NIOSH HEALTH HAZARD EVALUATION REPORT

HETA # 2005-0346-3008
Dixie Regional Medical Center
Saint George, Utah

July 2006

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DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Respiratory Disease Hazard Evaluations and Technical Assistance Program (RDHETAP) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSH) Act of 1970, 29 U.S.C. 669(a)(6), or Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, 30 U.S.C. 951(a)(11), which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

RDHETAP also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Terri A. Pearce, PhD, Stephen B. Martin, MS, PE, and Michelle R. Vingle, MS of the RDHETAP, Division of Respiratory Disease Studies (DRDS). Desktop publishing was performed by Amber Harton.

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

HIGHLIGHTS OF THE NIOSH HEALTH HAZARD EVALUATION AT DIXIE REGIONAL MEDICAL CENTER – SAINT GEORGE. UTAH

The National Institute for Occupational Safety and Health (NIOSH) received a confidential Health Hazard Evaluation (HHE) request from Intermountain Health Care (IHC) employees working at Dixie Regional Medical Center (DRMC) in Saint George, Utah. The request reported concerns about inadequate maintenance practices and poor indoor air quality (IAQ), including excess water and mold growth in heating and air conditioning units and in a crawlspace under one of the buildings. Employee health problems included pulmonary system, immune system, and skin ailments.

WHAT NIOSH DID

- Spoke by telephone with the requesters and DRMC management
- Reviewed written information, photographs, and video provided by requesters
- Read reports, letters and memoranda prepared by external consultants, the Utah Occupational Safety and Health (UOSH) and the IHC Office of Safety, Security, and Environmental Health
- Spoke to UOSH Compliance Safety and Health Officers regarding their site visit findings
- Performed walkthrough surveys of the DRMC River Road and 400 East campuses
- Reviewed documentation regarding ventilation system performance and maintenance
- Provided management and employees with feedback about our onsite observations

WHAT MANAGERS CAN DO

- Establish an indoor air quality (IAQ) program at DRMC
- Improve all standard maintenance procedures to include information on proper personal protective equipment
- Conduct weekly visual inspections of the River Road crawlspace and maintain the water detection system and ventilation fans in the area
- Change ventilation filters on appropriate schedules and improve ventilation system record-keeping
- React quickly to any future water incursion to prevent mold growth
- Increase visual inspections of 400 East AHUs during the rainy season
- Use a pump or other means to remove the water and quickly replace any ventilation filters that have been wetted if standing water is found in AHU drain pans
- Repair leaks and remediate mold growth in mechanical room housing AHU 4th West at 400 East
- Promptly investigate employee reports of IAQ issues and respond to employee health concerns

WHAT NIOSH FOUND

- Both DRMC facilities were generally clean and well-maintained
- The River Road crawlspace was dry with no visible mold present
- A modular zone water detection system had been installed in the crawlspace to detect future leaks
- Air handling unites (AHUs) at both DRMC campuses had proper filter configurations installed in each and no filters were excessively dirty or damaged
- Signs of rust and standing water were present in several 400 East AHUs indicating excess condensation and improper drainage
- Suspected mold growth existed in the mechanical room housing AHU 4th West at 400 East

WHAT EMPLOYEES CAN DO

- Immediately report water damage or mold growth to management
- Inform DRMC facilities management about IAQ issues
- Report work-related health symptoms or complaints to the Employee Health Nurse
- Seek physician care and advice for health symptoms or concerns
- Wear proper personal protective equipment as described in DRMC maintenance procedures when working in or around AHUs

CDC Workplace Safety and Health

What To Do For More Information:

We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2005-0346-3008

NIOSH

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#2005-0346-3008 Dixie Regional Medical Center
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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a confidential Health Hazard Evaluation (HHE) request on August 23, 2005 from Intermountain Health Care (IHC) employees working at Dixie Regional Medical Center (DRMC) in Saint George, Utah. The request reported concerns about inadequate maintenance practices and poor indoor air quality (IAQ), including excess water and mold growth in heating and air conditioning units and in a crawlspace under one of the buildings. Employee health problems included lung, immune system, and skin ailments. The HHE was originally closed with a letter to the requesters on September 1, 2005. Due to continued occupational health concerns of the requesters, the HHE reopened in January 2006. NIOSH staff visited DRMC on January 30-31, 2006.

