Design for the Environment

A Competitive Edge for the Future

Toolkit

Design for Environment (DfE) Toolkit

Minnesota Office of Environmental Assistance
Minnesota Technical Assistance Program (MnTAP)

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Preface

Included in this toolkit are:

- An introduction to Design for Environment (DfE)
- A product scoring tool for evaluating product designs in relation to environmental impacts
- Reference materials

This Design for the Environment (DfE) toolkit is a mechanism that allows companies to benefit by incorporating environmental attributes early into product design.

Product design is a critical determinant of a manufacturer's competitiveness. The National Research Council estimates that 70 percent or more of the costs of product development, manufacture and use are determined during the initial design stages. This Design for the Environment (DfE) toolkit gives companies the tools needed to incorporate environmental attributes early into product design. Incorporating environmental attributes can result in reduced materials use and waste, improved designs, reduced future liabilities and other efficiencies.

The advantages are numerous.

Use of DfE also demonstrates environmental responsibility to customers and thus can bring improved market position in the global marketplace. Product design is a unique point of leverage from which to influence environmental impact. This is the stage when decisions are made about the types of resources and manufacturing processes that will be used. These decisions ultimately determine the waste streams. Once a product is designed, its environmental attributes are largely fixed. The result of incorporating DfE into design can be high-quality, environmentally sound products that enjoy a competitive advantage.

In summary, the benefits of implementing a Design for the Environment program are numerous.

- **Reduced cycle times**
- **Reduced costs**
- **Improved products**
- **Reduced regulatory concerns**
- **Reduced future liability**
- **Improved market position**
- **Improved environmental performance**

This toolkit is designed to allow integration of DfE into existing design practices.

A growing number of companies, including AT& T, Phillips, Motorola, AMP, Boeing Defense and Space, Xerox, Sony and Patagonia, use DfE procedures to bring an environmental perspective to their design processes.

This toolkit is designed to allow integration of DfE into existing design practices where many design aspects such as customer appeal, safety, cost and other product attributes are considered. Design engineers can meet as a group to use the toolkit. It is practical to use and does not

require a large time commitment. The toolkit will help designers develop a numerical score for a product that shows them where the product is strong and where it needs improvement with regards to environmental concerns.

In addition to the DfE tool, this kit includes reference data and information. The reference data provides additional information for answering questions when using the toolkit. This reference data section is also designed to be expanded as additional sources of information become available. Users are encouraged to seek out additional sources of information to add to this reference section. The toolkit is a working model that can be adapted and modified by product design teams.

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This toolkit can be used by design teams to:

- Evaluate environmental attributes of potential product designs
- Evaluate environmental attributes of existing product designs
- Provide a score that can facilitate internal communication
- Evaluate potential design changes
- Develop a tailored tool for their own use
- Compare two products

In addition, this material can be used by engineering students to study DfE principles and implementation.

The DfE tool described in this publication was originally developed by Dr. T. E. Graedel and Dr. B. R. Allenby for AT&T, where it has been used quite effectively. Others have modified the matrix system and found it to be useful as well.

What is Design for the Environment?

A systematic way to incorporate environmental attributes into product design.

Design for Environment (DfE) is a systematic way of incorporating environmental attributes into the design of a product. There are three unique characteristics of DfE:

- **The entire life-cycle of a product is considered.**
- **Point of application is early in the product realization process.**
- **Decisions are made using a set of values consistent with industrial ecology, integrative systems thinking or another framework.**

DfE considers the potential environmental impacts of a product throughout its life-cycle.

DfE considers the potential environmental impacts of a product throughout its life-cycle. A product's potential environmental impacts range from the release of toxic chemicals into the environment to consumption of nonrenewable resources and excessive energy use. Life stages of a product include the time from the extraction of resources needed to make the product to its disposal. In effect, designers design a product life-cycle not just the product. An awareness of a product's life- cycle will help the company avoid environmental surprises and liabilities. Ideally, the design team will seek to reduce these environmental impacts to the lowest level possible.

A general product life-cycle is illustrated in *figure 1, page 7.* The earlier in the product design life-cycle that a design team considers environmental factors, the greater the potential for environmental benefit and cost reduction. For the purposes of this toolkit, the life-cycle of a product has been condensed into the five stages shown in *figure 2, page 8.* The life stages in this abridged life-cycle are incorporated into the matrix system presented in this toolkit.

These five stages are:

- *Premanufacture* – During this stage, parts and raw materials are procured for use in manufacturing products.
- *Manufacture* – All stages of production within the company, from the time the raw materials enter the facility until the product is ready for packaging. Includes chemical or thermal processing, assembly and finishing.
- *Packaging and Distribution* – The material is packaged for both transport and purchase, routed through the appropriate distribution and transport system, and delivered to the consumer.
- *Use and Maintenance* – The time from when the customer receives the product until the customer is ready to dispose of the product. This includes maintenance, as well as the time after partial replacements or overhauls – as long as the consumer is in possession of the product.
- *End of Life* – The product is recycled, remanufactured or removed from the life-cycle entirely by landfilling or incineration.

Figure 1. *The General Product Life Cycle*

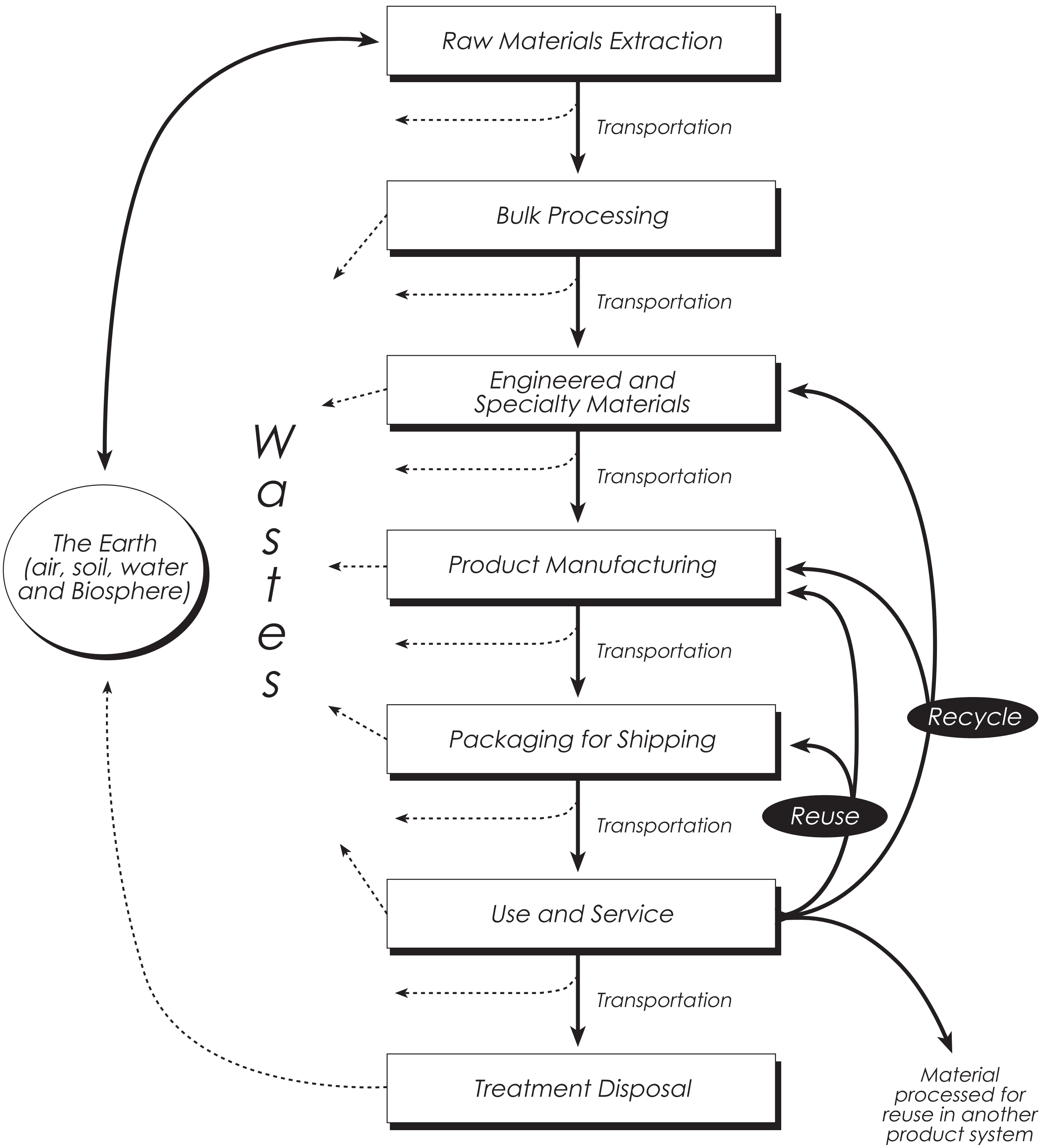
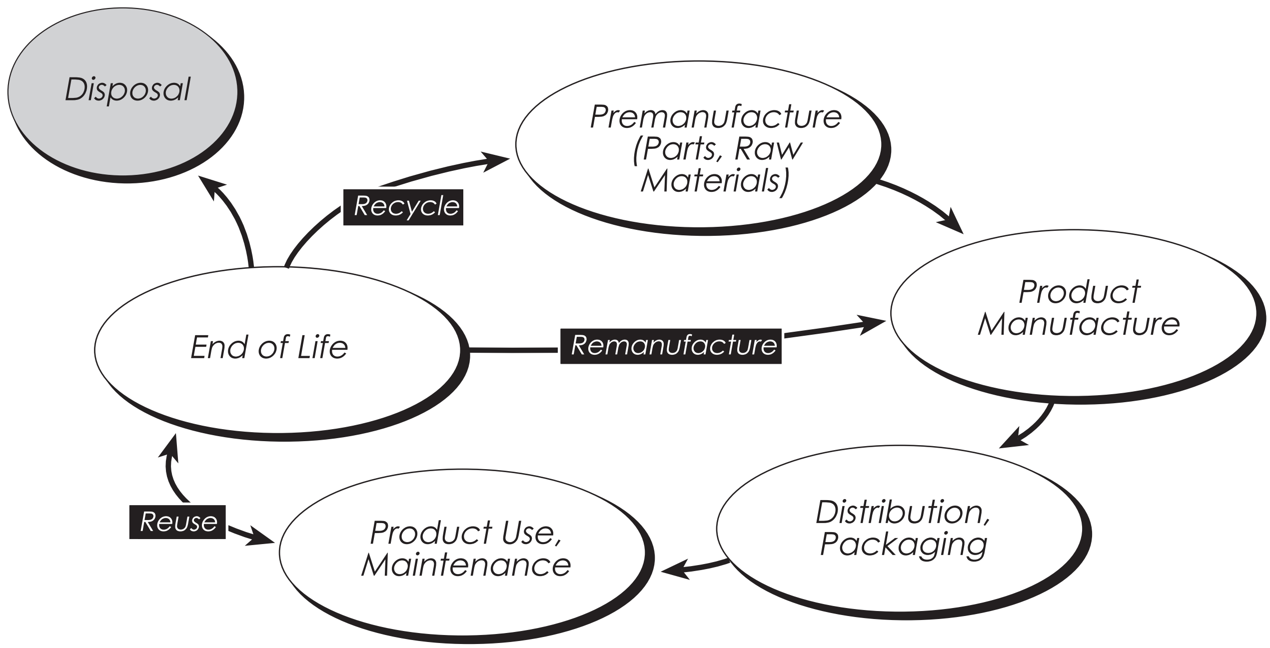


Figure 2. *The Abridged Product Life-Cycle*



The life-cycle stages shown in the general product life-cycle (*figure 1, page 7*) can be combined under different headings than the five listed above if these headings do not adequately reflect a product's life-cycle.

DfE takes a proactive approach to environmental considerations.

Focusing only on complying with environmental regulation compliance can be costly. Hazardous waste management generates unnecessary costs if it can be shown that the hazardous materials creating the wastes could be eliminated from the manufacturing process. DfE takes a proactive approach to environmental considerations. Asking pertinent questions during the design phase regarding the potential environmental impact of a proposed product often reveals environmental liabilities that need to be addressed. For instance, if a product contains lead or mercury, can the use of these heavy metals be eliminated? If not, has the product been designed so that the material will be accessible or recoverable at the end of the product's life? If solvents are used in the manufacture of the product, are proper recovery/disposal mechanisms in place? Could the company become liable for future disposal problems with the material?

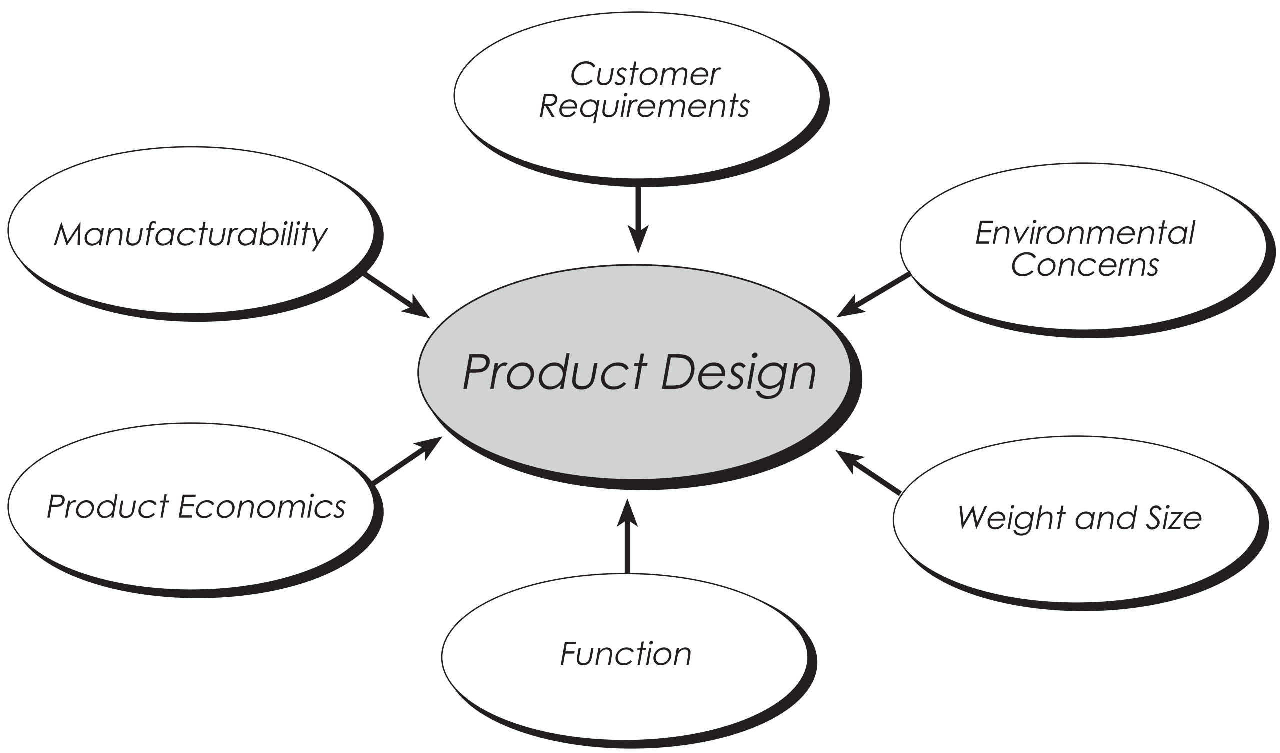
"Design for Environment aims to bridge the gap between two traditionally separate functions: product development and environmental management. The goal of DfE is to bring these two functions into closer contact and address product life-cycle issues that are often ignored."

-Implementing Design for Environment: A Primer

DfE is intended to become an integral part of the development process

Design for Environment does *not* imply that a product is designed solely for the environment or that the environment is the only consideration. DfE is intended to become an integral part of the product development process along with other design considerations, such as product economics, customer requirements, manufacturability and required product functions (*figure 3*). These parameters could be considered as part of a general design function "Design for X" (DfX), where X represents relevant design issues such as those just mentioned.

Figure 3. *Product Design Considerations*



The incorporation of DfE into the design program will help to minimize future environmental liabilities.

DfE does not guarantee regulatory compliance, or address every environmental issue. However, the incorporation of DfE into the design program will help to minimize future environmental liabilities, improve the environmental performance of a company and its products, and prepare the manufacturer to meet existing and future government regulation.

Why Design for the Environment?

Global initiatives are requiring greater product responsibility from producers. In Europe, new regulations have been enacted that require producers to take more responsibility for their products by providing for the disposal or recycling of products at the end of their useful life. Labeling products with environmental performance data can help to differentiate products as well.

Companies are experiencing increasing pressure and expectations to develop environmentally conscious products and processes from a variety of sources.

Companies are now expected by regulators, consumers, environmental advocate groups, and industry associations to develop environmentally conscious products and processes. DfE provides a method for meeting these demands. Potential benefits to the manufacturer include:

- Improved designs
- Reduced costs and time-to-market
- Improved market position
- Reduced regulatory concerns
- Reduced future liability
- Improved environmental performance

Improved designs

Design for Environment emphasizes one more design attribute in addition to those already being considered (e.g. cost, size). It allows the manufacturer to improve the performance of their product and position themselves in an evolving world of environmental regulations and consumer demand.

Incorporating Design for Environment concepts may also improve product characteristics as related to other design parameters. For instance, Xerox has redesigned several of its copier subassemblies so that they contain fewer different materials and are easy to remove from the copier itself. As a result, Xerox is able to refurbish many of these subassemblies and reuse them. This has resulted in a reduction of solid waste as well as significant cost savings for Xerox.

Companies may be able to extend market share or reach new markets by adding "green" attributes to their products.

Reduced costs and time-to-market

By designing out hazardous materials, the manufacturer can reduce time-to-market by avoiding the time and resources required to obtain necessary permits. At the same time, the company can realize cost savings by eliminating or replacing materials that have high disposal costs. One example is substituting stainless steel sleeves for chromium plated coatings on a cam shaft.

Improved market position

Companies may be able to extend market share or reach new markets by adding "green" attributes to their products. As state and federal agencies develop purchasing guidelines for the procurement of environmentally preferable products, for instance, manufacturers with established DfE programs will be able to offer a competitive product. By consistently developing environmentally conscious methods and products, the company establishes a reputation of environmental responsibility. It is possible for environmental quality, like other product characteristics, to become a distinguishing feature of a product. The company can employ marketing strategies to make the most of its environmental performance as perceived by consumers. Fuel-efficient furnaces, for instance, are beneficial to the environment and represent a marketable cost-savings to the consumer at the same time.

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Reduced regulatory concerns

Design for Environment enables a company to anticipate and address future trends in environmental compliance and regulation. By taking a proactive approach to environmental responsibility, manufacturers may be able to position themselves ahead of those companies with reactive strategies. In other words, companies may incorporate future environmental demands and regulations into their current product and process design procedures, rather than be faced with the costly burden of reworking designs once new legislation or consumer demands are in place.

Implementing a DfE program can help a manufacturer identify sources of pollution and waste. These are costly, because the materials generated must be treated and be disposed of and because these are unused materials. Reducing pollution and waste through DfE can enable a company to produce the same products for less cost. Eliminating the use of toxic materials in the manufacturing process can save a company significant amounts of time and money. This includes the elimination of compliance activities that require extensive paperwork and follow-up, such as Toxic Release Inventories (TRI) or Occupational Safety and Health Administration (OSHA) regulations.

Reducing pollution and waste through DfE can enable a company to produce the same products for less cost.

Reduced future liability

Resolving potential environmental hazards before they occur can represent significant savings to the company. An informed decision during the design stage can avoid costly environmental liabilities. By eliminating toxic materials from products or designing products that are easily recyclable, companies may avoid significant costs required to dispose of the product. In addition, reducing toxic releases during processing helps eliminate potential costs of treating contaminated water or soil.

An informed decision during the design stage can avoid costly environmental liabilities.

Superior environmental performance can only benefit the world community as a whole.

Improved environmental performance

Design for Environment can not only improve a company's economic and regulatory standing, but goes well beyond the boundaries of the company. Design for Environment addresses both local concerns, such as toxic pollutant discharge, and major international ones, such as ozone depletion, global warming and human health concerns. Industrial activity continues to have a tremendous impact on the environment. Superior environmental performance can benefit the world community as a whole as each manufacturer contributes through integrating environmental concerns into the design process.

