# <u>2005</u> Annual Report on Work-Related Asthma in Michigan



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# Summary:

This is the 15th annual report on work-related asthma (WRA) in Michigan. For the years 1989-2003, where all reports have been processed, an average of 141 new people each year have been reported to the Michigan Department of Labor and Economic Growth with asthma caused or aggravated by exposures in the workplace. From 1988 to 2005, a total of 2,400 people with WRA have been identified through the Michigan Surveillance System that tracks occupational illness. Additional reports for 2004 and 2005 are still being processed. In this year's report we have again included brief clinical summaries on each of the new cases of work-related asthma reported in 2005 (see Appendix I).

There have been four work-related asthma deaths since 2003. In 2005, investigations were completed for two individuals who died from work-related asthma; a waitress died in May 2004, from second hand cigarette smoke exposure in a bar, and a production worker died in December 2005 from isocyanate exposure in an adhesive manufacturing facility. Also, in 2004, a dairy farmer died from an asthma attack while cleaning out a bulk milk tank, after a sodium hypochlorite/sodium hydroxide solution was mistakenly mixed with the product used in the second rinse, an acid, and chlorine gas was generated. In the year 2003, one worker died after repeated exposure to an isocyanate used in the sprayon truck-bed lining industry.

We know that the reports received are an under-representation of the true number of individuals with WRA in our state. There are a number of ways to estimate the extent of WRA in a given population, including: the use of self-reports from surveys, statistical estimates from studies, and an actual census count of disease. A consensus statement from the American Thoracic Society concluded: "The median value of 15% is a reasonable estimate of the occupational contribution to the population burden of asthma" (1). A survey of the adult population in Michigan found that 9.7% of Michigan residents reported they had been told by a doctor or told a doctor that their asthma was related to a job they had, either currently or in the past (2). All of these methods to develop an estimate of the magnitude of work-related asthma in Michigan indicate that WRA is a significant problem in our state. We estimate there are 65,000 - 97,000 people in Michigan with work-related asthma.

Workplace exposures may cause new onset asthma from exposure to an allergen or an irritant that precipitates inflammatory changes, or work exposures may exacerbate pre-existing asthma from exposure to an irritant. Almost ninety percent of the reports received in Michigan involve the new onset of asthma. Michigan Occupational Safety and Health Administration (MIOSHA) enforcement inspections at the workplaces of these individuals reveal a large number of fellow workers with asthma or respiratory symptoms compatible with asthma.

There are over 400 documented agents or work processes associated with workrelated asthma. The most comprehensive listing of known causes of work-related the asthma be found following web site: can at www.remcomp.fr/asmanet/asmapro/agents.htm. Known allergens such as isocyanates and metal working fluids are the most commonly reported cause of work-related asthma in Michigan, representing 14.6% and 11.5% of the Michigan WRA cases, respectively. About 1% of the Michigan workforce is employed in manufacturing companies where isocyanates are used.

Work-related asthma is affecting men and women equally, generally in the 30-50 year old age range. The average annual incidence rate of work-related asthma among African Americans is 2.0 times greater than among Caucasians. Exposures are occurring in a wide range of workplaces. When an inspection is conducted at the workplace, significant numbers of symptomatic individuals have been identified. However, air monitoring at these same facilities typically reveals that the exposures to the suspected allergen or irritant are within existing workplace standards (95% of the time).

The Michigan WRA surveillance team has worked on many recent initiatives to understand more about certain high-risk exposures or industry and occupation groups. A manuscript on asthma among health care workers from the four states that track work-related asthma (California, Massachusetts, Michigan and New Jersey) was published in 2005 (3). A second manuscript on asthma among school employees from the same four states has been prepared (4).

Another ongoing initiative in Michigan has been the development and presentation of a training workshop on work-related asthma to both the State's industrial safety and health staff and companies that have employees at risk for workrelated asthma. The workshop's aim is to increase awareness of asthma, including its causes and triggers in the workplace so that MIOSHA field staff as well as company Health and Safety Representatives can evaluate the potential for exposures and develop work-related asthma prevention strategies. An additional initiative to increase awareness of WRA among health care providers is needed to reduce morbidity and mortality from the condition.

# Background:

In 1988, the State of Michigan instituted a surveillance program for work-related asthma with financial assistance from the National Institute for Occupational Safety and Health (NIOSH). The surveillance program is a joint project of the Michigan Occupational Safety and Health Administration (MIOSHA) in the Michigan Department of Labor and Economic Growth (MDLEG) and Michigan State University (MSU). The goal of the surveillance program is to prevent work-related asthma through the reporting of index patients. The reporting of the index patient is regarded as a sentinel health event that may lead to the identification of other employees from the same facility, at risk of developing asthma or who have developed similar breathing problems.

There are three major sources used to identify persons with work-related asthma: reports from physicians; reports from hospitals (since 1989); and claims filed since 1988 with the Bureau of Workers' Compensation. Both physicians in private practice and those working for industry send reports to the MDLEG. Reports from hospitals are requested once each year. Hospital discharge summaries for individuals with a primary or secondary diagnosis of a respiratory condition due to chemical fumes and vapors (ICD-9 506.0-.9) as well as individuals with a primary or secondary diagnosis of asthma (ICD-9 493) where the principal payer is listed as workers' compensation are obtained from the Michigan Health and Hospital Association's (MHA) Michigan inpatient database to verify the completeness of reporting by the hospitals. Other sources used to identify cases include: Michigan's two Poison Control Centers (since 2001); reports from co-workers or from the State's industrial hygienists; one report from the Mine Safety and Health Administration; and, four reports from death certificates.

A person is considered to have work-related asthma from sensitization to a workplace exposure if: A) they have a physician diagnosis of asthma, B) onset of respiratory symptoms associated with a particular job that then improve or are relieved when the patient is not working, and C) they work with a known occupational allergen, or have evidence of an association between work exposures and a decrease in pulmonary function testing.

Additional criteria are used to record three other categories of asthma associated with work. If only criteria A) and B) above are met, the person is considered to have possible work-related asthma. An enforcement industrial hygiene investigation at the patient's work site may be conducted by MIOSHA to determine the allergen and to document its associated exposure levels. If a person had physician-diagnosed asthma before beginning work and their asthma became worse at a particular job, the person is considered to have work-aggravated asthma. Occupational asthma from exposure to an allergen at work typically develops after a variable period of symptom-less exposure to the sensitizing agent. However, if a person develops asthma for the first time immediately after an acute exposure to an irritating chemical at work, the patient is considered to have Reactive Airways Dysfunction Syndrome (RADS) (5).

After the patient is interviewed and the work-relatedness of the condition evaluated, an industrial hygiene investigation may be conducted at the patient's workplace. At this follow-up investigation, co-workers are interviewed to determine if other individuals are experiencing similar breathing problems from exposure to the suspected allergen. An industrial hygienist conducts air monitoring for any suspected allergens and reviews the company's health and safety program. After the investigation is completed, a report of air sampling results and any recommendations are sent to the company and union (or designated labor representative, if the company does not have a union).

In 1998, the surveillance program also began sending letters about potential problems with exposures to some of the companies where the index cases were exposed to an allergen but a MIOSHA inspection was not planned. These letters, in lieu of inspections, are sent to the company health and safety director, and require the company to evaluate exposures to whatever suspected allergens were identified through the telephone interview with the index case.

# **Results:**

### <u>Reports</u>

Table 1 shows that 2,400 people were confirmed with work-related asthma between 1988 - 2005. Figure 1 presents the same data in a bar graph of the number of cases identified each year and the types of work-related asthma that were confirmed. The reports are divided into four categories: occupational asthma, possible occupational asthma, aggravated asthma, and RADS. One hundred forty-six additional patients have been confirmed since last year's report. Figure 2 shows the overlap of the 2,305 patients by reporting sources for 1988-2004.

The data is incomplete for 1988 since the surveillance system was initiated in that year. For the year 2003, 144 cases have been confirmed; this is similar to the 143

cases reported in 2002. To date we have not yet received complete hospital reporting for the years 2004 and 2005. Patient interviews are still needed for seven reports of patients from hospitals, one report from a physician, and one report from a poison control center in 2004. Patient interviews are still needed for one report of a patient from a hospital, one report from workers' compensation, one report from a death certificate, six reports of patients from physicians, and three reports of patients from a poison control center in 2005.

### <u>Gender</u>

One thousand two hundred and fifty-one (52.1%) of the persons with work-related asthma are women and 1,149 (47.9%) are men.

### <u>Race</u>

Race was known for 2,356 of the 2,400 individuals with work-related asthma. Of the 2,356, 1,806 (76.7%) of the persons with work-related asthma are Caucasian, 451 (19.1%) are African American, 41 (1.7%) are Hispanic, 21 (0.9%) are Alaskan or American Indian, eight (0.3%) are Asian, and 29 (1.2%) were listed as "other."

The average number of incident cases of African Americans with work-related asthma each year for 1992-2003 was 28. In 1998 there were 539,621 African Americans in the Michigan labor force (6). The annual incidence rate for work-related asthma in African Americans, therefore, was 5.2/100,000 workers. The respective data for Caucasians was 113 new cases per year and 4,368,720 Caucasians in the Michigan labor force. The annual incidence rate of work-related asthma in Caucasians, therefore, was 2.6/100,000 workers. The African American rate of work-related asthma was 2.0 times greater than the rate for Caucasians.

### <u>Age</u>

The dates of birth range from 1905 - 1985. The average year of birth is 1955.

### Location in State

Figure 3 shows the county in which the patient worked where they developed workrelated asthma. The main locations are: Wayne (588 cases, 25.1%), Oakland (312 cases, 13.3%), and Macomb (225 cases, 9.6%). Table 2 and Figure 4 show the annual average incidence rates of work-related asthma among the general working population in each county. Based on the annual average incidence of reports of confirmed cases per 100,000 adult workers, Luce (15.0 per 100,000), Clare (11.9 per 100,000), Osceola (8.6 per 100,000), and Cheboygan (7.8 per 100,000) have the highest rates. It should be noted that, even though Luce had the highest incidence rate of work-related asthma, the rate is based on only six cases (see Table 2). Table 3 shows the annual incidence rates for the larger metropolitan areas and the whole state for the years 1990 through 2003 separately.

### Type of Industry

Figure 5 shows the distribution of major industry types for all asthma cases identified from 1988-2005. Sixty-six percent of the WRA cases worked in manufacturing, followed by 19% in the services industry, 5% in the trade industry, 3% in construction and mining, and 7% in miscellaneous industries. Table 4 shows the specific types of Michigan industries where the exposures to the occupational allergens occurred from 1988 to 2005. The predominant industries for the total number of cases identified between 1988 and 2005 were in the manufacturing sector: automobile (40.0%), fabricated metal products (4.0%), industrial and commercial machinery and computer equipment (4.1%), rubber and miscellaneous plastic products (3.4%), and foundries (3.0%). Workers in the health field also accounted for a high percentage of the total number of patients (9.8%).

The incidence rate of work-related asthma by industry type ranges from 0.4 cases per 100,000 in general merchandise stores and in miscellaneous retail shops, to a high of 19.7 cases per 100,000 in the manufacture of transportation equipment. The industries with the highest annual average incidence rates besides the manufacture of transportation equipment included: foundries with 12.1 cases per 100,000 workers; the manufacture of other nondurables with 10.7 cases per 100,000 workers; the manufacture of rubber products with 7.6 cases per 100,000 workers; and the manufacture of other durables with 7.3 cases per 100,000 workers.

Table 5 shows the annual incidence rates for the 1990 through 2003 work-related cases within those industries that had 20 or more reports. Overall, by broad industrial classification, the average annual incidence rates were: 10.9 cases per 100,000 workers in the manufacturing industry; 2.6 cases per 100,000 workers in the construction and mining industry; and 1.0 case per 100,000 workers in the service producing industry.

Table 6 shows the predominant exposures causing work-related asthma in Michigan. The most frequent exposures were to isocyanates (14.6%), metal working fluids (11.5%), cleaning solutions (8.6%), exhaust, smoke and fumes (5.8%), welding fumes (4.5%), and solvents (3.1%). The agent has not yet been identified for 352 patients (14.7%). The exposures to unknown agents occurred 193 times in the manufacturing sector and 159 times in an office setting.

