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# 2013 ANNUAL REPORT

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## TRACKING WORK-RELATED ASTHMA IN MICHIGAN



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## *Work-Related Asthma Surveillance Program*

### TABLE OF CONTENTS

<b>SUMMARY</b>	<b>1-2</b>
<b>BACKGROUND</b>	<b>2</b>
<b>PROCEDURES</b>	<b>2-4</b>
<b>RESULTS</b>	<b>4-25</b>
<b>DISCUSSION</b>	<b>26-28</b>
<b>REFERENCES</b>	<b>29</b>
<b>APPENDIX</b>	<b>30-38</b>

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There are many resources available to help employers, employees, health care professionals and others understand more about work-related asthma. Links to these resources can be found at: [www.oem.msu.edu](http://www.oem.msu.edu).

## *Summary*

This is the 23rd annual report on work-related asthma (WRA) in Michigan.

In 2010, in a publication in the Journal of Asthma, researchers found that in a random sample of Michigan adults 54.1% self-reported that their asthma was

### Acronyms

**OA** Occupational Asthma

**AA** Work-Aggravated Asthma

**POA** Possible Occupational Asthma

**RADS** Reactive Airways Dysfunction Syndrome

**LARA** MI Department of Licensing & Regulatory Affairs

**MIOSHA** Michigan Occupational Safety & Health Administration

**NAICS** North American Industrial Classification System

**NIOSH** National Institute for Occupational Safety & Health

**PEL** Permissible Exposure Limit

**REL** Recommended Exposure Limit



**This report was funded by the National Institute for Occupational Safety & Health, under cooperative agreement U60-OH008466.**

**We sincerely appreciate the commitment of those health care providers who understand the public health significance of diagnosing a patient with an occupational illness, as well as the Michigan employees who took the time to share their experiences about their work and subsequent development of work-related asthma.**

caused or aggravated by their work, and yet only 22% reported having a discussion with their health care provider about their concern about the effect of work on their asthma<sup>1</sup>. These same individuals were

more symptomatic and had more health care usage than other Michigan adults with asthma. This study highlights the importance of health care providers considering whether their patients with asthma have work-related triggers.



**There are over 300 known asthma-causing agents used in the workplace. Thousands more substances have not been evaluated for their asthma-causing potential. The Association of Occupational & Environmental Clinics (AOEC) has a web site with an on-line look-up feature to identify asthma-causing agents.**  
<http://www.aoecdata.org/>

**Part 56 of the Michigan Public Health Code requires reporting of all known or suspected occupational illnesses or work-aggravated health conditions to the Michigan Department of Licensing & Regulatory Affairs within 10 days of discovery.**

## Summary, continued...

- ◆ Since 2006, the number of cases identified each year has been less than the overall average of 137.
- ◆ From 1988-2013, 3,272 WRA cases have been identified through the MI tracking system.
- ◆ We estimate there are 65,000-97,000 adults in MI with WRA.
- ◆ 83% of the MI WRA patients have new-onset asthma; 17% have pre-existing asthma aggravated by an exposure at work.
- ◆ MIOSHA enforcement inspections at the workplaces where an individual with WRA was reported revealed that, on average, one out of every six of their fellow workers has asthma or respiratory symptoms compatible with asthma.
- ◆ Isocyanates-12.3%, and cleaning agents- 11.8%, are the most commonly reported exposures causing WRA in MI.
- ◆ About 1% of the MI workforce is employed in manufacturing where isocyanates are used.
- ◆ The average incidence rate of WRA among African Americans is 1.4 times greater than that of Caucasians.

## Background

In 1988, the State of Michigan instituted a tracking program for WRA with financial assistance from NIOSH. This is a joint project of MIOSHA (LARA) and Michigan State University (MSU), Department of Medicine, Division of Occupational and Environmental Medicine.

The reporting of an index patient is a sentinel health event that may lead to the identification of employees from the same facilities who are also at risk of developing asthma or who have developed similar breathing problems. The goal is to prevent WRA through the identification and workplace follow-up of these index patients.

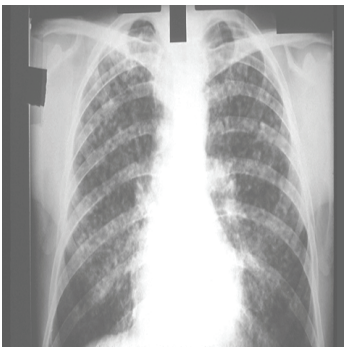
## Work-Related Asthma Tracking Procedures...

### SOURCES TO IDENTIFY PATIENTS

- Patients are identified through mandatory reporting of any known *or suspected* occupational illnesses, including WRA.
- ◆ **Health Care Providers** Private practice, working for industry
  - ◆ **Hospitals** ICD-9 506.0-.9 & 493, Workers' Compensation payer
  - ◆ **Workers' Compensation Agency**
  - ◆ **Poison Control Center**
  - ◆ **Reports from Co-Workers or MIOSHA Field Staff** confirmed by a health care provider
  - ◆ **Death Certificates**
  - ◆ **Clinical Laboratories for specific IgE Allergy Testing**

# WRA Tracking Procedures in Michigan

IDENTIFY PATIENTS	INTERVIEW PATIENTS	WORKPLACE INSPECTION	FOLLOW UP ACTIVITIES
<ul style="list-style-type: none"> <li>◆ <b>Review OD Reports</b> -Submitted to LARA</li> <li>◆ <b>Known or Suspected</b> -Work-Related Asthma</li> <li>◆ <b>Letter to Patient</b></li> </ul>	<ul style="list-style-type: none"> <li>◆ <b>Telephone Interview</b> -Medical and work history</li> <li>◆ <b>Obtain Medical Records</b> -Breathing test results</li> <li>◆ <b>Physician Review</b></li> </ul>	<ul style="list-style-type: none"> <li>◆ <b>Inspection Referral</b> -MIOSHA determines inspection type</li> <li>◆ <b>On-Site Inspection</b> -Assess exposures, conduct air monitoring -Injury &amp; Illness Log -MSU interviews workers -Evaluate medical program</li> </ul>	<ul style="list-style-type: none"> <li>◆ <b>Inspection Results</b> -Company -Workers -Reporting Physician</li> <li>◆ <b>Letters to Individual Co-Workers</b> -See doctor if breathing problems reported during interview</li> <li>◆ <b>Analyze Data</b> -Annual Report -Other outreach &amp; educational materials</li> </ul>



## INTERVIEW PATIENTS

A telephone interview with the suspected WRA patient is conducted, and medical records are obtained, including any pulmonary function test results. A board-certified internist and occupational medicine physician reviews all collected information.

## WORK-RELATED ASTHMA REQUIRES

- A) Physician diagnosis of asthma.
- B) Onset of respiratory symptoms associated with a particular job that resolve or improve away from work.
- C) Work with a known allergen, or an association between work exposure and a decrease in pulmonary function.

## THESE ARE THE SUBCATEGORIES OF WRA

### New Onset

- 1) Occupational Asthma (OA) if A), B), and C) are met.
- 2) Possible WRA (POA) if only A) and B) are met.
- 3) Reactive Airways Dysfunction Syndrome (RADS) if symptoms develop after an acute exposure.<sup>2</sup>

### Exacerbation

- 4) Work-Aggravated Asthma (AA) if had asthma in the 2 years prior to job, but asthma worsens at work.

**A study of Michigan asthma patients found that as much as 54% of adult asthma was caused or aggravated by exposures in their job.<sup>1</sup>**

## Workplace Inspections

After the patient interview is completed and the work-relatedness is determined, a MIOSHA workplace enforcement inspection may be conducted.

### During an Inspection:

- ◆ Co-workers are interviewed to determine if other individuals are experiencing similar breathing problems from exposure

to the allergen.

- ◆ Air monitoring for any suspected allergens is conducted.
- ◆ The company’s health and safety program is reviewed.

After the investigation is complete, a report of air sampling results and any recommendations is sent to the company and made available to workers. A

copy of the report is also sent to the reporting physician.

### OTHER FOLLOW UP ACTIVITIES

Outreach, educational activities, and recommendations may be developed based on the findings. An annual report summarizing the activity is completed each year.



**Welding activities expose workers to heated metal fume, as well as surface contaminants such as oils or dirt and dust.**

## Results

The following sections report the cumulative results of WRA surveillance from 1988 to date.

### REPORTS

Table 1 shows that 3,272 people were confirmed with WRA between 1988—2013. The reports are divided into: occupational asthma (OA), possible occupational asthma (POA), aggravated asthma (AA) and Reactive Airways Dysfunction Syndrome (RADS). Eighty-four additional patients have been confirmed since last year’s report. Figure 1 shows the overlap of the patients by reporting sources for 1988—2013.

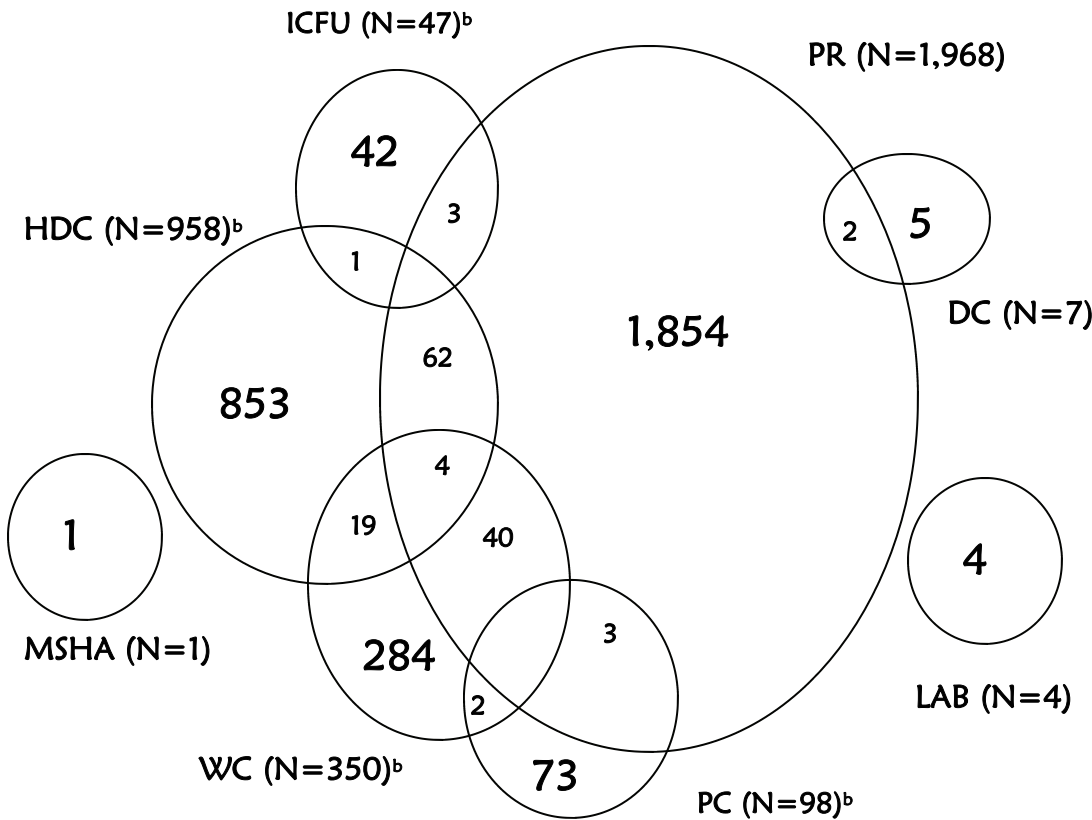
**TABLE 1**  
Number of Confirmed Cases of Work-Related Asthma by Year and Type

YEAR	Disease Status				TOTAL
	OA	POA	AA	RADS	
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	82	36	14	18	150
1993	75	69	13	19	176
1994	65	59	15	13	152
1995	57	34	19	17	127
1996	61	59	24	11	155
1997	53	74	19	16	162
1998	46	74	18	9	147
1999	48	65	16	12	141
2000	49	67	31	17	164
2001	50	51	20	19	140
2002	39	59	24	21	143
2003	29	64	28	23	144
2004	39	61	37	30	167
2005	43	66	21	23	153
2006	34	61	29	14	138
2007	20	41	34	28	123
2008	16	53	25	16	110
2009	20	41	31	8	100
2010	16	41	30	16	103
2011	19	26	19	3	67
2012	16	19	35	10	80 <sup>a</sup>
2013	15	25	31	6	77 <sup>a</sup>
<b>Total</b>	<b>1,100</b>	<b>1,229</b>	<b>564</b>	<b>379</b>	<b>3,272</b>

<sup>a</sup>Reports are still being processed for calendar years 2012 and 2013; an increase in these totals will be reflected in next year’s annual report.

**83% of WRA in Michigan is new onset; 17% is pre-existing asthma aggravated by exposure to an allergen or trigger at work.**

**FIGURE 1**  
**Overlap of Reporting Sources for 3,272 Confirmed**  
**Work-Related Asthma Patients: 1988-2013<sup>a</sup>**



**Doctors are the most frequent reporters of workers with occupational diseases.**

**The sooner an individual with WRA is diagnosed and removed from the agent associated with their asthma, the better the prognosis for improvement in symptoms.**

<sup>a</sup> Ns represent the total number for that source.

Reporting Source: HDC=Hospital Discharge; PR=Physician Referral; DC=Death Certificate; WC=Workers' Compensation; ICFU=Index Case Follow-Up; MSHA=Mine Safety & Health Administration; PC=Poison Control Center; LAB= Laboratory IgE.

<sup>b</sup> There was an overlap of PC-HDC for 18 individuals and of one individual for PC-ICFU, and WC-PC-HDC for one individual each.

## Demographics

### GENDER

- ◆ Women 1,759, 54%
- ◆ Men 1,513, 46%

### YEAR OF BIRTH

- ◆ Range 1905—1995
- ◆ Average 1957

### RACE

- ◆ Caucasian 2,427, 74%
- ◆ African American 606, 19%
- ◆ Hispanic 68, 2%
- ◆ Alaskan/American Ind. 25, 1%
- ◆ Asian 14, <1%
- ◆ Other 36, 1%
- ◆ Unknown 96, 3%

### ANNUAL INCIDENCE RATE

- ◆ African American 2.75
- ◆ Caucasian 1.92

The annual incidence rate for African Americans is 1.4X greater than that of Caucasians (95% CI 0.85, 2.44).

Numerator is the average number of WRA cases by race for 2007-2011 reporting years. Denominator Source: American Community Survey Civilian Labor Force by Race in MI, 2007-2011.

## Location in State



Table 2 and Figure 2 show the annual average incidence rates of WRA among the working population, by county. The highest rates were in Luce (13.9 cases per 100,000), Clare (11.5 cases per 100,000), Cheboygan (8.2 cases per 100,000), Osceola (7.5 cases per 100,000), Tuscola (6.7 cases per 100,000), Genesee (6.2 cases per 100,000), Montmorency (6.1 cases per 100,000) and Sanilac (6.0 cases per 100,000).

**TABLE 2**  
Average Annual Incidence Rates of Work-Related Asthma  
Among Michigan Workers by County of Exposure: 1989-2011<sup>a</sup>

County	Avg Annual Inc		Cases 1989-2011	County	Avg Annual Inc		Cases 1989-2011
	# EE's <sup>b</sup>	Rate <sup>c</sup>			# EE's <sup>b</sup>	Rate <sup>c</sup>	
Alcona- Iosco	10,600	2.5	6	Jackson	63,400	3.0	44
Alger	3,325	1.3	1	Kalamazoo-Calhoun-Van Buren	210,700	1.9	90
Alpena	13,375	3.6	11	Kent-Ottawa-Muskegon-Allegan	580,900	1.2	166
Antrim	5,850	1.5	2	Lake	1,875	4.6	2
Arenac	4,550	3.8	4	Luce	2,500	13.9	8
Baraga	3,750	3.5	3	Mackinac	3,825	2.3	2
Barry	12,550	1.7	5	Manistee	8,250	1.6	3
Berrien	70,200	1.7	27	Marquette	28,600	3.0	20
Branch	15,775	5.8	21	Mason	10,425	1.3	3
Cass	10,425	1.7	4	Mecosta	12,100	2.2	6
Charlevoix	10,850	2.8	7	Menominee	9,050	0.5	1
Cheboygan	6,900	8.2	13	Montcalm	19,900	3.5	16
Chippewa	14,950	1.2	4	Montmorency	2,150	6.1	3
Clare	7,925	11.5	21	Newaygo	10,675	4.9	12
Clinton-Eaton- Ingham	235,900	2.5	133	Oceana	6,050	2.2	3
Crawford	4,475	4.9	5	Ogemaw	6,950	5.0	8
Delta	15,700	1.7	6	Ontonagon	2,325	1.9	1
Dickinson	14,825	3.2	11	Osceola	7,550	7.5	13
Emmet	16,575	1.3	5	Otsego	11,875	3.3	9
Genesee	164,400	6.2	235	Roscommon	6,250	4.9	7
Gladwin	4,875	1.8	2	Sanilac	12,975	6.0	18
Gogebic	6,950	1.3	2	Schoolcraft	2,825	1.5	1
Grand Traverse- Benzie-Kalkaska-Leelanau	60,125	2.4	33	Shiawassee	19,275	1.4	6
Gratiot	14,975	3.5	12	St. Joseph	25,025	1.7	10
Hillsdale	16,350	3.2	12	Tuscola	13,675	6.7	21
Houghton- Keweenaw	15,000	2.3	8	Washtenaw-Lenawee-Livingston	282,700	3.6	234
Huron	13,500	5.8	18	Wexford-Missaukee	17,825	2.0	8
Ionia	16,700	2.9	11	Saginaw-Bay-Midland	178,400	3.8	154
Iron	4,000	3.3	3	<u>Detroit, MSA<sup>d</sup></u>	<u>2,125,000</u>	<u>3.1</u>	<u>1,502</u>
Isabella	29,600	2.5	17	<b>All Michigan Counties<sup>e</sup></b>	<b>4,528,000</b>	<b>2.9</b>	<b>3,013</b>

<sup>a</sup> 1989 through 2011 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2012 and 2013 is not yet complete. Therefore, 1988, 2012 and 2013 reports are not included in this table.

