements of the ventilation parameters
non-patient rooms are shown in Table 4.

The median outside supply of fresh air measured in the two
patient rooms was 100 cfm. A supply airflow of 100 cfm is
equivalent to 6,000 cubic feet of air per hour. These fig
yield 3.8 ACH for a two-patient room and 3.7 ACH for a fou
patient (two fan coil units) room, all of which is outside
In the Nurses' Station, the median fresh air of 45 cfm
delivered through the fan coil unit results in 1.7 ACH for
room. These calculated air exchanges meet the evaluation
criteria for patient rooms, but are less than the recommer
10 ACH for isolation rooms (Table 1).

The two-patient rooms (Room 240 and 242) evaluated on the
side of the second floor have the ducted supply and exhaus
system which uses the newer roof heat exchanger and air
handling unit on the second floor. Air supply flowrate wa
210 cfm in each room. The exhaust airflow was nearly equa
the supply. The volume of these two rooms was 990 cubic f
(10 ft. x 11 ft. x 9 ft.). The fresh air supplied to thes
rooms is equivalent to 12.7 ACH. These rooms meet the
evaluation criteria for air exchange rates recommended for
isolation rooms.

The older HVAC system supplies air to rooms on the third f
East Wing. The three rooms on the south side of the MDR-T
ward had supply air flowrates ranging from 154 cfm to 132

The range in air exchange rates for these three rooms was calculated to be from 5.9 ACH (Room 308) to 2.4 ACH (Room values that are less than those recommended for isolation rooms, but sufficient for patient rooms. The supply air t hallway from this same HVAC system was measured at 482 cfm Other rooms on the third floor served by the older HVAC sy had air exchange rates ranging from 1.7 ACH in Room 318, a four-patient room, to 8.8 ACH in Room 311, a room housing patients. Thus, Room 318 does not meet the requirements f patient room, while Room 311 is sufficient for patients nc needing isolation.

Rooms on the third floor nearer to the Center Section of t hospital are ventilated with individual fan coil units and newer HVAC system. The fan coil units were all set to the fan setting and the access panels to the fan controls were locked or the fan speed knobs removed. The rate of total airflow delivered to these patient rooms ranged from 205 c 260 cfm. Of the two rooms accessible with the hospital's cherry-picker, the outside airflow into the rooms was negligible, indicating that the dampers on the fan coil ur were closed. Inspection of the damper in one of the ident rooms by the maintenance superintendent revealed that the damper was indeed in the closed position. The ACHs for th rooms cannot be calculated because of the uncertainty of t amount of fresh air being delivered to the fan coil unit. However, the results calculated for rooms on the second fl should be indicative of the numbers that could be obtained patient rooms on the third floor.

During the ventilation measurements, the damper on the mix box in Room 311 was initially found to be closed, shutting the delivery to air to the room. The maintenance superintendent opened the damper to its full open positior before the 230 cfm reading was obtained. In Room 318, pat complained of the room being too cold. The 90 cfm measure may be the result of the damper being partially closed to alleviate the cold temperature perceptions of the patients Finally, patients in Room 331 had placed towels and clothi over the supply grille of the fan coil unit to block the f of air, most likely to alter the temperature of the room. the rooms that temperature and relative humidities were measured during the survey, the median temperature was fou be 72°F and the median relative humidity was 65%. These m values are cooler than recommended guidelines for hospital well as too humid.[6]

The results of the smoke tube tests revealed that none of patient rooms were under negative pressure (airflow into t

room). In all cases, the smoke plume would hover near the opening with little or no direction to the movement of the smoke. When smoke was released near the double doors in t hallway separating the MDR-TB ward from the rest of the fl it move rapidly from the drug-sensitive TB ward toward the TB ward, down the hallway toward the solarium at the end o hall. The air from the MDR-TB ward is then exhausted out the building through the two exhaust grilles in the solari The admissions office on the first floor of the hospital w under negative pressure as witnessed by the strong movemer smoke from the hallway into the room. An additional exhaus had been placed on the outside wall of the room, near the ceiling, to boost the negative pressure characteristics.

Smoke released at doors that separate the Department of Corrections from the TB hospital never showed movement tow the prison area. This same pattern was seen for other ter in the east end of the hospital; smoke would always move t the hospital and never into the non-hospital spaces.

