DEPARTMENT OF HEALTH & HUMAN SERVICES U.S. Public Health Service

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

May 24, 2007
HETA 2006-0308

Nina Rose Hatfield, Deputy Assistant Secretary
National Business Center
Department of the Interior
1849 C Street NW
Washington, DC 20240

Dear Ms. Hatfield:

On June 28, 2006, you contacted the National Institute for Occupational Safety and Health (NIOSH), requesting a health hazard evaluation (HHE) at the Department of the Interior (DOI), National Business Center (NBC) in Washington, D.C. You asked NIOSH to provide recommendations to help resolve indoor environmental quality (IEQ) problems associated with the Main Interior Building (MIB) modernization project. In response to your request, myself and Mr. Scott E. Brueck, MS, CIH, conducted a site visit on August 14-16, 2006; a closing conference was held on the morning of August 17, 2006.

Our main points of contact were Mr. Dirk J. Meyer, AIA, Program Manager of the Modernization Program Office (MPO), Mr. Kenneth J. Tunney, Building Management Specialist, Ms. Gay Bindocci, Ed.D., and Mr. R.C. "Skip" Vaughn of Jacobs Facilities, Inc. During the evaluation we also met with management and staff employees of DOI, NBC, the Solicitor's and other offices in the MIB, the General Services Administration (GSA), Jacobs Facilities, Inc., and Grunley Construction, the prime contractor for the project. This letter summarizes findings from our evaluation and provides you with recommendations as requested.

Key Finding and Recommendations

NIOSH investigators at the MIB found that failure to design and maintain the renovation area under negative pressure (with respect to the adjacent occupied office areas) is the most likely reason for the ongoing IEQ problems at the MIB. Maintaining construction areas under negative pressure is considered by NIOSH investigators to be an appropriate practice and a fundamental and necessary aspect of proper IEQ when joint office occupancy and renovation activities are underway.

Background

The MIB modernization project began approximately 5 years ago and involves extensive demolition and renovation in all six wings of the MIB. The work is divided into 6 phases, with each phase corresponding to a specific wing of the building. At the time of our evaluation, wing 4 was under renovation. The work entails infrastructure upgrades to the heating, ventilating and air-conditioning (HVAC) systems, plumbing, electrical, and fire protection systems, as well as removal of asbestos-

containing material and lead-based paint and some major modifications such as new stairways. Although employees are removed from the wing under renovation, adjacent wings of the building remain occupied during renovation. The modernization project is currently expected to continue until the year 2012.

Employee complaints of poor IEQ have been received since the MIB renovation project began. Complaints have including unpleasant odors and unusual dustiness, eye and upper respiratory irritation, and asthma and allergy aggravation in some employees. You asked NIOSH to make an on-site visit, evaluate the wing 4 renovation project, and make recommendations relating to IEQ controls for the MIB renovation.

The Modernization Program Office serves as the administrative center for the renovation activity, with liaisons from the DOI and GSA sharing responsibility. Grunley Construction is contracted to GSA. During our investigation, we understood that the main GSA point of contact for IEQ issues was Mr. John Daw, the Construction Team Leader, along with Ms. Donna Milsten, Project Manager and the designated IEQ representative for Grunley Construction.

Previous NIOSH Evaluations at MIB

In 1999, NIOSH received a request for an HHE (HETA 99-0324) concerning a variety of IEQ issues. NIOSH investigators conducted a site visit at the MIB and provided the DOI with recommendations. The October 26, 2000, report from that evaluation identified a kitchen smoker with an exhaust stack discharge close to the roof as a potential source of soot and odors in the building, and recommended improvements to the ventilation system. In 2006, NIOSH investigators responded to a confidential employee request (HETA 2005-0277) for an HHE related to IEQ concerns associated with the MIB modernization project. A close-out letter (dated February 3, 2006) was sent to Mr. Meyer containing detailed information, guidance, and recommendations regarding how to appropriately and safely conduct renovation projects in occupied settings; the letter included recommendations on the following:

- adopting the NIOSH Good Practice Guidelines for Maintaining Acceptable Indoor Environmental Quality During Construction and Renovation Projects;
- streamlining communications, including providing material safety data sheet (MSDS) information and data regarding environmental sampling) to employees;
- responding promptly to worker health complaints; and
- creating a joint committee composed of DOI and GSA management and employee representatives responsible for addressing building-related complaints.