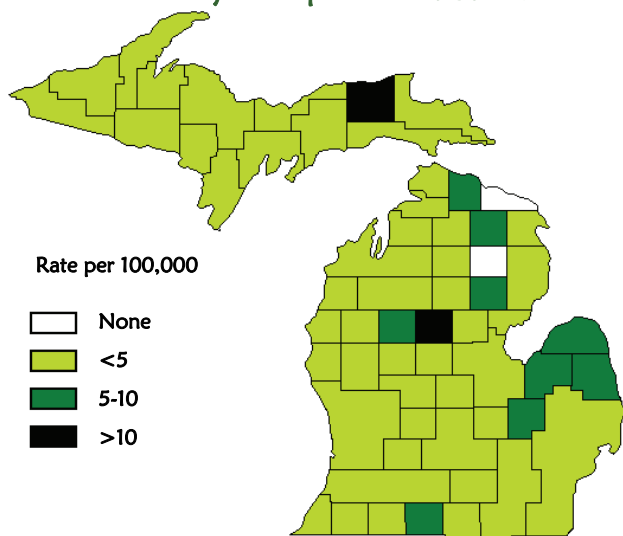
<sup>b</sup> Source: MDCD/Employment Service Agency 2001 Annual Average Labor Statistics for Employment by Place of Work. Some employee population data is only at a multi-county level, as indicated (i.e., not available at a single county level). Therefore, some data is presented with grouped counties.

<sup>c</sup> Rates are based on the average number of cases per year from 1989-2011, per 100,000 Michigan workers.

<sup>d</sup> MSA=Metropolitan Statistical Area and includes Lapeer (31 cases), Macomb (273 cases), Monroe (27 cases), Oakland (390 cases), St. Clair (51 cases) and Wayne (730 cases) counties.

<sup>e</sup> Forty-nine cases had an out-of-state exposure and 22 had an unknown county of exposure, for the 1989-2011 reporting period.

**FIGURE 2**  
Average Annual Incidence Rate of WRA by County of Exposure: 1989-2011<sup>a</sup>



<sup>a</sup> 1989 through 2011 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2012 and 2013 is not yet complete. Therefore, 1988, 2012 and 2013 reports are not included in this figure.

## Type of Industry

Table 3 shows the Michigan industries by NAICS codes, where the exposures to occupational allergens occurred from 1988 to 2013. The predominant industries were in manufacturing (59%) and health care and social assistance (12%).

The incidence rate of WRA by industry type ranges from 0.1 cases per 100,000 in management of companies to a high of 10.4 cases per 100,000 in manufacturing. Industries with the next highest annual average incidence rates were: mining with 6.1 cases per 100,000 workers and health care and social assistance with 3.2 cases per 100,000 workers.

Table 4 shows the average annual incidence rates for WRA cases *within manufacturing*.

**TABLE 3**  
Number of Work-Related Asthma Patients, 1988-2013 by Primary Industrial Exposure and Annual Average Incidence Rate per 100,000 Workers, 1989-2011 (Years of Complete Reporting)

2002 North American Industry Classification System		WRA Cases 1988-2013		Number of Employees <sup>a</sup>	Ann. Average Incidence Rate <sup>b</sup>	
		#	%		Rate	# Cases
11	Agriculture, Forestry, Fishing, & Hunting	20	0.6	81,664	1.0	19
21	Mining	12	0.4	8,600	6.1	12
22	Utilities	15	0.5	35,300	1.7	14
23	Construction	84	2.6	199,800	1.7	79
31-33	Manufacturing	1,919	58.6	761,400	10.4	1,823
42	Wholesale Trade	39	1.2	175,400	0.9	37
44-45	Retail Trade	90	2.8	530,700	0.7	84
48-49	Transportation & Warehousing	65	2.0	92,900	2.8	59
51	Information	22	0.7	70,400	1.2	19
52	Finance & Insurance	28	0.9	157,700	0.7	24
53	Real Estate & Rental & Leasing	16	0.5	55,700	1.2	16
54	Professional, Scientific & Technical Services	28	0.9	258,700	0.4	26
55	Management of Companies & Enterprises	1	<0.1	73,600	0.1	1
56	Administrative & Support & Waste Management	68	2.1	267,000	0.9	56
61	Educational Services	147	4.5	332,000	1.8	138
62	Health Care & Social Assistance	389	11.9	499,300	3.2	371
71	Arts, Entertainment & Recreation	28	0.9	53,500	2.0	25
72	Accommodation & Food Services	92	2.8	345,200	1.1	87
81	Other Services (except Public Administration)	71	2.2	256,100	1.1	66
92	Public Administration	126	3.9	390,400	1.3	116
00	Unknown	12	0.4	--	--	12
<b>Total</b>		<b>3,272</b>	<b>100.4<sup>c</sup></b>	<b>4,568,564</b>	<b>2.9</b>	<b>3,084</b>

<sup>a</sup>Source: Michigan Department of Technology, Management & Budget, Labor Market Information, Industry Employment (CES), 2002. The total non-farm industry employment in Michigan in 2002 was 4,486,900. Agriculture: 2002 U.S. Census of Agriculture-State Data. Selected Operator Characteristics by Race: 2002.

<sup>b</sup>Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2012 and 2013 is not yet complete. Therefore, 1988, 2012 and 2013 reports are not included in the calculation of the annual average incidence rate.

<sup>c</sup>Percentage does not add to 100 due to rounding.



**TABLE 4**  
**1,823 Work-Related Asthma Cases from Manufacturing Industries: 1989-2011<sup>a</sup>**

	2002 North American Industry Classification System	WRA Cases #	Ann Avg Rate <sup>a</sup>	# Employees <sup>b</sup>
311	Food Mfg	58	7.9	31,900
323	Printing & Related Support Activities	18	3.9	20,200
325	Chemical Mfg	97	12.5	33,800
326	Plastics & Rubber Products Mfg	99	9.8	43,700
327	Nonmetallic Mineral Product Mfg	17	4.2	17,600
331	Primary Metal Mfg	65	10.0	28,300
332	Fabricated Metal Product Mfg	99	5.1	84,500
333	Machinery Mfg	138	7.5	79,700
334	Computer & Electronic Product Mfg	12	2.5	21,100
336	Transportation Equipment Mfg	1,089	15.9	296,900
337	Furniture & Related Product Mfg	13	1.8	31,000
	Miscellaneous Mfg (*includes NAICS: 312-16,321-322,324,335,339)	118	7.1	72,700

<sup>a</sup>Average annual incidence rate, based on cases from 1989-2011 per 100,000 adult workers in each industrial category, and represents years with complete reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2012 and 2013 is not yet complete. Therefore, 1988, 2012 and 2013 reports are not included in this table.

<sup>b</sup>Source: Michigan Department of Technology, Management and Budget, Labor Market Information, Industry Employment (CES), 2002.

**Workers can be exposed to sensitizing agents in any type of industry.**



### *Type of Exposure*

Table 5 shows the exposures associated with WRA among Michigan workers. The most frequent exposures reflect the importance of the vehicle manufacturing industry in the State, and the widespread use of cleaning products across all industry sectors. Most frequently identified exposures include: isocyanates (MDI, TDI, HDI and others) accounting for 403 (12.3%) of the WRA case exposures and cleaning products, associated with 385 (11.8%) of Michigan’s WRA patients. Metal working fluids (coolants) accounted for 319 (9.7%) of Michigan worker exposures.

There is ongoing interest in ingredients in cleaning products that can cause new-onset asthma and aggravate existing asthma. These products, used both in the home and in all industry sectors (services, manufacturing, etc.) can con-

tain disinfectants, often in the form of quaternary amines, which have been repeatedly shown to cause asthma among workers who either use them or are in the area when they are being used.

Welding is the fifth most common cause of work-related asthma in Michigan. Both welders themselves as well as individuals who work in the same area may be affected by welding fume. A 2011 publication highlights the morbidity and high health care costs from asthma associated with welding<sup>3</sup>.

The Michigan WRA Tracking Program has developed a brochure on the hazards of cleaning agents. It is available at: [www.oem.msu.edu](http://www.oem.msu.edu), and can be found under the **Resources Section**.

**TABLE 5**  
**Top Work Place Exposures Associated with**  
**Confirmed WRA Patients: 1988-2013**

<u>Exposure Agent</u>	<u>#</u>	<u>%</u>
Isocyanates	403	12.3
Cleaning Solutions	385	11.8
Metal Working Fluids	319	9.7
Unknown (Mfg.)	244	7.5
Unknown (Office)	196	6.0
Exhaust/Smoke/Fumes	162	5.0
Welding Fume-Stainless & Other	145	4.4
Solvents	112	3.4
Paint Fumes	81	2.5
Epoxy	71	2.2
Fungus	69	2.1
Formaldehyde	66	2.0
Acids	64	2.0
Latex/Rubber	61	1.9
Chlorine	50	1.5
Fire	45	1.4
Plastic Fumes	44	1.3
Chemicals Used in Construction	40	1.2
Acrylates	39	1.2
Cobalt	31	0.9
Animal Dander	28	0.9
Flour	27	0.8
Fragrances	26	0.8
Wood Dust	26	0.8
Ammonia	23	0.7
Styrene	23	0.7
Cigarette Smoke	21	0.6
Herbicide/Pesticide	21	0.6
Aldehydes	18	0.6
Fiberglass	18	0.6
Chromium	14	0.4
Amines	13	0.4
Caustics	13	0.4
Cement Dust	13	0.4
Grain Dust	12	0.4
Printing Inks	12	0.4
Rust Inhibitor	12	0.4
Anhydrides	11	0.3
Cosmetology Chemicals	11	0.3
Medication	11	0.3
Plants/Organic Matter	11	0.3
Asphalt	8	0.2
Fire Extinguisher Powder	8	0.2
Insecticides	8	0.2
Meat Wrapper's Asthma	8	0.2
<u>Other<sup>a</sup></u>	<u>249</u>	<u>7.6</u>
<b>Total</b>	<b>3,272</b>	<b>99.8<sup>b</sup></b>

<sup>a</sup>There were 6 cases each w/exposure to: Azodicarbonamide, Heat, Nitrogen, Paper Dust, Pickling Ingredients, Polyurethane, Sewage, Solder Fume, Sulfur Dioxide.

There were 5 cases each w/exposure to: 1,1,1 Trichloroethane, Enzymes, Freon, Photo Developing Fluids, Textile Lint.

There were 4 cases each w/ exposure to: Asbestos, Coal Dust, Drywall Dust, Mold Release Spray, Rose Hips, Sulfonate, Trichloroethylene, X-Ray Developing Fluids.

There were 3 cases each w/exposure to: Cadmium Solder, Coal Tar, Colophony, Copier Toner, Dimethyl Benzyl Ammonium Chloride, Hydraulic Oil, Kerosene, Lime Dust, Natural Gas, Nickel, Polyethylene, Sand, Sludge, Vinyl Acetate Acrylic, Zinc Oxide.

There were 2 cases each w/exposure to: Ammonium Chloride, Cellulose, Cold Air, Concrete Sealer, Cooking Oil, Copper Oxide, Exercise, Explosion, Fireproofing Chemicals, Gas and Oil Refinery Exposures, Glaze, Methamphetamine Lab, Ozone, Pepper Gas, Perchloroethylene, Phosgene, Polyester, Polyvinyl Butyrate, Sulfite, Talcum Powder, Teflon, Zinc.

There was 1 case each w/exposure to: 1,3-Dichloro-2-Propanol, 1,3 Dichloro 5 5-Dimethyl Hydrantoin, Ammonium Bifluoride, Anesthesia, Barbeque Smoker, Benzoate Esters, Blood, Blue Prints, Capsaicin, Car Window Sealant, Ceramic Powder, Crude Oil, Cyanide, Deck Stain, Desert Storm, Dry Ice, Ethylene Oxide, Fertilizer, Flares, Flux, Gortex, Heated Polyvinyl Chloride, Iodine, Isopropyl Alcohol, Methanol, Mica, Monoammonium Phosphate, Ninhydrin, Nonylphenol polyethylene glycol ether, Nylon-polyhexamethylene Adipamide, Odor, Phenol, Pigment, Plasma Cutting, Plating Chemicals, Platinum, Potassium Aluminum Fluoride, Polybutadiene, Soda Ash, Sodium Chlorite, Soot, Stress, Swimming Pool Shock, Tetrahydrofuran, Titanium Tetrachloride, Tuberculosis Vaccine, White Lithium, World Trade Center Exposure, Zinc Borate.

<sup>b</sup>Percentage does not add to 100 due to rounding.

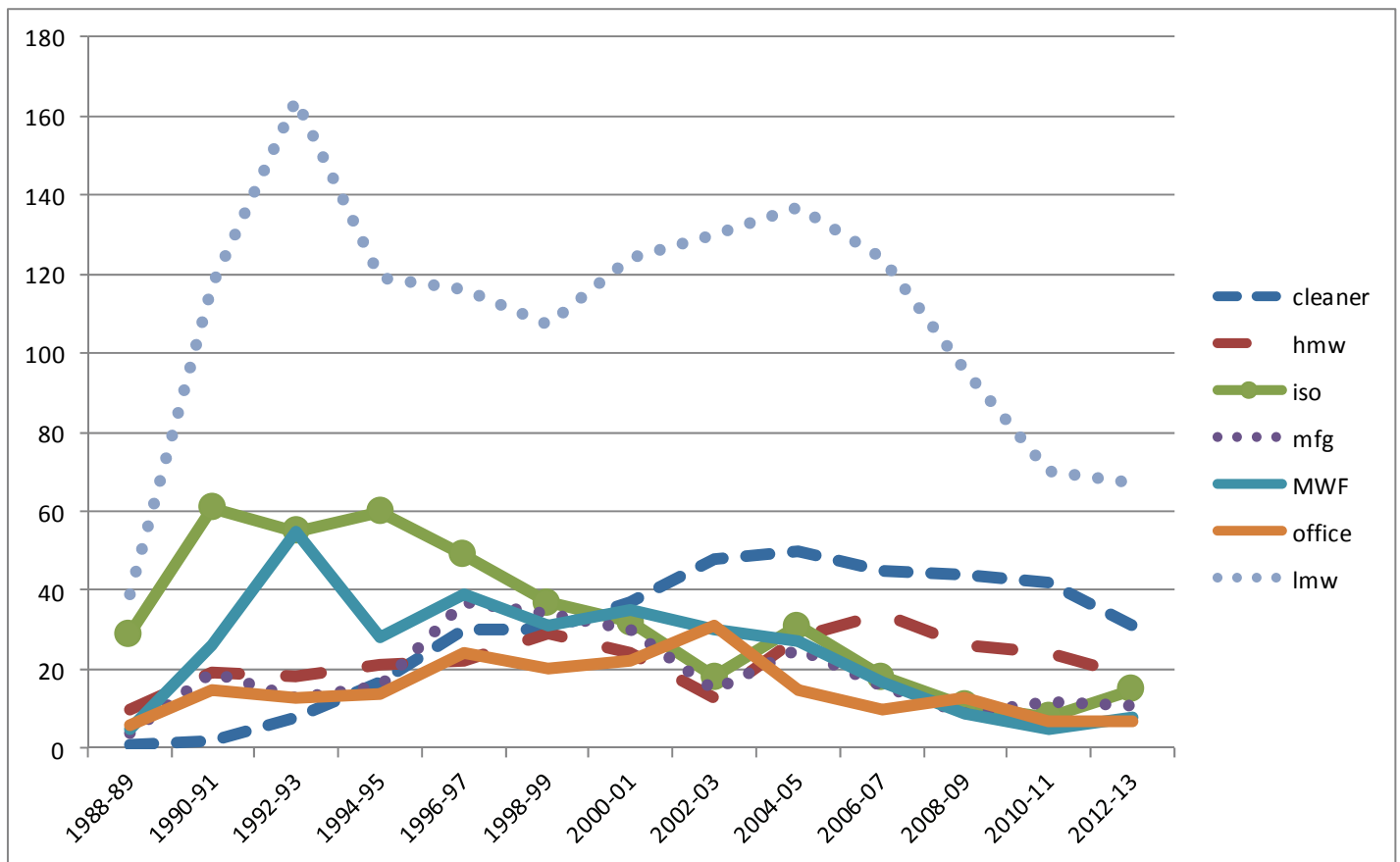
## Type of Exposure, continued...