# Medical Results

Table 7 shows patients' cigarette smoking status. Twenty percent of patients were smoking when their work-related asthma developed. This is a lower percentage than the state average and markedly lower than that found in a blue collar working population.

Forty-three percent of the WRA patients had a family history of allergies (Table 8). Forty-six percent of the asthma patients had a personal history of allergies or asthma (Table 9). Four hundred ninety-five (45.1%) of the 1,097 patients with a personal history of allergies or asthma previously had asthma.

One thousand nine hundred sixty-two of the patients identified with work-related asthma had persistence of their asthma symptoms (Table 10). This was true for 612 of 635 (96.4%) of those still exposed as well as 1,350 of 1,566 (86.2%) no longer exposed to the substance causing their asthma. Among those no longer exposed, 49.2% stated their symptoms were less severe compared to 30.6% among those still exposed who reported their symptoms were less severe. Similarly, 86.1% of those still exposed were continuing to take asthma medications while 77.6% of those no longer exposed were still taking asthma medications. Among those no longer exposed, 28.2% stated they were taking fewer medications while only 19.2% of those still exposed were taking fewer medications (Table 10).

One thousand thirty-four of 2,140 (48.3%) patients with known workers' compensation status had applied for workers' compensation. Cases were pending for 519 (50.2%) of those who applied, while 358 (34.6%) had received awards and 157 (15.2%) had been denied.

Although 2,400 individuals were confirmed with work-related asthma, we could find objective testing for hyperreactivity by methacholine challenge or pre- and postbronchoprovocation for only 74% of cases. In addition, we found only 0.5% of cases had specific antigen bronchoprovocation, 2.7% of cases had peak flow monitoring and only 2.4% of cases had pre- and post-work shift testing.

### Industrial Hygiene

The 2,400 people with work-related asthma worked at 1,638 different facilities. Five hundred thirty-five facilities were inspected 623 times. Eighty-eight of the 1,638 facilities were inspected more than once. Sixteen inspections were completed since last year's report. Inspections are scheduled at 46 (2.7%) facilities (Table 11). Eighty-five companies received letters notifying them that a disease report had been received and asked them to investigate potential exposures causing the respiratory problem, including indoor air problems. No follow-up was planned for 895 companies, 53 companies were no longer in business, and 24 companies no longer used the occupational allergen associated with the development of asthma in the index case.

Air sampling for allergens was conducted during 435 of the inspections. Forty-five of the 418 (10.8%) facilities with a NIOSH recommended exposure limit (REL) for the allergen were above the NIOSH REL. Twenty-one (4.8%) of the 434 facilities with a MIOSHA standard for the allergen were above the enforceable MIOSHA permissible exposure limit (PEL) (Table 12).

Table 13 shows the allergens that were found to be above the NIOSH and/or MIOSHA limits. No exposures above permissible limits for allergens were identified during this past year's inspections. Formaldehyde (40.0%) was the most frequently sampled allergen found to be above the NIOSH REL, followed by styrene (13.3%) and metal working fluids (11.1%). Welding fume (23.8%) was the most frequently sampled allergen found to be above the MIOSHA enforceable PEL, followed by styrene (19.0%) and glutaraldehyde (14.3%).

Interviews of fellow workers were performed at 487 of the 623 inspections. Coworkers of the index cases reported daily or weekly breathing symptoms or onset of new asthma since beginning to work at that company in 342 of the 487 (70.2%) companies. The average percentage of co-workers with symptoms in these 342 companies was 20.4%, ranging from 2% to 100%. Interviews of 1,081 co-workers from 145 companies found no co-workers with symptoms. One thousand four hundred thirty-eight of the 8,683 (16.6%) co-workers interviewed had symptoms consistent with work-related asthma (new onset asthma or bothered at work by daily or weekly shortness of breath, wheezing or chest tightness) (Table 14).

The Michigan Occupational Safety and Health Administration (MIOSHA) Injury and Illness logs kept by employers listed 558 workers from 119 companies as having asthma or asthma-like symptoms. Only nine workers identified in the interviews with daily or weekly breathing symptoms were also listed on the Michigan OSHA log. Therefore, a total of 1,987 symptomatic workers were identified during the 623 inspections.

# Michigan Workforce Exposed to Isocyanates

Isocyanates are the most commonly reported cause of work-related asthma in Michigan. The United States Environmental Protection Agency (EPA) requires reporting by facilities that use any one of 650 different chemicals in amounts greater than 10,000 pounds per year and are a manufacturer, mining or electrical generator and have at least 10 employees. Isocyanates are one of the 650 substances for which reporting is required. Queries of reportable chemicals can be generated to identify state-level statistics on facilities.

We identified Michigan's isocyanate-using companies in the Toxic Release Inventory (TRI) to estimate the number of workers employed in manufacturing companies that use isocyanates. This estimate under-counts non-manufacturing exposed workers such as auto body paint shop employees since the EPA database does not include these types of non-manufacturing establishments. On the other hand it is an over-count of manufacturing employees since the <u>total number</u> of employees at a given facility that reported isocyanate use were counted even though only a smaller percentage of the workers would have worked with or around isocyanates and therefore have been potentially exposed to isocyanates.

A list of counties with the companies that reported the use of isocyanates in calendar year 2004 (the most recent year for which this information is available) can be found in Table 15. The number of workers employed in companies that use isocyanates, the total number of workers in these counties, and the percentage of workers where isocyanates are used is listed.

# Work-Related Asthma Fatalities

Fortunately, a very small percentage (0.01-0.02%) of individuals with asthma die from asthma. In 2005, two work-related asthma deaths were investigated; a waitress died from exposure to second hand cigarette smoke in a bar in May 2004, and a production worker died from exposure to isocyanates in an adhesive manufacturing facility in December 2005. In prior reports we described two other asthma deaths: in 2004 there was an acute fatality of a dairy farmer from exposure to the chemicals used to clean a milk tank; in 2003 there was an acute fatality from a work place exposure to methylene diphenyl diisocyanate (MDI) used in the truck bed spray-on lining business. Descriptions of the two deaths investigated in 2005 follow:

On May 1, 2004, a 19-year-old African American female waitress working at a bar died from an asthma attack. The bar was divided into two separate areas, the bar area with limited seating and a room with a disc jockey (DJ) booth. When the victim arrived at work at 9:45 pm, she talked with the DJ who was setting up in the adjacent room, then walked about 25 feet to an open section of the bar. The bar owner stated she was not experiencing any difficulty breathing at that time. There were approximately 30 people in the bar area. No individuals were in the

room with the DJ. According to the owner, the bar was not "overly smoky." Shortly after the victim went behind the bar, she grabbed the bar manager, saying she needed to get to the hospital and that she needed fresh air. The victim said she wished she had her inhaler with her. As the two walked out from behind the bar toward the back door, the victim collapsed on the dance floor. The bar patrons were asked if anyone had an inhaler. Someone did, and the victim attempted to use the inhaler but was unable to do so. According to the bar manager, the inhaler mist came back in to her face. Emergency Medical Service (EMS) was called and she was transported to a local hospital where she was declared dead 30 minutes from the time of the call to EMS. The complete report of this incident is available at <u>www.oem.msu.edu</u>.

A 50-year-old white male collapsed on December 13, 2005, while working at an adhesive manufacturer. The adhesives contained isocyanates. During the course of his employment at the facility, the victim had developed work-related asthma from exposure to isocyanates. On the day of his collapse, the victim was working in a room where a barrel of isocyanates was opened. Upon his exposure to the isocyanate material, he complained of shortness of breath to a fellow worker. He used his asthma inhaler to attempt to alleviate his shortness of breath, and then he collapsed. Police arrived within five minutes and cardiopulmonary resuscitation was provided by both police and fellow workers. Life support EMS arrived and transported the victim 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

# Discussion:

In our previous annual reports, we have emphasized the fact that the cases reported in Michigan's surveillance system are likely an undercount of the true number of cases of work-related asthma in the state. This continues to be true. Studies suggest that work exposures are important etiologic agents in a significant percentage (15%) of adults with asthma (1,2). An average of 141 new people each year are reported to the Michigan Department of Labor and Economic Growth (DLEG) with confirmed work-related asthma. One hundred forty-four reports were confirmed in 2003, the most recent year with complete data. Although the total number of work-related asthma cases has not varied significantly (115-176), the number of individuals with exposure to a known occupational sensitizer (disease category "OA") appears to show a definite downward trend. There was a peak of 87 cases in 1990 with a drop to 29 cases in 2003 (see Table 1). The reason for this trend is unknown and may be related to changes in reporting sources or to the success of work places in better controlling their employees' exposures to known sensitizers.

Based on responses from the 2001 BRFSS random sample of Michigan residents, we would estimate that there are a total of 62,693 (95% CI 42,011 - 83,375) Michigan adults with work-related asthma in the state (2). Based on the medical literature we would estimate that there are 97,500 Michigan adults with work-related asthma (1). Using capture-recapture analysis, we estimate 228 - 801 adults in Michigan develop work-related asthma each year (7).

As in the previous annual reports on work-related asthma in Michigan, the workers reported are generally young to middle age Caucasian men and women, with the greatest number being reported from the Detroit metropolitan area. However, the rate of work-related asthma in African Americans is 2.0 times greater than among Caucasians. Based on an analysis conducted for previous annual reports, factors from the work-related asthma surveillance data that would contribute to greater morbidity among African-Americans include: a greater likelihood to continue to be exposed to the allergen; having a longer time of exposure before leaving work; and being less likely to receive workers' compensation. Another recent trend and concern is the hiring of temporary workers. As companies find new ways to trim costs, more temporary workers are being hired to do work on an as-needed basis. The transient nature of temporary work underscores the potential for undercounting of cases of WRA when employees move from job to job, especially those jobs that have a high potential for exposure to sensitizing agents.

Individuals in the Michigan work force tend to develop their asthma from exposures to agents in the manufacturing sector, particularly automobiles, machinery, metals, chemicals, and rubber and plastics. The predominant causes of work-related asthma remain isocyanates (14.6%) and metal working fluids (11.5%). We have again updated the table first presented in the 2002 Work-Related Asthma Annual Report (Table 15) on the number of manufacturing workers in companies that use isocyanates. In some counties, more than 5% of the workforce

is employed in manufacturing facilities where isocyanates are used: Montcalm (12%); Barry (8%); and Mecosta (8%). Health care providers can use this information to heighten their awareness of potential exposure to isocyanates among their patients with asthma. One of the asthma deaths investigated in 2005 highlights the adverse consequences of physicians not identifying asthma as work-related. The death of the worker from isocyanate work-related asthma would have been prevented if any one of the three doctors involved in his medical care had removed him from the exposure.

Asthma symptoms persist despite removal from the precipitating work exposures (Table 10). Studies have shown that the sooner an individual is removed from the exposure causing their asthma after symptoms develop, the more likely the individual's symptoms will resolve (8). On the average, among the 1,566 individuals no longer exposed, 2.8 years elapse from time of onset of respiratory symptoms at work to date last exposed. We do not have data on how much of this delay is secondary to the individual not seeking medical care and how much is related to the physician not recommending that the individual leave the exposure.

Neither personal habits such as cigarette smoking nor individual susceptibility as measured by personal or family history of allergies are predictive of who will develop work-related asthma. Approximately 50% of the asthma patients have no personal or family history of allergies and 80% are not smoking cigarettes at the time their asthma symptoms develop (Tables 7-9).

Although most facilities where the patient developed asthma were not found to be in violation of exposure standards, there were high percentages of symptomatic fellow workers in those facilities. Inspections of these sites also found that 50% were in violation of other MIOSHA standards. It is possible that sampling was not conducted under similar enough working conditions as the exposures associated with the development of the index cases' asthma, such as incidents of spills or leaks or that the current standards are not protective enough. We identified 1,438 fellow workers with symptoms compatible with work-related asthma. Five hundred fifty-eight individuals were listed on the Michigan OSHA log as having work-related asthma. There was a small overlap (nine individuals), although one might expect a greater overlap of the co-workers with symptoms to be reported on the log. Part of the reason for the lack of overlap is that half of the symptomatic individuals indicate they have never seen a doctor for their respiratory symptoms.