Success in DfE

Listed below are just some of many examples of successful DfE implementation by a variety of manufacturers.

XEROX

XEROX has found that DfE- related activities have produced savings of several hundred million dollars, while reducing the amount of material sent to the landfill. Their newest digital copier has components arranged in subassemblies so they can be easily removed. The fuser roll that was previously disposable is now made of a combination of aluminum and steel that can be re-coated again and again. These activities have enabled Xerox to reuse, recycle and remanufacture machines at the end of their product life.

BMW and Volkswagen

BMW and Volkswagen are both using DfE to study the disassembly and recycling of recovered materials in automobiles. BMW has a goal of eventually making automobiles out of 100% reusable/recyclable parts.

Hewlett Packard

Hewlett Packard's 850 series of inkjet printers were designed under a DfE framework. The outer casings include post-consumer plastic from recycled telephones. The modular architecture and use of few permanent screws makes the printers easy to disassemble for repair or recycling. Any plastic parts larger than three grams are identified and marked by type. Components of the printer are molded using a thin-walled process so less material is needed. These printers also use 80% less power than dot matrix printers. Power down and sleep modes means 50% less energy is used by this series of printers than comparable inkjet printers.

Sun Microsystems, Inc.

Sun Microsystems, Inc., an electronics manufacturer, has included a variety of disassembly features and post-consumer plastics in their products since implementing a DfE program. Heavy metals have also been eliminated from plastics, packaging, inks and manuals used in Sun Products.

IBM Corporation

IBM has incorporated numerous design for the environment (DfE) features in the AS/400 Advanced Series computer product line including on/off power programming, powder coatings, coding of plastic parts and a new method for attaching acoustic foam that facilitates removal for recycling. IBM also uses recycled plastic in many product lines. Plastic parts are kept free of contamination from labels and paint so that they are recyclable. The IBM 3900 Advanced Function Printing System is upgradable so that the entire system does not have to be replaced for improved performance.

General Motors Corp. Saturn Division

General Motors is working with the University of Tennessee to develop a software program that tracks the energy and environmental impact of every part of a car during the car's life-cycle. The software will also determine design changes that will make certain parts easier to recycle or reuse. Saturn designers will be able to look at the environmental component of their design decisions.

Implementing DfE

Implementation and integration of DfE will vary from company to company. The implementation process is affected by a number of steps. Necessary steps to implementing DfE include investigation, promotion, reporting and rewarding, and feedback.

Investigation

A manufacturer should examine the context in which to implement the Design for Environment program.

A manufacturer should examine the context in which to implement the DfE program. The company should seek to establish relevant and achievable environmental goals within the design process, that will establish the company and its products as environmentally responsible. The design process should be considered, as well as the most appropriate point at which to use the toolkit. The company should consider the position it hopes to hold in the local, national or international markets, particularly in regard to relevant industry standards. Can the company anticipate pending environmental legislation or requirements? Will meeting the standards of systems such as ISO 14000 help to establish the company in new markets? Can the DfE program be developed to a point that satisfies the "eco-management" standards of ISO 14000? Has the company signed on to any environmental commitments or organizations such as the International Chamber of Commerce, the 16 Principles of Sustainability.

Establishing specific goals for the company and outlining methods for achieving them enables a manufacturer to assign specific responsibilities to departments and individuals.

Establishing *specific* goals for the company and outlining methods for achieving them enables a manufacturer to assign responsibilities to departments and individuals. The more specific the goal and methodology, the easier it will be to measure progress in achieving the company's objectives. The ability to measure progress toward objectives is essential in sustaining DfE. As long as affected departments are able to see progress in implementing DfE, the momentum of the implementation continues to increase.

Promotion

Communicating the company's goals and strategies for DfE is critical to the success of the program. Of particular importance are upper level management, the design team and production managers. Even a raised awareness among the production employees can significantly affect the environmental performance of a company. It is important that commitments to DfE be made by top management officials and members throughout the company before implementing the design and production procedures. This commitment is essential to the continued success of environmental initiatives.

It is important that commitments to DfE be made by top management officials and members throughout the company before implementing the design and production procedures.

This communication can initially take place through a seminar, a series of workshops or other method as appropriate to the company. These education methods have been successful at places such as the Boeing Defense and Space Group, Motorola and AMP. At this time, specific environmental challenges faced by the company and methods for meeting those challenges would be presented. Roles would be established for departments and individuals.

Report and Reward

In order to measure the progress of a DfE program, the manufacturer should establish specific measures. For instance, if the goal for a company is 100% toxin-free products, it would be advantageous to track the reduction (perhaps by weight) of toxic materials in the product(s).

Incentives and disincentives can be used to manage implementation of DfE. Incorporating specific measures into the program allows the company to establish viable incentive and reward programs. Beneficial product and process changes, in fact, are often proposed by workers on the factory floor who have an intimate knowledge of specific product characteristics or manufacturing procedures. If a company is serious about DfE, it should include methods to monitor application of DfE concepts, track results and reward improvements to product design.

If a company is serious about DfE, it should include methods to monitor application of DfE concepts, track results, and reward improvements to product design.

Feedback

Communication is important. Regularly scheduled meetings, updates and reports establish the momentum of DfE in a company, and ensure that no one is left "out of the loop."

At the same time, production managers should be kept up to date so that design changes do not catch them unaware. Other manufacturing personnel need to be included, as well, to ensure the quality of decisions in the design process. Designers should seek the input of quality managers, suppliers, purchasers, environmental managers and customers. Establishing this feedback system will greatly improve DfE analyses and decisions. As involved parties realize the impact of their input on the process, support will grow for the DfE program throughout the company and among its customers.

Regularly scheduled meetings, updates, reports, etc. establish the momentum of DfE in a company, and ensure that no one is left "out of the loop."

As part of this process, the company should determine whether it is on target to reach specified time objectives. If not, additional resources or alternative procedures may be required. On the other hand, if progress is being made, the company should identify those procedures that are beneficial to the environmental program.

DfE can be implemented in several ways. These include:

- **Incremental product change**
- **Process improvement**
- **New product concepts**

Incremental product change

Small, incremental product changes can reduce the environmental impact of current products. Rather than designing a completely new product, the design team examines individual product characteristics and improves them with each model release. This type of approach is the most common and usually represents the easiest changes to implement. Making a home furnace more fuel-efficient is an example of this methodology.

Process improvement

Modifying entire processes may reduce the environmental impact of many products. Although this approach may present a few more technical challenges than for incremental product changes, there are often process characteristics that are still relatively simple to implement. Minimizing volatile emissions on a painting line, for instance, would improve the environmental performance of all products associated with the production line.

New product concepts

DfE can lead to radical changes in existing products or processes as well as entirely new technologies. This approach requires "out of the box thinking" but can offer beneficial business opportunities to manufacturers. For instance, recent developments in the printing industry allow printers to use electronic imaging in their pre-press departments, thereby reducing chemical wastes from photodeveloping and platemaking.

Implementing DfE can lead to changes in one or a number of individual product features

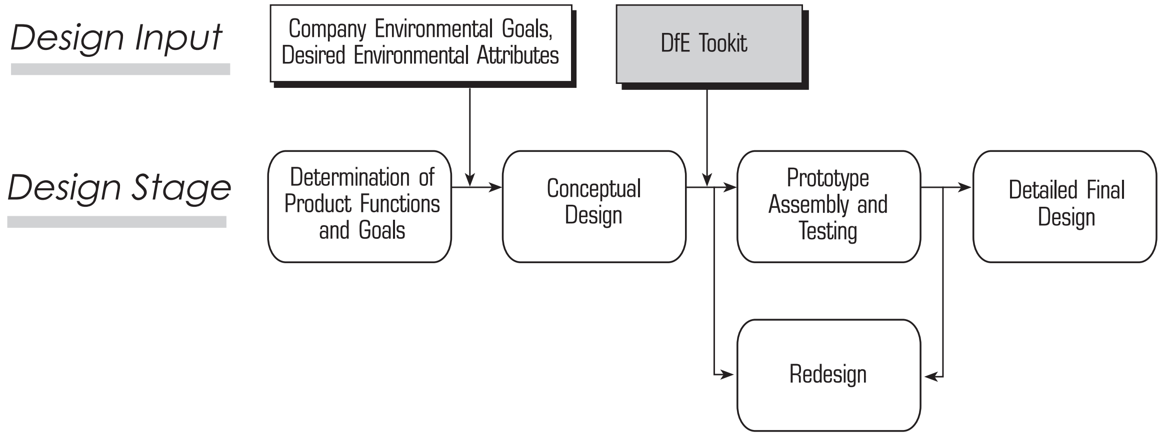
Implementing DfE can also lead to changes in one or a number of individual product features. Below is a partial list of examples of new product design features that can be introduced to improve the environmental attributes of products:

- **Using alternative joining technologies such as snaps, darts and screws instead of adhesives.**
- **Minimizing or eliminating embedded metal threads in plastics.**
- **Using screws of similar head technology.**
- **Minimizing the variety of materials used (including fillers, colors and additives).**
- **Marking plastics clearly with resin type identifiers.**
- **Using components made of known materials.**
- **Avoiding painting and putting labels on recyclable parts.**
- **Using modular architecture, so that modules can be replaced to upgrade or repair equipment.**
- **Using ceramics instead of plastics with flame retardants.**
- **Leasing of products for "take-back" and reuse.**
- **Using "power down or sleep modes" for electronic devices to cut energy use during inactivity.**

Implementing DfE: An Example

XYZ Co., after analyzing a product design using the DfE Toolkit, sets a goal of eliminating all toxic materials from a product in three years. As part of this objective, the company realizes benefits in decreased regulatory concerns and potential liabilities. XYZ Co. allocates the challenge of finding acceptable substitutes for the toxic materials to its research and development department. R&D in turn consults the production managers to establish required material characteristics for quality production. The department assembles a list of toxic materials contained in the product, as well as possible alternatives. Monthly

Figure 4. An Overview of Product Design and Design Inputs



updates from the department establish the progress being made toward finding substitutes for the toxic materials. As the team proposes design changes, it consults production managers and other interested parties to determine the feasibility of the changes. As the research team finds substitutes, the toxic materials are crossed off the list. XYZ Co. holds regular meetings to determine whether the progress is on target to meet the time objective of three years.

In the case of XYZ Co., within the first year substitutions have been found for almost half the toxic materials. The company recognizes that most of these substitutions have come through contact with other manufacturers. As a result, XYZ Co. focuses the majority of resources on inter-company communication, further enhancing the DfE implementation.

The tool included in this publication is intended to be used in the conceptual phase of the product realization process...

Every company uses a unique approach to product realization. It is useful to generalize this design process and see how DfE can be applied *(figure 4)*. Design teams will generally need to know materials and manufacturing processes required by a particular product design. A review of the matrix during earlier stages may put a product in an environmental context and help with design specifications as well.

Different approaches and tools are appropriate for different phases of the design process. During early design phases, company goals or principles and desired environmental attributes can be useful in developing a set of product specifications. Early specifications can include material selection restrictions, recyclability, durability or other functional requirements. *The tool included in this publication is intended to be used in the conceptual phase of the product realization process, once the design team has selected materials for a prototype and outlined initial manufacturing processes. Although* the tool is geared toward product design, it can also be easily used to evaluate of existing products.

Explanation of Product DfE Matrix

To determine the environmental impact of a product, pertinent questions must be asked to consider the effects of the product design throughout the product's life.

To determine the environmental impact of a product, pertinent questions must be asked about the effects of the product design throughout the product's life. In the following section, there are 100 questions that address a wide range of design and environmental topics.

The questions are designed to encourage consideration by the design team of potential environmental impacts caused by the manufacture, use and disposal of the product. In addition, the matrix highlights areas of environmental concern and provides manufacturers with ideas and options for resolving those concerns.

The questions have been written in a manner general enough to apply to numerous types of products. Question syntax is sometimes unavoidably vague. Space has been provided, however, for users to note specific product attributes. There will likely be other environmental parameters considered in the product design, and *the design team should feel free to adapt or modify the questions to their own use.*

Who should use the toolkit?

This DfE Toolkit is intended for use by the product design team.

This DfE Toolkit is intended for use by the product design team. Those that are responsible for the design of the product will be the ones who are best able to quickly answer the matrix questions and address possible design changes. Other concerned parties, such as production managers, management and sales staff may be an important part of the evaluation process as well. Team members may need at least half a day to go through the product analysis together, particularly if more than one product design alternative is being considered. Another alternative is to hold four one- hour meetings one week apart to evaluate a product. The premanufacturing survey can be done before or during the evaluation process.

Although several resources are provided in this toolkit, it may not be possible to answer every question in the initial design analysis. This is particularly true of the sections on resource extraction. Some questions may require further research by team members to complete the product analysis. Even if the design team is unable to answer all of the questions, the matrix will be helpful in evaluating the product.

The intent of this toolkit is to raise questions regarding a product's environmental impacts that may not have been previously considered and to provide a semi-quantitative analysis of alternative product designs. As individual manufacturers adapt the toolkit to their needs, the actual scores will be relevant only to the company itself.

Product Design Matrix: Design for Environment Toolkit

LIFE STAGE	Environmental Concern					Total
	1 Materials	2 Energy Use	3 Solid Residue	4 Liquid Residue	5 Gaseous Residue	
A Premanufacture	(A.1)	(A.2)	(A.3)	(A.4)	(A.5)	
B Product manufacture	(B.1)	(B.2)	(B.3)	(B.4)	(B.5)	
C Distribution, packaging	(C.1)	(C.2)	(C.3)	(C.4)	(C.5)	
D Product use, maintenance	(D.1)	(D.2)	(D.3)	(D.4)	(D.5)	
E End of life	(E.1)	(E.2)	(E.3)	(E.4)	(E.5)	
Total						

Adapted from *Industrial Ecology*. T.E. Graedel and B.R. Allenby. Englewood Cliffs, New Jersey: Prentice Hall, 1995. Used by permission of the authors.

Matrix locations are indicated by the numbers in the upper left hand corner of each box.

Maximum Total Score **without** Matrix Element A = **100 points**

Maximum Total Score **including** Matrix Element A = **125 points**

Instructions for Using the DfE Matrix

The Product Design for the Environment (DfE) Matrix, *upon which this toolkit is based, is found on page 18. Use the questions found on pages 20 - 27 , to score product designs using this matrix system. Design team members should save the printed materials provided as original copies and make duplicates as needed for product evaluations. Additional aids such as a manufacturing flow diagram and materials specification information can be useful for answering the matrix questions.*

Using the DfE Matrix

1) **Information from a survey of your parts and raw materials suppliers is used to answer the A.1 - A.5 matrix element questions.** If you do not wish to survey your suppliers, or want to do it at a later time, begin with the questions for matrix element B.1.

2) **Answer each matrix question on pages 21-27 "yes" or "no." If the answer is "yes", circle the number of points in the "yes" column for that question. If the answer is "no", circle the zero for that question. If the question does not apply to your product or your product has no impact in this area, answer "yes."** For example, question B.4 asks, "If hazardous solvents or oils are used, have alternatives been thoroughly investigated?" If your process does not use solvents or oils at all, then the product design has no potential impact in this area, and your answer would be "yes." The questions have been written so that "yes" indicates a positive or no environmental impact, whereas "no" indicates a negative environmental impact.

3) **For each matrix element, determine a score from 0 - 5 by adding the number of circled "yes" answers. Enter this number in the corresponding box on the matrix.** For example, if you answered "yes" to the first two questions in Matrix Element B.2 (product manufacture, energy use) "4" is placed in **row** 2, **column** 2. Note that each matrix element or box is mapped to its corresponding questions by a number in the upper left hand corner.

4) **Add the scores in each column and write the total in the corresponding cell in the "Total" row. Add the scores in each row and write the total in the corresponding cell in the "Total" column.**

5) **Add the numbers in the "Total" column and again in the "Total" row. The sums should be the same. Enter this sum into the remaining box on the bottom right-hand corner of the matrix**. The result is a relative score for the product that can be used to compare a product currently being designed with an existing product, or to compare alternative designs for a new product. The totals for each of the life stages (rows) and the environmental impacts (columns) indicate areas of strength and areas for improvement in terms of the environmental attributes of a product over its entire life-cycle. The scores are relative, comparative scores that are strictly for internal company use. The maximum total score without matrix element A (supplier survey question information) is 100 points. With matrix element A the maximum score is 125 points.

Words in **bold** in the matrix questions are defined *on pages 30 - 31. If* the question is followed by a "see . . . ," see this reference for further data, information or explanation related to the question.

Matrix Questions

Information obtained from a survey of your parts and raw materials supplier (refer to page 65 of the reference section) is used to answer the questions for Matrix Element A. If you do not wish to survey your suppliers go to Matrix Element B.

Premanufacture

As indicated by the survey of your suppliers:

A.1: Premanufacture, Materials

What percent of your company's suppliers for this product or component have an Environmental Management System (EMS) in place? (circle one)

0% or unknown = 0 points
1 to 5 % = 2 points
6 to 25% = 3 points
26 to 50% = 4 points
>50% = 5 points

A.2: Premanufacture, Energy

What percent of your company's suppliers for this product or component have formal energy conservation practices in place, such as the Environmental Protection Agency's Green Lights Program? (circle one)

0% or unknown = 0 points
1 to 5 % = 2 points
6 to 25% = 3 points
26 to 50% = 4 points
>50% = 5 points

A.3: Premanufacture, Solid Residue

What percent of your company's suppliers for this product or component have ISO 9000 or ISO 14000 in place or regularly publish a company environmental report? (circle one)

0% or unknown = 0 points
1 to 5 % = 2 points
6 to 25% = 3 points
26 to 50% = 4 points
>50% = 5 points

A.3: Premanufacture, Liquid

What percent of your company's suppliers for this product or component have a water conservation program ? (circle one)

0% or unknown = 0 points
1 to 5 % = 2 points
6 to 25% = 3 points
26 to 50% = 4 points
>50% = 5 points

A.5: Premanufacture, Gaseous

What percent of your company's suppliers for this product or component have a formal program in place for minimizing air emissions? (circle one)

0% or unknown = 0 points
1 to 5 % = 2 points
6 to 25% = 3 points
26 to 50% = 4 points
>50% = 5 points

Enter the point value of each of the circled answers into the corresponding " matrix element A boxes" of toolkit matrix sheet for this product or component.

