Cleaner Production:
One Dry Cleaner at a Time

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July 1, 2003

Mr. Sergio Musmanni, Executive Director
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San José, Costa Rica

Dear Mr. Musmanni,

Enclosed is our report entitled Cleaner Production: One Dry Cleaner at a Time. It was written at the Centro Nacional de Producción más Limpia (CNP+L) during the period of May 12 through July 1, 2003. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Costa Rica. Copies of this report are simultaneously being submitted to Professor Susan Vernon-Gerstenfeld and Professor H.J. Manzari for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you and Carlos Perera Heinrich have devoted to us.

Sincerely,

Matthew G. Benvenuti

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Report Submitted to:

Professors Susan Vernon-Gerstenfeld and H. J. Manzari

Costa Rica, Project Center

By

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Mr. Sergio Musmanni, Executive Director
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CLEANER PRODUCTION: ONE DRY CLEANER AT A TIME

July 1, 2003

This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of Centro Nacional de Producción más Limpia or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

Abstract

This report, prepared for the Centro Nacional de Producción más Limpia (CNP+L), examines the lack of disposal methods for dry cleaning solvents in Costa Rica. CNP+L is concerned with this problem because they focus on the promotion of cleaner production. Because of the harmful effects associated with these solvents, alternative disposal methods are crucial. We verified the need for alternative disposal methods through interviews with dry cleaners. With a matrix analysis, we determined that the best long-term solution is to make the GreenEarth Solution the primary cleaning solvent in Costa Rica. We also recommend that a chemical recycling plant be setup in a centralized location in Central America, so that all Central American countries would benefit.

Authorship Page

Matthew Benvenuti, Katherine Labbe, and Jessica Michaels developed this report. All three authors created each section equally.

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Executive Summary

The hazards associated with the dry cleaning industry have been a global problem since the process first originated. The Centro Nacional de Producción más Limpia (CNP+L) in Costa Rica, which specializes in the cleaner production of industries in Costa Rica, has taken an interest in these hazards, which include adverse human health effects, ozone depletion, and water pollution. Costa Rica is a country that values the environment and is in a constant search for ways to preserve it. Although the dry cleaners of Costa Rica use many of the same hazardous practices as the rest of the world, the dry cleaners in Costa Rica have shown an interest in recycling chemicals and developing safer practices.

There was a large increase in the number of dry cleaning establishments in Costa Rica approximately five years ago (Dry Cleaner C, Personal Communication, May 29, 2003). The large number of dry cleaning establishments also brought about a large increase in the production and use of hazardous solvents. Many of the solvents used in dry cleaning weaken the central nervous system and one of the most common chemicals, perchloroethylene (perc) (See Glossary), is a suspected carcinogen. Because dry cleaning is such a dangerous process, it is constantly changing as people continue to search for safer, more effective methods of cleaning.

The goal of our project was to recommend the best economically attractive technology (BEAT) that the dry cleaning industry in Costa Rica should implement. Part of our goal also was to reduce or eliminate the solvents that are disposed of in a manner that is harmful to the people and the environment of Costa Rica. The objectives of our project were 1) determine the effects of the dry cleaning solvents on the people and the environment of Costa Rica and to increase dry cleaners' awareness of the harmful effects of improper practices, 2) investigate the current health and safety practices that are followed in the Costa Rican dry cleaning establishments, 3) examine different alternatives to the current dry cleaning practices in order to determine the best alternative for Costa Rica, and 4) develop a plan that would persuade the dry cleaners in Costa Rica to adopt safe disposal methods of chemicals.

The two major types of chemicals used in the dry cleaning industry are petroleum-based solvents and halogenated solvents (See Glossary). The two most commonly used petroleum-based solvents are Stoddard solvent (See Glossary), also known as Varsol, and Exxsol D40. The composition of Varsol and Exxsol D40 varies slightly; however, the harmful effects of the solvents are similar and they can be used in the same type of machinery. Perchloroethylene is the halogenated solvent that is used in the dry cleaning industry and, as mentioned previously, is a suspected carcinogen.

In Costa Rica, the most commonly used chemical is Exxsol D40. Eight of the sixteen dry cleaning establishments in San José that we contacted use Exxsol D40. The reason why this chemical is used more often than perchloroethylene is because it is less expensive and is available locally (Dry Cleaner C, Personal Communication, May 29, 2003). Perchloroethylene must be imported from countries such as the

United States or Italy, which is expensive and time consuming. Exxsol D40 can be delivered in the same day that the chemical is requested.

Both perchloroethylene and Exxsol D40 are volatile (See Glossary) compounds, which is why a majority of the dry cleaners in San José claim that the dry cleaning solvents evaporate and they never have to dispose of any left over solvent. A representative from one dry cleaning chain explained that they dispose of their chemicals by pouring them into the sewage system. The same dry cleaner revealed that he knows that this procedure is not environmentally safe, but that no other disposal methods exist (Dry Cleaner C, Personal Communication, May 29, 2003). Eight out of eleven dry cleaning establishments that we interviewed in San José would be willing to recycle their chemicals if a process existed. Six out of eleven dry cleaners also claimed that they would be willing to switch their current process for a completely new process. The alternatives that Costa Rican dry cleaners would like to switch to are wet cleaning (See Glossary) and using perchloroethylene; however, they claim that it is currently too expensive to invest in new machinery.

Our interviews revealed that there are many reasons why some of the dry cleaners in San José do not want to recycle or implement a new process. Dry cleaners that use perchloroethylene claim that they have machines that recycle 80-85 percent of the solvent. They believe that this rate of recycling is sufficient and that they do not need to change their process. They also believe that perchloroethylene is the best alternative available and that it is not harmful in any way. Our interviews also revealed that dry cleaners that have fairly new machinery are hesitant about changing their processes because machinery is an expensive investment and they would rather wait until their machines are no longer functioning. The major reason behind the lack of change in the dry cleaning process in San José is because of a lack of money.

If the dry cleaning industry were able to receive funding, there would be many alternative dry cleaning processes that could be implemented. The most common alternatives that either eliminate or reduce the environmental problems associated with dry cleaning are wet cleaning, liquid carbon dioxide, GreenEarth Solution, and retrofitting (See Glossary). Each process has many benefits and disadvantages. Wet cleaning, which produces large amounts of wastewater, does provide a better alternative than the current processes. Liquid carbon dioxide is safe for the environment; however, the process is not able to clean certain types of stains that are protein-based (See Glossary). GreenEarth Solution is a non-toxic solvent that does not cause harm to humans or the environment. The negative aspect of the GreenEarth Solution is that the machinery is very expensive. Retrofitting is the least expensive of the possible alternatives, but it is not as environmentally safe as the others.

The recommendations that our team believes will most benefit the dry cleaning industry are: 1) switching to the GreenEarth Solution, 2) developing a recycling plant for Central America, and 3) beginning to incinerate spent solvent (See Glossary).

We recommended the GreenEarth Solution because it received the best score in our matrix analysis. Information on the GreenEarth Solution is found in Chapter 2, along with the descriptions of how and why dry cleaners should implement the GreenEarth Solution in Chapter 5. An explanation of our qualitative cost benefit analysis is found in Chapter 3, along with example matrices in Appendix G.

