Chapter 13
The Massachusetts Toxics Use Reduction Act: reducing the use of carcinogens

Rachel Massey and Molly Jacobs

1. Introduction

Efforts to regulate workers' exposure to carcinogens at the federal level in the U.S. have encountered many obstacles. The Occupational Safety and Health Act, adopted in 1970, had the potential to significantly improve working conditions in the US. The Occupational Safety and Health Administration (OSHA) made important progress in its first decade of existence, but over time, it has been weakened significantly, both as a result of reductions in funding, and as a result of Supreme Court decisions. For example, an OSHA initiative in 1989 to update Permissible Exposure Limits (PELs) for 212 chemicals and create new PELs for 164 chemicals was vacated by the U.S. Court in 1992. The vast majority of PELs in the U.S. are significantly out of date, as shown by scientific evidence.

In the context of very slow action at federal level to protect workers' health, some states in the US have taken the initiative to move forward independently. The Massachusetts Toxics Use Reduction Act (TURA), adopted in 1989, is one example. This chapter briefly explores what we can learn about preventing workplace exposures to carcinogens from data submitted under TURA over a twenty-year period.

2. The Massachusetts Toxics Use Reduction Act

TURA is designed to protect workers, communities, and the environment by encouraging businesses to reduce their use of toxic chemicals. It is designed to complement, not replace, other regulations governing the use and release of toxic chemicals.

Business sectors covered by TURA include manufacturing; electric, gas and sanitary services; chemical distribution; personal services (such as dry cleaning); and automotive repair, among others. Businesses in these sectors that use or manufacture large quantities of any one of more than 1,000 listed chemicals and have ten or more full-time employee equivalents are required to report their use of these chemicals and their byproducts each year; prepare a Toxics Use Reduction Plan every two years describing how they can reduce their use of toxics; and pay an annual fee. The fee is calculated based on number of employees (a rough proxy for company size) and the number of hazardous chemicals used. Under the current fee structure, the fees paid by individual businesses range from US $2,950 to US $31,450, and total revenue collected in fiscal year 2013 was US $2.9 million.

TURA defines a "large quantity" as 25,000 pounds (11.34 tons) per year if a firm manufactures or processes a substance, 10,000 pounds (4.54 tons) per year if a firm "otherwise uses" a substance, 1,000 pounds (0.454 tons) per year for substances designated as Higher Hazard Substances under TURA, or lower amounts (ranging from 0.1 gram to 100 pounds depending on the substance) for chemicals identified as persistent, bioaccumulative, and toxic (PBT) chemicals by the US Environmental Protection Agency (EPA).

The programme is implemented collaboratively by the Massachusetts Department of Environmental Protection (MassDEP), the Massachusetts Office of Technical Assistance and Technology (OTA) and the Massachusetts Toxics Use Reduction Institute (TURI). Together, the three agencies provide a range of services, including training, grants and technical assistance, to help companies reduce their use of toxic chemicals. Services are provided free of charge to any Massachusetts business (including those not subject to the TURA requirements and fees).

The implementing agencies work together with an Administrative Council, an Advisory Committee and a Science Advisory Board. The Administrative Council, which makes policy decisions on behalf of the programme, is composed of representatives of state agencies in the areas of environment, public health, public safety, economic development and labour. The Advisory Committee includes representation from a range of stakeholders, including representatives of organized labour.

These services, combined with mandatory reporting and planning, have produced important results. Over the first ten years of the programme, from 1990 to 2000, Massachusetts companies subject to TURA reduced toxic chemical use by 40% and on-site releases by 90%. Over the next ten years, from 2000 to 2010, they continued to make improvements, reducing toxic chemical use by 22% and on-site releases by 65%. These figures are production-adjusted, meaning that they represent true improvements in the efficiency with which companies use toxic chemicals per unit of product. Production-adjusted figures are calculated based on year-to-year changes in production volume, as reported by businesses, compared with changes in total chemical use.

3. Core principles of TURA

Toxics use reduction focuses on minimizing the use of toxic substances through process redesign and substitution with safer alternatives, rather than controlling emissions at the "end of the pipe". It serves as a form of primary prevention by reducing or eliminating carcinogens at their source, thus reducing the opportunity for exposure to industrial carcinogens in the workplace, in the environment, and in consumer products.

Core principles of TURA include the following:

— Focus on use. Many environmental statutes focus strictly on emissions or waste management. TURA, in contrast, focuses upstream on the manufacturing process where chemicals are used and wastes are first generated.

