BEYOND THE WALLS

Extending ICRA Outside and Underground for a Multi-Building Hospital Campus Construction Project

Clare Morris Broderick, P.E., LEED-AP
Division Operating Officer
Building Systems Engineering, Birdsall Services Group

- In collaboration with -

Patrick Lorimer, MPH
Division Operating Officer
Environmental Consulting, Birdsall Services Group

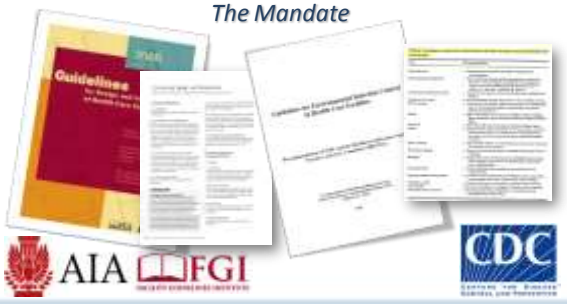
ICRA Plan - Beyond the Walls

The Mandate

- Healthcare facilities: significant emphasis on IAQ during construction & renovation projects.
- Construction-induced nosocomial infections dangerous for immune-suppressed patients; infection control measures are crucial.
- CDC & FGI/AIA Guidelines require ICRA be performed by multidiscipline infection control committee.
- In 2008, Paterson, NJ's St. Joseph's Regional Medical Center's Master Plan Implementation Project mandated shift from interior building ICRA focus to external excavation & demolition.
- St. Joseph's ICRA team succeeded in mitigation of health risks to their patients from the significant campus construction activity.

ICRA Plan - Beyond the Walls

The Mandate



ICRA Plan - Beyond the Walls

Crucial Components for Success

- **Assemble** ICRA team early! St. Joe's team formed in Design Development.
- **Conduct** regular ICRA focused meetings through all project phases, separate from design, owner & construction meetings. Integrate overall Risk Management process
  - site safety
  - building protective's
  - insurance & regulatory compliance issues
- **Identify** the hospital's critical areas potential airborne particulate risk
  - Understand the related existing building HVAC systems
  - paramount to a comprehensive and successful ICRA program
- **Ascertain** all ICRA costs, not only by contractor, owner direct labor & materials
  - engineering & consulting construction
  - Environmental Air Sampling
  - Construction Phasing & Protective's
- **Determine** impacts of construction schedule on ICRA
  - estimate costs of building demolition and site excavation means and methods
  - Know the ICRA specific activities to prevent dust migration
  - Protect ongoing hospital care at each stage

ICRA Plan - Beyond the Walls

St. Joseph's Regional Medical Center Master Plan

- Project Manager: **Sterling Barnett Little**, Arlington, Texas
- Architect: **Francis Cauffman**, New York, NY
- MEP, Structural, Site Engineering & Environmental Consultants: **Birdsall Services Group,** Eatontown, NJ
- Lobby Construction Manager: **O.A. Peterson**, Montclair NJ
- CCB Construction Manager: **Torcon, Inc.**, Red Bank, NJ
- 2008: Ground first broken on Master Plan Initiative
  - Expansion of the Paterson and Wayne campuses ($250M)
  - Paterson: $182.5M multi-faceted project added 185,000 sf to the facilities, including 174, 000 sf Critical Care Building
- Significant phased demolition, excavation, renovation, and new construction.
- Two campuses to stay fully-functional during project.
- Project completion: mid-2012.

St. Joseph's Regional Medical Center – Master Plan Implementation Project

City of Paterson, Passaic County, New Jersey

St. Joseph's Regional Medical Center – Master Plan Implementation Project

City of Paterson, Passaic County, New Jersey

ICRA Plan - Beyond the Walls

The Team

- With 3 years of campus demolition and construction activity, vigorous planning in the conceptual phase critical to ascertain potential risks
- Well before breaking ground, ICRA team formed. First meetings parallelled Design Development and Budget Determination Phase.
- Team consisted of:
  - Hospital Administration
  - Clinicians
  - Infection Control
  - Safety Officers
  - Facility Managers
  - Architects
  - MEP Engineering Consultants
  - Environmental Consultants
  - Construction Manager
  - Program Manager

ICRA Plan - Beyond the Walls

Critical Patient Areas

- Initial assessment, site investigation, impacts of projects
- Using 25+ sets of campus drawings, plans from 75+ years time span, quantified critical areas of hospitals & associated building systems:
  - HVAC systems and zones (60+ existing)
  - Areas served, size, location
  - Outside intake points
- ICRA team collectively:
  - honed in on those areas/systems most critically affected
  - assessed building envelope
  - determined extent of building sealing to protect against dust infiltration

ICRA Plan - Beyond the Walls

Plan Development: Monitoring Strategy

- Selection of most critical systems and strategic air sampling monitoring locations
- Critical Areas:
  - Emergency Department
  - Main Building Patient Entrance
  - Surgical Suite
  - ICU/CCU
  - Cath Lab Suite
  - Ancillary Patient Entries

ICRA Plan - Beyond the Walls

Putting the Plan into Action

- Environmental Monitoring**:** Establishing a Baseline
  - Initial task: Conduct 8-hour, on-site fugitive nuisance dust air monitoring using real time particulate sampling device
- Data was used to prepare a "Dust Control Plan"
- Areas to be monitored:
  - 275 Building Clinic renovation
  - Critical Care Building
  - New Hospital Lobby
  - Wayne Facility OR/ICU renovation

ICRA Plan - Beyond the Walls

Putting the Plan into Action

- Baseline established
- Ongoing monitoring data compared to baseline measurements:
  - Range from 0.001 milligrams per cubic meter (mg/m3) to 0.053 mg/m3
  - OSHA permissible exposure limit of 15 mg/m3 for particulates not otherwise regulated.
- Monitoring to continue on regular basis for approx. 2.5 years and provide quantitative means to determine potential dust infiltration

ICRA Plan - Beyond the Walls

Putting the Plan into Action: Protecting Patients Prior to Work

- Sealing locked/screwed shut exterior windows with silicone caulking on critically exposed building facades
- Inspecting and correcting air-handling unit pre-filter assemblies for tightness
- Changing pre-filters as needed
- Installing pre-filters on fresh air intake vents in vicinity of construction areas
- Positively pressurizing all critical care area HVAC systems
- Installation of pressure gauges through window framing at selected corridors for positive pressure indication over time
- At every stairwell doorway above ground floor, install alarms w/corresponding warning signage to prevent use of fire stairwells for normal employee traffic
- Extension of HVAC fresh air intake ductwork above ground level construction

ICRA Plan - Beyond the Walls

Putting the Plan into Action: Protecting Patients During the Work

- Contractor work practices and cleaning activities
- Taking exit doors bordering construction areas out of service
- Placing additional floor mats inside select stairwell entrances near construction areas
- Increasing routine housekeeping operations in critical areas to quickly clean residual soil tracked in by staff
- Safety cones to prevent ambulance parking and diesel odors from entrainment into Regan Building's Open Heart Recovery Room (OHRR)
- Periodically smoke test at suite entries to confirm pressurization
- Monitoring that sealed windows remain sealed
- Bio-fuel powered excavation equipment at ambient temperature above 55 degrees to eliminate odors associated with diesel
- Continuous water spraying during placement of demolition debris into waste containers to control the aerosolization of dust

