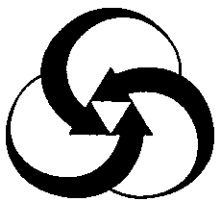
Shop Guide to Reduce Wastewater from the Machining and Metal Fabrication Industry

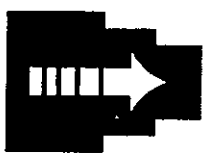
A Competitive Advantage Manual

Prepared by:



Institute of Advanced Manufacturing Sciences
(800) 345-4482

and



Waste Reduction and Technology Transfer Foundation
(205) 386-3869

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The Institute of Advanced Manufacturing Sciences (IAMS) is a not-for-profit organization whose mission is to improve the competitiveness of industry through technology transfer, training, and applied research. The Institute's specialized areas of expertise include: pollution prevention, machining and machine tool technology, and manufacturing productivity. Courses offered at their Cincinnati, Ohio training facility include: *Practical Machining Principles for Shop Application, Grinding Principles and Practice, Centerless Grinding, and Pollution Prevention seminars.*

The Waste Reduction and Technology Transfer Foundation (WRATT) is a not-for-profit organization funded by public and private sources dedicated to reducing the cost of industrial waste and protecting the environment. WRATT conducts confidential, free, voluntary, nonregulatory assessments for business and industry and conducts programs to educate the public, business, and industry representatives in reducing discharges to the environment, usually resulting in substantial cost savings. Retired engineers and scientists manage the programs.

Many individuals and organizations are recognized for their contributions to the completion of this work: CDS Graphics; Cincinnati Milacron; *Cutting Tool and Engineering* Magazine; DuBois Chemicals, Inc.; *Environmental Waste Management* Magazine; Independent Lubricant Manufacturers Association (ILMA); Minnesota Technical Assistance Program *(MnTAP); Modem Application News (MAN)* Magazine; Ohio EPA, Office of Pollution Prevention; *Pollution Engineering* Magazine; Rotex, Inc.; Tennessee Valley Authority (TVA); *Tooling and Production* Magazine, and the Waste Reduction Resource Center.

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INTRODUCTION

This manual has been written as the second manual of a two part series on how to reduce waste and wastewater discharges from metalworking and machining facilities. This manual is a companion to the *"Shop Guide to Reduce the Waste of Metalworking Fluids"* and, in some cases, uses similar text. It covers a broad range of wastewater discharge areas in a metalworking plant rather than simply metalworking fluids. Ideally, this manual provides methods in which manufacturers can obtain zero wastewater discharge. Metal finishing and painting are not discussed in any detail. For information on waste reduction techniques for metal finishers, please refer to *"A Pollution Prevention Resource Manual for Metal Finishers "' 1994,* available from the Institute of Advanced Manufacturing Sciences, Inc. Resource information is available for paint reduction techniques from the U.S. and Ohio EPA.

Much progress has been made in recent years in improving metalworking and fabrication processes as regulations regarding the discharges into the environment have become more stringent. This industry must continue to meet new standards which further decrease the amount and type of wastewater that may be discharged. Wastewater generated from the use of metalworking fluids, cooling water, rinse operations, plant cleanup, water-based parts washers, cooling and boiler water represent the majority of wastewater discharges. Therefore, waste minimization from these operations has proven to be an effective method of meeting discharge limitations. Furthermore, since the costs of cleaners, raw water, water treatment, and metalworking fluids used in manufacturing are major overhead costs, many companies find they benefit from the guidelines in this manual in the following ways:

* Lower costs by reducing wastewater volume discharged
* Lower costs by reducing the amount of water and chemicals consumed
* Improve manufacturing efficiency
* Reduce downtime and improve productivity
* Improve quality and reduce costs of the products they manufacture

This manual will prove useful for companies involved in cutting, metal removal, forming and joining.

It includes several excellent methods which have proven successful in many metalworking companies. Waste minimization, however, requires an investment of time and hard work. Since each company is different in its particular needs, what works best for one may not be the best for another. Taking advantage of their own expertise and knowledge of local conditions, operators of each facility must determine whether a particular technology can be implemented economically. Most importantly, for a

successful plan to be implemented, ***all*** personnel including owners, management, engineers, shop foremen, machine operators, etc. must buy in and become part of the team.

Metalworking and fabrication companies of all sizes are making significant reductions in their operating costs and mandated environmental waste handling concerns by investing in an effective, organized Waste Reduction Program. These programs involve more than simple waste recycling; they cannot be bought off the shelf, ready-to-use from any vendor. Often, a Waste Reduction Program becomes part of a company's overall Total Quality and Continuous Improvement efforts, improving and maintaining its competitive position in the marketplace.

REGULATORY BACKGROUND

The purpose of this manual is to provide practical ideas for reducing the volume and pollutant loading of wastewater discharges from metal fabricating operations. Compliance with the many environmental laws and regulations that govern wastewater treatment and disposal is beyond the scope of this manual. However, in waste reduction efforts it is important to at least be aware of the regulatory issues involved in treating or disposing of the wastewater. This regulatory framework is one reason for working on the front end of the operation to reduce the amount of wastewater treated or disposed.

The major environmental issue in disposing of wastewater from metal fabrication is compliance with the Clean Water Act (CWA). This federal law ties together federal, state and local regulatory efforts and is intended to restore and maintain waters of the nation in "fishable and swimmable" condition. A few metal fabricating companies will discharge directly to lakes, rivers, or streams. These discharges require a National Pollution Discharge Elimination System (NPDES) permit, usually obtained by negotiation with the state regulatory authority. The majority of companies, however, discharge indirectly to a local sewer system called a publicly operated treatment works (POTW). Wastewater discharge permits, issued by the POTW, authorize and regulate these discharges. Whether a direct or indirect discharger, a company must comply with applicable federal pretreatment standards (see Title 40, Code of Federal Regulations). Enforcement is by the state for NPDES permit holders, and by the local POTW for indirect dischargers as illustrated in ***Figure 1.*** In addition, for indirect discharges there may be local sewer use regulations that impose additional and much stricter requirements to prevent corrosive damage, obstruction of flow, harm to sewer workers, toxic damage to the treatment plant biomass, and pass-through of pollutants to the receiving waters.

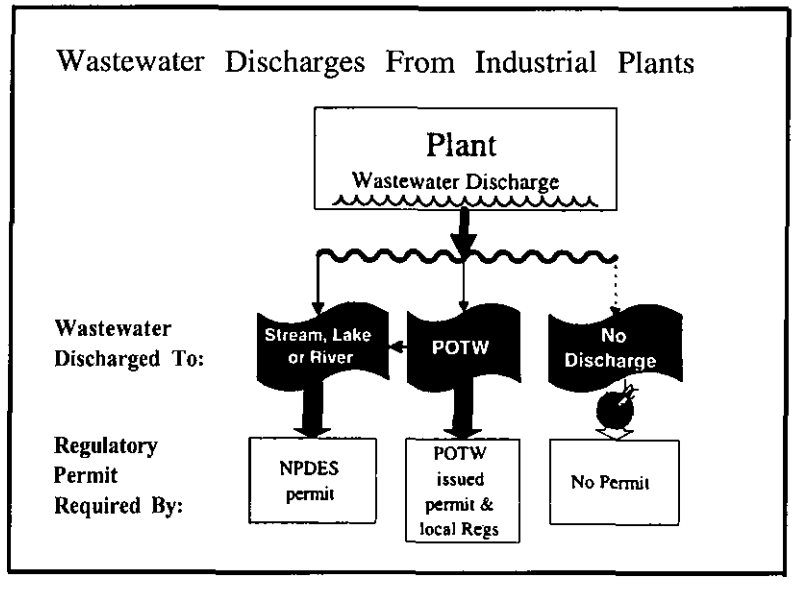


Figure 1.

For metal fabricators of finished parts, products and
pretreatment standard is the Metal Products and Ma
regulation, which will become final in September 1
regulation will affect these industry sectors:

- aerospace
- aircraft
- electronic equipment
- hardware
- mobile industrial equipment
- ordinance
- stationary industrial equipment

The compliance date for Phase I sectors will be thre

Phase II applies to these sectors:

- bus and truck
- household equipment
- instruments
- office equipment
- precious and non-precious metals
- railroads
- ships and boats

Phase II will be proposed in 1997.

The MP&M regulations replace existing regulations
operations in the covered sectors. Any company in
discharging more than one million gallons per year
will be subject to limits for

Aluminum	Nicke
Cadmium	Cyan
Chrome	Oil &

A company discharging wastewater with high concentrations of conventional pollutants, such as Biological Oxygen Demand (BOD), Total Suspended Solids (TSS) etc., may be subject to a surcharge by the POTW to recover the cost of treating the 'high strength' wastewater.

> ***TIP*** *- Establish contact and maintain a line of communication with the local POTW. Through this contact problems can be resolved early on, and useful information* about *future directions in regulations may be obtained.*

The domestic sewage exclusion, a provision of the hazardous waste law (RCRA), exempts from RCRA regulation any hazardous waste in wastewater discharged to a local POTW. Nevertheless, in the course of pretreatment, non-sewerable hazardous waste may be generated (sludge containing heavy metals, for example). Such hazardous wastes are specifically regulated under RCRA. A detailed set of regulations covers the generation and management of hazardous wastes. Disposal is very expensive, and if regulations are violated severe fines and criminal penalties may result.

While the rules and regulations for managing hazardous waste are complex, help is available. For more information, call:

- The state hazardous waste agency
- The EPA regional office
- The RCRA/Superfund Hotline - 1-800-424-9346
- EPA's Small Business Ombudsman Hotline - 1-800-368-5888
- A particular business' national trade association or its local chapter
- Refer to the EPA's "Understanding the Small Quantity Generator Hazardous Waste Rules: A Handbook for Small Business", document #530-SW-86-019
- ILMA's "Waste Minimization and Wastewater Treatment of Metalworking Fluids"

The sections that follow identify sources of wastewater and ways to reduce waste at its source rather than at "End of Pipe".

SOURCES OF WASTEWATER DISCHARGES AND SOURCE REDUCTION TECHNIQUES

- Aqueous (water-based) cleaning and rinsing
- Cooling water
- Alternative Cleaners
- Boiler Blowdown
- Air pollution control equipment
- Cutting and Blasting
- Deburring and mass finishing
- Water-based metalworking fluid operations
- Air Compressors

Other sources of wastewater not listed above may be significant in any given operation and should also be assessed. Methods to reduce waste at the source are discussed for each operation.

Case Study

A metal stamping and deep drawing operation based in the Midwest cleaned shop floors with one riding and two walk behind floor scrubbers. The concrete floors, due to the nature of the operation, became slippery with drawing oils and were cleaned daily. To avoid a $10,000 monthly surcharge, the oily wastewater was stored in a pit and then hauled away and processed locally.

The company tested and then purchased a tubular ultrafiltration system, resulting in an estimated cost analysis and annual payback as listed below:

Cost Analysis

Savings per Year:		
Wastewater hauling charge:		$48,038
Soap recovery with UF unit:		$13,613
	Total:	**$61,651**
Operating Costs per Year:		
Wastewater hauling charge:		$889
Electric cost to run pump:		$506
Cost of membrane cleaning:		$350
Membrane replacement cost:		$320
Labor cost:		$3,240
	Total:	**$5,305**
Equipment Cost:		
Ultrafiltration cost:		$12,600
Tanks, piping, controls:		**$2,000**
Installation:		$2,000
	Total:	**$16,600**
Savings:		$61,651
Less operating cost:		$5,305
Less equipment cost:		$16,600
First Year Savings Total:		**$39,746**
Future Years Savings:		**$56,346**

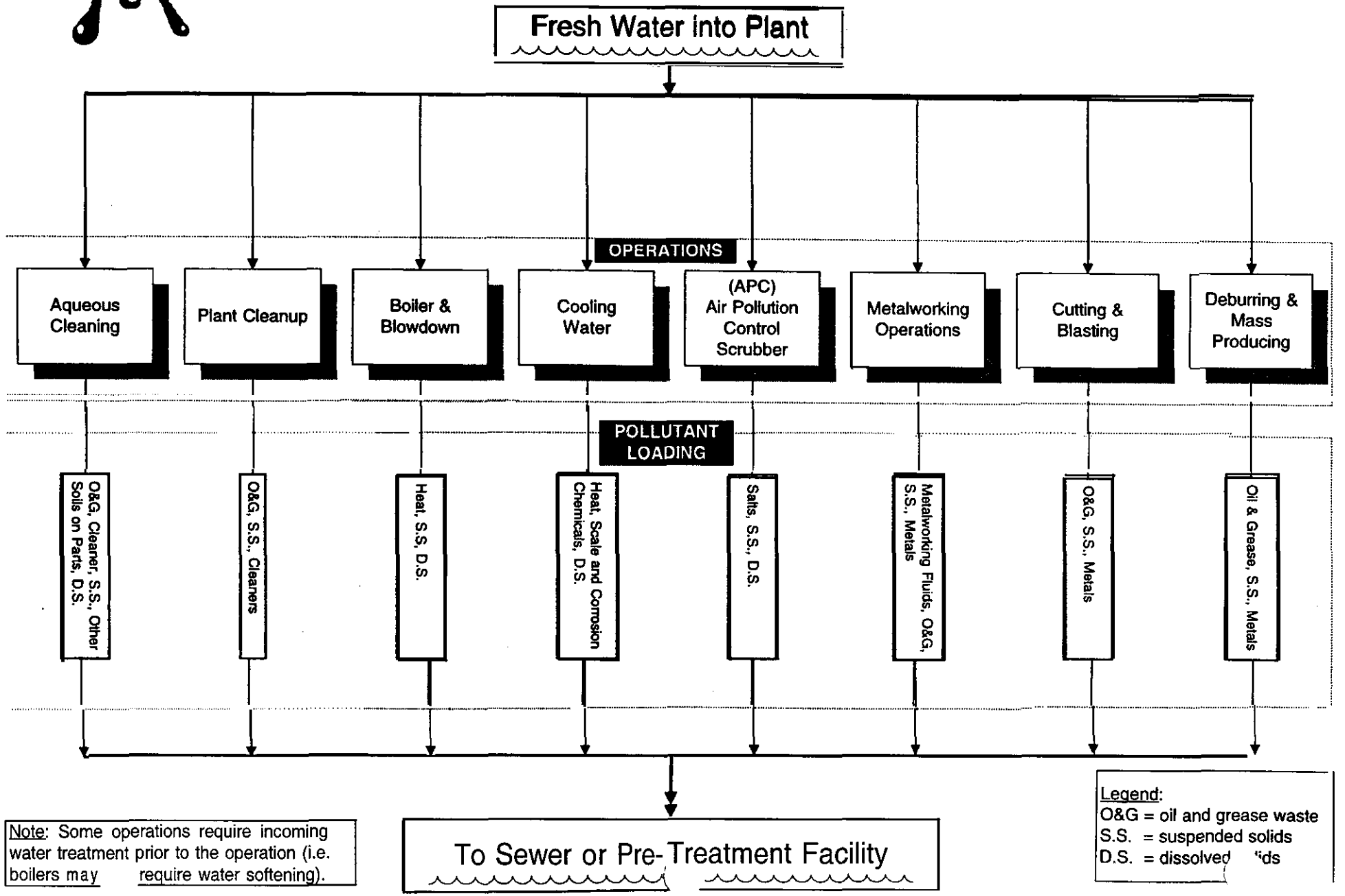
Figure 2 on page 8 shows possible sources of wastewater discharges in a metalworking shop prior to any water conservation efforts and typical pollutants that result from each operation above.