Product Manufacture

B.1: Product Manufacture, Materials Choice

(for each question circle one number)

For this product or component:	Yes	No
1) Is as much **recycled** material used in your product as possible?	1	0
2) Is the use of **hazardous** materials avoided or minimized? (see *figure 5 page 58, Hazardous Chemical Index, page 32)*	2	0
3) Are the amounts of materials that are used minimized?	1	0
4) Are the number of types of materials that are used minimized?	1	0

Total Points for Matrix Element B.1 ________

B.2: Product Manufacture, Energy Use

For this product or component:	Yes	No
1) Do the manufacturing process minimize the use of **energy- intensive** processes? *(for example, multiple cycles of heating and cooling, inefficient motors, see Motors Challenge Program page 63 etc.)*	2	0
2) Do manufacturing processes use cogeneration, heat exchange or other techniques to utilize wasted energy?	2	0
3) Is there minimal transportation between manufacturing and assembly points?	1	0

Total Points for Matrix Element B.2 ________

B.3: Product Manufacture, Solid Residue

(for each question circle one number)

For this product or component:	Yes	No
1) Are waste materials minimized and reused to the greatest extent possible during manufacturing? *(e.g., mold scrap, cutting scrap etc.)*	1	0
2) Have raw material and parts suppliers been contacted to encourage them to minimize the amounts and types of packaging materials entering your facility?	1	0
3) Has your company maximized the opportunities to reuse and reduce packaging waste when parts are shipped between facilities?	1	0
4) Has intentional introduction of all lead, cadmium, mercury and hexavalent chromium into the product materials been avoided?	2	0

Total Points for Matrix Element B.3 ________

B.4: Product Manufacture, Liquid Residue

For the manufacture of this product or component:	Yes	No
1) If **hazardous** solvents or oils are used have alternatives been thoroughly investigated? *(see vendor lists in the Reference Information section for information on alternative solvents and oils, if no solvents or oils are used in the manufacturing process the answer is "2" or no environmental impact)*	2	0
2) Are opportunities maximized to capture and reuse liquid by-products generated during the manufacturing process? *(if no solvents or oils are used in the project the answer is "2" or no environmental impact)*	1	0
3) Is the generation of **water pollutants** avoided or minimized?	2	0

Total Points for Matrix Element B.4 ________

B.5: Product Manufacture, Gaseous Residue

For the manufacture of this product or component:	Yes	No
1) Is the generation of **global warming or ozone-depleting gases** avoided? (see *Climate-altering Chemical Index, page 60)*	2	0
2) Is the generation of **hazardous** air pollutants avoided during the manufacturing process?	2	0
3) Is the use of solvents, paints, coatings or adhesives with high evaporation rates eliminated or minimized? *(i.e., materials that emit high VOCs or volatile organic compounds)*	1	0

Total Points for Matrix Element B.5 ________

Distribution, Packaging

C.1: Distribution, Packaging, Materials Choice

(for each question circle one number)

For this product or component:	Yes	No
1) Have **reusable transport packaging options** been explored for distribution between company facilities?	1	0
2) Have **reusable transport packaging options** been explored for distribution between your company and your suppliers?	2	0
3) Are **recycled** materials used in the transport and retail packaging ?	1	0
4) Are **recyclable** materials used in the transport and retail packaging ?		
5) Is the number of different types of materials used in the packaging minimized?	1	0
Total Points for Matrix Element C.1	______	

C.2: Distribution, Packaging, Energy Use

For this product or component:	Yes	No
1) Is either reusable packaging or material of the lightest weight and volume, yet functional transport and retail packaging material used?	5	0
Total Points for Matrix Element C.2	______	

C.3: Distribution Packaging, Solid Residues

For this product or component:	Yes	No
1) Is the packaging designed for easy separation of materials for reuse or recycling?	1	0
2) Are the types of packaging used commonly recycled?	2	0
3) Are the packaging materials clearly marked or easily identified by material type? *(e.g., plastics with resin type label etc.)*	2	0
Total Points for Matrix Element C.3	______	

C.4: Distribution, Packaging, Liquid Residues

(for each question circle one number)

For this product or component:	Yes	No
1) Have maximum precautions been take to prevent hazardous liquid spills during transport? *(e.g., extra containment layers or safety valves, if there are no hazardous liquids in the product or component the answer is "5" or yes, for no environmental impact)*	5	0

Total Points for Matrix Element C.4 ________

C.5: Distribution, Packaging, Gaseous Residues

For this product or component:	Yes	No
1) Does the transport or retail packaging not contain chlorinated polymers or plastics which may produce hazardous emissions if incinerated at low temperatures? (see Polymers page 62)	3	0
2) Does the packaging not contain bromated flame retardants that may produce hazardous emissions if incinerated at low temperatures?	2	0

Total Points for Matrix Element C.5 ________

Product Use, Maintenance

D.1: Product Use, Maintenance, Materials Choice

For this product or component:	Yes	No
1) Is the product or component easily disassembled for upgrade, repair or reuse?	1	0
2) Are parts readily available for the repair of this product or component?	1	0
3) Are potential barriers to recycling avoided such as using fillers, additives, or imbedded metal threads in plastics, applying paint to plastics, or using materials of unknown composition?	2	0
4) If plastics are used are they clearly marked by resin type?	1	0

Total Points for Matrix Element D.1 ________

D.2: Product Use, Maintenance, Energy Use

(for each question circle one number)

For this product or component:	Yes	No
1) Does the design facilitate minimal energy use while the product is in service?	2	0
2) Can this product or component adjust energy use based on the level of activity? (e.g. go into "sleep mode" during inactivity)	3	0
Total Points for Matrix Element D.2		

D.3: Product Use, Maintenance, Solid Residue

For this product or component:	Yes	No
1) Does the design avoid building in disposable components such as "one-time- use" cartridges, containers or batteries?	1	0
2) Are snaps, darts, screws of the same head type or other removable fasteners used and are adhesive or welds avoided for joining parts to make it easier to disassemble, repair, reuse or recycle?	2	0
3) Is this product designed to be easily repaired and/or upgraded rather than replaced entirely?	2	0
Total Points for Matrix Element D.3		

D.4: Product Use, Maintenance, Liquid Residue

For this product or component:	Yes	No
1) Does use of the product avoid the release of substances known to be **water pollutants**? (see Hazardous Chemical Index, page 32)	5	0
Total Points for Matrix Element D.4		

D.5: Product Use, Maintenance, Gaseous Residue

(for each question circle one number)

For this product or component:	Yes	No
1) Is the emission of hazardous **air pollutants** avoided during use or maintenance? *(see Hazardous Chemicals List, page 32)*	2	0
2) Is the emission of **global warming** and **ozone- depleting gases** avoided during use or maintenance? *(see Hazardous Chemical Index, page 32)*	3	0

Total Points for Matrix Element D.5 ________

End of Life

E.1: End of Life, Materials Choice

For this product or component:	Yes	No
1) Are the materials are easily reused or commonly recycled?	1	0
2) Are the materials easy to separate and identify by type?	1	0
3) Upon disposal are none of the materials required to be disposed of as hazardous waste?	1	0
4) Has the intentional introduction of lead, cadmium, mercury and hexavalent chromium into the product materials been avoided?	2	0

Total Points for Matrix Element E.1 ________

E.2: End of Life, Energy Use

For this product or component:	Yes	No
1) Can the plastic or fiber parts be safely used for energy generation ? (i.e., incineration, see Polymers on page 62, if there is no plastic or fiber materials used the answer is "2" or yes)	2	0
2) Upon disposal are there no hazardous materials that need to be transported to hazardous waste management facilities? (i.e., additional energy use is required to transport materials for special handling)	3	0

Total Points for Matrix Element E.2 ________

E.3: End of Life, Solid Residues

(for each question circle one number)

For this product or component:	Yes	No
1) Does the infrastructure exist (inside or outside the company) to recover/recycle the solid material(s)?	2	0
2) Does the product design avoid joining dissimilar materials in ways that are difficult to reverse?	3	0

Total Points for Matrix Element E.3 ________

E.4: End of Life, Liquid Residues

For this product or component:	Yes	No
1) Is the product designed so that problem liquid materials can be recovered during disassembly? *(if there are no liquids in the product or component the answer is "5" or yes, for no environmental impact)*	5	0

Total Points for Matrix Element E.4 ________

E.5: End of Life, Gaseous Residues

For this product or component:	Yes	No
1) Is release of substances known to be **ozone-depleting** and/or **global warming gases** avoided upon disposal of this product or component? *(see Climate-altering Chemical Index, page 32)*	2	0
2) Can gases contained in the product be recovered at the time of disassembly rather than lost? *(if there are no gases contained in the product or component the answer is "2" or yes)*	1	0
3) Is release of substances known to be **air pollutants** avoided upon disposal of this product or component?	2	0

Total Points for Matrix Element E.5 ________

Interpretation of Results

At this point in the process, members of the design team evaluate the product design(s) in light of the matrix scoring system. Discussion regarding possible changes to the product design to improve the environmental performance of the product take place.

The matrix scoring system allows the design team to:
- Score a product design as part of an overall product evaluation
- Compare alternative product designs
- Recognize areas where design changes are most imperative from an environmental standpoint

What to do with the score

The matrix score is a relative measure of the attributes of the product. It complements the economic, customer-value, manufacturability and other parameters that may be evaluated. The matrix score should become part of the overall assessment of a product and be used as an input in deciding which product design will be pursued.

Comparing alternative product designs

Since many of the terms used in the questions are subjective, a rating system that would be consistent among individual manufacturers, and especially across industry lines, is virtually impossible. As design teams adapt the toolkit to their own use, the scores will become relevant only within the company itself. The rating score enables the manufacturer to compare the environmental impact of alternative product designs. For instance, one design for a particular product may achieve a ranking of 84, while an alternative design for the same product may achieve only a 56. Clearly, the first product design is superior from an environmental perspective. When the scores are closer together (*e.g.* 63 versus 65), then subjective determinations need to be made by the design team as to the truly better product.

Recognizing needed changes

The design team should determine which design changes are truly impossible given the state of the company and its products, and which changes are reasonable efforts for the company to make. *The challenge is to avoid allowing processes to remain the same for the sake of convenience, when reasonable changes could be implemented.*

To prioritize possible improvements in a product, it is important to consider design changes in the context of parameters other than the environment.

Then the product improvements can be ranked from the most feasible to the least feasible. Below are some questions that can be used to rank the feasibility of design changes:

- Is the design change easy, moderate or impossible to implement?

- Would the product be significantly less costly, cost the same, or cost more to produce if the product design change is incorporated?

- Does the design change have a very high, no, or negative perceived value by most environmentally conscious consumers?

- Would the proposed design changes significantly decrease, not affect, or significantly increase the amount of time required to develop and manufacture the product?

Design Notes

Information learned from use of the matrix can be used to update and improve company design specifications and notes to include environmental preferences. For example, if mercury switches can be replaced by non-mercury alternatives, the alternative switches should be specified in any design notes or general company-wide parts/materials specifications. Another example would be the specification of water-based adhesives or paints as preferable materials or single-resin versus multiple-resin plastics.

The integration of environmental attribute preferences into company design documentation such as design notes will complement and reinforce the use of DfE tools.

Definitions

Air Pollutant A pollutant that is known to end up in the air once it is released to the environment. *(see Hazardous Chemicals List, page 38)*.

Bioaccumulative *Chemicals that accumulate in living (plant or animal) tissues*. Through bioaccumulation, chemicals that are relatively low in concentration in air, water or soil may reach relatively high levels in plants or animals. Elevated levels of these chemicals are often toxic to the organisms.

Built-in Energy *The amount of energy that has been invested in a material to bring it to its present form.* For instance, a plastic component that has been formed through injection-molding has required a larger energy investment than has the raw plastic grind that was used to produce the component. Although the raw plastic grind has required a significant energy input to bring it to its present level of refinement, it will require still more energy input (*e.g.* heating, pressure) to become the plastic component. If a manufacturer is able to reuse materials in a semi-processed form rather than first reducing it to a "raw" form, significantly less energy is consumed in the process.

Global Warming *Gases known to reside in the atmosphere and contribute to the disruption of planetary weather and temperature patterns.*The gases essentially act as insulation, preventing heat that has entered the atmosphere from escaping back into space. (See also Climate-altering Chemical Index.)

Energy-intensive *Processes that require large amounts of energy* (electric, gas, etc.).

Gaseous Residues *Pollutants generated in a gas form*. They include climate-altering gases, odorants (foul-smelling chemicals), vapors, air pollutants and others. *(see Hazardous Chemical Index page38).*

Hazardous A hazardous material is defined according to Department of Labor and IndustriesOccupational Safety and Health Standards as a chemical or substance that *"is either toxic or highly toxic, an irritant, corrosive, a strong oxidizer, a strong sensitizer, combustible, either flammable or extremely flammable, dangerously reactive, pyrophoric, pressure-generating, a compressed gas, a carcinogen, a teratogen, a mutagen, a reproductive toxic agent . . . ."*

Liquid Residues *Pollutants generated in a liquid form.* They include solvents, oil-slicks, water pollutants and others. (See also Hazardous Chemical Index.)

Nonrenewable A resource defined by the EPA as *a material that is not replaceable within a period of 200 years*. These include fossil fuels, petroleum, minerals, etc.

Ozone-depleting *Gases known to contribute to the destruction of the ozone layer*. The ozone layer is a protective layer of gas surrounding the earth that prevents much of the harmful ultraviolet rays generated by the sun from reaching ground level. (See also Climate-altering Chemical Index.)

Definitions Continued.

Recycled *Materials that have been previously processed and are reused to manufacture the same or different product. Pre-consumer recycling* includes the reuse of material that has been generated within the manufacturing process. Deformed plastic parts, for instance, can be ground and reinjected to produce an acceptable product. *Post-consumer recycling* is the reuse of products, or their constituent materials, that have already been used and discarded by the consumer. This type of recycling is preferable, as the material may otherwise be incinerated and landfilled.

Recyclable Although many materials are *potentially* recyclable, for some there does not exist a viable market to reuse the material. The end result, then, is the same as for an intrinsically non-recyclable material, the product is landfilled or incinerated. For the purposes of these questions, *a recyclable material will be one that can be reprocessed for use and one for which an active market exists to use the reprocessed material*. See Additional Resources for more information on determining active markets.

Renewable Resources that are essentially limitless in their supply and do not require replacement. Examples include solar, wind and geothermal energy. Manufacturers should consider the source of their energy. Electricity generated by wind props, for instance, would be considered a renewable resource.

Reusable A material or product that can be used again without reprocessing constituent materials (as opposed to **recyclable**, which requires reprocessing). Reusable water bottles are one example.

Reusable Transport Packaging Packaging materials that are durable for repetitive use within a closed-loop shipping system. The closed-loop shipping system can be between company facilities or between a company, its suppliers or customers or a third party. Often these containers are collapsible or nest within each other to save space on the return trip to their origination. Typically these containers can provide additional protection to products because of their durable nature.

Solids Residues Pollutants that are generated in a solid form. They include contaminated soils, plastic litter (such as beverage can retaining rings), discarded parts, or others.

Water Contaminant A pollutant that is known to end up in water resources (e.g. lakes, rivers, groundwater) once released into the environment. *(See Hazardous Chemical Index page 35).*

Index of Hazardous Chemical Pollutants

(Sorted Alphabetically)

Explanation of Table
All of the chemical substances contained in this list are considered "hazardous" materials. However, some hazardous materials may be much less detrimental to the environment and should be considered for use in place of the more toxic substances. This table is intended to provide information about the known environmental impacts of the listed materials. The table can also be used for decision making with regards to selecting materials for use that are the least harmful to both the public health and the general environment.

Substance Substances are listed in alphabetical order, without regard to spaces, numbers or prefixes such as a (alpha), b (beta), m (meta), n, N, o (ortho), p (para), s (sec), or t (tert), except when names are otherwise equivalent. For instance, 1,2,4-Trichlorobenzene is listed before 1,1,1-Trichloroethane, as -benzene comes before -ethane alphabetically. 1,1,1-Trichloroethane, however, is listed before 1,1,2-Trichloroethane, as the chemical names are identical and the order must be based upon the number prefix. In a similar manner, m-Xylene is listed before o-Xylene.

This score should become part of the overall assessment of a product and be used as an input in deciding which product design will be pursued.

CAS # Chemical Abstract Service registry number. This is the identifying number assigned by the Chemical Abstracts Service, a division of the American Chemical Society. CAS numbers are published by the service in the Registry-Common Names, which is updated annually.

Title III The chemicals checked under this heading are substances subject to reporting requirements under sections 302, 304 *or* 313 (TRI) of the Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III *and* chemicals listed under section 112(r) of Title III of the Clean Air Act Amendments (CAA) of 1990.

TRI The chemicals checked under this heading are only those substances subject to reporting under section 313 of the SARA Title III through the Toxic Chemical Release Inventory (TRI).

Codes The letter codes refer to individual agencies that have listed the substance as a hazardous material (in addition to the other agencies referred to separately in the index.)

The rating score enables the manufacturer to compare the environmental impact of alternative product designs.

A - American Conference of Industrial Hygienists (ACGIH), "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 1992-1993," available from ACGIH, 6500 Glenway Avenue, Building D-7, Cincinnati, Ohio 45211-4438.

I - American Industrial Hygiene Association (AIHA), "Workplace Environmental Exposure Level Guides" (1992), available from AIHA, 2700 Prosperity Place, Merrifield, VA 22081.

N - National Institute for Occupational Safety and Health (NIOSH), "Recommendations for Occupational Safety and Health Standards," August 1988, available from NIOSH, Publications Dissemination Office, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, OH 45226.

O - Occupational Safety and Health Administration (OSHA), Safety and Health Standards, Code of Federal Regulations, title 29, part 1910, subpart Z, "Toxic and Hazardous Substances, 1990." General information: Minnesota Department of Labor and Industry, Occupational Safety and Health Division, 443 Lafayette Road, St. Paul, MN 55101.

R - International Agency for Research on Cancer (IARC) Monographs on the Evaluation of the Carcinogenic Risks to Humans; Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs Volumes 1 to 42, Supplement 7 (1987). Available from: WHO Publications Center USA, 49 Sheridan Avenue, Albany, NY 12210.

S - Occupational Safety and Health Administration proposed standards.

T - National Toxicology Program (NTP) "Seventh Annual Report on Carcinogens," 1991. *Source*: Department of Labor and Industry, Occupational Safety and Health Standards. "Employee Right-to-know Standards." Parts 5206.0100-5206.0400.

Air Pollutants The substances checked under this category are materials listed by the Minnesota Pollution Control Agency, Air Quality Division as hazardous air pollutants. *"Facts about Air Quality Permit Rules," January 1996.*

Water Pollutants The substances checked under this category are materials listed by the Environmental Protection Agency as "Pollutants of Initial Focus in the Great Lakes Water Quality Initiative." *Code of Federal Regulations, 40 CFR Parts 9, 122, 123, 131, and 132. "Final Water Quality Guidance for the Great Lakes System; Final Rule." Vol. 60, No. 56; Thursday, March 23, 1995. pp15393*

Carcinogen The substances checked under this category are materials known or suspected to be carcinogens, or cancer-causing agents, as determined by OSHA, ACGIH, IARC, or the NTP. Roughly defined, a substance that is determined to be carcinogenic is likely to produce higher rates of cancer among populations exposed to the chemical for extended periods of time.

Endocrine Mimicker The substances checked under this category are materials "with widespread distribution in the environment reported to have reproductive and endocrine-disrupting effects." *Theo Colburn, Frederick S. vom Saal, and Ana M. Soto: Developmental Effects of Endocrine-Disrupting Chemicals in Wildlife and Humans. Environmental Health Perspectives. August 1993.* Endocrine mimickers generally interfere with the human endocrine, or hormone, system, and can interfere with normal biological and reproductive processes.

Bioaccumulative The substances checked under this category are materials listed by the Environmental Protection Agency as "Pollutants of Initial Focus in the Great Lakes Water Quality Initiative-Pollutants that are bioaccumulative chemicals of concern". *Code of Federal Regulations, 40 CFR Parts 9,*

122,123, 131, and 132. "Final Water Quality Guidance for the Great Lakes System; Final Rule." Vol. 60, No. 56; Thursday, March 23, 1995. pp 15392. Bioaccumulative chemicals are materials that accumulate in the living tissues of plants or animals. Because of this ability, chemicals that are found in relatively low concentrations in air, water or soil may reach extremely high levels of toxicity in living organisms.

Rating: For a limited number of substances, a rating system has been devised which rates air pollutants based on known attributes of the chemical, such as its toxicity, persistence in the environment, availability to living organisms, ability to spread through water, soil and air. The rating ranges from 0 to approximately 21, with 21 being the greatest (negative) potential environmental impact. It is a logarithmic scale, meaning that a substance with a rating of 15, for example, is calculated to have 10 times the potential environmental impact of a chemical with a rating of 14, one hundred times the potential impact of a chemical with a rating of 13, and so forth.

More information on the rating system may be found in "An Indexing System for Comparing Toxic Air Pollutants Based Upon Their Potential Environmental Impacts." *Gregory C. Pratt, Paul E. Gerbec, Sherryl Livingston, Fardin Oliaei, George Bollweg, Sally Paterson, and Donald Mackay. Chemosphere, Vol. 27, No.8, pp1359-1379, 1993.* Updated to July 1997 with material obtained from Gregory C. Pratt, Division of Air Quality, Minnesota Pollution Control Agency.

Disclaimer: Although every attempt has been made to assemble a thorough and accurate list of materials, the authors do not *guarantee* the accuracy of this chemical index. The user should not rely on the index to ensure regulatory compliance. The absence of a chemical from the index does not necessarily indicate that it is not regulated or reportable. The index is meant only to assist the user in selecting materials. Manufacturers should consult the appropriate updated lists provided under federal and state laws to determine chemical reporting requirements.