ICRA Plan - Beyond the Walls

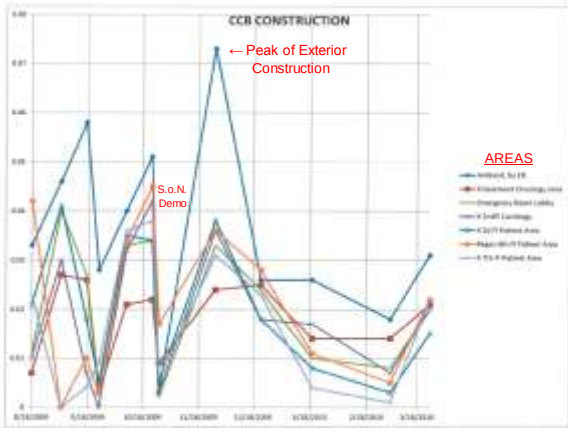
Keys to Successful Implementation

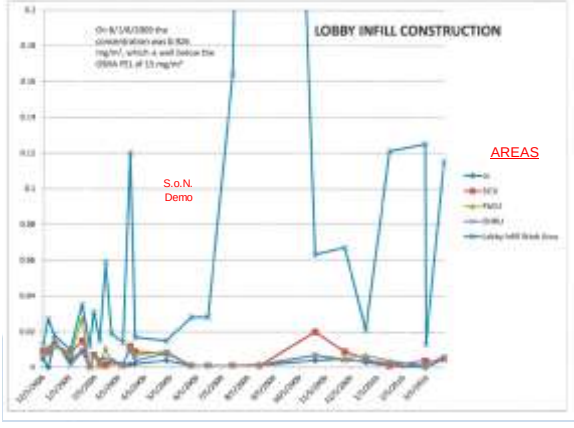
- ICRA measures custom-tailored
- Sampling Methodology
- Visual Investigation Protocol - regular on-site visual investigations to identify obvious sources of contamination
- Ongoing Review Process

ICRA Plan - Beyond the Walls

Air Monitoring Results

- Ongoing result comparisons throughout project identified total particulate measurements collected categorically as: "not detected above the instrument's level of detection"
- Consistently, results of ongoing testing- well within normal range of baseline
- CO/CO2 results non-detectable
- Particulate matter low
- Without exceptions, results indicative of successful mitigation protocol





ICRA Plan - Beyond the Walls

When Things Don't Go as Planned

- During demolition of School of Nursing, unexpected building collapse
  - High level of dust & debris
- Measures in place protected against potential infiltration to hospital
- Underscores importance of ICRA program in Construction Project Risk Management

ICRA Plan - Beyond the Walls

At What Cost?

PATERSON CAMPUS
Total Construction Cost: $138M
Grand Total Project Costs: $182.5M

ICRA Costs:
Contractor Protectives - $190,000

Owner In-house - $100,000

Engineering & Environmental
Air Monitoring - $116,000

Total ICRA Costs: $406,000

- **Compared to total project cost, ICRA costs were less than one quarter of one percent.**

Extending ICRA Outside the Walls

- As a risk management endeavor, the costs of ICRA are almost negligible relative to the total project costs of a major hospital campus expansion
- Throughout entire multi-phased project, CDC guidelines were successfully followed ensuring airborne dust particles were contained
- Throughout process, existing hospital functioned fully
  - Practices and procedures put in place ensured uninterrupted high quality patient care
- ICRA measures properly executed and overseen by interdisciplinary committee yielded substantial safety benefits

BEYOND THE WALLS

Extending ICRA Outside and Underground for a Multi-Building Hospital Campus Construction Project

Clare Morris Broderick, P.E., LEED-AP
Division Operating Officer
Building Systems Engineering, Birdsall Services Group

- In collaboration with -

Patrick Lorimer, MPH
Division Operating Officer
Environmental Consulting, Birdsall Services Group

ICRA Plan - Beyond the Walls
The Mandate

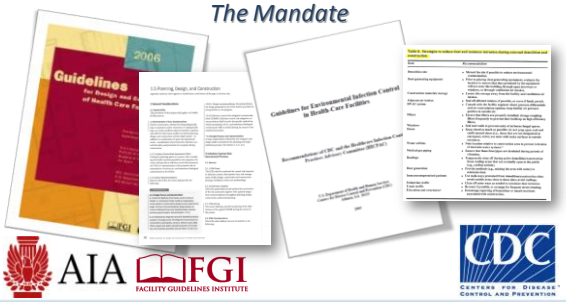
- Healthcare facilities: significant emphasis on IAQ during construction & renovation projects.
- Construction-induced nosocomial infections dangerous for immune-suppressed patients; infection control measures are crucial.
- CDC & FGI/AIA Guidelines require ICRA be performed by multidiscipline infection control committee.
- In 2008, Paterson, NJ's St. Joseph's Regional Medical Center's Master Plan Implementation Project mandated shift from interior building ICRA focus to external excavation & demolition.
- St. Joseph's ICRA team succeeded in mitigation of health risks to their patients from the significant campus construction activity.

ICRA Plan - Beyond the Walls
Crucial Components for Success

- **Assemble** ICRA team early! St. Joe's team formed in Design Development.
- **Conduct** regular ICRA focused meetings through all project phases, separate from design, owner & construction meetings. Integrate overall Risk Management process
- **Identify** the hospital's critical areas potential airborne particulate risk
- **Ascertain** all ICRA costs, not only by contractor, owner direct labor & materials
- **Determine** impacts of construction schedule on ICRA

ICRA Plan - Beyond the Walls

The Mandate



AIA FGI FACILITY GUIDELINES INSTITUTE

CDC CENTERS FOR DISEASE CONTROL AND PREVENTION

Helpful Links:

CDC Guidelines

FGI Guidelines

ICRA Plan - Beyond the Walls

St. Joseph's Regional Medical Center Master Plan

- Project Manager: **Sterling Barnett Little**, Arlington, Texas
- Architect: **Francis Cauffman**, New York, NY
- MEP, Structural, Site Engineering & Environmental Consultants: **Birdsall Services Group,** Eatontown, NJ
- Lobby Construction Manager: **O.A. Peterson**, Montclair NJ
- CCB Construction Manager: **Torcon, Inc.**, Red Bank, NJ
- 2008: Ground first broken on Master Plan Initiative
  - Expansion of the Paterson and Wayne campuses ($250M)
  - Paterson: $182.5M multi-faceted project added 185,000 sf to the facilities, including 174, 000 sf Critical Care Building
- Significant phased demolition, excavation, renovation, and new construction.
- Two campuses to stay fully-functional during project.
- Project completion: mid-2012.

St. Joseph's Healthcare System | Francis Cauffman | Birdsall Services Group | torcon | Sterling Barnett Little, Inc.