Since implementing an entirely different system of dry cleaning has high capital costs, incineration of chemicals can begin immediately in order to lessen the hazards associated with dry cleaning. The spent solvents can be incinerated in kilns and used as an energy source for the kilns that they are incinerated in. Another disposal option for the chemicals would be a recycling center. Since petroleum-based solvents are used in other industries, dry cleaners would not be the only industry that would benefit from a recycling center. Because there are no recycling centers in Central America that recycle spent solvents, all Central American countries could benefit from a recycling center. One advantage of recycling is the seventy percent recovery of solvents, which decreases the amount of new solvent needed. Another benefit is that a recycling plant allows for fewer hazards to the environment and the people. Lastly, the waste from recycling of solvents can be used in other industries as an alternative fuel or a cement additive. Further descriptions of the benefits of recycling can be found in Chapters 4 and 5.

Resumen Ejecutivo

Ha habido muchos problemas asociados con la industria del lavar en seco desde su inicio. El Centro Nacional de Producción más Limpia (CNP+L) en Costa Rica está interesado en estos problemas, los cuales incluyen los efectos adversos de la salud de los seres humanos, la agotación del ozono y la contaminación del agua. Costa Rica es un país que valora el medio ambiente y siempre quiere encontrar las maneras apropiadas para conservarlo. Aunque las tintorerías usen muchos de los métodos dañinos de lavado en seco como el resto del mundo, ellos han demostrado un interés en el reciclar de los productos y en el desarrollar de prácticas más seguras.

Hace cinco años, el número de los establecimientos de lavado en seco en Costa Rica aumentó (La Tintorería C, Comunicación Personal, el 29 de mayo, 2003). También hubo un aumento en la producción y el uso de los solventes dado el crecimiento del número de tintorerías en los últimos años. Muchos de los solventes de lavado en seco debilitan el sistema central de nervios. También, es posible que percloroetileno, uno de los solventes más comunes, cause cáncer. Los métodos de lavado en seco cambian constantemente porque el proceso es muy peligroso y la gente quiere encontrar una manera de lavado en seco más segura y más efectiva.

La meta de nuestro proyecto ha sido examinar y estudiar la mejor tecnología económica que la industria de lavado en seco en Costa Rica debe de implementar. Los objetivos de nuestro proyecto fueron 1) determinar como los solventes de lavado en seco afectan el medio ambiente y la populación de Costa Rica y aumentar el conocimiento de las tintorerías de los efectos peligrosos de prácticas impropias, 2) investigar las prácticas actuales de salud y seguridad en los establecimientos de lavado en seco en Costa Rica, 3) examinar las alternativas diferentes de lavado en seco para determinar la mejor alternativa por Costa Rica y 4) persuadir que las tintorerías adopten métodos modernos.

Los químicos principales para el lavado en seco son solventes en base de petróleo y solventes halogenados. Los dos solventes en base de petróleo más comunes son Varsol y Exxsol D40. La composición de Varsol y Exxsol D40 varia un poco, sino los efectos dañinos son similares y puede usarlos en el mismo tipo de máquina. El solvente halogenado que las tintorerías usan es percloroetileno y es posible que sea un carcinógeno.

En Costa Rica, el solvente más común es Exxsol D40. Ocho de los dieciséis establecimientos de lavado en seco en San José que pudimos entrevistar, señalaron que con usan Exxsol D40. Las tintorerías usan este producto químico porque es más barato que percloroetileno y pueden comprarlo en Costa Rica (La Tintorería C, Comunicación Personal, el 29 de mayo, 2003). Percloroetileno sólo se compra de países extranjero, como los Estados Unidos o Italia. Cueste mucho y toma mucho tiempo en llegar al país. Pueden repartir Exxsol D40 el mismo día en que las tintorerías lo pidan.

Percloroetileno y Exxsol D40 son compuestos volátiles, es la razón por la cual la mayoría de las tintorerías en San José reclaman que los solventes de lavado en seco se evaporen y ellos nunca se tienen que deshacerse de ningunos productos químicos. Un

representante de una tienda de una cadena de lavado en seco explicó que ellos botan sus químicos en las cloacas. El mismo establecimiento nos reveló que este procedimiento no es bueno para el medio ambiente, pero no hay otra manera para deshacerse de los productos químicos (La Tintorería C, Comunicación Personal, el 29 de mayo, 2003). Ocho de los once establecimientos que entrevistamos en San José reciclarían sus productos químicos si una procesa existiera. Seis de las once tiendas de lavado en seco también dijeron que cambiarían su práctica actual por un proceso moderno. Las alternativas que las tintorerías querrían usar son el proceso de lavado con agua y el solvente percloroetileno. Sin embargo, dijeron que las máquinas eran demasiado caras ahora y no pueden comprarlas.

Hay muchas razones por qué unas tintorerías en San José no quieren reciclar o implementar un proceso moderno. Los establecimientos de lavado en seco que usan el percloroetileno reclaman que tienen máquinas que pueden reciclar ochenta a ochenta y cinco por ciento del solvente. Ellos creen que esto rato de reciclar es suficiente y que no necesiten cambiar su proceso. También creen que percloroetileno es la mejor alternativa y que un solvente que no sea peligroso. En nuestras entrevistas, aprendimos que las tintorerías que tienen las máquinas que son más o menos nuevas no quieren cambiar sus procesos. La maquinaria moderna es cara y las tintorerías quieren esperar hasta las máquinas que tienen no funcionan antes compran máquinas nuevas. La falta de dinero es la razón principal por la cual el proceso de lavado en seco ya no ha cambiado.

Con dinero, habría muchos procesos alternativos para la industria de lavado en seco. Las alternativas que pueden eliminar o reducir los problemas del medio ambiente de lavado en seco son el lavado con agua, líquido del anhídrido carbónico, la Solución GreenEarth y reconversión. Cado proceso tiene unos beneficios y unas desventajas. El lavado con agua produce mucha agua de desecho, pero es mejor que los procesos actuales. Líquido del anhídrido no es peligroso para el medio ambiente, sin embargo, el proceso no puede quitar unas manchas en la base de proteína. La Solución GreenEarth es un solvente que no es tóxico y no daña al medio ambiente ni los seres humanos. El aspecto negativo de la Solución GreenEarth es que las máquinas del solvente son muy caras. La reconversión es la alternativa más barata, pero no es tan seguro como las otras.

Nuestras recomendaciones para las tintorerías son: 1) cambie su solvente a la Solución GreenEarth, 2) desarrolla un centro de reciclaje por América Central, y 3) empiece a incinerar los solventes usados.

Recomendamos la Solución GreenEarth porque recibió la mejor puntuación en nuestro análisis de la matriz. Se puede encontrar más información sobre la Solución GreenEarth en Cápitulo2 y se puede encontrar más información sobre la implementación de esta alternativa en Capítulo 5. Se puede encontrar una explanación de nuestro análisis de los beneficios de los costes en Capítulo 3 y un ejemplo de la matriz en el Apéndice G.

Hay otras técnicas que las tintorerías pueden implementar inmediatamente para reducir los efectos dañinos de lavado en seco. Uno de los métodos es la incineración. Los solventes usados pueden ser incinerados en los hornos y pueden dar energía a los hornos. Otra opción de la disposición de los productos químicos es un centro del reciclar. Las tintorerías no sería la sola industria que beneficiaría de un centro del reciclaje porque otras industrias también usan los solventes en base de petróleo. Todos los países en América Central pueden beneficiar del centro del reciclaje. Ahora no hay un centro del reciclaje de los solventes usados en América Central. Un beneficio del reciclar es la recuperación de setenta por ciento de los solventes. Esto reduce la cantidad del solvente nuevo que es necesitado. Una planta de reciclar tiene menos dañinos al medio ambiente y la población. Por último, puede usar el desperdicio del reciclaje de los solventes en otras industrias como un combustible o un aditivo de asfalto. Se puede encontrar más descripciones de los beneficios de reciclar en los Capítulos 4 y 5.