### EXPOSURE TRENDS

Figure 3 shows the number of individuals with work-related asthma by type of exposure from 1988-2013. Trends are shown for the five most common causes of WRA and all other exposures that could be grouped as either low molecular weight (i.e. chemicals, metals) or high molecular weight (i.e. organic material, plant or animal) agents. The data is grouped into 2-year time categories to give more stability to smaller numbers of cases in a single year. The number of individuals with WRA caused by

metal-working fluids and other chemicals with low molecular weights appears to be trending downward. Diisocyanates were decreasing until 2010-2011. Office, manufacturing, and animal or plant products with high molecular weights appear unchanged and cleaning agents appear to be trending upward except for 2012-2013; however, the 2012-2013 data are provisional at this time and cases are still being identified and interviewed about their exposures.

**FIGURE 3**  
**WRA Patients by the Five Most Common Types of Exposures\* and All of the Other High and Low Molecular Weight Compounds, Trend by 2-Year Time Periods: 1988-2013**



\*Cleaner=cleaning agents, hmw=high molecular weight agents, iso=diisocyanates, mfg=manufacturing agents, MWF=metal working fluids, office=office exposures, lmw=low molecular weight agents.

## Medical Results

The percentage of Michigan adult smokers has varied over time, from a high of 28.4% in 1998, to a low of 20.5% in 2010, an increase in 2011 to 23.3%, and a decrease to 21.4% in 2014.

### SMOKING STATUS

Table 6 shows patients' cigarette smoking status. Nineteen and a half percent of patients were smoking when their asthma developed. This is slightly lower than the state average (21.4%) and markedly lower than that found in blue collar working populations.

### ALLERGIES AND ASTHMA

Forty-four percent of WRA patients had a

family history of allergies (data not shown).

Fifteen percent of the asthma patients had a personal history of allergies and asthma (Table 7). Forty-eight percent had no history of allergies or asthma.

### HEALTH CARE USAGE

Sixty-five percent of the WRA patients had at least one visit to the Emergency Department in their lifetime, and 35% had at least one hospitalization for their work-related asthma (Table 8). The average number of ED visits was 5.6 and the average number of hospitalizations was 3.8.

**TABLE 6**  
Cigarette Smoking Status of 3,163<sup>a</sup>  
Confirmed WRA Patients: 1988-2013

	Smoking Status						TOTAL
	Current		Ex-Smoker		Non-Smoker		
	#	%	#	%	#	%	
OA	227	21.1	421	39.1	430	39.9	1,078
POA	182	15.2	496	41.4	521	43.5	1,199
AA	106	20.3	146	28.0	270	51.7	522
RADS	103	28.3	137	37.6	124	34.1	364
All	618	19.5	1,200	37.9	1,345	42.5	3,163

<sup>a</sup>Missing data on 109 patients.

**TABLE 7**  
Personal History of Allergies or Asthma Among  
2,996<sup>a</sup> Confirmed WRA Patients: 1988-2013

	Personal History of...							
	Allergies & Asthma		Asthma Only		Allergies Only		No Allergies or Asthma	
	#	%	#	%	#	%	#	%
OA	54	5.3	49	4.8	304	29.8	614	60.1
POA	79	7.0	54	4.8	383	34.1	608	54.1
AA	290	53.8	220	40.8	12	2.2	17	3.2
RADS	17	5.4	35	11.2	77	24.7	183	58.7
All	440	14.7	358	11.9	776	25.9	1,422	47.5

<sup>a</sup>Missing data on 276 patients.

**TABLE 8**  
Health Care Usage Among Confirmed  
WRA Patients: 1988-2013

Lifetime History of Health Care Usage			
ED Visit <sup>a</sup>		Hospitalized <sup>b</sup>	
Yes	No	Yes	No
# (%)	# (%)	# (%)	# (%)
1,987 (65)	1,082 (35)	1,024 (35)	1,903 (65)
Range		Range	
1-300 visits		1-200 hospitalizations	
AVG 5.6 ±15.0		AVG 3.8±10.3	

<sup>a</sup>Missing data on 203 patients.

<sup>b</sup>Missing data on 345 patients.

### SYMPTOMS

Two thousand six hundred forty-three of the patients with WRA had persistence of their asthma symptoms (Table 9). Higher percentages of those *still exposed* continued to have breathing problems and take asthma medicine compared to those *no longer exposed*. Higher percentages of those *no longer exposed* had improved breathing and were taking less medicine.

## Medical Results, continued...

## Workplace Investigations

### OBJECTIVE MEDICAL TESTING

The percentage of WRA patients who had different types of pulmonary function testing was:

- ◆ Pre-post bronchoprovocation 55%
- ◆ Methacholine challenge 19%
- ◆ Peak flow monitoring at work & home 3%
- ◆ Pre-post work-shift 3%
- ◆ Specific antigen challenge <1%

### WORKERS'

#### COMPENSATION

About half of the WRA patients applied for Workers' Compensation benefits; about a third of those who applied for benefits were awarded compensation for their breathing problems.

- ◆ Applied 49%....among those who applied:

Pending approval 47%  
 Received benefits 36%  
 Denied benefits 17%

**TABLE 9**  
**Persistence of Symptoms and Medication Use in 2,990**  
**Confirmed WRA Patients: 1988-2013**

Still Exposed?	Total	Breathing Problems Still Present?				Still Taking Asthma Medications?			
		Yes		Less		Yes		Less	
		#	%	#	%	#	%	#	%
Yes	870	836	96.1	260	29.9	755	86.8	160	18.4
No	2,120	1,807	85.2	1,017	48.0	1,678	79.2	611	28.8
Total	2,990 <sup>a</sup>	2,643		1,277		2,433		771	

<sup>a</sup>Information missing on 282 individuals.

**TABLE 10**  
**Status of Facilities Where Confirmed WRA Patients Were Exposed to Allergens: 1988-2013**

Inspection Status	# Patients Represented	Companies	
		#	%
Inspected	1,219	781 <sup>a</sup>	33.2
No Follow-up Planned	1,843	1,377	58.5
Scheduled for Inspection	8	8	0.3
Out of Business	73	65	2.8
No Longer Use Occupational Allergen	27	26 <sup>b</sup>	1.1
Sent Company Letter to Check Exposures <sup>d</sup>	102	96	4.1
Total	3,272	2,353 <sup>c</sup>	100.0

<sup>a</sup>781 inspections were conducted in 659 different workplaces.

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

<sup>c</sup>Represents 2,231 different facilities.

<sup>d</sup>The company was sent information on how to address potential exposures including indoor air issues in their workplace that may be causing respiratory health problems.

### INDUSTRIAL HYGIENE

A total of 781 workplace inspections have been conducted since 1988 (Table 10); 122 of those facilities had been inspected more than once. Thirteen inspections have been completed since last year's report.

Air sampling for allergens was conducted during 565 inspections (Table 11); 28 (5.0%) of the 558 facilities with a MIOSHA standard for the allergen were above the enforceable permissible exposure limit.



**Many substances have no method for air monitoring or have not been evaluated for their asthma-causing potential.**

**Workers exposed to asthma-causing agents BELOW permissible limits are developing work-related asthma.**

**TABLE 11**  
**Air Monitoring Results from 781**  
**Workplace Inspections: 1988-2013**

<u>Air Sampling – NIOSH Standard</u>	<u>#</u>	<u>%</u>
Above NIOSH Standard	67	8.6
Below NIOSH Standard	471	60.3
No NIOSH Standard	29	3.7
Unknown (no report yet)	1	0.1
Did Not Sample for an Allergen	27	3.5
<u>Did Not Sample</u>	<u>186</u>	<u>23.8</u>
<b>Total</b>	<b>781</b>	<b>100.0</b>

<u>Air Sampling – MIOSHA Standard</u>	<u>#</u>	<u>%</u>
Above MIOSHA Standard	28	3.6
Below MIOSHA Standard	530	67.9
No MIOSHA Standard	7	0.9
Unknown (no report yet)	1	0.1
Did Not Sample for an Allergen	29	3.7
<u>Did Not Sample</u>	<u>186</u>	<u>23.8</u>
<b>Total</b>	<b>781</b>	<b>100.0</b>

**AIR MONITORING**

Table 12 shows the allergens that were above the NIOSH and/or MIOSHA limits. The top four allergens found to be above the NIOSH REL were:

- ◆ Formaldehyde
- ◆ Cobalt
- ◆ Styrene
- ◆ Metal Working Fluids

The top four allergens found to be above the MIOSHA enforceable PEL were:

- ◆ Welding Fume
- ◆ Cobalt
- ◆ Styrene
- ◆ Glutaraldehyde

**TABLE 12**  
**Allergens Above the MIOSHA Permissible Exposure Limit (PEL) and/or**  
**NIOSH Recommended Exposure Limit (REL): Michigan 1988-2013**

<u>Asthma-Causing Agents</u>	<u>Above NIOSH REL</u>		<u>Above MIOSHA PEL</u>	
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>
Formaldehyde	28	43.1	1	3.7
Cobalt	7	10.8	5	18.5
Styrene	6	9.2	4	14.8
Metal-Working Fluids	5	7.7	1	3.7
Glutaraldehyde	4	6.2	3	11.1
HDI	4	6.2	No PEL	--
MDI	3	4.6	0	--
Wood Dust	3	4.6	2	7.4
Chromic Acid	1	1.5	1	3.7
Ethylene Oxide	1	1.5	0	--
Phthalic Anhydride	1	1.5	1	3.7
Starch	1	1.5	0	--
Total Dust (Dry Plant Materials)	1	1.5	0	--
Welding Fume (Total Particulate)	No REL	--	7	25.9
<u>Flour Dust</u>	<u>No REL</u>	<u>--</u>	<u>2</u>	<u>7.4</u>
<b>TOTAL</b>	<b>65</b>	<b>99.9<sup>a</sup></b>	<b>27</b>	<b>99.9<sup>a</sup></b>

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

## Co-Worker Interviews at Workplace Investigations

Co-workers were interviewed during 602 of the 781 inspections. Workers had daily or weekly breathing symptoms associated with work or new onset asthma since beginning to work at 391 of the 602 (65%) companies. The average percentage of co-workers with symptoms in these 391 companies was 20.5%. All 1,635 co-workers from the remaining 211 companies reported no daily or weekly breathing symptoms associated with work. One thousand five hundred eighty-three of the 10,166 (15.6%) co-workers interviewed had symptoms consistent with

work-related asthma (Table 13).

The MIOSHA Injury and Illness Logs (Form 300) kept by employers listed 583 workers from 135 companies with asthma or asthma-like symptoms. Only 10 workers identified in the interviews with daily or weekly chest tightness, shortness of breath or wheezing were also listed on the MIO-OSHA Log. Combining the information from the interviews and Injury and Illness Log, a total of 2,166 symptomatic workers were identified during the 781 MIOSHA enforcement inspections.



**1 in 6 co-workers of the index patient with asthma reported similar breathing problems in the workplace.**

**TABLE 13**  
**Breathing Symptoms Among Co-Workers of the 3,272 Confirmed WRA Patients: 1988-2013**

Symptoms	Disease Status of the Index Patient									
	ALL		OA		POA		AA		RADS	
	#	%	#	%	#	%	#	%	#	%
Daily or Weekly SOB, Wheezing or Chest Tightness	1,583	15.6	1,107	15.8	432	15.1	6	12.0	38	13.9
Workers Interviewed	10,166		6,990		2,852		50		274	
Workers on OSHA Log	583		402		168		2		11	
# Companies w/Ee on Log	135	17.3	92	20.4	38	13.2	1	6.7	4	15.4
# Companies Inspected	781		452		288		15		26	
Total Workers w/Symptoms <sup>a</sup>	2,166		1,509		600		8		49	

<sup>a</sup>Ten individuals were identified both on the co-worker questionnaire and the OSHA Log.

## Work-Related Asthma Deaths

Fortunately, a very small percent (0.01-0.02%) of asthma patients die from asthma. From 2003 to 2008, we have identified eight work-related asthma deaths.

There were no work-related asthma

deaths identified in calendar years 2009 through 2013.

We have published articles on some of the work-related asthma deaths<sup>4,5</sup>.



**Limiting asthma management to just the treatment of symptoms is an unacceptable way to manage work-related asthma.**

## Michigan Workforce Exposed to Select Causes of WRA

The United States Environmental Protection Agency (EPA) requires reporting by manufacturers, mines or electrical utilities that have at least 10 employees and use any one of 650 different chemicals in amounts greater than 10,000 pounds per year. Queries of reportable chemicals can be generated to identify state-level statistics.

We identified Michigan's isocyanate-using companies in the EPA Toxic Release Inventory (TRI) to estimate the number of workers employed by manufacturers potentially exposed to isocyanates, the most commonly reported cause of WRA in Michigan (Table 14). Our estimate under-counts non-manufacturing-exposed employees such as those at auto body paint shops because the EPA does not include non-manufacturing establishments. Conversely, our estimate over-counts manufacturing employees because we included the total number of employees at each facility that reported isocyanates, even though not all workers at these facilities would have worked with or around isocyanates.

Another source to identify chemical exposures associ-

ated with WRA comes from the Michigan Department of Environmental Quality (DEQ). The chemicals listed in the Michigan Facilities' Guide to SARA Title III, Emergency Planning and Release Reporting (December 2007, 6th edition) are subject to reporting under the Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313, triggered by threshold amounts of 25,000 pounds manufactured or processed or 10,000 pounds otherwise used at Michigan facilities.

Unlike the EPA TRI data, all companies must report if they meet the threshold amount of chemical used; there are no limitations to reporting based on the type of facility or the number of individuals employed.

Between the two reporting sources, there were 113 companies that reported the use of isocyanates in calendar year 2013, which is up from 106 companies in 2012. The number of workers employed in companies that use isocyanates, the total number of workers in these counties, and the percentage of workers who work in facilities where isocyanates are used is listed in Table 14. The 37,835 workers potentially exposed to isocyanates in 2013 is up from the 33,659 potentially exposed in 2012.

**TABLE 14**

### Michigan Workers Employed in Manufacturing Facilities Where Isocyanates are Used, by County

County	Company Name <sup>c,d</sup>	# Workers Employed <sup>a</sup> by Isocyanate-Using Facilities	Total # Workers in the County <sup>b</sup>	% Workers Potentially Exposed to Isocyanates
ALLEGAN	HAWORTH INC JOHNSON CONTROLS INTERIORS PMSC JOHNSON CONTROLS INTERIORS—MAPLEWOOD FAC	2249	50452	4.5
BARRY	BRADFORD WHITE CORP	1100	27731	4.0
BAY	RENOSOL-BAY CITY PLANT	20	47209	<0.1
BENZIE	MAGNA INTERIOR TRIM COMPONENTS	320	7460	4.3
BERRIEN	LECO CORP NILES STEEL TANK VAIL RUBBER WORKS INC	225	65195	0.3
CALHOUN	COMCAST URETHANE CONVERIS FLEXIBLES US	173	59935	0.3
CHARLEVOIX	EAST JORDAN FOUNDRY	504	11428	4.4
CLARE	RENOSOL	300	10489	2.9



Table 14, continued...