TIP *- Making a water flow diagram like Figure 2 before water conservation measures have been implemented will also allow operators to look at the total flow of water and categorize the wastewater streams in size, type, and quantity of waste. This information can then be used to formulate a water conservation process such as that shown in* **Figure 3,** page 9.

TIP*- The operations that generate the greatest amount of wastewater and those in which easy and low cost changes can be made should be addressed first.*

Figure 1 -- Without Water Conservation

Typical Water-Flow Diagram for a Metalworking Plant Before Water Conservation Measures

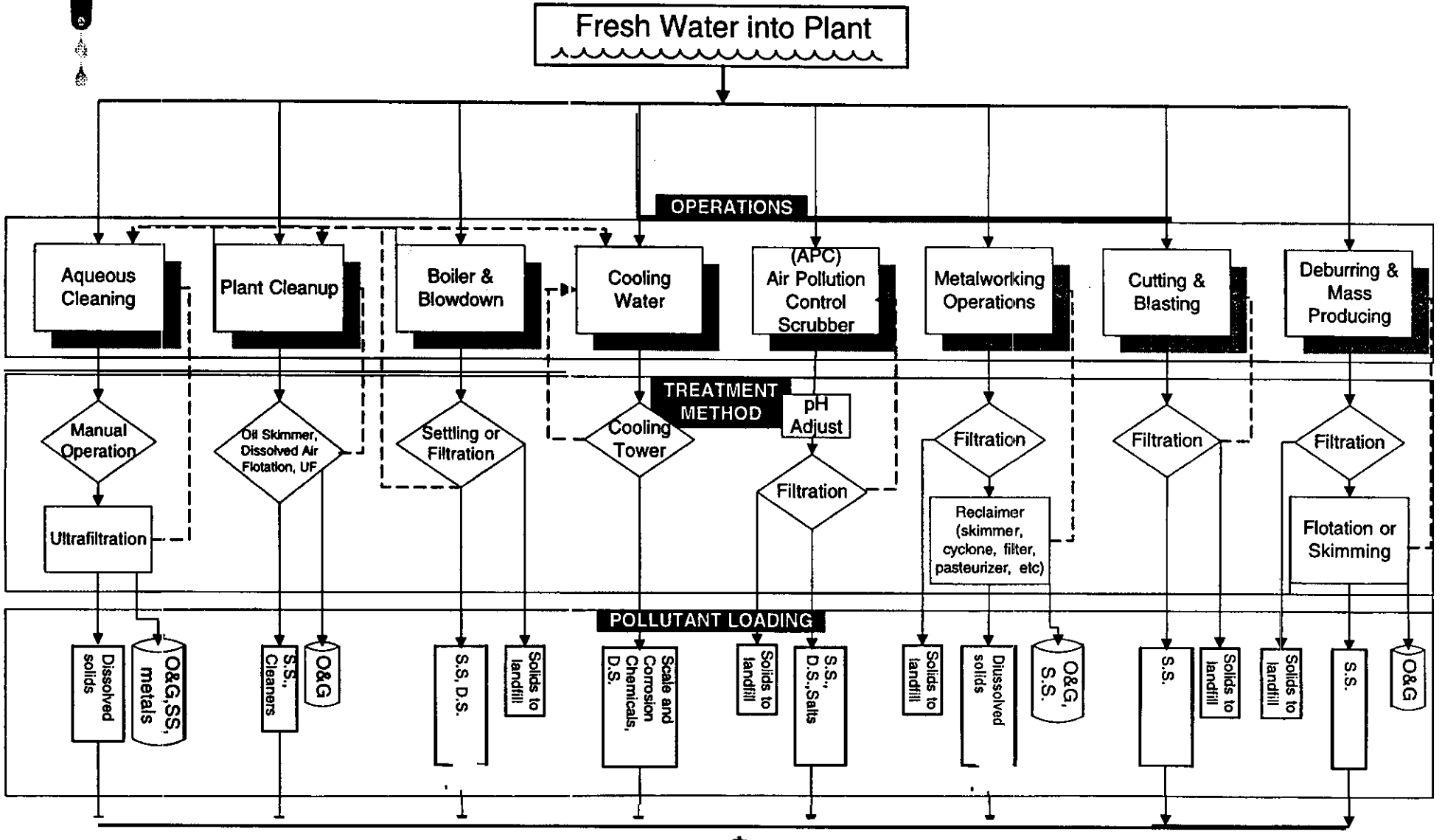


Note: Some operations require incoming water treatment prior to the operation (i.e. boilers may require water softening).

Legend:
O&G = oil and grease waste
S.S. = suspended solids
D.S. = dissolved solids

Figure 3 -- With Water Conservation

Typical Water-Flow Diagram for a Metalworking Plant after Water Conservation Measures



Notes: It may be possible to collect the Oil & Grease waste streams and use them as a supplementary fuel in the local boiler (if regulations allow).
The total wastewater sewer stream may require pre-treatment before discharge.

Legend:
O&G = oil and grease waste
- - - - = recycled solution
S.S. = suspended solids
D.S. = dissolved solids

Aqueous (Water-based) Cleaning & Rinsing

Traditionally, oily parts were cleaned by either dipping them in solvent or suspending them in a solvent vapor chamber. This typically involved the use of chlorinated solvents, many of which posed significant health liabilities and were classified ozone depletors. Today, tight restrictions on the production of some chlorinated solvents (such as 1 ,1 ,1 trichloroethane) and the liabilities associated with their use have led to the use of aqueous (water-based) and semi-aqueous cleaning processes.

Today, discharges of spent aqueous cleaning solutions and rinsewater frequently make up a significant portion of wastewater generated by a typical metal fabrication facility. Shops that have switched to aqueous cleaners from solvent cleaners often have noticed a significant increase in wastewater volume and in some cases, compliance problems. The use of aqueous cleaning systems, however, generally results in a reduction of total disposal costs when compared to solvent cleaning systems.

As detailed in *Figure 4,* aqueous cleaning systems can incorporate filtration equipment which allows cleaning solutions to be reused, resulting in significant reduction of wastewater disposal.

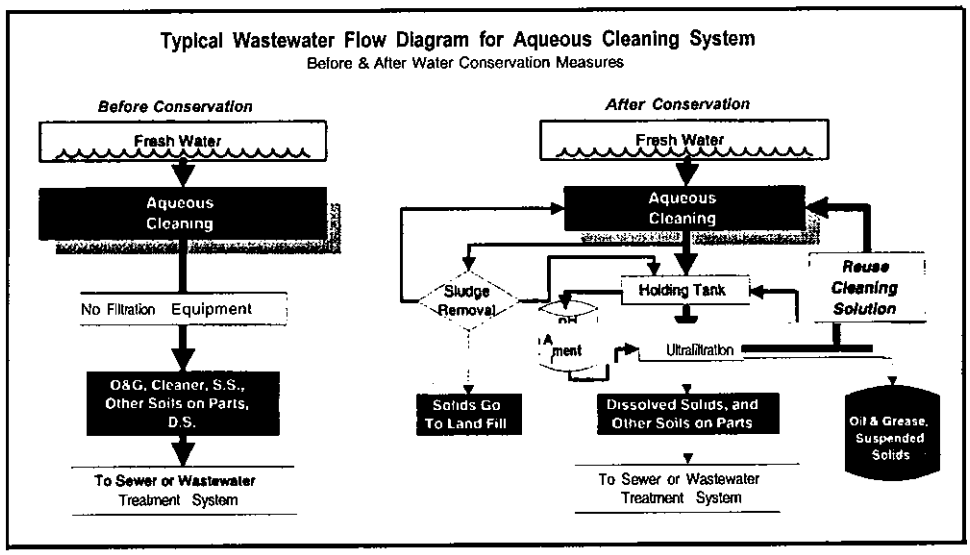


Figure 4.

Case Study

An Ontario-based engine mount parts manufacturer faced a challenge when replacing a vapor degreasing cleaning system (using 1, 1, 1-trichloroethane) with a water-based system. After researching possible equipment options, the company installed a high volume, fully automated aqueous cleaning system. By eliminating 1 ,1 ,1 -trichloroethane, the plant avoided solvent recycling as well as hazardous disposal cost concerns. "Wastes from the new system are minimal and, 'parts are even cleaner than when vapor degreasing was used,'... *Pollution Engineering,* March 1996, pp. 58-59.

The following sections provide methods for correctly selecting and evaluating aqueous cleaners as well as extending the life of aqueous cleaners.

Aqueous and Semi-Aqueous Based Cleaners

The use of aqueous and semi-aqueous cleaners has grown tremendously. The technology of these cleaners has improved significantly and they are now considered to be reliable alternatives for many solvent-based applications.

- *Aqueous cleaners*

  Aqueous cleaners are **water** based chemistries that can be categorized into two major groups: Acidic and alkaline-based products. Both types of aqueous cleaners contain

  - *surfactants* (from surface-active agents)
  - emulsifiers (which help with oil removal)
  - detergents

  The difference between acids and alkaline products is defined by their pH, a chemical characteristic that ranges from 0 to 14 with a pH of 7 being neutral.

	Acids	Neutral	Alkaline
pH	0-7	7	7-14

  - Acidic products contain at least one type of acid; however, most contain a blend of different acids, depending on the application for which the cleaner was designed.
  - Likewise, alkaline products may contain *builders* which help in the cleaning process, hard water control agents, rust inhibitors, and inhibitors to protect soft metals from corrosion.

- *Semi-aqueous cleaners*

Semi-aqueous cleaners are water/solvent based compounds. Many semi-aqueous cleaners contain terpenes (which typically have an "orange, lemon peel, or pine" odor). Advantages of semi-aqueous cleaners over aqueous cleaners include the ability to more readily dissolve oil and grease and hold it in solution for a longer period of time. The disadvantage of this characteristic is that the oil and grease is more difficult to remove once it has been emulsified in the solution. These type of products are used quite often in ultrasonic and other agitation devices.

Drying times of parts may increase when changing from a solvent-based process to an aqueous based process. Additionally, parts may be more susceptible to rusting due to contact with water and longer drying times.

Types of Soils

Soils "are contaminants left on the surface that are not from the original materials of construction."

TIP - Think of soil removal as the transference of the soil from the object being cleaned into the aqueous cleaning solution. This process of course generates "waste "water, which must be handled accordingly. The pollutants in the "waste "water then, are directly related to the soil removed, type of cleaner; etc. The table below lists possible soils and their sources.

TYPES OF SOILS

SOIL TYPE	OPERATIONS
Oily soils: animal, vegetable and petroleum oils	Metal cutting, metal forming and rust protection
Semi-solid soils: greases, soaps, abrasives and waxes	Buffing and polishing
Solid soils: carbonaceous films, metal oxides and shop dirt	Heat treating and storage

WASTEWATER = Soils + Cleaner + Water + Other Sources

Selecting the Correct Cleaner

The correct selection of an aqueous or semi-aqueous cleaner requires an assessment of the cleaning **process** and **part** prior to the evaluation process. The following parameters should be reviewed:

- What type of surface(s) on the part is being cleaned? What are the materials of construction? Do the parts contain ferrous-only substrates, or do they contain soft metals such as aluminum, tin, or zinc?

***TIP** - The type of surface being cleaned and soils present will determine the type of cleaner chemistry that can be used. For example, since soft metals are susceptible to alkalinity pH attack, an inhibited alkaline product should be considered. If all ferrous parts are being cleaned, than an uninhibited product can be used.*

- What is the porosity, geometry, and position of the part? These parameters will determine the best product for a given application.

- What are the incoming soils on the parts that will be removed during the cleaning process? Are just oils and greases being removed, or are other contaminants, such as dust, metals, rust inhibitors, metalworking fluids, etc. being removed?

***TIP** - The chemistry of the type of soil to be removed will determine the best overall cleaner for a given situation.*

- What is the minimum accepted level of cleanliness? Does virtually all dirt have to be removed, or is the cleaning process used to remove only gross levels of dirt?

***TIP** - Review the suppliers MSDS to make sure the cleaner is compatible with the cleaning system, part, and employees.*

It is recommended that a aqueous or semi-aqueous cleaner supplier be contacted during the selection process.

The type of cleaner selected determines the type of soil removed (waste generated), the volume of wastewater, and the overall level of cleaning satisfaction.

Evaluation of Cleaners

The use of aqueous cleaners for parts cleaning requires a three-step process:

- *Cleaning*
- *Rinsing*
- *Drying*

Each of these steps needs to be looked at carefully during the evaluation process to ensure that the desired results are obtained. Likewise, results from a comparison of different cleaners should be evaluated in each one of these three steps.