— Focus on hazard. Many environmental statutes rely on qualitative or quantitative risk assessments as a basis for deciding what measures are necessary to protect human health and the environment. By contrast, under TURA, the focus is on hazard. Hazard is an inherent characteristic of a chemical, such as carcinogenicity, neurotoxicity, or mutagenicity. The purpose of TURA is to reduce or eliminate the use of hazardous chemicals. There is no requirement to prove that exposure will occur, or to calculate risk, in order for a chemical to be subject to TURA requirements.

— Protection of workers, consumers and the environment. An industrial facility that has no emissions to the environment may still expose workers to toxic substances used within the facility, and may expose consumers to toxic substances incorporated into the product. The definition of toxics use reduction explicitly creates a mandate to consider the full range of impacts, including those on the environment, workers, and consumers.

— Avoiding risk shifting. The definition of Toxics Use Reduction in the law incorporates the concept of avoiding risk shifting among environmental media or among groups of people.

— Avoiding regrettable substitutions. TURA requires businesses to analyze the environmental health and safety profiles of any alternatives they consider. This requirement helps to guard against regrettable substitutions, in which a business replaces a chemical or material of concern with one of equal or greater hazard. The TURA programme agencies also work to support this goal by conducting alternatives assessments for individual chemical uses, helping to guard against adoption of chemicals whose hazards are poorly understood.

4. Using the TURA data to examine trends in carcinogen use

Because of the annual reporting requirements under TURA, Massachusetts has a valuable data set showing trends in chemical use since 1990. In a recent study, we analyzed this data to learn about trends in the use of carcinogens. (For more detailed information on the trends described below, see Jacobs *et al.* 2014.)

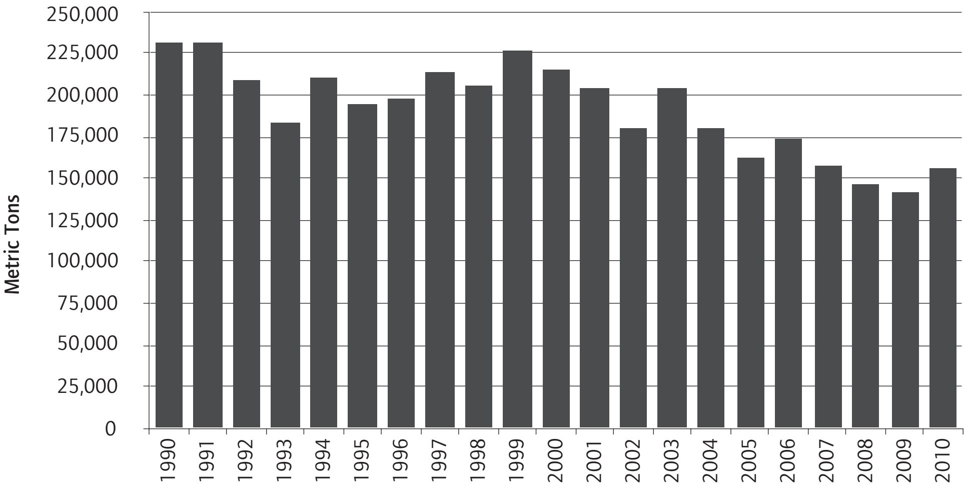
We identified 74 industrial carcinogens that have been reported under TURA at some point between 1990 and 2010. We analyzed trends for this group of 74 chemicals, as well as for subsets of this group. We also divided the group of 74 chemicals into smaller groups of chemicals linked to individual cancer sites or types, and examined each of those groups individually.

There are some limitations in using the TURA data. Because the law excludes some industry sectors, the TURA programme does not capture chemical use and environmental release data from all businesses that use, manufacture or release chemicals. The TURA data also does not reflect emissions from consumer products. Another limitation is that some facilities subject to TURA requirements have been granted trade-secret exemptions, rendering their data inaccessible. There are also many important categories of industrial carcinogens that are not captured by the TURA data. These include ionizing radiation, exposures to complex chemical mixtures in workplaces, and exposures in agriculture and via consumer products.

4.1 Overall use and release trends of carcinogens

The data show that from 1990 to 2010, businesses reporting to the TURA programme documented significant reductions in their use and releases of known and suspected carcinogens. While total use fluctuated over the years, overall there was a 32% decline, from 231,078 metric tons in 1990 to 165,802 metric tons in 2010 (Figure 1). The chemical used in the largest quantity was styrene monomer, accounting for 76% of the known and suspected carcinogen total use from 1990 to 2010. Excluding styrene, even greater declines occurred: a 53% reduction, from 51,664 metric tons in 1990, to 24,267 metric tons in 2010.