The high percentages of symptomatic individuals are consistent with estimates of the prevalence of work-related asthma in the state. The presence of symptomatic

co-workers suggests that some of the occupational health standards may not be sufficiently protective to ensure a safe workplace. Ideally, the state would institute comprehensive standards that cover medical surveillance programs for potentially exposed workers, work practices, education, and procedures to handle non-routine exposures such as during maintenance, as well as spills or leaks and other unexpected releases.

Medical monitoring is particularly relevant to reducing the burden of work-related causes of asthma. The longer a person with symptoms remains exposed, the more likely their asthma will become a chronic problem (8). MIOSHA is currently promulgating a new standard for the diisocyanates. An advisory committee of the Michigan Occupational Safety and Health Commission has drafted a diisocyanate standard for consideration. The deaths in 2003 and 2005 of workers from exposure to isocyanates might have been prevented if more comprehensive standards for the use of isocyanates were in place. The proposed standard should better inform employers and employees of the hazards related to the use of diisocyanates. The 2003 death occurred in a small three-person shop and reflects the spread of the use of new technology without adequate information on safe work practices. Small employers require additional knowledge of safe work practices to prevent sensitization of their employees. The 2005 death occurred in a company that, although it provided medical monitoring, did not properly utilize the results of the medical monitoring. Even medical professionals may not be fully aware of the hazards related to returning sensitized individuals to their places of employment.

The percentages of individuals reported with work-related asthma that this surveillance system documented as having had breathing tests performed in relation to work is less than 10%. This reflects the standard of medical care in the United States where the diagnosis of work-related asthma is made from the patient's history. More frequent use of objective pulmonary function testing performed in relation to work would allow health care providers to feel more confident about advising their patients to leave their exposure. Cessation of exposure is the most important aspect of treatment of work-related asthma. Patients who are removed from exposure the soonest have the best prognosis (8).

Ongoing vigilance in the identification of WRA and using opportunities for education and intervention at many levels continues to be a priority in Michigan. For example, the Michigan Chapter of the American Lung Association, under contract to the Michigan Department of Community Health, maintains a web site of resources on asthma called the Michigan Asthma Communication Network (MACN). The web site can be accessed at: <u>www.getasthmahelp.com</u>. Information on work-related asthma is included on this web site.

An educational initiative that continued this past year provided workshops on asthma in the workplace for the MIOSHA safety and health field staff and employers. The program was developed to increase awareness of asthma, the hazards commonly found in the workplace, and ways to help facilities control exposures that could cause or aggravate asthma among their employees.

Recognition of work-related asthma is critical in managing adults with asthma. The deaths in 2003 and 2005 of individuals with asthma from isocyanate exposures are attributable to the lack of recognition of an association between the individual's respiratory problems and work exposure to occupational sensitizers by both the employer and health care provider. The deaths of these Michigan workers underscore the importance of efforts aimed at the understanding and reduction of WRA in our state.

The report of a patient with known or suspected work-related asthma is a sentinel health event that is critical to effective occupational disease surveillance. Case reporting from physicians offers the opportunity for the most timely workplace interventions, compared to receiving reports from hospitals. With continued support and increasing awareness of work-related asthma by physicians and other health professionals, we can continue to provide timely intervention in the workplace, offer suggestions for reducing workplace exposures even if they are below current permissible exposure limits, document the need for the development of new standards, identify new occupational allergens, and prevent co-workers from developing disease.

Given the potential that 15% or more of adults with asthma have work-related asthma, work-related asthma needs to be integrated into all asthma initiatives planned on surveillance and education, both for health care providers and the public.

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# Figure 1. Number of Confirmed Cases of Work-Related Asthma by Year and Type







Reporting Source Codes: HDC=Hospital Discharge Data; PR=Physician Referral; DC=Death Certificate;

WC=Workers' Compensation; ICFU=Index Case Follow Up; MSHA=Mine Safety and Health Administration; PC=Poison Control Center.

Figure 3. Distribution of Confirmed Work-Related Asthma Patients by County of Exposure: 1988-2005



Total Michigan Patients: 2,340ª

**Oakland** and **Wayne** counties had the highest number of work-related asthma patients, with 312 and 588 individuals, respectively.

<sup>a</sup> County of exposure was unknown for 20 patients. Forty patients were exposed out-of-state to an allergen.

Figure 4. Average Annual Incidence Rates of Work-Related Asthma Among Michigan Workers by County of Exposure: 1989–2003<sup>a</sup>



<sup>a</sup> Rate per 100,000 among Michigan workers. Source: MESC 1996 Annual Average Labor Statistics for Employment by Place of Work. In 1996, there were a total of 4,345,000 Michigan workers.



Trade (n=112), 5%

Table	1.	Num	oer	of C	Conf	irmed	Case	es of
Work-	Re	lated	Ast	thma	by	Year	and	Type

	Dise	ase Status <sup>a</sup>			
<u>YEAR</u>	<u>OA</u>	POA	<u>AA</u>	RADS	<u>TOTAL</u>
1988	23	7	0	1	31
1989	43	12	3	5	63
1990	87	35	14	8	144
1991	55	30	14	16	115
1992	81	37	14	18	150
1993	75	69	13	19	176
1994	65	59	15	13	152
1995	56	35	19	17	127
1996	61	59	24	11	155
1997	53	74	19	16	162
1998	45	75	18	9	147
1999	49	64	16	12	141
2000	49	67	31	17	164
2001	50	51	20	18	139
2002	39	59	24	21	143
2003	29	64	28	23	144
2004	38	57	32	25	152
<u>2005</u>	<u>29</u>	<u>52</u>	<u>5</u>	<u>9</u>	<u>95</u>
Total	927	906	309	258	2,400

<sup>a</sup>OA = occupational asthma; POA = possible occupational asthma; AA = aggravated asthma; RADS = reactive airway dysfunction syndrome.

# Table 2. Average Annual Incidence Rates of Work-Related AsthmaAmong Michigan Workers by County of Exposure:1989-2003

<u>County</u>	Number of <u>Employees</u> ª	Avg.Annual <u>Inc. Rate<sup>b</sup></u>	Total Cases <u>1989-2003</u>	<u>County</u>	Number of <u>Employees</u> ª	Avg.Annual <u>Inc. Rate<sup>b</sup></u>	Total Cases <u>1989–2003</u>
Alcona- Iosco	11,425	1.2	2	Jackson	60,200	3.5	32
Alpena	13,325	3.0	6	Kalamazoo-Calhoun-VanBuren	206,300	1.6	49
Antrim	5,475	2.4	2	Kent-Ottawa-Muskegon-Allegan	534,300	1.4	111
Arenac	4,575	4.4	3	Lake	1,600	4.2	1
Baraga	3,500	3.8	2	Luce	2,675	15.0	6
Barry	11,775	1.1	2	Manistee	7,450	1.8	2
Berrien	71,200	1.8	19	Marquette	27,875	3.1	13
Branch	13,550	4.9	10	Mason	10,325	1.9	3
Cass	10,650	1.9	3	Mecosta	13,100	1.0	2
Charlevoix	10,250	2.6	4	Menominee	9,500	0.7	1
Cheboygan	7,675	7.8	9	Montcalm	18,725	3.9	11
Chippewa	15,475	1.3	3	Montmorency	2,200	6.1	2
Clare	7,300	11.9	13	Newaygo	10,375	3.2	5
Clinton-Eaton-Ingham	228,700	2.5	85	Oceana	6,200	1.1	1
Crawford	4,425	3.0	2	Ogemaw	6,225	1.1	1
Delta	15,100	1.8	4	Osceola	7,775	8.6	10
Dickinson	14,375	4.2	9	Otsego	11,050	5.4	9
Emmet	14,950	1.8	4	Roscommon	6,550	3.1	3
Genesee	181,800	6.5	177	Sanilac	13,125	5.6	11
Gladwin	5,025	2.7	2	Schoolcraft	2,775	2.4	1
Gogebic	6,475	1.0	1	Shiawassee	19,150	1.7	5
Grand Traverse-Benzie-				St. Joseph	25,250	1.6	6
Kalkaska-Leelanau	57,950	2.6	23	Tuscola	14,100	4.7	10
Gratiot	14,200	2.8	6	Washtenaw-Lenawee-Livingston	260,500	4.3	169
Hillsdale	15,200	3.9	9	Wexford-Missaukee	16,950	1.6	4
Houghton-Keweenaw	14,700	1.4	3	Saginaw-Bay-Midland	175,000	4.2	110
Huron	13,225	6.0	12	Detroit, MSA <sup>c</sup>	2,051,000	3.4	1,054
Ionia	16,125	3.7	9	Out of State			39
Iron	4,125	3.2	2	Unknown	<u></u>		<u>20</u>
Isabella	25,250	1.3	5	All Michigan Counties	4,345,000	3.2	2,063

<sup>a</sup> Source: MESC 1996 Annual Average Labor Statistics for Employment by Place of Work. Some employee population data is only available at a multi-county level, as indicated (i.e., not available at a single county level). Therefore, some data is presented with grouped counties. <sup>b</sup> Rates are based on the average number of cases per year from 1989-2002, per 100,000 Michigan workers.

<sup>c</sup> MSA=Metropolitan Statistical Area and includes Lapeer (24 cases), Macomb (191 cases), Monroe (18 cases), Oakland (278 cases), St. Clair (21 cases) and Wayne (522 cases) counties.

# Table 3. Annual Incidence Rates of Work-Related Asthma Among Michigan Workers by Major Metropolitan Area: 1990-2003

	Clinton- <u>Eaton-Ingham<sup>a</sup></u>	Kent-Ottawa- <u>Muskegon-Allegan</u>	Saginaw- <u>Bay-Midland</u>	Detroit <u>MSA<sup>b</sup></u>	Total (all <u>Michigan)</u>
1990	1.4 (3)	2.2 (8)	2.4 (4)	3.0 (58)	3.6 (144)
1991	3.8 (8)	1.4 (5)	4.3 (7)	2.7 (50)	3.0 (115)
1992	5.6 (12)	0.7 (3)	1.8 (3)	4.6 (86)	3.8 (150)
1993	3.7 8)	1.3 (6)	1.8 (4)	6.4 (121)	4.4 (176)
1994	1.8 (4)	3.5 (7)	1.8 (3)	4.4 (85)	3.7 (152)
1995	2.2 (5)	1.2 (6)	1.7 (3)	3.4 (69)	3.0 (127)
1996	1.3 (3)	0.9 (5)	2.9 (5)	4.0 (91)	3.5 (155)
1997	2.2 (5)	1.1 (6)	4.5 (8)	3.7 (77)	3.6 (162)
1998	2.6 (6)	1.4 (8)	3.9 (7)	3.7 (79)	3.3 (147)
1999	0.9 (2)	1.7 (10)	5.5 (10)	2.7 (59)	3.1 (141)
2000	1.3 (3)	1.5 (9)	8.7 (16)	3.0 (66)	3.6 (164)
2001	3.0 (7)	0.9 (5)	6.2 (11)	2.9 (62)	3.1 (139)
2002	3.4 (8)	1.0 (6)	4.6 (8)	3.2 (68)	3.2 (143)
2003	3.4 (8)	1.2 (6)	9.6 (13)	2.7 (56)	3.2 (144)

<sup>a</sup>Rate per 100,000 Michigan workers. Rate, number of cases in parentheses. Source: MDCD (formerly the MESC) Annual Average Labor Statistics for Employment by Place of Work, for each year 1990-2003 separately.

<sup>b</sup>MSA=Metropolitan Statistical Area. For the years 1990-1995, includes Lapeer, Livingston, Macomb, Monroe, Oakland, St. Clair, and Wayne counties. For 1996- 2003 does not include Livingston county because of a change in the counties associated with certain MSA's (including Detroit).