DRMC is comprised of two separate facilities, River Road Campus and 400 East Campus. The HHE requesters reported concerns at both. At the River Road Campus, there was concern about potential mold exposures related to a water leak in the crawlspace under the building. Requesters reported that leaking high-pressure ventilation ductwork running through the crawlspace created positive pressure causing air to flow from the crawlspace into the hospital. At the 400 East Campus, requesters were concerned about uncontrolled renovations that might have allowed contaminants to enter patient care areas and employee workspaces. Additionally, there were numerous concerns with the 400 East heating, ventilating, and air conditioning (HVAC) systems resulting in possible dust and mold exposures. Poor maintenance practices resulting in dirty/moldy ductwork and filters, improper or missing filters, and standing water in the air handling units (AHUs) were also reported.

NIOSH found both campuses to be generally clean and well-maintained. The crawlspace area at River Road was dry with no visible mold present. Any mold growth that had occurred during the water leak had been remediated. A borate-based fungicide had been applied to the support columns and some areas of the soil floor. To help rapidly detect any future water leaks (or incursion from the outside) in the crawlspace, DRMC installed a modular-zone water-detection system complete with seven moisture-sensing cables. Additionally, proper air vents and small fans had been installed in the crawlspace to help keep the area dry. The HVAC systems at River Road were clean and functioning properly, with correct filter configurations installed in each.

Multiple structural changes and renovations at the 400 East campus had resulted in 13 different AHUs of various age from various manufacturers. Each unit had filters installed in the correct configuration during the NIOSH visit, and no filters appeared excessively dirty or damaged. Many of the 400 East AHUs were installed without allowing the height needed for proper condensate drainage. There was rust from standing water resulting from the overflow of drain pans. The facilities manager stated that standing water

is typical during the rainy season of late summer and early fall when high outdoor humidity overwhelms the ability of the AHUs to remove moisture from the incoming air. The facilities manager also stated that during these periods, excess condensation from cooling coils can cause the filters to become saturated with water that might facilitate mold growth. However, during NIOSH's visit in January, no mold growth or wetted filters were found. Suspected mold growth was found in the rooftop mechanical room housing AHU 4th West. We conducted a video examination of the interior ventilation ductwork on the third floor of the 400 East building. The air supply duct was clean and free from any visible dirt deposits. The return ductwork had visible accumulations of lint attributed to the high volume of linens that are used by the hospital. Aside from the lint, there was no excess dirt or evidence of mold growth seen during the duct examination.

NIOSH conducted a site visit at the River Road and 400 East Campuses of Dixie Regional Medical Center in Saint George, Utah to address employee concerns about water incursion and inadequate maintenance that might be adversely impacting the indoor air quality at their workplace. NIOSH found evidence of previous water incursion in the River Road crawlspace and in some air handling units at the 400 East Campus. Water-monitoring equipment had been installed in the crawlspace to detect future leaks. Modifications were planned for air handlers known to retain water during the wet season. Management had implemented policies and procedures to ensure better monitoring of areas prone to water incursion and identified a contact person for employee concerns.

Keywords: NAICS 622110 (General Medical and Surgical Hospitals), mold, indoor air quality, IAQ

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a confidential Health Hazard Evaluation (HHE) request on August 23, 2005 from Intermountain Health Care (IHC) employees working at Dixie Regional Medical Center (DRMC) in Saint George, Utah. The request reported concerns of inadequate maintenance practices and poor indoor air quality (IAQ), including excess water and mold growth in heating and air conditioning units and in a crawlspace under one of the buildings. Employee health problems included lung, immune system, and skin ailments. The HHE was originally closed with a letter to the requesters on September 1, 2005. Due to continued occupational health concerns of the requesters, the HHE reopened in January 2006. NIOSH staff visited DRMC on January 30-31, 2006.

BACKGROUND

DRMC is a hospital owned and operated by Intermountain Healthcare and is composed of two campuses, River Road and 400 East. River Road serves as an acute care facility and was opened in 2003. The building is approximately 420,000 square feet with four stories, a partial basement, and a crawlspace under the remaining part of the structure. The building was built in four sections (main, patient tower, physician offices, emergency room). Support for the structure is provided by large concrete columns extending down to bedrock. The crawlspace has a soil floor and is approximately 3 feet to 16 feet in height, depending on which section of the building is above it. In the past, 400 East served as the main hospital for the St. George area until the newer River Road facility was opened. Currently, 400 East provides services which include a wound clinic, women's and children's services, IV therapy, a cancer center, and a same-day surgery center. The campus is approximately 200,000 square feet and was originally constructed in 1975. A 72,000 square foot addition was added in 1983 to house business offices. Other smaller additions were constructed in 1986, 1990, and 1999.