Figure 1 **Total use of known and suspected carcinogens, Massachusetts TURA Program, 1990-2010**

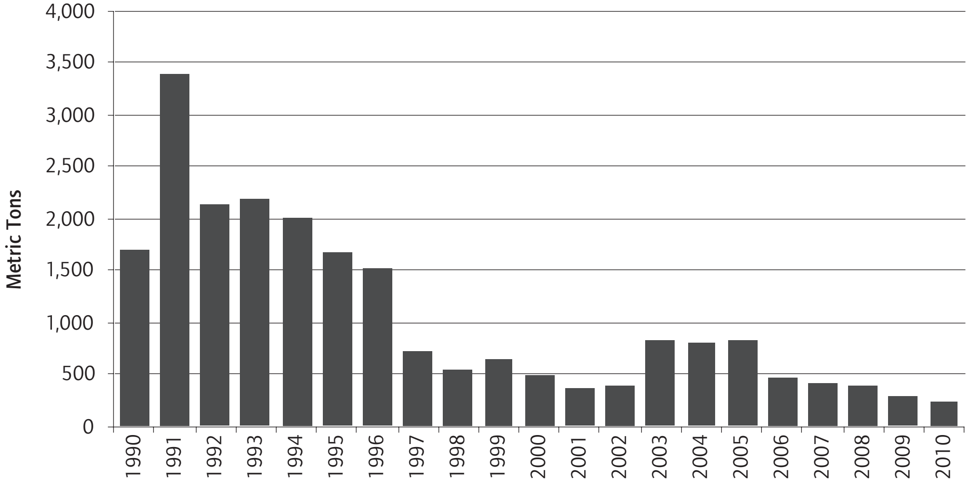


Note: Based on publicly available data. Data claimed trade secret are not included in these figures.

Reporting by electric utilities was phased into the TURA programme in 1991; reductions in emissions are measured beginning that year. Total reported releases have declined substantially since 1991. From 1991 to 2010, releases declined by 93%, from 3,402 metric tons to 249 metric tons, respectively (Figure 2).

While the declines in reported use and release of known and suspected carcinogens by facilities reporting to TURA are promising, large amounts of carcinogens continue to be used and released. In 2010, over 136,000 metric tons of known and suspected carcinogens were used and over 225 metric tons were released to the environment, highlighting the need for on-going efforts to reduce carcinogen use and releases.

Figure 2 **Total environmental releases of known and suspected carcinogens Massachusetts TURA Program, 1990-2010**



Note: Based on publicly available data. Data claimed trade secret are not included in these figures.

4.2 Trends in carcinogens associated with specific cancer sites

We also examined trends for smaller groups of chemicals associated with eleven individual cancer sites, including cancers of the bladder, brain and other central nervous system (CNS), breast, kidney, liver, lung, pancreas, prostate and testis as well as leukemia and non-Hodgkin's lymphoma.

As shown in Table 1 (p. 128), we found that use had decreased for all eleven groups of carcinogens. Releases to the environment have declined for all except the group of chemicals associated with bladder cancer. Because the volume of styrene used far exceeds all other chemicals in Massachusetts, styrene trends can mask those of other chemicals. When we exclude styrene, the declines are greater for a number of categories.

Table 1 **Use and environmental releases of carcinogens associated with specific cancer types, percent change, 1990-2010**

Type of Carcinogen	Use % Change, 1990-2010	Environmental Releases % Change, 1990-2010
Bladder	-49%*	+18%**
Brain/CNS	-51%	-78%**
Breast/Mammary Gland	-26% (-21%***)	-97%
Kidney	-62%	-86%**
Leukemia	-28% (-59% ***)	-86%**
Liver	-58%	-97%
Lung	-31%* (-51%***)	-77%**
Non-Hodgkin's Lymphoma	-28%* (-58%***)	-86%**
Pancreas	-28% (-53%***)	-97%
Prostate	-65%*	-97%
Testis	-88%	-96%

* Overall programme progress is affected by changes in reporting for polycyclic aromatic compounds.
** Trend is influenced by changes in TURA reporting requirements that eliminated the exemption for reporting combustion-related emissions by Waste to Energy (WtE) incinerators.
*** Percent change over the same time period if styrene monomer is excluded from the data.

Note: This table was originally printed in Jacobs *et al.* (2014).

5. Toxics use reduction and cancer prevention: ways forward

Facilities reporting under TURA have achieved significant reductions in their use and releases of carcinogens. These reductions illustrate the benefits of toxics use reduction. When companies are required to examine their use of a toxic chemical, many find ways to use it more efficiently, while many others find options for replacing it with a safer substitute chemical or process.

