MIFACE INVESTIGATION REPORT: # 05MI141

SUBJECT: Chemical Worker Died From Work-Related Asthma

Summary:

On December 13, 2005, a 50-year-old male chemical worker collapsed while working at an adhesive manufacturer. The adhesives contained isocyanates, and during the course of his employment at the facility, the decedent had developed work-related asthma. On the day of his collapse, the decedent worked third shift in the mixing room where isocyanates were added to reactors and finished product unloaded from these reactors. At approximately 5:45 a.m., the decedent was observed staggering from a physically separated (by a wall) warehouse area, signaling that he could not breathe (See Diagram 1). He may have used his asthma inhaler in an attempt to alleviate his shortness of breath. An employee helped the decedent to the break room where the decedent collapsed in the doorway. Fellow workers provided the decedent with oxygen. Police arrived within five minutes and breathing assistance continued. The decedent suffered a pulmonary arrest and police initiated cardiopulmonary resuscitation. An automatic external defibrillator (AED) was applied, however, it indicated not to shock the decedent. CPR was continued until EMS personnel arrived at approx 6:05 a.m. and he was transported to a local hospital. A spontaneous pulse was regained after 23 to 25 minutes of resuscitation but the deceased never regained consciousness and died in the hospital six days later. The deceased had sought medical care for shortness of breath in relation to work in July 2002, seven months after beginning work. The facility provided annual medical examinations to its employees that included physical examination, urine and blood testing and pulmonary function testing. The deceased had participated in the medical examinations provided by the company as well as seen his primary care physician and a pulmonary specialist for his asthma.

RECOMMENDATIONS

- Companies using isocyanates should provide a medical surveillance program that is performed by a health care provider who is knowledgeable in how to diagnose and manage individuals with possible work-related asthma.

- The results of company medical screenings should be integrated into management decisions regarding health and safety issues and job assignments.

- Physicians caring for patients with asthma need to be aware of how to diagnose and manage work-related asthma and the adverse consequences of not having or acting on that knowledge.

INTRODUCTION

On December 13, 2005, a 50-year-old male chemical worker collapsed while working at an adhesive manufacturer. He died six days later in the hospital after never regaining consciousness. On December 20, 2005, MIFACE investigators were informed by the Michigan Occupational Safety and Health Administration (MIOSHA) personnel who had received a phone call during regular hours, to the MIOSHA office in Lansing that a work-related injury had occurred on December 13, 2005, and that the individual had died on December 19, 2005. On February 1, 2006, the MIFACE researcher spoke with the facility manager (Safety and Health (S&H) Coordinator), reviewed the medical records of 18 workers participating in the company's medical screening program, conducted a walkthrough of the part of the facility where isocyanates were used, and reviewed the medical records of the deceased, including his autopsy report.

The facility had been in business for nearly 30 years. The company formulated isocyanate- and epoxy-containing adhesives. The decedent was initially hired as a temporary worker. After working six months as a temporary worker, in December 2001 he was hired as a full time employee. There were 21 production employees (including the deceased), all of who were provided annual medical examinations. The company supplied both half-mask and full- face piece respirators to employees.

The company for whom the decedent worked provided annual medical examinations for employees. The annual medical examinations were provided under contract to the company by a family practitioner. The examination consisted of a history of diagnosed medical conditions, a physical examination, routine blood and urine tests, and pulmonary function tests (spirometry). The annual examination did not include questions about medical symptoms. There was no evidence in the medical notes that spirometric results were compared from year to year. If a result was less than predicted and the computer printout of the spirometric results stated abnormal, then there was a note from the family practitioner on the medical chart indicating the breathing test results were reduced. No notes were found in the medical charts that the family practitioner communicated any recommendations to the company. The family practitioner kept copies of the medical results and copies were sent to the decedent's employer. The company forwarded the medical results to the company's corporate office in another state. The MIOSHA investigation revealed that the corporate office reviewed employee medical records to determine if the physician had conducted appropriate medical tests. Neither the plant nor the corporate office staff reviewed the employee medical records for health concerns or health-related content.