Chapter 1: Introduction

This report was prepared by members of Worcester Polytechnic Institute Costa Rica Project Center. The relationship of the Center to the Centro Nacional de Producción más Limpia (CNP+L) and the relevance of the topic to CNP+L are presented in Appendix A.

The disposal of hazardous waste has been a prominent global environmental issue for several years. Countries throughout the world have been searching for answers to this problem, along with developing laws to regulate both the production and disposal of hazardous wastes. Countries such as the United States, Japan, and Germany have developed high-tech machines that are able to either recycle or incinerate many harmful chemicals. However, a problem arises with the developing countries of the world. These countries often do not have the finances that are needed to correctly take care of hazardous wastes. Many of these countries have few, if any, regulations that require the proper disposal of toxic chemicals. The developing countries that do have regulations have difficulty enforcing the policies, which results in a lack of compliance with the laws. Costa Rica is an example of a country that has a minimal number of laws that deal with hazardous waste disposal. The country also has a lack of enforcement of hazardous waste laws. The improper disposal of chemicals, such as those that are used in the dry cleaning industry, can cause adverse health effects on humans and can cause a great amount of damage to the environment. The people of Costa Rica value their environment and its preservation, which makes the disposal of hazardous wastes an important issue in their country.

The hazardous wastes that the solvents in the dry cleaning industry produce have been known to degrade slowly in the soil and to contaminate the groundwater. The solvents also produce toxic gases that deplete the ozone layer. Along with the effects that the solvents have on the environment, they also cause serious health issues in humans. Many of the solvents used in the dry cleaning industry cause fatigue, headache, nausea, and problems with the central nervous system. Perchloroethylene (perc) is a popularly used solvent that is a suspected carcinogen. Because of the large amount of problems associated with the solvents used in dry cleaning, there has been an abundance of research in the development of new solvents. This project identifies the problems associated with dry cleaning in Costa Rica and recommends an economical solution for replacing the currently used processes.

The major chemicals used in dry cleaning in Costa Rica are petroleum-based solvents. The most commonly used petroleum-based solvents in the country are Exxsol D40 and Varsol. Petroleum-based solvents are highly reactive and because the solvents have a low flashpoint (See Glossary) they explode easily. The effects of the solvents are seen in the employees of dry cleaning shops, local residents, and the environment. The solvents are known to cause serious health problems in humans and animals. Petroleum-based solvents enter the body through inhalation, contact with skin, and ingestion. Inhaling these chemicals can cause cough, headache, nausea, confusion, and unconsciousness (International Chemical Safety Cards [ICSC] 0361). Exxsol D40 can cause redness in the eyes, cough, diarrhea, sore throat, and vomiting. Varsol can cause numbness to the extremities, prolonged reaction time, fever, narcosis (See Glossary), and convulsions (International Chemical Safety Cards [ICSC] 1380).

The chemical perchloroethylene is used in Costa Rica on occasion, but is the major dry cleaning chemical used in the United States (Stricoff, 1983). The United States used Stoddard solvent (See Glossary) until the 1930s, but changed to perc because it cleans more thoroughly than Stoddard solvent, it does not have a tendency to explode, and it is readily available. Currently eighty-five percent of dry cleaners in the United States use perc as their main solvent (www.cdc.gov/niosh/drycleaning/drycleaning.html). Perchloroethylene is uncommon in Costa Rica because it is much more expensive than the petroleum-based solvents that are produced locally and the dry cleaners claim that it causes damage to certain types of laundry.

Perchloroethylene, like petroleum-based solvents, is also known to be hazardous to the environment and to humans. The chemical enters the body through inhalation, ingestion, or contact with the skin. Some of the effects of perchloroethylene on humans include depression of the central nervous system, liver damage, kidney damage, impaired memory, confusion, dizziness, headache, drowsiness, eye, nose or throat irritation, narcosis, and upper respiratory problems (Department of Health and Human Services [DHHS] (National Institute for Occupational Safety and Health [NIOSH]) Publication No. 97-157; www.osha-slc.gov/dts/chemicalsampling/data/CH_260500.html). Perchloroethylene has also been thought of as a cancer risk for many years and has prompted a large amount of research in this area, which we will discuss in Chapter 2 (Blackwood, 2002).

The harmful effects of perchloroethylene and petroleum-based solvents have led to a search for ways to clean up areas that have been contaminated with the chemicals, along with a search for the development of new solvents or dry cleaning methods. Two of the new techniques for cleaning garments are wet cleaning and the GreenEarth Solution. Wet cleaning does not use solvents. Instead, the process uses a mixture of detergent and water, the concentration of which depends on the type of stain and clothing. The GreenEarth Solution is a non-toxic, silicon-based solvent that thoroughly cleans clothes without causing harmful effects to humans and the environment. These two methods, along with others, will be further explained in Chapter 2.

Solvents often contaminate the environment through leaks in piping systems or by direct deposits on soil. There are different techniques that are required for cleaning petroleum-based solvents and perchloroethylene from the environment. In order for biological degradation to take place, the chlorine molecules of perchloroethylene must be removed. The techniques that have been developed for this purpose are degradative solidification-stabilization (DS/S) (See Glossary) and the use of the hydrogen release compound (HRC) (See Glossary). Petroleum-based solvents require a large amount of oxygen in order for biological degradation to occur. A technology that was developed for this is known as the oxygen release compound (ORC) (See

Glossary). These methods of remediation (See Glossary), among others, will be discussed with more detail in Chapter 2.

The Centro Nacional de Producción más Limpia (CNP+L) is an organization that has a special interest in making the dry cleaning industry safer for humans and the environment. According to the mission statement of the company, CNP+L helps companies find ways to dispose of their waste in an environmentally safe and economical manner with a priority set in pollution prevention at the source (http://www.cnpml.or.cr/index2.html). The company became specifically interested in the dry cleaning industry when the Executive Director of CNP+L, Sergio Musmanni, witnessed a local dry cleaner dumping solvent into a drain outside of a dry cleaning shop (Personal communication, May 26, 2003). He questioned the dry cleaner about this practice and discovered that it was the normal method of disposal. Because the mission of CNP+L is to work towards creating cleaner production, eco-efficiency, and pollution prevention in Costa Rica, Mr. Musmanni thought that the dry cleaning industry should be thoroughly examined. The possible risks and dangers associated with many dry cleaning solvents, which have been introduced in this chapter and will be further explained in Chapter 2, increased Mr. Musmanni's concern and led to the development of this project. The Centro Nacional de Producción más Limpia is explained in more detail in Appendix A.

The goal of this project was to determine the best economically attractive technology (BEAT) that either reduced or eliminated the presence of toxic chemicals in the environment. The goal of the project also included reducing the amount of solvent disposed in a manner that is harmful to the residents of Costa Rica. This included informing the dry cleaning establishments in Costa Rica of environmentally safe disposal methods. The project also investigated alternative methods of professional cleaning and made recommendations of how they can be implemented in Costa Rica.

The objectives of the project were to:

- Determine the effects of dry cleaning solvents on the people and the environment of Costa Rica and to increase dry cleaners' awareness of the harmful effects of improper practices.
- Investigate the current health and safety practices followed in Costa Rican dry cleaning establishments.
- Examine different alternatives to the current dry cleaning practices in order to determine the best alternative for Costa Rica.
- Develop a plan to persuade the dry cleaners in Costa Rica to adopt safe disposal methods of chemicals.