In March 2004, a water main leak below physician offices at River Road caused significant flooding in the crawlspace area under the main portion of the building. The leak went undetected allowing a large amount of water to saturate the crawlspace floor and to collect in the lowest areas, reaching over 3 feet deep in some places. Cardboard forms used to shape the large concrete columns during construction had been left in place after construction was completed. These cardboard forms extended from below ground level to several inches above the level of the soil. When the crawlspace flooded, the cardboard absorbed water and facilitated mold growth. After an estimated 3-4 weeks of continuous water leakage, a musty or moldy odor was reported by employees working in the basement print shop (main part of the building). Based on these reports, hospital management discovered and repaired the leaking water main. Contractors were hired to dry the area using pumps to remove all standing water and large fans to circulate air to aid in drying the soil. Once the space was dry, the contractors remediated the mold by removing the damp cardboard forms from around the concrete columns and other debris left in the area during construction. During these efforts, complaints were filed with the Utah Occupational Safety and Health Division (UOSH) regarding improper personal protective equipment and worker training. UOSH inspected the remediation operations and subsequently issued citations to the contractor and DRMC. Appropriate corrective actions were taken and the remediation was completed in November 2004.

Concerns about both campuses were submitted in a Health Hazard Evaluation request to NIOSH. At River Road, requesters were concerned about mold exposure they might have received prior to remediation of the crawlspace. They reported that leaking high-pressure ventilation ductwork running through the crawlspace created positive pressure causing air flow from the crawlspace into the hospital. At

400 East, requesters were concerned about uncontrolled renovations that might have allowed contaminants to enter patient care areas and employee workspaces. Additionally, there were numerous concerns with the 400 East heating, ventilating, and air-conditioning (HVAC) systems resulting in possible dust and mold exposures. Concerns included poor maintenance practices resulting in dirty/moldy ductwork and filters, improper or missing filters, and standing water in the air handling units (AHUs).

METHODS

NIOSH responded to the HHE request through email correspondence and telephone interviews with both the requesters and DMRC officials. NIOSH also reviewed all photographs, video, and documents provided by the requesters. Telephone discussions were also held with the Utah Occupational Safety and Health Division Compliance Manager and the Compliance Safety and Health Officer who had visited both DRMC campuses prior to the NIOSH visit. Additional telephone interviews were conducted with a Region 8 OSHA officer who had reviewed the Utah response to DRMC employee complaints, a member of DRMC management, and the DRMC facilities manager. After conducting the telephone discussions, it was determined that a site visit to DRMC was warranted. The site visit was conducted on January 30-31, 2006.

After an opening meeting with facilities and DRMC management representatives, NIOSH conducted walkthrough evaluations at both DRMC campuses. The evaluations were based primarily on visual inspections to identify conditions or characteristics that might impact indoor air quality. Focus was placed on the areas and systems described by requesters as potentially being related to their health symptoms, namely areas of water incursion and the HVAC systems. NIOSH visually examined the crawlspace and the HVAC systems at River Road. NIOSH visually examined the AHUs at 400 East and used a remote-controlled video camera (Microinspector®, Lloyd's Inc., Rapid City, SD) to enter and record video from inside ventilation ductwork reported to contain high levels of dirt and mold. During the inspections at both facilities, management personnel and the infection control nurse accompanied NIOSH and were interviewed during the process. Additionally, HVAC maintenance logs and other documentation were reviewed to gather information on filter types, filter change-out schedules, and the overall preventative maintenance process. After both inspections were completed, a closing meeting was held to discuss NIOSH findings and observations with the stakeholders.

RESULTS AND DISCUSSION

NIOSH was given access to all areas of both DRMC campuses. In general, the facilities were clean and well-maintained. Access to the crawlspace area is restricted to two openings at River Road, one from inside the hospital in Mechanical Room #1, and the other from outside near the loading dock. The crawlspace area was dry with no visible mold present. During the remediation efforts, all construction debris in the area was removed, and most of the cardboard forms had been removed from the concrete support columns (Figure 1). One cardboard form was found still in place, and it did show evidence of previous saturation, but there was no mold growth (Figure 2). Any mold growth that did occur during the water leak had been remediated and a borate-based fungicide had been applied to the support columns and some areas of the soil floor. Since November 2004, when remediation work in the crawlspace was completed, a contractor has collected periodic samples for airborne mold spores in the crawlspace and in areas on the first floor of the hospital. No elevated levels of mold spores have been found in the crawlspace when compared to outdoor levels, and levels inside the hospital are lower than outdoors.

To help rapidly detect any future water leaks (or incursion from the outside) in the crawlspace, DRMC has installed a modular zone water detection system complete with seven moisture sensing cables (Figure 3). This detection system interfaces with the computer-controlled building ventilation monitoring system to provide immediate alarms to facilities staff if moisture is detected in the area. The DRMC facilities manager has also implemented weekly visual inspections of the entire crawlspace area to verify proper operation of the water sensing cables and to check for signs of water in the areas not covered by the water detection system.