Cleaning and rinsing usually consists of five steps, commonly referred to as the W.A.T.C.H. principle. The W.A.T.C.H. principle provides an easy means to remember the different steps involved in all aqueous cleaning:

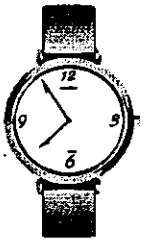
Water

Action

Time

Chemical

Heat



All components of the W.A.T.C.H. principle are integrated and necessary for the whole system to work. When one component is modified (by design or accident), it affects the overall cleaning results. Furthermore, it may be necessary to increase the other components to make up for a deficiency in another.

TIP *- By optimizing the WA.T.C.H. principle, the amount of waste cleaner and rinse water discharged to the sewer can be minimized.*

WATER:

Water is used for several reasons in cleaning. Often referred to as the "universal solvent", water dissolves almost everything to some degree. Water is the medium that carries the cleaning agent to the part and then, along with the cleaner, removes the soil from the part, holds it in solution, and takes the soil to another area (i.e. sump, sewer, etc.) for disposal. Water is also used to deliver energy to the part. This energy comes from both water pressure (PSI) and water flow (gallons per minute (GPM)).

How much water (GPM) is being applied? At what pressure is the water being applied? Through what type of nozzle configuration is the water sprayed? How far is the nozzle from the part or surface being sprayed?

***TIP** - The answer to these questions determines the amount of applied force delivered to the part as well as the amount of wastewater generated during the chemical and rinse stages.*

ACTION:

Action is one of the key components of a successful cleaning program since *physical force* is often required to remove a soil from a surface. Action ranges from simple 'elbow grease' to automated spray washer systems. The level of sophistication largely depends on how critical the operation is to the operation of the plant.

How much physical action is required at given temperature, water flow, etc.? Would a spray washer make more sense than a hot tank dip operation? Or do the parts require soaking time in an immersion tank? Would increasing the flow rate (GPM) through the nozzles make sense, or would increasing the pressure of the recirculation pump make more sense? Optimizing *action* can greatly reduce water usage and disposal.

TIME:

In any manufacturing operation, time is critical. As part of the W.A.T.C.H. principle, time is typically reduced to a minimum by adjusting the other variables. Check the operation once in a while to ensure that the time factor is at the lowest possible limit for acceptable cleaning level.

How long should a part remain in a cleaner? Will satisfactory results occur if the contact time is reduced? How does the time factor affect the production process? Can the other variables (water, action, chemical, or heat) be increased to reduce the required time? Can automatic timers be set up to automatically process the parts or notify personnel that it is time to move on to the next step?

CHEMICAL:

Chemical concentration is extremely important in most cleaning operations. The ratio of cleaner to soil determines how well the solution cleans and how long the solution lasts. By using the right amount of cleaner, the other variables can be reduced without sacrificing cleaning results. Also, the life of the cleaning solution can be increased by 'recharging' the system with new, additional chemical.

Is the correct type of chemical cleaner being used? Should a soft metal safe product be used instead of an all metal (ferrous) cleaner? Are the soils being removed or would a more aggressive cleaner do a better job? Is the concentration correct? Is the concentration checked with pH strips or with a titration kit? Should an acid be used instead of an alkaline cleaner?

TIP *- The correct chemistry is important in achieving desired results, and will ensure that the cleaning solution is maximized, thereby reducing the amount of waste generated.* ***Remember, more is not necessarily better.***

HEAT:

Heat is important in the cleaning operation because, as temperature rises, the effectiveness of the cleaning solution increases, just as cleaning dishes with hot water is easier than with cold water. What is the optimum operating temperature?

TIP *- By using the correct temperature, less cleaning solution can be used and fluid life can be extended.*

The answer to the above questions determine the amount of applied energy (heat, chemical, physical force) delivered to the part as well as the amount of wastewater generated during the chemical and rinse stages. There is an optimal pressure, GPM, temperature, concentration, and contact time for every operation. Has the operation optimized these variables? Check with several equipment and chemical vendors to verify that each cleaning system is indeed running at top performance.

For example, if the concentration of chemical is accidentally decreased due to a leak, a change in a pump setting, a plugged orifice tip, etc., the, other variables will have to be increased to get the same level of cleanliness. The heat of the solution may have to rise, the time in which the part is cleaned may have to be increased, or the action may have to increased or be improved.

TIP *- Keeping a daily or weekly log of each cleaning system is important since it allows for trends or rapid changes in variables to be identified and corrected quickly. Without close monitoring of these variables, when a problem occurs, it may take a significant time (downtime) to identify the problem and come up with the correct solution.*

Aqueous and semi-aqueous cleaners are generally applied through a hot tank immersion process, ultrasonic tank, spray washer cabinet process, or pressure washer. Also, plant cleanup processes such as floor scrubbing, mopping, pressure washing, etc. should be investigated.

Optimizing the efficiency of the cleaning process will minimize wastewater disposal from aqueous cleaning and rinsing.

Prolonging the Life of Cleaners

Today, since discharges of spent aqueous cleaning solutions and rinsewater frequently make up a significant portion of wastewater generated by a typical metal fabrication facility, methods to reduce, recycle and reuse aqueous solutions are important. Some ways to reduce, reuse, and recycle aqueous cleaning solutions are discussed below.

Use Deionized Water

Deionized water can be used to prolong the useful life of cleaners, rinses and metal working fluids. The higher the mineral content ("hardness") of the makeup water, the more likely stability problems will occur with soluble oils, semi-synthetic metal working fluids, cleaning products, or rinse water. The level of hardness is dependent on the amount of calcium (Ca") and magnesium (Mg') ions dissolved within the water. When using city water or well water to replenish water in a metalworking fluid, cleaner, or rinsewater, the dissolved solids do **not** evaporate but build up over time. This "boiler effect" results in changes in liquid alkalinity and can lead to problems of corrosion, bacteria growth and residues in systems that reuse the specific solution.

TIP - Therefore, when mixing water to maintain the correct concentration level or for special rinse applications, use deionized water or water treated by a reverse osmosis unit if the hardness of city or well water is too high. This will lower the level of minerals added to the system.

To develop an appropriate water treatment method, start with a raw water analysis. If the plant is served by a public water supply, the local vendor of water can provide the needed data. The cleaner or fluid manufacturer may then recommend some form of water treatment based on the water analysis.

Recommendations could include the use of:

- An in-line ion exchange (IX) system
- A reverse osmosis (RO) unit.

Purify Solutions

Keeping the cleaning and rinsing solutions free of contaminants is also of prime importance. The cleaning solution can often be reused simply by removing or separating the contaminants, such as solids, oils, greases, etc., from the solution. Care should be taken that the detergent in the cleaner (surfactant) is not separated and removed from the cleaning solution. Some of these removal or separation methods are as follows:

- Solids: Filtration by paper or in-line filters.
- Oils /Greases: Flotation followed by skimming, acid cracking, heat cracking, or membrane filtration by a Ultrafiltration (UF) unit.
- Dissolved Contaminants (Cations and Anions, including: Metals): Removed by use of Ion Exchange (IX) or Reverse Osmosis (RO) units.

These technologies will be discussed in more detail in the *"Wastewater Treatment and Recycling Technologies"* section of this manual.

Rinses

Following aqueous cleaning, water is used to rinse the cleaner from the part. Either spray rinses or rinse tanks can be used. Several proven methods can be used to reduce water usage in rinsing including countercurrent rinsing and the reuse of rinse water for first rinses or as makeup water for the cleaner tank. Using these methods will reduce discharges to the sewer.

Tank Rinses

Counterflow or countercurrent rinse techniques can be used to effectively minimize the amount of rinse water used:

- Fresh water is added to rinse tank #3 (cleanest) rinse tank and only when contamination level increases to a specific level.
- Excess water from tank #3 flows into rinse tank #2 and excess water from this tank flows into rinse tank #l
- Water from rinse tank #l (dirtiest) is used as make up for the aqueous cleaning operation
- Deionized (DI) water is used for make up rinse tank #3 to maintain a low level of impurities in the cleaner

Reduce Dragout
Prolong the life of the water in the rinse tanks by:

- slowing workpiece withdrawal rate
- lengthening drain time
- modifying of the workpiece to allow better drainage
- adding drain boards to collect and return dragout to cleaner tank
- using air knives to remove cleaner from workpiece

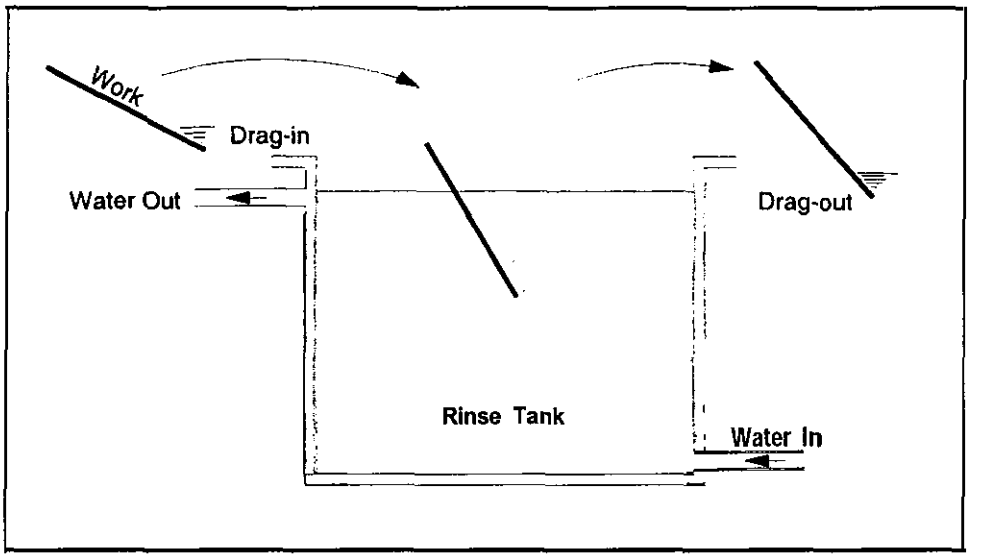


Figure 5. Illustration of Drag-out

Make rinsing more efficient by:

- using flow restrictors and nozzles to reduce rinse water flow (running rinse tank)
- agitating rinsewater to improve rinsing efficiency
- use of wetting agents

Spray Rinses
Collect spray rinse in an empty tank and return it to the cleaning solution tank, or collect it for reuse as a first rinse followed by a clean water final rinse. The use of deionized water may or may not be required depending on the rate of water turnover.

***TIP** - In cases where the cleaning solution is heated, resulting in rapid evaporation, the use of spray rinsing directly over the cleaning tank will help to replenish the water and maintain the **proper** fluid level in the cleaning tank. Concentration of cleaning chemical should be checked and tested as necessary to assure proper amount. This can be accomplished by chemical titration.*

Alternative Cleaners

Carbon Dioxide (CO^2)

Carbon Dioxide (CO^2) cleaning is a high-energy, nonhazardous, nontoxic alternative to the conventional cleaning methods. CO^2 is a highly controllable substance - the temperature and pressure can easily be monitored and controlled (such as by pressure chamber) - allowing for optimum cleaning. When CO^2 cleaning is used no solvent or wastewater discharges are created.

Case Study

An Elmore, Ohio plant was challenged, after a substantial perchloroethylene (PCE) spill, to find an alternative method for the PCE-based cleaning of their beryllium and beryllium alloy products. The company chose to install a Carbon Dioxide (CO^2) based cleaning system. They also chose to use a pressure chamber to control both the temperature and pressure of the CO^2 for optimum cleaning. Before the change, the company was using more than 24 million lb./yr. of steam for the operation of the solvent-based cleaning system. Natural gas was necessary to produce this steam, under the new method, 31.66 million $ft.^3$ /yr. of natural gas was eliminated. A large amount of electricity was utilized to manufacture PCE, operate the PCE-based cleaning processes, and to recycle the wastes from the process. Under the new method, the plant had a savings of about 323,000 kWh/yr by reducing PCE production and eliminating the cleaning and recycling processes all together. Economically, the plant expects to see a savings of $282,000/yr.

Case Study

Carbonate/Bicarbonate (baking soda)

As outlined throughout this manual, there are many successes in converting to an aqueous-based cleaning system from one based on solvents or vapor. Many users, however, find that their performance requirements are not met by the aqueous cleaning systems or that they find it difficult to integrate such a system into their existing processes. Cleaning and surface preparation using carbonate and bicarbonate systems are well known processes in both the industrial and consumer areas.

Products containing sodium carbonate and bicarbonate materials have become more popular due to their environmentally safe reputation, cost and performance considerations, as well as advances in the chemical formulation. The historical disadvantages such as scale build-up have also been drastically minimized. The blasting media area has also seen many changes, as an alternative to plastic, glass bead and sand (coarse) grit blasting, carbonate/bicarbonate blasting is far less aggressive and is much easier to clean up.

Cooling Water

Cooling water, particularly once-through cooling water, frequently makes up part of the wastewater from a metal fabrication shop. Cooling water can be once-through or closed-loop (open tower or heat exchanger).

Open-ended, once-through systems
In this type of cooling, water is used **once** for cooling and discharged to the sewer, an inefficient process at best. Normally, unless the equipment that uses once-through cooling water is equipped with thermostats or timers, the water utilizes only 50% of its potential to absorb heat, therefore making it ideally suited for reuse. Some potential reuses of spent cooling water are:

- Collect and reuse in other cooling applications;
- Use as make-up water for rinse tanks and systems, process tanks, cooling towers, fume scrubbers, boiler water (should be processed through a softener or DI unit prior to use in boilers), water-based coolant (this water should also be softened or passed through a DI unit prior to use as make up).
- Can be used in deburring operations, floor cleaning operations, rinse operations, watering lawns, etc.

