Resource for Greening Commercial and Industrial Machinery and Equipment Repair and Maintenance
Pollution Prevention Information

Version 1.0
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Greening of Commercial and Industrial Machinery and Equipment Repair and Maintenance

Toronto's ChemTRAC program includes an Environmental Reporting and Disclosure Bylaw (Municipal Code Chapter 423) that requires local businesses to track and report their use and release of 25 priority substances. The ChemTRAC program provides an opportunity for you to identify strategies for improving your environmental performance. Strategies include those that reduce the use and release of the 25 priority substances. Strategies may also reduce the use and release of other chemicals that may have a health and/or an environmental impact. This Greening Resource for Commercial and Industrial Machinery and Equipment Repair and Maintenance will help you understand the chemicals that you are using and find ways to reduce or eliminate their use. For additional resources, including a Guide to Reporting visit http://www.toronto.ca/chemtrac/.

Machinery and Equipment Repair and Maintenance

This business sector repairs and maintains commercial and industrial machinery and equipment. These businesses sharpen/install commercial and industrial machinery blades and saws, provide welding repair services, or repair agricultural and other heavy and industrial machinery and equipment (e.g. forklifts and similar equipment, machine tools, commercial refrigeration equipment, construction equipment and mining machinery). This sector does not include automotive and electronics maintenance and repair.

Priority Substances and Other Chemicals of Concern

Toronto Public Health has identified 25 substances of priority health concern that are commonly used and released by businesses in the City of Toronto. As part of ChemTRAC, the Environmental Reporting and Disclosure Bylaw requires businesses and facilities to track and report on any of the listed priority substances that a facility manufactures, uses or releases to the environment if the amounts are equal to or above the reporting limits. In addition to the priority substances, industrial processes commonly use and release other chemicals of concern that may have a health and/or an environmental impact that are not subject to the by-law.

The Commercial and Industrial Machinery and Equipment Repair and Maintenance sector may use and produce some of these priority substances and other chemicals of concern. Each of these chemicals may have an impact on human health and/or the environment. Below are the substances that may be used or produced by your facility and its operation. This is not an exhaustive list.

Substances that may be used or produced by your repair and maintenance facility and its general operations

Chemical Sources	Priority Substances Tracked by ChemTRAC	Other Chemicals of Concern*
Shop towels may contain:	• Heavy metals: - Chromium - Lead - Cadmium - Nickel - Mercury • Volatile Organic Compounds (VOCs[1]) (from towels/wipes soaked in solvent, oils and lubricants) • Solvents • Benzene	
Cleaning substances may contain:	• Solvents, such as mineral spirits • Tetrachloroethylene (Perchloroethylene or PERC) • VOCs: xylene, toluene, turpentine • Benzene	
Grease removal substances may contain:	• Heavy Metals: - Cadmium - Chromium • VOCs: xylene, toluene • Tetrachloroethylene (Perchloroethylene or PERC) • Benzene	
Refrigerants may contain:	• VOCs • Carbon Tetrachloride • Trichloroethylene • Trichloromethane • Dichloromethane	• Chlorofluorocarbons (CFCs)[2]
Paint may contain:	• Lead • VOCs	• Arsenic
Paint and rust removal substances may contain:	• Heavy metals: - Cadmium - Chromium - Lead • VOCs: xylene, toluene • Tetrachloroethylene • Benzene	• Arsenic
Welding and Soldering may use and release:	• Heavy Metals: - Chromium (hexavalent) - Lead - Manganese - Nickel • Particulate Matter (PM2.5)[3] • Nitrous oxides (NOx)	

Notes:

* Chemicals that may have a health and/or an environmental impact.

1. VOCs are emitted as gases from certain solids or liquids. Smog forms when VOCs are combined with nitrous oxides (NOx) in sunlight.
2. Chlorofluorocarbons (CFCs) are a banned substance under the Montreal Protocol; however, they may still be found in older refrigeration units.
3. Particulate matter (PM) consists of airborne particles in solid or liquid form (e.g., dust). $PM_{2.5}$ is airborne particulate matter with a mass median diameter less than 2.5 micrometres.