2. Germicidal UV Radiation

The use of germicidal UV lamps was noted in four different rooms of the hospital. The UV lamps are present in the admissions office on the first floor of the hospital, two pulmonary laboratories on the third floor, and a physician office also located on the third floor. The UV lamps, manufactured by Westinghouse, are 30 watt bulbs placed in mounted fixtures that do not allow for direct viewing of t bulb by people working in the room. In all but one instan the fixtures are located above the room's door, with the l directed towards the ceiling. There is one fixture in Roo 341, a pulmonary laboratory, that is located under a cabin along the east wall at about chest level. It is standard operating procedure at the hospital to turn the UV lamps o only while the room is unoccupied. A sign is supposed to placed on the outside of the door whenever the UV lamps ar The lamps are controlled with a switch on the wall next to door, with the exception of the pulmonary laboratory lamp the wall under the cabinet. This lamp is turned on or off using a wall plug.

3. Personal Respiratory Protection

The hospital's policy on employees' respiratory protection recently been changed to include the required use of dispo dust and mist particulate respirators whenever one enters MDR-TB ward. General compliance with this regulation was observed during the survey period. The use of the disposa

particulate respirators was sporadic in other areas of the hospital. There were instances observed by the NIOSH investigators where the respirators were worn incorrectly. example, instances were noted where only one of the two st was worn or the respirator was worn upside down.

B. Employee Medical Monitoring

The TB hospital's written surveillance protocol will be used
outline for the medical record review evaluation, which follo
Sentences taken from the protocol will appear in bold letteri

1. **All new employees shall have a chest x-ray examination tak
within the last three months.**

   Initial review of records shows compliance.

2. **All new employees will have a PPD skin test unless they ha
documented significantly positive test.**

   Initial review of records revealed an absence of independe
documentation for new employees who stated they had a prev
positive PPD skin test. This documentation is important t
verify the time that the PPD skin test conversion took pla
prior to employment at A.G. Holley Hospital and that it, i
fact, did occur.

3. **If the reaction is less than 10 mm, a second test will be
performed within at least one week, but not more than thre
weeks.** (Initial employee hire skin tests are referred to
PPD #1 and PPD #2 in the A.G. Holley Hospital charting sys
and all reactions less than 10 mm are recorded only as
"negative.".)

   The review of records revealed poor compliance with this
procedural step. A lack of standardization regarding the
timing of the first two employee PPD skin tests, and
differences in interpreting results, has led to several
discrepancies:

   - Most of the charts reviewed with a negative PPD #1 did
record the placement of PPD #2 within 3 weeks of hire.

   - It could not be ascertained why some, but not all,
employees had received PPD #2 skin tests. Employees wi
intermediate (5-9 mm) reactions on the PPD #1 may have
preferentially targeted for follow-up initial PPD tests

   - The written protocol does not state how to interpret th
result if an employee is negative on PPD #1 but positiv
PPD #2.

     One employee with a negative PPD at the time of hir
had a positive follow-up PPD 12 days later. This wa
reported as a work-related PPD conversion. The

employee health nurse informed me that other employ
with the same test results were designated "positiv
the time of hire."

Another employee with a negative PPD #1 , and no PP
#2, at the time of hire had a positive PPD 6 months
later; this was also reported as a work-related PPD
conversion.

4. **All significant reactors will receive a chest x-ray examir if not previously performed.**

   Initial review of records shows compliance.

5. **All new employees, who provide direct patient care, having reaction of less than 10 mm, will have a repeat skin test six-month intervals, and, annually for employees with mini exposure.**

   Initial review of records shows inconsistent compliance wi this procedural step. The following observations are base an examination of the spiral bound skin test record book c May 19-21, 1992. This book records, by department, the na of employees eligible for the skin testing program, and th results of the skin test.

   The nursing staff is scheduled for January and June testir Fourteen of 24 nurses had not yet been skin tested in 1992

   - *Nursing 7-3:30 shift*: No skin tests were performed in January, 1992. Five of 8 nurses were tested in March, 1992. The other 3 nurses had not yet been teste 1992.
   - *Nursing 3-11:30 shift*: Five of 9 nurses were tested ir January, 1992. The other 4 nurses had not yet been tes in 1992.
   - *Nursing 11-7:30 shift*: None of the 7 nurses had yet be tested in 1992.