County	Company Name <sup>c,d</sup>	# Workers Employed <sup>a</sup> by Isocyanate-Using Facilities	Total # Workers in the County <sup>b</sup>	% Workers Potentially Exposed to Isocyanates
CLINTON	INNOVATIVE POLYMERS INC	10	35234	<0.1
CRAWFORD	WEYERHAUESER	125	5222	2.4
DICKINSON	GREDE LOUISIANA-PACIFIC-SAGOLA OSB	580	12172	4.8
EATON	AXSON N AMERICA GM LANSING DELTA TWP	1030	50780	2.0
GENESEE	ASI PACKAGING COMPANY DELPHI ELECTRONICS & SAFETY FERGUSON BLOCK CO INC	1014	168248	0.6
HILLSDALE	DOW CHEMICAL	45	17300	0.3
INGHAM	HUNTSMAN ADVANCED MATERIALS S GROUP AUTOMOTIVE WILLIAMSTON PRODUCTS INC	290	131223	0.2
ISABELLA	DELFIELD CO	600	34325	1.7
JACKSON	MILSCO MICHIGAN SEAT TAC MFG	850	64406	1.3
KALAMAZOO	AZON USA DAVID A CHENOWETH ROOFING PARKER HANNIFIN CORP STRYKER INSTRUMENTS	3279	115933	2.8
KENT	GRAND RAPIDS FOAM TECHNOLOGIES HB FULLER LACKS WHEEL TRIM SYSTEMS LEON PLASTICS NA FUELS SYSTEM REMFG PURFORMS INC RICHWOOD INDUSTRIES INC UNIVAR USA	1187	299728	0.4
LENAWEE	ANDERSON DEVELOPMENT HI-LEX CONTROLS INSULSPAN INTEVA PRODUCTS	645	40684	1.6
LIVINGSTON	ATREUM HOWELL (INTIER AUTOMOTIVE) ATREUM-BRIGHTON	400	83189	0.5
LUCE	LOUISIANA-PACIFIC CORP-NEWBERRY SIDING	111	2230	5.0
MACOMB	AXALTA COATING SYSTEMS CHRYSLER STERLING HTS ASSY DUPONT MT CLEMENS PLT FAURECIA INTERIOR SYSTEMS INTERNATIONAL CASTING CORP NJT ENTERPRISES ROMEO RIM INC SHELBY FOAM SYSTEM WOLVERINE BRONZE	4628	370022	1.3
MARQUETTE	ARGONICS—MI PLANT	60	31607	0.2
MASON	DUNA-LUDINGTON PLANT GREAT LAKES CASTING	244	13260	1.8
MECOSTA	WOLVERINE WORLD WIDE	540	17580	3.1
MIDLAND	DOW CHEMICAL CO- 1790 BLDG & 1100 BLDG	2000	38636	5.2
MONTCALM	AGA MARVEL KENT FOUNDRY	274	22220	1.2

Table 14, continued...

County	Company Name <sup>c,d</sup>	# Workers Employed <sup>a</sup> by Isocyanate-Using Facilities	Total # Workers in the County <sup>b</sup>	% Workers Potentially Exposed to Isocyanates
<b>OAKLAND</b>	ARMALY SPONGE BEHR AMERICA, MAHLE CASS POLYMERS OF MI EAGLE INDUSTRIES EXOTIC RUBBER & PLASTICS CORP FANUC ROBOTICS—CORP HDQTRS ITW FUTURA COATING, ITW POLYMERS LYMTAL INTERNATIONAL INC OTTO BOCK POLYURETHANE TECHNOLOGIES RECTICEL UREPP N AMERICA	870	553069	0.2
<b>OCEANA</b>	BARBER STEEL FOUNDRY CORP	50	11930	0.4
<b>OGEMAW</b>	TAYLOR ENTRANCE SYSTEMS	55	8088	0.7
<b>OTTAWA</b>	DAKE OEM EAGLE PACKAGING MAGNA ENGINEERED GLASS	444	122957	0.4
<b>SAGINAW</b>	ESSENTRA POROUS TECHNOLOGIES GLASTENDER GRUPO ANTOLIN NEXTEER AUTOMOTIVE CORP SAGINAW METAL CASTING OPERATIONS STC	4380	82239	5.3
<b>SANILAC</b>	GRUPO ANTOLIN MIDWEST RUBBER CO NUMATICS SANDUSKY MAIN TRELLEBORG YSH INC	784	17153	4.6
<b>ST CLAIR</b>	IAC PORT HURON IAC ST CLAIR	470	67160	0.7
<b>ST JOSEPH</b>	IAC MENDON	800	26341	3.0
<b>VAN BUREN</b>	BASF CORP SPECIAL-LITE INC	182	31720	0.6
<b>WASHTENAW</b>	EXTANG CORP FAURECIA INTERIOR SYSTEMS THETFORD CORP	2049	173115	1.2
<b>WAYNE</b>	ALPHA RESINS BASF CORP—LIVONIA PLANT BASF CORP—WYANDOTTE PLANT BAY LOGISTICS CHRYSLER JNAP CYGNET AUTOMATED CLEANING EFTEC EQ DETROIT IMA FOAM PLANT PLASTOMER CORP POOF-SLINKY INC RECYCLED POLYMERIC MATERIALS UNIVAR USA—ROMULUS WINDSOR MACHINE & STAMPING (US) LTD WOODBIDGE CORP	4944	732812	0.7
<b>WEXFORD</b>	REC BOAT HOLDINGS-CRUISER PLANT	4	11773	<0.1
<b>TOTAL</b>		<b>37,835</b>	<b>4,306,000</b>	<b>0.9</b>

<sup>a</sup>Source: Michigan Manufacturers' Directory, 2015 and [www.acinet.org](http://www.acinet.org) accessed April 16, 2015.

<sup>b</sup>Source: Michigan Labor Market Information, Data Explorer, [www.milmi.org](http://www.milmi.org) accessed April 16, 2015.

<sup>c</sup>Source: U.S. Environmental Protection Agency, Toxics Release Inventory, Michigan Companies Using Isocyanates in 2013 (report April 16, 2015).

<sup>d</sup>Source: MI Dept of Environmental Quality, FOIA Request for SARA Title III Emergency Planning & Release Reporting of isocyanates, for calendar year 2013, received 4-23-2015 and 5-14-2015.

## Michigan Workforce Exposed to Select Causes of WRA, continued

Table 15 summarizes the companies, by county, using other chemicals that are known to cause asthma and those that are irritants and capable of causing Reactive Airways Dysfunction Syndrome. Those that can cause asthma are: Bisphenol A, Cobalt, Epichlorohydrin, Formaldehyde, Methyl Acrylate, Phthalic and Maleic Anhydride and Styrene. Ammonia and Chlorine are classified as irritants. These companies were identified through the MI DEQ SARA Title III Emergency Planning and Release Reporting for calendar year 2013.

Additional chemical exposures associated with WRA in Michigan can be found at: <http://www.oem.msu.edu/userfiles/file/Resources/MichiganWorkforceChemicalReport-with%20agent%20tables.pdf>

**TABLE 15**

### Michigan Facilities by County, Reporting Toxic Chemicals to the Michigan Dept. of Environmental Quality (DEQ) Under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA)<sup>a</sup>

#### SUBSTANCES CAPABLE OF CAUSING ASTHMA:

Acrylates, Anhydrides, Bisphenol A, Cobalt, Epichlorohydrin, Formaldehyde & Styrene

#### SUBSTANCES CAPABLE OF CAUSING REACTIVE AIRWAYS DYSFUNCTION SYNDROME: Ammonia & Chlorine

A=Ammonia, B=Bisphenol A, CH=Chlorine, CO=Cobalt, E=Epichlorohydrin, F=Formaldehyde, MA=Maleic Anhydride, M=Methyl Acrylate, MMA=Methyl Methacrylate, P=Phthalic Anhydride, S=Styrene

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
<b>ALGER</b>	NEENAH PAPER - MICHIGAN INC	A	<b>BAY</b>	DOW CORNING CORP - AUBURN SITE	A, CH
<b>ALLEGAN</b>	BIRDS EYE FOODS LLC	A, CH		ESSEXVILLE WWTP	CH
	CHS INC-HAMILTON FARM BUREAU	A		MAMMEL, MICHAEL/FARM	A
	CSD	A		MERSEN USA BN. CORP.	CH
	HUDSONVILLE CREAMERY & ICE CREAM	A		QUANTUM COMPOSITES, INC.	S
	JBS PLAINWELL, INC.	A		WEST BAY COUNTY REGIONAL WASTEWATER	CH
	OTSEGO, CITY WELLS #3, #4, #5 & WWTP	CH	<b>BENZIE</b>	GRACELAND FRUIT, INC.	A
	SHERMAN WILLIAMS CO- HOLLAND	A		PLATTE RIVER ST FISH HATCHERY	F
	TIARA YACHTS INC	S		SMELTZER ORCHARD COMPANY	A
	UNIFORM COLOR CO	M, MA	<b>BERRIEN</b>	ADVANCE PRODUCTS CORP	A
	VAN ELDEREN INC.	F		BENTON HARBOR	A
	WATER RENEWAL	CH		BENTON HARBOR WATER PLANT	CH
<b>ALPENA</b>	AMERICAN PROCESS—ENERGY RECOVERY	A		BUCHANAN AGRONOMY & PETROLEUM	A
<b>ANTRIM</b>	JORDAN RIVER NAT FISH HATCHERY	F		BUCHANAN WATER & WWTP	CH
<b>ARENAC</b>	WHITESTONE PUMPING STATION	CH		COLOMA FROZEN FOODS INC	A
<b>BARRY</b>	CALEDONIA FARMERS ELEVATOR	A		GREG ORCHARDS & PRODUCE INC	A
	CARBON GREEN BIOENERGY	A, F		HANSON COLD STORAGE	A
	WATER TREATMENT FACILITY	CH		LECO CORPORATION	A
<b>BAY</b>	BAY CITY MUNICIPAL WATER TREATMENT PLANTS	CH		LEITZ FARMS LLC	A
	CROP PRODUCTION SERVICES	A		NCP COATINGS	A, P

Table 15, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
<b>BERRIEN</b>	NEW BUFFALO WATER PLANT	CH	<b>DELTA</b>	ESCANABA PAPER COMPANY	A, CH
	NILES, CITY - DECKER, FORT & FRONT WELLS & IRON REMOVAL	CH	<b>DICKINSON</b>	VERSO PAPER—QUINNESEC	CH
	OLD EUROPE CHEESE, INC.	A	<b>EATON</b>	AXSON NORTH AMERICA INC.	S
	SAINT JOSEPH WATER PLANT	CH		CASS POLYMERS OF MICHIGAN INC	S
	SANDVIK MATERIALS TECHNOLOGY	A		CROP PRODUCTION SERVICES	A
	WILBUR-ELLIS COMPANY	A		ETM ENTERPRISES INC.	S
<b>BRANCH</b>	ALERIS SPECIFICATION ALLOYS, INC.	CH		LANSING PLANT	A, CH
	PRIDGEON FARMS	A		MEIJER LANSING DISTRIBUTION	A
	QUINCY	CH		S.P.KISH INDUSTRIES	A
	WATER TREATMENT PLT/COLDWATER	CH	<b>EMMET</b>	ODEN STATE FISH HATCHERY	F
<b>CALHOUN</b>	ALBION PLANT	A	<b>GD TRAV-ERSE</b>	CENTREICE	A
	ANATECH, LTD.	F		CENTURY SUN METAL TREATING	A
	BATTLE CREEK WATER & WWTP	A, CH		CHERRY GROWERS INC	A
	GUARDIAN FIBERGLASS INC.	F		HILLSHIRE BRANDS, TRAVERSE CITY	A
	HOUSE OF RAEFORD FARMS, INC	A		MICHIGAN PLANT	A
	MARSHALL CITY WATER	CH		TCS TRAVERSE COLD STORAGE LLC	A
	MUSASHI AUTO PARTS-MICHIGAN INC	A		TRAVERSE CITY	CH
	POST FOODS - BATTLE CREEK	CH	<b>GENESEE</b>	A RAGNONE TREATMENT PLANT	CH
	PRAIRIE FARMS DAIRY, INC.	A		FLINT	A, CH
	THE ANDERSONS ALBION ETHANOL, LLC	A		FLINT WATER PLANT	CH
	VERONA PUMPING STATION	CH		HENDERSON ROAD PUMP STATION	CH
<b>CASS</b>	THE MENNEL MILLING CO. OF MICHIGAN	CH		KOEGEL MEATS INC.	A
<b>CHEBOYGAN</b>	CHEBOYGAN WELLHOUSE #4 & #7 & WWTP	CH		STOKES STEEL TREATING CO	A
<b>CHIPPEWA</b>	PENDILLS CREEK NFH	F		WATER POLLUTION CONTROL FAC	CH
	SULLIVAN CREEK NFH	F		WOODWORTH INC. FLINT	A
<b>CLINTON</b>	CROP PRODUCTION SERVICES 622	A	<b>GOGEBIC</b>	IRONWOOD WATER PUMP ST	CH
	MAHLE ENGINE COMPONENTS USA, INC.	A	<b>GRATIOT</b>	ALMA WASTEWATER PLANT	CH
	MARTIN BROWER	A		CITY OF ST. LOUIS WWTP	CH
	MICHIGAN MILK PRODUCERS ASSOC	A	<b>HILLSDALE</b>	BEF FOODS INC.	A
	SAVE-A-LOT LTD	A		CONAGRA FOODS INC	A
	SCCMUA	CH		HILLSDALE WWTP	CH
	WASTEWATER TREATMENT FACILITY	CH		PRATTVILLE FERTILIZER & GRAIN	A
<b>CRAWFORD</b>	ARCTIC GLACIER INC	A		THE ANDERSONS LITCHFIELD FARM	A
	GRAYLING GENERATING STATION	CH	<b>HOUGHTON</b>	MICHIGAN-AMERICAN WATER CO	CH
	WEYERHAEUSER NR COMPANY	F		OSMOSE HUBBELL	A

Table 15, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
<b>HURON</b>	BAD AXE WWTP	CH	<b>IONIA</b>	TWIN CITY FOODS	A, CH
	COOPERATIVE ELEVATOR	A		<b>IOSCO</b>	HURON SHORE REGIONAL UTILITY A
	DOW AGROSCIENCES LLC	A	ROSE ICE COMPANY		A
	FARMERS CO-OP GRAIN CO.	A	TAWAS UTILITY AUTHORITY WWTP		CH
	HARBOR BEACH WATER WORKS & WWTP	CH		TIP-TOP SCREW MFG IN	A
THUMB TOOL & ENGINEERING	A	<b>JACKSON</b>	CITY OF JACKSON WATER TREATMENT	CH	
<b>INGHAM</b>	ALDI INC - WEBBERVILLE		A	COVENTRY PARK	CH
	ALEXANDER CHEMICAL CORPORATION	A, CH	INDUSTRIAL STEEL TREATING	A	
	ARCTIC GLACIER—LANSING	A	JCC WELL HOUSE	CH	
	AURORA SPECIALTY CHEMISTRIES	E	KIMMEL ROAD WELL HOUSE	CH	
	CITY OF LESLIE WWTP	CH	MEADOW HEIGHTS WELL	CH	
	CREMER FARM CENTER, INC.	A	SOUTHVIEW PUMP STATION	CH	
	DYE WATER CONDITIONING PLANT	A	SPRINGPORT ELEVATOR INC	A	
	E LANSING-MERIDIAN WATER & SEWER	A	TENNECO - JACKSON ENGINEERING	A	
	HAWKINS, SID/FARM	A	WESTCHESTER PUMP STATION	CH	
	JORGENSEN FARM ELEVATOR	A	<b>KALAMA-ZOO</b>	CITY OF KALAMAZOO- STATIONS #28 & #39	CH
	LANSING MINT RD.	A		HAVILAND PRODUCTS COMPANY	F
	MASON P.O.T.W. PLANT	CH		KALAMAZOO WATER DIV/STA #1-#5, #8, #9, #11, #12, #14, #17, #18, #22, #24, #25, #31	CH
	MBI	A		KLC-1, KLC-2	A
	NITREX INC - MICHIGAN OPERATION	A		KNAPPEN MILLING CO	CH
	PIDD BROTHERS FARM	A		PHARMACIA & UPJOHN LLC	A, CH, E, F
	QUALITY DAIRY COMPANY	A		PRECISION HEAT TREATING COMPANY	A
	RICE, DONALD/FARM	A		THERMO FISHER SCIENTIFIC	F
	SYMMETRY MEDICAL INC-LANSING	CO	<b>KENT</b>	29th STREET WAREHOUSE	S
	THE ANDERSONS WEBBERVILLE	A		ARKEMA INC.	B, P
	WALNUT VU FARM/FARM	A		BIMBO BAKERIES USA	A
WATTERS & SONS FARM	A	BODYCOTE- GRAND RAPIDS		A	
WILLIAMSTON WATER TREATMENT	CH		BRENTAG GREAT LAKES LLC	A, F	
<b>IONIA</b>	BELDING TANK TECHNOLOGIES, INC	S		BRETON INDUSTRIAL PARK WAREHOUSE	S
	CARGILL KITCHEN SOLUTIONS	A		BUTTERBALL FARMS INC	A
	FARM DEPOT 3 LTD	S		CHASE STORAGE & CHASE ORCHARDS	A
	GALLAGHERS	A		COCA-COLA GRAND RAPIDS	A
	HENNERY	A		CONAGRA FOODS GRAND RAPIDS	A
	PORTLAND WWTP	CH		COUNTRY FRESH LLC	A
	STAHLIN ENCLOSURES	S		DISTRIBUTION CENTER #1	A
	TRW AUTOMOTIVE US LLC - PORTLAND	A		EAGLES ICE CENTER	A