Understanding Your Company's Impacts: Commercial and Industrial Equipment Repair and Maintenance

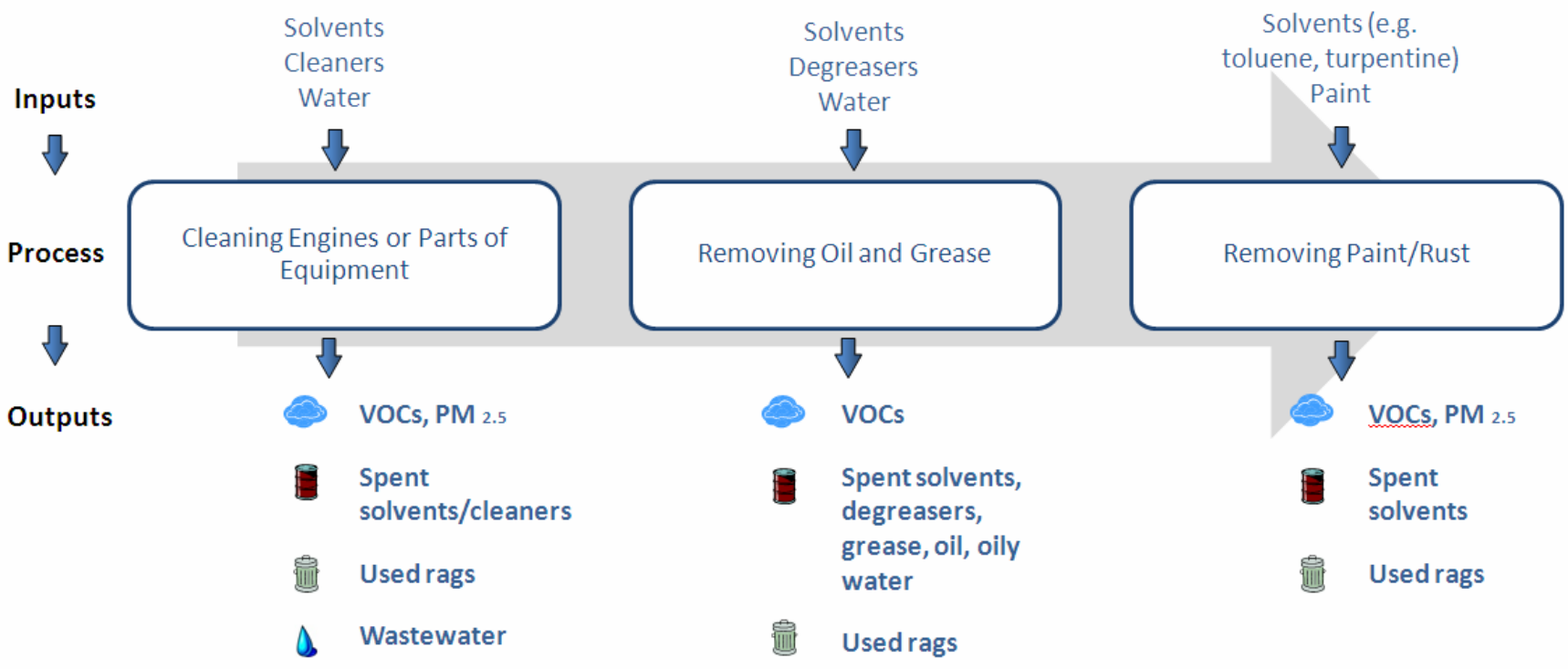
In commercial and industrial equipment repair and maintenance, there are several activities or processes that may contribute to the use and release of priority substances and other chemicals of concern. The use and release of chemicals depends on the type of process, as well as the equipment and chemicals that are used.

Waste oil and spent solvent account for the majority of chemicals used and released by this sector. There are also seasonal considerations accounting for different waste and chemical generation (i.e., cooling system repair and the associated refrigerants). Chemicals are frequently stored on site prior to being recycled. Managers may be unaware of how to dispose of obsolete chemicals, resulting in crowded storage facilities or inappropriate disposal.

The processes involved in equipment repair and maintenance vary from facility to facility. However, there are several operations that are common to most facilities. During maintenance, spent oil and grease are removed from engines. Items for repair may be cleaned with various solvents and stripped of paint and/or rust through sanding, sandblasting, milling and the use of burn ovens or liquid paint removal techniques. During the repair stage, cutting, drilling, grinding, milling and machining take place in order to fabricate or refurbish equipment parts. In the repair of cooling systems, coolants may be added to recharge the system. Broken parts may be repaired through welding and soldering.