St. Joseph's Regional Medical Center – Master Plan Implementation Project

City of Paterson, Passaic County, New Jersey

ICRA Plan - Beyond the Walls
The Team

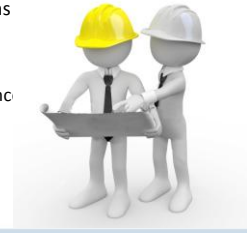
- With 3 years of campus demolition and construction activity, vigorous planning in the conceptual phase critical to ascertain potential risks
- Well before breaking ground, ICRA team formed. First meetings paralleled Design Development and Budget Determination Phase.
- Team consisted of:
  - Hospital Administration
  - Clinicians
  - Infection Control
  - Safety Officers
  - Facility Managers
  - Architects
  - MEP Engineering Consultants
  - Environmental Consultants
  - Construction Manager
  - Program Manager

ICRA Plan - Beyond the Walls
Critical Patient Areas

- Initial assessment, site investigation, impacts of projects
- Using 25+ sets of campus drawings, plans from 75+ years time span, quantified critical areas of hospitals & associated building systems:
  - HVAC systems and zones (60+ existing)
  - Areas served, size, location
  - Outside intake points
- ICRA team collectively:
  - honed in on those areas/systems most critically affected
  - assessed building envelope
  - determined extent of building sealing to protect against dust infiltration

ICRA Plan - Beyond the Walls
Plan Development: Monitoring Strategy

- Selection of most critical systems and strategic air sampling monitoring locations
- Critical Areas:
  - Emergency Department
  - Main Building Patient Entranc
  - Surgical Suite
  - ICU/CCU
  - Cath Lab Suite
  - Ancillary Patient Entries



ICRA Plan - Beyond the Walls

Putting the Plan into Action

- Environmental Monitoring: Establishing a Baseline
  - Initial task: Conduct 8-hour, on-site fugitive nuisance dust air monitoring using real time particulate sampling device
- Data was used to prepare a "Dust Control Plan"
- Areas to be monitored:
  - Clinic Building renovation
  - Critical Care Building
  - New Hospital Lobby
  - Wayne Facility OR/ICU renovation

ICRA Plan - Beyond the Walls

Putting the Plan into Action

- Baseline established
- Ongoing monitoring data compared to baseline measurements:
  - Pre-construction range from 0.001 milligrams per cubic meter (mg/m3) to 0.053 mg/m3
  - OSHA permissible exposure limit of 15 mg/m3 for particulates not otherwise regulated.
- Monitoring to continue on regular basis for approx. 2.5 years and provide quantitative means to determine potential dust infiltration

ICRA Plan - Beyond the Walls

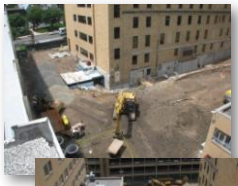
Putting the Plan into Action: Protecting Patients Prior to Work

- Sealing locked/screwed shut exterior windows with silicone on critically exposed building facades
- Inspecting & correcting air-handling unit pre-filter assemblies for tightness
- Changing pre-filters as needed
- Installing pre-filters on fresh air intakes (F.A.I.) in vicinity of construction

ICRA Plan - Beyond the Walls

Putting the Plan into Action: Protecting Patients Prior to Work

- Installation of pressure gauges through window framing at selected corridors for positive pressure indication over time
- At stairwell doorways above grade, install alarms & warning signage to prevent use of fire stairwells for normal employee traffic
- Extension of HVAC F.A.I. air intake ductwork above ground level construction



ICRA Plan - Beyond the Walls

Putting the Plan into Action: Protecting Patients During the Work

- Contractor work practices & cleaning activities
- Taking exit doors bordering construction areas out of service
- Placing floor mats inside select stairwell entrances near construction areas
- Increasing routine housekeeping operations in critical entry areas to quickly address foot traffic soil/dust

American Hospital Association

ICRA Plan - Beyond the Walls

Putting the Plan into Action: Protecting Patients During the Work

- Safety cones off parked ambulance so no diesel odors entered into Regan Building's Open Heart Recovery Room
- Periodically smoke test at suite entries to confirm pressurization
- Monitoring that sealed windows remain sealed
- Bio-fuel powered excavation equip. at <55 deg. F amb. to eliminate diesel odors
- Continuous water spraying during demo. debris transfer to waste containers to control the aerosolization of dust

American Hospital Association

ICRA Plan - Beyond the Walls

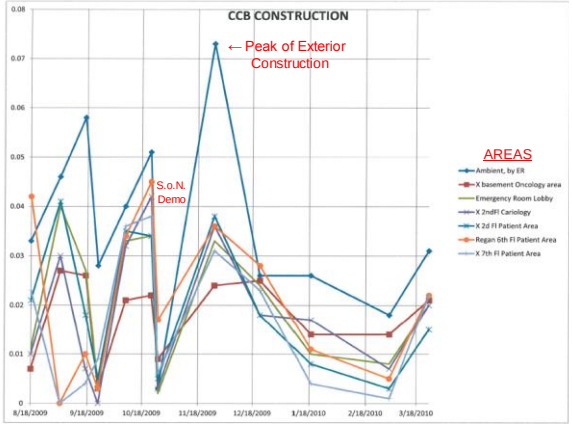
Keys to Successful Implementation

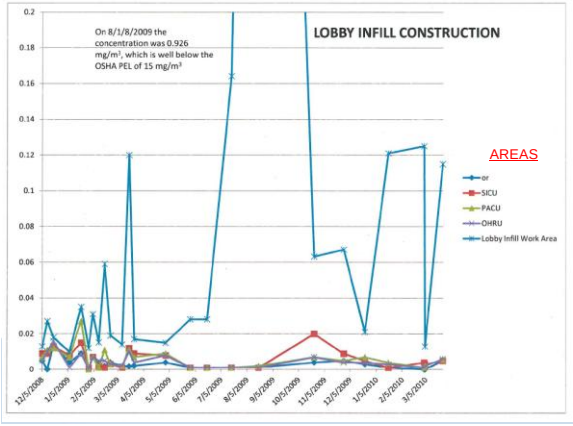
- ICRA measures custom-tailored
- Sampling Methodology
- Visual Investigation Protocol - regular on-site visual investigations to identify obvious sources of contamination
- Ongoing Review Process

ICRA Plan - Beyond the Walls

Air Monitoring Results

- Ongoing result comparisons throughout project identified total particulate measurements collected categorically as: "not detected above the instrument's level of detection"
- Consistently, results of ongoing testing- well within normal range of baseline
- CO/CO2 results non-detectable
- Particulate matter low
- Without exceptions, results indicative of successful mitigation protocol

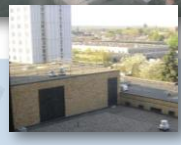




ICRA Plan - Beyond the Walls

When Things Don't Go as Planned

- During demolition of School of Nursing, unexpected building collapse
  - High level of dust & debris
- Measures in place protected against potential infiltration to hospital
- Underscores importance of ICRA program in Construction Project Risk Management



ICRA Plan - Beyond the Walls

At What Cost?