One high-pressure supply duct (from AHU #2) runs through the crawlspace (Figure 4). The ductwork was intact and no air leakage could be heard. The HHE requesters reported that this duct system was damaged during building construction which created positive air pressure and flow of air from the crawlspace into the hospital through leaks around the hatch inside Mechanical Room #1 (since this is the only connection between the crawlspace and the occupied space of the hospital). Previous damage to the supply duct could not be confirmed during our inspection, but if previous damage did exist, it appears to have been properly repaired. Additionally, during efforts to dry and remediate the crawlspace area, it was discovered that the original building design did not include air vents to allow outdoor air into the space. Since air vents are required by building code, vents were installed in July 2004 to help dry the area. Air vents now cover most of the perimeter of the crawlspace area and allow proper air circulation. DRMC has also installed small fans to facilitate additional air circulation to keep the area dry. The installation of the air vents and fans resulted in sufficient air movement through the crawlspace and a neutral pressure differential compared to outdoors. A positive pressure between the crawlspace and Mechanical Room #1 could not be verified during the NIOSH inspection, but that condition could have existed prior to installation of the vents and fans.

River Road has nine AHUs, all the same age and produced by the same manufacturer. The size and design of all AHUs are similar and the area(s) of the hospital that each unit serves determines the actual AHU configuration. The area(s) served by each AHU is presented in Table 1. Table 2 provides the proper filter configurations for each AHU at River Road. NIOSH found the proper configuration installed in each unit during the inspection. All filters appeared in good condition. Pressure drop across the filter banks was monitored by the computerized building control system and provided continuous feedback on ventilation system performance. The need to change ventilation filters was determined by monitoring the pressure drop across the filter banks. Computerized maintenance reports and handwritten maintenance logs were reviewed to determine the most recent filter changes prior to NIOSH's visit. These findings are presented in Table 3. The most recent filter change could not be determined from maintenance records for some filters (see Table 3). This was addressed with the DRMC facilities manager, who acknowledged shortcomings in the preventative maintenance recordkeeping system and assured NIOSH that the system would be improved in the future.

Multiple structural changes and renovations have occurred at the 400 East campus. The HHE requesters were concerned about uncontrolled renovations that might have allowed contaminants to enter patient care areas and employee workspaces. Photographs of potential problem areas were reviewed by NIOSH prior to the site visit. However, prior to the NIOSH visit, major construction activities were completed and only finishing work in the entrance and lobby area of the cancer center was being performed while NIOSH was onsite. This precluded NIOSH from making any conclusions on whether construction activities could have posed a health risk to hospital employees or patients.

The multiple additions and renovations at 400 East have resulted in 13 different AHUs of

various ages from various manufacturers. Tables 4 and 5 list the area(s) served by each of the AHUs and the proper filter configuration for each unit, respectively. Each unit had filters installed in the correct configuration during the NIOSH visit, and no filters appeared excessively dirty or damaged. The ventilation systems at 400 East interface with the computerized building control system, which is linked to River Road to allow centralized monitoring of temperature and humidity. However, pressure drops across the filter banks are not centrally monitored. Maintenance personnel visually inspect and monitor the units to determine if the filters should be changed or if standing water is present. Table 6 presents the most recent filter changes for each AHU at 400 East prior to NIOSH's visit. The information for Table 6 was compiled from a review of all available maintenance records. As with River Road, some filter changes could not be determined from the available records, and NIOSH was assured record keeping would be improved at both facilities.

Many of the 400 East AHUs were installed without allowing sufficient height for proper condensate drainage (Figure 5). Examination of these units found significant rust from standing water resulting from the overflow of drain pans or insufficient drainage (Figures 6 and 7). During the NIOSH visit in January, excess condensation in the ventilation systems was not a concern. Maintenance staff told NIOSH that during the rainy season of late summer and early fall, passing storms and the associated rise in ambient relative humidity could result in significant condensation events. During these events, standing water in the AHUs is common. It was also common for the filters to become saturated with water that might facilitate mold growth. To help control these events, better drains had been installed where possible, but the lack of AHU height with respect to the floor (or roof) renders the drains virtually useless during periods of extreme condensation. The DRMC facilities manager is aware of the condensation events and the concern for mold growth on wet ventilation filters. To alleviate this concern, the facilities manager plans to increase the frequency of visual AHU inspections during the rainy season. Suspected mold growth was found in the rooftop mechanical room housing AHU 4th West. The mold appeared to be the result of a prior roof leak which had wetted sheetrock (Figure 8). The room does not serve as a return air plenum and therefore does not have connectivity with the air supplied by the AHU.