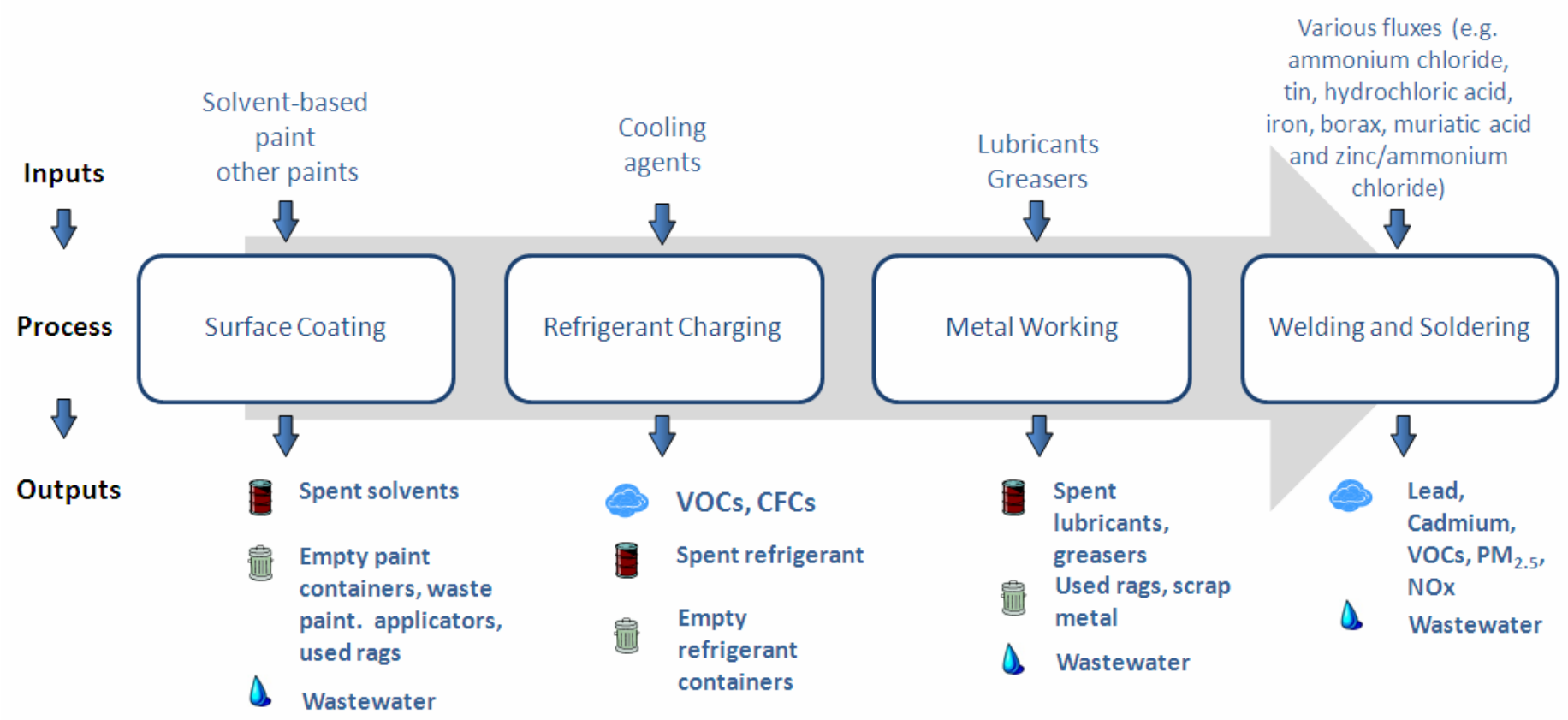
The following diagrams show the raw materials that may go into each process and the pollution that comes out of each process. This guide outlines the general processes for commercial and industrial equipment repair and maintenance. Your facility may have more specialized processes or only engage in some of these processes; however, it is possible that these priority substances and chemicals of concern may still be present. Symbols show whether the wastes typically go to air, landfill, sewer systems and/or treatment facilities (as liquid or hazardous wastes).