# Table 4. Primary Industrial Exposure for Confirmed Work-RelatedAsthma Patients: 1988-2005

Industry (SIC Code) <sup>a</sup>	Number 1988	Number of Cases <u>1988-2005</u> b			Ann. Average Incidence Rate <u>1989-2003</u> <sup>d</sup>	
MANUFACTURING (20-39)						
Automobile (37)	959	(40.0)	291,000	19.7	(861)	
Fabricated Metal Products (34)	96	(4.0)	128,000	4.6	(88)	
Ind. & Comm. Mach. & Computer Equipment (35)	99	(4.1)	133,000	4.0	(80)	
Rubber and Misc. Plastic Products (30)	82	(3.4)	67,000	7.6	(76)	
Foundries (33)	72	(3.0)	37,000	12.1	(67)	
Food and Kindred Products (20)	50	(2.1)	44,000	6.8	(45)	
Printing and Publishing (27)	20	(0.8)	43,000	3.1	(20)	
Electrical Equipment (36)	19	(0.8)	34,000	3.1	(16)	
Lumber and Wood (24)	19	(0.8)	18,000	6.7	(18)	
Paper and Allied Products (26)	19	(0.8)	21,000	5.4	(17)	
Furniture and Fixtures (25)	8	(0.3)	38,000	1.4	(8)	
Apparel Made from Fabric (23)	2	(0.1)	20,000	0.7	(2)	
Other Durables (32,38,39)	54	(2.3)	45,000	7.3	(49)	
Other Nondurables (22,28,29,31)	89	(3.7)	49,000	10.7	(79)	
WHOLESALE AND RETAIL TRADE (50-59)						
Eating and Drinking Places (58)	27	(1.1)	286,000	0.5	(20)	
Wholesale-Nondurable Goods (51)	19	(0.8)	75,000	1.2	(14)	
Wholesale-Durable Goods (50)	15	(0.6)	143,000	0.7	(15)	
Food Stores (54)	13	(0.5)	106,000	0.8	(12)	
Automotive Dealers and Gasoline Services (55)	12	(0.5)	86,000	0.9	(12)	
General Merchandise Stores (53)	10	(0.4)	128,000	0.4	(8)	
Miscellaneous Retail (52, 56, 57,59)	16	(0.7)	201,000	0.4	(12)	
SERVICES						
Health (80)	236	(9.8)	391,000	3.5	(208)	
Education (82)	94	(3.9)	379,000	1.4	(78)	
Business (73)	26	(1.1)	266,000	0.6	(22)	
Social Services (83)	18	(0.8)	86,000	1.1	(14)	
Automotive Repair (75)	16	(0.7)	39,000	2.4	(14)	
Engineering, Accounting, etc. (87)	12	(0.5)	101,000	0.7	(10)	
Other Services (70,72,76,79,81,86,89)	64	(2.7)	272,000	1.4	(57)	
CONSTRUCTION AND MINING (10-17)						
Special Trade Construction (17)	51	(2.1)	115,000	2.6	(44)	
Other Construction (15-16)	9	(0.4)	53,000	1.1	(9)	
Mining (10-14)	8	(0.3)	8,000	5.0	(6)	
MISCELLANEOUS INDUSTRIES						
Government (91-97)	68	(2.8)	275,000	1.4	(59)	
Transportation and Utilities (40-49)	49	(2.0)	168,000	1.7	(43)	
Finance, Insurance and Real Estate (60-67)	30	(1.3)	201,000	0.7	(22)	
Agricultural Production and Services (01,02,07) <sup>e</sup>	12	(0.5)	40,176	1.7	(10)	
<u>Unknown</u>	<u>7</u>	(0.3)		=	<u>(7)</u>	
Total	2,400		4,385,176	3.2	(2,122)	

°1987 Standard Industrial Classification code.

<sup>b</sup>Number of cases, percentages are in parentheses.

<sup>c</sup>Source:MESC 1996 civilian labor force and industrial employment estimates.

<sup>d</sup>Average annual incidence rate, total number of cases for 1989-2003 are in parentheses. Rates are based on average number of cases from 1989-2003 per 100,000 adult workers in each industrial category.

<sup>e</sup>Source: Michigan Department of Career Development, Statewide Average Monthly Industry Employment, 1996.

# Table 5. Primary Industrial Exposure for Confirmed Work-RelatedAsthma Patients: 1990-2003

INDUSTRY (sic) <sup>a</sup> Manufacturing	<u>1990</u> <sup>ь</sup>	<u>1991</u>	<u>1992</u>	<u>1993                                   </u>	<u>1994</u>	<u>1995 </u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000                                  </u>	<u>2001</u>	2002	<u>2003</u>
Food (20)	20.0 (9)	6.7 (3)	2.3 (1)	(0)	2.3 (1)	4.4 (2)	6.8 (3)	4.9 (2)	7.5 (3)	2.6 (1)	8.1 (3)	10.8 (4)	10.5 (4)	12.3 (4)
Chemicals (28,29)	17.0 (8)	4.3 (2)	14.0 (7)	12.0 (6)	7.8 (4)	14.3 (7)	6.1 (3)	14.3 (7)	10.0 (5)	10.2 (5)	10.6 (5)	6.5 (3)	4.3 (2)	15.4 (5)
Rubber & Plastics (30)	9.3 (5)	19.6 (10)	(0)	7.3 (4)	11.3 (7)	15.1 (10)	10.4 (7)	13.2 (9)	4.5 (3)	5.8 (4)	6.2 (4)	1.6 (1)	6.5 (4)	11.5 (5)
Foundries (33)	9.5 (4)	23.7 (9)	8.1 (3)	19.4 (7)	18.9 (7)	5.4 (2)	18.9 (7)	8.1 (3)	10.5 (4)	7.9 (3)	13.2 (5)	8.3 (3)	8.6 (3)	18.2 (5)
Fabricated Metals (34)	6.6 (8)	4.4 (5)	2.6 (3)	3.4 (4)	5.7 (7)	3.1 (4)	12.5 (16)	8.6 (11)	4.7 (6)	1.6 (2)	3.8 (5)	0.8 (1)	5.0 (6)	8.4 (7)
Industrial Mach. (35)	6.3 (8)	1.7 (2)	6.1 (7)	8.5 (10)	6.6 (8)	3.0 (4)	3.0 (4)	2.2 (3)	3.7 (5)	2.3 (3)	6.0 (8)	5.7 (7)	0.9 (1)	5.2 (4)
Transportation Equip. (37)	19.0 (56)	15.6 (44)	28.7 (82)	26.5 (74)	25.0 (71)	17.3 (51)	21.1 (59)	21.1 (61)	23.7 (65)	23.9 (65)	23.0 (70)	22.5 (64)	16.8 (47)	11.9 (32)
Other Durables (38,39)	19.2 (5)	8.0 (2)	4.9 (2)	9.8 (4)	(0)	(0)	6.7 (3)	4.4 (2)	6.5 (3)	8.9 (4)	10.6 (5)	4.4 (2)	2.3 (1)	(0)
Miscellaneous Indus	tries													
Special Trade Const'n. (17)	1.1 (1)	2.3 (2)	4.6 (4)	6.7 (6)	3.2 (3)	0.9 (1)	1.7 (2)	0.8 (1)	2.4 (3)	2.3 (3)	1.4 (2)	3.6 (5)	3.7 (5)	2.3 (3)
Transp. & Util. (40-49)	0.6 (1)	1.3 (2)	1.9 (3)	4.5 (7)	2.5 (4)	1.2 (2)	(0)	0.6 (1)	0.6 (1)	1.7 (3)	1.6 (3)	2.2 (4)	2.2 (4)	0.7 (6)
Health (80)	1.6 (5)	1.9 (6)	3.4 (11)	3.6 (12)	3.8 (13)	3.7 (13)	3.3 (12)	6.3 (23)	6.0 (22)	4.6 (17)	4.6 (18)	3.8 (15)	5.0 (20)	2.5 (19)
Education (82)	0.6 (2)	0.6 (2)	0.8 (3)	2.2 (8)	0.8 (3)	1.1 (4)	2.1 (8)	2.3 (9)	1.3 (5)	0.3 (1)	1.2 (5)	0.7 (3)	3.3 (14)	1.4 (10)
<u>Government (91-97)</u>	<u>8.1 (5)</u>	<u>6.6 (4)</u>	<u>7.9 (5)</u>	<u>14.3 (9)</u>	<u>6.3 (4)</u>	<u>1.1 (7)</u>	<u>0.8 (5)</u>	<u>0.5 (3)</u>	<u>0.5 (3)</u>	<u>0.2 (1)</u>	<u>0.7 (2)</u>	<u>0.7 (2)</u>	<u>1.4 (4)</u>	<u>0.6 (4)</u>
Total (all industries)	3.6 (144)	3.0 (115)	3.8 (150)	4.4 (176)	3.7 (152)	3.0 (127)	3.5 (155)	3.6 (162)	3.3 (147)	3.1 (141)	3.6 (164)	3.1 (139)	3.2 (143)	3.2 (144)

°1987 Standard Industrial Classification code.

<sup>b</sup>Annual incidence rate (number of cases for each year). Rates are based on the number of cases per 100,000 adult workers in MI for each year separately.

Source: MI Department of Career Development, Employment Service Agency, Annual Average civilian labor force and industrial employment estimates (formerly the MESC).

# Table 6.Occupational Agents Associated with 2,400Confirmed Work-Related Asthma Patients:1988-2005

<u>Allergen</u>	Number	<u>Percent</u>
Isocyanates	351	14.6
Metal Working Fluids	275	11.5
Cleaning Solutions	207	8.6
Unknown (Mfg.)	193	8.0
Unknown (Office)	159	6.6
Exhaust/Smoke/Fumes	138	5.8
Welding Fumes	109	4.5
Solvents	75	3.1
Ероху	59	2.5
Latex/Rubber	56	2.3
Paint Fumes	56	2.3
Formaldehyde	49	2.0
Acids	42	1.8
Acrylates	35	1.5
Chlorine	33	1.4
Cobalt	29	1.2
Plastic Fumes	28	1.2
Fungus	21	0.9
Styrene	20	0.8
Wood Dust	20	0.8
Ammonia	19	0.8
Flour	19	0.8
Cigarette Smoke	16	0.7
Fire	16	0.7
Animal Dander	15	0.6
Chemicals Used in Construction	15	0.6
Herbicide/Pesticide	15	0.6
Chromium	14	0.6
Fiberglass	12	0.5
Glutaraldehyde	12	0.5
Printing Inks	12	0.5
Grain Dust	11	0.5
Amines	11	0.5
Caustics	9	0.4
Cement Dust	9	0.4
Meat Wrapper's Asthma	7	0.3
Pickling Ingredients	6	0.3
1,1,1 Trichloroethane	5	0.2
Cosmetology Chemicals	5	0.2
Nitrogen	5	0.2
Paper Dust	5	0.2
Rust Inhibitor	5	0.2
Solder Fumes	5	0.2

#### Table 6, continued.

Asbestos	4	0.2
Asphalt	4	0.2
Enzymes	4	0.2
Ethyl Alcohol	4	0.2
Freon	4	0.2
Insecticide	4	0.2
Photo Developing Fluids	4	0.2
Rose Hips	4	0.2
Sulfonate	4	0.2
Sulfur Dioxide	4	0.2
Trichloroethylene	4	0.2
Cadmium Solder	3	0.1
Colophony	3	0.1
Drywall Dust	3	0.1
Lime Dust	3	0.1
Maleic Anhydride	3	0.1
Mold Release	3	0.1
Perfume	3	0.1
Phthalic Anhydride	3	0.1
Polyhexamethylene Biquanide	3	0.1
Sand	3	0.1
Tar Fumes	3	0.1
X-ray Developing Fluids	3	0.1
<u>Other</u> <sup>a</sup>	<u>117</u>	<u>4.9</u>
Total	2,400	100.2 <sup>b</sup>

<sup>a</sup>There were two cases each with the following exposures: Azodicarbamide, Benzene, Coal Dust, Copier Toner, Copper Oxide, Ethylene Glycol Monobutyl Ether, Exercise, Fire Extinguisher Powder, Fireproofing Chemicals, Gas and Oil Refinery Exposures, Hay, Heat, Hydraulic Oil, Iodine, Kerosene, Medications, Naptha, Natural Gas, Nickel, Ozone, Pepper Gas, Phosgene, Plants/Flowers, Polyester, Polyethylene, Polyvinyl Butyrate, Psyllium, Sewage, Sludge, Sodium Hydroxide, Sulfite, Teflon, Textile Lint, Zinc, Zinc Oxide.