A video examination of the inside of ventilation ductwork was conducted on the third floor. The inside of a supply duct was inspected above the ceiling in the C-section area, while the inside of a return duct was inspected above the ceiling in the neonatal intensive care unit (NICU). Facilities management had not previously inspected ductwork and identified this area as being ductwork that was original to building construction. The occupied areas had been renovated, but the ductwork had been left in place and the facilities personnel felt it would represent ductwork that had been in use for the longest period. Upon examination, the air supply duct did not have any internal insulation and was clean with no visible dirt deposits (Figure 9). The return ductwork was lined with visible accumulations of lint (Figures 10 and 11). The lint accumulation was attributed to the high volume of linens that were used by the hospital. While lint in return air ducts is not desirable, any lint that remains airborne and carried back to the AHU (Figure 12) would be removed by the filters before it is re-circulated back into the hospital. Aside from the lint, there was no excess dirt or evidence of mold growth noticed during the duct examination.

In addition to the walkthrough inspections, NIOSH spoke with representatives from DRMC management about safety and health policy for employees. Management officials reported procedures they have implemented to better protect worker health while performing tasks in and around AHUs, such as changing filters or making repairs. Some of these written standard procedures incorporate worker safety considerations, such as the use of gloves, eye protection, and respiratory protection. All

employees are encouraged to report any work-related health complaints to the employee health nurse. Management also stated that employees should voice any indoor air quality or infection control concerns to the infection control nurse who participates in the decision-making process regarding hospital renovations and infection control risk assessments.

CONCLUSIONS

At DRMC, the two campuses are very different due to the age of the buildings and the technologies available at the time of their construction (or renovations). In general, both facilities were clean and well-maintained. The crawlspace under the River Road facility was dry with no visible mold present. During the 2003 remediation efforts, all construction debris in the area was removed and most of the cardboard forms had been removed from the concrete support columns. Any mold growth that did occur during the water leak was reported to have been remediated and a borate-based fungicide has been applied to the support columns and some areas of the soil floor. To help rapidly detect any future water leaks (or incursion from the outside) in the crawlspace under the building, a modular zone water detection system complete with seven moisture sensing cables has been installed. This water system, in conjunction with increased visual inspections, should ensure future leaks are identified and contained in a timely manner. Previous damage to the air supply duct from AHU2 running through the crawlspace could not be confirmed during the inspection. If previous damage did exist, it appears to have been properly repaired. Positive pressure between the crawlspace and Mechanical Room #1 could not be verified during the NIOSH inspection, although it is conceivable that such a condition might have existed prior to the installation of vents and fans during the remediation efforts. Proper filters were installed in each of River Road's nine AHUs and in all 13 AHUs at 400 East. All filters appeared in good condition with no excessive dirt, mold growth, or damage. Available maintenance records did not provide all past filter change information for several AHUs. This was addressed with the DRMC facilities manager, who assured NIOSH that maintenance record-keeping, would improve in the future.

Major construction activities at 400 East were completed prior to the NIOSH visit. Thus, NIOSH was unable to make a determination as to whether previous construction activities posed a health risk to hospital employees or patients. A video examination of the inside of ventilation ductwork conducted on the third floor at 400 East showed nothing of concern. Suspected mold growth was found in the rooftop mechanical room housing AHU 4th West. Many of the 400 East AHUs had been installed without allowing the height needed for proper condensate drainage, which results in standing water in the drain pans and structure of the filters with water. (Both conditions can facilitate mold growth.) This is primarily a concern during the rainy season of late summer and early fall when passing storms and the associated rise in ambient relative humidity result in significant condensation events. Better condensate drains have been installed where possible, but the lack of AHU height with respect to the floor (or roof) renders the drains virtually useless during periods of extreme condensation. The DRMC facilities manager is aware of the condensation events and the concern for mold growth on wet ventilation filters. To alleviate this concern, the facilities manager planned to increase the frequency of visual AHU inspections during the rainy season to allow for replacement of wetted filters and to remove excess condensate as necessary.

RECOMMENDATIONS

1. Establish an indoor air quality (IAQ) program at DRMC. Early and frequent communication with building occupants is important both to prevent IAQ problems from occurring and to secure cooperation when solving existing problems. It is important that clear procedures for recording and responding to

IAQ complaints be established to ensure adequate and timely response and to prevent small complaints from becoming major health or comfort problems. These would include:

- Logging all complaints or problem reports
- Collecting information about each complaint
- Ensuring confidentiality
- Determining a plan for response
- Identifying appropriate resources for response
- Applying remedial action
- Providing feedback to building occupants regarding the complaint and response actions
- Following-up to ensure that remedial action has been effective

2. Establish an IAQ team consisting of a coordinator, employee representatives, facilities management, and DRMC management to oversee implementation of the IAQ program. Encourage everyone to report any work-related health complaints to the employee health nurse and any indoor air quality or infection control concerns to the infection control nurse. Periodically, modify or enhance the IAQ program to address any concerns brought forth.