Figure 1: Preparation and Cleaning Processes



Symbols used in the flow diagram

Figure 2: Active Maintenance and Repair Processes



Symbols used in the flow diagram

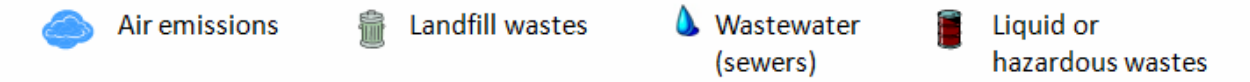
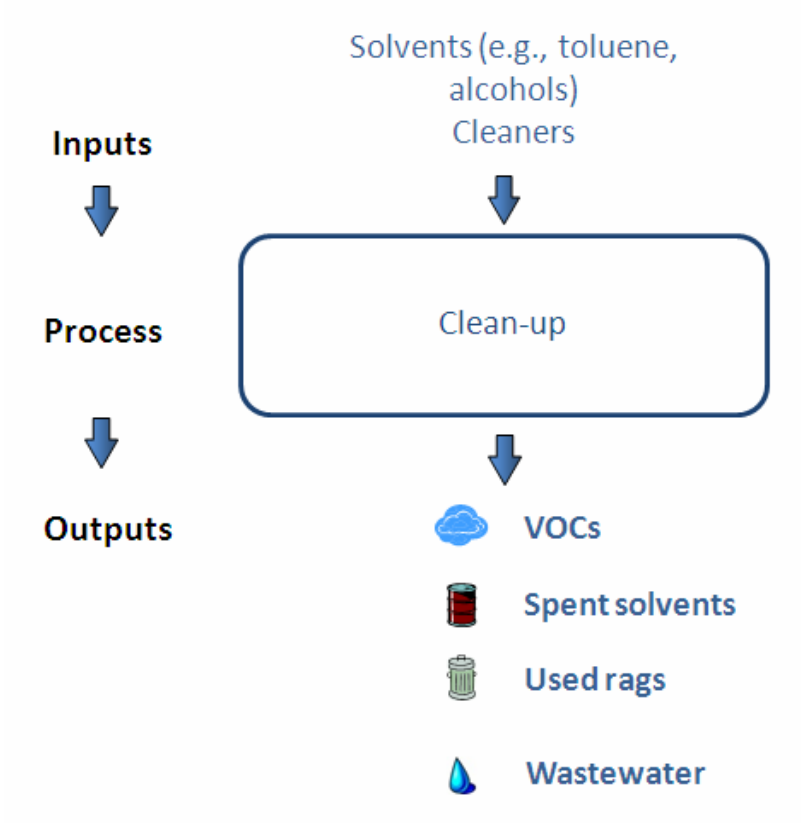
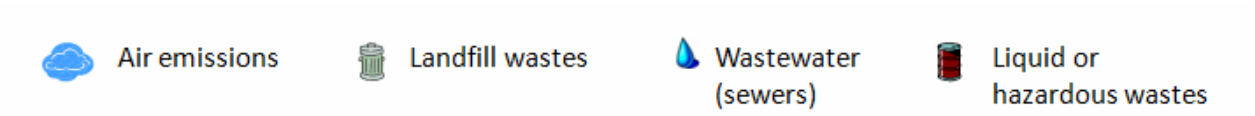


Figure 3: Clean-up



Symbols used in the flow diagram



Pollution Prevention Steps You Can Take

This resource identifies steps you can take to reduce or eliminate your use of the priority substances and other chemicals that may have a health and/or an environmental impact and to prevent pollution in the Commercial and Industry Machinery and Equipment Repair and Maintenance sector.

The pollution prevention measures identified in this information sheet can reduce costs and/or increase profits. 

Pollution Prevention Assessments – A Good First Step

Before you go too far with any given measure, you may want to do a Pollution Prevention Assessment of your business. You may need an outside expert to help. A typical Pollution Prevention Assessment will include mapping process flows, reviewing equipment uses, evaluating the way you use and store chemicals, evaluating the way you use energy, as well as reviewing waste handling practices and discharges. This assessment helps you to identify many pollution prevention opportunities (and any regulatory compliance issues) and decide which steps to take first.