There was one case each with the following exposures: 1,3, Dichloro-2-Propanol, 1,3 Dichloro 5 5-Dimethyl Hydrantoin, Ammonium Hydroxide, Anesthesia, Aromatherapy, Blood, Blue Prints, Cellulose, Chlorpyrifos, Citrus Spray, Concrete Sealer, Cyanide, Ethylene Oxide, Explosion, Fertilizer, Flares, Flux, Glaze, Gortex, Hair Remover, Heptane, Hydrogen Peroxide, Lactase, Lavender Soap, Limone, Methamphetamine Lab, Methanol, Methylene Chloride, Monoammonium Phosphate, Ninhydrin, Nylonpolyhexamethylene Adipamide, Odor, Perchloroethylene, Platinum, Potassium Aluminum Fluoride, Potassium Hydroxide, Soda Ash, Sodium Acetate, Soot, Stress, Talcum Powder, Tetrahydrofuran, Tuberculosis Vaccine, Vinyl Acetate, W-D 40, Weeds, Zinc Borate.

<sup>b</sup>Percentages do not add to 100 due to rounding.

# Table 7. Cigarette Smoking Status of Confirmed Work-Related Asthma Patients: 1988-2005

			Dise	ase Stati	12 <sub>P</sub>					
<u>Smoking Status</u>	<u>ALL</u> <sup>a</sup>		<u>0</u>	<u>OA</u>		<u>) A</u>	<u>AA</u>		RADS	
Current Smoker	474	(20.4)	194	(21.3)	139	(15.7)	64	(22.5)	77	(31.0)
Ex-Smoker	905	(38.9)	355	(39.1)	369	(41.8)	85	(29.8)	96	(38.7)
<u>Non-Smoker</u>	<u>946</u>	<u>(40.7)</u>	<u>360</u>	<u>(39.6)</u>	<u>375</u>	<u>(42.5)</u>	<u>136</u>	<u>(47.7)</u>	<u>75</u>	<u>(30.2)</u>
Total	2,325		909		883		285		248	

<sup>a</sup>Total number of cases: 2,325. Smoking status was missing on 75 individuals. Number of patients, percentages are in parentheses. <sup>b</sup>OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma; RADS=reactive airway dysfunction syndrome.

# Table 8. Family History of Allergies Among ConfirmedWork-Related Asthma Patients: 1988-2005

Family History			Dised	ise Statu	sb					
<u>of Allergies</u>	<u>ALL</u> °		OA		POA		<u>AA</u>		RADS	
YES	892	(42.6)	331	(39.4)	345	(42.6)	137	(58.3)	79	(38.2)
NO	<u>1,200</u>	<u>(57.4)</u>	<u>510</u>	<u>(60.6)</u>	<u>464</u>	<u>(57.4)</u>	<u>98</u>	<u>(41.7)</u>	<u>128</u>	<u>(61.8)</u>
Total	2,092		841		809		235		207	

<sup>a</sup>Total number of cases: 2,092. Missing data on 308 patients. Number of patients, percentages are in parentheses.

<sup>b</sup>OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma; RADS=reactive airway dysfunction syndrome.

# Table 9. Personal History of Allergies or Asthma Among Confirmed Work-Related Asthma Patients: 1988-2005

			Disea	se Status	<b>5</b> b					
<u>Personal History</u>	<u>Al</u>	<u>_Lª</u>	<u>c</u>	<u>)</u> A	<u>P(</u>	<u>DA</u>	4	AA	<u>R</u> /	DS
YES	1,097	(45.7)	353	(38.1)	379	(41.8)	282	(91.3)	83	(32.2)
<u>NO</u>	<u>1,303</u>	<u>(54.3)</u>	<u>574</u>	<u>(61.9)</u>	<u>527</u>	<u>(58.2)</u>	<u>27</u>	<u>(8.7)</u>	<u>175</u>	<u>(67.8)</u>
Total	2,400		927		906		309		258	

<sup>a</sup>Number of patients, percentages are in parentheses.

<sup>b</sup>OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma; RADS=reactive airway dysfunction syndrome.

# Table 10.Persistence of Symptoms and Medication Use in ConfirmedWork-Related Asthma Patients:1988-2005

		Breath	ing Problen	Still Taking Asthma Medication					
Medication		Ye	<u>:s</u>	Le	<u>255</u>	<u>Ye</u>	S	Le	ss
<u>Exposure Status</u>	<u>Total</u> ª								
Still Exposed	635	612	(96.4)	194	(30.6)	547	(86.1)	122	(19.2)
No Longer Exposed	<u>1,566</u>	<u>1,350</u>	<u>(86.2)</u>	<u>771</u>	<u>(49.2)</u>	<u>1,215</u>	<u>(77.6)</u>	<u>441</u>	<u>(28.2)</u>
Total	2,201	1,962		965		1,762		563	

<sup>a</sup>Total number of cases: 2,201. Information missing on 199 individuals. Number of patients, percentages are in parentheses.

# Table 11. Status of Facilities Where 2,400 Patients with Confirmed Work-Related Asthma were Exposed to Allergens: 1988-2005

	Number of Patients	Companies	
Inspection Status	<b>Represented</b>	Number	Percent
Inspected	1,025	623ª	36.1
No Follow-up Planned	1,151	895	51.9
Scheduled for Inspection	49	46	2.7
Out of Business	59	53	3.1
No Longer Use Occupational Allergen	25	24 <sup>b</sup>	1.4
Sent Company an Indoor Air Letter	42	36	2.1
<u>Sent Company Letter to Check Exposures</u>	<u>49</u>	49	<u>2.8</u>
Total	2,400	1,726 <sup>°</sup>	100.1 <sup>d</sup>

°623 inspections were conducted in 535 different facilities.

<sup>b</sup>Eight companies that no longer use the allergen were previously inspected.

<sup>°</sup>Represents 1,638 different facilities.

<sup>d</sup>Percentages do not add to 100 due to rounding.

# Table 12. Results of 623 Industrial Hygiene Inspections in 535 Facilities Where Patients with Confirmed Work-Related Asthma were Exposed to Allergens: 1988-2005

Inspection Results		
<u> Air Sampling – NIOSH Standard</u>	Number	Percent
Above NIOSH Standard	45	7.2
Below NIOSH Standard	373	59.9
No NIOSH Standard	17	2.7
Unknown (no report yet)	7	1.1
Did Not Sample for an Allergen	17	2.7
Did Not Sample	<u>164</u>	<u>26.3</u>
Total	623	<b>99.9</b> <sup>a</sup>
<u> Air Sampling – MIOSHA Standard</u>	Number	Percent
<u>Air Sampling - MIOSHA Standard</u> Above MIOSHA Standard	<u>Number</u> 21	<u>Percent</u> 3.4
<u>Air Sampling – MIOSHA Standard</u> Above MIOSHA Standard Below MIOSHA Standard	<u>Number</u> 21 413	<u>Percent</u> 3.4 66.3
<u>Air Sampling – MIOSHA Standard</u> Above MIOSHA Standard Below MIOSHA Standard No MIOSHA Standard	<u>Number</u> 21 413 1	<u>Percent</u> 3.4 66.3 0.2
<u>Air Sampling – MIOSHA Standard</u> Above MIOSHA Standard Below MIOSHA Standard No MIOSHA Standard Unknown (no report yet)	<u>Number</u> 21 413 1 7	<u>Percent</u> 3.4 66.3 0.2 1.1
<u>Air Sampling – MIOSHA Standard</u> Above MIOSHA Standard Below MIOSHA Standard No MIOSHA Standard Unknown (no report yet) Did Not Sample for an Allergen	<u>Number</u> 21 413 1 7 17	<u>Percent</u> 3.4 66.3 0.2 1.1 2.7
<u>Air Sampling - MIOSHA Standard</u> Above MIOSHA Standard Below MIOSHA Standard No MIOSHA Standard Unknown (no report yet) Did Not Sample for an Allergen <u>Did Not Sample</u>	<u>Number</u> 21 413 1 7 17 <u>164</u>	<u>Percent</u> 3.4 66.3 0.2 1.1 2.7 <u>26.3</u>

<sup>a</sup>Percentages do not add to 100 due to rounding.

# Table 13. Allergens Found to be Above the MIOSHA Permissible Exposure Limit (PEL) and/or NIOSH Recommended Exposure Limit (REL): Michigan 1988-2005

	Above NI	OSH REL	Above MIOSHA PEL		
Asthma-Causing Agents	Number	Percent	Number	Percent	
Formaldehyde	18	40.0	1	4.8	
Styrene	6	13.3	4	19.0	
Metal-Working Fluids	5	11.1	1	4.8	
Glutaraldehyde	3	6.7	3	14.3	
Cobalt	3	6.7	2	9.5	
HDI	3	6.7	No PEL		
MDI	2	4.4	0		
Wood Dust	2	4.4	2	9.5	
Chromic Acid	1	2.2	1	4.8	
Ethylene Oxide	1	2.2	0		
Starch	1	2.2	0		
Welding Fume (Total Particulate)	No REL		5	23.8	
<u>Flour Dust</u>	No REL	<u></u>	<u>2</u>	<u>9.5</u>	
TOTAL	45	<b>99.9</b> ª	21	100.0	

<sup>a</sup>Percentages do not add to 100 due to rounding.

# Table 14. Symptoms Consistent with Work-Related Asthma Among Fellow Workers of the 2,400 Confirmed Work-Related Asthma Patients

			Disease	e Status	of the I	index Pat	tient			
<u>Symptoms</u> <sup>a</sup> Daily or Weekly SOB, Wheezing or	<u>ALL</u> <sup>b</sup>		<u>0A</u>		<u>POA</u>		<u>AA</u>		<u>RADS</u>	
Chest Tightness	1,438	(16.6)	1,078	(17.2)	324	(15.1)	4	(16.0)	32	(13.2)
<u>OSHA Log</u> <sup>c</sup> Total <sup>d</sup>	<u>558</u> 1,996	<u>(19.2)</u>	<u>399</u> 1, <b>477</b>	<u>(22.8)</u>	<u>148</u> <b>472</b>	<u>(13.8)</u>	<u>2</u> 6	<u>(12.5)</u>	<u>9</u> <b>41</b>	<u>(9.1)</u>

<sup>a</sup>Denominator for calculating percentages was the number of workers interviewed. SOB=shortness of breath.

<sup>b</sup>Number of individuals with symptoms, percentages are in parentheses. OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma; RADS=reactive airways dysfunction syndrome.

<sup>c</sup>Numerator for calculating percentages was the number of companies with an employee other than the index patient on the OSHA log. Denominator for calculating percentages was the number of companies inspected.

<sup>d</sup>Nine individuals were identified both on the guestionnaire and the OSHA log.