The main methodology used to complete this project was interviews with managers or owners of dry cleaning establishments. This was done in order to determine the machinery they use, health and safety procedures, chemicals they use, and chemical disposal methods. The data that the interviews revealed was assessed to determine the best method to reduce improper chemical disposal and exposure to solvents. Since cost was a factor, the best solution was the one with the greatest benefits within the price range of the dry cleaning industry in Costa Rica.

Our investigation of laws and regulations in Costa Rica revealed that there are no laws that deal specifically with the dry cleaning industry other than the fire safety code that is mentioned in Chapter 5. This is a large variation from countries such as the United States, Mexico, Japan, and others who have established certain regulations that dry cleaners must follow. Regulations in developed countries often include a limit on the amount of solvent particles present in the air, ventilation systems, and proper disposal of solvent waste. Costa Rica does have laws that regulate the proper handling of hazardous materials; however, they are loosely enforced and not normally followed.

To effectively inform the people of Costa Rica about the hazards of dry cleaning, we developed three pamphlets. The first was for the dry cleaners themselves and included information on the alternatives to their current method of dry cleaning. It also explained the health risks to the workers and how to lessen exposure to the solvents. The second pamphlet was for the customers of dry cleaners. It detailed the potential dangers of having garments dry cleaned and it offered advice on how to lower the risk of negative health effects. The last pamphlet was created for the general population. It explained the potential hazards of living close to a dry cleaning establishment. It will most likely be made available at grocery stores for the best distribution.

The information that we included in our pamphlet for the dry cleaners was the benefits of recycling and definitions of incineration, retrofitting, the GreenEarth Solution, liquid carbon dioxide, and wet cleaning (See Glossary). The incineration of petroleum-based dry cleaning solvents can begin immediately. Since there is no alternative method of disposing of hazardous solvents, this process must begin now. If a recycling establishment is built, this will be a safer and more effective way to handle the hazardous solvents. Dry cleaners should begin recycling their chemicals as soon as possible. As dry cleaners need to replace their machinery, they should purchase machines that use the GreenEarth Solution. The experts of our matrix analysis, along with a study done by Consumer Reports, believe that the GreenEarth Solution is a very effective and safe method for dry cleaners to use (http://www.consumerreports.org/main/detailv2.jsp?CONTENT%3C%3Ecnt_id=299609&FOLDER%3C%3Efolder_id=162695&bmUID=1053100360286).

Chapter 2: Background Information

The purpose of this chapter is to create a frame of reference for this project. We examine the history of the dry cleaning industry in order to reveal what changes have been made in the United States and the changes that need to take place in Costa Rica. The changes in the United States can serve as a model for the changes that need to be implemented in Costa Rica; however, the changes in the United States have not been perfect. We also introduce the different types of solvents used in the dry cleaning process in the history section of the background. To further verify that there is a problem with the chemicals used in dry cleaning, we explain the problems that are associated with the most commonly used dry cleaning solvents. We examine dry cleaning machinery in this chapter in order to demonstrate the types and abilities of different types of machinery. Next, the process of retrofitting is detailed in order to allow the reader to understand how adding equipment and controls to machines can make the machinery safer. The major solvents used in the dry cleaning process are not only harmful to workers; they are also hazardous to the environment. We also discuss the environmental concerns associated with the solvents. We present prevention techniques and remediation (See Glossary) methods in order to demonstrate some of the options that Costa Rica can use to solve their problem with dry cleaning solvents. To allow the reader to have an understanding of how laws and regulations can help reduce the hazards associated with dry cleaning, we examine many that have been implemented in the United States. Finally, we explore the alternatives to the current procedures in order to allow the reader to be aware of the possible solutions that exist.

History of Dry Cleaning Solvents

Dry cleaning is a process to launder garments and household fabrics using liquid chemical solvents. According to GreenEarth, the history of dry cleaning begins with a legend, which claims that in France, in the late 1800's, someone accidentally discovered dry cleaning when he spilled turpentine on a tablecloth. The tablecloth had numerous stains that were not removable with conventional laundry. The stains came out of the tablecloth when the turpentine was spilled on it, which led to the washing of fabrics with a liquid other than water (http://www.greenearthcleaning.com/about.asp).

Turpentine continued to be used in the dry cleaning process along with a few other liquids. All of these chemicals shared the one characteristic of being hazardous to people and the environment. A majority of them were flammable at fairly low temperatures and produced harmful vapors. The dangers associated with these chemicals prompted a search for a replacement. During the first part of the 1900's, a chemical known as Stoddard solvent (See Glossary) was discovered and became the main chemical used. It was a petroleum-based liquid that cleaned well. The solvent was more readily available and was more economical than the previous options. The main problem with the solvent was its ability to explode and cause frequent fires at dry cleaning establishments (http://www.greenearthcleaning.com/about.asp).

Today, there are many dry cleaning solvents that are used in the industry. They normally fall under the two categories of petroleum-based and synthetic. The most commonly used petroleum-based solvent in Costa Rica is known as Exxsol D40. The chemical perchloroethylene (perc) (See Glossary) is the major dry cleaning solvent used in the United States (Stricoff, 1983).

Perchloroethylene, which is also known as tetrachloroethylene, is a toxic solvent that is hazardous to human health (Environmental Finance Center Region IX (EFC9), 2000; Department of Health and Human Services [DHHS] (National Institute for Occupational Safety and Health [NIOSH]) Publication No. 97-156; American Journal of Industrial Medicine, 2001;39:121-132). In the United States, perc must be disposed of as a hazardous waste. Roughly eighty-five percent of the thirty-six thousand dry cleaning shops in the United States use perc as the primary solvent (www.cdc.gov/niosh/drycleaning/drycleaning.html).

Harmful Effects of Dry Cleaning Solvents

Petroleum-based dry cleaning is an established process that can clean all types of garments and remove all stains. However, it is flammable and can burn if sufficient oxygen is present and the flash point (See Glossary) is reached. The flash point of the petroleum-based solvents used in dry cleaning ranges between 43 and 55 degrees Celsius, depending on the exact composition of the solvent. These temperatures are higher than standard operating conditions, which is room temperature (DHHS (NIOSH) Publication No. 97-155). The way to prevent combustion is to maintain the oxygen level below approximately eight percent through the use of a vacuum or displacement with another gas, such as nitrogen. Another method is to maintain the temperature of the system at least fifteen degrees Celsius below the flash point (DHHS (NIOSH) Publication No. 97-155). Petroleum-based dry cleaning is less expensive than dry cleaning with perchloroethylene and the solvent is less toxic (DHHS (NIOSH) Publication No. 97-150).

Exxsol D40, as mentioned previously, is the most commonly used petroleum-based solvent in Costa Rica. The compound is an aliphatic hydrocarbon (See Glossary) with a flash point of forty-three degrees Celsius and can cause explosion above forty degrees Celsius (http://www.zenkuren.or.jp/englis/cij.html). The solvent is bright and clear in appearance. Exxsol D40 easily reacts with strong oxidants (ICSC 1380).

The solvent, Exxsol D40, has many been known to cause many adverse health effects. When the chemical is inhaled, it can cause dizziness, headache, drowsiness, nausea, and unconsciousness. The chemical also can cause dry skin and can irritate the eyes. If the chemical is accidentally ingested, it can cause cough, diarrhea, sore throat, and vomiting (ICSC 1380).