Pollution Prevention - A Key to Good Management

Good management of your chemical purchases, chemical use and waste disposal is very important. You can improve your environmental performance through Pollution Prevention by:

- identifying how you are using the priority substances and other chemicals of concern that may have a health and/or an environmental impact
- figuring out how much you are using of each chemical and estimating the related emissions (see the earlier description for more information on how to estimate chemical use and emissions)
- discussing the options to reduce or to eliminate these chemicals and, where feasible, taking action. Actions could include:
    - using a different product
    - changing how you apply or clean up the chemical product/waste
    - training staff on how best to apply and clean up the chemical product/waste, or
    - installing new technology
    - maintaining equipment to ensure that leaks and general efficiencies are managed
- tracking the amount of chemicals you use and see if it goes down over time, and
- reviewing progress and identifying whether or not you need to make changes to the company's practices and procedures.

Changes you could make in your facility

The following table lists many options to help you reduce or stop using the priority substances and other chemicals of concern in your facility. Some measures will cost more than others, and some will be easier

to implement than others. Operators can implement certain measures by making minor changes in their day-to-day approaches; while others will require management to invest in new technologies.

The table provides a quick and simple way to take stock of what measures your business has already put into place and those measures that your business could apply. In completing the table, you are encouraged to prioritize the actions you would take. While it is not exhaustive, the table identifies many pollution prevention opportunities for the Commercial and Industrial Equipment Repair and Maintenance sector. When assessing the options, please consider your facility-specific conditions and how each option might affect pollution releases to the air, land and water.

The table identifies three general types of options and distinguishes each with a symbol:

Low-cost, good operating procedures – These measures involve operational and managerial changes that can reduce chemical use. They include simple changes to normal practices, process improvements, as well as training and good housekeeping opportunities. This measure does not need new technology purchases.

Choosing an alternative chemical – These measures involve replacing traditional products (such as solvents and cleaning products) with products that have less harmful properties. The ease and cost of these measures depends on the product and the process used.

New technology or system – These measures involve the installation of a new system, machine or process. The cost varies depending on the technology / system.

See ***More Resources*** for a list of additional resources related to pollution prevention in the commercial and industrial machinery and equipment repair and maintenance sector.

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If `No`, indicate the level of priority for action (High, Medium or Low)		
Cleaning Engines or Parts of Equipment							
Avoid unnecessary cleaning to limit the use of solvent.		☐	☐	☐	H	M	L
Use water-based, phosphate-free cleaners.		☐	☐	☐	H	M	L
If solvents are required, reuse spent solvent waste and recycle solvent waste.		☐	☐	☐	H	M	L
Set and implement a minimum strength of solvent necessary for cleaning.		☐	☐	☐	H	M	L
Purchase a gun washer, which operates much like a dishwasher and uses significantly less solvent.		☐	☐	☐	H	M	L
Use alternative nontoxic cleaning solutions (i.e. dibasic esters, N-methyl-2-pyrolidone, alkaline-, citric-, and water-based solvents) to help reduce VOCs.		☐	☐	☐	H	M	L
Removing Oil and Grease							
For light oils, use aqueous (water-based) degreasers to better separate the oil and solvent, improving recyclability.		☐	☐	☐	H	M	L
Use dedicated solvent sinks for parts washing to encourage solvent reuse and to limit improper drain disposal.		☐	☐	☐	H	M	L
Separate spent engine and lubricant oils from solvents, allowing for proper oil recycling and solvent reuse.		☐	☐	☐	H	M	L
Reuse and recycle spent solvent.		☐	☐	☐	H	M	L
Reuse and recycle spent oils and grease.		☐	☐	☐	H	M	L
Surface Coating							
Use water-based and less toxic coatings.		☐	☐	☐	H	M	L
Paint all products the same colour at the same time to reduce the frequency of equipment cleaning.		☐	☐	☐	H	M	L
Minimize fugitive overspray through improved painting techniques. (i.e. employee training, use of spray booths)		☐	☐	☐	H	M	L