Closed loop recirculating with open cooling tower
Closed-loop recirculating open tower systems use the process of evaporation to cool the water (evaporative loss is made up with fresh water). There are not many options for reducing water usage used in this type of system. If the cooling tower supplies water to several different units, the installation of temperature control valves or timers to reduce the flow rate through the equipment should be considered. This will reduce the pumping capacity at any one time (this is more of an energy reduction technique than water reuse technique). Proper control of blow down and bacteria, slime molds and algae build up is very important to proper tower operation.

Generally the blow down from cooling towers is not used for other water reuse purposes in the plant due to high dissolved solids.

Closed loop with either water or air cooled heat exchanger
This type of system does NOT have any water discharge (except during maintenance) so very little potential for reducing water usage and discharge exist.

TIP - Make up for this type of system should be either DI or softened water.

Deburring and Mass Finishing

The water discharged from deburring and mass finishing operations contains soaps, rust inhibitors, rock flour and abrasives. Normally, this water is used once and discharged to the sewer. This water can be purified and reused in much the same way as cleaning solutions:

- Solids can be removed by settling, filters, centrifuging, etc.
- Oil and grease can be removed by flotation and skimming.

> ***TIP*** *- By keeping the purification methods simple, many of the additives, such as soap and rust inhibitors are not removed and can therefore be reused along with the water*

Boiler Blowdown

Periodically, suspended and dissolved solids build up in steam boiler systems, and are "blow down" or discharged to the sewer. Several methods are used to minimize these discharges. Minimizing the production of steam, if feasible, is the first step in reducing boiler blowdown. When deionized water is used as the boiler feedwater, relatively small additions of chemicals are made to control pH and scavenge oxygen (which reduces corrosion).

It may be possible, if a cooling tower is nearby, to pump the boiler blowdown to the cooling tower sump, gaining a dual use of the boiler water and substituting the cooling tower blowdown for that of the boiler. The cooling tower must have the capability to handle the additional thermal load. If boiler feed water is city water softened by chemicals, then the boiler blowdown may require treatment before discharge. Recirculation of the treated blowdown to a cooling tower or other process should be investigated.

Wastewater from Cutting and Blasting

High pressure jets of water, with or without suspended abrasive, may be used to cut a variety of substances. After use, this water is discharged to the sewer. Again, several methods exist to reduce these discharges.

When metal is being cut, some suspended particulate metal may be generated and some slight amount of metal may be solubilized. The wastewater can be filtered to remove particulate and recycled to the cutting operation. In some cases, it may prove possible to recover and reuse the filtered abrasive. The concentration of dissolved metals can be controlled by using ion exchange treatment, or by blowdown with makeup using fresh water.

When non-metals (plastics, paper, wood) are being cut, an in-line filter may suffice to remove particulate so that the water may be recycled. If dissolved material accumulates, a blowdown or treatment may be used to manage the concentration of dissolved matter.

Occasionally grit or sand blasting may be performed using water as the medium of transport. The treatment in this process is essentially the same as for cutting: filtration, recovery and reuse of grit if possible, recirculation of water with dissolved solids controlled by blowdown or ion exchange.

Wastewater from Air Pollution Control Equipment

When a wet scrubber is used to control air pollution, the scrubber effluent becomes a wastewater stream. Air pollutants collected in wet scrubbers include particulate matter, acid gases, volatile organic compounds (VOC's), and some odor-causing compounds. Working to reduce the amount of air pollutants generated is a cost effective step to minimize this wastewater stream.

Particulate matter may be removed by settling and clarification and the settled sludge can be dried and landfilled. The clarified water may be recirculated to the scrubber except for a small blowdown which can be used to limit the buildup of dissolved material.

Usually caustic is added to acid gas scrubber water to neutralize the acid, producing soluble salts. Much of this water can be recirculated provided a blow down is used to limit the concentration of dissolved material. If lime is used to neutralized acid gas, insoluble salts may be produced. The treatment to remove these salts is similar to that in the previous section : Wastewater from cutting and blasting.

If water is used to scrub out VOC's, the scrubber effluent will require treatment in a biological plant or with granular activated carbon (GAC). Usually more cost effective methods of controlling air-borne VOC's are available, such as bio-filters.

When water is used to scrub out odors, some oxidizing agent, (e.g., permanganate, peroxide, etc.) is added to the scrubber influent. Typically the wastewater contains salts and other dissolved materials, and can be handled like wastewater from acid gas scrubbing.

Wastewater reduction methods include: 1) Reduce flow to scrubbers to the minimum required to meet air permit limits, and 2) Consider using a dry process for control of air contaminant concentrations.

Water-Based Metalworking Fluids

Spent metalworking fluids may be discharged to the sewer or disposed off-site by a waste hauler. Prolonging the life of the fluids will reduce disposal costs and may reduce discharge to the sewer.

No matter what part of a company's operating budget metalworking fluids represent, their effect on overall costs and productivity can be huge. A good fluid management program extends the useful life of metalworking fluids and has economic and environmental advantages.

- Improve quality and repeatability
- Decrease costs of disposal for spent fluids
- Less downtime for machine cleanouts and recharges
- Cleaner work environment and improved health conditions

Please refer to the *"Shop Guide to Reduce the Waste of Metalworking Fluids"* for further details.

Case Study

An article in *Environmental Waste Management* Magazine, September 1990, reviewed a Metal Stamping Company in Chicago specializing in the manufacture of drawn shells , switch housings, steel jackets, barrels, and artillery shell cups. They had been using both a non-petroleum, water-based synthetic coolant, as well as a petroleum-based lubricant in their transfer presses. Using these substantially reduced the life of the coolant. To replace their method of disposal (skimming tramp oil into 55-gallon drums and then brokering it to another firm), the company installed a portable ultrafiltration system. With this new system the company volumetrically reduced their wastewater, reducing the concentration of oily waste to 16 gallons or 29% water/drum (from 40 gallons and 73% water/drum), as well as increasing the fuel evaluation per drum to approximately 12,600 BTU's/lb. (up from 2,700 BTU). These reductions compiled a savings of $155/drum and an annual savings of $17,625. The total net savings in the first year alone was approximately $10,900, which resulted in subsequent annual savings in the $14,000 range.

Air Compressors

Water condensation from air compressors generally contains lubrication oil, which may require treatment depending on the concentration and discharge location. The use of oil skimmers or carbon filtration units may be used to reduce the level of oil in the wastewater discharge. Compare the capital, installation, and maintenance costs of installing an oil treatment system versus purchasing a new, more efficient air compressor system. New air compressors may use newer, less polluting technology.

WASTEWATER TREATMENT AND RECYCLING TECHNOLOGIES

Wastewater (such as aqueous cleaning solutions) ca
reused by filtering out contaminants and reusing (re
solution. Filtration can be done either on-line or by
larger processes, a large settling tank, skimmer, and
the return lines to continuously clean the solution.
it is generally more cost effective to have a small, s
that may also include floating oil coalescer, cyclone
ultrafiltration or microfiltration unit, or other techn

Figure 6 illustrates the division of equipment used
from wastewater.

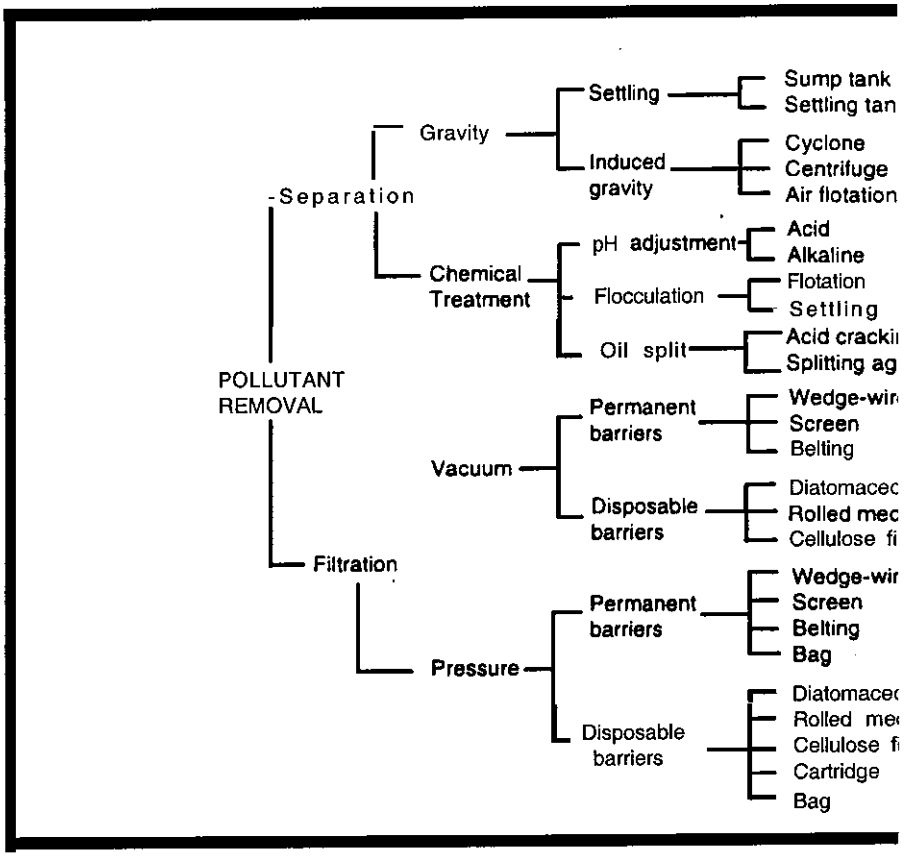


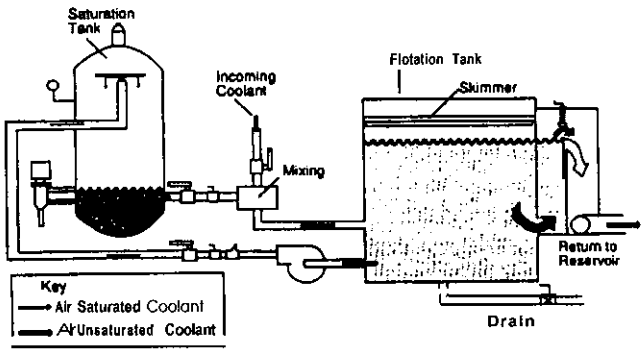
Figure 6.

As mentioned previously, wastewater is the sum of
combined with the original makeup water. The opti
therefore, will be based in part on the type and volu
used in the separation.

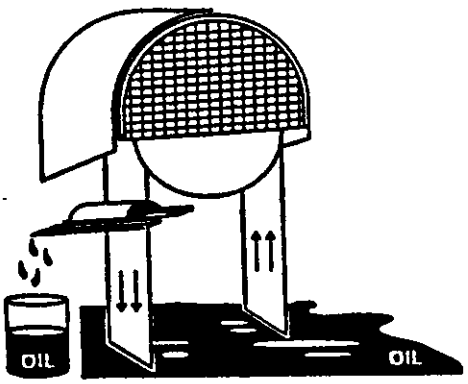
Wastewater treatment and reuse can be accomplish
systems or a combination of equipment listed in the

Proven technologies for treating wastewater for recycling are described below:

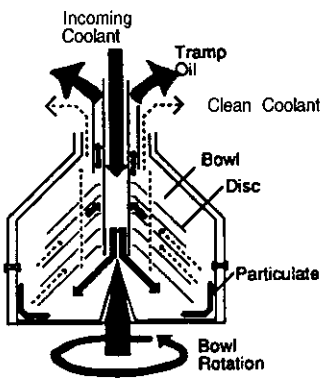
Method	Description
Air floatation unit	A device that uses aeration to float the solids and oil to the surface of the fluid where they are skimmed away.



Belt skimmer	A skimmer belt attracts oil and scrapes it into oil container.



Centrifuge	A rotating bowl that uses centrifugal forces to separate solids and oils.



Chemical Precipitation

Chemical treatment products are added to waste solutions to precipitate and coagulate dirt, oil and dissolved metals, allowing the resulting sludge to be skimmed off or 'dropped' to the bottom of a vessel.

Clarifier

Vessel in which the resultant sludge ('floc') of coagulated dirt, oil and metals is skimmed off or 'dropped' to the bottom of the vessel.

Cloth filter

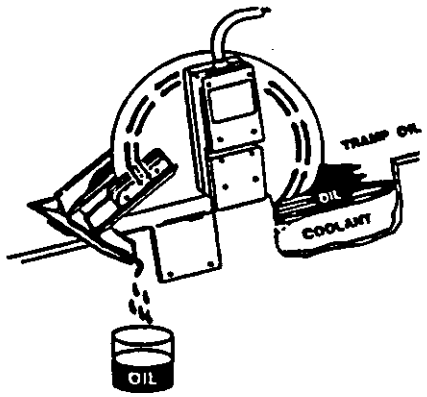
The solution drains through cloth filter media to remove solid materials.

Coalescer Tank

Plastic media that attracts oil to promote formation of oil 'floats' that can be skimmed off.

Disc skimmer

Skimmer disc attracts tramp oil and scrapes it into an oil container.



Drag tank

A tank with an automatic drag bar or rake device to remove metal shavings and other settled solids.

Evaporation

Waste solution is boiled, causing the water phase to be vaporized and exhausted, the free oils to be removed through an ovefflow weir, and solids to be settled and removed through a bottom port.

Filter press

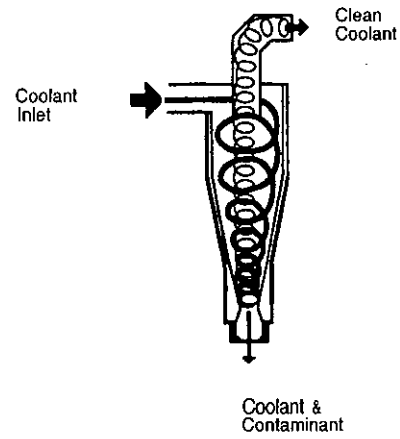
Hydraulic press used to remove the water ('dewater') from the sludge created from the chemical coagulation of dirt, oil and dissolved metals. Typical resulting sludge 'cake' is between 35 to 60% solids.