There were two separate MIOSHA inspections at the facility as a result of the incident: one inspection directly related to the fatality and one inspection was unrelated to the fatality. As a result of these two inspections, MIOSHA issued two Serious and one Other-than-Serious citations to the company at the conclusion of their investigations. The citations resulting from the fatality investigation were: 1) A Serious violation of the Medical Services and First Aid standard for not sending the deceased for medical evaluation when on multiple occasions he complained of respiratory symptoms at work;

and 2) An Other-than-Serious violation for not recording on the 2005 MIOSHA 300 log the death being investigated. As a result of a companion investigation, a Serious violation for an inadequate respiratory program was issued that was not associated with the fatality. The Serious violation included citations for:

- lack of a complete site-specific written respiratory protection program,
- allowing respirator use with facial hair,
- no annual training or monthly inspection of self-contained breathing apparatus (SCBA),
- lack of fit testing, and
- lack of review by the employer of physician's written opinion on whether an employee is medically fit to wear a respirator.

INVESTIGATION

The facility had two areas where isocyanates were mixed: the mixing room and south production. The mixing room had two "areas" separated by an aisle way (See Diagram 1). One "area" contained several reactors that formulated isocyanate-containing adhesives. Temperatures as high as 340^0F were reached during some of the processes. The deceased worked across the aisle way from the isocyanate reactors in the second "area" - epoxy formulation area. Although he had worked directly with isocyanates on previous jobs, his current job did not require him to work directly with isocyanates. . Other areas of the plant included a production area for adhesives that contained solvents, storage tanks for ingredients, and a large warehouse area for the products.

Approximately one year before his death, the decedent received training to be a backup for a job task that required repackaging 55-gallon drums of isocyanate-containing material. During this training, on three separate occasions, he told his supervisor that he was having breathing problems during this task. As a result, supervision removed him from training and he was no longer required to perform this task. Supervision placed him in the epoxy area in the mixing room.

There had been a respiratory death at the facility three years prior to this fatality. This was attributed to asphyxiation from nitrogen gas used to seal one of the reactors after the individual "fell into" the air space above the reactor.

If an employee experienced a breathing problem related to isocyanates, the company policy required that the employee should notify their supervisor/manager, or safety personnel. Once management had been informed of a possible isocyanate exposure, the Human Resources department contacted the company physician to make an appointment at the request of the employees' supervisor, manager or plant manager.

Some of his fellow workers knew about the deceased's sensitivity to isocyanates. The decedent had complained to fellow workers that he had a tight chest when they were done charging or dumping reactor batches in his work area. The decedent had also told his 3rd shift production lead and the third shift supervisor (who was also the Safety Coordinator) about his breathing problems. The third shift production lead also informed the third shift

supervisor about the decedent's breathing problems. The decedent described symptoms of tightness in his chest and that he was having breathing problems.

Night of Incident

The decedent manufactured and dumped a batch of non-isocyanate containing material. He also gathered 5-gallon pails, labeled them, and stacked them in the epoxy area during the latter part of the shift.

Approximately 30 feet east of the epoxy area, a product batch was dumped early during the shift (~10:30 p.m. - 2:00 a.m.) into two 250-gallon totes. A second batch of product was started at about 2:00 a.m.; approximately 1200 pounds of pure MDI material from 55-gallon drums was vacuum-loaded at 3:35 a.m.

Approximately 40 feet southeast of the epoxy area was another reactor. The reactor had the first batch of material containing isocyanates mixed on the first shift. The product was finished on the third shift and dumped into twenty-nine 55-gallon drums. The product contained approximately 4500 pounds of material which contained 10-30% MDI. The product download process took about two hours. A fellow employee indicated he saw the decedent wear his respirator in his work area while the batch dump was occurring. After the first batch was dumped, a second batch was started. No isocyanate material was added to the second batch.

A third mixing area (small batch area) was located about 50 feet northeast of decedent's work area. Isocyanate-containing product was manufactured in a three-drum reactor. Approximately 600 pounds of 55-67% MDI material was added at 4:45 a.m. by negative transfer from drums.

The general exhaust ventilation supplied make-up air along the east wall of the mixing room and exhausted air along the west wall of the mixing room. This air movement pattern allowed for the possibility for chemical vapors from isocyanate-containing processes to be exhausted toward the decedent's work area (Diagram 1).

At approximately 5:45 a.m., the decedent was observed staggering from the west warehouse area signaling that he could not breathe. It is unknown why he was in that area. It appears he may have used his asthma inhaler to attempt to alleviate his shortness of breath. An employee helped the decedent to the break room where decedent collapsed in the doorway. Another employee in the break room saw the inhaler. Fellow workers provided the decedent with oxygen. Police arrived within five minutes and breathing assistance continued. The decedent suffered a pulmonary arrest and police initiated cardiopulmonary resuscitation. An automatic external defibrillator (AED) was applied, however, it indicated not to shock the decedent. CPR was continued until emergency medical service (EMS) personnel arrived at approximately 6:05 a.m. EMS personnel transported him to a local hospital. A spontaneous pulse was regained after 23 to 25 minutes of resuscitation, but the decedent never regained consciousness and died in the hospital six days later.