# Table 15. Michigan Workers Employed in Manufacturing Facilities Where Isocyanates Are Used, by County, in Calendar Year 2004

<u>County</u>	# Workers Employed in Isocyanate-Using Facilities <sup>b</sup> Divided by Total # Workers <u>in the County</u> <sup>c</sup>	% Workers Where Isocyanates <u>are Used</u>	
Allegan, Kent,	10,320/576,300	2	COMPANIESª
Muskegon, Ottawa			Brunswick Bowling G P M H B Fuller Haworth Howard Miller Johnson Controls Interiors Knape & Vogt Magna-Donnelly Meridian Auto Systems Purforms, Inc. Richwood Industries Steelcase Wolverine World Wide
Barry	1,040/12,900	8	<b>COMPANIES</b> Bradford White
Bay, Saginaw, Midland	8,941/174,600	5	COMPANIES Delphi Saginaw Steering Dow Chemical Company Glastender Saginaw Metal Casting Operations (GM) GM Powertrain/Saginaw Malleable Iron Lendell Manufacturing
Berrien	1,995/71,000	3	<b>COMPANIES</b> Ancast, Inc. Bosch Braking

			Leco
			Tyler Refrigeration
Branch	25/16,250	<1	COMPANIES
			Acore Door
Calhoun,	420/213,800	<1	COMPANIES
Kalamazoo,			Azon USA
Van Buren			Cello-Foil
			Comcast Urethane
			Degussa Construction
			Special-lite
Cass	600/10,625	6	COMPANIES
			Georgie Boy Manufacturing
Charlevoix	500/10,575	5	COMPANIES
			East Jordan Iron Works
Clare	300/7,950	4	COMPANIES
			Renosol
Eaton,	1,218/233,700	<1	COMPANIES
Clinton,			ASC Inc.
Ingham			Axson
			Collins & Aikman
			GMVM Lansing Grand River Assembly
			Vantico-Huntsman Advanced Materials
Genesee	1,000/159,300	1	COMPANIES
			Delphi Energy and Chassis Flint East
Hillsdale	200/16,800	1	COMPANIES
			Dow
Iosco	60/10.125	1	COMPANIES
			Tawas Industries
<b>-</b> 1		•	
Jackson	900/02,700	۷	COMPAINTES
			Adco Products
			Michigan Seat
			i ac manutacturing

Lapeer, Macomb,	14,067/ 2,105,000	1	COMPANIES
Monroe,			Armaly Sponge
Oakland,			Autolign Manufacturing
St. Clair,			BASF
Wayne			Cass Polymers
			Collins & Aikman
			Daimler-Chrysler Jefferson Assembly
			Du Pont
			EFTEC
			EQ Detroit, Inc.
			H P Pelzer
			International Castina
			TTW Foamseal
			lear
			lymtal International
			M & H Industries
			Plastomer
			Poof-Slinky Inc.
			Recticel
			Recycled Polymeric Materials, Inc.
			Rivas Inc.
			Romeo Rim
			Sunrise Windows
			Takata Petri
			US Farathane
			Visteon
			Visteon Utica
			Wolverine Bronze
Lenawee,	4,905/282,900	2	COMPANIES
Livingston,			Anderson Development
Washtenaw			Atreum Howell (Intier Automotive)
			Brighton Interiors (Ontegra)
			Ixtlan Technologies
			Package Design & Manufacturing
			Pilkington Clinton
			Tecumseh Compressor Products
			Visteon Saline
			Woodbridge
Mason	220/10,700	2	COMPANIES
			Great Lakes Casting

Mecosta	1,000/13,225	8	COMPANIES
			Wolverine World Wide
Montcalm	2,382/19,500	12	COMPANIES
			Electrolux Refrigerator Division Kent Foundry Northland Corp.
Ogemaw	150/7,025	2	COMPANIES
			Taylor Building Products
Sanilac	150/12,975	1	COMPANIES
			Numatics
Upper	1,380/126,800	1	COMPANIES
Peninsula			Emerson Tool
			Grede Foundries
			Louisiana Pacific
Wexford,	980/18,200	5	COMPANIES
Missaukee			Four Winns Sport
			Hayes Lemmerz
TOTAL	58,803/ 4,475,000	1	

<sup>a</sup>Source: U. S Environmental Protection Agency. Toxics Release Inventory, Michigan Companies Using Isocyanates in 2004 (report generated June 15, 2006).

<sup>b</sup>Source: Michigan Manufacturer's Directory, 2003.

<sup>c</sup>Source: Michigan Department of Career Development/Employment Service Agency. Annual Average 2002 Area Labor Statistics, Total Wage and Salary Employment by Place of Work (5/9/2002).

# Appendix I

# 2005 Case Narratives by Type of Exposure & Industry

Abbreviations:

- POA = Possible Occupational Asthma
- OA = Occupational Asthma with a Known Sensitizer
- AA = Aggravated Asthma (Pre-existing Asthma Exacerbated at Work)
- RADS = Reactive Airway Dysfunction Syndrome

The case narratives that follow are based on information collected from interviews of patients about their health and work status.

# Animal Dander

#### EDUCATIONAL SERVICES

OA- Case 2339. A female in her 20s developed asthma after five years of working with experimental rats at a university. She continues to work for the university with the rats, has had worsening asthma symptoms, and requires more asthma medicine.

# **Cleaning Products**

#### EATING AND DRINKING ESTABLISHMENTS

RADS- Case 2404. A female in her 40s developed asthma from mopping the floor at a sandwich shop for approximately one and a half hours with undiluted bleach. This was not the first time she had been assigned this task, which she performed during the first month of her employment at this shop. However, the last time she mopped the floors in this manner, she developed severe breathing problems and was sent to a local hospital emergency department for breathing treatments. After her emergency department visit, she did not go back to work. Since that time, her asthma has improved and she requires less asthma medicine.

#### EDUCATIONAL SERVICES

POA- Case 2394. A female in her 50s developed asthma after working for 14 years for a university in the dining services unit. She was exposed to sprayed-on cleaners and disinfectants, some of which were possibly mixed. She has since been reassigned to a new work area and cleaning activities are not performed when she is present. However, her symptoms have worsened and she now requires more asthma medicine.

RADS- Case 2393. A male in his 40s worked for 13 years as a custodian at a university when he developed RADS from an acute exposure to the mixing of bleach and ammonia-based cleaning agents. Almost three years later at the time of interview, he was currently laid off. Since being laid off, his symptoms had improved. He was not using any asthma medicine because he cannot afford them.

#### HEALTH CARE SERVICES

POA- Case 2274. A female in her 50s developed asthma 12 years after working at a hospital. She describes exposures to molds and cleaning chemicals in her work area in the basement. Her work area was moved to a new

location and since that time her asthma symptoms have improved. She continues to need the same amount of asthma medicine.

POA- Case 2272. A female in her 60s developed asthma 13 years after working as a nurse at a hospital. She was exposed to hospital disinfectants and chemicals used to clean the dialysis units. She has been off work for the past four years, and since that time her symptoms have lessened and she requires less asthma medicine.

AA- Case 2342. A female in her 50s who worked in the laundry room of a nursing home experienced an exacerbation of her asthma at work. She had worked in the laundry room for five years. Since that time, she reports that her breathing problems have not improved although she requires less asthma medicine.

RADS- Case 2407. A female in her 30s developed asthma after exposure to a leak of disinfectant from a clogged drain in a hospital surgical decontamination department. She developed wheezing, cough, chest tightness and shortness of breath within 24 hours of this exposure, after initially being sent home with a severe headache. She continues to work in this area, continues to experience breathing problems and has had to increase her asthma medicine while at work, but requires no medication at home.

#### MANUFACTURING

POA- Case 2317. A female in her 30s worked as a janitor in an automotive manufacturing facility. Six years after working at the plant, she developed asthma from exposure to floor stripper and other cleaning agents. Five years later, she has continued to work at this facility in the same job, and reports that her symptoms have worsened and that she continues to require the same amount of asthma medicine.

#### WHOLESALE TRADE

RADS- Case 2322. A male in his 50s developed asthma while working on the facility maintenance crew at an automotive parts warehouse. He was exposed to a mixture of bleach and drain cleaner that produced a chemical cloud. He had worked for this facility for over 30 years with no breathing problems before this incident. When the chemicals mixed, he immediately experienced breathing difficulties, and went to a local emergency room for treatment. Since the acute onset of his symptoms after that incident, his breathing problems have worsened and he requires a greater amount of asthma medicine. He continues to work at this facility.

# Cobalt

#### MANUFACTURING

OA- Case 2347. A female in her 30s worked for two months as a purchasing agent at a tool and die shop when she developed asthma from exposure to cobalt dust that had settled on surfaces in her office. She reported being fired five months later due to excessive absences because of hospital and doctor visits for her breathing difficulties. Since leaving the company, her symptoms have improved and she requires less asthma medicine.

# **Diesel Fume**

#### TRANSPORTATION SERVICES

OA- Case 2417. A male in his 40s developed asthma while working for a package delivery service as a truck driver. His symptoms developed the first month he started to work for this company, and he had worked there

for almost three years at the time of the interview. In the past 6-7 months of working in this job, his symptoms had become more persistent. He reports exposure to diesel fume from idling delivery trucks at the loading dock. He continues to work for this company, and his symptoms are worsening. He reports trying to avoid the diesel fume exposures by driving trucks without leaks.

# Formaldehyde

#### MANUFACTURING

OA- Case 2402. A male in his 30s developed asthma two months after starting work at a plastic injection mold manufacturing company. He was exposed to formaldehyde and chemicals used to purge the machines. During one machine purge, he developed breathing difficulties and went to a local hospital emergency room for treatment. He reported that his company refused to take him for treatment, that he drove himself to the hospital. After that incident, he was fired; he reports that the company said they had no work for him due to slow business. He continues to experience breathing problems. He is not taking any asthma medicine because he has no health insurance and cannot afford the medication.

# Glue

#### MANUFACTURING

POA- Case 2418. A female in her 50s developed asthma two years after beginning work at a rubber and plastic product manufacturing facility. She worked in production running a glue line, and was exposed to glue and solvents as she hand-fed parts through the glue applicator, then set them on a conveyor belt to dry. Since that time, she has been reassigned to a different job. However, she now requires more asthma medicine, and her symptoms have improved.

POA- Case 2334. A female in her 40s developed asthma from exposure to glues in the production of automobile headliners, six months after she began working for this company. She continued to work for this company with this exposure for approximately six more years. Despite being off work, her symptoms and asthma medicine use have remained unchanged. She is currently not working.

# Indoor Air Quality

#### EDUCATIONAL SERVICES

POA- Case 2323. A female in her 60s worked as an elementary school teacher for 14 years when the building where she taught experienced water damage due to a faulty radiator. There was subsequent mold growth. The radiator was repaired and she moved her class to a different room. Her symptoms have lessened, but she continues to take the same amount of asthma medicine.

POA- Case 2316. A male in his 50s who worked at an elementary school as a media specialist for 14 years developed asthma from an undetermined exposure through the ventilation in the library. Almost two years later he has continued to work at the school, and reports a worsening of his symptoms. He continues to require the same amount of asthma medicine.

POA- Case 2369. A female in her 30s developed asthma one year after beginning to work as a high school teacher when renovations were being done at the school where she worked. The renovation work created

possible exposures to mold, cleaning products and construction dust. She continues to work as a teacher and reports that her symptoms are much improved on summer vacation when she is not working. She continues to require the same amount of asthma medicine. Since her diagnosis, she has had symptoms with exposure to chalk, weeds, pollen, dust mites, cats and dogs that shed.

#### HEALTH CARE SERVICES

POA- Case 2269. A female in her 40s worked at a hospital 20 years in the patient registration office when "suddenly the work air started to cause her airways to close up." She reported that her symptoms improved when she was off work. Her breathing problems have worsened and she requires more asthma medicine.

POA- Case 2328. A female in her 50s worked as an employee assistance counselor at a mental health services facility. Three years after working at this facility, she developed breathing problems from possible exposure to mold. On her doctor's advice, she quit working at this facility. One month after leaving that job, her symptoms have improved although she continues to take the same amount of asthma medicine.

#### OFFICE WORK

POA- Case 2388. A female in her 60s developed asthma one year after beginning to work for an apartment management company. She was exposed to mold from a leaking roof in her office. Three years after the development of her asthma, she was placed on medical leave. Since that time, her symptoms have stayed the same and she continues to take the same amount of asthma medicine.

POA- Case 2380. A male in his 50s worked at an automotive manufacturing facility in the customer relations department. He developed asthma after working at the company for 22 years, from possible exposure to mold contamination. Seven years later he left his job due to his respiratory difficulties and other health issues attributed to the mold exposures at work.

POA- Case 2423. A male in his 40s worked for 22 years in the customer relations department for an automotive manufacturing facility. After 22 years, his office was moved to a new building that had evidence of water damage and mold. After working in this building for five years, he developed asthma. He continues to work at this location and his symptoms have worsened. He requires a greater amount of asthma medicine to control his symptoms.

RADS- Case 2303. A female in her 20s worked as a receptionist for a family practice physician for four years when she was exposed to a moldy batch of copy paper. She immediately developed breathing problems. Once the moldy paper was discarded, her symptoms lessened and she now requires less asthma medicine.

POA- Case 2270. A female in her 50s developed asthma approximately six months after beginning to work as an apartment complex manager. She also lived at the complex. She reported mold growth in her apartment and in the basement of the building where her office was located. A little over a year after working in this job, she reported that she was fired for missing too much work getting medical attention. This was the same day she reported the mold problems to her supervisor. Since leaving this job, her symptoms have lessened, although she continues to take the same amount of asthma medicine. She has been unable to find a new job, six months later.