Method of Evaluation

We used chemical tracer smoke to evaluate airflow pathways through penetrations, cracks, and separations between the renovation area and the adjacent office areas. We inspected the physical integrity of the construction doors and barricades and the ante rooms that lead to wing 4 on the 1st and 7th floors. We inspected the construction barricades in the hallway areas and the occupied office areas throughout the wing and inspected the same construction barricades on the renovation/construction side of wing 4. We looked for any indications of breeches through or

around the barricade walls (e.g., visual evidence of dustiness, chemical smells, unusual odors, inappropriate pressurization, etc.) that might suggest inadequate isolation of the renovation side from the occupied side of the wing.

Improper pressurization, such as positive pressure in the renovation area, can cause air to travel from the renovation area to the adjacent office areas. We focused our investigation on identifying potential "unplanned pathways" for air to move between these two areas. These unplanned pathways can include inadequately sealed ventilation ductwork, conduit and wall penetrations such as holes in walls that were created during demolition, as well as through stairwells. Unplanned pathways coupled with improper pressurization can result in construction-related air contaminants migrating out of the renovation area and causing complaints of poor IEQ in the adjacent office areas.

At various times during our investigation, we spoke with building occupants regarding IEQ and the MIB renovation. We also spoke with some employees off-site and informally spoke with 10 employees from the Solicitors Office (because IEQ complaints were reported from this area) and other offices in the building.

We reviewed the April 5, 2002 DOI Modernization Indoor Air Quality (IAQ) Plan and the IAQ Plan supplement dated January 16, 2003. The supplement states that Grunley Construction will adopt the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) *IAQ Guidelines for Occupied Buildings Under Construction.* Both documents were written by Grunley Construction specifically for the MIB project.

Results and Observations

The most significant finding was that the modernization area was intentionally operating under positive pressure with respect to the adjacent occupied office areas. Maintaining a construction area under negative pressure is a standard and recommended practice when construction and renovation activities take place in occupied buildings. Negative pressure is recommended to ensure (to the greatest degree possible) that air contaminants such as vapors and dusts that are generated inside the construction zone are not transported into the adjacent office work areas. Eliminating all unplanned pathways (e.g., by sealing) is not always feasible. As noted, the MIB modernization area was not operated under negative pressure; rather, high volume air handling units [Carrier Model 40RM012, reported to supply 4000 cubic feet per minute (cfm)] were used to supply conditioned air to the renovation area, making the area positive in relation to the adjacent office areas. Reportedly, the conditioned air was not being supplied for comfort ventilation for the workers; the air was supplied to prevent temperature fluctuations that might affect the structure of the building. The air handling units were in place on each floor of the 4th wing and they drew their make-up air from the main corridors on each floor. Small (1000 cfm) portable negative air/filtration machines were also in the renovation area but these units were not connected to exhaust to the exterior of the building so they would have no effect on pressure in the modernization area. These units appeared to be used only for air filtration. No visual indicators of pressure differential (e.g., Magnehelic® gauges) were present at any of the construction barricades or doors.

Photo 1: Incomplete construction barricade from the renovation side.

While a majority of the ante rooms, construction and doorway barricades inspected appeared to be well designed and appropriately installed, we noted that numerous barricades installed between the communicating doorways (doors located between an occupied area and the renovation areas) had not been installed consistent with the engineering designs or blueprints for these barriers. The most common finding was an inconsistency in how and whether the barricades had been installed on the construction side of the communicating doorways (Photo 1). The barricade design called for two layers of drywall with a layer of polyethylene between, and fiberglass insulation and sealing tape around the perimeter on each side of the doorway. In addition to the missing barricades on the construction side, we observed that sealing tape was often missing, or was detached, that sometimes an opening was visible at the bottom of the barricade, and sometimes the polyethylene and/or fiberglass layer was absent.