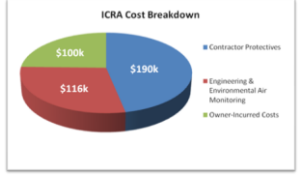
PATERSON CAMPUS
Total Construction Cost: $138M
Grand Total Project Costs: $182.5M

ICRA Costs:
Contractor Protectives - $190,000

Owner In-house - $100,000

Engineering & Environmental Air Monitoring - $116,000

Total ICRA Costs: $406,000



- **Compared to total project cost, ICRA costs were less than one quarter of one percent.**

Comparison of ICRA costs to Total Project Cost

"A Drop in the Bucket"

ICRA Costs	
Contractor Protectives:	$190,000
Engineering & Env. Air Monitoring:	$116,000
Owner-Incurred Costs:	$100,000
Total ICRA Costs:	**$406,000**

ICRA Plan - Beyond the Walls

The Takeaway…

- As a risk management endeavor, the costs of ICRA are almost negligible relative to the total project costs of a major hospital campus expansion
- Throughout entire multi-phased project, CDC guidelines were successfully followed ensuring airborne dust particles were contained
- Throughout process, existing hospital functioned fully
  - Practices and procedures put in place ensured uninterrupted high quality patient care
- ICRA measures properly executed and overseen by interdisciplinary committee yielded substantial safety benefits

ASHE

American Hospital Association

BEYOND THE WALLS:
EXTENDING ICRA OUTSIDE AND UNDERGROUND FOR A MULTI-BUILDING HOSPITAL CAMPUS CONSTRUCTION PROJECT

Clare Morris Broderick, PE, LEED-AP
Division Operating Officer of Building Systems Engineering,
Birdsall Services Group
Eatontown, New Jersey

- in collaboration with -

Patrick Lorimer, MPH
Division Operating Officer of Environmental Consulting,
Birdsall Services Group
Eatontown, New Jersey

Abstract

The healthcare construction industry has put significant emphasis on the proper management of indoor air quality during construction and renovation projects. Guidelines from the Center for Disease Control (CDC) require an Infection Control Risk Assessment (ICRA) by a multidiscipline infection control committee to serve as a proactive strategy to protect healthcare patients from these environmental hazards. In 2008, a complex multi-building construction project for St. Joseph's Regional Medical Center in New Jersey, encompassing renovations, demolition, and new construction on the fully-functioning hospital campus, mandated that an ICRA committee be formed with focus shifted from the traditional interior concerns to those that are produced by external excavation, demolition and construction. As the hospital's multidiscipline engineering and environmental consultant, Birdsall Services Group was active in the formulation of the ICRA team, which developed a program that included measures such as dust barrier systems, construction and pedestrian traffic control, demolition activity dust mitigation, building exterior infiltration protectives, visual monitoring, and air system flow and pressurization controls. An overall testing protocol and plan was executed, which encompassed baseline air monitoring, and ongoing testing optimized for the protection of critical hospital areas, as mandated by the construction work areas and schedule. Throughout demolition and construction, CDC guidelines were successfully followed, and the measures facilitated the successful mitigation of health risks to patients from significant nearby construction activity.

St. Joseph's Regional Medical Center Master Plan Project Summary

St. Joseph's Healthcare System is comprised of St. Joseph's Regional Medical Center and St. Joseph's Children's Hospital on the Paterson campus, St. Joseph's Wayne Hospital, a division of St. Joseph's Regional Medical Center, on the Wayne campus, St. Vincent's Nursing Home in Cedar Grove, Visiting Health Services of New Jersey, and more than two dozen ambulatory and clinic sites located across northern New Jersey. With New York-based Francis Cauffman Architects as the lead on the project, and Birdsall Services Group (BSG) retained as the Engineer of Record providing Master Plan services and a full complement of engineering and consulting services, ground was broken in 2008 on a master plan initiative to expand the Paterson and Wayne campuses. Initiated by a comprehensive Master Plan effort which began in 2006 and encompassed the two campuses, this multi-million dollar, multi-faceted project added over 185,000 square feet to the facilities, including a new 174,000 square foot Critical Care Building at the Paterson campus. The new Critical Care Building is the cornerstone of the new Paterson campus plan and includes an expansion of the Emergency Department, two floors of Intensive Care Suites, and a new Operating Suite complete with state-of-the art specialized digital and robotic equipment.

The full range of services provided by BSG for the project included Master Plan Services, Preliminary Assessment Services, Commissioning Services, Cost and Value Engineering, Structural Engineering, Mechanical Engineering, Electrical Engineering, Plumbing Engineering, Fire Protection Engineering, Site Civil Engineering, Surveying, Utility Permitting, Flood Analysis, Landscape/Lighting, Remedial Investigation, Health and Safety Compliance, Vapor Intrusion Investigation, and Asbestos Compliance. The project included a significant amount of new construction, and the design challenges for the infrastructure at the Paterson campus were several-fold. The existing urban hospital campus has been redesigned to improve patient entry, access and flow and to replace outmoded buildings, systems, and infrastructure. To achieve these goals, key design elements included the new

Critical Care Building, an infill Lobby Building, a structured parking facility with retail, and surface parking lots, entryways, and drop-off aisles. To make way for the new construction, multiple aged campus buildings were demolished (the School of Nursing in the 100 Plaza Building, the Johnson Building, the Auditorium Building, the Parking Garage and the Medical Records Building), and significant renovations were made within the Xavier Building, Seton Building and the Regan building.

Rationale

With healthcare-associated infections (HAI) posing a large threat to immune suppressed patients, environmental infection control measures are crucial. Outbreaks of HAIs have occurred in association with construction, demolition and renovation. One of the most common fungi associated with HAIs, Aspergillus is of paramount concern in relation to any environmental disturbances that produce airborne dust particles.[1] Found both in indoor and outdoor environments including soil, most people breathe in Aspergillus spores everyday without being affected. But for people with weakened immune systems or lung diseases, such as found in hospital patients, Aspergillus can cause a spectrum of illness including allergic reactions, lung infections, and infections in other organs.[2]

For hospital construction projects, it is now required by multiple agencies that an Infection Control Risk Assessment (ICRA) be performed by a multidiscipline infection control committee to serve as a proactive strategy against environmental hazards such as Aspergillus for all patients, especially those in the most critical conditions. An ICRA is an evaluation of the potential risk of transmitting biological agents in the facility during construction activity. It is on the basis of the ICRA that specific recommendations for mitigating infection risks are made. In a collaborative effort with the Healthcare Infection Control Practices Advisory Committee (HICPAC), guidelines from the CDC state "environmental disturbances caused by construction and/or renovations and repair activities in and near health-care facilities markedly increase the airborne Aspergillus spp. spore counts in the indoor air of such facilities, thereby increasing the risk for healthcare-associated Aspergillosis among high-risk patients."[3] The CDC endorses a multidisciplinary ICRA team approach to coordinate at various stages of construction activities, and depending on the complexity of the project, recommends representation of members from, (and perhaps even beyond), "environmental services, employee health, engineering, and infection control" (see Appendix A). The guidelines also outline responsibilities for the members, including development of a comprehensive project management plan, risk assessment, and the establishment of site-specific infection-control protocols, among other functions. The multidisciplinary team considers the environment, infectious agents, human factors, and the

[1] Donna Haiduven, "Nosocomial Aspergillosis and Building Construction," Medical Mycology 47 (2009) s210-s216, Informa Healthcare, 14 March 2012 <www.informahealthcare.com>.