Table 15, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
<b>KENT</b>	EARTHGRAINS BAKING CO INC.	A	<b>KENT</b>	WYOMING CLEAN WATER PLANT	CH
	EMERALD SPA CORPORATION	S	<b>KEWEENAW</b>	SUSANS BIG DUMMY	A
	FINISHMASTER INC #990 DIST CR	S		SUSANS DAIRY	A
	FORTY-FOURTH STREET FACILITY	A		SUSANS FARM	A
	FRUIT RIDGE APPLE CO	A		TOOTSIE ROLL MOVERS INC	A
	GM COMPONENTS HOLDINGS, LLC	A	<b>LAPEER</b>	LAPEER GRAIN EAST	A
	GORDON FOOD SERVICE	A		LAPEER PLATING & PLASTICS	F
	GRAND RAPIDS EDGE ICE ARENA	A	<b>LEELANAU</b>	CHERRY GROWERS-PLT 2	A
	GRANDVILLE	A, CH		LEELANAU FRUIT COMPANY	A
	HEEREN BROS	A	<b>LENAWEE</b>	ADC MAIN PLANT	F,MA,MMA,S
	JACK BROWN PRODUCE INC	A		ADC-NF3 PLANT	A
	KENT QUALITY FOODS INC	A		AIRGAS CARBONIC, INC	A
	KING MILLING COMPANY	CH		CROP PRODUCTION SERVICES 634 & 641	A
	LACKS TRIM SYSTEM - AIRLANE PLANT	F		DAIRY FARMERS OF AMERICA	A
	LACKS WHEEL SYSTEMS	F		GREAT LAKES CHEMICAL	A,CH
	LOWELL WWTP & WATER TREATMENT	CH		WAR-AG FARMS SERVICES LLC	A
	MICHIGAN NATURAL STORAGE CO	A		WELLHOUSE #3 #8 #9 #10 #11 #12 & #14	CH
	MICHIGAN TURKEY PRODUCERS	A		WILBUR-ELLIS COMPANY - MUNSON	A
	NBHX TRIM USA	S	<b>LIVINGSTON</b>	AMERICAN COMPOUNDING SPECIAL-TIES	MA
	NORTH RIDGE ORCHARD LLC	A		ASAHI KASEI PLASTICS NA	MA
	PATTERSON ICE CENTER	A		CHEMCO PRODUCTS, INC.	F
	PLASTIC PLATE INC (KRAFT)	F		COR-MET INC	CO
	REMICO STREET FACILITY	CH, F		GORDON FOOD SERVICE	A
	RIDGEKING APPLE PACKING & STORAGE	A		KELSEY HAYES CO	CH
	RIVERIDGE PACKING	A		PEPSI COLA METROPOLITAN BOTTLING	A
	S1	A		WATER PLANT & WWTP	CH
	SPARTA FACILITY	A	<b>LUCE</b>	NEWBERRY WWTP	CH
	SPARTAN STORES DISTRIBUTION	A	<b>MACKINAC</b>	WATER TREATMENT PLANT & WWTP	CH
	SPECIALTY HEAT TREATING, INC.	A	<b>MACOMB</b>	AXALTA COATING SYSTEMS	B, MMA, S
	STATE HEAT TREATING COMPANY	A		BOSCOS PIZZA	A
	SUPERIOR SEAFOOD INC.	A		CARBIDE TECHNOLOGIES	A
	SUPERIOR STONE PRODUCTS INC	MMA, S		DU PONT- MT CLEMENS PLANT	B, F, MMA, S
	SYSCO GRAND RAPIDS, LLC	A		EVERFRESH / LA CROIX BEVERAGES	A
	THE HOME CITY ICE CO	A		FINI FINISH PRODUCTS INC	CH
	UNIVAR USA	B, S		FORMSPRAG LLC	A
	VI-CHEM CORPORATION	S		GM LLC TECHNICAL CENTER	A
	VILLAGE OF SPARTA WATER DEPT	CH		METALLURGICAL PROCESSING CO	A

Table 15, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
<b>MACOMB</b>	NEXEO SOLUTIONS	S	<b>MUSKEGON</b>	ESCO COMPANY, LLC	P
	NITRO-VAC HEAT TREATING	A		GMI COMPOSITES, INC	S
	NORBROOK PLATING	A		HOWMET CORP - PLTS 1, 3, 5 & 10	B, CO
	REINHART FOODSERVICE LLC	A		INTRACITY DISPATCH-LAKETON	B
	SPECIALTY STEEL TREATING, INC.	A		L-3 COMBAT PROPULSION SYSTEMS	A
	STEEL PROCESSING COMPANY LLC	A		LAKE WELDING SUPPLY CO INC	A
	TURRI'S ITALIAN FOODS, INC	A		PARAMELT (M. ARGUESO)	B
<b>MARQUETTE</b>	KI SAWYER WWTP	CH	<b>NEWAYGO</b>	SNAPPY APPLE FARMS INC	A
	MAIN	MMA, S		SUN CHEMICAL CORPORATION	A
	NEGAUNEE WASTEWATER TREATMENT	CH		WEBB CHEMICAL SERVICE CORP	B, F
<b>MASON</b>	HOUSE OF FLAVORS INC	A	<b>OAKLAND</b>	GERBER PRODUCTS COMPANY	A
	JOS. SANDERS INC	A		BEHR AMERICA INC (MAHLE)	A
	LUDINGTON WASTEWATER PLANT	CH		CHEMICAL BLENDING	F
	MICHIGAN FOOD PROCESSORS	A		CHOR INDUSTRIES INC.	A
<b>MECOSTA</b>	LEPRINO FOODS COMPANY REMUS	A	COMMERCIAL STEEL TREATING	A	
	UNITED STATES MARBLE INC.	S	DEPOR INDUSTRIES	F	
<b>MENOMINEE</b>	L.E. JONES COMPANY	CO	DETROIT SKATING CLUB	A	
	MENOMINEE WATER TREATMENT & WWTP	CH	DETROIT STEEL TREATING CO.	A	
	RULEAU BROS INC	A	ENGINEERED HEAT TREAT INC	A	
<b>MIDLAND</b>	CITY OF MIDLAND - WATER & WWTP	CH	FARMINGTON HILLS ICE ARENA	A	
	DOW- MICHIGAN OPERATIONS	A, B, CH, E, MMA, S	FERNDALE	A, CH	
	DOW CORNING - MIDLAND PLANT	A, CH	FOGLERS ORCHARD & FARM MKT	A	
	HOMESTEAD TOOL - SMC PLANT	S	GENERAL MOTORS PROVING GD	CH	
	MERSEN USA MIDLAND-MI INC	CH	HAZEL PARK VIKING ARENA	A	
	STYRON LLC - MI OPERATIONS	M, MMA, S	JOHN LINDELL ICE ARENA	A	
<b>MONROE</b>	ADVANCED HEAT TREAT CORP	A	MACDERMID INCORPORATED	F	
	DETROIT EDISON - MONROE POWER PLT	A	MARBELITE CORPORATION	S	
	HOME CITY ICE COMPANY- Toledo	A	MATHESON VALLEY	A	
	INDEPENDENT DAIRY INC	A	NOVI ICE ARENA	A	
	MAYBEE FARMERS INC	A	ONYX-ROCHESTER ICE ARENA	A	
	MEIJER NEWPORT DISTRIBUTION	A	RMT WOODWORTH, SOUTHFIELD	A	
	OTTAWA LAKE CO-OP ELEVATOR	A	SPECIALTY STEEL TREATING INC	A	
	ROYSTER-CLARK, INC. 655	A	STONE SOAP COMPANY INC	F	
	MONTCALM	MUD/DME	A	SUBURBAN TRAINING CENTER	A
	<b>MUSKEGON</b>	ALLOY RESOURCE CORPORATION	CH	SULZER METCO (US) INC	CO
BAYER CROPSCIENCE USA		A	SUN STEEL TREATING INC	A	
COLE'S QUALITY FOODS, INC.		A			

Table 15, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
<b>OAKLAND</b>	US FOODS INC.	A	<b>OTTAWA</b>	LAKE WELDING SUPPLY COMPANY INC	A
	VILLAGE OF HOLLY WWTP	CH		LAKESHORE FILTRATION PLANT	CH
	WATERFORD IRON REMOVAL 5-1, 12-1, 14-1, 16-1 & 2, MS-1, 19-1, 24-1, 25-1 & 2, 28-1,31-1	CH		LEO DIETRICH & SONS	A
	WOODWORTH INC PONTIAC	A		MEAD JOHNSON AND COMPANY, LLC	CH
<b>OCEANA</b>	2ND STREET STORAGE	A	MICHIGAN CELERY PROMOTION CO-O	A	
	ARBRE FARMS CORPORATION	A	MIDWAY DAIRY	A	
	HART DIVISION	A	MIEDEMA PRODUCE INC	A	
	MICHIGAN FREEZE PACK	A	NEIL JACOBSEN FARM	A	
	OCEANA COUNTY FREEZER STORAGE,	A	NEUBECKER FARMS	A	
	PETERSON FARMS MAIN CAMPUS	A	POLYPLY COMPOSITES LLC.	S	
<b>OGEMAW</b>	SANDVIK HARD MATERIALS	CO	QUINCY STREET, INC	A	
<b>OSCEOLA</b>	ADVANCED FIBERMOLDING	S	REQUEST FOODS	A	
	DEAN DAIRY HOLDINGS,LLC dba LIBERTY DAIRY COMPANY	A	RICHARD BROTHERS FARM	A	
	VENTRA EVART, LLC	F	RYDER HOLLAND LOGISTIC CTR	A	
	YOPLAIT REED CITY	A	SPECIALTY HEAT TREATING OF HOLLAND INC	A	
<b>OTSEGO</b>	GAYLORD	CH	SUPERIOR SALES INC	A	
<b>OTTAWA</b>	ALLENDALE PLANT	A	THE EDGE ICE ARENA	A	
	B & B FARMS	A	VERTELLUS HEALTH SPEC PRODUCTS	A, MA	
	BEUSCHEL FRUIT & DAIRY	A	VISSER DAIRY FARM	A	
	BOAR'S HEAD PROVISIONS CO INC	A	ZEELAND FACILITY	A	
	BODYCOTE-HOLLAND	A	ZEELAND FARM SERVICES, INC	A	
	COUNTY LINE DAIRY	A	<b>SAGINAW</b> AGRIMUM ADVANCED TECH (US)	A	
	CREME CURLS BAKERY, INC.	A	BRIDGEPORT WWTP	CH	
	CRISP HEART PRODUCE	A	BUENA VISTA WWTP	CH	
	CRISP HILL DAIRY FARM	A	DOW CORNING CORPORATION - HEALTHCARE IND MFG	A	
	DIETRICH ORCHARDS	A	FRANKENMUTH CITY OF WATER & WWTP	CH	
	FITZPATRICK FARM	A	FRUTCHEY BEAN CO	A	
	GEORGETOWN ICE CENTER	A	HI-TECH STEEL TREATING, INC.	A	
	GERRIT VANDENTOP FARM	A	NEXTEER AUTOMOTIVE	A	
	GREENLY STREET PLANT	A	SAGINAW CHARTER TWP RETENTION BASIN & WWTP	CH	
	GRUPPEN FARMS	A	SAGINAW STOKER DRIVE	CH	
	INTERSTATE WAREHOUSING LLC	A	THOMSON AEROSPACE & DEFENSE	A	
	J.B.SIMS GENERATING STATION	CH	WATER & WWTP, SAGINAW	CH	
	JOHN F. DONNELLY PLANT	A	WINFIELD SOLUTIONS LLC	A	
	JUANA'S PACKING CO., LLC-MAIN PLANT	A	<b>SANILAC</b> CROP PRODUCTION SERVICES - BROWN CITY, DECKERVILLE & SANDUSKY	A	
	KEN ZEINSTRAS FARMS	A	CROSWELL WATER PLANT	CH	



Table 15, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
<b>SANILAC</b>	DGP INCORPORATED	S	<b>TUSCOLA</b>	CARO WWTP	CH
<b>SHIAWASSEE</b>	AIRGAS SPECIALTY PRODUCTS - OWOSSO	A		CASS CITY WWTP	CH
	BANDKAU FARMS	A		COOPERATIVE ELEVATOR CO	A
	BENJAMIN, BEN FARM	A	<b>VAN BUREN</b>	ALBEMARLE CORP, SOUTH HAVEN	MA
	BRANT FARMS	A		ALLOY STEEL TREATING CO INC	A
	CRAMBELL FARM	A		CITY OF SOUTH HAVEN, WWTP	CH
	CUPID FARMS	A		COCA COLA REFRESHMENTS	A
	DEMERLY FARM	A		DECATUR	A
	DURLING FARMS, LLC	A		FRUIT BELT CANNING COMPANY INC	A
	FROOM FARMS LLC	A		GRAND JUNCTION FACILITY	A
	HARVEST MILLS	A		HARTFORD WAREHOUSE	A
	HULL FARMS	A		LAWRENCE FREEZER CORP.	A
	KONDEL FARMS	A		PAW PAW RIVER PRODUCE	A
	LUCHENBILL FARM	A		PAW-PAW PLANT	A
	MACHINE TOOL & GEAR, INC.	A		RYDER PAW PAW LOGISTIC CTR	A
	NORDER FARM	A		SHAFER LAKE FRUIT, INC	A
	OGINSKY FARM	A		SILL FARMS MARKET, INC	A
	PICNIK FARMS	A		ST. JULIAN WINE COMPANY INC	A
	SPEZIA FARMS	A		WELCH FOODS, INC.	A
	TAYLOR FARMS	A	<b>WASHTENAW</b>	ANN ARBOR	A, CH
	UNITED SUPPLIES INC	A		ANN ARBOR, CITY OF WPP	A
	V V FARMS	A		ANN ARBOR ICE CUBE	A
	VAN GILDER-MALONE FARM	A		ARCTIC GLACIER INC. YPSILANTI	A
	VANDERHOOF FARMS	A		CHELSEA MILLING CO	CH
	WAUSAUKEE COMPOSITES INC.	S		CROP PRODUCTION SERVICES	A
	WILLIAMS FARMS	A		DAPCO INDUSTRIES	A
	ZDUNIC FARM	A		ELECTRO ARC MFG. COMPANY	A
<b>ST CLAIR</b>	DUNN PAPER, INC.	CH		GAS RECOVERY SYSTEMS LLC	A
	LK HURON WATER TREATMENT	CH		PHOTO SYSTEMS, INC./BOTTCHER AMER	F
	MARSYVILLE ETHANOL	A		THETFORD CORPORATION	F
	MARYSVILLE, CITY OF WWTP	CH	<b>WAYNE</b>	3M DETROIT ABRASIVE	F
	PORT HURON	CH		A&R PACKING CO INC	A
	Z F MARYSVILLE AXLE DRIVES	A		ARCTIC COLD STORAGE	A
<b>ST JOSEPH</b>	ABBOTT NUTRITION - STURGIS	A		ARCTIC EDGE ICE ARENA	A
	AQUATIC CO.	S		ARTED CHROME PLATING INC	CH
	MENDON UNIT 635	A		BASF CORPORATION	A, M, MA, MMA, S
	MICHIGAN MILK PRODUCERS	A		BLD CANTON	A
	STURGIS WWTP	CH		BODYCOTE THERMAL PROCESSING	A
	THREE RIVERS WWTP	CH		BOTTLING GROUP LLC, PEPSI BOTT	A

Table 15, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
WAYNE	BRENN'TAG GREAT LAKES LLC	A	WAYNE	MCLANE FOOD SERVICE - PLYMOUTH	A
	C. F. BURGER CO	A		MELVINDALE CIVIC ARENA	A
	CANTON	A		MICHIGAN DAIRY	A
	CANTON RENEWABLES	A		NORTHEAST WATER PLANT	CH
	CARDINAL HEALTH	F		POLYCHEMIE INC	F
	CHRYSLER-JEFFERSON NORTH ASSY	E, F		POLYMER CONCRETE CORPORATION	S
	CITY SPORTS CENTER	A		PRAXAIR DISTRIBUTION INC	A
	CLASSIC PLATING	A		PVS NOLWOOD CHEMICALS, INC.	F
	COMPUWARE ARENA	A		PVS TECHNOLOGIES, INC.	CH
	COOPER HEAT TREATING LLC	A		S & F FOODS	A
	COUNTRY FRESH, LLC - LIVONIA	A		SANTEMP	A
	CREST INDUSTRIES INC	S		SHERWOOD FOOD DIST	A
	DAIRY FRESH FOODS INC	A		SOUTH HURON VALLEY WWTP	CH
	DBA ALDOA COMPANY	E		SOUTHWEST WATER PLANT	CH
	DEARBORN ICE SKATING CENTER	A		SPRINGWELLS WATER TREATMENT PLT	CH
	DETROIT PRODUCTION	A		SYSCO DETROIT, LLC	A
	DETROIT WWTP	CH		TRENTON CHANNEL POWER PLANT	A
	DIVERSITAK - DETROIT & HIGHLAND PARK	A		TRENTON, CITY OF WWTP	CH
	DRDC	M		UNISTRUT-WAYNE MANUFACTURING	A
	DYNAMIC SURFACE TECHNOLOGIES INTERNATIONAL	A		UNIVAR USA—ROMULUS	MA
	EDDIE EDGAR ARENA	A		WATER WORKS PARK PLANT	CH
	FARMER'S COLD STORAGE, LLC.	A		WOLVERINE PACKING COMPANY DIST PLT & LAMB & VEAL PLANT	A
	FAYGO BEVERAGES INC.	A		WOODWORTH INCORPORATED	A
	FREEZER & DRY STORAGE LLC	A		WYANDOTTE POWER PLANT	CH
	FREEZER SERVICES OF MI LLC	A		YACK ARENA	A
	FRITZ PRODUCTS	CH	WEXFORD	AAR MOBILITY SYSTEMS	F
	HOME CITY ICE COMPANY - DETROIT	A		CADILLAC	CH
	INLAND WATERS POLLUTION CONTROL, INC.	S		CADILLAC PLANT	S
	INTERSTATE CHEMICAL COMPANY, INC.	F		CRUISER DIVISION	S
	JCI JONES CHEMICALS INC.	CH		HARING TOWNSHIP WATER SUPPLY	CH
	KENNEDY RECREATION CENTER	A			
	LINCOLN DISTRIBUTING	S			
	MASTRONARDI PRODUCE	A			

<sup>a</sup>Source: Michigan Department of Environmental Quality (DEQ). Michigan Facilities' Guide to SARA Title III, Emergency Planning and Release Reporting, December 2007, 6th edition. The chemicals listed in this table are subject to reporting under the Emergency Planning and Community Right-to-Know Act (EPCRA) section 313, which is triggered by threshold amounts of 25,000 pounds manufactured or processed or 10,000 pounds otherwise used at facilities in Michigan. The companies listed in this table were current as of calendar year 2013 from a report generated by the Michigan DEQ on 4-23-15 and 5-14-15.