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Abate [see Temephos]										
A-a-C (2-amino-9H-pyrido[2,3-b]indole				R			✓			
Acenaphthene	83-32-9	✓				✓				7.46
Acenaphthylene	208-96-8	✓				✓	✓			
Acetaldehyde	75-07-0	✓	✓	AO	✓					10.96
Acetamide	60-35-5	✓	✓	R	✓		✓			
Acetic Acid	64-19-7	✓		AO						
Acetic Anhydride	108-24-7	✓		AO						
Acetone	67-64-1	✓		AON						7.16
Acetone cyanohydrin	75-86-5	✓	✓	IN						
Acetonitrile	75-05-8	✓	✓	ANO	✓					
Acetophenone	98-86-2	✓	✓	AI	✓					
2-Acetylaminoflourene	53-96-3	✓	✓	AI	✓		✓			
Acetylene	74-86-2	✓		ONT						
Acetylene dichloride [see 1,2-Dichloroethylene]										
Acetylene tetrabromide	79-27-6			AO						
Acetylsalicylic acid	50-78-2	✓		A						
Acrolein	107-02-8	✓	✓	AO	✓	✓				13.24
Acrylamide	79-06-1	✓	✓	ANOR	✓		✓			13.39
Acrylic acid	79-10-7	✓	✓	A	✓					11.74
Acrylonitrile	107-13-1	✓	✓	ANORT	✓	✓	✓			13.10
Actinomycin D	50-76-0	✓		R			✓			
Adipic acid	124-04-9	✓		A						
Adiponitrile	111-69-3	✓		A						
Adriamycin	23214-92-8			RT			✓			
AF-2[2-(2-furyl)-3-(5-nitro-2-furyl) acrylamide]	3688-53-7			R			✓			
Aflatoxins	1402-68-2			RT			✓			
Alachlor	15972-60-8	✓	✓					✓		
Aldicarb	116-06-3	✓	✓					✓		
Aldrin	309-00-2	✓	✓	AN		✓	✓			13.66
Allyl alcohol	107-18-6	✓	✓	AO						
Allyl chloride (3-Chloroprene)	107-05-1	✓	✓	ANO	✓		✓			11.47
Allyl glycidyl ether (AGE)	106-92-3			ANO						
Allylisothiocyanate	57-06-7			I						
Allyl propyl disulfide	2179-59-1			AO						
a-Alumina (Aluminum oxide)	1344-28-1	✓	✓	A						10.16
Aluminum (including alkyls)	7429-90-5	✓	✓	A		✓				13.96
2-Aminoanthraquinone	117-79-3	✓	✓	T			✓			
p-Aminoazobenzene	60-09-3	✓	✓	R			✓			
o-Aminoazotoluene (C.I. Solvent Yellow #3)	97-56-3	✓	✓	R			✓			
p-Aminobenzoic acid	150-13-0			I						
Aminobiphenyl [see 4-Aminodiphenyl]										
4-Aminodiphenyl	92-67-1	✓	✓	ANOT	✓		✓			
2-Aminoethanol [see Ethanolamine]										
1-Amino-2-methylanthraquinone	82-28-0	✓	✓	T			✓			
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole				R			✓			
2-Aminopyridine	504-29-0			AO						
3-Amino 1,2,4-triazole [see Amitrole]										
Amitrole	61-82-5	✓	✓	ART			✓	✓		
Ammonia	7664-41-7	✓	✓	ANOS						9.39
Ammonium chloride	12125-02-9	✓		A						
Ammonium perfluorooctanoate	3825-26-1			A						
Ammonium sulfamate	7773-06-0	✓		AO						
n-Amyl acetate	628-63-7	✓		AO						8.12
s-Amyl acetate	626-38-0	✓		AO						
Analgesic mixture containing phenacetin				R			✓			

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Aniline and homologues	62-53-3	✓	✓	AO	✓		✓			10.53
o-Anisidine	90-04-0	✓	✓	AOT	✓		✓			
p-Anisidine	104-94-9	✓	✓	AOT						
o-Anisidine hydrochloride	134-29-2	✓	✓	T			✓			
Anthracene	120-12-7	✓	✓	R		✓	✓			4.05
Antimony and compounds, as Sb	7440-36-0	✓	✓	ANO	✓	✓				15.53
Antimony trioxide, handling and use, as Sb production	1309-64-4	✓	✓	A			✓			
ANTU (a-Naphthyl thiourea)	86-88-4	✓		AO						
a-Aramite	140-57-8			R			✓			
Aroclors [see Polychlorinated biphenyls]										
Arsenic, inorganic/organic, as As	7440-38-2	✓	✓	ANORT	✓	✓	✓			15.08
Arsine	7784-42-1	✓		ANO						
Asbestos (all forms)	1332-21-4	✓	✓	ANORT	✓	✓	✓			
Asphalt (petroleum) fumes	8052-42-4			AN						
Atrazine	1912-24-9	✓	✓	A				✓		
Auramine (technical grade)	492-80-8	✓	✓	R			✓			
Azaserine	115-02-6	✓		R			✓			
Azathioprine	446-86-6			RT			✓			
Azinphos-methyl (Guthion)	86-50-0	✓		AO		✓				
Aziridine [see Ethyleneimine]										
Barium, soluble compounds, as Ba	7440-39-3	✓	✓	AO						12.69
Barium, sulfate	7727-43-7			A						
Baygon (Propoxur)	114-26-1	✓	✓	A	✓					
Baytex [see Fenthion]										
Benomyl	17804-35-2	✓	✓	A				✓		
Benzaldehyde	100-52-7			I						
1,2-Benzanthracene (Benz[a]anthracene)	56-55-3	✓		ART		✓	✓			
Benzene	71-43-2	✓	✓	ANORT	✓	✓	✓			11.16
Benzenethiol (Phenyl mercaptan, Thiophenol)	108-98-5	✓		AN						
Benzidine	92-87-5	✓	✓	AONRT	✓	✓	✓			14.13
Benzidine-based dyes		✓	✓	N		✓	✓			
3,4-Benzofluoranthene (Benzo[b]fluoranthene)	205-99-2	✓		ART		✓	✓			
11,12-Benzofluoranthene (Benzo[k]fluoranthene)	207-08-9	✓		R		✓	✓			
Benzo[j]fluoranthene	205-82-3	✓		R			✓			
Benzoic Acid	65-85-0									6.53
Benzoperylene (Benzo[ghi]perylene)	191-24-2	✓				✓				
Benzophenone				I						
p-Benzoquinone [see Quinone]										
Benzotrichloride	98-07-7	✓	✓	RT	✓		✓			
Benzoyl chloride	98-88-4	✓	✓	IN						
Benzoyl peroxide	94-36-0	✓	✓	ANO						
Benzo[a]pyrene (3,4-Benzopyrene)	50-32-8	✓		ART		✓	✓			16.05
Benzyl acetate	140-11-4			A						
Benzyl alcohol				I						
Benzyl chloride	100-44-7	✓	✓	ANO	✓		✓			10.48
Benzyl violet 4B				R			✓			
Beryllium (and compounds)	7440-14-7	✓	✓	ANMORT	✓	✓	✓			
Biphenyl (Diphenyl)	92-52-4	✓	✓	AO	✓					3.97
Bis-(2-chloroethoxy) methane	111-91-1	✓	✓			✓				
N,N-Bis-(2-chloroethyl)-w-naphthylamine (Chlornaphazine)	49-40-31	✓		R			✓			
Bischloroethyl nitrosourea (BCNU)	154-93-8			RT			✓			
Bis-(2-chloroethyl) ether (Dichloroethyl ether)	111-44-4	✓	✓	AO	✓	✓				12.66
Bis-(2-chloroisopropyl) ether	108-60-1	✓	✓	I		✓				8.13
Bischloromethyl ether (BCME)	542-88-1	✓	✓	AORT	✓		✓			13.68
Bis-(2-ethylhexyl) phthalate [see Di(2-ethyhexl)phthalate]										
Bismuth telluride	1304-82-1			A						

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Bitumens (extracts of steam-refined/air-refined)	8052-42-4			R			✓			
Bleomycins				R			✓			
Borates, tetra, sodium salts	1303-96-4			R						
Boron oxide	1303-86-2			AO						
Boron tribromide	10294-33-4			A						
Boron trifluoride	7637-07-2	✓	✓	ANO						
Bromacil	314-40-9	✓	✓	A						
Bromochloromethane [see Chlorobromomethane]										
Bromodichloromethane (Dichlorobromomethane)	75-27-4	✓	✓			✓	✓			11.26
Bromoform	75-25-2	✓	✓	AO	✓	✓				13.17
Bromomethane [see Methyl bromide]										
4-Bromophenyl phenyl ether	101-55-3	✓				✓				
Bromotrifluoromethane [see Trifluorobromomethane]										
1,3-Butadiene	106-99-0	✓	✓	ANOR	✓		✓			12.35
Butane	106-97-8	✓		A						
1,4-Butanediol dimethylsulfonate (Myleran)	55-98-1			RT			✓			
Butanethiol [see Butyl mercaptan]										
2-Butanone [see Methyl ethyl ketone (MEK)]										
2-Butoxyethanol (EGBE)	111-76-2			AO						9.19
n-Butyl acetate	123-86-4	✓		AO						8.31
s-Butyl acetate	105-46-4	✓		AO						
t-Butyl acetate	540-88-5	✓		AO						
Butyl acrylate	141-32-2	✓	✓	A						
n-Butyl alcohol	71-36-3	✓	✓	AO						7.50
s-Butyl alcohol	78-92-2	✓	✓	AO						
t-Butyl alcohol	75-65-0	✓	✓	AO						9.30
Butylamine	109-73-9	✓		AO						
Butyl benzyl phthalate	85-68-7	✓				✓				10.14
Butylated hydroxyanisole (BHA)	25013-16-5			R			✓			
4-t-Butylcatechol				I						
Butyl cellosolve [see 2-Butoxy ethanol]										
Butylene oxide	106-99-9&106-	✓	✓	I						
n-Butyl glycidyl ether (BGE)	2426-08-6			AO						
n-Butyl lactate	138-22-7			A						
Butyl mercaptan	109-79-5			ANO						
o-s-Butylphenol	89-72-5			A						
p-t-Butyltoluene	98-51-1			AO						
Butyraldehyde	123-72-8	✓	✓	I						
a-Butyrolactone				R			✓			
n-Butyronitrile	109-74-0			N						
Cadmium and its compounds (as Cd)	7440-43-9	✓	✓	ANRT	✓	✓		✓		16.00
Cadmium, dust and salts (as Cd), fume	7440-43-9	✓	✓	ANO			✓			16.00
Cadmium oxide, fume (as Cd)	1306-19-0	✓		ANO						
Cadmium oxide production (as Cd)		✓		A			✓			
Calcium chromate	13765-19-0	✓		ART			✓			
Calcium cyanamide	156-62-7	✓	✓	A	✓					
Calcium hydroxide	1305-62-0	✓		A						
Calcium oxide	1305-78-8			AO						
Calcium sulfate (Gypsum)	7778-18-9			A						
Camphor, synthetic	76-22-2			AO						
Caprolactam	105-60-2	✓		A	✓					7.99
Captafol	2425-06-1	✓		A						
Captan	133-06-2	✓	✓	A	✓					
Carbaryl (Sevin)	63-25-2	✓	✓	ANO	✓			✓		
Carbofuran (Furadan)	1563-66-2	✓	✓	A						
Carbon black	1333-86-4			ANOR			✓			

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Carbon diflouride [see Carbonyl flouride]										
Carbon dioxide	124-38-9			ANO						
Carbon disulfide	75-15-0	✓	✓	ANO	✓					11.39
Carbon monoxide	630-08-0			ANO						9.70
Carbon tetrabromide	558-13-4			A						
Carbon tetrachloride (tetrachloromethane)	56-23-5	✓	✓	ANORT	✓	✓	✓			15.36
Carbonyl chloride [see Phosgene]										
Carbonyl fluoride (Carbon difluoride)	353-50-4	✓		A						
Carbonyl sulfide	463-58-1	✓	✓		✓					
Carrageenan, degraded	9000-07-01			R			✓			
Catechol (Pyrocatechol)	120-80-9	✓	✓	A	✓					7.81
Cellosolve acetate [see 2-Ethoxyethyl acetate]										
Ceramic fibers (respirable size)							✓			
Cesium hydroxide	21351-79-1			A						
Chloramben	133-90-4	✓	✓		✓					
Chlorambucil	305-03-3	✓		RT			✓			
Chloramphenicol	56-75-7			IR			✓			
Chlordane	57-74-9	✓	✓	AO	✓	✓	✓	✓	✓	13.30
Chlordecone (Kepone)	143-50-0	✓	✓	NRT			✓			
Chlorendic acid	115-28-6	✓	✓	T			✓			
Chlorinated camphene (Toxaphene)	8001-35-2	✓	✓	AOT	✓		✓	✓		
Chlorinated diphenyl oxide	31242-93-0			AOT						
Chlorinated paraffins (C12, 60% Chlorine)	108171-26-2			T			✓			
a-Chlorinated toluenes				R			✓			
Chlorine	7782-50-5	✓	✓	ANO	✓					10.22
Chlorine dioxide	10049-04-4	✓	✓	AO						10.71
Chlorine trifluoride	7790-91-2			AO						
Chloroacetaldehyde	107-20-0	✓		AO						
Chloroacetic acid (mono-)	79-11-8	✓	✓		✓					
Chloroacetone	78-95-5			A						
2-Chloroacetophenone (Phenylacylchloride)	532-27-4	✓	✓	AO	✓					13.59
Chloroacetyl chloride	79-04-9			A						
4-Chloroanaline	106-47-8		✓							8.21
Chlorobenzene (mono-)	108-90-7	✓	✓	AO	✓	✓				10.14
Chlorobenzilate	510-15-6	✓	✓		✓					
o-Chlorobenzylidene malonitrile (OCBM)	2698-41-1			AO						
Chlorobromomethane	74-97-5			AO						
2-Chloro-1,3-butadiene [see Chloroprene]										
p-Chloro-m-cresol	59-50-7	✓				✓				
Chlorodibromomethane	124-48-1	✓				✓				11.88
Chlorodifluoromethane (Fluorocarbon 22)	75-45-6	✓	✓	A						
Chlorodiphenyl (PCB)		✓	✓	AORT		✓	✓	✓	✓	
42% chlorine	53469-21-9									
54% chlorine	11097-69-1									
1-Chloro, 2,3-epoxy-propane [see Epichlorohydrin]										
Chlor(o)ethane	75-00-3	✓	✓	N		✓				
2-Chloroethanol [see Ethylene chlorohydrin]										
Chloroethylene [see Vinyl chloride]										
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	13010-47-4			RT			✓			
1-(2-Chloro ethyl)-3-(4-methylcyclohexyl)-	13909-09-6			R			✓			
1-nitrosourea (methyl-CCNU)										
2-Chloroethyl vinyl ether	110-75-8	✓				✓				
Chloroform (Trichloromethane)	67-66-3	✓	✓	ANORT	✓	✓	✓			14.17
bis(2-Chloroisopropyl)ether [see Bis(2-chloro...]										
Chloromethane [see Methyl chloride]										
bis(Chloromethyl) ether (BCME) [see Bischloromethyl...]	542-88-1	✓	✓	ANO			✓			

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Chloromethyl methyl ether [see Methyl chloromethyl ether]	107-30-2									
4-Chloro-3-methylphenol [see p-Chloro-m-cresol]										
3-Chloro-2-methylpropene	563-47-3	✓	✓	T			✓			
2-Chloronaphthalene	91-58-7	✓				✓				
1-Chloro-2-nitrobenzene	88-73-3									9.45
1-Chloro-4-nitrobenzene (p-Nitrochlorobenzene)	100-00-5			AO						9.54
1-Chloro-1-nitropropane	600-25-9			AO						
Chloropentafluoroethane (Fluorocarbon 115)	76-15-3			A						
Chlorophenol	106-48-9	✓		R			✓			
2-Chlorophenol	95-57-8	✓				✓				8.31
4-Chloro-o-phenylenediamine	95-83-0			RT			✓			
4-Chlorophenyl phenyl ether	7005-72-3	✓				✓				
Chlorophenoxy herbicides				R			✓			
Chloropicrin [Trichloronitromethane)	76-06-2	✓	✓	AO						
Chloroprene	126-99-8	✓	✓	ANO	✓		✓			9.46
3-Chloroprene [see Allyl chloride]										
2-Chloropropionic acid	598-78-7			A						
p-Chloro-o-toluidine	95-69-2	✓	✓	R			✓			
o-Chlorostyrene	2039-87-4			A						
Chlorosulfonic acid	7790-94-5	✓		I						
o-Chlorotoluene	95-49-8			A						
2-Chloro-6-(trichloromethyl) pyridine [see Nitrapyrin]	1929-82-4									
Chloropyrifos	2921-88-2	✓		A		✓				
Chlorotrifluoroethylene	79-38-9	✓		I						
Chromic acid	7738-94-5	✓		NO						
Chromite ore processing (Chromate), as Cr		✓		A			✓			
Chromium metal	7440-47-3	✓	✓	AO		✓				
Chromium (II) compounds, as Cr		✓	✓	A	✓					
Chromium (III) compounds, as Cr		✓	✓	A	✓					12.12
Chromium (VI) compounds, as Cr (water soluble)		✓	✓	ANO			✓			
Chromium (VI) compounds		✓	✓	AN	✓		✓			15.63
Chromium (VI) compounds, certain water insoluble ones		✓	✓	ANORT						
Chromyl chloride	14977-61-8			A			✓			
Chrysene	218-01-9	✓		AN		✓	✓			
Chrysotile [see Asbestos]										
C.I. Basic Red 9 Monohydrochloride	569-61-9			T			✓			
C.I. Solvent Yellow #3 [see o-Aminoazotoluene]										
C.I. Direct Black 38 (technical grade)	1937-37-7	✓	✓	RT			✓			
C.I. Direct Blue 6 (technical grade)	2602-46-2	✓	✓	RT			✓			
C.I. Direct Brown 95 (technical grade)	16071-86-6	✓	✓	R			✓			
Cisplatin	15663-27-1			R			✓			
Citrus Red No. 2				R			✓			
Clopidol	2971-90-6			A						
Coal, dust				AO						
Coal tars, coal tar pitches, and coal tar				ANORT			✓			
pitch volatiles (as benzene solubles)	65996-93-2									
Cobalt, elemental and inorganic compounds, as Co	7440-48-4	✓	✓	A						
Cobalt, metal dust and fume, as Co	7440-48-4	✓	✓	ANO	✓					
Cobalt carbonyl, as Co	10210-68-1	✓	✓	A						
Cobalt hydrocarbonyl, as Co	16842-03-8			A						
Coke oven emissions		✓		NOT	✓		✓			
Conjugated estrogens				RT			✓			
Copper	7440-50-8	✓	✓			✓				15.06
Copper dust and mists, as Cu	7440-50-8	✓	✓	AO						
Copper fume	7440-50-8	✓	✓	AO						
Cotten dust, raw				ANO						

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Crag herbicide [see Sodium-2,4-dichlorophenoxyethyl sulfate]	136-78-7									
Creosotes	8001-58-9	✓	✓	R			✓			
p-Cresidine	120-71-8	✓	✓	RT			✓			
Cresol, all isomers	1319-77-3	✓	✓	ANO	✓					8.82
m-Cresol	108-39-4	✓	✓	ANO	✓					8.30
o-Cresol	95-48-7	✓	✓	ANO	✓					7.22
p-Cresol	106-44-5	✓	✓	ANO	✓					7.46
Cristobalite [see Silica-crystalline]										
Crocidolite [see Asbestos]										
Crotonaldehyde	4170-30-3	✓	✓	AO			✓			
Crufomate	299-86-5			A						
Cumene	98-82-8	✓	✓	AO	✓					
Cupferron	135-20-6	✓	✓	T			✓			
Cyanamide	420-04-2			A						
Cyanides, as Cn	151-50-8&143-	✓		AO	✓	✓				
Cyanogen	460-19-5	✓		A						
Cyanogen chloride	506-77-4	✓		A						
Cycasin	14901-08-7			R			✓			
Cyclohexane	110-82-7	✓	✓	AO						7.94
Cyclohexanethiol	1569-69-3			N						
Cyclohexanol	108-93-0	✓	✓	AO						
Cyclohexanone	108-94-1	✓		ANO						5.02
Cyclohexene	110-83-8			AO						
Cyclohexylamine	108-91-8	✓		A						
Cyclonite (RDX)	121-82-4			A						
Cyclopentadiene	542-92-7			AO						
Cyclopentane	287-92-3			A						
Cyclophosphamide	50-18-0	✓		RT			✓			
Cyhexatin	13121-70-5			A						
2,4-D (2,4-Dichlorophenoxyacetic acid)	94-75-7	✓	✓	AO	✓	✓		✓		9.46
Dacarbazine	4342-03-04			RT			✓			
Daunomycin	20830-81-3	✓		R			✓			
DBCP [see 1,2 Dibromo-3-chloropropane]										
DDD	72-54-8	✓				✓			✓	14.57
DDE	72-55-9	✓			✓	✓			✓	13.78
DDT (Dichlorodiphenyltrichloroethane)	50-29-3	✓		ANORT		✓	✓	✓	✓	14.21
DDVP [see Dichlorvos]										
DEHP [see Di(2-ethylhexyl phthalate]										
Decaborane	17702-41-9	✓		AO						
Decabromodiphenyl oxide	1163-19-5	✓	✓	I						
Demeton [see Systox]	8065-48-3									
Diacetone alcohol	123-42-2			ANO						
N,N-Diacetylbenzidine				R			✓			
2,4-Diaminoanisole and its salts	615-05-4	✓	✓	N			✓			
2,4-Diaminoanisole sulfate	39156-41-7	✓	✓	T			✓			
4,4'-Diaminodiphenyl ether [see 4,4'-Oxydianiline]										
1,2-Diaminoethane [see Ethylenediamine]										
2,4-Diaminotoluene (Toluene 2,4-diamine)	95-80-7	✓	✓	IRT	✓		✓			14.36
o-Dianisidine dihydrochloride	20325-40-0	✓	✓	N			✓			
o-Dianisidine hydrochloride	111984-09-9	✓	✓	N			✓			
Diazinon	333-41-5	✓	✓	A		✓				
Diazomethane	334-88-3	✓	✓	AO	✓		✓			
Dibenz[a,h]acridine	226-36-8	✓		RT			✓			
Dibenz[a,j]acridine	224-42-0	✓		RT			✓			
1,2:5,6-Dibenzanthracene (Dibenz[a,h]anthracene)	53-70-3	✓		RT		✓	✓			
7H-Dibenzo[c,g]carbazole	194-59-2	✓		RT			✓			