[2] D. Riley, J. Freihaut, W. Bahnfleth, Z. Karapetyan, "Indoor Air Quality Management and Infection Control in Health Care Facility Construction," Proceedings of the CIB World Building Conference, 2004, 17 Feb. 2012, <http://www.engr.psu.edu/iec/publications/papers/indoor_air_quality.pdf>.

[3] L.M. Sehulster, et al., Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). (Chicago, IL: American Society for Healthcare Engineering/American Hospital Association, 2004).

impact of the proposed project. Beyond team member responsibilities, it is recommended all hospital staff and construction workers in and around the site are aware of the protocols being implemented to ensure daily adherence for the duration of the project.

In addition to a CDC requirement, an ICRA is also mandated by the *Guidelines for Design and Construction of Health-Care Facilities*, formerly known as the "American Institute of Architects (AIA) Guidelines". Having originally developed the concept of ICRA, the *Guidelines* define it as "a multidisciplinary process intended to proactively identify and mitigate risks from infection that could occur during construction activities" and represent standards for best practices in U.S. healthcare. And like the CDC document, the *Guidelines* recommend that, at minimum, an ICRA team should be comprised of expertise in infection prevention and control, direct patient care, facility design, and HVAC and plumbing systems when appropriate. According to this document, ICRA considerations should also extend to design elements, surfaces and furnishings, construction elements. Additionally, the *Guidelines* outlines the significance of planning and Infection Control Risk Mitigation Recommendations (ICRMR) that are the responsibility of the team prior to the start of construction activities.[4]

ICRA guidelines have historically addressed the concerns for dust-producing activities related to renovation projects *inside* actively functioning hospitals. However, complex projects consisting of multi-building construction, demolition, and renovation activity adjacent to functional hospital buildings pose even greater risks to patient safety and require an ICRA strategy that extends beyond the standard CDC and AIA recommendations to outside the building and underground on site.

In 2008, St. Joseph's Regional Medical Center in Paterson, NJ began the $182,500,000 expansion project on the campus of their Acute Care Facility. Mostly occupied now, and slated for total completion in mid-2012, the multiphase project involved the construction of 174,000 sf of treatment and waiting areas, Critical Care Units, a Surgical Intensive Care Unit, pre-op and post-op areas, trauma bays, an Emergency Department, an Open Heart Cardiac Care Unit, and an Intensive Respiratory Unit. The ambitious project was necessary to meet the growing demand of patient care in the region. The tight site constraints required significant excavation and the demolition of a number of buildings, including a mid-twentieth century School of Nursing that was situated adjacent to the functioning hospital. This complex project on a fully-operating campus mandated that an ICRA committee be formed with focus shifted from solely interior concerns to balance and seriously consider those that would be produced by the external excavation and demolition. This awareness was the foundation of BSG's ICRA initiative for this project.

ICRA Plan Development

It was understood that vigorous planning during the conceptual phase of the St. Joseph's Regional Medical Center Master Plan project would best ascertain the potential risks, and the development of an interdisciplinary program to guide the planning of the additions and renovations was executed very early in the process. Well in advance of breaking ground, the ICRA team was assembled during the Design Development and Budget Determination Phase. The complete team consisted of hospital administration, clinicians, infection control,

[4] The Facility Guidelines Institute, Guidelines for Design and Construction of Health Care Facilities, 2010 edition.

safety officers, facility managers, architects, BSG's MEP engineering consultants and environmental consultants, the construction manager and program manager.

BSG performed a preliminary assessment and site investigation to ascertain the risks involved. BSG utilized campus drawings and plans and identified on site each of the HVAC systems, zones, areas served and size, and outside air intake points. Using this information of existing building systems, the ICRA team identified those most likely to be critically affected by construction work, assessed the building envelope and determined the extent of building sealing necessary to make the perimeter tighter and less likely to allow for the infiltration of dust. Critical areas were determined based also on the level of patient care and susceptibility, and adjacency to the work site. Accordingly, the ICRA team selected the most critical HVAC systems for temporary positive pressure adjustment and physical locations for strategic air sampling monitoring throughout the hospital that would continue throughout the duration of construction activities.

Notably, it was ascertained that the close proximity of the demolition of the 100 Plaza Building (formerly a mid-twentieth century School of Nursing) and the new construction activities of the Critical Care Building additions had the potential to pose construction-induced infection risk to health-compromised patients in the active existing hospital facility. Areas deemed critical for protection were the Emergency Department (ED), the Main Building Patient Entrance, the Inpatient and Outpatient Surgical Suites, the ICU/CCU, and the Cath Lab.

Putting the Plan into Action

Environmental Monitoring

In November of 2008, BSG's Health, Safety, and Environmental Hygiene Services Division was requested by SJRMC to act as the qualified Environmental Consultant to conduct baseline air monitoring, as well as conduct supplementary air monitoring during on-going construction activities. The purpose of the sampling was to ensure the effectiveness of a written dust control plan and the dust control measures employed during renovation and construction activities, which were understood to occur for a period of approximately 2.5 years. This was to include activities for the 275 Building Clinic renovation, the Critical Care Building, the new Hospital Lobby, and the Wayne facility OR/ICU renovation. The environmental testing would be the tool to confirm that the chosen designed ICRA protocols were being performed as required.

With careful consideration of the hospitals 60-plus HVAC systems, The ICRA team identified the most critical monitoring points inside and around the existing building as determined by our MEP design team and facilities management staff. BSG's Environmental Consultants developed a planned schedule for regular on-site monitoring to consist of sampling and analysis of specific potential contaminants to convey air quality within designated areas at these aforementioned locations of the hospital campus. It was determined that the field measurements for total particulates, such as nuisance and inert dust not otherwise regulated, would be compared to the existing Occupational Safety and Health Administration (OSHA) permissible exposure limited (PEL) standard, based upon the assumption that the respirable fraction of the particulates contain no asbestos and less than 1% silica, which was confirmed by SJRMC prior to the start of the project. The scope of services also included additional monitoring and testing services on an as-needed, expedited basis for fast reaction to emergent conditions of concern.

Establishing a Baseline

The initial task was to conduct full-time (8-hour) on-site baseline fugitive nuisance dust air monitoring using a real-time total particulate sampling device prior to demolition and earthwork along the perimeter of the construction areas to verify compliance with the specifications and applicable regulations. This data was used to prepare a "Dust Control Plan" and served to establish control levels for continuous monitoring as well as to provide a basis for which to document through a quantitative means that potential dust within the occupied areas of the Hospital had not increased due to the ongoing renovations and construction activities. At the conclusion of these initial IAQ measurements and air monitoring activity, baselines were established for all areas to be tested. Total particulate measurements from ongoing monitoring were to be compared to the baseline measurements that ranged from 0.001 milligrams per cubic meter (mg/m3) to 0.053 mg/m3 and the OSHA permissible exposure limit (PEL) of 15 mg/m3 for particulates not otherwise regulated.

ICRA Processes

ICRA protocols were tailored at various locations throughout the campus in accordance with the level of construction/renovation activity, an assessment of the critical areas on the campus in relation to Hospital occupancy, the map of HVAC air intake systems of the buildings throughout the campus, and the likely potential to pose construction-induced infection risk based on proximity to personnel and health-compromised patients in occupied areas of the Hospital.