Granulated Activated Carbon (GAC)

A treatment compound that adsorbs certain pollutants such as organic chemicals, chlorine, and low levels of heavy metals.

Hydrocyclone

A cyclonic device that separates solids from the solution.



Ion Exchange

Ion exchange (IX) resin beads remove dissolved metals from waste stream. Resin tanks are shipped back to manufacturer for reconditioning or reconditioned in-house.

Microfiltration

Solution is pressurized and passed through cylindrical tubes containing a semi-permeable membrane, with 'cleaned' solution (called "permeate") passing through membrane, while dirty fluid is concentrated, recirculated and eventually pumped out for off-site disposal. Particle size removal down to 1 .O microns.

pH adjustment system

Solution's pH (alkalinity or acidity) is modified prior to reuse or treatment.

Reverse osmosis

A process that reverses (by the application of pressure) the flow of water in the natural process of osmosis so it passes from the more concentrated to the more dilute solution. Removes dissolved metals and other ions from the solution or waste stream.

Pressure filter

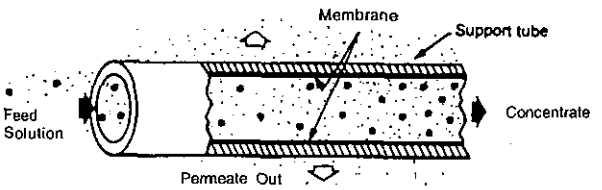
Solution is forced under pressure through a canister or bag filter media.

Settling tank

A tank containing baffles and weirs to assist in the settling of solids.

Ultrafiltration (UF)

Fluid is pressurized and passed through cylindrical tubes containing a semi-permeable membrane, with 'cleaned' fluid (called "permeate") passing through membrane, while dirty fluid is concentrated, recirculated and eventually pumped out for off-site disposal. Particle size removal down to 0.01 microns.



Vacuum Distillation

Water-based waste is boiled in an enclosed vessel under vacuum, the vapor is then condensed to a pure distillate, leaving contaminates or reclaimed chemicals behind

Vacuum filter

Solution is pulled by vacuum through a roll or cylinder media.

WASTEWATER REDUCTION TECHNIQUES

Waste reduction can actually improve the materials efficiency of a given plant operation, leading to improved manufacturing efficiency. By reducing waste at its source, less wastewater is generated, leading to decreased costs for materials handling and the handling, treating and disposing of wastewater.

Each and every operation must be carefully reviewed so that the best one may be selected. There is no substitute for careful analysis and a *new approach* to the problem of waste reduction. There is no one best solution that will fit every situation, since each situation is unique. The challenge of improving an operation in a cost effective manner can result in a very satisfying conclusion.

Process Changes

The first step in reducing wastewater streams is to carefully review the process which produced the waste water. Ask "what can be done to change, or even eliminate the process and reduce the waste water at the same time." The key is to deterrnine the real need for the process, what function is being served and why is the process needed.

TIP - Think of the action in terms of the value it delivers; reduce each process to a description that contains two words, a noun and a verb, e.g., "clean parts."

TIP - In order to reach a definition of the "root need/reason for the process, ask the question in terms of "why do we really perform or need this process? " Ask this question at least two or three times, or until the root reason has been uncovered.

There are five basic ways in which a process change could result in a reduction of waste water streams. (Don't be limited to these, however; the unique situation may result in additional basic approaches. Remember, this is the time to thoroughly study the process, or processes in question.) Now is the time to be creative.

- **Eliminate the Process -**
  This is always the first step. Ask the question, is this process really needed, or, what would happen if the process were eliminated. If a process does not add enough value, it should be discontinued. (This is a somewhat subjective issue, and must be done with great care, involving a team of individuals with a wide range backgrounds.)

- **Eliminate the Use of Water -**
  How might water be totally eliminated from the process? Would some other material be an appropriate substitute?
  Can a dry lubricant be substituted?
  Can the product be used as received at this operation?
  Can air be used in place of coolant when machining parts?
  Can carbon dioxide pellet or carbonate blasting be substituted for cleaning operations?
  Have abandoned water lines removed to eliminate water leaks.

- **Reduce the Use of Water -**
  How might water usage be reduced, or how can a lower volume of water still perform the same function?
  Reduce the flow of water. Turn off the water when the process is shut down.

- **Recycle or Reuse the Water, A Closed System -**
  Consider how a closed system could be established that would constantly reuse the water rather than discarding it. Use treatment technologies to remove unwanted contaminants and return the water to the process.

- **Use the Water Discarded in Other Processes -**
  Can the waste water from this process be used successfully in another process?
  For cooling water, take the heat generated and absorbed in the cooling water and use it in another process.
  Non-potable water can be used in plant facilities i.e. - toilets, urinals, boiler feed water, cooling tower make-up, and landscaping.

Water Conservation Techniques and Reuse

The water quality requirements for each specific plant operation may different. For example, the quality of water used in a final rinse will be different than that used for cleaner makeup. It is important to determine the aualitv of water needed for each oneration; only then can a plant-wide reuse program be implemented.

Tracking Water Usage

Before anything else is done, determine the amount of water used (total volume) and where it is used must be documented. A careful accounting of the water usage cannot be overemphasized. For example, to make a plan for any trip, the starting point must be known. The destination is the next step. So the first step in water conservation and reuse is to list each process that uses water and the volume of water consumed during a given time span. Installing water meters on the in-line side of each major process will provide a good measure of water consumption over time.

***TIP** - A simple plot of the water consumption over time can be extremely useful. It will graphically show the long term trend (up or down), and when the peak volumes occur From this data a prediction about what to expect in the future can be made. (Caution: be sure to obtain input from a variety of people when creating a forecast for the future. For example, if a product line is going to be moved to another plant, this must be included in the forecast.)*

Selection of the time frames for the analysis is a vital step. For a long term overview, monthly data may be sufficient, and going back two or three years may be appropriate if that time frame is consistent with future plans and growth. But don't forget the short term data as well. A daily plot by the hour can have real value when trying to determine what is occurring in the facility and what for example, clean-up or other processes, occur during the night shift. Taken in perspective, the yearly, monthly, weekly and daily plots of water usage will provide significant data and understanding for the next phases of the study.

***TIP** - A chart of descending water usage in the plant will identify what processes use the most water and which use the least. (Obviously, we should begin our quest for reduction where we have the most opportunity!) A plot of the water use for the high volume process would be helpful in determining why the volume is high and how it can be reduced. (For help in these analyses, work with Quality Assurance Engineers or Manufacturing Engineers.)*

By knowing how much water is used, when it is used, where it is used, and it's quality in and out, the next phase of the project can be initiated: figuring out how to *control* the volume of water being consumed.

Employee Education

All associates who can impact the volume of water being used must be advised of the project to reduce the volume of water being used. Each individual aware of the reduction project, becomes a potential input into the process of learning how to reduce waste water flow.

***TIP** - The individual(s) who work daily with the process being studied for wastewater reduction are the most knowledgeable people on what is really going on with that process. They observe it minute by minute, and have a keen understanding of what might be done to assist the project successfully. In short, they are a substantial resource that must be used.*

To create a more effective involvement, individuals must be trained in waste reduction techniques, pollution prevention, and the cost of disposal of wastewater. Trained and involved associates will become committed to the effort and have an interest in the success of the program.

Reuse Water that Requires no Treatment

Process water that does not become contaminated and requires no treatment for use in a given process is an excellent candidate for reuse. There is no reason to throw away a resource if it can be readily reused without any negative impact on the process in question.

The key to this approach is to be certain that the water is not contaminated. In some closed loop systems, the water is kept from contact with any outside material. It performs its function by way of a transfer mechanism. (An example of this is the cooling water in an automobile and the transfer of heat.) When a closed loop system is open to the atmosphere or other potential source of contamination, care must be exercised to monitor the water for potential damaging contaminants.

Case Study

A 1992 USEPA Environmental Research Brief [EPA/600/S-92/0 15] summarized recommendations for waste minimization for a manufacturer of metal bands, clamps, retainers, and tooling. Four practices being utilized by the manufacturer were outlined. Tap-water from the metal cleaning process is being used as the make-up. Redirecting the rinse water overflow from the cascade rinse and using it instead resulted in cost savings and waste reduction by having reduced the amount of water being purchased and sewered. The waste reduction totaled an estimated 650,000 gal per year, saving approximately $1 ,100/yr with a payback of only 0.4 years. The draining time for parts over caustic cleaner and electrosoap tanks is only around 5 seconds. Increasing this time to 10 seconds increased the amount of solution draining back into the tank subsequently increasing the bath lifetimes. Through a minor process change, the waste reduction savings estimated 250 gal/yr saving $340 annually, with an immediate payback. In the metal cleaning line, the tap-water and cascade rinse rates were set much higher than required. Installing flow reducers with flow meters on the rinse tanks substantially reduced water usage allowing for the reduction of approximately 125,000 gal/yr of wastewater. This is estimated to save about $220/yr with a payback of 0.6 years.

Turn Off Water During Periods of Non-use

This obvious action is often overlooked in the press of other activities, and especially at shift changes. Educating for the individuals involved will help establish new habits. Water valves can be manually or automatically opened or closed based on the specific needs of the operation.

> ***TIP*** *- Develop a cost* for *water use during periods when it is not needed but left "on ". Knowledge of the cost of any wasteful activity focuses attention on and increases awareness of that activity.*

Most individuals will respond to requests to shut off water once they understand why the request is made and the negative impact on cost.

> *TIP - One easy way to learn what water sources are left running is to tour the plant during a full shut down. Running water can be heard much more readily than when the noise of production masks the noise of the water. Performing these checks on a regular basis helps to gauge how well the education program is doing.*

Figure 4 on page 10 illustrates typical methods used to reuse and conserve water usage in a metalworking plant.

IMPLEMENTING WASTE REDUCTION

The methods suggested in the previous sections should spark some ideas of cost-effective waste reduction techniques that can be used in many shop operations. Outlined below are two ways in which a company can implement a waste reduction plan.

Setting Up a Waste Reduction Team

Consider setting up a Waste Reduction Team at each facility to identify, plan, and implement a waste reduction strategy. Draw on other resources within the company to assess all aspects of the program:

Include personnel from production, maintenance, engineering, purchasing, management and accounting
Identify waste sources and their associated overall cost
Give this *manual* to each team member to help spark ideas
Review the following areas:

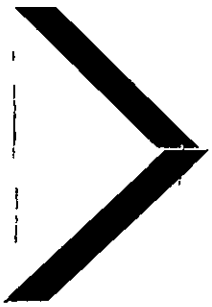
1. General housekeeping
2. Water conditions
3. Waste source
4. Gather information from vendors and other resources (listed in the ***"Where To Go To Learn More"*** and ***"Vendor Guide"*** of this manual)
5. Evaluate the performance, economics and quality impact of all alternatives
6. Implement improvements that make the most sense
7. Measure and report the cost savings to the team and management
8. Motivate the team and foster continuous improvement
9. Make corrections to the process as necessary

A plant *Self Assessment Survey* is included in the next section as a suggested starting point. Completing the assessment survey is a time consuming task. By adding their input and recording factual data, each team member will assist the others to understand what goes into the program to achieve and maintain high production output and minimize wastewater from all operations of the plant. The data gathered and recorded will aid in identifying the real cost for purchasing, storing, using, and recycling, and disposing of wastewater.

Outlined below are the suggested steps for a successful waste reduction program:

Waste Reduction Process:

- Form Waste Reduction Team
- Define Goals
- Complete Assessment Process
- Develop Strategy & Design
- Implement Waste Reduction
- Train Employees
- Continue Support



Results:

- Employee Awareness
- Waste Reduction
- Technology Transfer
- Improved Efficiency

SELF ASSESSMENT SURVEY

Directions: Collect data for a plant water use survey by doing the following:

1.a) Get the total usage from the water and sewer bills (usually in cost per 100 cubic feet (ccf)):

b) Calculate total water usage in gallons per month: (calculation: No. of ccf x 745 = No. of gallons per month)

e) Estimate or measure the individual usages in gallons per day (GPD) or convert gallons per minute (GPM) to gallons per month (see d below). (This can be accomplished by using a meter, or stopwatch and measuring flow into a bucket or drum.)

d) Convert GPM to gallons per month. (Calculation: No. of GPM x 60 min/hr = gal/hr x hrs of operation per day = gallons/day x No. of working days = gallons per month.)

2. **List the results of your survey in TABLE I below:**

TABLE I -- Monthly Water Usage

	Quantity	Percentage
Plant Water Usage	**(gal/mo)**	**(%)**
Sanitary (sinks, toilets, showers)		
Parts Cleaning		
Cooling		
Floor Cleaning		
Water-based Metalworking Fluids		
Deburring & Mass Finishing		
Boiler Blowdown		
Cutting		
Blasting		
Air Pollution Scrubbers		
Other		
Total of all uses:		100%

3. **Determine the cost per month for water and sewer. Fill out Table II below:**

TABLE II -- Cost Per Month for Water and Sewer

	QUANTITY	QUANTITY	COST
CHARGES	**(ccf)**	**(gallons)**	**(month)**
Water Charges			
Sewer Charges			
Sewer Surcharges			
Sewer Deducts for Product or Evaporation losses			

SELF ASSESSMENT SURVEY (continued)

5. **Compare your usage to a benchmark.**
   a. A typical metal fabrication shop uses:
   Calculation *: # employees x 50 gallons per day (GPD)/employee = total GPD*
   b. How many gallon per day should my shop use? (No. of ***employees x 50GPD/employee)*** _____GPD
   c. My shop uses _____ GPD (gallons per day)
   d. How do you compare to the industry average? Above or below?
   e. Do you need to look at water use reduction? Yes or no?

6. **Look at potential for reducing water use in your plant by using:**

   Cleaning & Rinsing:
   - using flow nozzles
   - conductivity controls for rinses
   - rinse tank agitation
   - counter-flow rinses
   - static or recovery rinses
   - drag out reduction

   Practices & Procedures
   - tracking and posting shop water use
   - employee training
   - turning off flowing water at night, on-breaks etc.