Walk-off mats were in place at most but not all of the construction entry doors on the 1st and 7th floors. Where mats were installed, they were not oriented lengthwise in the path of foot traffic, which is optimum for the mat to be most effective in removing dust from foot traffic. We also noted some interior doors in the anterooms of the construction barricades on the 1st and 7th floors propped open; this negates the effect of the automatic door closers. Tracer smoke indicated the anterooms are only able to maintain negative pressure in the anteroom area when these interior doors are closed.

On several of the floors within the construction areas polyethylene sheeting and duct tape was used to seal return air ducts in the hallway. On many floors, the duct tape and polyethylene had come loose. These situations are obvious pathways for air to move from the modernization area to other areas of the building (Photo 2). Tracer smoke provided a visual indication that air was being moved to other areas of the building, most likely the mezzanine area where other central HVAC systems for the MIB are located.

Photo 2: Loose polyethylene sheeting and duct tape allowing an unplanned air pathway.

On some floors of the renovation area we found holes in the wallboard of former office areas. In one area on the 7th floor, large holes were present in the baseboard area after demolition and removal of the old marble baseboards. The baseboards were obviously removed for reuse but when this was done, it exposed the hollow, thin walled terra cotta bricks behind the baseboards. In some areas the terra cotta blocks were broken out completely, other areas only had holes in them (Photo 3). Tracer smoke went into the holes in the terra cotta bricking, as well as the holes in the drywall. This suggests an unplanned pathway for air to move from the renovation area to other areas of the building. The most likely explanation for this was the pressure differential caused by the positive pressure created by the Carrier ventilation units.

Photo 3: Example of a hole in the terra cotta blocking after demolition of pre-existing marble baseboard. Smoke is being entrained into the hole.

Other examples of unplanned pathways were at elevator landings on floors 2-5. We noted holes in the ceilings where lighting had previously hung and confirmed that these holes were under negative pressure when evaluated with tracer smoke. We also noted that the elevator shafts were under negative pressure when tested using smoke. Both are examples of unplanned pathways.

We observed workers dry sweeping construction debris rather than using wet methods (or vacuuming) to suppress dust. Dry sweeping is not an effective method for controlling dusts during construction/renovation in occupied buildings. We also observed a construction worker wearing an N95 respirator incorrectly. Incorrect respirator use is generally an indication of either lack of training or worker safety oversight. An evaluation of the respirator program was not conducted as part of this HHE.

Fire extinguishers with expired inspections were noted in several locations in the modernization area (specifically 1st and 2nd floors west corridor, next to the restrooms.) We immediately brought this to the attention of both GSA and the safety manager for Grunley Construction.

We confirmed that Grunley Construction wrote two documents describing the need for IEQ controls and a control plan during the MIB renovation project. The first document, dated April 5, 2002, states that Grunley Construction will implement an indoor air quality management plan. The document says the plan will include a description of construction, practices to prevent creation of dust, activation procedures for HVAC systems, cleaning requirements for ductwork, and a description of ventilation systems used during demolition and construction operations. In general terms, the document outlines how some of these actions might be accomplished. The second document, dated January 16, 2003, is a supplement to the original plan in which Grunley Construction states: "During construction, meet or exceed the requirements of the *Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction,* 1995, and protect stored or installed absorptive materials from moisture damage." The document states that photographs will be taken to "show IAQ management measures implemented, protection of ducts, physical barriers protecting areas under construction and sequencing of installation of absorption materials."

We did not find any evidence that Grunley Construction implemented an effective IEQ plan for the MIB project. We did not find nor were we provided with any other written plans, documentation, or photographs. When we spoke with a Grunley construction superintendent and inquired about how the SMACNA Guidelines were being implemented, we found that the superintendent was unaware of the SMACNA guidelines or that Grunley Construction had adopted or intended to adopt these as part of their IEQ management plan.

Informal discussions were conducted with ten MIB staff working in the building. Of those we spoke with, half reported experiencing some type of health problem or symptom including eye irritation and trouble wearing contact lenses, aggravation of allergies, upper respiratory irritation and lower respiratory symptoms including chest tightness, aggravation of pre-existing asthma and experiencing asthma attacks while in the building. The employees reported to us that they associated these health problems and symptoms with working in the MIB. The other half did not report building related symptoms. The most common complaint or concern (from both groups) was dustiness outside the construction barricades and the presence of odors. Those interviewed reported smelling chemical vapors, burning materials, welding odors, and sweet odors.