   The engineering staff is reportedly on a yearly May testir schedule. Fifteen of 19 engineers were tested in June or July 1990; one refused testing. Seventeen of 19 engineers tested in February or March 1992. No tests are recorded f 1991, creating a 19 month time gap between testing times.

6. **A history of Bacillus Calmette-Guerin (BCG) does not precl an initial screening test and a reaction of 10 mm or more should be managed as a tuberculous infection.**

   Compliance with this step could not be assessed from the records reviewed.

7. **Routine repeated chest x-rays are not recommended.**

   No routine repeat chest x-rays were noted later than 1985.

8. **Employees who have completed an adequate course of treatme preventive treatment will be exempt from further screening unless symptomatic.**

   Compliance with this step could not be assessed from the records reviewed. In addition, the circumstance of an emp who skin converts but is not eligible for a course of trea is not addressed.

9. **All employees, regardless of skin test reaction, should be instructed to report promptly if they have a persistent co or other pulmonary symptoms.**

   Compliance with this step could not be assessed from the records reviewed.

   The employee health nurse informed NIOSH investigators tha her knowledge, only one employee with a previously positiv had ever received a chest x-ray due to pulmonary symptoms. illness was unrelated to TB.

10. **An awareness of coughing, persistent or excessive, by any employee (especially Direct Patient Care Provider) should reported to the Infection Control Committee Chairperson ar Health Services and receive prompt attention.**

    Compliance with this step could not be assessed from the records reviewed.

VII. CONCLUSIONS

The patient rooms on the second and third floors of the A.G. Hol Hospital were found to generally meet the ventilation requiremen "patient rooms," as specified by the AIA and ASHRAE criteria, in where the outside air supply could be measured. There were inst however, where closed dampers on fan coil units or inadequate su air volumes resulted in less than the required 2 ACH for patient or the 25 cfm/person requirement of fresh air stipulated by ASHR

no instance were the "isolation room" requirements met in patien locations measured during the evaluation. Included in the defic are: (1) the use of recirculating room fan coil units; (2) not m the 6 ACH requirement with at least two of the air changes being outside air; and (3) no inward movement of air (negative pressur the hallway to the isolation room. The air removed from patient did eventually reach the outside; however, it had to travel down hallways on both the second and third floors before being exhaus Thus, the potential exits for transmission of TB bacilli from infectious patients to other patients and hospital personnel as result of the airflow movements in the hospital.

The median temperature and relative humidity measurements made d the survey were less than optimum according to ASHRAE evaluation criteria. The temperatures were cooler than the recommended 75° more humid than the 50% guideline for RH. Visual inspections of individual fan coil unit revealed that some sediment had accumul the drain pans in spite of the packaged bactericides placed in t pans. The sediment build up could possibly lead to the release bioaerosols into patient areas. Finally, the patients' alterati the HVAC system (cardboard, towels, or clothing placed over air grilles) will cause the ventilation system to operate in a less efficient, and possibly inadequate, manner.

The TB surveillance protocol, with supplemental clarification, i adequate infection monitoring strategy for hospital personnel. However, the failure to adhere to the protocol systematically ha caused the program to be deficient.

VIII. RECOMMENDATIONS

The following recommendations are offered to minimize the potent nosocomial transmission of TB at A.G. Holley TB Hospital.

1. The CDC guidelines for approaches to TB control "...requires early identification, isolation, and treatment of persons wi active tuberculosis."[1] The hospital needs to redesign some o patient rooms to meet all of the requirements for acid-fast bacilli (AFB) isolation rooms as outlined by the CDC, ASHRAE AIA. Because of the residential nature of the hospital, not patient rooms must be AFB isolation rooms. However, while patients are still considered to be infectious early in thei chemotherapy, they should be isolated from other TB patients from hospital staff.

2. It appears that the patient rooms on the north side of the s floor nearly meet the requirements for AFB isolation. Rooms and 242 have a ducted supply and exhaust air system that del over 12 ACH of fresh air to the room. There are no fan coil

in the rooms that recirculate room air. A slight increase i amount of air exhausted from the rooms should put the room u negative pressure when the door to the room is closed. Unde current configuration of the hospital, only a few patient ro are located along the north side of the building. It might beneficial for some of the utility rooms and hospital staff on this side to be converted to patient AFB isolation rooms use the existing HVAC system, with slight modifications.