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Dibenzofurans	132-64-9	✓	✓		✓					9.05
Dibenzo[a,e]pyrene	129-65-4	✓		R			✓			
Dibenzo[a,h]pyrene	189-64-0	✓		RT			✓			
Dibenzo[a,i]pyrene	189-55-9	✓		RT			✓			
Dibenzo[a,l]pyrene	191-30-0	✓		R			✓			
Diborane	19287-45-7	✓		AO						
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	✓	✓	NORT	✓		✓	✓		15.94
1,2-Dibromoethane [see Ethylene dibromide]										
Dibrom (Dimethyl-1,2-dibromo-2-dichloroethyl phosphate)	300-76-5	✓	✓	A						
2-N-Dibutylaminoethanol	102-81-8			A						
Dibutylphenylphosphate	2528-36-1			A						
Dibutyl phosphate	107-66-4			AO						
Dibutyl phthalate	84-74-2	✓	✓	AO	✓	✓				9.97
Dichloroacetylene	7572-29-4			A			✓			
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	✓	✓	AO		✓				7.92
1,3-Dichlorobenzene	541-73-1	✓	✓			✓				
1,4-Dichlorobenzene	106-46-7	✓	✓	AORT	✓	✓	✓			10.43
3,3'-Dichlorobenzidine	91-94-1	✓	✓	ANORT	✓	✓	✓			5.75
3,3'-Dichlorobenzidine dihydrochloride	612-83-9	✓	✓	T			✓			
Dichlorobromomethane [see Bromodichloromethane]										
1,4-Dichloro-2-butene	764-41-0	✓	✓	A						
3,3'-Dichloro-4,4'-diaminophenyl ether				R			✓			
Dichlorodifluoromethane (Fluorocarbon 12)	75-71-8	✓	✓	AO						
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5			AO						
1,1-Dichloroethane	75-34-3	✓	✓	ANORT	✓	✓	✓			10.71
1,2-Dichloroethane [see Ethylene dichloride]										
1,1-Dichloroethylene [see Vinylidene chloride]										
1,2-Dichloroethylene	540-59-0	✓	✓	AO		✓				6.87
Dichloroethyl ether [see Bis-(2-chloroethyl0 ether]	111-44-4									
Dichlorofluoromethane [see Dichloromonofluoromethane]	75-43-4									
Dichloromethane [see Methylene chloride]										
Dichloromonofluoromethane (Fluorocarbon-21)	75-43-4	✓	✓	AO						
1,1-Dichloro-1-nitroethane	594-72-9			AO						
2,4-Dichlorophenol	120-83-2	✓	✓			✓				9.72
1,2-Dichloropropane [see Propylene dichloride]										
1,3-Dichloropropane (technical grade)	542-75-6	✓	✓	RT	✓	✓	✓			10.62
Dichloropropene	542-75-6	✓	✓	A						
2,2-Dichloropropionic acid	75-99-0	✓		A						
Dichlorotetrafluoroethane (Fluorocarbon 114)	76-14-2	✓	✓	AO						
Dichlorvos (DDVP)	62-73-7	✓	✓	AO	✓					
Dicofol	115-32-2	✓	✓					✓		
Dicrotophos	141-66-2	✓		A						
Dicyclohexylmethane-4,4'-diisocyanate	5124-30-1	✓		N						
Dicyclopentadiene	77-73-6	✓	✓	A						
Dicyclopentadienyl iron	102-54-5			A						
Dieldrin	60-57-1	✓		ANO		✓	✓	✓	✓	14.94
Dienoestrol	84-17-3			R			✓			
Diepoxybutane	1464-53-5	✓	✓	T			✓			
Di-2,3-epoxy propyl ether				N			✓			
Diethanolamine	111-42-2	✓	✓	A	✓					2.71
Diethylamine	109-89-7	✓		AO						8.24
2-Diethylaminoethanol	100-37-8			AO						
Diethylene dioxide [see 1,4-Dioxane]										
Diethylene glycol	111-46-6			I						
Diethylene glycol monoethyl ether				I						
Diethylene tramine	111-40-0			A						

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Diethyl ether [see Ethyl ether]										
Di(2-ethylhexyl)phthalate (DEHP)	117-81-7	✓	✓	AONRT	✓	✓	✓			12.42
Diethyl hydrazine				R			✓			
Diethyl ketone	96-22-0			A						
Diethyl phthalate	84-66-2	✓		A		✓				7.99
Diethylstilbestrol	56-53-1	✓		RT			✓			
Diethyl sulfate	64-67-5	✓	✓	RT	✓		✓			
Difluorodibromomethane (FREON 12B2)	75-61-6			AO						
Diglycidyl resorcinol ether (DGE)	101-90-6	✓	✓	ANORT			✓			
Dihydrosafrole	94-58-6	✓	✓	R			✓			
Dihydroxybenzene [see Hydroquinone]										
Diisobutyl ketone	108-83-8			ANO						
Diisobutylene	25167-70-8			IN						
Diisocyanates (not including those listed separately)		✓		N						
Diisopropylamine	108-18-9			ANO						
3,3' Dimethoxybenzidine (o-Dianisidine)	119-90-4	✓	✓	RT	✓		✓			
Dimethoxymethane [see Methylal]										
Dimethyl acetamide	127-19-5			AO						
4-Dimethylaminoazobenzene	60-11-7	✓	✓	NORT	✓		✓			
Dimethylaminobenzene [see Xylidene]										
trans-2-2[(Dimethylamino)methylimino]							✓			
-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole				R						
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	✓	✓	AO						
Dimethylbenzene [see Xylene]										
3,3'-Dimethylbenzidine [see o-Tolidine]										
Dimethylcarbamoyl chloride	79-44-7	✓	✓	ART	✓		✓			
Dimethyl-1,2-dibromo-2-dichloroethyl										
phosphate [see Dibrom]	300-76-5									
N-Dimethyl ether (Methyl ether)	115-10-6	✓		I						
Dimethylformamide (N-methylformamide)	68-12-2	✓	✓	AO	✓					8.74
2,6-Dimethyl-4-heptanone [see Diisobutyl ketone]										
1,1-Dimethylhydrazine	57-14-7	✓	✓	ANORT	✓		✓			
1,2-Dimethylhydrazine				R			✓			
Dimethylnitrosoamine [see N-Nitrosodimethylamine]										
2,4-Dimethylphenol (2,4-Xylenol)	105-67-9	✓	✓			✓				10.51
Dimethylphthalate	131-11-3	✓	✓	AO	✓	✓				7.67
Dimethyl sulfate	77-78-1	✓	✓	AOTR	✓		✓			
Dimethyl terephthalate	120-61-6			I						
Dimethylvinyl chloride	513-37-1			T			✓			
Dinitolmide [see 3,5-Dinitro-o-toluamide]	148-01-6									
m-Dinitrobenzene	99-65-0	✓	✓	AO						
o-Dinitrobenzene	528-29-0	✓	✓	AO						
p-Dinitrobenzene	100-25-4	✓	✓	AO						
4,6-Dinitro-o-cresol (DNOC, 2-Methyl-4,6-dinitrophenol)	534-52-1	✓	✓	ANO	✓	✓				
2,4-Dinitrophenol	51-28-5	✓	✓		✓	✓				11.51
3,5-Dinitro-o-toluamide (Zoalene)	148-01-6			A						
Dinitrotoluene-mixed isomers	25321-14-6	✓	✓	ANO	✓	✓	✓			
2,4-Dinitrotoluene	121-14-2	✓	✓	ANO	✓	✓	✓			11.98
2,6-Dinitrotoluene	606-20-2	✓	✓	ANO	✓	✓	✓			11.47
Dioctyl phthalate	117-84-0	✓				✓				
1,4-Dioxane (Diethylene dioxide)	123-91-1	✓	✓	ANORT	✓		✓			11.35
Dioxathion (Delanov)	78-34-2	✓		A						
Dioxins [see 2,3,7,8-Tetrachlorodibenzo-p-dioxin]										
Diphenyl [see Biphenyl]	92-52-4									
Diphenylamine	122-39-4	✓	✓	A						
Diphenyl ether [see Phenyl ether]										

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1,2-Diphenylhydrazine (Hydrazobenzene)	122-66-7	✓	✓	T	✓	✓	✓			11.84
Diphenylmethane diisocyanate [see Methylene bisphenyl isocyanate (MDI)]										
Dipropylene glycol methyl ether	34590-94-8			AO						
Dipropyl ketone (4-Heptanone)	123-19-3			A						
Di-s-octyl phthalate [see Di[2-ethylhexyl]phthalate]										
Diquat dust	231-36-7			A						
Disulfiram	97-77-8	✓		A						
Disulfoton (Disyston)	298-04-4	✓		A						
2,6-Di-t-butyl-p-cresol	128-37-0			A						
Diuron	330-54-1	✓	✓	A						
Divinyl benzene	1321-74-0			A						
Dust, Inert or Nuisance				A						
Including:										
Aluminum, metal and oxide										
Calcium carbonate										
Calcium silicate										
Calcium sulfate										
Cellulose (paper fiber)										
Emery										
Glycerin Mist										
Graphite (synthetic)										
Gypsum										
Kaolin										
Limestone										
Magnestite										
Marble										
Mineral Wool Fiber										
Pentaerythritol										
Perlite										
Plaster of Paris										
Portland Cement										
Precipitated Silica										
Rouge										
Silica gel										
Silicon										
Silicon carbide										
Starch										
Stearates										
Sucrose										
Titanium Dioxide										
Vegetable oil mists (except castor, cashew nut, or similar irritant oils)										
Zinc stearate										
Zinc oxide dust										
Dyfonate [see Fonofos]										
Emery	1302-74-5			A						
a-Endosulfan	959-98-8	✓		A		✓		✓		11.35
b-Endosulfan	33213-65-9	✓		A		✓		✓		11.35
Endosulfan sulfate	1031-07-8	✓				✓				
Endrin	72-20-8	✓		AO		✓				
Endrin aldehyde	7421-93-4	✓				✓				
Enflurane	13838-16-9			A						
Enzymes [see Subtilisins]										
Epichlorohydrin (1-Chloro-2,3-epoxy propane)	106-89-8	✓	✓	ANORT	✓		✓			12.95
EPN	2104-64-5	✓		AO						

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1,2-Epoxybutane (1,2-Butylene oxide)	106-88-7	✓	✓		✓					
1,2-Epoxypropane [see Propylene oxide]										
2,3-Epoxy-1-propanol [see Glycidol]										
Erionite	66733-21-9			R			✓			
Erythromycin	114-07-8			I						
Estrogens (not conjugated):							✓			
Estradiol	50-28-2			T						
Estrone	53-16-7			T						
Ethinyl estradiol	57-63-6			T						
Mestranol	72-33-3			T						
Ethane	74-84-0	✓		A						
Ethanethiol [see Ethyl mercaptan]										
Ethanol [see Ethyl alcohol]										
Ethanolamine	141-43-5			A						8.67
Ethinyl-oestradiol	57-63-6			R			✓			
Ethion	563-12-2	✓		A						
2-Ethoxyethanol	110-80-5	✓	✓	ANO						9.44
2-Ethoxyethyl acetate	111-15-9			AO						9.86
Ethylacetate	141-78-6	✓		AO						6.83
Ethyl acrylate	140-88-5	✓	✓	AORT	✓		✓			9.18
Ethyl alcohol	64-17-5			AO						7.74
Ethylamine (mono-)	75-04-7	✓		AO						8.69
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5			AO						
Ethyl benzene	100-41-4	✓	✓	AO	✓	✓				8.95
Ethyl bromide	74-96-4			AO			✓			
Ethyl butyl ketone (3-Heptanone)	106-35-4			AO						
Ethyl carbamate [see Urethane]										
Ethyl chloride	75-00-3	✓	✓	AO	✓					9.22
Ethylene	74-85-1	✓	✓	A						
Ethylene chlorohydrin (Chloroethanol)	107-07-3	✓		AO						
Ethylenediamine	107-15-3	✓		AO						
Ethylene dibromide (1,2-Dibromoethane)	106-93-4	✓	✓	ANORT	✓		✓			14.75
Ethylene dichloride (1,2-Dichloroethane)	107-06-2	✓	✓	ANOT	✓	✓	✓			13.89
Ethylene glycol, particulate and vapor	107-21-1	✓	✓	A	✓					7.26
Ethylene glycol dinitrate (EGDN)	628-96-6			ANO						
Ethylene glycol methyl ether acetate	110-49-6			AO						
Ethyleneimine (Aziridine)	151-56-4	✓	✓	ANO	✓		✓			
Ethylene oxide	75-21-8	✓	✓	ANOSRT	✓		✓			11.67
Ethylene thiourea	96-45-7	✓	✓	NRT	✓		✓			
Ethyl ether	60-29-7	✓		AO						
Ethyl formate	109-94-4			A						8.96
Ethylidene dichloride [see 1,1-Dichloroethane]										
Ethylidene norbornene	16219-75-3			A						
Ethyl mercaptan	75-08-1	✓		ANO						
Ethyl methanesulfonate	62-50-0	✓		R			✓			
N-Ethylmorpholine	100-74-3			AO						
N-Ethyl-N-nitrosourea				R			✓			
Ethyl silicate	78-10-4			AO						
Fenamiphos	22224-92-6	✓		A						
Fensulfothion	115-90-2	✓		A						
Fenthion	55-38-9	✓	✓	A						
Ferbam	14484-64-1	✓	✓	AO						
Ferrovanadium; dust	12604-58-9			AO						
Fibrous glass dust [see Glass]										
Fluoranthene	206-44-0	✓				✓				10.83
Fluorene	86-73-7	✓				✓				9.68

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Fluoride, as F, as dust	16984-48-8			ANO						
Fluorides, inorganic				N						
Fluorine	7782-41-4	✓	✓	AO						
Fluorocarbon, Polymers				N						
Fluorocarbon 11 [see Trichlorofluoromethane]	75-69-4									
Fluorocarbon 12 [see Dichlorodifluoromethane]										
Fluorocarbon 13b1 [see Trifluoromonobromomethane]										
Fluorocarbon 21[see Dichloromonofluoromethane]										
Fluorocarbon 22 [see Chlorodifluoromethane]										
Fluorocarbon 112 [see 1,1,2,2-Tetrachloro-1,2-difluoroethane]										
Fluorocarbon 112a [see 1,1,1,2-Tetrachloro-2,2-difluoroethane]										
Fluorocarbon 113 [see 1,1,2-Trichloro-1,2,2-trifluoroethane]										
Fluorocarbon 114 [see Dichlorotetrafluoroethane]										
Fluorocarbon 115 [see Chloropentafluoroethane]										
Fluorotrichloromethane [see Trichlorofluoromethane]										
Fonofos	944-22-9	✓		AO						
Formaldehyde	50-00-0	✓	✓	ANORT	✓		✓			10.91
Formamide	75-12-7			A						
Formic acid	64-18-6	✓	✓	AO						
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole				R			✓			
Furan, tetrahydro- [see Tetrahydrofuran]										
Furfural	98-01-1	✓		A						
Furfuryl alcohol	98-00-0			AN						
Gallium arsenide	7440-55-3			N			✓			
Gases, simple asphyxiants:				A						
Acetylene										
Argon										
Ethane										
Ethylene										
Helium										
Hydrogen										
Methane										
Neon										
Propane										
Propylene										
Gasoline	8006-61-9			A						
Germanium tetrahydride	7782-65-2			A						
Glass, fibrous or dust				AN			✓			
Glu-P-1(2-Amino-6-methyldipyrido[1,2-a:3;2'-d])-imidazole				R			✓			
Glu-P-2(2-Aminodipyrido[1,2-a:3,2'-d])-imidazole				R			✓			
Gluteraldehyde	111-30-8			A						
Glycerin mist	56-81-5			A						
Glycidaldehyde	765-34-4	✓		R			✓			
Glycidol (2,3-Epoxy-1-propanol)	556-52-5			AO			✓			
Glycidyl ethers				N			✓			
Glycol ethers		✓			✓					
Glycol monoethyl ether [see 2-Ethoxyethanol]										
Glycolonitrile (Formaldehyde cyanohydrin)	107-16-4			N						
Grain dust (oat, wheat, barley)				A						
Graphite (all forms except graphite fibers)	7782-42-5			AO						
Griseofulvin				R			✓			
Guthion [see Azinphos-methyl]										
Gypsum [see Calcium sulfate]	13397-24-5									
Gyromitrin (Acetaldehyde formylmethyl hydrazone)	16568-02-8			R			✓			

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Hafnium	7440-58-6			AO						
Halothane	151-67-7			AN						
Halowax [see Trichloronapthalene]										
HCFC-21 [see Dichloromonofluoromethane]										
Heptachlor	76-44-8	✓	✓	AO	✓	✓	✓	✓		13.12
Heptachlor epoxide	1024-87-3	✓		AO	✓	✓	✓	✓		14.77
Heptane (n-Heptane)	142-82-5			ANO						
2-Heptanone [see Methyl n-amyl ketone]										
3-Heptanone [see Ethyl butyl ketone]										
Hexachlorobenzene	118-74-1	✓	✓	AT	✓	✓	✓	✓	✓	15.55
Hexachlorobutadiene	76-68-3	✓		A	✓	✓	✓		✓	
Hexachloro-1,3-butadiene	87-68-3		✓							14.63
Hexachlorocyclohexane isomers (including Lindane)		✓	✓	RT		✓	✓		✓	13.80
Hexachlorocyclopentadiene	77-47-4	✓	✓	A	✓	✓				12.12
Hexachloronaphthalene (Halowax 1014)	1335-87-1	✓	✓	AO	✓	✓	✓			14.19
Hexadiene	592-42-7			I						
Hexafluoroacetone	684-16-2			A						
Hexamethylene diamine	124-09-4	✓		I						
Hexamethylene-1,6-diisocyanate	822-06-0	✓		AN	✓					
Hexamethylphosphoramide	680-31-9	✓	✓	ART	✓		✓			
Hexane (n-Hexane)	110-54-3	✓	✓	ANO	✓					9.57
Hexane, other isomers	107-83-5;107-8	✓		A						
1,6-Hexanediamine	124-09-4			A						
1,6-Hexanediol diacrylate	13048-33-4			I						
1-Hexanethiol	111-31-9			N						
2-Hexanone [see Methyl n-butyl ketone]	591-78-6									
Hexone [see Methyl isobutyl ketone]	108-10-1									
s-Hexyl acetate	108-84-9			AO						
Hexylene glycol	107-41-5			A						
Hydrazine	302-01-2	✓	✓	ANORT	✓		✓			12.70
Hydrazine sulfate	10034-93-2	✓	✓	T			✓			
Hydrazobenzene [see 1,2-Diphenylhydrazine]										
Hydrochloric acid	7647-01-1	✓	✓		✓					
Hydrogen	1333-74-0	✓		A						
Hydrogenated terphenyls	61788-32-7			A						
Hydrogen bromide	10035-10-6			AO						
Hydrogen chloride	7647-01-0	✓	✓	AO						9.40
Hydrogen cyanide	74-90-8	✓	✓	ANO						10.93
Hydrogen flouride, as F	7664-39-3	✓	✓	ANO	✓					
Hydrogen peroxide	7722-84-1	✓		A						
Hydrogen selenide, as Se	7783-07-5	✓		AO						
Hydrogen sulfide	7783-06-4	✓		ANO						12.19
Hydroquinone	123-31-9	✓	✓	ANO	✓					
4-Hydroxy-4-methyl-2-pentanone [see Diacetone alcohol]										
2-Hydroxypropyl acrylate	999-61-1			A						
Indene	95-13-6			A						
Indeno(1,2,3-cd)pyrene (2,3-o-phenylene pyrene)	193-39-5	✓		RT		✓	✓			
Iodine	7553-56-2			AO						
Iodoform	75-47-8			A						
Iodomethane [see Methyl iodide]										
IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)				R			✓			
Iron						✓				
Iron dextran complex	9004-66-4			RT			✓			
Iron pentacarbonyl, as Fe	13463-40-6	✓	✓	A						
Iron salts, soluble, as Fe				A						
Isoamyl acetate	123-92-2	✓		AO						