#### RETAIL TRADE

POA- Case 2382. A male in his 40s developed asthma while working at a home improvements store. His symptoms began about 10 months after beginning to work at the store, after water damage from a fire in the

building led to mold growth. At the time of interview, the patient was on medical leave. His symptoms had remained the same and he was taking the same amount of asthma medicine when he was first diagnosed.

POA- Case 2370. A female in her 30s developed asthma seven years after working at a home improvements store. A fire had occurred in the building, after which water damage caused mold growth. Her symptoms developed in relation to the onset of the mold exposure. She has since been reassigned to a new work area, and her symptoms and use of asthma medicine have decreased.

POA- Case 2373. A male in his 30s worked at a home improvement store for six years, in the mill work area when he was exposed to mold that grew from water damage related to a fire. Four months after his asthma developed, he was relocated to a different store. Since that time his symptoms have improved and he requires less asthma medicine.

AA- Case 2321. A male in his 50s worked for a garage door distribution center where he was possibly exposed to mold. He experienced an exacerbation of his asthma a year after starting to work at this company. He has continued to work in this building, which has been cleaned for mold, and reports that his symptoms and asthma medicine use have remained unchanged.

#### MANUFACTURING

POA- Case 2451. A male in his 50s developed asthma while working in an office at an automotive parts manufacturing facility. He had worked at the facility for over 20 years with no symptoms; within a year of the building having water damage and a potential mold issue, he developed breathing difficulties. He continues to work at the facility, his symptoms have become worse and he now requires more asthma medicine.

# Isocyanates

#### MANUFACTURING

OA- Case 2454. A male in his 40s worked at a military equipment manufacturing facility for 21 years; he developed asthma six years after beginning to work at this plant. He was exposed to isocyanate-containing paint in his job as a painter. He continues to work at this facility doing the same job, wearing a filtered mask. He continues to experience breathing problems and requires asthma medicine.

OA- Case 2428. A male in his 40s worked as a program manager for an industrial robot manufacturing facility. He had worked at this company for 10 years when he was exposed to isocyanates from an improperly installed paint application booth at a customer's company. For approximately six months he experienced breathing difficulties, which then resolved with cessation of exposure to isocyanates. He continues to work for this company.

OA- Case 2489. A male in his 50s died from an asthma attack from exposure to isocyanates at work. He had worked almost five years at this chemical production facility as a chemical mixer. His asthma developed several months after beginning to work at the company. Despite an annual exam by the company doctor, repeated visits to his primary care physician, and a referral to a pulmonologist; none of the health care providers suggested he change his work environment. He remained at the same place of employment, performing similar tasks. He required increasing amounts of asthma medication. His final asthma attack, at work, left him unconscious in the hospital for six days before he died.

OA- Case 2359. A male in his 50s worked in a foundry as a chipper/grinder for two years when he developed asthma from exposure to isocyanates (MDI) used to make the molds. He continued to work an additional 28 years until he took an early retirement because of his asthma. Approximately three years after his retirement, his symptoms have worsened and he requires more asthma medicine to control his symptoms.

OA- Case 2385. A male in his 30s worked as a chemical operator, charging reactors at a chemical manufacturing facility. Four years after starting to work for this company, he developed asthma from exposure to isocyanates. He reported wearing personal protective equipment (PPE) when he was charging a machine, but that he did not wear PPE when the machine next to him was being charged. He continues to work at this facility. Over the last 8-10 months since his diagnosis, and initiation of asthma medicine, his symptoms have improved.

OA- Case 2319. A female in her 60s developed asthma while working at an automobile manufacturing facility. She was exposed to isocyanate-containing paints in the vehicle spraying area. She worked at the company for 26 years.

OA- Case 2381. A male in his 20s acutely developed asthma three months after starting to work at an automotive seat manufacturing facility, when he was exposed to a leak of TDI after a hose broke and sprayed him with the isocyanate. He immediately felt ill and was treated for breathing problems at a local hospital Emergency Department. He continues to work at this facility, requires less asthma medicine, although his breathing problems have not improved.

OA- Case 2273. A male in his 50s developed asthma one year after working in the headliner department of an automotive parts manufacturing facility. An isocyanate-based catalyst was used to bond the headliner layers together, and this was then sent through a hot oven to bake. He was provided a paper mask while working in this job. He has continued to work at this facility for the past five years, and has been given a restriction from this work area. He continues to experience asthma symptoms and take asthma medicine.

OA- Case 2267. A male in his 50s developed asthma the same month he began working at an automotive seat cushion manufacturing facility. He was exposed to leaks of the isocyanate, TDI. His job was in the foam trim and repair department, which was physically located next to the machine that made the seat cushions. He tried wearing a dust mask as well as a full face respirator. He was fired three months after starting this job, being told that he could not keep up with the production line. Since then his symptoms have lessened and he is not taking any asthma medicine because he cannot afford them. He has been unable to find new employment for over a year since being fired.

OA- Case 2268. A male in his 40s developed asthma while working as a welder at a stainless steel restaurant equipment manufacturing facility. He worked there for over 10 years before his asthma developed from exposure to isocyanates used to make foam insulation for the hot/cold restaurant food production and serving tables. He continues to work at this facility, and reports that his symptoms have improved with time away from the company.

OA- Case 2356. A male in his 40s worked as a welder at a stainless steel food equipment container manufacturer for over 16 years. He developed asthma from exposure to isocyanates from the foam used to insulate the stainless steel containers. He continued to work in this environment for seven years, after which he was assigned to a new work area. However, he continues to experience breathing problems, which are worse at work, and continues to require asthma medicine. His company doctor told him there is nothing wrong with him and his family doctor told him that he may have allergies.

OA- Case 2413. A male in his 40s worked as an electrician at an automotive manufacturing facility for nine years before he developed asthma from exposure to isocyanate-containing glue in an area where auto bodies were robot-welded. After his asthma developed, he continued to work as an electrician in the welding area for two more years until he was moved out of that environment to a different work area. Since he moved to a new location, his symptoms have lessened and he requires less asthma medicine.

OA- Case 2355. A male in his 50s had been working at an automotive manufacturing plant for 25 years when he developed asthma from exposure to isocyanate-containing glues. When removed from the exposure due to layoffs, his symptoms lessened and he stopped taking asthma medicine.

OA- Case 2331. A male in his 30s worked for two months as a general laborer running a mold machine in a foundry with exposure to isocyanate fume when he developed asthma. Three months after being diagnosed with work-related asthma, he was no longer working for this company. His symptoms lessened and he stopped taking asthma medicine, because he reported he did not have enough money to pay for his prescriptions. After five months of unemployment, he has since found new work in the food service industry.

OA- Case 2387. A female in her 40s worked in an automotive headliner manufacturing facility for 11 years, as a general laborer when she developed asthma. She was exposed to isocyanates in the adhesive/catalyst spraying area. After working nine more years in this exposure area, she was moved to a new area of the facility. Despite being moved, her symptoms have remained the same and she continues to take the same amount of asthma medicine.

# Metal Working Fluids

#### MANUFACTURING

OA- Case 2415. A male in his 60s developed asthma approximately seven years after beginning to work as an assembler in an automotive parts manufacturing facility. He was exposed to metal working fluids for the 23 years he worked at this company. He took an early retirement because of his asthma, and since then his breathing problems have continued to worsen, requiring him to take more asthma medicine. In the four years since his retirement, he has been hospitalized for his lung problem six times, and visited an emergency room four times.

OA- Case 2433. A male in his 40s developed asthma while working at an automotive engine manufacturing plant as an electrician for 21 years. He was exposed to metal working fluids while performing maintenance activities on the production machines. He worked at this facility for two more years, after which he was moved to a new facility with the same company. He has continued to be exposed to coolants for the past five years at the new location, and his symptoms and asthma medicine use have increased.

OA- Case 2336. A female in her 60s developed asthma while working as an assembler at an automotive transmission assembly plant. She had worked at the plant for 26 years before her asthma began from exposure to coolants. Almost one year after her asthma developed, she was placed on medical disability. Six months after being placed on disability, her symptoms have remained the same and she continues to take the same amount of asthma medicine.

OA- Case 2396. A female in her 50s developed asthma nine years after beginning to work at an automotive assembly plant. She was exposed to coolants, and continued to work in this exposure for 18 years longer, until she was placed on medical disability for her asthma. Two years after being on disability, she continues to experience symptoms and take asthma medicine.

OA- Case 2409. A male in his 40s worked as a maintenance machine repairman at an automotive parts manufacturing facility. He developed asthma after 18 years of working around the machining coolants. Six months after his symptoms began, he was placed on disability leave. Since that time, his symptoms have resolved although he continues to take asthma medicine.

OA- Case 2309. A male in his 40s developed asthma two years after working in the quality control department at an automotive parts manufacturer. He was exposed to metal working fluids that were present in a mist form in the air. Since his initial asthma attack at work, he avoids this area and his symptoms have resolved.

OA- Case 2305. A male in his 60s developed asthma 39 years after working at an automotive manufacturing facility. He had worked in the metallurgy department during this time, and was exposed to metal working fluids used to cut metal parts. He retired on a medical disability and since that time he requires less asthma medicine. His asthma symptoms have not improved.

OA- Case 2400. A male in his 60s developed asthma 40 years after working at an automotive engine plant. For 20 years prior to the onset of his asthma, he had worked as a machine set-up operator. He was exposed to metal dust and metalworking fluids. Despite being off work, his symptoms have remained the same and he still requires the same amount of asthma medicine.

# **Multiple Exposures**

#### CONSTRUCTION

OA- Case 2414. A male in his 30s developed asthma from exposures to epoxy and cement dust shortly after beginning to work for a company that lays concrete for basements and floors (flatwork). He has continued to work for this company for over two years, and reports his symptoms have remained the same and he requires less asthma medicine. He now wears a paper mask when performing his jobs duties, which he reports has helped control his symptoms.

#### MANUFACTURING

POA- Case 2362. A female in her 40s developed asthma after working for a chemical manufacturing facility for 21 years. She was exposed to a spill of ammonia and butanol when there was an equipment failure during her shift. Her breathing symptoms have decreased in the three years since the spill and she requires less asthma medicine. She continues to work at the facility.

POA- Case 2375. A male in his 40s worked for a steel company as a machinist for four years when he developed asthma from exposure to metal dust he had to shovel out of a clogged conveyor. At the time of this exposure, he went on a short term disability leave and has not yet returned to his job. His symptoms have remained the same, although he requires an increased amount of asthma medicine since the exposure.

POA- Case 2383. A male in his 50s developed asthma after working 19 years at an automotive manufacturing facility as a production worker covering the side surfaces of vehicles with tack-off, and cleaning the surfaces as well. Seven years later the plant closed. Since that time, his symptoms have improved although he continues to require the same amount of asthma medicine. He has been laid off for the past year.

POA- Case 2386. A male in his 60s worked at an automotive manufacturing plant as a lift-truck driver. He developed asthma after 30 years of working at this facility, with exposure to plastic and paint fume. He

continued to work in this environment for three years, after which he retired. Since retirement, his symptoms and asthma medicine use have remained unchanged.

POA- Case 2384. A female in her 40s worked at an industrial thermometer manufacturing facility as an assembler. Two months after she was hired she developed asthma. She described exposures to kerosene, mineral spirits and welding flux at this facility. She left that job approximately one year later and started work at an automotive parts manufacturer. At this location, she also experienced breathing difficulties while doing light assembly, from exposures to fume from plastic injection mold machines. She quit that job the same month she hired in, because of her asthma. Despite being off work, her symptoms have not improved.

POA- Case 2458. A male in his 60s was a millwright at a steel mill for 26 years before he developed asthma. He was exposed to steel dust, oils, steel coatings, acids and coal dust. He occasionally wore a respirator when repairing equipment at the mill. Twenty years later, he continues to work at the facility, mainly in an office setting in the last few years. However, his asthma continues to worsen and he requires more asthma medicine.