3. Additional AFB isolation rooms might be located on the south of the hospital, where the newer HVAC system with the fan co units are in operation. In order to meet the requirements f sufficient fresh air, the bottom opening of the fan coil uni be shut off so that only outside air enters the unit. All o fan coil units were delivering at least 210 cfm of supply ai made up of a mixture of room air through the bottom of the u and fresh air through the duct on the outside wall. If all supply were fresh air, the number of air changes per hour wo exceed six, and there would also be no recirculation of room as stipulated in the ventilation requirements for AFB isolat rooms. Additional mechanical work would, however, be necess the exhaust system that removes air from the room to insure these rooms are kept under negative pressure with respect to adjacent areas. The NIOSH investigators were unable to dire measure air flow through the exhaust grilles because of thei location behind the pipes of the fan coil units. Smoke test showed that the capture of smoke into the exhaust system was variable. Sometimes good capture was observed with the smok while at other times, it seemed as though the air flow rever direction. The direction of airflow at the door of the pati rooms confirmed that not enough air was being exhausted from room to put it under negative pressure. Perhaps additional exhaust fans on the side of the building that serve fewer ro than the current exhaust system would allow for greater room exhaust potential.

4. Air-to-air rotary wheel heat exchangers are susceptible to 1 10% cross-leakage according to ASHRAE.[19] Cross-leakage, cros contamination, or mixing of air between the supply and exhau airstreams occur in all rotation energy exchangers through t mechanisms; carryover and leakage. Carryover occurs as air entrained within the volume of the rotation medium and is ca into the other airstream. Leakage occurs because the differ static pressure across the two airstreams drives air from th higher to the lower static pressure region. It can be a significant problem when exhaust air potentially contains to infectious agents, as is the case at A. G. Holley State Hosp Methods for the control of cross-leakage to a level below 0. described in the 1992 ASHRAE handbook, HVAC Systems and

Equipment.[19] Also, the possibility of increasing the efficie of the filtration system on the mechanical air handling unit second and third floors from 85% to 99.97% (HEPA) efficient be investigated by a qualified HVAC contractor.

5. All of the outside air dampers on the fan coil units need to checked by the hospital's mechanical engineering staff to ma sure that they are in the maximum open position. Measuremen airflow through the vents on the outside of the building on of the fan coil units revealed that air was not flowing into building. A subsequent visual inspection of one of these un hospital staff confirmed that the damper was closed.

6. The exhaust ventilation for rooms on the south side of the hospital for the third floor is not sufficient to pull air o the patient rooms. Currently, holes drilled in the steam he on the wall are the only way that air is exhausted to the ou Smoke tests in these patient rooms showed very poor capture smoke near the heaters. Additional mechanical ventilation w needed in the rooms in order to achieve isolation characteri The current configuration of patient housing at A.G. Holley the MDR-TB patients and drug-sensitive TB patients who are beginning their chemotherapy located in rooms in this area o hospital. These rooms are the most likely candidates for AF isolation.

7. Visual inspection of several of the fan coil units revealed condensate drain pans that were contaminated with rust scale possible mold growth. The hospital's maintenance staff curr uses a packaged biocide that they place in the pan. The eff kill range of the packaged biocide does not appear to cover entire area of the drain pan. A preventive cleaning schedul with removal of the pan and cleaning with an EPA-approved disinfectant, which is more rigorous than current practices maintain cleaner fan coil units with a reduced potential for bioaerosol contamination of patient rooms.

8. Work practices at A.G. Holley Hospital limit occupational ex to the germicidal UV lights by specifying that the lamps are turned on only when the rooms are vacant and there is a sign placed on the door noting that UV light is present in the ro This practice does not assure that a patient or hospital emp cannot be exposed to high levels of UV radiation by inadvert entering a room when the lamps are energized. A lockout sys that automatically turns off the electrical supply to the UV when doors are opened needs to be installed in rooms where germicidal UV radiation continues to be used.