## Discussion

The consensus in the medical literature is that the true number of WRA cases is much greater than what is actually reported in public health surveillance systems, including Michigan's. The American Thoracic Society (ATS) released a consensus statement in 2003 that estimates in 15% of adults with asthma, the asthma is caused by work exposures.<sup>6</sup> In 2011, a second ATS consensus statement estimated 21.5% of adults with asthma have work-aggravated asthma.<sup>7</sup> The combined estimates from these consensus statements would indicate that 36.5% of all adult asthma is work-related.

For the years 2008-2010, 52.5% (95% CI 48.2-56.8%) of Michigan adults who were ever employed and currently have asthma reported that a health care provider told them or they told a health provider their asthma was caused or made worse by exposures at work.<sup>1</sup> Table 16 shows how this percentage varied by age, gender, race, annual income and education. Among those individuals who responded their asthma was caused or made worse by work, only 22% had a discussion about work's effect on their asthma with their health care provider.<sup>1</sup> At minimum, the data suggest that providers are not addressing concerns of their patients and probably missing the identification of WRA triggers.

National data showed that individuals with work-related asthma had higher mean numbers of days with asthma symptoms. Individuals with more days of symptoms were more likely to not be able to work or perform usual activities.<sup>8</sup>

On average, 137 new people each year have been reported to the Michigan Department of Licensing and Regulatory Affairs (LARA) with confirmed WRA. In recent years, the number of reports has decreased. Sixty-seven reports were confirmed in 2011, the most recent year with complete data. The number of individuals with exposure to a known occupational sensitizer (disease category OA) shows a downward trend since the 1990s. The reason for this trend is unknown and may be related to changes in reporting sources or to the success of workplaces in better controlling their employees' exposures to known sensitizers.

Based on responses from the 2005 BRFSS random

sample of Michigan residents, we estimate that up to 62,000 (95% CI 42,000—83,000) Michigan adults have their asthma caused or aggravated by work.<sup>1</sup> Based on the medical literature we would estimate that there are 97,500 Michigan adults with WRA.<sup>6</sup> Using capture-recapture analysis, we estimate 228—801 adults in Michigan develop WRA each year.<sup>9</sup>

Workers 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 WRA in African Americans is 1.4 times greater than among Caucasians. Based on an analysis conducted for previous annual reports, factors from the WRA surveillance data that would contribute to greater morbidity among African Americans include: a greater likelihood to continue to be exposed to the workplace agent, having a longer time of exposure before leaving work, and being less likely to receive Workers' Compensation.

As companies trim costs, especially in light of reduced production schedules, more temporary workers are being hired on an as-needed basis. The transient nature of temporary work underscores the potential for under-counting 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 workforce tend to develop their asthma from exposure to agents in the manufacturing sector, particularly automobiles, machinery, metals, chemicals, and rubber and plastics. The predominant causes of WRA are isocyanates (12.3%), cleaning products (11.8%) and metal working fluids (9.7%). Until recently, metal working fluids were the second most frequently reported exposure at work.

The trend of fewer individuals with the known causes of WRA such as diisocyanates, metal-working fluids and high molecular weight compounds would suggest improvements in controls when these agents are used since the number of facilities using isocyanates has increased. The lack of change in cases secondary to office and manufacturing exposures, and the increase in WRA secondary to cleaning agents suggests that exposures in these situations have proven more difficult to control (Figure 3).

We updated the table first presented in the 2002 Work-Related Asthma Annual Report (Table 14) on the number of manufacturing workers in companies that use isocyanates. In Luce, Midland and Saginaw counties, approximately 5% of the work force is employed in facilities where isocyanates are used. Health care providers can use this information to heighten their awareness of potential exposures to isocyanates among their patients with asthma.

Table 15 shows selected agents by county and company that have been associated with WRA. Health care providers can use this table as an initial step in evaluating possible exposure for their patients if they work at one of the facilities listed.

Asthma symptoms may persist despite removal from the precipitating work exposures (Table 9). Studies show that the sooner an individual is removed from the exposure after symptoms develop, the more likely the individual's symptoms will resolve.<sup>10</sup> On the average, among the 2,120 individuals who are no longer exposed to the causal agent, almost three years elapse from 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.

Data from the United Kingdom estimated that when medical care and lost time are factored in, the work-related asthma costs were 100 million dollars per year with 49% of the cost borne by the patient, 48% by the State and only 3% by the employer.<sup>11</sup> We do not have cost estimates for Michigan, but given the fact that only 49% of individuals applied for Workers' Compensation benefits and we do not have universal health insurance as in the United Kingdom, we suspect that the individual patients in Michigan bear a high percentage of the costs associated with work-related asthma.

TABLE 16

**Proportion of Asthma Attributable to Work Among Michigan Adults Who Were Ever Employed and Who Currently Have Asthma, Michigan Asthma Call Back Survey, 2008-2010 Combined**

AGE in years	Proportion, %	95% Confidence Interval
18-34	39.9	29.6-51.1
35-64	61.8	57.5-65.9
>=65	43.8	38.3-49.5
GENDER		
Male	54.7	46.3-62.8
Female	51.4	46.5-56.2
RACE		
White	50.5	45.7-55.2
Black	58.9	46.7-70.1
ANNUAL INCOME		
<\$20,000	60.6	51.1-69.3
\$20,000-\$34,999	60.3	50.6-69.1
\$35,000-\$49,999	51.4	41.2-61.5
\$50,000-\$74,999	54.7	42.2-66.7
>=\$75,000	44.8	37.8-52.0
EDUCATION		
< High School	62.6	46.7-76.3
High School Graduate	57.4	49.1-65.3
Some College	51.1	43.4-58.7
College Graduate	48.7	41.7-55.8



Personal habits like cigarette smoking and individual susceptibility measured through personal or family history of allergies do not predict who develops WRA. About 50% of the WRA patients identified through the Michigan Tracking System have no personal or family history of allergies and 80% are not smoking cigarettes at the time their asthma symptoms develop (Tables 6-8).

Although most facilities where the patient developed asthma were in compliance with exposure standards, there were high percentages of symptomatic co-workers identified in those facilities. It is possible that either air sampling was not conducted under similar enough conditions as the exposures associated with the development of the index cases' asthma, such as spills or leaks, or that the current standards are not protective enough.

We identified 1,583 fellow workers with symptoms compatible with WRA (Table 13). Five hundred eighty-three individuals were listed on the MIOSHA Injury and Illness Log (Form 300) as having WRA or symptoms compatible with WRA. There was only an overlap of 10 individuals of co-workers reporting symptoms on co-worker interviews and those being reported on the MIOSHA 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.

Medical monitoring is particularly relevant to reducing the burden of work-related causes of asthma. The longer a person with asthma remains exposed, the more likely their asthma will become a chronic problem.<sup>10</sup> A review of companies using isocyanates showed that only 32% were providing periodic medical surveillance.<sup>12</sup>

The percentages of individuals reported with work-related asthma that this surveillance system documented with breathing tests performed in relation to work was less than 10%. This reflects the standard of medical care in the United States where the diagnosis of WRA 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 work exposure.

Cessation of exposure is the most important aspect of treatment; patients who are removed from exposure the

soonest have the best prognosis.<sup>10</sup> Effective asthma treatment requires that the health care providers consider a patient's asthma triggers. Many times the health care provider reacts to concerns that their patient raises about workplace exposures, rather than proactively inquiring whether their patient has triggers at work that contribute to their respiratory symptoms. One of the factors related to a 2005 death caused by isocyanate exposure was that the primary care physician waited until the patient requested a medical restriction, rather than instructing the patient at an earlier time that he needed to be removed from any further exposure to isocyanates at work.

The report of a patient with known or suspected WRA 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 WRA 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 the current permissible exposure limits, document the need for the development of new standards, identify new occupational allergens, and prevent co-workers from developing disease.

The potential that 54% of Michigan adults with asthma report that work causes or aggravates their work-related asthma must be integrated into all asthma initiatives planned on surveillance and education, both for health care providers and the public.

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# APPENDIX

## 2013 PATIENT NARRATIVES BY TYPE OF INDUSTRY & EXPOSURE

Abbreviations:

- OA = Occupational Asthma with Exposure to a Known Sensitizer
- POA = Possible Occupational Asthma, Work-related Symptoms, but Exposure is not a Known Sensitizer
- AA = Aggravated Asthma (Pre-Existing Asthma Exacerbated at Work)
- RADS = Reactive Airways Dysfunction Syndrome

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

TABLE OF CONTENTS	Pages
Manufacturing	30-33
Educational Services	34
Health Care Services	34-35
Wholesale & Retail Services	35
Office	35-36
Agriculture	36
Miscellaneous Services & Industries	36-38
Military	38
Construction	38
Transportation	38



## MANUFACTURING

### EXPOSURE TO ISOCYANATES

**OA3401.** A male in his 40s developed asthma within the same year he became a mixer at a methylene diisocyanate formulating and packaging company. He developed wheezing, a cough, and shortness of breath. Four years later, he was treated in the Emergency Department for his symptoms. He was prescribed Qvar and Albuterol. He was given a respirator, and since that time, his symptoms subsided and he no longer required medication. On spirometry, his FVC was 98% of predicted, FEV<sub>1</sub> was 94% of predicted, and his FEV<sub>1</sub>/FVC was 96% of predicted. He was a half a pack a day cigarette smoker from his early twenties until he quit in his early forties.

**OA3344.** A female in her 40s developed asthma within the same year that she became an inspector/supervisor at a bus seat manufacturing company, her workplace of five years. She was exposed to MDI-containing glue. She experienced a cough and shortness of breath, and was prescribed Qvar, Albuterol, Prednisone, and Singulair. A few months later, she was reassigned to prevent further exposure. Her asthma improved and she required less medication. On spirometry, her FVC was 91% of predicted, FEV<sub>1</sub> was 83% of predicted, and her FEV<sub>1</sub>/FVC was 91% of predicted. She was a half a pack a day cigarette smoker since her early twenties.

**OA3514.** A man developed asthma in his 30s while working at a robotic cell manufacturer. His job was as an electrician/builder, and his duties involved making control panels. He was assigned to this job through a temporary employment agency. He was sprayed with isocyanates when a hose broke that contained isocyanates. After this exposure, his breathing problems began. He was off work for over a year, and when he returned to work, he experienced an asthma attack within 15 minutes of being at the plant. He was reassigned to an office job in a different building where there were no isocyanates used.

**OA3412.** A male in his 50s developed asthma after performing general labor at an automobile headliner manufacturing company for 12 years. He was exposed to methylene diisocyanate (MDI). He developed wheezing, a cough, shortness of breath, and chest tightness, all of which were worse at work. He was prescribed a nebulizer, a rescue inhaler, and Avocort. He continued to work at the company with ongoing exposure. His asthma worsened, but he required the same amount of asthma medication. He was a two pack a day cigarette smoker from his mid-teens until he quit in his early thirties.

**OA3449.** A male in his 50s developed asthma after five years of welding for a steel company. He was exposed to methylene diisocyanate (MDI), welding fume and paint fumes. He developed wheezing, a cough, and shortness of breath. He was prescribed Advair, Spiriva, and Ventolin. On spirometry, his FVC was 76% of predicted, FEV<sub>1</sub> was 32% of predicted, and his FEV<sub>1</sub>/FVC was 42% of predicted. He continued to work at this company for another four years and was hospitalized six times for breathing problems before he went on sick/

disability leave. His breathing problems improved and he required less asthma medication. On average, he smoked a pack of cigarettes a day since his mid-teens.

**OA3439.** A female in her 20s developed asthma after a few months of working at an automobile parts manufacturing company. She was exposed to polyurethane, fiberglass and dust. She developed wheezing, a cough, chest tightness, and shortness of breath. She was prescribed ProAir, Prednisone, and Medrol. She was treated in the Emergency Department three times and hospitalized once for breathing problems. After her hospitalization, she quit this job upon her doctor's advice. Her asthma symptoms improved and she required less asthma medication. She smoked about 2 cigarettes a day from her late teens, and quit in her mid-twenties.

## EXPOSURE TO METAL WORKING FLUIDS

**OA3334.** A male in his 60s developed asthma while working maintenance at an air conditioning product manufacturer. He started experiencing chest tightness, a cough, shortness of breath, and wheezing after working at the company for 25 years, when the company moved to a new location with poor ventilation. He was prescribed Albuterol and Advair. He continued to work at the company for 15 years, during which he continued to be exposed to smoke from the burning oil of the cutting machines. His asthma worsened during that time and he required more medication. On spirometry, his FVC was 106% of predicted, FEV<sub>1</sub> was 118% of predicted, and his FEV<sub>1</sub>/FVC was 112% of predicted. He was a lifetime non-smoker.

**OA3464.** A male in his 30s developed asthma after working as a machinist at an automobile parts manufacturer for almost 20 years, during which he was exposed to machine coolant. He developed a cough, chest tightness, and shortness of breath. He continued to work for this company for another 20 years. His symptoms worsened after he was switched from the midnight shift to the day shift, which had more production. He was reassigned to a job where he was no longer exposed to the coolant. On spirometry, his FVC was 90% of predicted, FEV<sub>1</sub> was 88% of predicted, and his FEV<sub>1</sub>/FVC was 98% of predicted. He was an ex-cigarette smoker.

**AA3510.** A male in his 30s experienced an exacerbation of his pre-existing asthma while working on an assembly line at an automobile parts manufacturing company. His duties included assembling parts and packaging, during which he was exposed to coolant fumes and oil from the machines. He had been in this position for almost five months when he developed wheezing, a cough, chest tightness, and shortness of breath. These symptoms led to him being treated in the ED twice and hospitalized four times. He was prescribed Qvar and continued using his previous Albuterol and ProAir prescriptions. About a year later, he quit upon his doctor's advice, but his breathing problems became worse and he required more medication. He was a lifetime non-smoker.

**OA3406.** A male in his 40s developed asthma after more than 10 years of working as a machinist for a metal automobile parts manufacturer. He developed a cough and shortness of breath. He was treated in the Emergency Department three times, and he was prescribed Turdoza and Ventolin. He continued to work for the company with ongoing exposure. His asthma symptoms and medication remained unchanged. On spirometry, his FVC was 81% of predicted, FEV<sub>1</sub> was 81% of predicted, and his FEV<sub>1</sub>/FVC was 104% of predicted. He smoked about 15 cigarettes a day since his early twenties except for a seven-year period when he quit smoking but then returned to smoking cigarettes.

## EXPOSURE TO CLEANING AGENTS

**POA3399.** A female in her 50s developed asthma after working on an assembly line at a car part manufacturer for about one year. She was exposed to a surfactant called Rosewater, a nonylphenol polyethylene glycol ether, while working close to the area where it was being sprayed. This exposure led to the development of wheezing, a cough, chest tightness, and shortness of breath. She was treated in the Emergency Department one time, and prescribed Albuterol. On spirometry, her FVC was 55% of predicted, FEV<sub>1</sub> was 53% of predicted, and her FEV<sub>1</sub>/FVC was 96% of predicted. She continued to work for the company with ongoing exposure. Her asthma was still present with symptoms and medication remained the same. She was a pack a day smoker from her late teens but quit in her mid-thirties.