Stoddard solvent, which is an example of a petroleum-based solvent, has been a commonly used solvent for many years. The chemical is a mixture of many different substances and commonly has variances in composition. The basic composition is a mixture of saturated aliphatic hydrocarbons, alicyclic hydrocarbons, and aromatic hydrocarbons (See Glossary). The mixture may also contain benzene (ICSC 0361). Stoddard solvent is commonly known by the brand name Varsol.

The chemical is colorless and has both an odor and taste similar to kerosene (Agency for Toxic Substances and Disease Registry [ATSDR], 1995). The solvent reacts readily with strong oxidants and causes fires and explosions. Due to the flammability of the solvent, many places in the United States require storage permits from fire stations for dry cleaning shops that use the chemical (Stricoff, 1983). The solvent also reacts with certain forms of plastics and rubber (ICSC 0361). Although Stoddard solvent has a high reactivity, it is still in common use because it is easy to find and is inexpensive (Stricoff, 1983).

Stoddard solvent is extremely dangerous to humans who come in contact with it. It causes a wide variety of harmful effects to the entire body. The substance can enter the body through inhalation of vapors, contact with skin, or ingestion. Inhalation of the chemical causes coughing, headache, nausea, confusion, and unconsciousness (ICSC 0361). The short-term effects of the chemical are usually irritation of the eyes and upper respiratory tract. It may also cause problems with the central nervous system. The long-term effects of the chemical are also known to cause problems with the central nervous system. Other health effects associated with the solvent are narcosis (See Glossary), prolonged reaction time, fever, convulsions, and numbness of the arms and legs. If the chemical comes into contact with skin, burns and dry skin result.

The chemical also has adverse health effects on rats, cats, and dogs. When these animals breathed the chemical for a prolonged period of time, they had seizures. Guinea pigs have also been known to suffer from bronchitis (See Glossary) after contact with Stoddard solvent. However, these effects have not been observed in humans (ATSDR, 1995).

There is no medical test to tell if a person has either been exposed to Stoddard solvent or will suffer any health problems due to exposure. Because the chemical is a mixture of many different substances, the body is affected in a variety of ways. Some of the substances in Stoddard solvent can be detected in breath, blood, urine, and fat (ATSDR, 1995).

Perchloroethylene (perc) is colorless and has an odor similar to that of ether or chloroform (See Glossary) (www.oshalc.gov/dts/chemicalsampling/data/CH_260500.html). Its boiling point is 250°F, and its melting point is negative eight degrees Fahrenheit, which makes it a liquid at room temperature. It is a listed hazardous waste in both its pure and spent forms (See Glossary) (Ohio Environmental Protection Agency (Ohio EPA), 1993). Perchloroethylene is based on carbon chemistry (http://www.greenearthcleaning.com/about.asp). According to Yoshioka, Krauser, & Guengerich, (2002), approximately 100 million kilograms of perc is produced annually in the United States. Perchloroethylene is a halogenated solvent (See

Glossary) composed of two carbon atoms that are double bonded to each other and two chlorine atoms attached to each carbon.

Although a majority of dry cleaners in the United States use perchloroethylene, it also has hazardous effects similar to those of the past solvents. Perchloroethylene is known to be dangerous for both humans and the environment. It is a common contaminant in waste sites (Yoshioka et al., 2002). Perc has caused a great number of issues to arise in dry cleaning. It is very costly to clean up sites where perc has leached or been dumped in the ground. It is also expensive to dispose of the chemical correctly and has caused an abundance of controversy between the dry cleaning industry and environmental organizations (http://www.greenearthcleaning.com/about.asp).

Perchloroethylene enters the body through the respiratory system or contact with the skin. The symptoms of exposure include depression of the central nervous system, liver damage, kidney damage, impaired memory, confusion, dizziness, headache, drowsiness, eye, nose, or throat irritation, narcosis, and upper respiratory problems (Department of Health and Human Services [DHHS] (National Institute for Occupational Safety and Health [NIOSH]) Publication No. 97-157; www.osha-slc.gov/dts/chemicalsampling/data/CH_260500.html). It can also cause dermatitis (See Glossary) if it comes in contact with the skin. According to a study in the American Journal of Industrial Medicine, exposure to perc can increase the chances of many types of cancer. These include cancers of the tongue, lung, cervix, bladder, esophagus, and intestines. Perc is also known to cause ischemic heart disease (See Glossary) and urinary stones (American Journal of Industrial Medicine, 2001; 39:121-132). In the same study, those with exposure to perchloroethylene experienced a thirty-five percent increase in cancer deaths.

Perchloroethylene is a suspected carcinogen and has prompted a large amount of research in this area (Blackwood, 2002). One study showed that perc caused hepatocellular carcinomas (See Glossary) in mice (Yoshioka et al., 2002). Another study explained that there was an excess of emphysema, Hodgkin's disease, and esophagus, larynx, lung, and cervix cancer observed in people who had contact with perc compared to the normal population (Blair, Petralia, & Stewart, 2003). A third study showed that there were an increased number of cases of laryngeal and oesophageal squamous cell carcinomas (See Glossary) within the dry cleaning industry. The laryngeal cancer also appeared to increase with the number of years spent in dry cleaning. The researchers of this experiment, who also controlled for alcohol and cigarette use, believe their data is consistent with previous reports of excess risk of certain cancers in dry cleaners. The experiment also suggests that the previous studies that dealt with the carcinogen effects of perc did not control for alcohol and cigarette use, and have underestimated the relative risks of such cancers (Vaughan, Stewart, Davis, & Thomas, 1997).

Many other studies have also been conducted to prove the harmful effects of perc on humans. A recent study showed that a large number of toxicities are associated with perchloroethylene. Experiments with animals showed that the liver was the most probable location of problems due to perc (Yoshioka et al., 2002). Mr. S. Weininger, a professor of Chemistry at Worcester Polytechnic Institute, (personal communication, March 20, 2003) agrees with the findings and explained that perchloroethylene is known to accumulate in fatty tissue (See Glossary) and is mostly drawn to the liver. This causes fatty liver degeneration along with other health complications. These complications include necrosis, liver enlargement, abnormal liver function, decreased adenosinetriphosphate (ATP) levels, and increased serum transaminases (See Glossary). Although these effects have been mainly seen in mice, it is believed that they also affect humans in a similar manner (Yoshioka et al., 2002).

Table 1 refers to the deaths of dry cleaning workers who were exposed to both perchloroethylene and a form of petroleum-based solvent, usually Stoddard solvent.

Table 1: Deaths in Dry Cleaning Workers

Cause of Death	Number of Deaths	SMR
Tongue Cancer	2	3.04
Esophageal Cancer	9	2.40
Intestinal Cancer	24	1.63
Rectal Cancer	7	2.16
Pancreatic Cancer	15	1.89
Trachea, Bronchus, Lung cancer	46	1.46
Female Genital Organ Cancer	15	1.24
Cervical Cancer	8	1.98
Male Genital Organ Cancer	9	1.02
Kidney Cancer	3	1.27
Bladder and Other Urinary Cancer	10	3.15
All Cancers	195	1.35
Respiratory System	55	1.26
Pneumonia	31	1.57
Emphysema	6	1.28
Digestive System	34	1.28
Stomach and Duodenum	10	3.11
Cirrhosis of Liver	12	1.19

Source: American Journal of Industrial Medicine 39:121-132, 2001

The SMR in the table refers to the Standardized Mortality Rate (See Glossary), which is determined by dividing the number of observed deaths by the number of expected deaths. The expected deaths are based on mortality rates in each age group. An SMR over one is considered significant because it indicates that there were more deaths for that cause than in the general population. The effects of these solvents on the workers are obvious, as they suffer more frequently from numerous diseases.