The more significant ICRA measures included:

- On critical existing building exposures, sealing locked/screwed shut exterior windows with silicone caulking;
- Sealing of certain exterior brick façades between subject rooms to minimize vapor intrusion;
- Inspecting air-handling unit pre-filters for tightness;
- Changing pre-filters as needed;
- Positively pressurizing all critical care area HVAC systems;
- Installing pre-filters on fresh air intake vents in the vicinity of construction areas;
- The installation of pressure gauges through the window framing in particular corridors to ensure that the portions of the Hospital bordering the construction work areas were maintained under positive pressure to prevent/minimize fugitive dust from becoming entrained through the building envelope;
- Alarms placed on every doorway above ground floor with corresponding warning signage leading into stairwells to prevent fugitive dust from being tracked up the fire stairwell into the occupied areas of the Hospital;
- Installation of a ductwork extension on the fresh air intake of the heating, ventilation and air condition (HVAC systems) serving areas of concern;
- The implementation of Contractor work practices and cleaning activities during renovation and construction operations to reduce the spread of dust and construction-related contaminants to other areas of the Hospital;
- Taking exit doors bordering construction areas out of service;
- Temporarily close any under-window fan coil units on building exposures facing new construction areas, serving patient rooms;
- Placing additional floor mats inside particular stairwell entrances near construction areas and increasing routine housekeeping operations in these areas to clean any residual soil tracked in by the staff;

- Safety cones placed outside to temporarily prevent ambulance parking in order to prevent diesel odors from becoming entrained into the first floor Regan Building's Open Heart Recovery Room (OHRR);
- Over course of construction, periodically smoke test at suite entries to confirm pressurization;
- Monitoring that sealed windows remain sealed;
- The use of bio-fuel powered excavation equipment once the ambient temperature was sustained above 55 degrees to eliminate odors associated with diesel;
- Spraying water continuously during the placement of demolition debris into waste containers to control the aerosolization of dust.

These measures closely model the strategies outlined in the CDC Guidelines below.

[5]

Table 8. Strategies to reduce dust and moisture intrusion during external demolition and construction

Item	*Recommendation*
Demolition site	• Shroud the site if possible to reduce environmental contamination.
Dust-generating equipment	• Prior to placing dust-generating equipment, evaluate the location to ensure that dust produced by the equipment will not enter the building through open doorways or windows, or through ventilation air intakes.
Construction materials storage	• Locate this storage away from the facility and ventilation air intakes.
Adjacent air intakes	• Seal off affected intakes, if possible, or move if funds permit.
HVAC system	• Consult with the facility engineer about pressure differentials and air recirculation options; keep facility air pressure positive to outside air.
Filters	• Ensure that filters are properly installed; change roughing filters frequently to prevent dust build-up on high-efficiency filters.
Windows	• Seal and caulk to prevent entry of airborne fungal spores.
Doors	• Keep closed as much as possible; do not prop open; seal and caulk unused doors (i.e., those that are not designated as emergency exits); use mats with tacky surfaces at outside entrances.
Water utilities	• Note location relative to construction area to prevent intrusion of dust into water systems.*
Medical gas piping	• Ensure that these lines/pipes are insulated during periods of vibration.
Rooftops	• Temporarily close off during active demolition/construction those rooftop areas that are normally open to the public (e.g., rooftop atrium).
Dust generation	• Provide methods (e.g., misting the area with water) to minimize dust.
Immunocompromised patients	• Use walk-ways protected from demolition/construction sites; avoid outside areas close to these sites; avoid rooftops.
Pedestrian traffic	• Close off entry ways as needed to minimize dust intrusion.
Truck traffic	• Reroute if possible, or arrange for frequent street cleaning.
Education and awareness+	• Encourage reporting of hazardous or unsafe incidents associated with construction.

[5] L.M. Sehulster, et al., Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). (Chicago, IL: American Society for Healthcare Engineering/American Hospital Association, 2004). P.30

Sampling Methodology

Ongoing monitoring, in the form of real-time direct read measurements, was conducted on regular intervals established by the ICRA Team and aligned with the recommendations of BSG's Environmental Consultants. The measurement schedule was dictated by the level of activity at the time of construction. Indoor Air Quality tests were performed to measure three basic parameters, namely carbon dioxide (CO2), carbon monoxide (CO), and total Volatile Organic Compounds (VOCs) parameters. Measurements were compared to a baseline IAQ parameter, the respective New Jersey Indoor Air Quality Standard (N.J.A.C. 12:100) and the American Conference of Governmental Industrial Hygienists (ACGIH) standards/exposure limit, and OSHA PEL. The ongoing data collection was deemed necessary to assess if the engineering controls and work practices being conducted by the Contractor and the Client's custodial staff at the time of each investigation were adequate to control dust and other contaminants that might be generated during the renovation and construction operations. Weather was also monitored and recorded with the understanding that the dust activity is affected by winds and precipitation. The ICRA Team and BSG made necessary recommendations for changes in testing areas and frequencies if the data deemed it necessary throughout the process.

Visual Investigation Protocol

The efforts conducted by BSG included regular on-site visual investigations to identify obvious sources of contamination and conditions known to have potential negative impacts on indoor air quality. During the course of this investigation, the major work areas were evaluated to ensure that all parties involved in the project were adhering to the existing means and methods that had been established for this specific project.