   Water Reuse
   - Reuse boiler blowdown for cleaning
   - Reuse cooling water for cleaning
   - Reuse rinse water for making up cleaning solutions

   TIP: Concentrate on your biggest water users first.

7. **Have you developed procedures to prolong cleaner life and to decide when to dump tanks and rinses?**
   - Do you use skimmers, filters or chemical additions to prolong life?
   - Do you test cleaning solutions to determine when to make-up and when to dispose?

8. **Have you developed methods and procedures for cutting fluid maintenance?**
   - Do you have a schedule for dumping cutting fluids?
   - Do you use skimmers, filters or chemical addtions to prolong life?
   - Do you test cleaning solutions to determine when to make-up and when to dispose?

SELF ASSESSMENT SURVEY (continued)

9. **List in TABLE III below your water quality requirements for water reuse and/or sewer discharge:**
   - What is the quality of your current raw water (city water)?
   - What is the quality of your current wastewater discharge?

TABLE III -- Water Quality Requirements

Parameter	Current Wastewater	Sewer Discharge Limits	Requirements for Water Reuse	Raw Water Supply
Oil & Grease				
Copper				
Chromium				
Nickel				
Cadmium				
Lead				
Total Susnended Solids				
Biochemical Oxygen Demand				
pH				
Total Kejdahl Nitrogen				
Surfactants				

10. **Have you considered options for or sought expert advice in water treatment & reuse technologies?**

a. Oil separation (removes oil and grease)
   - skimmers
   - belts
   - splitting
   - dissolved air flotation

b. Evaporation (reduces volume)
   - high temperature
   - vacuum

c. Chemical Additions (forms floc or controls pH)
   - coagulation
   - flocculation
   - neutralization

d. Physical Separation (removes solids)
   - Settling, filtration, centrifugation
   - Membranes (UF and RO)
   - Adsorption (grannular activated carbon)

---------- END OF SURVEY----------

RESOURCES: WHERE TO GO TO LEARN MORE

State Pollution Prevention Offices - Most states provide non-regulatory pollution prevention technical assistance for industry. Call the National Pollution Prevention Roundtable (202-466-7272) to learn about a particular state's options.

The U.S. Environmental Protection Agency (EPA) - provides free technical information on a variety of pollution prevention topics and cleaner technologies. For a publications list contact: CERI Publications Unit, US EPA, (5 13-569-7562). A wealth of information is available from Enviro$ense, EPA's environmental information system. Enviro$ense can be found via the World Wide Web (Internet) at http:// wastenot.inel.gov/envirosense.

The Independent Lubricant Manufacturers Association (ILMA) is a trade association that provides information on metalworking fluids and lubricants. (703-836-8503) ILMA has published an excellent collection of articles titled, *Waste Minimization and Wastewater Treatment of Metalworking Fluids, 1990.*

Institute of Advanced Manufacturing Sciences (IAMS) provides both waste reduction technical assistance and expertise in machining and machine tool technology. Related courses are offered regularly at their training facility in Cincinnati: *Practical Machining Principles for Shop Application, Grinding Principles and Practice, and Centerless Grinding Principles.* IAMS also has published the *Machining Data Handbook, 3rd Edition (1980),* (call 5 13-948-2000). Additionally, the Institute also has an excellent Information Center for both research and applied environmental technologies_. Internet home page: *http://www. iams. org*

Waste Reduction and Resource Center (WRRC), 1-800-476-8686, provides multimedia waste reduction information supported by reports, contact lists, referrals, case summaries, seminar support, on-site technical assistance, vendor files and a video library. Provides support in FL, GA, KY, MI, NC, SC, TN, DE, DC, MD, PA, VA, and WV.

Waste Reduction and Technology Transfer (WRATT) Foundation provides free, confidential, voluntary, non-regulatory assessments for business and industry and conducts training programs on waste minimization call: (205) 386-3869.

GLOSSARY OF TERMS

Aqueous	Water-based solution, typically used for cleaning, etching, or modifying surface characteristics. Have replaced many solvent cleaning operations in recent years.
Biocide	An EPA registered product added to aqueous solutions to inhibit the growth of bacteria, fungi, and molds. Typically used in cooling towers and metalworking fluids.
Biomass	Biological treatment system that utilizes naturally occurring bacteria.
BOD	Biochemical oxygen demand of water; a measure of the oxygen required by bacteria for oxidation of the soluble organic matter under controlled test conditions.
Coagulation	The neutralization of the charges of colloidal matter.
Coalescence	The gathering together of coagulated colloidal liquid particles in to a single continuous phase.
COD	Chemical oxygen demand; a measure of organic matter and other reducing substances in water.
Concentrate	Agents and additives that, when added to water, create a cleaning solution or other type of fluid.
Coolant	Fluid that reduces temperature buildup at the tool/workpiece interface during machining
Cutting Fluid	Liquid used to improve workpiece machinability, enhance tool life, flush out chips and machining debris, and cool the workpiece and tool. Three basic types are: straight oils: soluble oils, which emulsify in water; and synthetic fluids, which are water-based chemical solutions having no oil. Each category often exhibits some properties of the other.
Deionization (DI)	Removal of ions from a water-based solution, usually by resins.
Eductor	A simple chemical/water proportioning device that operates based on a pressure drop across an orifice. Used typically for automatic make-up of aqueous and semi-aqueous cleaning solutions.
Electrolyte	A substance that dissociates into two or more ions when it dissolves in water.
Emulsion	Suspension of one liquid in another, such as oil in water.
Filtrate	The liquid remaining after removal of solids as a cake in a filter.
Filtration	The process of separating solids from a liquid by means of a porous substance through which only the liquid passes.
Flocculation	The process of gathering coagulated particles into settleable flocs.

Hazardous	Having a negative affect on the environment or posing a threat to human health.
ILMA	Independent Lubricant Manufacturers Association.
Inhibited	A cleaning produced that contains chemicals to help reduce the corrosion of soft metals.
Ion Exchange (IX)	A process by which certain ions of given charge are absorbed from solution within an ion-permeable absorbent, being replaced in the solution by other ions of similar charge from the absorbent.
Lubricant	Substance that reduces friction between moving parts. Can be liquid (hydrocarbon oil), solid (grease), or gaseous (air). Important characteristics are to prevent metal-to-metal contact between moving surfaces, be a cooling medium, and protect surfaces from rust and corrosion.
Lubricity	Measure of the relative efficiency with which a cutting fluid or lubricant reduces friction between surfaces.
Membrane	A barrier, usually thin, that permits the passage only of particles up to a certain size.
Microfiltration	A physical molecular separation process which operates at moderate pressure (30 psi) through a semi-permeable membrane.
Miscible	Ability of a liquid to mix with another liquid.
MSDS	Material Safety Data Sheet required by OSHA for all industrial chemicals.
NPDES Permit	The National Pollution Discharge Elimination System permit required by and issued by EPA.
OSHA	Occupational Safety and Health Administration. Regulates health and safety standards in the work place.
PH	A means of expressing hydrogen ion concentration in terms of the powers of 10; the negative logarithm of the hydrogen ion concentration. Used to measure the relative acidity or alkalinity of aqueous or semi-aqueous cleaning solutions.
Pollutant	A contaminant at a concentration high enough to endanger the environment or public health.
POTW	Publicly Owned Treatment Works for sewage treatment.
Precipitate	An insoluble reaction product in an aqueous chemical reaction, usually a crystalline compound that grows in size to become settleable.
Rag	Debris that accumulates at an oil-water interface.
RCRA	Resource Conservation and Recovery Act. Regulates the generation, transportation, treatment, storage and disposal of hazardous solid waste.

Reverse Osmosis (RO)	A process that reverses (by the application of pressure) the flow of water in the natural process of osmosis so that it passes from the more concentrated to the more dilute solution.
SARA	Super-fund Amendments and Reauthorization Act. Contains the Emergency Planning and Community Right-to-Know Act.
Sedimentation	Gravitational settling of solid particles in a liquid system.
Semi-aqueous	Partially water-based solution, typically used for cleaning, etching, or modifying surface characteristics. Contain some level of solvent Have replaced many solvent cleaning operations in recent years.
Semi-synthetic Cutting Fluid	Water-based chemical solution that contains some oil.
Separation	Removes the particles from the fluid using a characteristic of the materials, i.e. density or magnetism. Separators randomly remove particles. A certain size of particle removal cannot be guaranteed.
Shop Air	Pressurized air system used for operating pneumatic pumps and systems.
Surcharge	An additional cost charged by a POTW to a wastewater discharger
Surfactant	A surface active agent; usually an organic compound whose molecules contain a hydrophilic (having an affinity for water) group at one end and a lipophilic (having an affinity for oil) group at the other (a detergent).
Swarf	Metal fines and grinding wheel particles generated during grinding.
TCLP	Toxicity Characteristic Leaching Procedure test method used by labs to determine if waste is classified as hazardous.
Titration	Testing method that uses reagents to determine concentrations of metalworking fluids and other chemical solutions.
Ultrafiltration (UF)	A physical molecular separation process which operates at moderate pressure (30 psi) through a semi-permeable membrane.
Viscosity	Measure of a fluid's tendency to flow; varies with temperature.
voc	Volatile Organic Compounds
Waste	An unwanted by-product of a manufacturing process.

Aqueous Cleaning, Wastewater Reuse, and Waste Treatment Equipment Vendors

This is an alphabetical guide of vendors for Aqueous Cleaners, Degreasers, Filtration Equipment, Wastewater Treatment Chemicals & Equipment, and other support materials used in the metalworking industry. Included is a list of each company's name, address, phone, fax, contacts, and product offering. This list is not comprehensive and represents some of the available vendors, products and services they offer.

Company Name	Address	City	St	Zip	Phone#	Fax#	Equipment Listing
A.M.L. INDUSTRIES, INC.	3500 DAVISVILLE ROAD	HATBORO	PA	19040	215-443-7878	215-674-3252	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
ABANAKI CORPORATION	17387 MUNN ROAD	CHAGRIN FALLS	OH	44023	216-543-7400	516-543-7404	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
ADF SYSTEMS, LTD.	1301 19TH ST. N.	HUMBOLDT	IA	50548	515-332-5400	515-332-4475	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
ADVANCED ENGINEERING	2544 BARRINGTON CT.	HAYWARD	CA	94545	510-293-5900	510-293-5948	AQUEOUS CLEANING - DEGREASING|CLEANING - NOS|CLEANING - DEGREASING
ADVANCED RECOVERY TECHNOLOGIES CORP	4784 EVANSTON AVENUE	MUSKEGON	MI	49442	616-788-2911	616-788-2317	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
AFL INDUSTRIES, INC.	3661 W BLUE HERON BLVD	RIVIERA BCH	FL	33404	407-844-5200	407-844-5246	MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT
ALFA LAVAL SEPARATION INC.	955 MEARNS ROAD	WARMINSTER	PA	18974-0556	215-443-4000	215-443-4112	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
ALKOTA CLEANING SYSTEMS	P.O. BOX 288	ALCESTER	SD	57001	605-934-2222	605-934-1808	CLEANING - AQUEOUS|CLEANING - NOS|EQUIPMENT MAINTENANCE - NOS
ALLEN FILTERS, INC.	P.O. BOX 747	SPRINGFIELD	MO	65801	417-865-2844	417-865-2469	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT
ALMCO INC.	902 EAST MAIN STREET	ALBERT LEA	MN	56007	507-377-2102		EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| - EFFLUENT|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
AMERICAN COLLOID COMPANY	1500 W SHURE DRIVE	ARLINGTON HEIGHTS	IL	60004	708-392-4600	708-506-6199	MACHINING - COOLANTS / CUTTING OILS| - EFFLUENT|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
AMERICAN METAL WASH INC.	360 EUCLID AVENUE	CANONSBURG	PA	15317	412-746-4203	412-746-5738	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
APPLIED MEMBRANES INC.	110 BOSSTICK BLVD	SAN MARCOS	CA	92069	619-727-3711	619-727-4427	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| |WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
APPLIED TECHNOLOGY	517 WEST 46TH STREET	MINNEAPOLIS	MN	55409	612-825-6111		CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
AQUA MAGNETICS INTERNATIONAL, INC.	915-B HARBOR LAKE DRIVE	SAFETY HARBOR	FL	34695	813-447-2575	813-726-8888	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
AQUALOGIC, INC.	30 DEVINE STREET	NORTH HAVEN	CT	6473	203-248-8959		CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
BALER EQUIPMENT COMPANY	PO BOX 25150	PORTLAND	OR	97225	503-292-4118	503-297-5991	CHEMICAL MANUFACTURING|FOOD PROCESSING| |PAPER MANUFACTURING|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
BARR & MURPHY INC.	17W755 BUTTERFIELD ROAD, SUITE 27	OAKBROOK TERRACE	IL	60181	708-261-7161	708-627-3039	WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
BECKART ENVIRONMENTAL, INC.	6900 46TH ST.	KENOSHA	WI	53144	414-656-7680	414-656-7899	CHEMICAL MANUFACTURING|CLEANING - CLEANING - NOS| |MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - NOS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|
BETTER ENGINEER. MFG. INC.	5361 TOWN CENTER CRT	BALTIMORE	MD	21236	410-931-0000	410-931-0053	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
BIOTECH INTERNATIONAL, INC.	1005 WEST PARK ONE	SUGAR LAND	TX	77478	713-240-7880	713-240-7881	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - LUBRICANTS|EQUIPMENT MAINTENANCE - NOS|MACHINING - COOLANTS / CUTTING OILS
BLACKSTONE ULTRASONICS	9 NORTH MAIN ST.	JAMESTOWN	NY	14702	716-665-2340	716-665-2480	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
BLASER SWISSLUBE INC.	WESTGATE INDUSTRIAL PARK	GOSHEN	NY	10924	914-294-3200	914-294-3102	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - NOS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
BLUE WAVE ULTRASONICS	960 S. ROLFF STREET	DAVENPORT	IA	52802	319-322-0144	319-322-7180	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
BOCK ENGINEERED PRODUCTS, INC.	P.O. BOX 5127	TOLEDO	OH	43611	419-726-2645	419-726-8583	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
BON AQUA INTERNATIONAL, INC.	P.O. BOX 19047	GREENSBORO	NC	27419	919-294-7575	919-294-5644	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
BRANSON ULTRASONICS CORPORATION	41 EAGLE ROAD	DANBURY	CT	06813-1961	203-796-0400	203-796-0450	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
BUCKEYE INTERNATIONAL, INC.	2700 WAGNER PLACE	MARYLAND HEIGHTS	MO	63043	314-291-1900		CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
BUCKMAN LABORATORIES, INC.	1256 NORTH MCLEAN BLVD	MEMPHIS	TN	38108	800-BUCKMAN		CLEANING - WASTE WATER TREATMENT - OIL/SOLID REMOVAL
BURT PROCESS EQUIPMENT, INC.	1050 SHERMAN AVENUE	HAMDEN	CT	6518	203-287-1985	203-288-7354	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
CAROL COMPANY	1362 W. 9TH STREET	UPLAND	CA	91786	909-981-2947		CLEANING - AQUEOUS|EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - LUBRICANTS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
CINCINNATI MILACRON MARKETING COMPANY	PO BOX 9013	CINCINNATI	OH	45209	513-841-8121		CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
CONTAMINANT RECOVERY SYSTEMS, INC.	P.O. BOX 3868	CENTREDALE	RI	02911-3868	401-231-3770	401-231-3360	CHEMICAL MANUFACTURING|CLEANING - COATING APPLICATION|CLEANING - NOS| |MACHINING - COOLANTS / CUTTING OILS| |PAPER MANUFACTURING|WASTE WATER TREATMENT - NOS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE W
CPC ENGINEERING CORP.	441 MAIN STREET	STURBRIDGE	MA	1566	508-347-7344	508-347-7049	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
CULLIGAN INTERNATIONAL CO.	ONE CULLIGAN PARKWAY	NORTHBROOK	IL	60062	800-451-3260	708-205-6030	WASTE WATER TREATMENT - SOLID LIQUID SEPARATION, WATER TREATMENT
CUNO PROCESS FILTRATION PRODUCTS	400 RESEARCH PARKWAY	MERIDEN	CT	6450	203-237-5541	203-238-8977	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
D.R. SPERRY & COMPANY	112 NORTH GRANT STREET	NORTH AURORA	IL	60542	708-892-4361	708-892-1664	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
DEGREASING DEVICES	105 DRESSER ST.	SOUTHBRIDGE	MA	1550	508-765-0045		CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
DESALINATION SYSTEMS, INC.	1238A SIMPSON WAY	ESCONDIDO	CA	92029	619-746-4995	619-747-8253	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
DETREX CORPORATION	26000 CAPITAL AVENUE	REDFORD	MI	48239-2499	313-937-0600	313-937-0834	ASSEMBLY|CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - SOLDERING|CLEANING - VAPOR DEGREASING
DUBOIS CHEMICALS, INC.	255 EAST 5TH STREET, SUITE 1200	CINCINNATI	OH	45202	513-762-6000	513-762-6801	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
DURIRON COMPANY INC.	9542 HARDPAN ROAD	ANGOLA	NY	14006	716-549-2500	716-549-3950	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
DYNAMIC PROCESS INDUSTRIES	1900 WEST NORTHWEST HIGHWAY	DALLAS	TX	75220	214-556-0010	214-556-9149	MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
DYNATEC SYSTEMS	909 JACKSONVILLE ROAD	BURLINGTON	NJ	8016	609-387-0330	609-387-2060	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
EAGLEBROOK, INC.	1150 JUNCTION AVE	SCHERERVILLE	IN	46375	800-428-3311	219-322-2560	MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
EDJETECH SERVICES	22036 FAIRGROUNDS ROAD	WELLINGTON	OH	44090	216-774-7007		CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
EIMCO PROCESS EQUIPMENT COMPANY	PO BOX 300	SALT LAKE CITY	UT	84110	801-526-2000	801-526-2005	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT

Aqueous Cleaning, Wastewater Reuse, and Waste Treatment Equipment Vendors

Company Name	Address	City	St	Zip	Phone#	Fax#	Equipment Listing
ENERVAC CORPORATION	700 FRANKLIN BLVD.,P.O. BOX 98	CAMBRIDGE	ON	N1R 5S9	519-623-9890	519-623-8250	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - LUBRICANTS|EQUIPMENT MAINTENANCE - NOS|MACHINING - COOLANTS / CUTTING OILS
ENVIRO-PROCESS SYSTEMS	P.O. BOX 731	BRONXVILLE	NY	10708	914-965-0599	914-965-0789	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
ENVIRONMENTAL CONTROL SYSTEMS INC.|ECS	2220 PLAINFIELD PIKE	CRANSTON	RI	2920	401-942-1822		CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
ENVIRONMENTAL SERVICES GROUP	PO BOX 1257	ENGLEWOOD CLIFFS	NJ	7632	800-877-2436	201-569-1513	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
ENVIRONOMICS, INC.	955 INDUSTRIAL ROAD	SAN CARLOS	CA	94070-4117		415-592-1543	MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
EPOC	3065 NORTH SUNNYSIDE	FRESNO	CA	93727	209-291-8144	209-291-4926	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
ERTEL ENGINEERING COMPANY	PO BOX 3245	KINGSTON	NY	12401	914-331-4552		EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
ETUS, INC.	1511 KASTNER PLACE	SANFORD	FL	32771	407-321-7910	407-321-3098	MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
FACET QUANTEK, INC.	P.O. BOX 50096	TULSA	OK	74150-0096	918-834-2929	918-836-7383	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
FILTER SPECIALISTS, INC.|FSI INC.	P.O. BOX 735, 100 ANCHOR ROAD	MICHIGAN CITY	IN	46360	219-879-3307	219-879-0744	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
FILTERTECH	FAIRGROUNDS DRIVE	MANLIUS	NY	13104-0527	315-682-8815	315-682-8825	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - LUBRICANTS
FILTRONICS, INC.	1157 NORTH GROVE STREET	ANAHEIM	CA	92806	714-630-5040	714-630-1160	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
FLO TREND SYSTEMS, INC.	707 LEHMAN	HOUSTON	TX	77018	713-699-0152	713-699-8054	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
FLOTTWEG	7095 INDUSTRIAL ROAD	FLORENCE	KY	41042-6270	606-283-0200	606-283-9678	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
FLUORMATIC MIDWEST LTD.	875 N. ELLSWORTH AVE.	VILLA PARK	IL	60181	708-833-3200	708-530-8698	ASSEMBLY|CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - SOLDERING|CLEANING - VAPOR DEGREASING
FREMONT INDUSTRIES, INC.	4400 VALLEY IND. BLVD. N.	SHAKOPEE	MN	55379	612-445-4121	612-496-3027	CLEANING - AQUEOUS|CLEANING - NOS|EQUIPMENT MAINTENANCE - NOS
G.M.F. INDUSTRIES, INC.	PO BOX 6688	LAKELAND	FL	33807	813-646-5081	813-644-5049	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
GENERAL INDUSTRIES INC.	716 SOUTH JOHN STREET	GOLDSBORO	NC	27530	800-899-0132		CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
GHS ENVIRONMENTAL	12251-B FM529	HOUSTON	TX	77041	713-466-9600		CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
GLITSCH, INC.	P.O. BOX 3100	PARSIPPANY	NJ	07054-0918	201-299-9350		CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
GRAVER WATER	2720 U.S. HIGHWAY 22	UNION	NJ	7083	201-964-2400	201-964-7770	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| | WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
GRAVITY FLOW SYSTEMS INC.	P.O. BOX 525 34 NORTH CHURCH STREET	CARBONDALE	PA	18407-0525	717-282-6036	717-282-3081	WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
GRAYMILLS	3705 N. LINCOLN AVENUE	CHICAGO	IL	60613	312-248-8825	312-477-8673	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
GREAT LAKES ENVIRONMENTAL INC.	463 VISTA	ADDISON	IL	60101	708-543-9444	708-543-1169	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
GRISWOLD CONTROLS	2803 BARRANCA ROAD, P.O. BOX 19612	IRVINE	CA	92714	714-559-6000	714-559-6088	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
HENKEL CORPORATION	11501 GOLDCOAST DRIVE	CINCINNATI	OH	45249	513-530-7702	513-530-7711	BIOCIDE|FOOD PROCESSING|WASTE WATER TREATMENT - NOS|WATER TREATMENT
HOFFLAND ENVIRONMENTAL, INCORPORATED|ACS ENVIRONMENTAL	303 SILVER SPRING ROAD	CONROE	TX	77303	409-856-4515	409-856-4589	CHEMICAL MANUFACTURING|CLEANING - COATING APPLICATION|CLEANING - NOS| |MACHINING - COOLANTS / CUTTING OILS| |PAPER MANUFACTURING|WASTE WATER TREATMENT - NOS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE W
HUBBARD HALL INC.	PO BOX 790	WATERBURY	CT	06725-0790	203-758-5521	203-756-9017	MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
HUDSON INDUSTRIES	BOX 2212	HUDSON	OH	44236	216-487-0668	216-487-0811	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
HURRICANE SYSTEMS, INC.	PO BOX 687	JACKSON	MI	49204	517-787-3481	517-787-2349	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
HYDE PRODUCTS, INC.	28045 RANNEY PARKWAY	CLEVELAND	OH	44145	216-871-4885	216-871-1143	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
HYDRANAUTICS	8444 MIRALANI DRIVE	SAN DIEGO	CA	92126	619-536-2500	619-536-2578	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| | WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
HYDRO-FLO TECHNOLOGIES INC.	125 W. FAY AVENUE	ADDISON	IL	60101	708-543-8012	708-543-0470	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
HYDROCAL	22732 GRANITE WAY, SUITE A	LAGUNA HILLS	CA	92653	714-455-0765	714-455-0764	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
HYDROFLOW INCORPORATED	ONE NORTHWESTERN DRIVE	SALEM	NH	3079	603-898-3388	603-898-3408	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - NOS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
ILLINOIS WATER TREATMENT COMPANY	PO BOX 560	ROCKFORD	IL	61105-0560	815-877-3041		CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
INDUSTRIAL FILTER & PUMP MANUFACTURING COMPANY	5900 OGDEN AVENUE	CICERO	IL	60650-3888	708-656-7800	708-656-7806	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
INDUSTRIAL FILTERS COMPANY	9 INDUSTRIAL ROAD	FAIRFIELD	NJ	7004	201-575-0533	201-575-9238	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
INDUSTRIAL MAGNETICS INC.	1240 M-75 SOUTH P.O. BOX 80	BOYNE CITY	MI	49712-0080	616-582-3100	616-582-2704	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
INDUSTRIAL ULTRAVIOLET SYSTEMS, INC.	1501 MAIN STREET	TEWKSBURY	MA	1876	508-851-2855	508-640-0613	BIOCIDE|FOOD PROCESSING|WASTE WATER TREATMENT - NOS|WATER TREATMENT
INFILCO DEGREMONT INC.	PO BOX 71390	RICHMOND	VA	23255-1390	804-756-7500	804-756-7643	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
INLAND TECHNOLOGY INC.	2612 PACIFIC HIGHWAY EAST	TACOMA	WA	98424	206-922-8932	206-926-0577	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
INTERCONT PRODUCTS	2600 N WESTGATE	SPRINGFIELD	MO	65803	417-869-9549	417-866-0437	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
J.S. MANNOR MACHINE CORPORATION	427 EAST JUDD STREET	WOODSTOCK	IL	60098	815-338-8700	815-338-8711	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
JENSEN FABRICATING ENGINEERS, INC.	PO BOX 307D	EAST BERLIN	CT	6023	203-828-6516	203-828-0473	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
KOCH MEMBRANE SYSTEMS INC.	850 MAIN STREET	WILMINGTON	MA	1887	508-657-4250	508-657-5208	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| | WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT

Aqueous Cleaning, Wastewater Reuse, and Waste Treatment Equipment Vendors

Company Name	Address	City	St	Zip	Phone#	Fax#	Equipment Listing
KOMLINE-SANDERSON	12 HOLLAND AVENUE	PEAPACK	NJ	07977-0257	908-234-1000	908-234-9487	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
L&T TECHNOLOGIES, INC.	194 SOUTH MAIN STREET	WEST BRIDGEWATER	MA	2379	508-586-9972		CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| | WASTE WATER TREATMENT
LAKOS	1385 NORTH CLOVIS AVENUE	FRESNO	CA	93727	209-255-1601	209-255-8093	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - NOS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT
LANCO CORPORATION	1766 STEHOUWER N.W.	GRAND RAPIDS	MI	49504	616-791-9100	616-453-1832	CHEMICAL MANUFACTURING|CLEANING - COATING APPLICATION|CLEANING - MACHINING - COOLANTS / CUTTING OILS| - EFFLUENT|WASTE WATER TREATMENT - NOS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE W
LANDA	13705 N.E. AIRPORT WAY	PORTLAND	OR	97230	800-547-8672	800-535-0941	CLEANING - AQUEOUS|EQUIPMENT MAINTENANCE - LUBRICANTS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
LEWIS CORPORATION	102 WILLENBROCK ROAD	OXFORD	CT	06478-1033	203-264-3100	203-264-3102	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
LIQUID-LIFE SEPARATOR SYSTEMS|THOMAS PUMP COMPANY, INC.	2301 E. LIBERTY STREET	AURORA	IL	60504	708-851-9393	708-851-9397	CHEMICAL MANUFACTURING|CLEANING - COATING APPLICATION|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
MAN-GILL CHEMICAL	23000 ST CLAIR AVE	CLEVELAND	OH	44117	216-486-5300	216-486-1214	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
MASS TECHNOLOGY	808 13TH STREET	EAST MOLINE	IL	61244	309-755-1101		CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
MASTER CHEMICAL CORPORATION	501 WEST BOUNDARY	PERRYSBURG	OH	43551-1263	419-874-7902	419-874-0684	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
MCGEAN-ROHCO, INC.	2910 HARVARD AVENUE	CLEVELAND	OH	44105-3010	216-441-4900	216-441-1377	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
MCTIGHE INDUSTRIES INC.	P.O. BOX 928	MITCHELL	SD	57301	605-996-1162	605-996-1908	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
MEGATOR CORP	562 ALPHA DRIVE	PITTSBURGH	PA	15238	412-963-9200	412-963-9214	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
MEMTEC AMERICA/MEMCOR	5 WEST AYLESBURY ROAD	TIMONIUM	MD	21093	410-252-0800	410-628-0017	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
MEMTEK	28 COOK STREET	BILLERICA	MA	1821	508-667-2828	508-667-1791	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
METRE-GENERAL, INC.	9085 MARSHALL COURT	WESTMINSTER	CO	80030	303-430-0095	303-430-7337	MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
MIDBROOK INDUSTRIES	1745 HAMLIN ROAD	ROCHESTER HILLS	MI	48309	313-852-2490	313-852-5520	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TMT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPAR.
MONROE ENVIRONMENTAL CORPORATION	11 PORT AVENUE P.O. BOX 806	MONROE	MI	48161	313-242-7654	313-242-5275	CLEANING - AQUEOUS|EQUIPMENT MAINTENANCE - NOS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
NAPCO	PLYMOUTH IND. PARK	TERRYVILLE	CT	6786	203-589-7800	203-589-7304	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
NATIONAL FLUID SEPARATORS	827 HANLEY IND. COURT	ST. LOUIS	MO	63144	314-968-2838	314-968-4773	MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
NEUTRALIZATION TECHNOLOGY, INC.	2485-A AUTUMNVALE DRIVE	SAN JOSE	CA	95131	408-945-8445	408-945-0845	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
NEW HOLLAND NORTH AMERICA	PO BOX 262	NEW HOLLAND	PA	17557-0262	717-355-1458	717-355-1459	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - LUBRICANTS|MACHINING - COOLANTS / CUTTING OILS
NEY ULTRASONICS	1280 BLUE HILLS AVENUE	BLOOMFIELD	CT	6002	203-288-6149	203-288-6150	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
NOVAMAX TECHNOLOGIES INC.	1615 JOHNSON ROAD N.W.	ATLANTA	GA	30318	404-799-1292	404-799-1873	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
NUMOR SYSTEMS CO.	1635 LOSEY AVE.	JACKSON	MI	49203	517-783-3414	517-783-5442	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
OBERLIN FILTER COMPANY	404 PILOT COURT	WAUKESHA	WI	53188-5785	414-547-4900	414-547-0683	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
OIL MOP, INC.	145 KEATING DRIVE	BELLE CHASSE	LA	70037	504-394-6110	504-392-8977	MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
OIL SKIMMERS INC.	P.O. BOX 33092	CLEVELAND	OH	44133	216-237-4600	216-582-2759	MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
OILPURE SYSTEMS	2323 SIXTH STREET P.O. BOX 7007	ROCKFORD	IL	61125	815-962-7020	815-962-7360	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - LUBRICANTS
OSMONICS	5951 CLEARWATER DRIVE	MINNETONKA	MN	55343	612-933-2277	612-933-0141	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| | WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
OYLBELT CORP.	P.O. BOX 92	NORTHLAKE	WI	53064	414-968-7515	414-968-1028	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
OZONE RESEARCH & EQUIPMENT CORPORATION	3840 NORTH 40TH AVENUE	PHOENIX	AZ	85019	602-272-2681		BIOCIDE|FOOD PROCESSING|WASTE WATER TREATMENT - NOS|WATER TREATMENT
OZONIA NORTH AMERICA - GRIFFIN DIVISION	178 ROUTE 46	LODI	NJ	7644	201-778-2131	201-778-2367	BIOCIDE|FOOD PROCESSING|WASTE WATER TREATMENT - NOS|WATER TREATMENT
PAN AMERICAN ENVIRONMENTAL	P.O. BOX 661274	CHICAGO	IL	60666	708-860-7557	708-690-9954	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
PASCO PRODUCTS AND SERVICES	THE BYRNE BUILDING	PHOENIXVILLE	PA	19460	215-983-9585	215-983-9313	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
PBR INDUSTRIES	400 FARMINGDALE ROAD	WEST BABYLON	NY	11704	516-422-0057	516-422-1406	ASSEMBLY|CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - SOLDERING|CLEANING - VAPOR DEGREASING
PCI OZONE AND CONTROL SYSTEMS, INC.	ONE FAIRFIELD CRESCENT	WEST CALDWELL	NJ	7006	201-575-7052	201-575-8941	BIOCIDE|FOOD PROCESSING|WASTE WATER TREATMENT - NOS|WATER TREATMENT
PENFIELD	8 WEST STREET	PLANTSVILLE	CT	6497	203-621-9141	203-621-2380	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| | WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT
PETRONETICS INC	P.O. BOX 155	GREAT NECK	NY	11022	516-454-7600	516-829-5791	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|EQUIPMENT MAINTENANCE - LUBRICANTS
PILLAR POWER SONICS	6480 DOBBIN ROAD	COLUMBIA	MD	21045	216-497-7441	216-497-7442	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
POLY PRODUCTS CORPORATION	P.O. BOX 151	ATWOOD	CA	92601	714-538-0701	714-538-0891	CLEANING - AQUEOUS| |METAL PLATING - NOS|WASTE WATER TREATMENT - NOS
PROCECO INDUSTRIAL MACH.	1243 DORION ST.	MONTREAL	PQ	H2K4A2	514-527-1333	514-527-5404	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
PROGRESSIVE RECOVERY INC.|PRI	P.O. BOX 126	DUPO	IL	62239	618-281-7196	618-281-7930	ASSEMBLY|CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - SOLDERING|CLEANING - VAPOR DEGREASING
PROSYS CORP.	187 BILLERICA ROAD	CHELMSFORD	MA	1824	508-250-4940	508-250-4977	CLEANING - AQUEOUS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL
PROTECTAIRE SYSTEMS CO.	8N450-A TAMELING CT.	BARTLETT	IL	60103	708-697-3400	708-697-1065	CLEANING - COATING APPLICATION|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
R&D FOUNTAIN INDUSTRIES		ALBERT LEA	MN		800-328-3594		SPRAY CABINET, AGITATED IMMERSION, PARTS BASKET
RAMCO EQUIPMENT CORP.	32 MONTGOMERY STREET	HILLSIDE	NJ	7205	908-687-6700	908-687-0653	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
RANSOHOFF	N. 5TH ST. AT FORD BLVD.	HAMILTON	OH	45011	513-863-5813		CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
RGF ENVIRONMENTAL SYSTEMS	3875 FISCAL COURT	WEST PALM BEACH	FL	33404	407-848-1826		CLEANING - AQUEOUS|CLEANING - NOS|EQUIPMENT MAINTENANCE - NOS
ROHM AND HAAS COMPANY	727 NORRISTOWN RD., BLDG 20, SUITE 100	SPRING HOUSE	PA	19477	215-641-7099	215-619-1613	CLEANING - NOS|COATING - ADHESIVE APPLICATION|COATING - NOS| |COATING - PRINTING| | - |PETROLEUM RECOVERY|REFINING
RUDDUX CORPORATION	P.O. BOX 247	BASKING RIDGE	NJ	7920	201-221-1755	201-221-9384	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
S&K PRODUCTS INTERNATIONAL, INC.	80 RED SCHOOLHOUSE ROAD #102	CHESTNUT RIDGE	NY	10977	914-425-6200	914-425-6670	CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
SANBORN TECHNOLOGIES	7 INDUSTRIAL PARKWAY	MEDWAY	MA	2053	508-384-3181	508-384-5346	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|FOOD PROCESSING|MACHINING - COOLANTS / CUTTING OILS| | WASTE WATER TREATMENT - SOLUTE REMOVAL|WATER TREATMENT

Aqueous Cleaning, Wastewater Reuse, and Waste Treatment Equipment Vendors

Company Name	Address	City	St	Zip	Phone#	Fax#	Equipment Listing
SEPARATION TECHNOLOGY, INC.	P.O. BOX 218	VAN WYCK	SC	29744	803-285-5050	803-285-4849	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
SEREC CORPORATION	PO BOX 28129	PROVIDENCE	RI	2908	401-421-6080	401-521-5690	CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
SERFILCO	1777 SHERMER ROAD	NORTHBROOK	IL	60062-6360	708-559-1777	708-559-1995	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
SOMAT WASTE REDUCTION TECHNOLOGY	855 FOX CHASE	COATESVILLE	PA	19320	215-384-7000	215-380-8500	CHEMICAL MANUFACTURING|FOOD PROCESSING|PAPER MANUFACTURING|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
SONICOR INSTRUMENT CORPORATION	100 WARTBURG AVENUE	COPIAGUE	NY	11726	516-842-3344	518-842-3389	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - SOLDERING|CLEANING - VAPOR DEGREASING
SONITEC	85 SARGEANT ST.	HOLYOKE	MA	1040	413-532-6089	413-534-5893	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
SPARKLER FILTERS, INC.	BOX 19	CONROE	TX	77305	409-756-4471	409-539-1165	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
SPRAY BOOTH SYSTEMS, INC.	PO BOX 15070	FORT WORTH	TX	76119	817-572-4029	817-483-4625	CLEANING - COATING APPLICATION|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
STAR SYSTEMS	101 KERSHAW STREET|P.O. BOX 518	TIMMONSVILLE	SC	29161	803-346-3101	803-346-3736	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
SWEN SONIC		DAVENPORT	IA		319-322-0144		ULTRASONIC IMMERSION, RINSING/DRYING EQUIPMENT, WASTE TREATMENT SYSTEMS
TALLY CLEANING SYSTEMS	PO BOX 1305	ATTLESBORO FALLS	MA	2763	508-695-1007	508-695-6335	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - NOS|CLEANING - VAPOR DEGREASING
TAYLOR CHEMICAL COMPANY, INC.	PO BOX 768	LAWRENCEVILLE	GA	30246	404-339-4460		CLEANING - AQUEOUS| |MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
TAYLOR ENVIRONMENTAL PRODUCTS, INC.	628 OLD ROBINSON ROAD	LOUISVILLE	MI	39339-9099	601-773-3421	601-773-7139	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
TENCO HYDRO, INC.	4620 FOREST AVENUE	BROOKFIELD	IL	60513	708-387-0700	708-387-0732	CLEANING - AQUEOUS|EQUIPMENT MAINTENANCE - NOS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
TEXO CORP.	2801 HIGHLAND AVE	NORWOOD	OH	45219	513-731-3400		CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
THE HILLIARD CORPORATION	100 WEST FOURTH STREET	ELMIRA	NY	14902-1504	607-733-7121	607-733-3009	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
THE MART CORPORATION	24568 ADIE ROAD	MARYLAND HTS	MO	63043	314-567-7222	314-567-6551	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
TREATMENT TECHNOLOGIES	P.O. BOX 730	HONEY BROOK	PA	19344	610-273-2977	610-286-6145	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
U.S. FILTER|LANCY SYSTEMS AND EQUIPMENT	181 THORN HILL ROAD	WARRENDALE	PA	15086-7527	412-772-0044	412-772-1360	EQUIPMENT MAINTENANCE - HYDRAULIC FLUIDS|MACHINING - COOLANTS / CUTTING OILS| |WASTE WATER TREATMENT - OIL/SOLID REMOVAL|WASTE WATER TREATMENT - SOLID LIQUID SEPARATION
VALIANT INTERNATIONAL INC.	1180 EAST BIG BEAVER RD	TROY	MI	48083	313-689-9555	313-689-1001	CLEANING - AQUEOUS|CLEANING - DEGREASING|CLEANING - VAPOR DEGREASING
VAN AIR SYSTEMS INC.	2950 MECHANIC STREET	LAKE CITY	PA	16423	814-774-2631	814-774-3482	CLEANING - AQUEOUS|MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
VIC MANUFACTURING	1620 CENTRAL AVENUE NE	MINNEAPOLIS	MN	55413	612-781-6601	612-781-8559	CLEANING - NOS|COATING - ADHESIVE APPLICATION|COATING - NOS| |COATING - PRINTING||| - |PETROLEUM RECOVERY|REFINING
WASTEWATER ENGINEERS, INC.	6801 E. 15 MILE RD.	STERLING HEIGHTS	MI	48312	313-826-7777		CLEANING - AQUEOUS| |MACHINING - COOLANTS / CUTTING OILS|WASTE WATER TREATMENT - OIL/SOLID REMOVAL
WATER CYCLE	14 HUGHES, SUITE B-100	IRVINE	CA	92718	714-587-8660	714-587-8664	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
WATER VAP SYSTEMS	5738 HEISER	HOUSTON	TX	77087	713-649-2657	713-645-3583	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT
ZEP MANUFACTURING COMPANY	2909 S. 160TH ST.	NEW BERLIN	WI	53151	414-786-9100		CLEANING - DEGREASING|EQUIPMENT MAINTENANCE - NOS
ZERO DISCHARGE TECHNOLOGIES	4610 WESTOVER ROAD	CHICOPEE	MA	1022	413-593-5477	413-593-1631	CHEMICAL MANUFACTURING|CLEANING - AQUEOUS|CLEANING - NOS|MACHINING - COOLANTS / CUTTING OILS| |SOLID - OIL SEPARATION|WASTE WATER TREATMENT - NOS|WATER TREATMENT
ZIMPRO/PASSAVANT INC.	2600 COMMERCE SQUARE DRIVE	IRONDALE	AL	35210	800-633-9501	205-956-6198	CHEMICAL MANUFACTURING|FOOD PROCESSING| |WASTE WATER TREATMENT - SOLID LIQUID SEPARATION|WATER TREATMENT

INSTITUTE OF ADVANCED MANUFACTURING SCIENCES
1111 Edison Drive • CINCINNATI Ohio 45216
513.948.2000 * 800.345.4482 * FAX: 513.948.2109
http://www.iams.org

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