The people with the highest risk of perchloroethylene exposure are the workers in the dry cleaning facilities. Many different methods can be applied to reduce the exposure and risks of the workers. Proper ventilation is an effective and inexpensive method to lessen the exposure of the workers in a dry cleaning shop. Ventilation captures perchloroethylene vapors before they have a chance to be inhaled by a worker (DHHS (NIOSH) Publication No. 97-157). The vapors are not eliminated, but relocated. The two types of ventilation are local ventilation, which removes the vapors from the work area, and general ventilation, which dilutes the concentration of vapors. For more information on ventilation, see Appendix E.

Types of Dry Cleaning Machines

The machines used in the dry cleaning process have evolved over time to become safer for both humans and the environment. The current methods of dry cleaning take place in a machine that is similar to home washing machines, but it also dries the clothing. Modern machines reduce chemical exposure to the workers and help an establishment save money in solvent costs through the recycling of solvent (DHHS (NIOSH) Publication No. 97-155). The five generations of machinery have progressively become less hazardous for the worker and the environment.

The three basic steps in the dry cleaning process are cleaning, extracting, and drying. In the cleaning step, the garments are immersed in the solvent and agitated to remove stains and soils. The next step is extracting, in which the excess solvent is removed from the clothing. This stage reduces solvent waste, as recovered solvent is reused. The final step tumbles the clothes while blasting them with hot air to evaporate the solvent. The hot air then passes through condensing coils, where it becomes a liquid (Ohio EPA, 1993). This liquid is then reused. The garments are aerated (See Glossary) with fresh air to deodorize them before removal from the machine.

The first generation machine (See Glossary), which can be seen in Figure 1, poses the greatest threat, but is less expensive than other generations. This machine, which is extremely hazardous, was used in the United States until the 1960s. When using a first generation machine, the worker must transport garments soaked in solvent from the washer to the dryer because the first generation machine is not a single unit. Since the first generation machine involves the transferal of solvent soaked clothes, the worker has a higher exposure to solvent. This transfer also increases the potential of accidental leaks or spills.

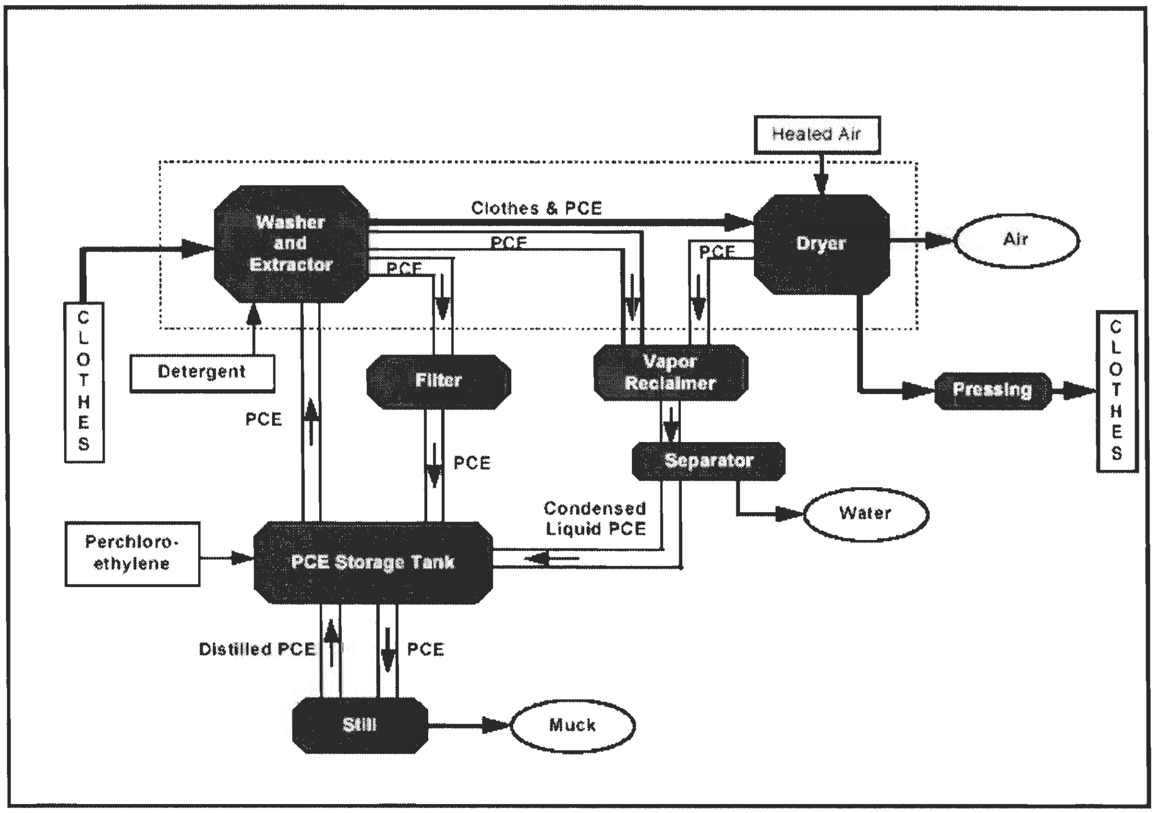

Figure 1: Process Flow Diagram for Perchloroethylene Solvent Transfer Dry Cleaning Machines (Source: USEPA, 1991b)

The first machine to incorporate the washer and dryer together is the second generation machine (See Glossary). In 1993, approximately sixty-six percent of all dry cleaning machines in the United States were second generation (United States Environmental Protection Agency (USEPA), 1995). The second generation machine has a venting mechanism, and during aeration the solvent vapors are vented to either the atmosphere or a non-refrigerated vapor recovery system (See Glossary) (DHHS (NIOSH) Publication No. 97-155). This type of machine has low recovery of used solvent and a high rate of air pollution.

Beginning in the 1970s, third generation machines (See Glossary) began to be used. These machines included the use of a refrigerated condenser (See Glossary). The addition of a refrigerated condenser cools the air used in the drying phase so that more solvent can be recovered. After the air has been cooled and the solvent has been recovered, the air returns to the drying drum and passes through the garments again. The third generation machine is only open to the atmosphere when the door is open, which makes it a closed system. This machine also has a great increase in the amount of solvent recovered as well as a decrease in the emissions of perchloroethylene.

The fourth generation machine (See Glossary) is similar to the third generation, but it also contains a secondary vapor control system known as a carbon adsorber (See Glossary). This device lowers the concentration of perc in the machine cylinder to below three hundred parts per million (ppm) at the end of the drying phase (DHHS (NIOSH) Publication No. 97-155). This combination of a refrigerated condenser and a carbon adsorber is much more effective than either one is alone.

In Germany, the fifth generation (See Glossary) dry cleaning machine is commonly used, but is rarely used in the United States. This machine is identical to the fourth generation machine except for a monitor inside the machine drum and an automatic locking door (DHHS (NIOSH) Publication No. 97-155). The monitor reads the concentration of perchloroethylene and ensures that the amount of perc is lower than three hundred ppm before the door unlocks. The lock mechanism guarantees that the worker will not be exposed to a greater maximum level of perchloroethylene than ordained.