The Massachusetts Office of Technical Assistance and Technology and the Massachusetts Toxics Use Reduction Institute have documented how these results were achieved in a number of toxics use reduction case studies. Table 2 provides examples of these experiences for 6 known or suspected carcinogens.

While these declines in use and releases of known and suspected carcinogens by facilities reporting to TURA are promising, current quantities being used and released into the environment are still sizable. Key carcinogens that have been used in large quantities over time and still continue to be used in large quantities include styrene monomer, lead and lead compounds, methylene chloride, formaldehyde, and trichloroethylene. The quantities used and released raise continued concern for public and occupational health and indicate a continued need for TUR activities.

Table 2 **Carcinogen reduction examples: company case studies**

Carcinogen	Toxics use reduction examples
Chloroform	• Chemgenes Corporation, a biotechnology company with 25 employees, supplies building blocks for DNA and RNA manufacturing. • From 2005 to 2012, ChemGenes reduced its use of chloroform by 55% and hexane by 35%, resulting in a net savings of US $215,000. In 2012, the TURA programme provided a grant to help ChemGenes purchase a new solvent recovery and recycling system, which will allow additional reductions in solvent use. Factoring in the grant, ChemGenes estimates a return on investment in less than two years.
Hexavalent chromium	• Independent Plating is a metal finishing company. • In 2012, Independent Plating installed a trivalent chromium plating line as a substitute for some of its hexavalent chromium processes.
Lead (& cadmium)	• AlphaGary Corporation (now owned by Mexichem) manufactures plastic compounds for end uses including wire and cable, automotive, consumer goods, packaging and other applications. • Beginning in 1998, AlphaGary began work to reduce use of lead in its products. By 2004, the company achieved a 30% reduction in the use of lead and lead compounds, as well as reducing other toxic materials such as cadmium compounds and other heavy metals.
Methylene chloride	• Crest Foam manufactures flexible polyurethane foam for furniture, cushioning applications for the home, packaging and medical applications. • Crest Foam eliminated the use of 86 metric tons/year of methylene chloride by installing an innovative foam manufacturing process that uses CO2 instead of methylene chloride or CFC-11 as the auxiliary blowing agent. • Four Massachusetts facilities were featured in a study of methylene chloride substitution. Three of the facilities (a rubber products company, an electrical equipment manufacturer, and a vessel cleaning company) eliminated methylene chloride, while the fourth (a metal finisher) dramatically reduced its use of methylene chloride.
Perchloroethylene	• A series of case studies of 8 Massachusetts dry cleaners show how they were able to switch from perchloroethylene to 100% wet cleaning while saving money and reducing their use of energy and water. All the cleaners are small family businesses. • Among other examples, KMK Cleaners achieved a 40% reduction in energy costs and more than a 50% reduction in water use, and saved approximately US $1500 per month in operating costs. Silver Hanger Cleaners reduced electricity use by 20% and natural gas use by 14%, while saving more than US $2,700 in the first year.
Trichloroethylene	• V.H. Blackinton is a manufacturer of metal uniform insignia such as badges and metals, as well as jewelry. • The facility made substantial investments to modernize its plating and finishing operations, leading to significant reductions in water use and in the use of acids and bases in waste treatment and plating operations. The facility eliminated the use of a number of toxic chemicals, including trichloroethylene. • Lightolier is a manufacturer of aluminum reflectors for lighting products with over 400 employees. • The facility eliminated the use of approximately 566 metric tons of trichloroethylene. Through process modification and adoption of safer substitutes, the facility eliminated more than 1,814 metric tons of air emissions, with savings of more than US $2 million.

Note: All the businesses described in this table received assistance from the Massachusetts Office of Technical Assistance and Technology and/or from the Massachusetts Toxics Use Reduction Institute, and the information presented here is drawn from case studies by the two agencies. These case studies are available at: http://www.turi.org/TURI_Publications/Case_Studies

This table was originally printed in Jacobs *et al.* (2014).

5.1 Opportunities for further reductions

The dramatic reductions in carcinogen use and releases over the past twenty years document the feasibility of toxics use reduction as a cancer prevention strategy. There continue to be many opportunities for further reductions in carcinogen use; examples include the following.

Large quantities of formaldehyde continue to be used in the manufacture of adhesives and resins for use in a variety of applications, including the production of chipboard, decorative paper for use in architectural applications, and others. Opportunities for continued reductions in the use of formaldehyde include investment in the development, testing and marketing of safer adhesives and resins based on safer materials.