POA- Case 2343. A female in her 40s developed asthma four years after working at an automotive glass manufacturing facility. Her job was to load talcum powder into a machine at the furnace used in the production of automotive glass. She continued to work at this facility for six years until she was transferred to a different plant. At the new plant, she continues to be exposed to talcum powder as well as dust from a nearby sanding booth, even though her job is now in the paint department. Since working in the paint shop over the last two years, her symptoms have remained the same although she has stopped taking asthma medicine.

RADS- Case 2346. A male in his 40s developed RADS while working at a fertilizer manufacturing plant. He developed his asthma when an explosion occurred from a mixture of sulfur nitrate and ammonia. He had worked at the plant for almost two years before the explosion occurred. Since that time, the company no longer uses sulfur nitrate. His symptoms have remained the same although he requires less asthma medicine.

OA- Case 2434. A female in her 50s worked as a machine operator at an automotive headliner and seat cushion manufacturing facility. Her asthma developed two years after working at the company, from exposure to isocyanates and a sprayed-on mold release agent. She continued to work in this environment for 10 years until a leak of MDI and the mold release agent led to her placement on medical leave. Since that time, her symptoms have improved and she requires less asthma medicine.

POA- Case 2397. A male in his 50s developed asthma shortly after beginning to work at an automotive assembly plant as a machine repairman. He continued to work in the plant for 14 years, during which time his symptoms have worsened and his asthma medicine has increased. He continues to be exposed to fume from the vehicle undercoating process.

POA- Case 2427. A male in his 50s developed asthma 14 years after working at a paper mill. He was chronically exposed to chlorine and caustics used to clean out the paper machines. He requires less asthma medicine and his symptoms have decreased since he was moved to a new job location at the company.

OA- Case 2419. A male in his 20s developed asthma one year after beginning to work at a polyurethane foam production facility. His job was to run an extrusion machine. He was given a paper mask to wear, but it did not help control his asthma symptoms. He reported being fired from this job after his family medical leave ran out. Despite cessation of his exposure, his symptoms have worsened and he requires a greater amount of asthma medicine. Exposure to any type of plastic material now triggers his asthma.

POA- Case 2307. A female in her 50s developed asthma 11 years after working at an automotive parts manufacturing facility on an injection mold machine. She was exposed to the heated plastic used in the mold machines as well as the coloring used to dye the parts. Since her diagnosis, her symptoms have continued to worsen and she requires more asthma medicine.

POA- Case 2389. A female in her 30s developed asthma while working for an automotive parts manufacturing facility, working on prototypes. Her breathing symptoms began after she moved to a different building which she reported had mold in the air conditioning ductwork. She had worked for this company for four years before her asthma developed, and reported that her symptoms become worse when out on the shop floor, compared to working in her office which is located next to the shop. She continues to work at the facility.

AA- Case 2354. A male in his 50s experienced an exacerbation of his asthma 26 years after working in an automotive assembly plant in the windshield installation department. He continued to experience exacerbations of his asthma in this department for two more years until his retirement. Since no longer being in the plant, his symptoms have lessened and he takes less asthma medicine.

POA- Case 2353. A male in his 40s worked at an automotive disc brake manufacturing facility as a machine operator. He developed asthma after working at this facility for 29 years, when a filter was improperly installed, blowing out metal chips and dust into the work area. When he turned off the filter, he immediately experienced breathing difficulties and went to a local hospital Emergency Department. Since that time, the filter was repaired, his symptoms have lessened and he is taking less asthma medicine.

POA- Case 2266. A male in his 50s developed asthma 20 years after working at an automotive assembly plant. He was exposed to cleaners used on stainless steel. He continued to work in these exposures and experience asthma symptoms for ten more years till he retired. He reported that it took two years after his retirement for his symptoms to improve.

# Secondhand Cigarette Smoke

#### EATING AND DRINKING ESTABLISHMENTS

POA- Case 2378. A female in her 20s developed asthma shortly after beginning to work as a waitress at a restaurant. She was exposed to secondhand cigarette smoke at the restaurant where she continues to work. She reports that her breathing problems have lessened with the prescription of asthma medicine to control her symptoms.

# Solvents and Other Chemicals

#### MANUFACTURING

RADS- Case 2426. A female in her 40s developed RADS after an acute exposure to hydrogen sulfide gas coming out of an oil storage tank, while working at an oil company. She had worked for the company for three months prior to this incident. She continues to work for this company but not in the area where her exposure occurred. Four months after the incident, at the time of the patient interview, she indicated the continued presence of symptoms, although less severe, and continues to take asthma medicine.

POA- Case 2314. A female in her 40s worked at an automotive manufacturing facility for 19 years. Then she moved to a job with the same company, on an assembly line testing fuel pumps with a Stoddard solvent-

containing chemical, with poor ventilation. After being exposed to this chemical for approximately four months, she developed asthma. One month later she was placed on medical disability. Since that time, her symptoms have improved although she continues to require the same amount of asthma medicine.

POA- Case 2390. A male in his 40s worked for 10 years at an automotive engine manufacturing facility. After that time, he worked at the same facility as a tappet lifter, installing tappets on engines. Kerosene was used to charge the tappets. After being exposed to kerosene in this job for three months, he developed asthma. Approximately one year later he was assigned to a new location and since that time, for the past year, his symptoms have improved and he no longer requires asthma medicine.

POA- Case 2453. A female in her 30s developed asthma while working as an assembler at an automotive parts manufacturer. Her asthma developed after working there for three years, with exposure to polypropylene fume. After her symptoms developed, she was assigned to a new work area away from the polypropylene. Since that time, her symptoms have improved although she continues to require the same amount of asthma medicine.

POA- Case 2395. A female in her 50s developed asthma while working at an automotive assembly plant. She worked there with no breathing problems for 15 years; the next year she was moved to a job where she was exposed to chemicals where the windshield was prepped for assembly. She continues to work in this area. Her symptoms have stayed the same; however, she now requires more asthma medicine to control her asthma.

POA- Case 2432. A female in her 50s worked for an automotive parts manufacturing facility for two years when she developed asthma from exposure to smoke from the machine she was operating. The smoke resulted from the tempering of the spring wire used to make transmission clutches. She continued to work at this job for six years until quitting because of her breathing difficulties. She reports a worsening of her symptoms and increased use of asthma medicine since she left the company. She has been unable to hold a job for the past six years because of her asthma.

POA- Case 2340. A female in her 30s who worked at an automotive assembly plant for five years was taken to a local hospital emergency department for breathing problems from exposure to a natural gas leak. She immediately had trouble breathing as well as an allergic rash and hives. She continues to work at this facility, and reports that her symptoms and need for asthma medicine have remained unchanged.

POA- Case 2345. A female in her 60s worked for six years as an inspector at an automotive parts manufacturing facility when she developed asthma from exposure to the substances used to make spark plugs. She continued to work at this job for 21 years, and then was assigned to a new work location where she continues to work. Since moving to a new job at the plant, her symptoms have improved although she continues to require the same amount of asthma medicine.

POA- Case 2308. A female in her 40s worked as an inspector at a wood laminate manufacturer for six years before her asthma developed from exposure to the fumes released from newly installed laminate-making machines. The machines were set up and run prior to the installation of proper ventilation. She reports being fired when her breathing problems began, for refusing to speak with the manager about the incident. Since leaving the company, her symptoms have improved although she continues to require the same amount of asthma medicine. Six months after being fired from this company, she had not been able to find new employment.

AA- Case 2330. A female in her 20s experienced an exacerbation of her asthma while working at an automotive assembly plant. She had worked at the company for five years when a gasoline leak occurred. She estimates that since the initial leak, there have been at least 12 additional gasoline leaks. She continues to work at the plant. Over time her symptoms have worsened and she is now taking more asthma medicine.

POA- Case 2312. A female in her 40s worked at an automotive plastic parts manufacturing facility for three years when she developed asthma from exposure to plastic fume. She continued to work in that environment for 15 years until being placed on medical leave by her allergist. Since being on leave, her symptoms have improved and she stopped taking asthma medicine.

POA- Case 2282. A female in her 50s worked as a traffic controller in an automotive manufacturing facility for nine years when she developed asthma from exposure to the fume from a plastic injection molding machine. The company started a new line that was equipped with ventilation that fed outside; however, the outside duct was located near an intake vent for the air conditioning unit for her office. Her symptoms began when this system was installed. Six months after that incident, her office was moved. Her symptoms remain unchanged and she continues to require the same amount of asthma medicine.

POA- Case 2348. A male in his 60s worked at an automotive assembly facility for 23 years when a new type of fire retardant work uniform was issued to his work group of electrician assemblers. He wore the new uniforms for two weeks, and after which he developed a whole body rash along with breathing problems. Three months later, the employee was told he was no longer required to wear the special uniform; however, the patient was also laid off due to "lack of work." Since being off work, his breathing symptoms have improved although he continues to require the same amount of asthma medicine. His rash has not yet resolved.

#### OIL AND GAS EXTRACTION

POA- Case 2366. A female in her 40s worked as a lab technician for an oil refinery for 13 years when she developed asthma from an unknown exposure in the laboratory. She continues to work in the lab, and after six months of treatment for her breathing difficulties, she reports her symptoms have resolved and she has stopped taking asthma medicine.

#### RECREATIONAL SERVICES

RADS- Case 2403. A male in his 30s worked as an equipment repairman at a golf course for two years when he was exposed to chemicals used to treat the greens while cleaning out a sprayer. Within 24 hours, he developed breathing problems. He quit this job upon his doctor's advice about 10 months later. Despite leaving work, his symptoms have not improved and he requires more asthma medicine.

RADS- Case 2411. A female in her 30s was employed as a part time maintenance worked at a movie theater for six years when she developed RADS from exposure to a leaking battery in a storage room. Her symptoms have continued since that exposure, and she requires a greater amount of asthma medicine.

#### RETAIL TRADE

RADS- Case 2374. A female in her 40s worked for 15 years as a beauty products sales consultant. She developed RADS from breathing aromatherapy fumes that her employer used during her work shift. It was a product not usually used in the store. Since that time, her symptoms have lessened although she continues to require the same amount of asthma medicine over one year after the incident occurred.

#### SANITATION SERVICES

POA- Case 2271. A male in his 30s developed asthma after working for six years as a truck spotter at a hazardous waste processing facility. He was not wearing any personal protective equipment when he was

exposed to some hazardous waste that was being dumped, and on that particular day he developed breathing problems and was sent to the hospital. Since that incident, he has been reassigned to a new job at the company. His symptoms have improved although he continues to require the same amount of asthma medicine.

#### TRANSPORTATION SERVICES

POA- Case 2326. A male in his 40s worked for eight years driving a cement truck for ready mix cement. The vacuum tubing on the truck that fed the cement to the mixing barrel of his truck was broken and he was exposed to clouds of leaking cement dust for a period of about four months. During this time, he developed asthma. About one year later he quit this job upon his doctor's advice, because of his breathing difficulties. Since that time his symptoms have lessened although he continues to require the same amount of asthma medicine. One year after leaving this job he has been unable to find new employment.

# Welding Fume

#### MANUFACTURING

AA- Case 2304. A male in his 40s experienced an exacerbation of his asthma approximately three months after starting to work as a machine operator at an automotive parts manufacturing facility. He was exposed to fume from the automatic arc welding machine he was assigned to operate. He was moved to a new job away from exposure to the welding fume. However, his symptoms have continued to worsen, and he continues to require the same amount of asthma medicine.

POA- Case 2341. A female in her 50s worked as a welder at an automotive parts manufacturing facility. After 14 years, she developed asthma from exposure to welding fume. She continued to work as a welder at the plant for 15 years until a worsening of her asthma caused her to be placed on medical disability.

POA- Case 2467. A female in her 50s worked at an automotive manufacturing facility as an automotive assembler. After working there for 15 years, where she was exposed to spot welding fume, she developed asthma. Despite being on medical leave for over a year, her asthma symptoms have not improved and her asthma medicine use has remained unchanged.

#### TRANSPORTATION SERVICES

POA- Case 2399. A male in his 40s developed asthma while working for a package delivery service as a body man and painter. His symptoms developed nine years after working for this company, and he notes that his wheezing occurs when he welds on aluminum. He reports that the ventilation consists of three small fans that typically are not used. He continues to work at this company, his symptoms have stayed the same and he continues to take the same amount of asthma medicine.