	Low-cost, good operating procedures		Choosing an alternative chemical		New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If `No`, indicate the level of priority for action (High, Medium or Low)		
Use control devices (e.g., carbon absorbers and thermal or catalytic incinerators) to recover or destroy VOCs released through paint fumes.		☐	☐	☐	H	M	L
Use low VOC-content coatings (e.g., waterborne coatings, powder coatings, and higher solid coatings).		☐	☐	☐	H	M	L
Use a system with increased transfer efficiency (e.g., electrostatic spraying).		☐	☐	☐	H	M	L
Appropriately dispose of paint booth filters if they meet hazardous waste characteristics based on the acceptability limits of the sanitary landfill in your jurisdiction.		☐	☐	☐	H	M	L
Substitute paper/cardboard filters with metal filters for all coating operations to eliminate contaminated paper/cardboard waste.		☐	☐	☐	H	M	L
Schedule batch processing that allows wastes or residues from one batch to be used as an input for the subsequent batch (e.g., paint lighter to darker shades).		☐	☐	☐	H	M	L
Removing Paint and/or Rust							
Replace chemical stripping agent (e.g. methyl chloride) with less volatile solvents, such as aqueous solutions of caustic soda.		☐	☐	☐	H	M	L
Properly store and reuse stripping agents.		☐	☐	☐	H	M	L
Use centrifuge or filtration system to separate paint sludge from stripper, allowing reuse.		☐	☐	☐	H	M	L
Use water-jet blasting as an alternative to chemical stripping.		☐	☐	☐	H	M	L
Use abrasion stripping techniques such as plastic media blasting (PMB), sodium bicarbonate, dry ice or wheat starch blasting as an alternative to chemical stripping.		☐	☐	☐	H	M	L
Use thermal stripping (CO2 lasers and high intensity quartz lamps), which help loosen paint for removal as an alternative to chemical stripping.		☐	☐	☐	H	M	L
Use cryogenic stripping (dip or spray equipment with liquid nitrogen), which help loosen paint for removal as an alternative to chemical stripping.		☐	☐	☐	H	M	L
Use hot caustic (water-based) strippers (equipment is dipped in a caustic bath at over 90℃), which help loosen paint for removal as an alternative to chemical stripping.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If `No`, indicate the level of priority for action (High, Medium or Low)		
If chemical strippers must be used, replace with less harmful alternatives such as N-methyl-2-pyrollidone and dibasic esters.		☐	☐	☐	H	M	L
Metal Working							
Set facility-wide standards or guidelines that minimize the use of metal working fluids (MWFs).		☐	☐	☐	H	M	L
Improve the enclosure and ventilation of machine tools to reduce chemical release and improve workplace air quality.		☐	☐	☐	H	M	L
Adjust machine parameters to reduce mist formation.		☐	☐	☐	H	M	L
Use MWFs with specialty additives to suppress mist.		☐	☐	☐	H	M	L
Use MWFs formulated to be more agreeable to recycling and waste-treatment.		☐	☐	☐	H	M	L
Welding and Soldering							
Use alternative solders, fluxes, and filler metals to reduce the toxicity of the waste stream (e.g., cadmium-bearing solders, lead-bearing solders, and low-VOC solder and brazing fluxes).		☐	☐	☐	H	M	L
Use a rosin-type flux (non-corrosive) to reduce the need to clean the joint or assembly.		☐	☐	☐	H	M	L
If cleaning is necessary, choose an alkaline cleaner that has lower levels of toxicity.		☐	☐	☐	H	M	L
Modify application methods to deliver only as much flux, solder, or filler metal as needed to form the joint.		☐	☐	☐	H	M	L
Optimize the heating of filler metal through improved equipment control, monitoring, and worker training.		☐	☐	☐	H	M	L
Regularly remove dross (impurities) from flux or solder baths to increase bath life.		☐	☐	☐	H	M	L
Waste, Wastewater and Residue							
Separate wastes, such as solid waste materials from other wastes for reuse. Mixing wastes may make recycling impossible.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If `No`, indicate the level of priority for action (High, Medium or Low)		
Ensure stripping and painting areas have: • Containment • Impermeable floors • No direct access to outside the facility.		☐	☐	☐	H	M	L