9. If respirators are supplied to employees for use around pati with TB, the administration staff of A.G. Holley TB Hospital should institute a respirator protection policy that, at a minimum, meets the requirements set forth by the Occupationa Safety and Health Administration in 29 CFR 1910.134, "Respir protection."[20] The minimum requirements include a written standard operating procedure for the selection and use of respirators; training and instructions on respirator usage; cleaning, repair, and housing of respirators; the continued surveillance of work area conditions for worker exposure and stress, and for the evaluation of the effectiveness of the respirator program; and the medical evaluation of employees determine that they are physically able to wear the respirat selected for use.

   The recent NIOSH draft guidelines for respiratory protection lists, in Table 3, hospital procedures having a high, medium indeterminant potential of aerosolization of droplet nuclei. A.G. Holley Hospital may meet the criteria for potential of aerosolization in the following circumstances. Any cough-in procedure or sputum induction procedure is classified in the guidelines as a high potential procedure where positive-pres air-line, halfmask respirators are the minimally acceptable personal respiratory protection. Intensive care units, with routine procedures and AFB isolation rooms are classified as medium potential areas where powered, air-purifying respirat (PAPR) with a halfmask and HEPA filters are the minimally acceptable personal respiratory protection. For both levels potential for aerosolization, an effective respiratory prote program should be implemented along with the issuance of the appropriate respirator.[16]

10. The written PPD skin testing protocol is essentially adequat actual adherence to the protocol is inconsistent. Additiona written clarification, as well as educational efforts direct towards employees and those persons administering the skin t program, should improve compliance with the protocol.

    Double initial PPD screening for new employees is an appropr measure for workers subject to repeated periodic tuberculin testing.[21,22,23] Because the immunologic response to PPD can wa over time, some persons previously infected with mycobacteri have a negative result with a single PPD skin test. The sti of the first test, however, may boost the subsequent respons that it is considered a positive reaction.[24] Individuals who not been infected with mycobacteria will not respond positiv even to the second dose of PPD. A booster effect may occur atypical mycobacterial infection, remote *M. tuberculosis* infection, as well as previous vaccination with BCG.[21,25,26] O

study at the San Francisco General Hospital revealed an over booster effect of 5.4% among 3800 employees. Higher rates w reported for Vietnamese (44.4%), Filipino (24.9%), persons > years of age (11.2%).[26]

The booster effect is best elicited by placing the second PP test one week following the first; less than a one week wait period is less efficacious.[25] The booster effect may persist a year or, perhaps, longer.[24] Omission of the second initial introduces uncertainty in determining the cause of a positiv result at a later date; the positive result may reflect a ne *M. tuberculosis* infection or may be due to the booster effec positive response on the second PPD done at the time of hire however is clearly due to previous infection.

Periodic, repeat, skin testing at intervals of 6 or 12 month dependent on the level of exposure (direct patient care of infectious TB patients), is appropriate. The review of reco revealed erratic compliance with the schedule of repeat skin testing. Improved compliance is strongly encouraged.

Employees who have converted to a positive skin test are appropriately eliminated from the on-going skin test program this is not specifically delineated in the written protocol.

For employees who have converted are referred for follow-up, record maintained on-site should contain sufficient informat document adequate follow-up care. If follow-up care and/or chemoprophylaxis is not obtained, the reasons why it was not should be ascertained and recorded, and alternative arrangem should be made, if needed.

11. PPD skin tests should be offered to terminating employees cl the time of their termination. However, even a PPD skin tes which is placed and read during the final week of employment not reflect the last several weeks of exposure to *M. tubercu* This is due to a time delay between infection and sensitizat following exposure to *M. tuberculosis* there is a complex immunologic response resulting in the sensitization of circu lymphocytes. Only after these lymphocytes are appropriately sensitized will the PPD skin reaction become positive. This sensitization process takes several weeks.[24] Employees who a terminating employment should be informed of this fact. A s test obtained three months following termination should adeq reflect and possible infection with *M. tuberculosis* from the previous employment.

12. Employee tuberculosis screening programs may serve as survei instruments to provide a means of detecting trends in

occupationally acquired infection. If a trend is detected, can be taken to find the failure in the infection control pr and prevent infection among coworkers. Two essential requir of any surveillance activity are adherence to an appropriate protocol and scrupulous maintenance of records. The protoco (discussed above) should define the population to be surveye define how infection is ascertained, and determine how indiv will be followed. Records should be maintained in a manner allows both preservation of, and easy access (by appropriate medical and public health personnel) to, the information. Surveillance activities are on-going by nature, and surveill systems should allow an on-going review of data.