Hexavalent chromium is another chemical for which important toxics use reduction opportunities exist. Hexavalent chromium is used for corrosion resistance, but can be replaced by safer alternatives in many cases. Some businesses report being reluctant to adopt alternatives primarily due to color consistency. There is an on-going need for collaboration between manufacturers and customers to test and adopt safer alternatives. Research and development is under way to investigate safer alternatives, including trivalent chromium, for a variety of specific applications.

Other notable examples of future TUR/cancer prevention opportunities include reducing the use of methylene chloride and perchloroethylene. Paint strippers containing methylene chloride are banned for consumer use and severely restricted for professional or industrial use in the European Union, but continue to be used in the US.

Perchloroethylene, used widely for garment cleaning, can be replaced entirely with professional wet cleaning, while saving money, energy and water. The TURA programme has provided technical and financial support to many small businesses to help them eliminate this carcinogen from their workplaces. There are minimal technical barriers to shifting to safer alternatives for garment cleaning. There is, however, a significant need for education and financial assistance to enable small businesses to make the transition successfully.

Finally, it should be noted that other regulatory approaches have also been important drivers of changes observed in the TURA data. Examples include OSHA's adoption of regulatory standards for occupational exposure to methylene chloride in 1997, and the US EPA's adoption of Maximum Achievable Control Technology (MACT) standards for halogenated solvents in 1994, as well as subsequent updates (24) (25). More recently, regulations adopted in Europe, such as the Restriction of Hazardous Substances for electronic products, have helped to drive change within Massachusetts (26). There are many opportunities to motivate and facilitate additional TUR in the United States through adoption of complementary regulations at the federal or state level.

Conclusion

Toxics use reduction, which prevents carcinogenic exposures at their source, is a powerful tool for cancer prevention. The large reductions in use and releases of known and suspected carcinogens by facilities reporting to the TURA programme illustrate the impact of toxics use reduction. The experience of this programme has shown that when companies are required to examine their use of a chemical, many find ways to use it more efficiently, others find options to adopt safer substitutes, and others change their manufacturing process altogether to eliminate the need for the chemical. Continued work to minimize the use of carcinogens in manufacturing and services can help to reduce the global burden of cancer.

Acknowledgments

This chapter draws on work previously published, including Jacobs *et al.* (2013) and Jacobs *et al.* (2014). The authors gratefully acknowledge Heather Tenney and Elizabeth Harriman, whose research and guidance were central to the work featured in this chapter.

References and suggestions for additional reading

Clapp R.W., Jacobs M.M. and Loechler E.L. (2008) Environmental and occupational causes of cancer: new evidence 2005-2007, Reviews on Environmental Health, 23 (1),1-37.

Jacobs M.M., Massey R.I. and Clapp R.W. (2013) The burden of cancer from organic chemicals, in Carpenter D.O. (ed.) Effects of persistent and bioactive organic pollutants on human health, Hoboken, NJ, John Wiley & Sons.

Jacobs M.M., Massey R.I., Tenney H. and Harriman E. (2013) Opportunities for cancer prevention: trends in the use and release of carcinogens in Massachusetts, Methods and Policy Report 29, Lowell, MA, Toxics Use Reduction Institute.

Jacobs M.M., Massey R.I., Tenney H. and Harriman E. (2014) Reducing the use of carcinogens: the Massachusetts experience, Reviews on Environmental Health, 29 (4), 319-340.

Kriebel D., Jacobs M.M., Markkanen P. and Tickner J. (2011) Lessons learned: solutions for workplace safety and health, Lowell, MA, Lowell Center for Sustainable Production. http://www.sustainableproduction.org/downloads/LessonsLearned-FullReport.pdf

Massachusetts Department of Environmental Protection (2012) 2010 Toxics use reduction information release. http://www.mass.gov/eea/docs/dep/toxics/priorities/10relfin.pdf

Massey R.I. (2011) Program assessment at the 20 year mark: experiences of Massachusetts companies and communities with the Toxics Use Reduction Act (TURA) program, Journal of Cleaner Production, 19 (5), 505-516.

Reuben S.H. (2010) Reducing environmental cancer risk: what we can do now, President's Cancer Panel, 2008-2009 Annual report. http://deainfo.nci.nih.gov/advisory/pcp/annualReports/pcp08-09rpt/PCP_Report_08-09_508.pdf

Toxics Use Reduction Institute (TURI) website: www.turi.org

All links were checked on 24.07.2018.