Medical Record Review

As part of the MIFACE investigation, fourteen production employees completed an asthma symptom questionnaire developed for the Michigan Sentinel Event Notification System for Occupational Risk (SENSOR) program and 18 workers gave permission to have their company medical records reviewed. One individual reported daily cough, wheezing and shortness of breath when working in the epoxy-mixing area on the asthma symptom questionnaire.

In addition to the decedent's medical records, which will be discussed later, 5 of the 18 individuals whose medical records were reviewed had changes of concern:

- Worker A: Abnormal pulmonary function test results. No indication if this individual had respiratory symptoms or if this individual had respiratory symptoms related to work. No follow-up testing performed.
- Worker B: Abnormal pulmonary function test results that were attributed to an upper respiratory infection. No follow-up testing performed.
- Worker C: On asthma medication that was increased in 2005 as compared to 2004. No indication if this individual had respiratory symptoms related to work. No pulmonary function tests performed in relationship to work.
- Worker D: Significant decrease in FEV_1 from 3.93 liters in October 2004 to 2.70 liters in December 2005. No indication if this individual had respiratory symptoms or if this individual had respiratory symptoms related to work. No follow-up testing performed.
- Worker E: Abnormal pulmonary function test results. No indication if this individual had respiratory symptoms or if this individual had respiratory symptoms related to work. No follow-up testing performed.

Decedent's Medical Record

The decedent began to work at the company in December 2001. For the first six months he worked for a temporary agency. Approximately seven months later, in July 2002, he first sought care for respiratory problems at an urgent care facility. He sought care for respiratory problems again at the same urgent care facility in December 2002, February 2003, July 2003, and September 2004. Initial diagnoses at the urgent care facility included "acute bronchitis with mild bronchospasm", and "acute trachitis with possible reactive airways disease and bronchospasm." The medical record from December 2002 states: "He alleges he had been in his normal state of health until yesterday evening, and apparently until today noting a sensation of chest tightness apparently when exposed to glue fumes that commonly permeate the atmosphere at his work site." In the July 2003 urgent care visit it was noted he left work because of shortness of breath.

After the February 2003 urgent care visit he was referred to a primary care physician who diagnosed asthma and began him on asthma medication. The primary care doctor saw him on May 2003, July 2003, September 2003, November 2003, July 2004, September

2004, November 2004 and August 2005. The primary care doctor first noted the relationship of symptoms at work in November 2003; "shortness of breath this morning while at work. He notices chemical at work seem to trigger his asthma. He does not wear a respirator and has talked to the occupational health doctor at the job site. They are monitoring his breathing. He doesn't seem to have trouble outside of the office." The relation of his respiratory symptoms to work was noted by his primary care doctor in the next four visits of the deceased. On his last visit to the primary care doctor in August 2005 he was referred to a pulmonologist. The referral occurred after the deceased told his primary care doctor that he was considering leaving work and "is wondering if there is any medical reason for leaving his job that might help him retain his severance".

The decedent was seen by the pulmonologist in October 2005. The pulmonologist's impression was "reactive airways disease that most likely is occupationally related." The pulmonologist indicated he asked the decedent to obtain the name of the company doctor so he could send this medical record to him. He then went on to say: "I do think that it is going to become necessary for them to try and minimize his exposure to isocyanates, since I do feel that he most likely having flares from his work environment. Certainly, if they cannot do this, then we will proceed down the road to spirometry before work and spirometry after work to document changes in his flows and proceed down that road if becomes necessary." The decedent was to return to the pulmonologist in approximately two months' time for clinical evaluation and repeat spirometry, but died before he could return.

The other set of medical records on the decedent were those performed by the family practitioner as part of the company's annual medical examination. These were from January 2002, September 2002, October 2003, and October 2004. His blood and urine tested normal in December 2005 and he died before having a physical exam and spirometry in 2005. The company records noted asthma in October 2003, and an association of his respiratory symptoms with isocyanate exposure in October 2004. The decedent's spirometry was first abnormal in October 2004. No mention of the drop in the forced expiratory volume from his initial test in January 2002 was made in his record. No recommendations for following up the symptoms were noted other than the deceased was urged to quit smoking.