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Isoamyl alcohol	123-51-3			AO						
Isobutyl acetate	110-19-0	✓		AO						
Isobutyl alcohol	78-83-1	✓		AO						
Isobutyronitrile	78-82-0	✓		N						
Isocyanuric acid	108-80-5			I						
Isooctyl alcohol	26952-21-6			A						
Isophorone	78-59-1	✓		ANO	✓	✓				7.64
Isophorone diisocyanate	4098-71-9	✓		AN						
Isophthalic acid				I						
Isoprene	78-79-5	✓		I						
Isopropoxyethanol	109-59-1			A						
Isopropyl acetate	108-21-4			AO						
Isopropyl acetone [see Methyl isobutyl ketone]										
Isopropyl alcohol	67-63-0	✓	✓	ANO						7.84
Isopropylamine	75-31-0	✓		A						
N-Isopropylaniline	768-52-5			A						
Isopropyl benzene	98-82-8									10.44
Isopropyl ether	108-20-3			AO						
Isopropyl glycidil ether (IGE)	4016-14-2			ANO						
Kaolin dust	1332-58-7			A						
Kepone [see Chlordecone]	143-50-0									
Ketene	463-51-4			AO						
Lasiocarpine	303-34-4	✓		R			✓			
Lead, as Pb	7439-92-1	✓	✓	ANO	✓	✓	✓	✓		15.55
Lead acetate	301-04-2	✓		T			✓			
Lead chromate, as Pb and Cr	7758-97-6	✓		ART			✓			
Lead phosphate	7446-27-7	✓		T			✓			
Lindane (and other hexachlorocyclohexane isomers)	58-89-9	✓	✓	AOT	✓		✓	✓		13.79
Lithium hydride	7580-67-8	✓		AO						
Lithium hydroxide (and monohydrate)	1310-65-2			I						
Lithium oxide	12057-24-8			I						
L.P.G. (Liquid Petroleum Gas)	68476-85-7			AO						
Magnesite	546-93-0			A						
Magnesium oxide fume	1309-48-4			AO						
Malathion	121-75-5	✓	✓	ANO		✓				
Maleic anyhydride	108-31-6	✓	✓	AO	✓					7.63
Malononitrile	109-77-3	✓	✓	N						
Mancozeb				I				✓		
Maneb	12427-38-2	✓	✓					✓		
Manganese, elemental and compounds, as Mn	7439-96-5	✓	✓	AO	✓					13.38
Manganese cyclopentadienyltricarbon, as Mn	12079-65-1			A						
Manganese tetroxide	1317-35-7			A						
MBOCA [see 4,4'-Methylenebis[2-Chloroaniline]]										
*MeA-a-C(2-Amino-3-methyl-9H-pyrido[2,3-b]indole)				R			✓			
Medroxyprogesterone acetate				R			✓			
Melphalan	148-82-3	✓		RT			✓			
Mercaptoacetic acid [see Thioglycolic acid]										
Mercaptoethanol				I						
Mercury compounds, as Hg	7439-97-6	✓	✓	AN	✓	✓			✓	19.80
Merphalan				R			✓			
Mesityl oxide	141-79-7			ANO						
Mestranol	72-33-3			R						
Methacrylic acid	79-41-4			A						
Methane	74-82-8	✓		A						
Methanethiol [see Methyl Mercaptan]										
Methanol [see Methyl alcohol]										

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Methomyl (Lannate)	16752-77-5	✓		A				✓		
Methoxsalen with ultra-violet A therapy (PUVA)				RT			✓			
Methoxychlor	72-43-5	✓	✓	AO	✓	✓		✓		
2-Methoxyethanol (Methyl cellusolve)	109-86-4	✓	✓	AO						10.47
2-Methoxyethyl acetate [see Ethylene glycol methyl ether acetate]										
4-Methoxyphenol	150-76-5			A						
3-Methoxypropylamine	5332-73-0			I						
Methyl acetate	79-20-9			AO						
Methyl acetylene (Propyne)	74-99-7	✓		AO						
Methyl acetylene-propadiene mixture (MAPP)	59355-75-8			AO						
Methyl acrylate	96-33-3	✓	✓	AO						7.21
Methyl acrilonitrile	126-98-7	✓	✓	A						
Methylal (Dimethoxy methane)	109-87-5			AO						
Methyl alcohol (Methanol)	67-56-1	✓	✓	ANO	✓					7.50
Methylamine (mono-)	74-89-5	✓		AO						
Methyl amyl alcohol [see Methyl isobutyl carbinol]										
Methyl n-amyl ketone (2-Heptanone)	110-43-0			ANO						
N-Methyl aniline	100-61-8			AO						
2-Methylaziridine [see Propyleneimine]										
Methylazoxymethanol and its acetates				R			✓			
Methyl benzene [see Toluene]										
Methyl bromide (Bromomethane)	74-83-9	✓	✓	ANO	✓	✓	✓			13.50
Methyl t-butyl ether	1634-04-4	✓	✓	I	✓					9.74
Methyl-n-butyl ketone (2-Hexanone)	591-78-6			ANO						
Methyl cellosolve [see 2-Methoxyethanol]										
Methyl cellusolve acetate [see Ethylene glycol methyl ether acetate]										
Methyl chloride (Chloromethane)	74-87-3	✓	✓	ANO		✓	✓			12.83
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6	✓	✓	ANO	✓	✓				
Methyl chloromethyl ether (Chloromethyl methyl ether)	107-30-2	✓	✓	ANO	✓		✓			
5-Methylchrysene	3697-24-3	✓		R			✓			
Methyl-2-cyanoacrylate	137-05-3			A						
Methylcyclohexane	108-87-2			AO						
Methylcyclohexanol	25639-42-3			AO						
o-Methylcyclohexanone	583-60-8			AO						
2-Methylcyclopentadienyl manganese tricarbonyl, as Mn	12108-13-3	✓		A						
Methyl demeton	8022-00-2			A						
2-Methyl-4,6-dinitrophenol [see 4,6-Dinitro-o-cresol]										
4,4'-Methylene-bis-(2-chloroaniline) (MBOCA)	101-14-4	✓	✓	ANRT	✓		✓			
1,1-Methylene-bis-(4-cyclohexylisocyanate)	5124-30-1	✓		A						
4,4'-Methylene-bis-(N,N-dimethyl)benzenamine	101-61-1	✓	✓	T			✓			
4,4'-Methylene-bis-(2-methylaniline)				R			✓			
Methylene bisphenyl isocyanate (MDI)	101-68-8	✓		ANO	✓					12.36
Methylene chloride (Dichloromethane)	75-09-2	✓	✓	ANO	✓	✓	✓			12.32
4,4-Methylenedianiline and its dihydrochloride	101-77-9 and 1	✓	✓	ANRT	✓		✓			10.06
Methylene di-phenyl diisocyanate [see Methylene bis-...]										
Methyl ethyl ketone (MEK, 2-Butanone)	78-93-3	✓	✓	ANO	✓					9.70
Methyl ethyl ketone peroxide	1338-23-4	✓		AO						
Methyl ethyl ketoxime	96-29-7			I						
Methyl formate	107-31-3	✓		AO						
5-Methyl-3-heptanone [see Ethyl amyl ketone]	541-85-5									
Methyl hydrazine (mono-)	60-34-4	✓	✓	ANO	✓		✓			9.70
Methyl iodide (Iodomethane)	74-88-4	✓	✓	ANO	✓		✓			
Methyl isoamyl ketone	110-12-3			AN						
Methyl isobutyl carbinol	108-11-2			AO						
Methyl isobutyl ketone (Hexone, Isopropyl acetone)	108-10-1	✓	✓	ANO	✓					9.76

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Methyl isocyanate	624-83-9	✓	✓	AO	✓					
Methyl isopropyl ketone	563-80-4			A						
Methyl methanesulfonate	66-27-3			R			✓			
Methyl mercaptan	74-93-1	✓		ANO						
Methyl methacrylate	80-62-6	✓	✓	AO	✓					3.79
2-Methyl-1-nitroanthraquinone				R						
N-Methyl-N'-nitro-N-nitrosoguanidine (MNNG)	70-25-7	✓		R			✓			
N-Methyl-N-nitrosourea				R			✓			
N-Methyl-N-nitrosourethane				R			✓			
Methyl parathion	298-00-0	✓	✓	AN						
N-Methyl-2-pyrrolidone	872-50-4	✓	✓	I						
Methyl n-propyl ketone	107-87-9			ANO						
Methyl silicate	681-84-5			A						
a-Methyl styrene	98-83-9			AO						
Methylthiouracil	56-04-2	✓		R			✓			
Methyltrichlorosilane	75-79-6	✓		I						
Metiram-complex	9006-42-2	✓	✓					✓		
Metribuzin	21087-64-9	✓	✓	A				✓		
Metronidazole	443-48-1			RT			✓			
Mevinphos (Phosdrin)	7786-34-7	✓	✓	A						
Mica, dust	12001-25-2			AO						
Michler's Ketone	90-94-8	✓	✓	T			✓			
Mineral fibers				A	✓					
Mineral oils (lubricant, base oils, and derived products)				AORT			✓			
Mirex	2385-85-5			RT		✓	✓	✓	✓	
Mitomycin C	50-07-7	✓		R			✓			
Molybdenum, soluble/insoluble compounds, as Mo	7439-98-7			AO						
Monochlorobenzene [see Chlorobenzene]										
Monocrotaline				R			✓			
Monocrotophos (Azodrin)	6923-22-4	✓		A						
Morpholine	110-91-8			AO						
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone				R			✓			
Mustard gas	505-60-2	✓	✓	RT			✓			
Nafenopin				R						
Naled [see Dibrom]										
Naphtha (Coal Tar)	8030-30-6			O						
Naphtha (VM&P Naptha)	8032-32-4			A						
Naphtha (Rubber Solvent)				AO						
Naphthalene	91-20-3	✓	✓	AO	✓	✓				8.48
Naphthalene diisocyanate	25551-28-4			N						
b-Naphthylamine (2-Naphthylamine)	91-59-8	✓	✓	ANORT			✓			
a-Naphthylthiourea [see ANTU]										
Niax-a Catalyst ESN	62765-93-9			N						
Nickel, elemental, soluble, and insoluble compounds, as Ni	7440-02-0	✓	✓	ANORT	✓	✓	✓			14.96
Nicotine	54-11-5	✓		AO						
Niridazole				R			✓			
Nitrapyrin	1929-82-4	✓	✓	A						
Nitric acid	7697-37-2	✓	✓	ANO						
Nitric oxide	10102-43-9	✓		AO						
Nitrilotriacetic acid	139-13-9	✓	✓	T			✓			
5-Nitroacenaphthene				R			✓			
p-Nitroaniline	100-01-6	✓	✓	AO						
5-Nitro-o-anisidine	99-59-2	✓	✓	T			✓			
Nitrobenzene	98-95-3	✓	✓	AO	✓	✓				10.45
4-Nitrobiphenyl [see 4-Nitrodiphenyl]	92-93-3									

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p-Nitrochlorobenzene [see 1-Chloro-4-nitrobenzene]	100-00-5									
Nitrochloromethane [see Chloropicrin]										
4-Nitrodiphenyl (4-nitrobiphenyl)	92-93-3	✓	✓	ANO	✓		✓			
Nitroethane	79-24-3			AO						
Nitrofen	1836-75-5	✓	✓	RT			✓	✓		
1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone				R			✓			
N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide				R			✓			
Nitrogen	7727-37-6			A						
Nitrogen dioxide	10102-44-0	✓		ANO						9.67
Nitrogen mustard	51-75-2	✓	✓	RT			✓			
Nitrogen mustard hydrochloride	55-86-7			T			✓			
Nitrogen trifluoride	7783-54-2			AO						
Nitroglycerin (NG)	55-63-0	✓	✓	ANO						10.60
Nitromethane	75-52-5			AO						
2-Nitronapthalene	581-89-5			N			✓			
2-Nitrophenol	88-75-5	✓	✓			✓				
4-Nitrophenol	100-02-7	✓	✓		✓					
1-Nitropropane	108-03-2			AO						
2-Nitropropane	79-46-9	✓	✓	ANORT	✓		✓			10.39
N-Nitrosodi-n-butylamine	924-16-3	✓	✓	RT			✓			
N-Nitrosodiethanolamine	1116-54-7	✓		RT			✓			
N-Nitrosodiethylamine	55-18-5	✓	✓	RT			✓			
N-Nitrosodimethylamine	62-75-9	✓	✓	AONRT	✓	✓	✓			
p-Nitrosodiphenylamine	156-10-5	✓	✓	T		✓	✓			
N-Nitrosodipropylamine (N-Nitrosodi-n-propylamine)	621-64-7	✓	✓	RT		✓	✓			
N-Nitroso-N-ethylurea	759-73-9	✓	✓	T			✓			
N-Nitroso-N-methylurea	684-93-5	✓	✓	T	✓		✓			
3-(N-Nitrosomethylamino)propionitrile				R			✓			
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (NNK)	64091-91-4			R			✓			
N-Nitrosomethylethylamine				R			✓			
N-Nitrosomethylvinylamine	4549-40-0	✓	✓	RT			✓			
N-Nitrosomorpholine	59-89-2	✓	✓	RT	✓		✓			
N-Nitrosonornicotine	1654-55-8	✓	✓	RT			✓			
N-Nitrosopiperidine	100-75-4	✓	✓	RT			✓			
N-Nitrosopyrrolidine	930-55-2	✓		RT			✓			
N-Nitrososarcosine	13256-22-9			RT			✓			
Nitrotoluene	99-08-1	✓		AO						
Nitrotrichloromethane [see Chloropicrin]										
Nitrous oxide	10024-97-2			AN						
Nonane	111-84-2			A						
Norethisterone	68-22-4			RT			✓			
Ochratoxin A	303-47-9						✓			
Octachloronaphthalene	2234-13-1	✓	✓	AO						
Octachlorostyrene						✓			✓	
Octane	111-65-9			ANO						
1-Octanol	111-87-5			I						
Oestradiol	50-28-2			R			✓			
Oestrone	53-16-7			R			✓			
Oil mist, mineral	8012-95-1			A			✓			
Organo (alkyl) mercury				O						
Organotin compounds				NO						
Osmium tetroxide, as Os	20816-12-0	✓	✓	AO						
Oxalic acid	144-62-7			AO						
Oxychlordane								✓		
4,4'-Oxydianiline (4,4'-Diaminodiphenyl ether)	101-80-4	✓	✓	RT			✓			
Oxygen difluoride	7783-41-7			AO						

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Oxymetholone	434-07-1			RT			✓			
Ozone	10028-15-6	✓	✓	AO						
PBB [see Polybrominated biphenyls]										
PCB [see Chlorodiphenyl]										
Panfuran S (containing dihydroxymethylfuratrizine)				R			✓			
Paraffin wax fume	8002-74-2			A						
Paraquat-respirable sizes	4685-14-7			A						
Paraquat dichloride	1910-42-5	✓	✓	AO						
Parathion	56-38-2	✓	✓	ANO	✓	✓		✓		
Particulate polycyclic aromatic hydrocarbons (PPAH) [see Coal tar pitch volatiles]										
Pentaborane	19624-22-7	✓		AO						
Pentachlorobenzene	608-96-5	✓				✓			✓	13.06
Pentachloroethane	76-01-7	✓	✓	N						
Pentachloronaphthalene	1321-64-8			AO						
Pentachloronitrobenzene (Quintobenzene)	82-68-8	✓	✓	A	✓					
Pentachlorophenol (PCP) [see also Chlorophenols]	87-86-5	✓	✓	AO	✓	✓		✓		14.20
Pentaerythritol	115-77-5			A						
Pentaerythritol triacrylate	3524-68-3			I						
Pentane	109-66-0	✓		ANO						
2-Pentanone [see Methyl n-propyl ketone]	107-87-9									
Perchloroethylene (Tetrachloroethylene)	127-18-4	✓	✓	ANO	✓		✓			12.30
Perchloromethyl mercaptan	594-42-3	✓	✓	AO						
Perchloryl fluoride	7616-94-6			AO						
Perfluoroisobutylene	382-21-8			A						
Perlite	93763-70-3			A						
Petroleum Distallates (Naphtha)	8002-05-9			O						
Phenacetin	62-44-2	✓		RT			✓			
Phenacyl chloride [see a-Chloroacetophenone]										
Phenanthrene	85-01-8	✓	✓			✓				
Phenazopyridine	94-78-0			RT			✓			
Phenazopyridine hydrochloride	136-40-3			RT			✓			
Phenobarbitol				R			✓			
Phenol	108-95-2	✓	✓	ANO	✓	✓				8.45
Phenothiazine	92-84-2			A						
Phenoxyacetic acid herbicides				R			✓			
Phenoxybenzamine hydrochloride	63-92-3			RT			✓			
m-Phenylenediamine (1,3-Phenylenediamine)	108-45-2	✓	✓	A						
o-Phenylenediamine (1,2-Phenylenediamine)	95-54-5	✓	✓	A			✓			
p-Phenylenediamine	106-50-3	✓	✓	AO	✓					
2,3-o-Phenylene pyrene [see Indeno [1,2,3-cd] pyrene]										
Phenyl ether	101-84-8			AO						
Phenyl ether-biphenyl mixture, vapor	8004-13-5			O						
Phenylethylene [see Styrene, monomer]										
Phenyl glycidyl ether (PGE)	122-60-1			ANO			✓			
Phenylhydrazine	100-63-0			ANO			✓			
Phenyl mercaptan [see Benzenethiol]										
N-Phenyl-b-naphthylamine	135-88-6			AN			✓			
Phenylphosphine	638-21-1			A						
Phenytoin (and sodium salts of)	57-41-0	✓	✓	RT			✓			
Phorate (Thimet)	298-02-2	✓		A						
Phosdrin (Mevinphos)	7786-34-7	✓		AO						
Phosgene (Carbonyl chloride)	75-44-5	✓	✓	ANO	✓					
Phosphamidon	13171-21-6	✓		O						
Phosphine	7803-51-2	✓	✓	AO	✓					
Phosphoric acid	7664-38-2	✓	✓	AO						