Many different designs and components are involved in a dry cleaning machine. A dry-to-dry machine is one that requires no clothing transfer from washer to dryer. This allows the garments to enter and exit the machine dry. The second through fifth generation machines are all dry-to-dry. The primary vapor control system is the refrigerated condenser and can be seen in Figure 2. This system is found on the third, fourth, and fifth generation machines.

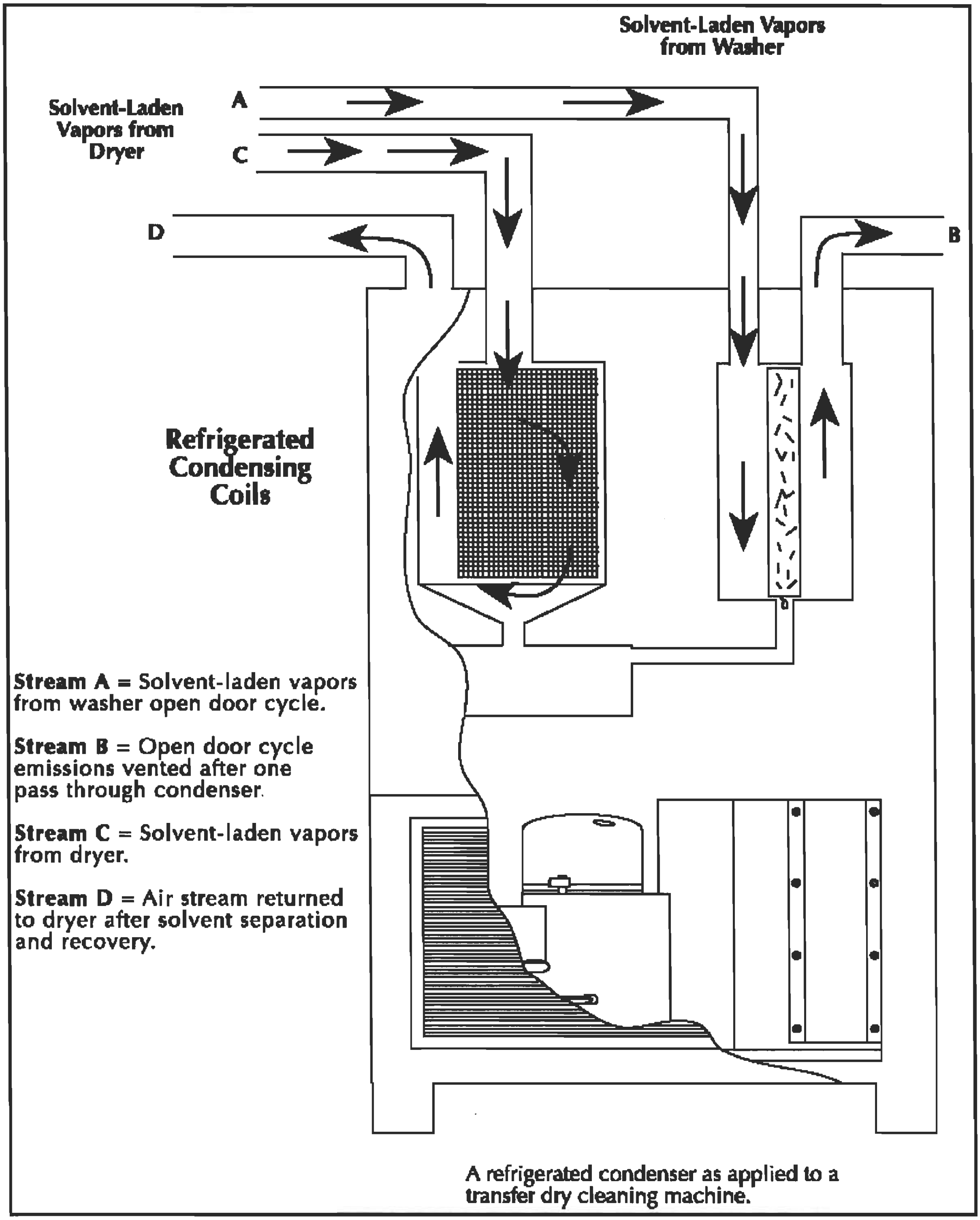

Figure 2: Flow Diagram of a Refrigerated Condenser (Source: USEPA 1991a)

The secondary vapor control system is the carbon adsorber, which is shown in Figure 3. A carbon adsorber sends the hot air used to dry the garments through activated carbon that adsorbs the perchloroethylene vapors (USEPA, 1995). Models with both a carbon adsorber and a refrigerated condenser recover perc through the adsorber first, then the refrigerated condenser. By law, a carbon adsorber must be able to reduce the perc concentration to less than three hundred ppm (DHHS (NIOSH) Publication No. 97-155). The carbon in the adsorber should not have any contact with steam or water. Fourth and fifth generation machines both contain carbon adsorbers (DHHS (NIOSH) Publication No. 97-155).

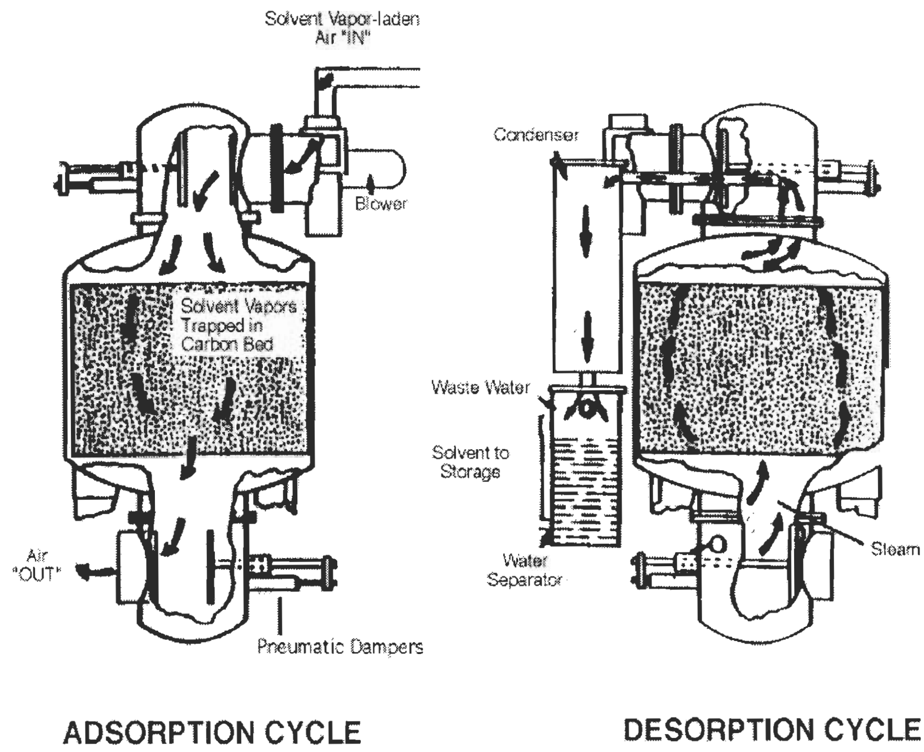

Figure 3: Flow Diagram of a Carbon Adsorber (Source: USEPA, 1995)

Retrofitting

Retrofitting (See Glossary) is the process of adding equipment that is unavailable at the original time of production. The benefits of retrofitting are significant; however, it is not always practical. If a machine is very old and run down, then a new machine is the best option. This process only allows a machine to be upgraded one generation. If a dry cleaner would like to change from first generation machinery to a third generation machine, a new piece of equipment must be purchased.