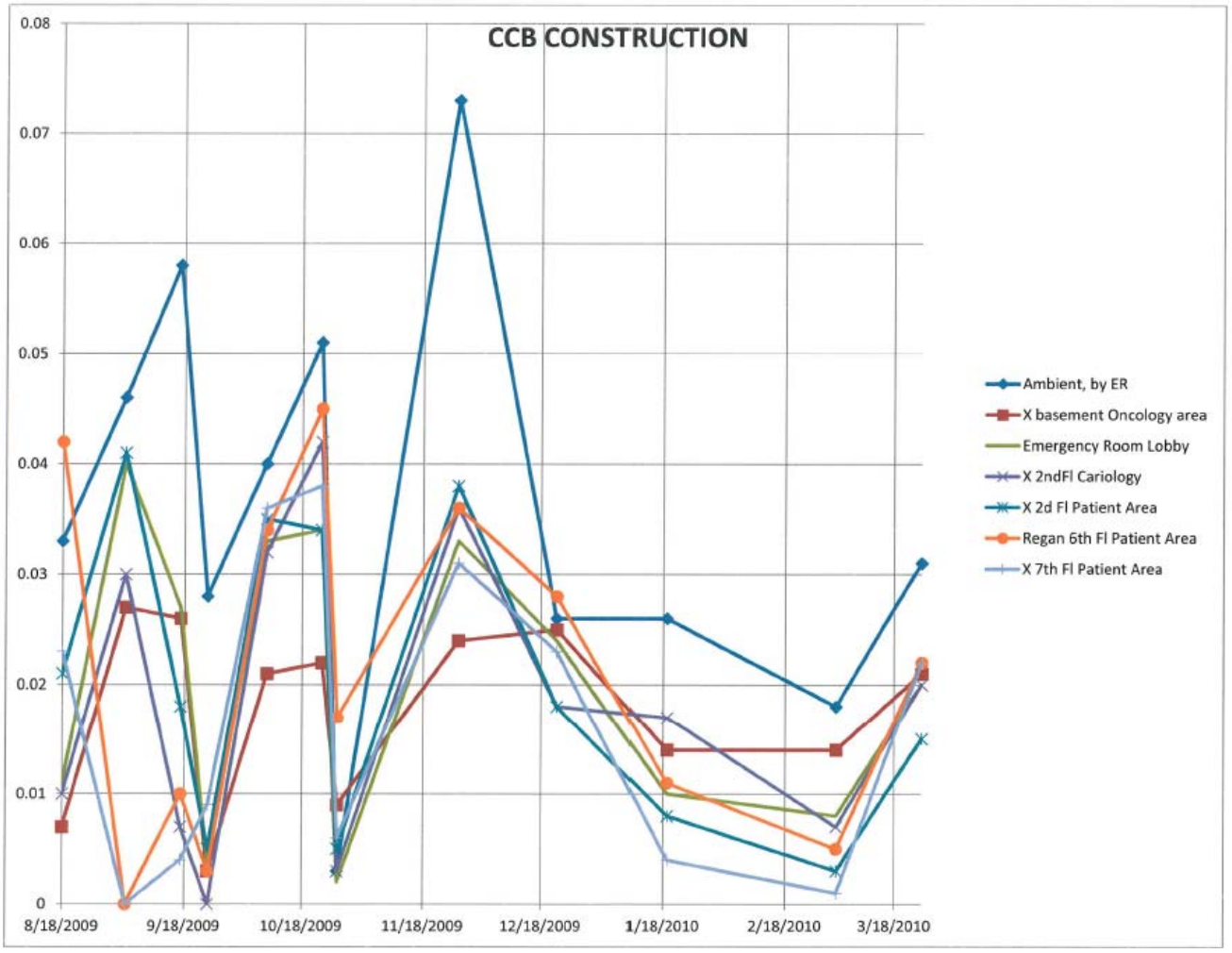
Ongoing Review Process

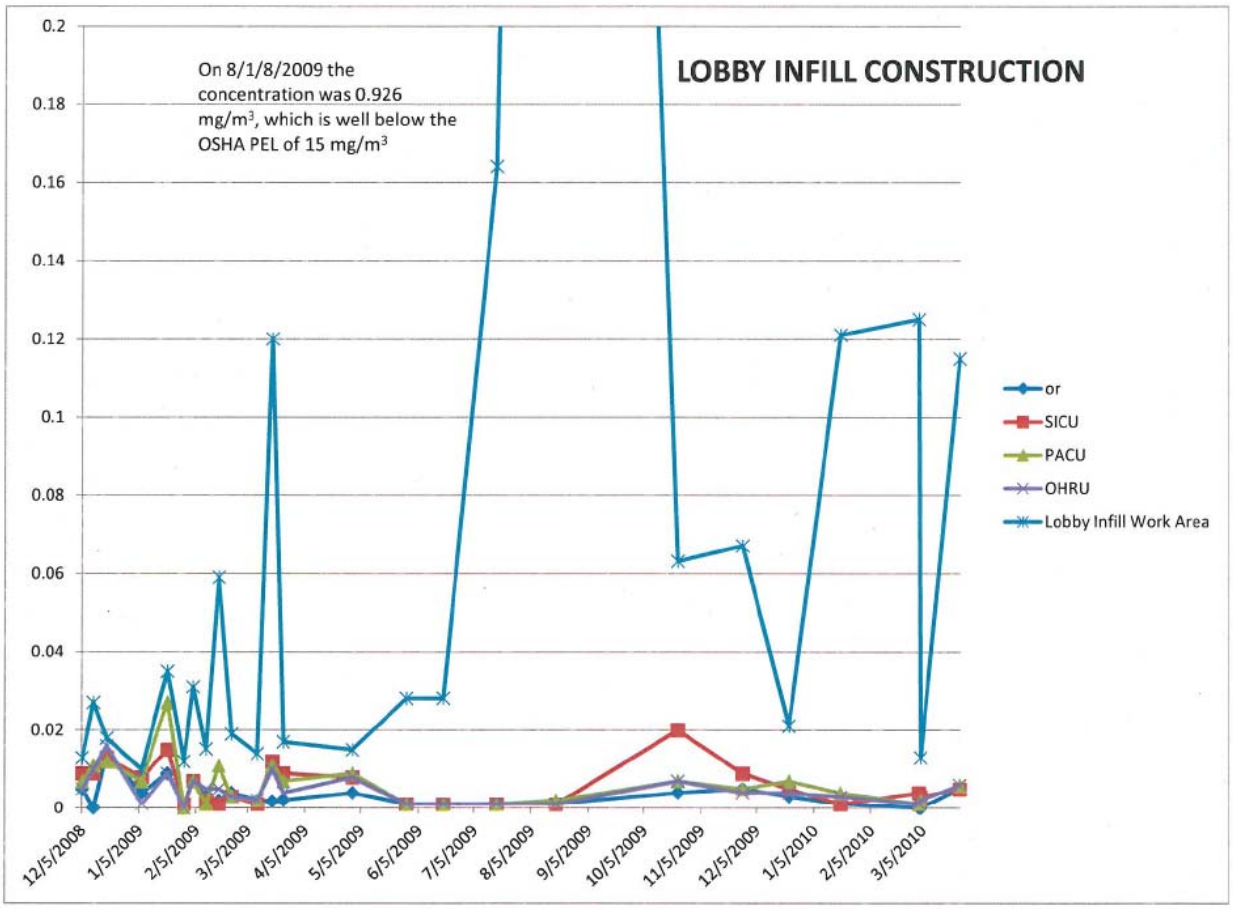
An important part of the ICRA progression was the implementation of a review process during each new phase of the construction activities to evaluate if any additional investigation and/or sampling would need to be conducted, or if additional control needed to be implemented. Infection Risk protocols in place were adapted to the needs of the activity and dictated by results of the ongoing testing. For example, in March of 2009, IAQ measurements collected in the Regan Building during the "Lobby Infill Phase" indicated successful dust mitigation, however moderate dust accumulation was observed on the secondary air filter/pre-filter on the fresh air intake on the Regan Building located by one particular doorway exposed to the construction area. Based on these findings, BSG recommended that the Client's Contractor should continue to implement the current engineering controls, work practices and cleaning activities being used during the renovation operations given its effectiveness to control the spread of dust and construction related contaminants into the occupied areas of the Hospital, but the pre-filter on the fresh air intake by the Regan door should be replaced regularly as a proactive preventative measure. This is just one representative example of the ongoing effort of the ICRA Team to adapt the protocol to the needs of the project. In all cases, recommendations for amended practices or corrective engineering controls were fully vetted as appropriate, and discussed with all of the Contractors' personnel and hospital staff to ensure they were implemented throughout the duration of the project.