Conclusions

We identified a lack of appropriate negative pressurization between the modernization area and the

occupied areas of the building. We identified numerous unplanned air pathways where air pollutants generated in the renovation area can migrate to adjacent occupied areas of the building. Unless appropriate control measures are implemented (and evaluated for effectiveness after implementation), construction contaminants such as dusts, fumes, and chemical odors are likely to continue affect the occupied areas of the MIB. As we discussed during the closing conference, we found no evidence of immediate, life threatening health issues for occupants of the MIB. However, we did find conditions that could explain the occupant complaints of odors and dustiness related to demolition and construction. Occupant complaints of odors and irritant health symptoms are likely associated with exposures to construction-generated dusts and vapors due to a lack of appropriate and effective IEQ controls for renovation and construction in an occupied building.

Recommendations

Most of the following recommendations were discussed at the closing conference and are provided here to help resolve IEQ problems in the MIB. Developing or adopting unambiguous IEQ and building management guidelines, policies, and practices that can be incorporated into future construction contracts is strongly recommended to help prevent future IEQ problems with the ongoing renovation work in the MIB.

1) Negative pressurization ("negative air")

Demolition and construction areas should be kept under negative pressure for the duration of the construction and renovation project and depending on finishes and furnishings installed, for some time after renovation has ended. The renovation areas should be held under negative pressurization of at least 0.01 to 0.02 inches of water gauge. Because 4000 cfm of conditioned corridor air is being supplied to each wing of the modernization area, at least 4400 cfm exhaust air (roughly 10% more air than is currently being supplied) needs to be exhausted for the construction areas to be maintained under negative pressure. In all cases, airflow direction should be confirmed to be from the occupied areas of the building into the area under renovation. Several steps may be necessary to accomplish this including adjusting the balance on the HVAC systems in the occupied areas and using multiple portable exhaust systems in the area under renovation. Air exhausted from the renovation area should be filtered and should not be located in proximity to outside air intakes for central HVAC units since odors will not be removed by filtration alone. While smoke testing can be used to qualitatively evaluate for negative pressurization and to spot test specific areas, manometers or Magnehelic® gauges should be installed in multiple locations around the perimeter of the work area for quantitative confirmation of negative pressurization. Continued complaints of odors and dusts in occupied areas of the building can also be indicators of potentially ineffective IEQ controls in the renovation areas.

2) Implementation of SMACNA guidelines

GSA and the MIB Modernization Program Office should work cooperatively with Grunley Construction to insure appropriate implementation of an effective building IEQ plan that is consistent with the SMACNA *IAQ Guidelines for Occupied Buildings Under Construction.* This document is published by the Sheet Metal and Air Conditioning Contractors National Association and the first edition (copyright 1995) may still be available from: SMACNA Publications 4201 Lafayette Center Drive, Chantilly, VA 22021-1209. A second edition is forthcoming following a public review and comment period which ended in February, 2007.

3) Designated persons
Individuals from GSA, DOI, and Jacobs Facilities Inc. knowledgeable in the practice of IEQ should be assigned the authority and responsibility for insuring that the SMACNA guidelines are implemented and are effective in addressing the immediate IEQ problems, and preventing future occupant complaints. Punch lists or checklists should be developed and used by the designated persons to evaluate measurable aspects of conformity with the SMACNA guidelines. Walkthrough inspections should be conducted on a regular basis (at least weekly) by the designated individuals to observe and assess effectiveness of IEQ controls and to evaluate appropriate worker safety and health practices during renovation. Examples of measurable aspects of conformance with an IEQ control plan include checking for appropriate pressure differentials between the work areas and the occupied areas, use of appropriate work practices to suppress construction generated dusts, ensuring that all pathways (planned and unplanned) between the work area and the occupied area have been identified and (where appropriate for unplanned pathways), sealed. Other measurable aspects include ensuring that only low VOC emitting products (those that meet contract or agreed upon specifications) are used in the work area, ensuring that appropriate housekeeping practices are used and confirming workers' knowledge of those practices and procedures identified to minimize IEQ problems during the demolition and renovation processes. It is also important to remember that the types of pollutants generated during renovation will change based on the stage of renovation. Subcontractors must also be adequately trained on proper work practices and implementation of contaminant controls, and must be held accountable for following the procedures identified in the IEQ control plan.