CAUSE OF DEATH

The death certificate was completed prior to the autopsy report. The cause of death on the death certificate was chronic obstructive pulmonary disease. The autopsy report listed death as acute anoxic encephalopathy secondary to cardiopulmonary collapse. Chronic changes of asthmatic airway disease were present including significantly thickened basement membranes, bronchiolar gobbet cell metaplasia and hyperplasia. No other causes for the deceased's cardiopulmonary collapse including myocardial infarct or pulmonary embolism were found.

RECOMMENDATIONS/DISCUSSION

- Companies using isocyanates should provide a medical surveillance program that is performed by a health care provider who is knowledgeable in how to diagnose and manage individuals with possible work-related asthma.

Isocyanates are the most common cause of work-related asthma in Michigan. Between 1988 and 2007, 2,676 individuals have been diagnosed with work-related asthma; 370 of these individuals or 13.8% of the Michigan work-related asthma cases are caused by exposure to isocyanates (2007 Annual Report on Work-Related Asthma in Michigan). Deaths from asthma secondary to exposure to isocyanates have previously been reported, including a death in Michigan in 2003 (Chester et al, 2005). Although the company provided medical screening, the following deficiencies were noted in the company's program:

1. No record of whether individuals were experiencing respiratory symptoms, particularly in relationship to work was collected. The history section of the medical records asked about the diagnosis of medical conditions (i.e. asthma) but not the occurrence of symptoms.
2. No indication that the pulmonary function test results for a given individual were compared to results from previous years to assess whether there was a drop in function beyond that expected by aging. One of the advantages of performing annual pulmonary function tests is to monitor for a significant drop in lung function even if the individual's results remain normal in comparison to published predicted normals. Published predicted normals are based on the average individual of the same gender, age and height and are not as sensitive as comparing an individual to their own results in the past. A recent guideline of how to evaluate pulmonary function changes over time has been developed by the American College of Occupational and Environmental Medicine (Townsend MC, 2005; also on the Web at http://www.acoem.org/guidelines.aspx?id=756
3. No indication in the medical records that individuals were informed of their results and that medical follow-up was conducted on individuals with abnormal results.

The standard of medical care in Michigan as well as the rest of the United States for evaluating a patient for work-related asthma does not include specific challenge testing with the suspected agent. The standard of medical care for diagnosing work-related asthma is a history from the patient of respiratory symptoms related to work, and evidence of hyperreactivity on spirometry either with pre/post bronchodilator and/or methacholine. Although recommended, few health care providers have the patient perform pulmonary function testing in relation to work (e.g., peak flow monitoring at least four times a day at work then a week off work or spirometry before and after work or spirometry at the end of a work week and then at the end of a week off work). Specific challenge testing with the suspected work allergen is only done as research and is not part of regular medical care.

Recommendations on the frequency and content of medical examination for individuals exposed to isocyanates or other allergens can be found at the following web sites:

Michigan State University, Occupational and Environmental Medicine Division. www.oem.msu.edu. Click on Resources, and then scroll down until Work-Related Asthma, Recommended Medical Screening Protocol for Workers Exposed to Occupational Allergens.

British Occupational Health Research Foundation. www.bohrf.org.uk. Click on Occupational Asthma, then click on Work-related asthma & rhinitis; algorithm for case finding and management in primary care.

- The results of company medical screenings should be integrated into management decisions regarding health and safety issues and job assignments.

In order for the results of medical screening to be of use in protecting individuals from adverse workplace health effects, the results of the screening need to be used by the facility to assist in controlling exposure and making job assignments. Occupational medicine ethics dictate that an individual's actual medical results not be shared with non-medical personnel but that medical restrictions be communicated to managerial and supervisory staff that can act to implement these restrictions. In this case a restriction indicating that the deceased could not work in a building where isocyanates were being used would have been appropriate. Such a restriction would have protected the individual and not revealed medical information.

- Physicians caring for patients with asthma need to be aware of how to diagnose and manage work-related asthma and the adverse consequences of not having or acting on that knowledge.

According to an American Thoracic Consensus Statement, approximately 15% of asthma in adults is work-related (Balmes et al, 2003). This is a significant percentage and physicians caring for adults with asthma need to be up to date on how to diagnose and manage patients with work-related asthma. The family practitioner under contract to provide the company's annual medical examination, the decedent's primary care physician and pulmonologist did not manage the decedent's work-related asthma in an effective or timely manner, and was determined to be a factor in this death.