Information which should be readily accessible includes: determination of which groups of employees are eligible for skin testing program and why others are not eligible. It sh be possible, with relative ease, to produce a "snap-shot" su for a given group of individuals: total number of persons, n of persons being tested, number of persons ineligible for te and number of skin test conversions during a particular time frame. Information on both current and recent employees sho accessible. A more complex, but useful, system would take i account the length of time an individual had worked in a giv location. It is important to identify the *rate* of conversio well as the actual *number* of conversions. Information on th total employee population, or sub-populations, is needed to determine rates of PPD skin conversion.

13. The current record-keeping system has several inadequacies. use of file folders containing employee health information o loose 3" x 5" and 5" x 8" index cards has great potential fo inadvertent loss. Additionally, as a space saving measure, previous employee health nurse took apart several records of former employees, grouping the 3" x 5" and 5" x 8" cards separately. The location of those records was unknown to th current employee health nurse, and not all records could be during the course of this investigation.

    The current system does not allow quick assessment of the to employee population to determine who is, and who is not, bei tested, and if not, why not. Computers can certainly facili surveillance systems, but it is also possible to function adequately without such capability.

14. Personnel time needs to be dedicated in order to accomplish recommendations (10-13) above. The current employee health is reassigned to assist with patient care frequently. If it not possible to assign a nurse full time to the employee hea service, alternative staffing arrangements should be discuss

Some of the work described above may be performed by appropr trained clerical personnel. For example, some of the record keeping and periodic report generation may be performed by a individual with appropriate administrative and educational s

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5. NIOSH Atlanta Office
6. U.S. Department of Labor\OSHA, Region IV

For the purpose of informing affected employees, copies of this
shall be posted by the employer in a prominent place accessible
employees for a period of 30 calendar days.

Table 1

Ventilation Evaluation Criteria[1,2]

HETA 92-215
A.G. Holley State Hospital
Lantana, Florida

May 20-21, 1992

Area Designation	Air movement relationship to adjacent area	Minimum air changes per hour outside air	Minimum total air changes per hour	Recirc-ulated by means of room units[3]	All air exhausted directly to outside
Operating room	Out	3	15	No	--
Delivery room	Out	3	15	No	--
Newborn nursery	--	1	6	No	--
Recovery room	--	2	6	No	--
Intensive care	--	2	6	No	--
Isolation room	In	--	6	No	Yes
Isolation anteroom	Out	--	10	No	Yes
Patient room	--	--	2	--	--
Examination room	--	--	6	--	
ER trauma room	Out	3	15	No	--
Autopsy room	In	--	12	No	Yes

1 Selected ventilation guidelines adapted from the American Institut Architects Guidelines for Construction and Equipment of Hospital a Medical Facilities (reference #4).

2 This table covers ventilation for comfort, as well as for asepsis odor control in areas of acute care hospitals that directly affect patient care. Areas where specific standards are not given shall ventilated in accordance with ASHRAE Standard 62-1989, "Ventilatio for Acceptable Indoor Air Quality Including Requirements for Outsi Air."

3 Because of cleaning difficulty and potential for buildup of contamination, recirculating room units shall not be used in areas marked "No." Isolation and intensive care unit rooms may be ventilated by reheat induction units in which the primary air supp from a central system passes through the reheat unit.

TABLE 2

Ventilation and Environmental Results in
Second Floor Patient Rooms

HETA 92-215
A.G. Holley State Tuberculosis Hospital
Lantana, Florida

May 20-21, 1992

LOCATION	ROOM TEMPERATURE FAHRENHEIT	ROOM RELATIVE HUMIDITY	FAN SPEED	ROOM SUPPLY	ROOM EXHAUST	OUTSIDE SUPPLY
Room 229 - east unit	73°	59%	Low	210 cfm	---	---
east unit			High	450 cfm		
west unit			Low	265 cfm		
west unit			High	425 cfm		
Room 230 - east unit	69°	66%	Low	270 cfm	---	115 cfm
east unit			High	510 cfm		115 cfm

west unit	Low	280 cfm	90 cfm
west unit	High	500 cfm	100 cfm

TABLE 2 (Continued)