3. Continue weekly visual inspections of the entire crawlspace area to verify proper operation of the water detection system and check for signs of water in the areas not covered by the water sensing cables. Respond to all alarms from the water detection system as if a leak has occurred, regardless if the alarm turns out to be false. During crawlspace inspections, assure all ventilation fans in the crawlspace area are operating properly.

4. Remove all remaining cardboard forms from the concrete support columns in the crawlspace under River Road.

5. Improve AHU drainage systems at 400 East where possible. During the rainy season, conduct daily inspections of the 400 East AHUs for standing water and saturated ventilation filters. If standing water is found, take necessary steps to drain the water. All saturated ventilation filters should be changed as quickly as possible.

6. Change out all ventilation filters on appropriate schedules determined by pressure drop through filter banks or according to manufacturer recommendations. Improve maintenance record-keeping so that all filter changes and AHU maintenance tasks can be tracked in the facilities computerized record system. Proper maintenance of AHUs is critical for infection control and IAQ in hospitals. The Centers for Disease Control and Prevention has developed specific guidelines for environmental infection control in hospitals.[1] This guidance is also useful for ensuring good IAQ during maintenance and renovation of hospital facilities. Additional guidance is available from the American Society for Heating, Refrigerating, and Air-Conditioning Engineers regarding ventilation system performance and maintenance.[2]

7. Improve all preventative maintenance standard procedures to include proper personal protective equipment. Provide workers with all appropriate personal protective equipment for any tasks they are asked to perform. Respirators should only be used as part of a complete, written OSHA respiratory protection program described in 29 CFR 1910.134.[3]

8. Repair all leaks, dry any areas of water incursion, and remediate the mold in the mechanical room housing AHU 4th West and other areas where mold might be found. Useful guidance documents on mold remediation are available from the Occupational Safety and Health Administration and the Environmental Protection Agency.[4, 5] These documents provide specifics on when clean-up is appropriately handled by in-house maintenance staff and when it should be

performed by properly-trained mold remediation contractors.

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Table 1. Air Handling Units and Locations Served River Road Campus – Dixie Regional Medical Center, St. George, Utah	
Air-Handling Unit	**Location Served**
AHU1	2nd Floor Operating Rooms
AHU2	1st Floor Emergency Room
AHU3[A]	All Floors of the Diagnostic Tower
AHU4[A]	All Floors of the Diagnostic Tower
AHU5[A]	All Floors of the Diagnostic Tower
AHU6[B]	All Floors of the Patient Tower
AHU7[B]	All Floors of the Patient Tower
AHU8[C]	All Floors of the Physician Office Building
AHU9[C]	All Floors of the Physician Office Building

[A] AHU3, AHU4, and AHU5 all feed into one main supply duct providing air to all locations in the Diagnostic Tower.

[B] AHU6 and AHU7 both feed into one main supply duct providing air to all locations in the Patient Tower.

[C] AHU8 and AHU9 both feed into one main supply duct providing air to all locations in the Physician Office Building.

Table 2. Air-Handling Unit Filter Configurations River Road Campus – Dixie Regional Medical Center, St. George, Utah			
Air-Handling Unit	**Filters Installed in Unit[A]**		
	2″ MERV[B] 8 Prefilters	12″ 95%[C] Synthetic Final Box Filter	11½″ High Efficiency (HEPA)[D] Final Box Filter
AHU1	✓		✓
AHU2	✓	✓	
AHU3	✓	✓	
AHU4	✓	✓	
AHU5	✓	✓	
AHU6	✓	✓	
AHU7	✓	✓	
AHU8	✓	✓	
AHU9	✓	✓	

[A] As observed during the NIOSH visit on January 30, 2006. The check mark (✓) represents which filters were installed inside each system.

[B] MERV refers to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Minimum Efficiency Reporting Value (MERV) described in the American National Standards Institute (ANSI)/ASHRAE Standard 52.2-1999 entitled *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*.

[C] Filters provide a 90-95% average efficiency when tested using the methods outlined in ANSI/ASHRAE Standard 52.1-1992 entitled *Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter*.

[D] High-efficiency particulate air (HEPA) filters provide ≥99.97% efficiency against 0.3 micrometer (μm) particles.