Guidelines for diagnosing and managing work-related asthma can be found at:

Bernstein IL, Chan-Yeung M, Malo JL, Bernstein DI ed. Asthma in the Workplace. New York: Marcel-Dekker Inc. 1999.

Chan-Yeung M, Malo JL. Occupational asthma. New England Journal of Medicine 1995; 333:107-112.

Clinique des Maladies Respiratoires web server for work-related asthma: http://www.remcomp.fr/asmanet/asmapro/agents.htm. The web server has relational database consisting of over 70 different work-related asthma cases that can be retrieved either directly from the list of all cases or by the name of a specific agent causing work-related asthma (over 350 different agents are listed) or according to the type of job the person is performing (over 140 different jobs are listed).

Friedman-Jiminez G, Beckett WS, Szeinuk J, Petsonk EL. Clinical evaluation, management, and prevention of work-related asthma. American Journal of Industrial Medicine 2000; 37:121-141.

RESOURCES

MIOSHA Standards cited in this report can be directly accessed from the Michigan Department of Labor and Economic Growth, MIOSHA website www.michigan.gov/mioshastandards. The Standards may also be obtained for a fee by writing to the following address: Michigan Department of Labor and Economic Growth, MIOSHA, MIOSHA Standards Section, P.O. Box 30643, Lansing, Michigan, 48909-8143. MIOSHA Standard Section phone number is (517) 322-1845.

- MIOSHA General Industry Occupational Health Standard Part 472, Medical Services and First Aid.
- Michigan Occupational Safety and Health Act, 154, P.A. 1974, Part 11, Michigan Administrative Rule for Recording and Reporting of Injuries and Illnesses.
- MIOSHA General Industry Occupational Health Standard, Part 472, Respiratory Protection.
- Balmes J et al. American Thoracic Society: Occupational Contribution to the Burden of Airway Disease. Am J Respir Crit Care Med 2003; 167:787-797.
- Chester DA, Hanna EA, Pickelman BG, Rosenman KD. Asthma Death After Spraying Polyurethane Truck Bedliner. American Journal of Industrial Medicine 2005; 48:78-84.
- Townsend MC. Evaluating Pulmonary Function Change Over Time in the Occupational Setting. Journal of Occupational and Environmental Medicine 2005; 47:1307-1316. http://www.acoem.org/guidelines.aspx?id=756

Medical Monitoring for Allergens

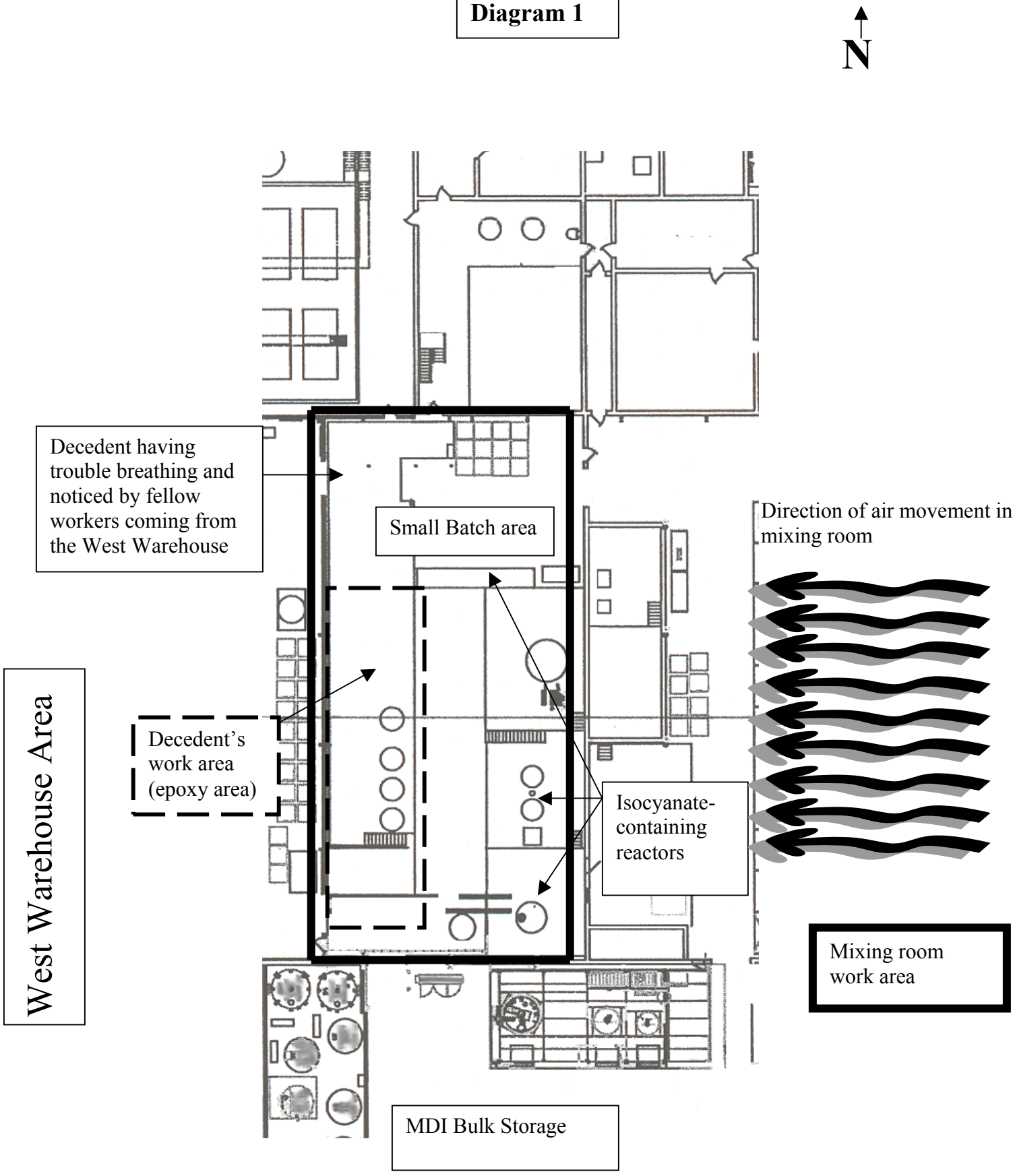
- Michigan State University, Occupational and Environmental Medicine Division. www.oem.msu.edu
- British Occupational Health Research Foundation. Occupational Asthma: Identification, Management and Prevention: Evidence Based Review and Guidelines. www.bohrf.org.uk