4) Communication Although attempts at improving communication of IEQ issues have been implemented at the MIB through avenues such as the biweekly IEQ forum, a common theme among many of the occupants we interviewed was a sense that important information was not adequately being communicated to them. DOI and GSA should continue to focus and improve efforts to provide building occupants with current information related to the modernization activities, results of IEQ complaint investigations, and building air quality improvement efforts. The information should be disseminated in a timely manner and in a format that is easily understandable to occupants. Refer to the SMACNA publication for additional information about communication with building occupants during construction activities.

5) Construction walls and barricades
Barricade walls installed in communicating doorways between the modernization area and the occupied area should extend around the complete perimeter of the opening (with no gaps at the floor) and should be consistent with the design criteria in the engineering drawings. Daily inspection of these barriers should be conducted and when deficiencies are found to exist, they should be remedied as soon as possible.

6) Housekeeping
Floor or surface dusts generated during demolition and construction should be vacuumed using high efficiency particulate air (HEPA) filtered vacuum cleaners. Brooms should be restricted from construction areas. In the rare occasions where sweeping is required (e.g., the area cannot be vacuumed), a light water misting (where appropriate) or use of dust coagulants (i.e. products like Dry Sweep™) should be used. Floor surfaces outside of or adjacent to the renovation area should be wet-mopped several times daily to remove dirt. Housekeeping staff should pay increased attention to floor and horizontal surfaces adjacent to the entrances and exits of construction areas. Construction personnel should be responsible for housekeeping inside the renovation areas.

7) Traffic into and out of construction areas
Either fabric or adhesive walk-off mats should be used to limit foot tracking of construction generated dusts into non-construction areas of the building. Mats should be positioned lengthwise with the long (4') axis leading into the renovation areas for greater dust removal. If adhesive mats are used, they should be stripped to expose a new adhesive surface as soon as a mats surface becomes discolored or is no longer tacky to the touch (this will depend on the volume of foot traffic). Soiled adhesive mats should be carefully stripped to avoid dislodging the dust adhered to the mat onto the adjacent floor area. Carpet mats should be cleaned or vacuumed with a machine equipped with HEPA filtration, or sent to the commercial provider (if rented) for cleaning.

8) Rubbish removal from the construction area
Refuse elevators should be used to remove construction debris from the renovation area. Removal should be done in a way that limits dust release from the load; the use of tarping is one example. Do not move rubbish loads through corridors and hallways of the MIB.

9) Heating, ventilating and air-conditioning (HVAC) systems
Hallway return air grilles for the HVAC systems serving the construction area should be protected from dusts generated during the work process using two layers of polyethylene sheeting, each taped and sealed separately around the perimeter of the duct opening. Workers should be trained and knowledgeable in the reasons for this precaution. Daily inspection of all sealed and blocked ductwork (and other unplanned pathways) should be conducted to insure that tape has not come loose or the polyethylene has not been damaged.

10) Risk communication for building occupants
Our recommendation for professional risk communication for building occupants was discussed briefly at the closing conference. Risk communication (using a well-qualified professional versed specifically in aspects of IEQ) is recommended to inform MIB occupants regarding risks inherent in building occupancy while construction is occurring and to help minimize anxiety and tensions that have developed in the MIB, relating to renovation and IEQ issues.

We hope that our investigation and the results and recommendations contained in this letter are helpful to you, the contractor, and the employees of the MIB in identifying IEQ problems and implementing solutions. We appreciate the efforts and thank the personnel from MPO, DOI, NBC, GSA and Jacobs Facilities Inc. that assisted us with this evaluation. NIOSH recommends that employers post a copy of this letter for 30 days at or near work areas of affected employees. If you or any of your staff have any questions related to this HHE or additional assistance in the future, please contact me at (303) 236-5946.

Sincerely yours,

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