Ventilation and Environmental Results in
Second Floor Patient Rooms

HETA 92-215
A.G. Holley State Tuberculosis Hospital
Lantana, Florida

May 20-21, 1992

LOCATION	ROOM TEMPERATURE FAHRENHEIT	ROOM RELATIVE HUMIDITY	FAN SPEED	ROOM SUPPLY	ROOM EXHAUST	OUTSIDE SUPPLY
Room 232 - east unit	73°	58%	Low	240 cfm	---	100 cfm
east unit			High	415 cfm		110 cfm
west unit			Low	250 cfm		100 cfm
west unit			High	510 cfm		100 cfm
Room 243 - east unit	72°	66%	Unit Broken			
west unit			Low	330 cfm	---	---

west unit			High	530 cfm		
Room 240	---	---	N/A	210 cfm	-210 cfm	N/A
Room 242	---	---	N/A	210 cfm	-200 cfm	N/A

TABLE 3
Ventilation and Environmental Results in
Third Floor Patient Rooms

HETA 92-215
A.G. Holley State Tuberculosis Hospital
Lantana, Florida

May 20-21, 1992

LOCATION	ROOM TEMPERATURE FAHRENHEIT	ROOM RELATIVE HUMIDITY	FAN SPEED	ROOM SUPPLY	ROOM EXHAUST	OUTSIDE SUPPLY
MDR-TB Ward						
Room 301	---	---	N/A	132 cfm	(1)	N/A
Room 304	---	---	N/A	133 cfm	(1)	N/A
Room 308	---	---	N/A	154 cfm	(1)	N/A
Hallway	---	---	N/A	482 cfm	N/A	N/A
Room 309	---	---	N/A	120 cfm	(1)	N/A
Room 311	---	---	N/A	230 cfm	(1)	N/A
Room 318	---	---	N/A	90 cfm	(1)	N/A
Room 321	---	---	N/A	230 cfm	(1)	N/A
Room 324	---	---	N/A	260 cfm	(1)	N/A

TABLE 3 (Continued)

Ventilation and Environmental Results in
Third Floor Patient Rooms

HETA 92-215
A.G. Holley State Tuberculosis Hospital
Lantana, Florida

May 20-21, 1992

LOCATION	ROOM TEMPERATURE FAHRENHEIT	ROOM RELATIVE HUMIDITY	FAN SPEED	ROOM SUPPLY	ROOM EXHAUST	OUTSIDE SUPPLY
Room 329	73°	66%	Low (2)	255 cfm		---
Room 331	72°	62%	Low (2)	220 cfm		---
Room 332	---	---	Low	---		-60 cfm
			High			-50 cfm
Room 335	72°	64%	Low (2)	205 cfm		-50 cfm
Room 337	72°	65%	Low (2)	215 cfm		---
Room 338	72°	68%	Low (2)	210 cfm		---
Room 340 - east unit	72°	70%	Low (2)	220 cfm		---
west unit			Low (2)	260 cfm		---

N/A - Not Applicable
(1) - Exhaust ports drilled through wall heaters to outside chase.

(2) - Fan control knobs broken or removed; fan control cover locked.

TABLE 4

Ventilation and Environmental Results in
Non-Patient Rooms

HETA 92-215
A.G. Holley State Tuberculosis Hospital
Lantana, Florida

May 20-21, 1992

LOCATION	ROOM TEMPERATURE FAHRENHEIT	ROOM RELATIVE HUMIDITY	FAN SPEED	ROOM SUPPLY	ROOM EXHAUST	OUTSIDE SUPPLY
Room 231 - Rest Room	---	---	N/A	407 cfm (over door) 403 cfm (east end)	---	N/A
Room 237 - Nurses' Station	73°	61%	Low High	280 cfm 530 cfm	---	40 cfm 50 cfm
Room 312 - Doctor's Office	---	---	N/A	200 cfm	(1)	N/A

N/A - Not Applicable
(1) - Exhaust ports drilled through wall heaters to outside chase.
(2) - Fan control knobs broken or removed; fan control cover locked.