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Phosphorus (yellow)	7723-14-0	✓	✓	AO	✓					
Phosphorus oxychloride	10025-87-3	✓		A						
Phosphorus pentachloride	10026-13-8	✓		AO						
Phosphorus pentasulfide	1314-80-3			AO						
Phosphorus trichloride	7719-12-2	✓		AO						
Photomirex						✓			✓	
Phthalates								✓		
Phthalic anhydride	85-44-9	✓	✓	AO	✓					6.03
m-Phthalodinitrile	626-17-5			A						
Picloram (Tordon)	1918-02-1	✓	✓	A						
Picolines				I						
Picric acid (2,4,6-Trinitrophenol)	88-89-1	✓	✓	AO						
Pindone (2-Pivaloyl-a,3-indandione)	83-26-1			A						
Piperazine dihydrochloride	142-64-3			A						
Piperidine	110-89-4	✓		I						
Pival (Pindone)	83-26-1			AO						
2-Pivalyl-1,3-indandione [see Pival]										
Plaster of Paris [see Calcium sulfate]	26499-65-0									
Platinum (Metal)	7440-06-4			A						
Platinum, soluble salts, as Pt				AO						
Polybrominated biphenyls (PBB's)	36355-01-8	✓		RT			✓	✓		
Polychlorinated biphenyls (Aroclors) [see also Chlorodiphenyl]	1336-36-3	✓	✓	NRT	✓		✓			16.92
Polychlorobiphenyls (PCB's) [see Chlorodiphenyls]										
Polycyclic aromatic hydrocarbons		✓		T	✓		✓			
Polyethylene glycols	25322-68-3			I						
Polypropylene glycols	25322-69-4			I						
Polytetrafluoroethylene (TEFLON) decomposition products				A						
Ponceau MX				R			✓			
Ponceau 3R				R			✓			
Potassium bromate	7758-01-2	✓	✓	AIR						
Procarbazine	671-16-9			RT			✓			
Procarbazine hydrochloride	366-70-1			RT			✓			
Progesterone	57-83-0			RT			✓			
Progestins				R			✓			
Propane	74-98-6	✓		AO						
1,3-Propane sultone	1120-71-4	✓	✓	ART	✓		✓			
1-Propanethiol [see n-Propyl mercaptan]	107-03-9									
Propargyl alcohol	107-19-7	✓	✓	A						
b-Propiolactone	57-57-8	✓	✓	ANORT	✓		✓			
Propionaldehyde	123-38-6	✓	✓		✓					
Propionic acid	79-09-4	✓		A						
Propoxur [see Baygon]	114-26-1									
n-Propyl acetate	109-60-4			AO						
Propyl alcohol	71-23-8			AO						
Propylene	115-07-1	✓	✓	A						
Propylene dichloride (1,2-Dichloro propane)	78-87-5	✓	✓	AO	✓	✓				12.22
Propylene glycol	57-55-6			I						
Propylene glycol dinitrate (PGDN)	6423-43-4			A						
Propylene glycol monomethyl ether	107-98-2			A						8.12
Propyleneimine (2-Methylaziridine)	75-55-8	✓	✓	AORT	✓		✓			
Propylene oxide	75-56-9	✓	✓	AORT	✓		✓			12.19
n-Propyl mercaptan	107-03-9			NO						
n-Propyl nitrate	627-13-4			A						
Propylthiouracil	51-52-5			RT			✓			
Propyne	74-99-7	✓		AO						
Pseudocumene [see 1,2,4-Trimethylbenzene]										

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Pyrene	129-00-0	✓				✓				10.93
Pyrethrins (Pyrethrum)	8003-34-7	✓		AO						
Pyrethroids (synthetic)								✓		
Pyridine	110-86-1	✓	✓	AO						9.23
Pyrocatechol [see Catechol]										
Quartz [see Silica-Crystalline]										
Quinoline	91-22-5	✓	✓	I	✓					
Quinone	106-51-4	✓	✓	AO	✓					
Qunitobenzene [see Pentachloronitrobenzene]										
Radionuclides					✓					
Radon	10043-92-2				✓		✓			
RDX [see Cyclonite]										
Reserpine	50-55-5	✓		T			✓			
Resorcinol	108-46-3	✓		A						
Rhodium	7440-16-6			AO						
Ronnel	299-84-3			AO						
Rosin core solder decomposition products, as resin acids	8050-09-7			A						
Rosin core solder pyrolysis products, as Formaldehyde				A						
Rotenone (Commercial)	83-79-4			AO						
Rubber solvent (Naphtha) [see Naphtha-Rubber Solvent]										
Saccharin	81-07-2	✓	✓	RT			✓			
Safrole	94-59-7	✓	✓	RT			✓			
Selenium compounds, as Se	7782-49-2	✓	✓	AO	✓	✓				15.35
Selenium hexafluoride, as Se	7783-79-1			AO						
Selenium sulfide	7446-34-6	✓		T			✓			
Sesone [see Sodium 2,4-dichlorophenoxyethyl sulfate]										
Sevin [see Carbaryl]										
Shale oils	68308-34-9			R			✓			
Silane [see Silicon tetrahydride]										
Silica (SiO_2)	7631-86-9			ANOR			✓			
Silica-crystalline (respirable size)	14808-60-7						✓			
Silicon	7440-21-3			A						
Silicon carbide	409-21-2			A						
Silicon tetrahydride	7803-62-5	✓		A						
Silver, metal and soluble compounds, as Ag	7440-22-4	✓	✓	AO		✓				16.12
Soapstone, dust				AO						
Sodium azide	26628-22-8	✓	✓	A						
Sodium bisulfite	7631-90-5	✓		A						
Sodium 2,4-dichlorophenoxyethyl sulfate (CRAG, Sesone)	136-78-7			AO						
Sodium fluoroacetate	62-74-8	✓	✓	AO						
Sodium hydroxide	1310-73-2	✓		AO						
Sodium hypochlorite	7681-52-9	✓		ANO						
Sodium metabisulfite	7681-57-4			A						
Sodium o-phenylphenate	132-27-4	✓	✓	R			✓			
Sodium perfluoroacetate	62-74-8	✓	✓	A						
Sodium phosphate, tribasic- [see Trisodium Phosphate]										
Soots				RT			✓			
Stearates				A						
Sterigmatacystin				R			✓			
Stibine	7803-52-3			AO						
Stoddard solvent	8052-41-3			ANO						
Streptozotocin	18883-66-4	✓		RT			✓			
Strontium chromate, as Cr	7789-06-2	✓		ART			✓			
Strychnine	57-24-9	✓		AO						
Styrenes		✓	✓					✓		
Styrene, monomer	100-42-5	✓	✓	ANO	✓		✓			9.63

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Styrene oxide	96-09-3	✓	✓	R	✓		✓			
Subtilisins	1395-21-7			A						
Succinonitrile	110-61-2			N						
Sulfallate	95-06-7	✓		T			✓			
Sulfotep [see TEDP]										
Sulfur dioxide	7446-09-5	✓		ANO						10.11
Sulfur hexafluoride	2551-62-4			AO						
Sulfuric acid	7664-93-9	✓	✓	ANO						7.10
Sulfur monochloride	10025-67-9	✓		AO						
Sulfur pentafluoride (Dimer)	5714-22-7			AO						
Sulfur tetrafluoride	7783-60-0	✓		A						
Sulfuryl fluoride	2699-79-8	✓	✓	AO						
Sullfallate	95-06-7	✓		RT			✓			
Sulprofos	35400-43-2	✓	✓	A						
Systox (Demeton)	8065-48-3	✓		AO						
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	93-76-5	✓		AO				✓		
Talc (non-asbestiform, resp. and fibrous)	14807-96-6			AO						
Talc (containing asbestiform fibers)				AR			✓			
Tantalum, metal and oxide	7440-25-7			AO						
TEDP (Tetraethyldithionopyrophosphate)	3689-24-5	✓		AO						
Teflon decomposition products				A						
Tellurium and compounds, as Te	13494-80-9			AO						
Tellurium hexafluoride, as Te	7783-80-4	✓		AO						
Temephos	3383-96-8	✓	✓	A						
Tepp	107-49-3	✓		AO						
Terphthalic acid	100-21-0			A						
Terphenyls	26140-60-3			A						
1,2,3,4-Tetrachlorobenzene						✓			✓	
1,2,4,5-Tetrachlorobenzene	95-94-3	✓				✓			✓	12.52
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1746-01-6	✓		RT	✓	✓	✓	✓	✓	21.09
1,1,1,2-Tetrachloro-2,2-difluoroethane (Fluorocarbon 112a)	76-11-9			AO						
1,1,2,2-Tetrachloro-1,2-difluoroethane (Fluorocarbon 112)	76-12-0			AO						
1,1,2,2-Tetrachloroethane	79-34-5	✓	✓	ANO	✓	✓	✓			14.04
Tetrachloroethylene [see Perchloroethylene]	127-18-4					✓	✓			
Tetrachloromethane [see Carbon tetrachloride]										
Tetrachloronaphthalene	1335-88-2			AO						
Tetraethyl lead, as Pb	78-00-2	✓		AO						
Tetraethylene glycol diacrylate	17831-71-9			I						
1,1,1,2-Tetrafluoroethane				I						
Tetrahydrofuran	109-99-9	✓		AO						
Tetramethyl lead, as Pb	75-74-1	✓		AO						
Tetramethyl succinonitrile	3333-52-6			ANO						
Tetranitromethane	509-14-8	✓		AO						
Tetrasodium pyrophosphate	7722-88-5			A						
Tetryl (2,4,6-Trinitrophenylmethylnitramine)	479-45-8			AO						
Thallium-soluble compounds, as Tl	7440-28-0	✓	✓	AO		✓				
Thioacetamide	62-55-5	✓	✓	T			✓			
4,4'-Thiobis (6-t butyl-m-cresol)	96-69-5			A						
4,4'-Thiodianiline	139-65-1	✓	✓	R			✓			
Thioglycolic acid	68-11-1			A						
Thiols (n-alkane monothiols)				N						
Thionyl chloride	7719-09-7			A						
Thiourea	62-56-6	✓	✓	RT			✓			
Thiram	137-26-8	✓	✓	AO						
Thorium dioxide	1314-20-1	✓	✓	T			✓			
Titanium dioxide	13463-67-7			A						

Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Titanium tetrachloride	7550-45-0	✓	✓		✓					
o-Tolidine	119-93-7	✓	✓	ANRT	✓		✓			
o-Tolidine-based dyes				N			✓			
Toluene (methyl benzene)	108-88-3	✓	✓	ANO	✓	✓				8.64
Toluene 2,4-diamine [see 2,4-Diaminotoluene]	25376-45-8									
Toluene diisocyanate (mixed isomers)	26471-62-5	✓	✓	T			✓			
Toluene 2,4-diisocyanate (TDI)	584-84-9	✓	✓	ANOR	✓					10.88
p-Toluene sulfonyl chloride	98-59-9			I						
m-Toluidine	108-44-1			A						
o-Toluidine	95-53-4	✓	✓	ANORT	✓		✓			
p-Toluidine	106-49-0	✓		A			✓			
o-Toluidine hydrochloride	636-21-5	✓	✓	T			✓			
Toxaphene [see Chlorinated camphene]										
Transnonachlor								✓		
Tremolite [see Talc, fibrous]										
Treosulphan	299-75-2			R			✓			
Tributyl phosphate	126-73-8			AO						
Tributyl tin								✓		
Trichloroacetic acid	76-03-9			A						
1,2,4-Trichlorobenzene	120-82-1	✓	✓	A	✓	✓				9.80
1,1,1-Trichloroethane [see Methyl chloroform]										
1,1,2-Trichloroethane	79-00-5	✓	✓	ANO	✓	✓	✓			13.51
Trichloroethylene	79-01-6	✓	✓	ANO	✓	✓				11.09
Trichlorofluoromethane (Fluorocarbon 11)	75-69-4	✓	✓	A						
Trichloromethane [see Chloroform]										
Trichloronaphthalene (Halowax)	1321-65-9			AO						
Trichloronitromethane [see Chloropicrin]										
2,4,5-Trichlorophenol	95-95-4	✓	✓		✓	✓				
2,4,6-Trichlorophenol	88-06-2	✓	✓	RT	✓		✓			11.84
1,2,3-Trichloropropane	96-18-4	✓	✓	AO						
1,1,2-Trichloro-1,2,2-trifluoroethane (Fluorocarbon 113)	76-13-1	✓	✓	AO						6.93
Tricyclohexyltin hydroxide (Cyhexatin)	13121-70-5			A						
Tridymite [see Silica-Crystalline)										
Triethanolamine	102-71-6			A						
Triethylamine	121-44-8	✓	✓	AO	✓					9.82
Triethylene glycol diacrylate	1680-21-3			I						
Trifluorobromomethane (Fluorocarbon 13B1)	75-63-8			AO						
Trifluralin	1582-09-8	✓	✓		✓		✓			
Trimellitic anhydride	552-30-7			AN						
Trimethylamine	75-50-5	✓		AI						
Trimethylbenzene	25551-13-7		✓	A						8.16
Trimethyl phosphite	121-45-9			A						
Trimethylolpropane triacrylate	15625-89-5			I						
Trimethylolpropane trimethacrylate	3290-92-4			I						
2,2,4-Trimethylpentane	540-84-1	✓			✓					
2,4,6-Trinitrophenol [see Picric acid]										
2,4,6-Trinitrophenylmethylnitramine [see Tetryl]										
2,4,6-Trinitrotoluene (TNT)	118-96-7			AO			✓			
Tri-o-cresyl phosphate (TOCP)	78-30-8			AO						
Triphenyl amine	603-34-9			A						
Triphenyl phosphate	115-86-6			AO						
Tripoli	1317-95-9			A						
Tris(aziridinyl)-p-benzoquinone (Triaziquone)	68-76-8	✓	✓	R			✓			
Tris(1-aziridinyl)phosphine sulfide (Thiotepa)	52-24-4			RT			✓			
Tris(2,3-dibromopropyl)phosphate	126-72-7	✓	✓	T			✓			
Trisodium phosphate (Sodium phosphate, tribasic-)	7601-54-9	✓		I						

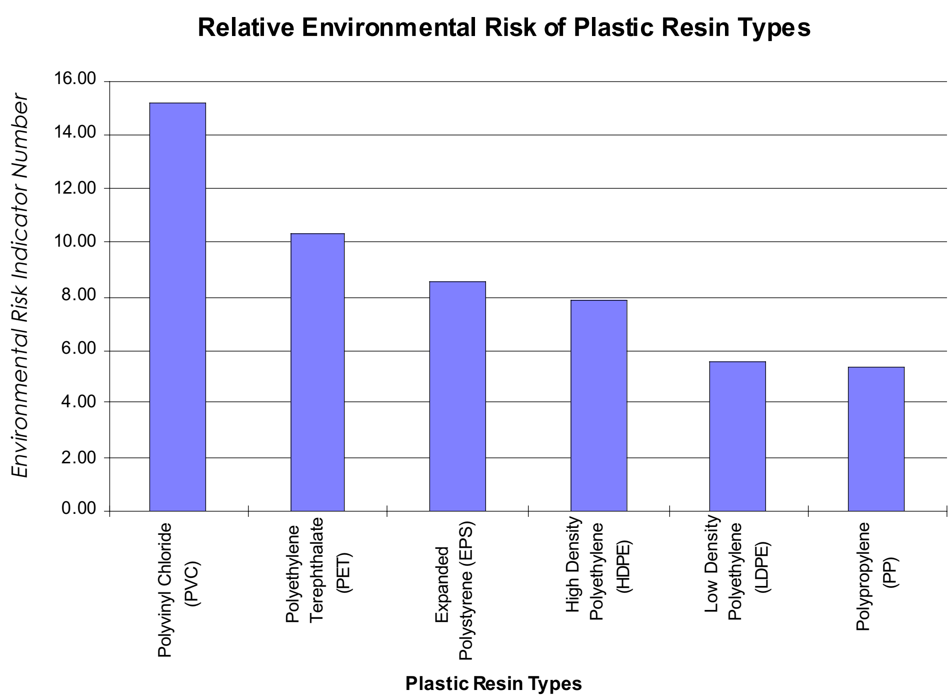
Substance	CAS #	Title III	TRI	Codes	Air Pollutant	Water Pollutant	Carcinogen	Endocrine Mimickers	Bio-accumulative	Rating
Trp-P-1 (and its acetate) (3-Amino-1,4-dimethyl-5H-pyrido-[4,3-b]indole)	62450-06-0			R			✓			
Trp-P-2 (and its acetate) (3-Amino-1-methyl-5H-pyrido-[4,3-b]indole)	62450-07-1			R			✓			
Trypan blue	72-57-1	✓	✓	R			✓			
Tungsten and compounds, as W	7440-33-7			AN						
Turpentine	8006-64-2			AO						
Uracil mustard	66-75-1	✓		R			✓			
Uranium, as U, natural compounds, soluble and insoluble	7440-61-1			AO						
Urea	2164-17-2	✓	✓	I						
Urethane (Ethyl carbamate)	51-79-6	✓	✓	RT			✓			
Valeraldehyde	110-62-3			A						
Vanadium, as V_2O_5, dust and fume	1314-62-1	✓	✓	ANO						
Vinyl acetate	108-05-4	✓	✓	AN	✓		✓			8.79
Vinyl benzene [see Styrene]										
Vinyl bromide	593-60-2	✓	✓	A	✓		✓			
Vinyl chloride (Chloroethylene, Chloroethene)	75-01-4	✓	✓	ANORT	✓	✓	✓			12.93
Vinyl cyanide [see Acrylonitrile]										
4-Vinyl cyclohexene	100-40-3			AI			✓			
Vinyl cyclohexene dioxide	106-87-6			A			✓			
Vinyl halides				N			✓			
Vinylidene chloride (1,1-Dichloroethylene)	75-35-4	✓	✓	A		✓	✓			
Vinyl toluene	25013-15-4			AO						
VM&P Naphtha [see Naptha (VM&P)]	8032-32-4									
Warfarin	81-81-2	✓		AO						
Waste anesthetic gases and vapors				N						
Welding fumes				A						
Wood dust; all soft and hard woods				AO						
Xylene (mixed isomers)	1330-20-7	✓	✓	ANO	✓					8.77
m-Xylene	108-38-3	✓	✓	ANO	✓					
o-Xylene	95-47-6	✓	✓	ANO	✓					
p-Xylene	106-42-3	✓	✓	ANO	✓					
m-Xylene a,a'-diamine (MXDA, m-m xylenediamine)	1477-55-0			A						
2,4-Xylenol [see 2,4-Dimethylphenol]										
Xylidine (mixed isomers)	1300-73-8			AO			✓			
Yttrium, metal and compounds, as Y	7440-65-5			A						
Zinc	7440-66-6	✓	✓			✓				14.03
Zinc chloride	7646-85-7	✓		AO						
Zinc chromate, as Cr	13530-65-9			ART			✓			
Zinc chromate, as Cr	11103-86-9			ART			✓			
Zinc chromate, as Cr	37300-23-7			ART			✓			
Zinc oxide, fume and dust	1314-13-2			ANO						
Zinc stearate	557-05-1			A						
Zineb	12122-67-7	✓	✓					✓		
Ziram	137-30-4	✓						✓		
Zirconium compounds, as Zr	7440-67-2			AO						

Plastics Environmental Risk Information (figure 5)

The following chart and graph provide information about the relative environmental risk of the production of these types of plastic resins. This information is useful for determining the relative risk between using these plastics as a material in a manufactured product. One method to rank environmental risk is by comparing fuel, materials use and emissions as shown in the charts below.