Maintenance, Management and Good Housekeeping							
Purchasing and Inventory							
Review suppliers' products regularly and select the most environmentally-responsible products when available.		☐	☐	☐	H	M	L
Keep an accurate inventory of products used (including chemical name, manufacturer, and MSDS sheet).		☐	☐	☐	H	M	L
Order solvents, paints and other product containers sized for minimum storage time to reduce waste from expired products.		☐	☐	☐	H	M	L
Work with suppliers to take back unused product.		☐	☐	☐	H	M	L
Apply in-house procedures for the safe receipt and handling of chemicals used for cleaning and equipment repair and maintenance.		☐	☐	☐	H	M	L
Cleaning							
Substitute cleaning products for less harmful cleaning products such as water-based biodegradable cleaners (no-VOC or low-VOC) or use recyclable solvents.		☐	☐	☐	H	M	L
Keep track of solvent use by process to identify sources of excessive use and waste.		☐	☐	☐	H	M	L
Improve manual cleaning practices: • Only use as much solvent as needed; do not excessively soak rags or cloths in solvent • Use a spray bottle or plunger • Reuse shop towels or wipes for repetitive tasks.		☐	☐	☐	H	M	L
Either launder towels on-site to recover solvent, or collect and send to an industrial laundry facility off-site.		☐	☐	☐	H	M	L
Do not allow rags to dry before being placed in collection cans and keep lids on cans to stop the VOCs from going into the air.		☐	☐	☐	H	M	L
Regularly maintain and clean machines/equipment to reduce cleaning effort, to extend equipment life, and to reduce solvent use.		☐	☐	☐	H	M	L
Use a two-stage cleaning process. Flush equipment with used solvent before cleaning with new solvent.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If `No`, indicate the level of priority for action (High, Medium or Low)		
Use solvents until they lose their effectiveness, as opposed to when they look dirty.		☐	☐	☐	H	M	L
Solvent recovery							
Store shop towels in a double-bottom drum to allow solvent to be collected.		☐	☐	☐	H	M	L
Recover solvents on-site from towels using the following methods: • Gravity drain • Mechanical wringing • Centrifuge • A solvent still.		☐	☐	☐	H	M	L
Reuse solvents or purchase solvents from a company that will pick up and recycle the spent solvent.		☐	☐	☐	H	M	L
Storage							
Store chemicals according to need, with minimum inventory kept on hand.		☐	☐	☐	H	M	L
Do not store hazardous material near floor drains.		☐	☐	☐	H	M	L
Store chemicals according to manufacturer's recommendations.		☐	☐	☐	H	M	L
Use secondary containment for liquid storage.		☐	☐	☐	H	M	L
Keep solvent, paint, stain, etc. containers tightly covered at all times. Storing liquids properly reduces air emissions and waste products.		☐	☐	☐	H	M	L
Eliminate all open buckets. Provide solvent in easily used, closed containers.		☐	☐	☐	H	M	L
Date containers when opened to ensure you use them before products expire. Recycle containers when empty.		☐	☐	☐	H	M	L
Mark all containers to identify the contents to avoid improper handling or disposal.		☐	☐	☐	H	M	L
Training							
Ensure employees are properly trained (WHMIS).		☐	☐	☐	H	M	L
Train workers to follow the standard work procedures (such as cleaning and set up), good housekeeping, and correct material handling methods to make sure all operators follow the same steps to reduce chemical use and waste.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If `No`, indicate the level of priority for action (High, Medium or Low)		
Train spray gun operators in proper spray techniques to minimize coating waste generation.		☐	☐	☐	H	M	L
Spills							
Use spigots and pumps when dispensing new materials and funnels when transferring wastes to storage containers to reduce possibilities of spills.		☐	☐	☐	H	M	L
Develop a spill response plan and post it so that it is available for all employees.		☐	☐	☐	H	M	L
Make spill kits available at the chemical storage rooms or racks for easy access.		☐	☐	☐	H	M	L
Train workers in emergency spill response.		☐	☐	☐	H	M	L
Other							
Ask employees for pollution prevention suggestions.		☐	☐	☐	H	M	L