**AA3356.** A female in her 40s experienced an exacerbation of her pre-existing asthma after working 25 years at a baby product manufacturer from an acute exposure to a flooring stripping solution. She developed wheezing, a cough, chest tightness, and shortness of breath. She was treated in the Emergency Department, and prescribed Prednisone in addition to her Albuterol inhaler and nebulizer solution. Her asthma improved and she required less medication. She was a lifetime non-smoker.

## EXPOSURE TO WELDING & SOLDERING FUME

**POA3351.** A male developed wheezing, shortness of breath, and chest tightness when he started working as a quality control technician at a circuit board manufacturing company in his 40s. He continued working in this position for 15 years before being diagnosed with asthma. His asthma symptoms were worse at work and got better when he was away from work on weekends and vacations. His asthma symptoms developed from exposure to soldering smoke and smoke from the plasma cutter. He was treated in the Emergency Department one time, and was prescribed Symbicort, Albuterol, Spiriva, and Tiotropium. He went on medical disability and his asthma symptoms improved. He was a four pack a day cigarette smoker from his mid-teens to his late 20s.

**POA3427.** A male in his 20s developed asthma after being exposed to smoke fume from welding while working as an operator at an automobile part stamping plant. After about three months at this company, he developed wheezing, a cough, chest tightness, and short-



ness of breath. He was seen in the Emergency Department two times, and was prescribed Proventil, Advair, ProAir, and an Albuterol nebulizer. On spirometry, his FVC was 76% of predicted, FEV<sub>1</sub> was 85% of predicted, and his FEV<sub>1</sub>/FVC was 114% of predicted. He was fired approximately four months after starting to work at the company. Since leaving the company, his asthma symptoms improved, but he continued to take the same amount of asthma medication. He was a five cigarette per day smoker from his early teens but quit in his mid-twenties.

**AA3422.** A female in her 50s experienced an exacerbation of her pre-existing asthma after 20 years of working for an automobile manufacturing company. She experienced wheezing and shortness of breath due to exposure to welding fume, and she was hospitalized. After this incident, she was no longer exposed to the welding fume, and her asthma symptoms improved. She continued to take Advair, Proventil, and Albuterol.

**POA3345.** A male in his 20s developed asthma about half a year after starting work at an automobile parts manufacturing company. He was a brazer/welder, which exposed him to brazing and welding fumes. He developed chest tightness and shortness of breath, and was prescribed ProAir. On spirometry, his FVC was 103% of predicted, FEV<sub>1</sub> was 103% of predicted, and his FEV<sub>1</sub>/FVC was 100% of predicted. A few months after the onset of his asthma symptoms, he quit upon his doctor's advice. His asthma symptoms lessened and he no longer required medication. He was a one cigarette a day smoker for one year in his late teens.

## EXPOSURE TO FLOUR

**OA3413.** A male in his 40s developed asthma about one year after starting to work at a bakery. His job as a machine operator included putting dough inside machines and sometimes mixing the dough for the production of doughnuts. He was exposed to flour and yeast. He developed wheezing, a cough, chest tightness, and shortness of breath. He was prescribed Albuterol, Advair, Dulera, and Montelukast. He was treated in the Emergency Department and hospitalized once for breathing problems. On spirometry, his FVC was 90% of predicted, FEV<sub>1</sub> was 88% of predicted, and his FEV<sub>1</sub>/FVC was 96% of predicted. Despite ongoing exposure, he continued to work for this company for another three years before he was reassigned. His asthma symptoms improved. He was a pack a day smoker since his late teens.

## EXPOSURE TO MISCELLANEOUS CHEMICALS AND DUSTS

**POA3430.** A female in her 30s developed asthma while working as a machine operator at an automobile plant. For this job, she was continuously exposed to various chemicals and fumes. She developed wheezing, chest tightness, and shortness of breath. She was prescribed Prednisone and Albuterol. She was treated in the Emergency Department six times and hospitalized once for breathing problems. About five years later, she decided to quit work because of her breathing problems. She was able to retire on disability, and her asthma symptoms improved. She was a three cigarette a day smoker since her mid-teens.

**AA3434.** A female in her 60s experienced an exacerbation of her pre-existing asthma within a month after being reassigned to the paint department at an automobile manufacturing plant, her workplace of over 30 years. She was exposed to paint primer particles in the air. She developed wheezing, a cough, chest tightness, and shortness of breath. She was prescribed Ventolin, Symbicort, and Albuterol to take in addition to her Advair and inhalers. A few months later, she was reassigned again, so that she was no longer exposed to the paint. Her asthma symptoms improved and she required less medication. She was a pack a week cigarette smoker from her mid-twenties until she quit in her early forties.

**OA3466.** A female in her 50s developed asthma after working as an assembler and tester at an airplane part manufacturing company for 10 years. She was exposed to epoxy and cyanoacrylate. She developed wheezing, a cough, and shortness of breath, and she was prescribed ProAir, Qvar, and Symbicort. On spirometry, her FVC was 103% of predicted, FEV<sub>1</sub> was 105% of predicted, and her FEV<sub>1</sub>/FVC was 101% of predicted. She was reassigned to a new job after her asthma was diagnosed, but her asthma symptoms persisted, although she required less medication. She was a lifetime non-smoker.

**AA3407.** A male in his 40s experienced an exacerbation of his pre-existing asthma while working as a supervisor at an automobile parts manufacturer. After a year at this job, he developed a cough and shortness of breath and was treated in the Emergency Department once. His breathing problems subsequently improved and he required less medication. He was a half a pack a day cigarette smoker from his late teens until he quit smoking in his early forties.

**RADS3490.** A male in his 40s developed RADS while working as a hydroblaster in a chemical plant. He started working for this company in his mid-twenties. After working at the plant for 15 years, he started working as the hydroblaster, during which he was exposed to sulfuric acid fumes twice while hydroblasting the top of the sulfuric acid tanks. He developed wheezing, a cough, chest tightness, and shortness of breath. He was treated in the Emergency Department once and was prescribed Albuterol. A few months after the development of his symptoms, he decided to quit work based on his lung problems. His asthma symptoms remained the same but he required less medication. He smoked about a quarter a pack of cigarettes a day since his late thirties.

**AA3320.** A male in his 50s experienced an aggravation of his pre-existing asthma after working at a foundry for 35 years. He was exposed to 1-methyl-2-pyrrolidinone, a metal cleaner, in his job as a precision sand technician, which he had been doing for about one year. His job included using an air wand to blow the metal cleaner off of the machines. He experienced a cough, chest tightness, and shortness

of breath and was prescribed Prednisone, Albuterol, and Qvar. Although he continued to work at the company with ongoing exposure, his asthma did improve and he required less asthma medication. He was a lifetime non-smoker.

**OA3458.** A male developed asthma in his 30s from exposure to ethylenediamine at his job as a master plater. He had worked at the plating plant for about 13 years before developing symptoms. He believes the symptoms occurred because of clogged and improper ventilation due to the company not following recommended cleaning timelines. He experienced wheezing, a cough, chest tightness, and shortness of breath, all of which were worse at work. He was treated at an Emergency Department three times, and prescribed Albuterol and steroids. He continued to work at the company with ongoing exposure. His asthma symptoms improved and he required less asthma medication, but continued to have breathlessness. He had smoked about a half a pack of cigarettes a day since his early teens.

**POA3496.** A female in her 50s developed asthma when given a new job as an inspector in the paint department of an automobile factory where she had worked for 11 years. She started experiencing shortness of breath and chest tightness, and was sent to the Emergency Department where she was prescribed Albuterol and Flovent. On spirometry, her FVC was 88% of predicted, FEV<sub>1</sub> was 93% of predicted, and her FEV<sub>1</sub>/FVC was 107% of predicted. Since then, she was reassigned. She was a current smoker.

**AA3374.** A male in his 30s experienced an exacerbation of his pre-existing asthma after a one time spill of titanium tetrachloride at a tool coating company. This spill was due to a loose bolt on the furnace and occurred approximately one year after he starting working as a furnace operator at the company. He immediately developed wheezing, a cough, chest tightness, and shortness of breath. He was treated in the Emergency Department and prescribed Albuterol. Although he took less medication and was no longer exposed to the titanium tetrachloride, his asthma symptoms worsened. He smoked 15 cigarettes a day since his mid-teens.

**RADS3460.** A male developed RADs in his 30s after exposure to cleaning agents, including Super Bright Aluminum cleaner. He also had a one-time exposure to concentrated sulfuric acid and hydrofluoric acid. This exposure occurred after he had been working at a pickle company for about a year and a half. He developed wheezing, chest tightness, and shortness of breath, for which he was treated in the ED and hospitalized one time. On spirometry, his FVC was 89% of predicted, FEV<sub>1</sub> was 86% of predicted, and his FEV<sub>1</sub>/FVC was 96% of predicted. He was prescribed Albuterol. He had since been out on Workers' Compensation. His asthma symptoms and asthma medication remained the same. He was a half a pack a day cigarette smoker from his teens but quit in his early thirties.

**POA3463.** A male in his 50s developed asthma due to exposure to a floor primer while working at a vehicle roof systems manufacturing plant. He developed wheezing, chest tightness, and shortness of breath and was prescribed Albuterol and Flovent. His breathing problems and asthma medication remained the same.

**POA3330.** A male assembly line leader at an automobile parts manufacturing company developed asthma in his 50s, four years after starting this job. He was exposed to a number of substances, including fiberglass, paper, glue, and a chemical catalyst for the molds. His job was to set up the assembly line, including computer entry to control the line. He developed wheezing, a cough, chest tightness, and shortness of breath, and was prescribed Combivent and Albuterol. On spirometry, his FVC was 121% of predicted, FEV<sub>1</sub> was 75% of predicted, and his FEV<sub>1</sub>/FVC was 63% of predicted. Even though he was reassigned, he was still exposed to the substance causing his asthma. His asthma worsened and he required more asthma medication. He smoked about a pack of cigarettes a day since his late teens.

**AA3410.** A female in her 40s experienced an exacerbation of her pre-existing asthma while working at a truck and bus assembly plant. She developed wheezing, a cough, shortness of breath, and chest tightness during the same month when she was moved to a new department, after working at the facility for 15 years. She was treated in the Emergency Department four times for breathing problems and was prescribed ProAir, a steroid, and a nebulizer. She retired after working for this company for over 35 years, her asthma symptoms improved and she required less asthma medication. She was a lifetime non-smoker.

**POA3471.** A female in her 20s developed asthma about a year after starting to work as an auditor at an automotive parts molding plant. She developed wheezing, a cough, chest tightness, and shortness of breath, and was prescribed Albuterol. She was treated in the Emergency Department one time for these symptoms. She decided to quit this job because of her lung problems. Since then, her asthma symptoms subsided and she no longer required asthma medication. She was a lifetime non-smoker.

**AA3367.** A male in his 20s experienced an exacerbation of his pre-existing asthma after an acute exposure to smoke, from some nearby transformers burning out. This occurred after five years of working for an automotive manufacturing company. He developed shortness of breath and was prescribed ProAir.

**AA3487.** A male in his 30s experienced an exacerbation of his pre-existing asthma after an acute exposure to sulfuric acid while working at a metal finishing company. Within 24 hours of exposure, he developed wheezing, a cough, shortness of breath and was hospitalized. He was prescribed Prednisone and Singulair in addition to Ventolin, which he had used for 20 years. He smoked half a pack of cigarettes per day since his mid-teens.

**AA3435.** A female in her 40s experienced an exacerbation of her pre-existing asthma after an acute exposure to smoke from something burning near her work area. She was working as an electrician for a steel company, which she had been doing for almost two years. She experienced a cough and shortness of breath. She was treated in the Emergency Department and hospitalized. On spirometry, her FVC was 114% of predicted, FEV<sub>1</sub> was 111% of predicted, and her FEV<sub>1</sub>/FVC was 85% of predicted. She went on sick/disability leave for a month, her symptoms improved and she no longer required asthma medication. She was a lifetime non-smoker.

## EDUCATIONAL SERVICES

### EXPOSURE TO INDOOR AIR CONTAMINANTS

**AA3363.** A female in her 30s experienced an aggravation of her pre-existing asthma while teaching kindergarten in a portable classroom. She had been teaching at this school for 17 years. She experienced chest tightness and shortness of breath, and was prescribed Symbicort and Xopenex. On spirometry, her FVC was 84% of predicted, FEV<sub>1</sub> was 78% of predicted, and her FEV<sub>1</sub>/FVC was 93% of predicted. She continued working at the school, with ongoing exposure. Her symptoms and medication remained the same. She smoked about five cigarettes a day for five years in her late teens.

**POA3441.** A female in her 40s developed asthma after working as a purchaser for the State of Michigan. She worked in this position for about 10 years before she developed wheezing, a cough, chest tightness, and shortness of breath. She was prescribed Albuterol, Advair, and Proair. She was treated in the Emergency Department and hospitalized one time for breathing issues. She retired with disability leave, but her asthma worsened and she required more asthma medication. She smoked a pack of cigarettes a day for 10 years, but quit in her late 20s.

### EXPOSURE TO ANIMAL DANDER

**OA3465.** A female in her 20s developed asthma while working as a lab animal technician at a university. Her duties included handling the animals and cleaning the cages. She was exposed to LAB/SAN 356 and 305 CPQ, which are cleaning agents that contain alkyl dimethyl benzyl ammonium chloride. After one year, she developed wheezing and shortness of breath, which got better when she was away on weekends and vacations. She was initially prescribed Symbicort, and later she was prescribed ProAir. On spirometry, her FVC was 123% of predicted, FEV<sub>1</sub> was 109% of predicted, and her FEV<sub>1</sub>/FVC was 88% of predicted. She continued working in the lab with ongoing exposure. Her asthma symptoms and asthma medication remained the same.

**AA3418.** A female in her 20s experienced an exacerbation of her pre-existing asthma when exposed to mice and rats while working as a graduate assistant in a university lab. She experienced wheezing, a cough, and chest tightness. On spirometry, her FVC was 142% of predicted, FEV<sub>1</sub> was 128% of predicted, and her FEV<sub>1</sub>/FVC was 92% of predicted. She continued to work with the lab animals. Her asthma symptoms and asthma medication remained the same. She was a lifetime non-smoker.

**OA3417.** A male in his 20s developed asthma a few years after working as a lab manager for a university. His job included handling rats and mice. He developed wheezing, a cough, and chest tightness, and was prescribed Singular. On spirometry, his FVC was 102% of predicted, FEV<sub>1</sub> was 91% of predicted, and his FEV<sub>1</sub>/FVC was 89% of predicted. He had IgE-specific antibodies to mice and rat blood. He continued to work in the lab. His asthma symptoms improved, but he continued to require the same amount of medication. He was a lifetime non-smoker.

## HEALTH CARE SERVICES

### EXPOSURE TO CLEANING PRODUCTS

**AA3329.** A female in her 40s experienced an aggravation of her pre-existing asthma while working as an X-ray technician for a healthcare system. Exposure to leaks or spills of Dispatch, a cleaning product containing bleach, exacerbated her asthma, causing wheezing, a cough, chest tightness, and shortness of breath. She was treated in the ER 12 times and hospitalized once for these symptoms. She was prescribed Xopenex and Pulmicort. She continued to work for the healthcare system, her asthma symptoms improved and she required less asthma medication. She was a lifetime non-smoker.

### EXPOSURE TO INDOOR AIR CONTAMINANTS

**AA3391.** A female in her 30s experienced an exacerbation of her pre-existing asthma after working at a medical equipment sales company for about 15 years. She developed chest tightness and shortness of breath after five years as a billing specialist, which she believed was due to bad carpet odor after a rainstorm. She was prescribed Albuterol and Advair. She was treated in the Emergency Department three times and hospitalized twice for breathing issues. She was no longer exposed to the substances causing her breathing problems since the company replaced the carpet with hardwood floors, but her asthma symptoms worsened and she required more asthma medication. She was a lifetime non-smoker.

**AA3373.** A female in her 30s experienced an exacerbation of her pre-existing asthma a few months after working as a customer service representative for an insurance company. She was chronically exposed to mold from rain damage while working in the office. She developed wheezing, a cough, chest tightness, and shortness of breath. She was treated in the Emergency Department twice, and was prescribed Albuterol, Prednisone, Advair, and Singular. She continued to work for this company, with ongoing exposure. Her asthma symptoms worsened and she required more medication. She was a lifetime non-smoker.

**AA3383.** A female in her 50s experienced an exacerbation of her pre-existing asthma while working as a receptionist at a doctor's office. She had an acute exposure to vinyl acetone paint fumes, six years after she began working for this company. She immediately developed

wheezing, a cough, chest tightness, and shortness of breath. After this exposure, her breathing problems and asthma medication remained the same. She was a lifetime non-smoker.

**AA3453.** A female in her 50s experienced an exacerbation of her pre-existing asthma after 20 years of working as a respiratory therapist in a hospital. She was exposed to wax stripping and floor cleaning chemicals during a short time period. Within 24 hours of exposure, she developed wheezing, chest tightness, and shortness of breath. On spirometry, her FVC was 81% of predicted, FEV<sub>1</sub> was 69% of predicted, and her FEV<sub>1</sub>/FVC was 85% of predicted. She was treated in the Emergency Department and hospitalized. She was prescribed Albuterol, Advair, Singulair, and Xolair injections. She was a lifetime non-smoker.