Data Analysis

Based upon the comparison of the visual investigation, regular discussions with the Client, and concurrent IAQ measurements collected during each monitoring period, it was concluded that overall the ICRA and construction work protocols implemented were adequate to minimize negative impacts to the indoor environment as a result of the dust generated during the ongoing construction/renovation operations. Ongoing comparisons throughout the span of the project

identified that the total particulate measurements collected ranged from “not detected above the instrument’s level of detection” to 0.030 mg/m3, and were similar and within the same order of magnitude as the baseline samples. While these results are indicative of successful mitigation protocol and infection control risk measures, it is worth noting that the measurements in every phase of the project were significantly below the OSHA PEL. All of the CO and CO2 measurements obtained within the areas of concern were identified as well below the N.J.A.C. trigger limit of 1000 ppm and the ACGIH exposure limit of 5000 ppm. All VOC measurements obtained within the areas of concern and indoor/outdoor control areas were below the instruments level of detection. The sole exception was an isolated incident of a worker in the process of applying a latex paint to the interior walls of an unoccupied room. Due to the potential for the latex paint off-gas VOCs, the spaces adjacent to this patient room were included as part of the OSHA baseline compliance air monitoring program.





Implications

It is critically important to maintain a healthy environment during construction. Having an ICRA team and program in place is crucial to the safety of the patients and hospital staff. However, as in our case, we deemed that standard ICRA measures (as recommended by the AIA and CDC) provided good framework for a plan but would not extend quite far enough. We felt that regular air sampling was imperative based on the dust-producing activities on site. Under the direction of the ICRA team, the client was in agreement that the cost implications of the additional air testing and safety measures were necessary. An article from OR Manager, Inc. reported that "cost is an issue in how often [air sampling] is done. Few hospitals do environmental sampling before construction projects for cost reasons."[6] It is our argument that the risk management benefits of additional air sampling outweigh the cost associated with the measure.

This was clearly illustrated by an unforeseen event on the St. Joe's job site during construction. Roughly halfway through the course of demolition of the School of Nursing, the building collapsed unexpectedly. Thankfully, due to superb site safety, no one was hurt as a result, and the ICRA measures that had been in place prior to the event ensured that the additional dust produced from the

[6] Jay Greene, "Preventing Infection During OR Construction," OR Manager, Inc., Vol. 22 No. 8, August 2006.

collapse was contained and kept away from at risk patient areas in the functioning buildings on campus.

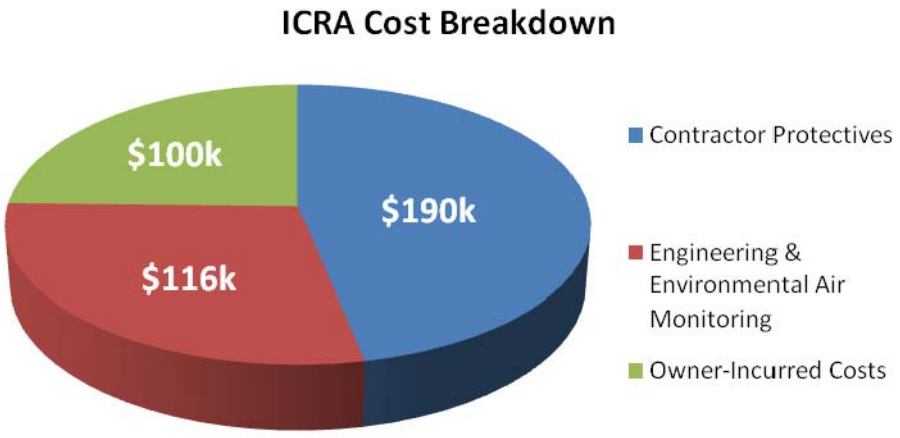
The building collapse serves as a keen reminder that unexpected and unforeseen circumstances can arise during any construction and renovation project, and when dealing with the health and safety of patients, careful planning and preparedness is crucial. It was due to the efforts of an invested ICRA team, and a carefully customized program of measures that extended above and beyond standard protocol, that helped to avoid catastrophe. It is our position that all projects deserve the same level of scrutiny in the development and implementation of ICRA protocols, and healthcare construction project teams not simply adopt the bare minimum of standard.

Cost Analysis

In a project of such a large scope, as in St. Joseph's Regional Medical Center, an ICRA program and its implementation is not the sole responsibility of any one party. Therefore, it is important to factor in the costs of implementation from all angles. The list of ICRA activities throughout the course of the project includes multiple responsible parties, including the general contractor, sub contractors, the engineering and environmental consultant, and the owner and facility staff. There are certainly situations in which costs may overlap - for example some owner costs overlap HVAC system maintenance – but the majority of costs are well defined, falling in the categories of contractor protectives and partitions, air monitoring, and internal labor and meetings. In general, the more entailed the phase of the project, the more complex and costly the monitoring and oversight will be. But even with the various required resources, the cost of an ICRA plan inside and outside the walls is only a fraction of the total investment of a hospital campus expansion project.

The total construction costs for the Paterson campus project amounted to $138 Million. The grand total for the Paterson campus project development cost, including all soft costs and equipment, was $182.5 Million. Costs associated specifically with ICRA measures for this project included a variety of activities and were divided between the contractors, the engineering and environmental consultant, and the owner-incurred costs for in-house meetings, sampling, and measures, all of which totaled $406,000. ICRA costs themselves were divided as such: Contractor Protectives, 46.8%; Environmental Air Monitoring, 28.6%; Owner-Incurred In-house Labor and Costs, $24.6%.

In summation, ICRA costs relative to the total construction costs amount to only a third of one percent. Moreover, the cost of ICRA relative to the total project costs amounted to less than a quarter of one percent. As a risk management endeavor, the costs are almost negligible relative to the total project cost and well worth the investment.



Summary

In sum, throughout St. Joseph's Healthcare System's multi-phased demolition and construction project, CDC guidelines were successfully followed ensuring airborne dust particles were contained and unable to infiltrate patient-care areas. Upon the end of construction, pre-construction conditions were reinstated. The new Lobby, Emergency Department, Critical Care and Surgical Suites are now fully occupied. Throughout the process, the existing hospital functioned fully. Having been able to successfully mitigate the health risks to patients from the significant nearby construction activity, this study shows substantial safety benefits of properly executed ICRA measures by a well-formed interdisciplinary committee.

References

Guidelines for Design and Construction of Health Care Facilities. Washington, DC: The American Institute of Architects, 2006. Print.

Haiduven, Donna. "Nosocomial Aspergillosis and Building Construction." *Medical Mycology* 47.No. s1 (2009): S210-S216 . *www.informahealthcare.com*. Web. 14 Mar. 2012.

Jay, Greene. "Preventing Infection During OR Construction." *OR Manager, Inc.* Aug. 2006: *http://ordesignandconstruction.com*. Web. 17 Feb. 2012.

Riley, D., Freihaut, J., Bahnfleth, W., and Karapetyan, Z. “Indoor air quality management and infection control in health care facility construction.” Proceedings of the CIB World Building Conference. 2004. *http://www.engr.psu.edu/iec/publications/papers/indoor_air_quality.pdf.* Web. 17 Feb. 2012.

Sehulster., L.M., et al.*Guidelines for environmental infection control in health-care facilities: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC).* Chicago, IL: American Society for Healthcare Engineering/American Hospital Association, 2004. Print.