Contact us to provide your feedback on this resource or to suggest any additional pollution prevention resources (email chemtrac@toronto.ca or call 416-338-7600).

	Low-cost, good operating procedures		Choosing an alternative chemical		New technology or system

More Resources

Air-Conditioners, Heating and Refrigeration Institute. Responsible Use Guide for Minimizing Fluorocarbon Emissions in Manufacturing Facilities.
http://www.ahrinet.org/ARI/util/showdoc.aspx?doc=146

- Detailed guide for reducing emissions and pollution in manufacturing facilities, discussing in detail:
  - Refrigerant recovery methods and tips
  - Minimizing fluorocarbon use in facilities
  - How to handle associated waste
  - Storage
  - Proper equipment shipping and transportation

American Industry Recycling Guide: Handling and Reuse of Refrigerants in the United States.
http://www.ahrinet.org/ARI/util/showdoc.aspx?doc=558

- An American industry guide to recycling and handling of refrigerants discussing in detail:
  - Guide on the use of recycled refrigerants, step by step process
  - Special considerations for mixed refrigerants

Canadian Pollution Prevention Information Clearing House (CPPIC). 2010. Home Page.
http://www.ec.gc.ca/cppic/En/index.cfm

- The CPPIC provides a comprehensive list of pollution prevention resources for Canadian sectors and industries, such as best management practices, fact sheets and sector profiles. Conduct a 'Sector Search' to find resources most relevant to your industry (Repair and Maintenance is found under the 'Other Services' sector link).

Environment Canada. Fact Sheet: Refrigeration and Air Conditioners
http://www.ec.gc.ca/ozone/default.asp?lang=En&n=4AB96C21-1

- A comprehensive list of halocarbons and the associated restrictions surrounding use.

Environment Canada. Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems
http://www.ec.gc.ca/ozone/default.asp?lang=En&n=127A4F77-1&offset=2&toc=show

- Guidelines for the reduction of atmospheric emissions of chlorofluorocarbons (CFCs) used in refrigeration and air conditioning applications.

Environmental Protection Agency - Vehicle and Equipment Maintenance and Repair
http://www.epa.gov/agriculture/tveh.html

- A comprehensive summary of machine shop repair and maintenance pollution prevention which includes how to manage used oil, spent fluids, batteries and other machine shop wastes. The website covers in detail:
  - Handling of used oil
  - Spent fluids
  - Considerations for battery use and recycling
  - Waste generated from machine shops

Northeast Waste Management Officials' Association: Pollution Prevention in Machining and Metal Fabrication. March 2001. A Manual for Technical Assistance Providers.
http://www.newmoa.org/prevention/topichub/23/NEWMOAmanual.pdf

- A guidance document which summarizes pollution prevention options in the machining and metal fabrication industries.
- The document covers the following topics in detail:
  - The processes and general operations in the metal fabrication industry
  - Pollution prevention opportunities
  - Methods for pollution prevention

- Innovation in pollution prevention

Noyes, Robert. Pollution Prevention Technology Handbook.
http://books.google.ca/books?id=__lqGczo9TwC&lpg=PP1&pg=PR9#v=onepage&q&f=false

- Summarizes pollution prevention in the iron and steel, metal fabrication, metal processing and commercial maintenance industries.

Skerlos, Steven J. Prevention of Metalworking Fluid Pollution: Environmentally Conscious Manufacturing at the Machine Tool.
http://www.umich.edu/~me589/R5_MWF.pdf

- A useful resource that outlines the substances of concern involved in machine tool manufacturing, environmental impacts, health impacts, and pollution prevention methods through process planning and modification. There is a good list of pollution prevention activities that machine operators can implement.

Sparks, John. The Basics of Alkaline In-Process Cleaning for Metal Substrates
http://www.p2pays.org/ref/12/11201.pdf

- A summary of different types of metal cleaners, the differences between them, what to look for, and how to choose a cleaner.
- The document details:
  - Methods of oil/grease/soil removal
  - Selecting the most suitable cleaner for a specific job

U.S. EPA 1992. GUIDES TO POLLUTION PREVENTION: The Mechanical Equipment Repair Industry
http://www.p2pays.org/ref/42/41936.pdf

- A comprehensive summary of pollution prevention methods for the mechanical equipment repair industry including extensive case studies and recommendations.
- The document details:
  - Waste minimization in the machine repair industry
  - Description of the processes involved in the industry
  - Waste minimization worksheets to help shop owners assess their waste generation
  - Case studies for reference