Medical Information on Work-Related Asthma

- Allergic Diseases Resource Center. Diagnosis of Occupational Asthma. http://www.worldallergy.org/professional/allergic_diseases_center/occupational_asthma/
- Centers For Disease Control, National Institute for Occupational Safety and Health. *Asthma and Allergies*. http://www.cdc.gov/niosh/topics/asthma/
- U. S. Department of Labor, Occupational Safety and Health Administration. *Safety and Health Topics: Occupational Asthma.* http://www.osha.gov/SLTC/occupationalasthma/index.html
- American College of Occupational and Environmental Medicine. *Evidence-Based Statement: Evaluating Pulmonary Function Change Over Time in the Occupational Setting*. http://www.acoem.org/guidelines.aspx?id=756
- Canadian Centre for Occupational Health and Safety. *OSH Answers: Diseases, Disorders & Injuries: Asthma*. www.ccohs.ca/oshanswers/diseases/asthma.html
- Washington Department of Labor and Industries, Safety & Health Assessment & Research for Prevention. *Diagnosing Work-Related Asthma*. www.lni.wa.gov/Safety/Research/files/AsthmaCme.pdf

Key Words: Asthma, isocyanates, adhesives, medical screening

Diagram 1


N
Decedent having trouble breathing and noticed by fellow workers coming from the West Warehouse
Small Batch area
Direction of air movement in mixing room
West Warehouse Area
Decedent's work area (epoxy area)
Isocyanate-containing reactors
Mixing room work area
MDI Bulk Storage

MIFACE
Investigation Report #05 MI 141
Evaluation

To improve the quality of the MIFACE program and our investigation reports, we would like to ask you a few questions about this report:

Please rate the report using a scale of:	**Excellent**	**Good**	**Fair**	**Poor**
	1	2	3	4

What was your general impression of this MIFACE investigation report?

Excellent	**Good**	**Fair**	**Poor**
1	2	3	4

Was the report…	**Excellent**	**Good**	**Fair**	**Poor**
Objective?	1	2	3	4
Clearly written?	1	2	3	4
Useful?	1	2	3	4

Were the recommendations …	**Excellent**	**Good**	**Fair**	**Poor**
Clearly written?	1	2	3	4
Practical?	1	2	3	4
Useful?	1	2	3	4

How will you use this report? (Check all that apply)

- ❑ Distribute to employees
- ❑ Post on bulletin board
- ❑ Use in employee training
- ❑ File for future reference
- ❑ Will not use it
- ❑ Other (specify) _____

Thank You!

Please Return To:

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Comments:

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