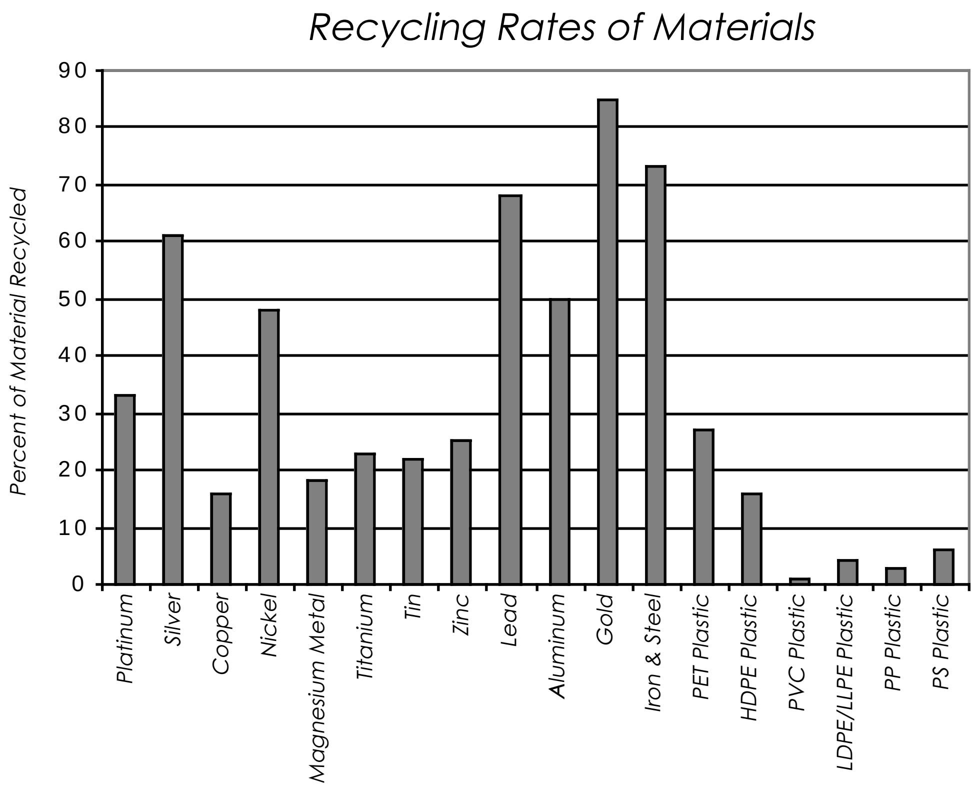
Relative Environmental Impact Ranking of Plastic Resins **(higher risk indicator = greater environmental impact)**	
Plastic Resin Types	**Environmental Risk Indicator Number**
Polyvinyl Chloride (PVC)	15.23
Polyethylene Terephthalate (PET)	10.38
Expanded Polystyrene (EPS)	8.60
High Density Polyethylene (HDPE)	7.83
Low Density Polyethylene (LDPE)	5.59
Polypropylene (PP)	5.37

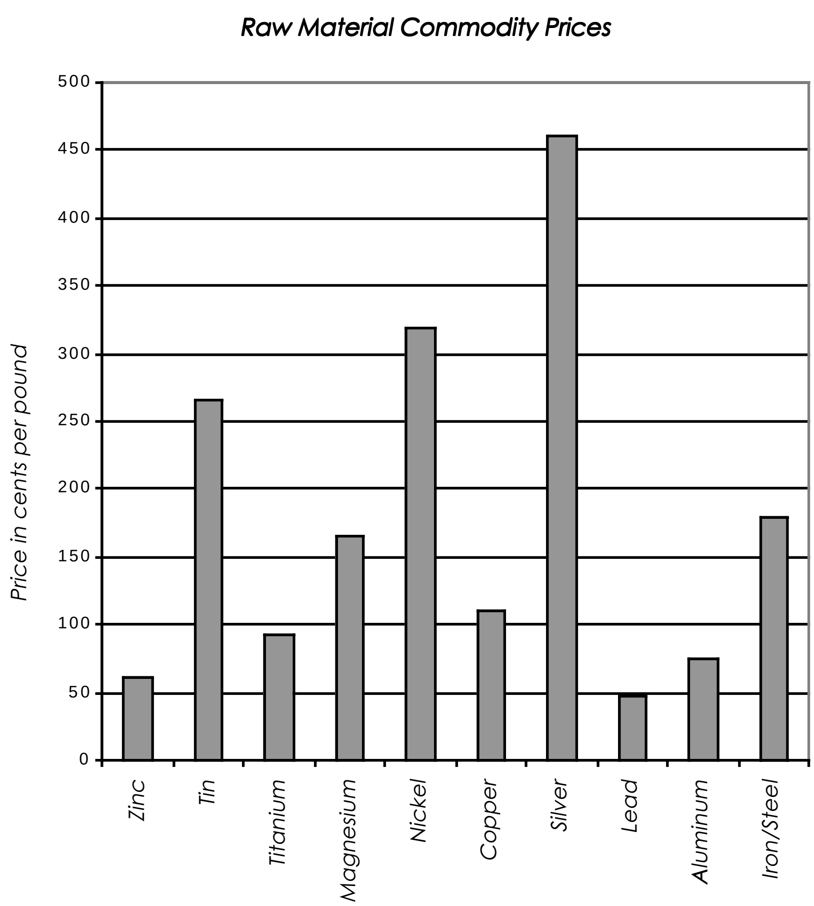
Report 10: Polymer Conversion. (Brussels, May 1997). Ranking is based on the ratios of comparative fuel, materials use and emissions that result from production of resins.



Product Manufacture — Materials Choice

(figure 6)





Sources: U.S. Geological Survey. 1997. Available on-line at htttp://minerals.er.usgs.gov/minerals/pubs/commodity.
1996 National Post-Consumer Plastics Rigid Container Recycling Rate Study. 1997. R.W. Beck Inc.

Note: All recycling rates are 1997 rates, except for plastic materials which are 1996 rates. The recycling rates are the amount of material recycled per total amount consumed in the United States in 1997. Plastic recycling rates include bottles, tubs/containers, film and miscellaneous packaging recycling rates for polycarbonate, ABS, nylon, plastic coded #7 and non-packaging plastics were not available in the American Plastics Council data. However, 64.7 million pounds of these types of plastics were recorded as being recycled in 1996.

Climate Altering Chemical Index

Ozone-Depleting and Global Warming Gases

The Earth's atmosphere has a naturally occurring shield of "global warming gases" including water vapor, carbon dioxide, methane, and nitrous oxide which traps radiant heat and keeps the planet in a comfortable, livable temperature range. Since the pre-industrial era atmospheric concentrations of carbon dioxide have increased 30 percent and methane concentrations have more than doubled. There is a growing concensus by international scientists that the buildup of global warming gases which include **carbon dioxide, methane, nitrous oxide and perfluorocarbons** can lead to major environmental changes. Below are listings of chemical formulations that can contribute to the formation of these greenhouse gases and to ozone depletion.

Class I Ozone Depletion and Global Warming Chemicals

Designation	Chemical Formula	Ozone Depletion Potential	Global-Warming Potential
CFC-11	CCl_3F	1	3,400
CFC-12	CCl_2F_2	0.89	7,100
CFC-13	$CClF_3$		13,000
CFC-111	C_2FCl_5		
CFC-112	$C_2F_2Cl_4$		
CFC-113	$C_2F_3Cl_3$	0.81	4,500
CFC-114	$C_2F_4Cl_2$	0.69	7,000
CFC-115	C_2F_5Cl	0.32	7,000
CFC-211	C_3FCl_7		
CFC-212	$C_3F_2Cl_6$		
CFC-213	$C_3F_3Cl_5$		
CFC-214	$C_3F_4Cl_4$		
CFC-215	$C_3F_5Cl_3$		
CFC-216	$C_3F_6Cl_2$		
CFC-217	C_3F_7Cl		
Halon-1211	CF_2ClBr	2.2-3.5	
Halon-1301	CF_3Br	8-16	4,900
Halon-2402	$C_2F_4Br_2$	5-6.2	
Carbon tetrachloride	CCl_4	1.13	1,300
Methyl chloroform	CH_3CCl_3	0.14	
Methyl bromide	CH_3Br		
Methyl chloride	CH_3Cl		
HBFC's	Several		
Nitrous oxide	N_2O		270

Global Warming (non-Ozone-Depleting) Chemicals

Designation	Chemical Formula	Ozone Depletion Potential	Global-Warming Potential
Carbon dioxide	CO_2	0	1
Methane	CH_4	0	11
HFC-125	CHF_2CF_3		90
HFC-134a	CFH_2CF_3		1,000
HFC-152a	CH_3CHF_2		2,400
Perfluorobutane	C_4F_{10}	0	5,500
Prefluoropentane	C_5F_{12}	0	5,500
Perfluorohexane	C_6F_{14}	0	5,100
Perfluorotributylamine	$N(C_4F_9)_3$	0	4,300

Designation	Chemical Formula	Ozone Depletion Potential	Global-Warming Potential

Class II Ozone Depletion and Global Warming Chemicals

Designation	Chemical Formula	Ozone Depletion Potential	Global-Warming Potential
HCFC-21	$CHFCl_2$	0.010	
HCFC-22	CHF_2Cl	0.048	1,600
HCFC-31	CH_2ClF	0.010	
HCFC-121	C_2HFCl_4	0.004	
HCFC-122	$C_2HF_2Cl_3$	0.004	
HCFC-123	$C_2HF_3Cl_2$	0.017	90
HCFC-124	C_2HF_4Cl	0.019	440
HCFC-125	C_2HF_5	0.000	3,400
HCFC-131	$C_2H_2FCl_3$	<0.001	
HCFC-132	$C_2H_2F_2Cl_2$	0.002	
HCFC-133	$C_2H_2F_3Cl$	0.070	
HCFC-141b	$C_2H_3FCl_2$	0.090	580
HCFC-142b	$C_2H_3F_2Cl$	0.054	1,800
HCFC-221	C_3HFCl_6		
HCFC-222	$C_3HF_2Cl_5$		
HCFC-223	$C_3HF_3Cl_4$		
HCFC-224	$C_3HF_4Cl_3$		
HCFC-225	$C_3HF_5Cl_2$		
HCFC-226	C_3HF_6Cl		
HCFC-231	$C_3H_2FCl_5$		
HCFC-232	$C_3H_2F_2Cl_4$		
HCFC-233	$C_3H_2F_3Cl_3$		
HCFC-234	$C_3H_2F_4Cl_2$		
HCFC-235	$C_3H_2F_5Cl$		
HCFC-241	$C_3H_3FCl_4$		
HCFC-242	$C_3H_3F_2Cl_3$		
HCFC-243	$C_3H_3F_3Cl_2$		
HCFC-244	$C_3H_3F_4Cl$		
HCFC-251			
HCFC-252			
HCFC-253			
HCFC-261			
HCFC-262			
HCFC-271	$C_3H_4FCl_3$		
$C_3H_4F_2Cl_2$			
$C_3H_4F_3Cl$			
$C_3H_5FCl_2$			
$C_3H_5F_2Cl$			
C_3H_6FCl			

Source: Graedel, T.E. and B.R. Allenby. Industrial Ecology. Englewood Cliffs, New Jersey: Prentice Hall, 1995. Copyright AT&T.

Polymers

Manufacture

Generally, the manufacture of synthetic polymers generates hazardous pollutants. Many additives, particularly heavy metals, pose serious environmental risks. Degradable polymers, such as lactic acid or starch-based materials, are a viable alternative to synthetic plastics and may virtually eliminate the generation of hazardous pollutants. See "Degradable Polymers"*(page 63)* for more information on this type of plastics.

Disposal

Many plastics, or polymers, generate hazardous materials upon incineration. Particularly troublesome are the polymers with halogenated (chlorinated, bromated, etc.) additives, such as those that make the polymer fire-retardant. Polyvinyl chloride (PVC) is also known to produce hazardous pollutants due to the chlorinated products generated during incineration.

On the other hand, materials such as polypropylene (PP), polyethylene (PE), polyurethanes (PU), polyethyleneterephthalate (PET), and high-density polyethylene (HDPE) burn relatively "cleanly" provided that they have no halogenated additives. Examples of relatively benign plastic products include milk jugs (PE) and pop bottles (PET).

Recycling

In general, the fewer additives a plastic contains, the easier it will be to combine with other similar plastics and recycle. Similarly, the fewer different plastics that are combined within a particularly product, the easier it will be to reuse the constituent materials.

Many companies have greatly increased their ability to recycle plastic components of their products by using only one or two types of plastics within a given module. For instance, Volkswagen has reduced the number of plastics in its bumper assembly, making the assembly relatively easy to separate from the car and recycle.

Degradable Polymers

A degradable material is one that is reduced by biodegradation, photodegradation, or chemodegradation to carbon dioxide, water and minerals, leaving no environmentally harmful residues. Biodegradation is the process whereby microbes metabolize the polymer into harmless products. Photodegradation is the process whereby the polymer chains are broken through the action of ultraviolet light (generally sunlight). Chemodegradation process whereby polymers are broken into harmless materials through chemical treatments.

Generally, the smaller the polymer chain (and thus a smaller molecular weight), the more easily biodegraded a polymer is. In many cases, the long polymer chains are broken up by photodegradation, and the actual transformation of the polymer "links" is further accomplished by microbes.

Vendors of Degradable Polymers

Last updated October 2003

Manufacturer	Material	Application	Contact Information
Archer Daniels Midland Company 4666 Faries Parkway Decatur, IL 62526	Manufacturer of starch especially made for plastics use	raw material	Phone: 1-800-637-5843 info@admworld.com www.admworld.com
St. Lawrence Starch Company (division of Cargill)	Manufacturer of starch especially made for plastics use	raw material	phone: (952) 742-7575 www.cargill.com/
Epron Industries Units 4-6 Ketton Business Estate Pit Lane Ketton, Stamford, Lincs PE9 Switzerland	Manufacturer of starch especially made for plastics use	raw material	phone: +44(0)1780 721697 enquiries@epronindustries.com www.epronindustries.com
National Starch and Chemical Co. American Excelsior Group (USA) 10 Fiderne Avenue Bridgewater, NJ 08807	Manufacturer of starch especially made for plastics use	raw material	phone: 1-800-797-4992 www.nationalstarch.com nscinquiry@salessupport.com
Amylum Tate & Lyle PLC Lower Thames Street London EC3R 6DQ United Kingdom	Manufacturer of starch especially made for plastics use	raw material	phone: +44 (0) 7626 6525 www.tateandlyle.com
Suedstaerke GMBH Postfach 1240 Schrobenhauser 86522	Manufacturer of starch especially made for plastics use	raw material	phone: +49 8252 913-0 www.suedstaerke.de
Novamont S.p.A. Via Fauser 8, I-28100 Novara, Italy	Supplies starch-based polymers under the trade name Mater- Bi	raw material	Novamont.SpA@novara.alpcom.it
Plantic Technologies, Inc. Unit 3 Angliss Park Estate 227-231 Fitgerald Road Laverton North, Victoria, Australia 3026	Corn starch, the primary ingrediant of Plantic (trademark) is from Australian-grown, non-genetically modified corn. According to the manufacturer it is completely biodegradable and non-toxic to humans and the environment.	biodegradable consumer products and raw material	phone: +61 3 9353 7900 www.plantic.com.au/company.html

Manufacturer	Material	Application	Contact Information
Cargill 15407 McGinty Rd West Wazata, MN 55391	Polylactides and copolymers Eco-Pla product line (lactic acid base)	extrudable, fully degradable (can be composted) no retooling of process required	phone: (952) 742-7575 www.cargill.com
UBC Films, Inc. 1950 Lake Park Drive Smyrna, GA 30080	Produces cellulose film made from wood pulp. The product is marketed under the names Cellophane and NatureFlex.	biodegradable consumer products and raw material	phone: (770) 437-5720 www.films.ucb-group.com/
Biocorp 5155 West Rosecrans Ave. Suite 1116 Los Angeles, CA 90250	Produces a wide range of biodegradable products made from corn and potato starch including cups, straws, plates, soup and salad containers, lawn/leaf bags, etc.	biodegradable consumer products	phone: (310) 491-3465 www.biocorpna.com
EarthShell Corporation Santa Barbara, California	Produces a compostable composite made from a blend of limestone, potato starch and recycled paper fiber	biodegradable consumer products	phone: (410) 847-9420 www.earthshell.com
Batelle AgriFood Columbus, Ohio	Research into biodegradable packaging technology	provides research	Dr. Bhima Vijayendran Dir. Of Technology Development phone: (614) 424-5741 vijayenb@battelle.org

Sample Letter to Parts/ Materials Suppliers

(Company Name)
(Company Address)

Dear Supplier:

To adequately assess the environmental performance of our products we need information about materials and parts coming into our facility. This information will be used for an internal evaluation of the environmental impacts of our products. We are asking that you fill out the following survey questions and return to:

Contact Name
(your company address)
fax number/e-mail

Thank you for your assistance and cooperation.

Raw Materials/Parts Supplier Environmental Survey

1) Does your company have an Environmental Management System (EMS) in place?

____Yes _____No

2) Is there a formal energy conservation program or practices in place at your company?

____Yes _____No

3) Does your company have ISO 9000 or ISO 14000 certification or does your company regularly publish an environmental report?

____Yes _____No

4) Is water conservation advocated and practiced at your company?

____Yes _____No

5) Does your company have a formal program to minimize hazardous air emissions?

____Yes _____No

Additional Resources

The Environmental Protection Agency (EPA) **website has information about EPA design for the environment initiatives, information products, links to related websites and opportunities to order publications. The website address is: www.epa.gov/dfe.**

Department of Energy (DOE) Motor Challenge Program Clearinghouse can answer questions about using energy-efficient electric motor systems. Call them on their hotline at 800/862-2086 or access their homepage at www.motor.doe.gov.

Industrial Ecology. 1995. T.E. Graedel and B.R. Allenby. Prentice Hall, Englewood Cliffs, New Jersey. Copyright AT&T. *This work by Drs. Graedel and Allenby, leaders in the field of industrial ecology, links industrial ecology with environmental science. It presents the matrix system upon which this toolkit is based, as well as supporting materials and Design for Environment processes.*

Implementing Design for Environment: A Primer. Digital Equipment Corporation and Massachusetts Institute of Technology Program on Technology, Business & Environment. Digital Corporation, 1997. Available on-line: http://www.mit.edu/ctipid/www/tbe/ *Provides manufacturers with an overall strategy for implementing Design for Environment within the company.*

"Applying the DFE Toolkit to an Electronic Switch." T.E. Graedel, G.C. Munie, B.K. Stolte, and G.C. Wightman. Proceedings of the 1996 IEEE International Symposium on Electronics and the Environment; May 6-8, 1996. Piscataway, NJ: Institute of Electrical and Electronics Engineers, Inc., 1996. 148-153. *Provides an example of using a Design for Environment process, similar to the one presented in this toolkit, in the development of an electronic switch for AT&T.*

Proceedings of the Institute of Electrical and Electronics Engineers, Inc. Annual Symposiums on Electronics and the Environment. *Held every year in May, the papers presented in this conference provide updates on current trends in DfE in the electronics field, examples of DfE implementation, and new resources available for DfE.* Copies are available from the IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854-4150.

Reusable Transport Packaging Directory This directory explains how to establish reusable transport system in your company and lists companies that sell reusable containers. It is available from the Minnesota Office of Environmental Assistance Clearinghouse at 651/215-0232 or 1-800/657-3843. This directory is also available on the OEA website at www.moea.state.mn.us.

Recycling Information

Minnesota Recycling Directory. *Published by the Minnesota of Environmental Assistance, this publication provides information on statewide recycling markets and collection locations. It includes a listing of buyers and sellers of recyclable materials.* This publication can be obtained by contacting the MOEA at 651/296-3417 or 800/657-3843.

American Metal Market. Publishes daily price quotes for several secondary ingot alloys. To order, call 212/887-8551.

Waste Age's Recycling Times. *This journal of recycling markets is published bi-weekly. Each issue provides an update on market prices for secondary materials including prices paid by processors and end-users. The journal also tracks and analyzes trends in the waste management area.* The journal can be ordered by contacting *Recycling Times*, P.O. Box 420168, Palm Coast, FL, 32142-0168. 800/829-5443.

Recycler's World - http://www.recycle.net/recycle/index.html
"A worldwide trading site for information related to secondary or recyclable commodities, by-products, used and surplus items or materials." *This web site provides information on numerous recyclable commodity markets and includes a worldwide materials exchange program where manufacturers can post materials available or view materials available. Commodity sections include automotive, metal, glass, textile, food, building materials and other recyclable material markets.*

Agencies/Organizations

University of Wisconsin-Madison
Department of Engineering Professional Development
432 North Lake Street
Madison, Wisconsin 53791-8897
Phone: 608/263-7429
Web site:http://edpwww.engr.wisc.edu
The department sponsors several seminars and classes throughout the year, educating design professionals in environmental issues and design. The department has developed company specific DfE course work and curriculum.

Minnesota Technical Assistance Program
1313 5th Street S.E., Ste. 207
Minneapolis, MN 55414-4504
Metro area: 612/627-4646
Greater Minnesota : (toll-free) 800/247-0015
Web site: www.umn.edu/mntap
Assists businesses and manufacturers in preventing pollution and developing environmentally responsible manufacturing processes. MnTAP also directs the Minnesota Materials Exchange Program (MMX), allowing Minnesota manufacturers to post and view available materials in the annual MMX catalog. MnTAP has numerous free resources available to manufacturers, including telephone assistance, site visits by MnTAP engineers, the student intern program, seminars and workshops, and general information on alternative technology and practices.

Minnesota Office of Environmental Assistance
520 Lafayette Road North
Second Floor
Saint Paul, Minnesota 55155-4100
Phone: 651/296-3417 or (toll-free) 800/657-3843
Web site: www.moea.state.mn.us The MOEA assists businesses with solid waste issues, as well as publishes/provides several printed resources. The MOEA administers grants to companies for developing pollution prevention and waste management technologies.

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