## EXPOSURE TO INDOOR AIR CONTAMINANTS AND MISCELLANEOUS CHEMICALS AND DUSTS

**POA3495.** A female in her 30s developed asthma after exposure to smoke as a result of a microwave fire. She worked as a billing and coding specialist for a health care system. She developed wheezing, a cough, chest tightness, and shortness of breath. She was treated in the Emergency Department twice and was prescribed Spiriva and Albuterol. Her asthma symptoms improved and she no longer required medication. She was a lifetime non-smoker.

**RADS3420.** A female developed RADS in her 50s from an acute exposure to epoxy paint fumes in her job as a registrar for a hospital. She developed wheezing, a cough, chest tightness, and shortness of breath, and was treated in the ED with a DuoNeb and an Albuterol nebulizer. Since then, she has been treated in the ED three times for breathing problems. Since this one-time acute exposure, her asthma symptoms improved. She continued to take the same amount of asthma medication. She was a lifetime non-smoker.

**OA3397.** A female in her 20s developed asthma two years after working as an RN in a hospital. She was exposed to powdered latex gloves. She developed wheezing, a cough, and shortness of breath, and was prescribed Albuterol, Prednisone, and Advair. On spirometry, her FVC was 96% of predicted, FEV<sub>1</sub> was 99% of predicted, and her FEV<sub>1</sub>/FVC was 103% of predicted. She continued to work for 12 years before deciding to quit due to her lung problems. During this time, she was treated in the Emergency Department nine times and hospitalized six times. Her asthma continued to worsen and she required more asthma medication. She smoked cigars in the past.

## WHOLESALE & RETAIL SERVICES

### EXPOSURE TO MISCELLANEOUS CHEMICALS AND DUSTS

**RADS3459.** After working for two years as a cashier at a retail store, a female developed RADS in her 30s while cleaning up an oil spill. She used a product called Spill Magic, which is an absorbent, to clean up the spilled oil. She developed wheezing and shortness of breath immediately following exposure, and was prescribed Albuterol, Nasonex, and Benadryl. After the initial spill and clean up, she developed reactions to dust, fragrances, and mold. Her asthma symptoms got worse throughout the work week and got better when she was away from work on weekends and vacations. She continued to work at this location with ongoing exposure. Her asthma symptoms improved and she required less asthma medication. She smoked about 1 cigarette a day for less than one year in her 20s.

**POA3450.** A male in his 50s developed asthma while working as a laborer in a thrift store. He was exposed to dust while stocking and scanning old books. He developed a cough and shortness of breath within the same year that he began this job and was treated in the Emergency Department. He was prescribed Prednisone and Albuterol. He previously smoked cigarettes.

**POA3396.** A female in her 40s developed asthma after being exposed to pesticides on tomato plants. She worked as an administrative assistant for a produce company. She graded and counted produce and processed produce pallets. She developed wheezing, a cough, chest tightness, and shortness of breath. She was prescribed Qvar and Albuterol. On spirometry, her FVC was 87% of predicted, FEV<sub>1</sub> was 92% of predicted, and her FEV<sub>1</sub>/FVC was 104% of predicted. She continued to work for the company, with ongoing exposure. Her asthma symptoms improved and she required less asthma medication. She was a lifetime non-smoker.

**AA3360.** A female in her 20s experienced an exacerbation of her pre-existing asthma while working in the customer service department of a retail store. She had an acute exposure to car battery acid a few months after starting this job while cleaning up a spill. Within 24 hours of exposure, she developed wheezing, a cough, chest tightness, and shortness of breath. She was hospitalized for this incident. Shortly after, she went on medical disability for her worsening asthma. She was a lifetime non-smoker.

**AA3437.** A female cashier working at a retail store experienced an exacerbation of her pre-existing asthma in her 50s. She experienced wheezing and shortness of breath and was started on medication. On spirometry, her FVC was 62% of predicted, FEV<sub>1</sub> was 66% of predicted, and her FEV<sub>1</sub>/FVC was 107% of predicted. Her breathing problems were still present and she still required asthma medication. She was a pack a day cigarette smoker since her late thirties.

## OFFICE

**POA3402.** A female in her 50s developed asthma within the same year that she started working as an Ad Account Executive for a cable and telephone company where she had been employed for almost 20 years. She developed wheezing and a cough while performing office work in a water-damaged area. She was prescribed Pulmicort. On spirometry, her FVC was 102% of predicted, FEV<sub>1</sub> was 91% of predict-

ed, and her FEV<sub>1</sub>/FVC was 89% of predicted. About a year and a half after the development of her symptoms, she was reassigned to work at home. However, her asthma symptoms and asthma medication remained the same. She was a three-cigarette-a-day smoker for four years in her teens.

**AA3387.** A female in her 30s experienced an exacerbation of her pre-existing asthma after eight years of working as an interpreter for a communication company. After an acute exposure to cinnamon brought in by a co-worker, she developed wheezing, chest tightness, and shortness of breath, and was treated in the ED. Since then, her asthma symptoms improved and she required less asthma medication. She was a lifetime non-smoker.

**AA3379.** A female in her 20s experienced an exacerbation of her pre-existing asthma upon an exposure to a fellow worker's perfume after working at a customer service call center for almost half a year. She experienced wheezing, a cough, chest tightness, and shortness of breath. Since then, the employees at her work were advised to limit the spraying of perfume in the closed office spaces. She went to the Emergency Department for breathing problems 20 times since starting at this company and was hospitalized four times. She continued to work at this location, and her asthma symptoms remained the same. She continued to take the same asthma medication: Albuterol, Singulair, and Prednisone. She was a lifetime non-smoker.

**POA3385.** A female developed asthma in her 40s while working in member services at a healthcare facility for over five years. She was exposed to mold, which was found in the ceiling of the office where she worked. She developed wheezing, a cough, chest tightness, and shortness of breath and was prescribed Advair. She continued to work for this company, with ongoing exposure. Her asthma symptoms and asthma medication remained the same. She was a lifetime non-smoker.

**AA3386.** A male in his 20s experienced an exacerbation of his pre-existing asthma while working as a customer service representative at a call center for a cable company. He was exposed to construction dust for almost a week before his employer placed him on sick leave. He developed wheezing, a cough, and shortness of breath. On spirometry, his FVC was 80% of predicted, FEV<sub>1</sub> was 76% of predicted, and his FEV<sub>1</sub>/FVC was 95% of predicted. The construction was completed and he was able to return to work. His asthma improved and he required less asthma medication. He was a lifetime non-smoker.

**POA3456.** A female receptionist in her 40s developed asthma within the same year she started working at a medical office. She developed wheezing, a cough, chest tightness, and shortness of breath. She was prescribed Albuterol, Prednisone, Singulair, Medrol, and Advair. On spirometry, her FVC was 71% of predicted, FEV<sub>1</sub> was 70% of predicted, and her FEV<sub>1</sub>/FVC was 97% of predicted. She was treated in the Emergency Department 20 times and hospitalized 10 times for breathing problems. At work, she moved to a new location, her asthma improved, but she required the same asthma medication. She was a lifetime non-smoker.

**AA3516.** A female in her late 20s with pre-existing asthma experienced an exacerbation of her asthma from exposure to a cleaning solution being sprayed in the office building where she worked. She experienced wheezing, chest tightness and shortness of breath, and was treated at a local hospital Emergency Department where she was given a bronchodilator and Decadron. She smoked a pack of cigarettes a day since her early 20s, but was actively trying to quit at the time of her ED visit.

## AGRICULTURE

### EXPOSURE TO CLEANING PRODUCTS

**POA3454.** A male in his 70s developed asthma while working at a dairy farm. After working maintenance at the farm for over 15 years, he was reassigned as a truck driver for delivering milk, where he was exposed to an acid sanitizer. During the year of his reassignment, he developed wheezing, a cough, chest tightness, and shortness of breath. He was treated in the Emergency Department three times and hospitalized once. He was prescribed Albuterol. On spirometry, his FVC was 109% of predicted, FEV<sub>1</sub> was 115% of predicted, and his FEV<sub>1</sub>/FVC was 100% of predicted. A few months later, he was reassigned to his original maintenance position. His asthma improved, but he required more asthma medication. He smoked a pack of cigarettes a day since his early twenties.

## MISCELLANEOUS SERVICES & INDUSTRIES

### EXPOSURE TO CIGARETTE SMOKE

**AA3444.** A female in her 60s experienced an exacerbation of her pre-existing asthma when working as a waitress at a casino. She was exposed to cigarette smoke. She developed wheezing, a cough, chest tightness, and shortness of breath, and was prescribed Albuterol, Prednisone, and Ventolin. She was seen in the Emergency Department and then hospitalized. She continued to work in the same job, and her asthma symptoms and medication remained the same. She smoked about 20 cigarettes a day in her late teens, but quit in her early 30s.

### EXPOSURE TO CLEANING PRODUCTS

**POA3370.** A female cashier and cook in her 30s developed asthma from exposure to a grill cleaner while cleaning the grill at a fast food restaurant. She experienced wheezing, a cough, chest tightness, and shortness of breath after working at this company for about 15 years. She was seen in the Emergency Department 12 times and hospitalized twice for breathing problems since starting at this job. She was

prescribed prednisone and an Albuterol nebulizer. Since being on sick leave, her asthma symptoms improved and she no longer required asthma medication. She was a lifetime non-smoker.

**AA3442.** A male in his late teens with asthma since childhood experienced an exacerbation of his asthma at his job as a janitor for a landscaping and contracting company. He was exposed to a mixture of cleaning agents when he was cleaning the bathrooms, which did not have any ventilation. He had worked at this job for five months before this exacerbation of his asthma occurred. He experienced wheezing, chest tightness and shortness of breath. He required two trips to the Emergency Department from exposure to the cleaning agents. On spirometry, his FVC was 89% of predicted, FEV<sub>1</sub> was 85% of predicted, and his FEV<sub>1</sub>/FVC was 94% of predicted. He was reassigned to a different job a couple of months later and since that time his asthma symptoms improved and he required less asthma medication. He was a lifetime non-smoker.

**AA3429.** A female in her 50s experienced an exacerbation of her pre-existing asthma after a one time exposure to chlorohydrate, an industrial-strength cleaner, while working as a recruiter at a utility company. She immediately developed wheezing, a cough, chest tightness, and shortness of breath, for which she was hospitalized. She was prescribed Prednisone and Albuterol. On spirometry, her FVC was 60% of predicted, FEV<sub>1</sub> was 66% of predicted, and her FEV<sub>1</sub>/FVC was 106% of predicted. She was let go around this time due to taking too much time off her for breathing issues. Since then, her breathing problems subsided and she was no longer taking asthma medication. She was a lifetime non-smoker.

**AA3445.** A male in his 20s experienced an exacerbation of his pre-existing asthma. He performed various side jobs for neighbors and friends. While using cleaning chemicals, he developed wheezing, shortness of breath, a cough, and chest tightness. His asthma symptoms and asthma medication remained the same since the cleaning agent exposure. He was a lifetime non-smoker.

**OA3500.** A female in her 20s developed asthma while working at a pet grooming company. She was exposed to bleach and another cleaning solution for about two weeks. She experienced wheezing, a cough, chest tightness, and shortness of breath. She was treated in the Emergency Department once and was prescribed Albuterol, Fluticasone, and Methylprednisolone. She smoked a half a pack of cigarettes a day.

**POA3446.** A male in his 30s developed asthma while working as a janitor for a cleaning service. He had only worked at this company for a few weeks before the daily exposure to cleaning chemicals caused wheezing, a cough, chest tightness, and shortness of breath. He was treated in the Emergency Department two times and was prescribed Albuterol. He continued to work at this company for three months, during which time his asthma symptoms continued to get worse. Finally, he quit because of his lung problems. His breathing problems and asthma medication remained the same. He was a pack a day smoker for five years from his late teens to his early twenties.

## EXPOSURE TO MISCELLANEOUS CHEMICALS AND DUSTS

**AA3440.** A male in his 50s experienced an exacerbation of his pre-existing asthma when exposed to Freon as a maintenance worker for a building maintenance and cleaning company. The exposure occurred while cleaning an air conditioning unit at a nursing home, during which the compressor ruptured and leaked Freon. He immediately experienced wheezing, a cough, chest tightness, and shortness of breath and was taken to the ED. He was prescribed Albuterol, which he was initially prescribed as a child. He continued to perform building maintenance, but no longer worked on air conditioning units. His asthma symptoms improved, but he continued to take asthma medication. He smoked about 15 cigarettes a day since his 40s.

**AA3519.** A male in his 50s with a history of asthma and seasonal allergies experienced an exacerbation of his asthma at work one day when he was exposed to fumes from burning plastic and oils in the machine room where the company's heating and air conditioning units were housed. He experienced wheezing, chest tightness and shortness of breath, and went to the local hospital emergency department for treatment. He continued to work for this company. He previously smoked a pack and a half of cigarettes a day from his mid-teens, but quit smoking in his mid-20s.

**AA3499.** A female hotel services worker experienced an exacerbation of her pre-existing childhood asthma at her job. The exposure which triggered her asthma was unknown.

**POA3498.** A female hair stylist in her 40s developed asthma after inhaling particles while mixing Schwarzkopf coloring bleach. She had done this job for almost 20 years, which consisted of cutting, styling, and coloring hair. She immediately experienced chest tightness and shortness of breath. She was seen in the Emergency Department one time for breathing problems and was prescribed Albuterol and a breathing treatment. She is no longer working as a hair stylist. Her asthma symptoms improved and she no longer required asthma medication. She was a lifetime non-smoker.

**RADS3395.** A male line cook at a restaurant developed RADS in his 20s after inhaling a large puff of smoke from a meat smoker. He developed wheezing, a cough, chest tightness, and shortness of breath. He was treated in the Emergency Department and hospitalized

once, where he was prescribed Albuterol. He continued to work for the restaurant for another three months before quitting. His breathing problems improved and he required less asthma medication. He was a two cigarette a day smoker for three years from his late teens to his early twenties.

## MILITARY

### EXPOSURE TO MISCELLANEOUS CHEMICALS AND DUSTS

**POA3369.** A male soldier developed asthma in his 20s while serving overseas in a desert location. He was caught in a desert storm and developed wheezing, a cough, chest tightness, and shortness of breath. He was prescribed Albuterol and DuoNeb. He was treated in the Emergency Department for breathing problems. Twenty years later, his breathing problems were still present and he still required asthma medication. He had smoked cigarettes in the past, but had not smoked for about five years.

**AA3537.** A male in his 50s experienced an exacerbation of his pre-existing asthma while working in the military. Co-worker fragrances triggered his asthma symptoms; his main symptoms were wheezing, cough and shortness of breath. On spirometry, his FVC was 78% of predicted, FEV<sub>1</sub> was 82% of predicted, and his FEV<sub>1</sub>/FVC was 106% of predicted. He was a lifetime non-smoker.

## CONSTRUCTION

### EXPOSURE TO HYDROFLUORIC ACID

**RADS3455.** A male in his 60s developed RADS after an acute exposure to hydrofluoric acid gas during his first month of working in construction as a boilermaker. He immediately developed wheezing, a cough, chest tightness, and shortness of breath. He was treated in the Emergency Department and hospitalized once. He was prescribed Albuterol. On spirometry, his FVC was 91% of predicted, FEV<sub>1</sub> was 65% of predicted, and his FEV<sub>1</sub>/FVC was 71% of predicted. He retired, but occasionally found work through a temporary employment agency. His asthma symptoms worsened and he continued to take asthma medication. He smoked a half a pack of cigarettes a day since his mid-teens.

## TRANSPORTATION

### EXPOSURE TO CLEANING PRODUCTS

**POA3298.** A female in her 20s developed asthma after a year of working for a trucking company, where she was exposed to cleaning agents and fragrances. She had just been promoted to office manager a couple of months before she developed shortness of breath. She was prescribed Symbicort and Ventolin. She was treated in the Emergency Department three times. On spirometry, her FVC was 90% of predicted, FEV<sub>1</sub> was 85% of predicted, and her FEV<sub>1</sub>/FVC was 94% of predicted. She went on sick leave, and since that time her asthma symptoms subsided and she required less asthma medication. She was a lifetime non-smoker.

### EXPOSURE TO BUS EXHAUST FUMES

**POA3400.** A male in his 40s developed asthma after exposure to bus exhaust fumes while working as an IT specialist for a transportation company. He experienced chest tightness and shortness of breath within the same year that he started this position. He was seen in the Emergency Department one time and was prescribed Qvar, Symbicort, and Ventolin. On spirometry, his FVC was 78% of predicted, FEV<sub>1</sub> was 87% of predicted, and his FEV<sub>1</sub>/FVC was 112% of predicted. He went on medical disability. His asthma symptoms and asthma medication use remained the same. He was a lifetime non-smoker.