Table 3. Dates of Most Recent Air-Handling Unit Filter Changes River Road Campus – Dixie Regional Medical Center, St. George, Utah			
Air-Handling Unit	**Filters Installed in Unit[A]**		
	2″ MERV[B] 8 Prefilters	12″ 95%[C] Synthetic Final Box Filter	11½″ High Efficiency (HEPA)[D] Final Box Filter
AHU1	12/22/2005		04/16/2005
AHU2	10/04/2005	ND[E]	
AHU3	01/27/2006	01/27/2006	
AHU4	01/27/2006	01/27/2006	
AHU5	09/30/2005	ND[E]	
AHU6	01/27/2006	01/27/2006	
AHU7	07/26/2005	10/27/2005	
AHU8	11/22/2005	07/27/2005	
AHU9	11/22/2005	07/27/2005	

[A] Information taken from air-handling unit maintenance logs. The shaded cells in the table represent filters that are not part of the standard filter configuration installed inside each system.

[B] MERV refers to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Minimum Efficiency Reporting Value (MERV) described in the American National Standards Institute (ANSI)/ASHRAE Standard 52.2-1999 entitled *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*.

[C] Filters provide a 90-95% average efficiency when tested using the methods outlined in ANSI/ASHRAE Standard 52.1-1992 entitled *Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter*.

[D] High-efficiency particulate air (HEPA) filters provide ≥99.97% efficiency against 0.3 micrometer (μm) particles.

[E] ND=not determined. The date of the last filter change could not be determined from information contained in the maintenance logs.

Table 4. Air-Handling Units and Locations Served 400E Campus – Dixie Regional Medical Center, St. George, Utah	
Air-Handling Unit	**Location Served**
AHU1	All 1st Floor North Offices
AHU2	2nd Floor Laboratories and 3rd Floor Operating Rooms
AHU3	2nd Floor Same Day Surgery Unit, 3rd Floor NICU, and all of 4th Floor North
5th Floor	All of 5th Floor North Wing
SF201	All of 3rd and 4th Floors EXCEPT Areas Served by SF204 and 4th West Fan
SF204	3rd Floor C-Section Rooms and 4th Floor South Pediatrics
4th West Fan	4th South Behavioral Medicine Unit and 3rd Floor South Rooms 311-316
DOF2	3rd Floor Maternal Fetal Medicine Unit
SF101	Entire South Basement and All of 2nd Floor South, EXCEPT Radiology (SF104)
SF104	2nd Floor South Radiology Unit
DOF1	2nd Floor Oncology and Basement Materials Management/Environ. Services/Pharmacy
AHU-CC	Basement Cancer Center
CCAC	Basement Cancer Screening Unit

Table 5. Air-Handling Unit Filter Configurations 400E Campus – Dixie Regional Medical Center, St. George, Utah					
Air-Handling Unit	**Filters Installed in Unit**[A]				
	2″ MERV[B] 8 Prefilters	4″ MERV[B] 8 Prefilters	2″ MERV[B] 8 Final Prefilters	29″ 95%[C] Synthetic Final Bag Filter	12″ 95%[C] Synthetic Final Box Filter
AHU1[D]	✓	✓			
AHU2	✓	✓	✓	✓	
AHU3	✓	✓	✓	✓	
5th Floor	✓	✓	✓	✓	
SF201	✓	✓	✓	✓	
SF204	✓	✓	✓	✓	
4th West Fan	✓				✓
DOF2	✓	✓	✓	✓	
SF101	✓	✓	✓	✓	
SF104	✓	✓	✓	✓	
DOF1	✓	✓	✓	✓	
AHU-CC	✓	✓	✓	✓	
CCAC[D]			✓		

[A] As observed during the NIOSH visit on January 31, 2006. The check mark (✓) represents which filters were installed inside each system.

[B] MERV refers to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Minimum Efficiency Reporting Value (MERV) described in the American National Standards Institute (ANSI)/ASHRAE Standard 52.2-1999 entitled *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*.

[C] Filters provide a 90-95% average efficiency when tested using the methods outlined in ANSI/ASHRAE Standard 52.1-1992 entitled *Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter*.

[D] The air-handling units supply air to areas of the hospital not involved with patient care procedures. These areas are designed for business occupancy only.

Table 6. Dates of Most Recent Air-Handling Unit Filter Changes 400E Campus – Dixie Regional Medical Center, St. George, Utah					
Air-Handling Unit	**Date of Most Recent Filter Change[A]**				
	2″ MERV[B] 8 Prefilters	4″ MERV[B] 8 Prefilters	2″ MERV[B] 8 Final Prefilters	29″ 95%[C] Synthetic Final Bag Filter	12″ 95%[C] Synthetic Final Box Filter
AHU1[D]	10/26/2005	10/31/2002			
AHU2	06/29/2005	06/29/2005	11/22/2005	05/16/2005	
AHU3	11/22/2005	11/22/2005	10/26/2005	12/11/2003	
5th Floor	12/21/2005	12/21/2005	ND[E]	ND[E]	
SF201	11/01/2005	09/17/2004	11/01/2005	09/17/2004	
SF204	09/23/2005	09/23/2005	11/23/2005	09/23/2005	
4th West Fan	09/27/2005				09/27/2005
DOF2	12/20/2005	12/20/2005	ND[E]	ND[E]	
SF101	11/22/2005	11/22/2005	11/22/2005	09/20/2004	
SF104	09/28/2005	09/28/2005	11/22/2005	09/20/2004	
DOF1	09/28/2005	09/28/2005	09/28/2005	07/06/2005	
AHU-CC	10/25/2005	10/25/2005	10/25/2005	10/25/2005	
CCAC[D]			ND[E]		

[A] Information taken from air-handling unit maintenance logs. The shaded cells in the table represent filters that are not part of the standard filter configuration installed inside each system.

[B] MERV refers to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Minimum Efficiency Reporting Value (MERV) described in the American National Standards Institute (ANSI)/ASHRAE Standard 52.2-1999 entitled *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*.

[C] Filters provide a 90-95% average efficiency when tested using the methods outlined in ANSI/ASHRAE Standard 52.1-1992 entitled *Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter*.

[D] The air-handling units supply air to areas of the hospital not involved with patient care procedures. These areas are designed for business occupancy only.

[E] ND=not determined. The date of the last filter change could not be determined from information contained in the maintenance logs.

Figure 1. Column support with cardboard form removed in the crawlspace below the DRMC River Road facility. Fungicide visible as white deposit (arrow).

Figure 2. Column support with cardboard form in place in the crawlspace below the DRMC River Road facility. There were signs of past water incursion (arrow) but no visible mold.

Figure 3. One of the moisture sensing cables (arrow) installed in the crawlspace under the DRMC River Road facility to help detect future water leaks.

Figure 4. Ventilation supply ductwork from AHU2 running through a portion of the crawlspace under the DRMC River Road facility.

Figure 5. Drain for SF201 at the DRMC 400 East facility does not provide sufficient drop for proper drainage of excess condensate collected on the cooling coils. This is typical of many AHUs at 400 East.

Figure 6. Rust caused by standing water in SF 101 at the DRMC 400 East facility. The standing water results from an excess of condensate collected during periods of rain/high humidity that overwhelms collection basins.

Figure 7. Rust caused by standing water in SF 101 at the DRMC 400 East facility. The excess condensate during periods of rain/high humidity typically saturates the filters. This is typical of many AHUs at 400 East.

Figure 8. Water damage and small amount of mold (arrow) in rooftop air handler room for AHU 4th West. The AHU has a ducted air return, so the room does not serve as a return air plenum.

Figure 9. Snapshot from video examination of the inside of the supply duct above the ceiling in the C-section area on the third floor of the DRMC 400 East facility. The ductwork was clean and free from any visible dirt deposits.

Figure 10. Snapshot from video examination of the inside of the return duct above the ceiling in the neonatal intensive care unit (NICU) on the third floor of the DRMC 400 East facility. The ductwork showed visible accumulations of lint.

Figure 11. Snapshot showing accumulation of lint inside of the return duct above the ceiling in the neonatal intensive care unit (NICU) on the third floor of the DRMC 400 East facility.

Figure 12. Pile of lint inside return fan (RF) 202 at the DRMC 400 East facility. Lint is easily removed by ventilation filters and not recirculated back into the hospital.

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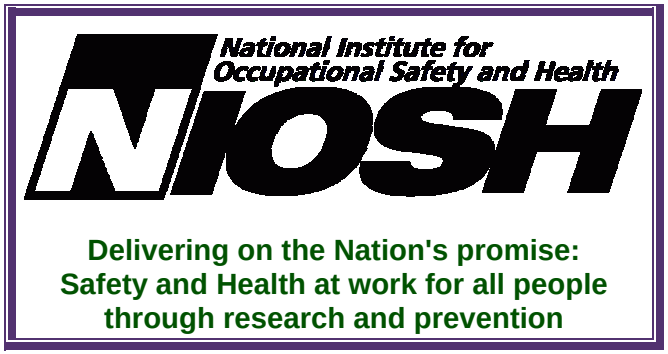

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