Retrofitting is commonly done to meet the standards set by the United States government while remaining within a budget. Adding a refrigerated condenser to a machine that previously used a water or air condenser, can lower worker exposure to perc by fifty percent and will also increase the span of solvent use (DHHS (NIOSH) Publication No. 97-155). Retrofitting a carbon adsorber onto a third generation machine can lower worker exposure by as much as ninety percent (DHHS (NIOSH) Publication No. 97-155). Retrofitting old machines will make them safer, healthier, and more economical.

Although new machines are safer to use, the cost to replace existing dry cleaning units is much higher than the cost to retrofit old machines. In 1995, it cost roughly $7,500 to retrofit a dry-to-dry second generation perchloroethylene machine with a refrigerated condenser, which will make it equivalent to a third generation machine. It would cost about $47,000 to replace the same unit with a fourth generation machine (USEPA, 1995). Although these numbers are from 1995 and both are likely to be different now, the large difference in price between retrofitting and buying a new machine still exists.

Environmental Concerns, Prevention, and Remediation

The dry cleaning process produces large quantities of hazardous waste. The types of hazardous waste produced from the dry cleaning process include used solvents, used carbon from carbon adsorbers, carbon cartridges, and still and powder residue (See Glossary) (Ohio EPA, 1993). According to Paul Mastrodominico, Hazardous Waste Coordinator at Global Remediation (personal communication, March 4, 2003), the proper disposal of a fifty-five gallon drum of spent perc costs approximately $350 in the United States. However, it is much more expensive to remediate (See Glossary) a contaminated site. In the same interview, Mr. Mastrodominico stated that the treatment of a contaminated site and disposal of the waste using traditional methods range from $5,000 to $1.5 million depending on the extent of contamination and the volume of contamination.

The dry cleaning industry affects the air by introducing emissions. The releasing of liquid wastes contaminates water and soil. Disposal of solid waste pollutes the soil as well. The greatest amount of waste introduced to the environment is through air releases of perchloroethylene and petroleum-based solvents. Ground water can become contaminated through spills, inadequate storage, and by disposing of solvents down a drain. Another concern is disposing of hazardous materials that are high in solvent, like filters, as non-hazardous waste (USEPA, 1995). In the United States, there is a recycling market for solvent recovered from the dry cleaning process. Better management has led to increases in off-site transfers of toxic chemicals for recycling.

Pollution prevention can improve efficiency and even increase profits. This can be achieved by reducing the amount of solvent initially placed in the machine, reusing solvent within the machine, improving management practices, and through substituting toxic chemicals for ones that are not hazardous (USEPA, 1995). Short-term pollution prevention can be achieved by improving operating practices and retrofitting machines (USEPA, 1995).

There have not been many environmental problems associated with Exxsol D40; however, it is known to be toxic to aquatic organisms. Exxsol D40 should never be washed into a sewage system, signaling that it has serious harmful effects (ICSC 1380).

There are many specific environmental hazards that are associated with Stoddard solvent (See Glossary). The solvent leaches into the groundwater and can cause harm to animals. The different substances in Stoddard solvent react differently in the environment on the chemical level. Certain chemicals attach to the soil and water and sink down into the sediment. Microorganisms break down a few of the chemicals in the solvent. A portion of the chemicals in Stoddard solvent is suspected to accumulate in plants and animals (ATSDR, 1995).

Many environmental problems also result from the usage of perchloroethylene. Ecological experiments, where perc was added to a freshwater pond, led to the extinction of several phytoplankton and zooplankton species in the pond (See Glossary). Perc is not expected to biodegrade, decompose through reaction with water, or absorb to soil particles (USEPA, 1995). This causes perc to settle in groundwater. The contaminated water may possibly cause health problems in people if they come in contact with the liquid.

Although many new solutions are being developed to replace the traditional process of dry cleaning with perchloroethylene, many problems still need to be solved dealing with the damage that perc has caused. Dry cleaners in the United States have been forced to pay large amounts of money to clean up areas in the groundwater and soil that have been contaminated with perc. Not only are clean up processes extremely costly, they also require long term programs that involve engineering designs, construction, expensive equipment, and a long-term system operation and maintenance (HRC, Regenesis, 2003). Because of these situations, a large amount of research has been done in the area of perc clean up.

A recent experiment was conducted, which demonstrated that degradative solidification/stabilization (DS/S) technology could treat perchloroethylene without producing many chlorinated intermediates (See Glossary) (Hwang & Batchelor, 2001, pp. 3792-3797). According to Mr. S. Weininger (personal communications, March 20, 2003), this experiment is important because it is believed that if perchloroethylene can be dechlorinated, microbes (See Glossary) will be able to digest the chemical and produce non-toxic products. The half-life (See Glossary) of perc is 13 to 335 days, which is enough time for the DS/S application to work. The only chlorinated product that was observed in the experiment was trichloroethylene (See Glossary); however, the amount present was very minimal. The experiment also showed that iron (II) could be used as an electron donor in order to reductively dechlorinate the compound (Hwang & Batchelor, 2001).

In the United States, a process for perchloroethylene clean up that is becoming increasingly popular is the use of the Hydrogen Release Compound (HRC) (See Glossary). The compound was developed at Regenesis and can be purchased through their company. This compound is able to clean up a site with minimal effort and in less time than previous techniques. HRC is environmentally safe and cost effective with the typical price of a clean up being one-third to one-half of the cost of other options (HRC, Regenesis, 2003). The compound allows for chlorinated solvent contaminates to degrade quickly with the slow release of lactic acid (See Glossary) due to hydration (http://www.regenesis.com/HRC/).

The process is reportedly very simple and works through a series of chemical and biological mediated reactions. The process begins with the HRC contacting subsurface moisture, which causes the compound to slowly release lactic acid. Next, indigenous anaerobic microbes, such as acetogens and others, metabolize the lactic acid and consistent low concentrations of dissolved hydrogen are produced (See Glossary). Different subsurface microbes, such as reductive dehalogenators (See Glossary), use the hydrogen in order to strip the solvent molecules of their chlorine atoms and to allow them to operate in this manner for about a year (http://www.regenesis.com/HRC/).

HRC remediation only takes one day to complete and within three months the perc levels in groundwater become undetectable. After only six months, levels of trichloroethylene (See Glossary), which is a hazardous by-product of perc, also become undetectable in the groundwater. HRC remediation (See Glossary) treats waste at a faster rate than many of the other technologies. The process continues for approximately fifteen months. Along with HRC's ability to clean up a site rapidly, the process also allows the dry cleaner to continue business while the clean up is in place because the use of large equipment is not necessary (HRC, Regenesis, 2003).

An effective method for the clean up of petroleum-based solvents is through the use of the Oxygen Release Compound (ORC) (See Glossary). This compound is very similar to HRC and was also developed by Regenesis. The basis behind the compound is that microorganisms need oxygen to degrade contaminants. ORC is able to slowly release oxygen in the ground so that degradation can occur at a faster and prolonged rate.

The process of using Oxygen Release Compound is much simpler than many other clean up methods. ORC is delivered to a clean up site as a powder and is then mixed with water to form a slurry (See Glossary) that can be injected into the ground. The slurry is pumped into the groundwater where it is able to spread freely. The compound continually releases oxygen for about a year, depending on the site. When a year has passed, it is simple to re-inject the ORC if there is still petroleum-based solvent present.

Because Oxygen Release Compound is a long lasting clean up technique, it is very cost-effective. The cost of using ORC is less than or equal to the cost of excavation and twenty-five to fifty percent less expensive than air sparging with vapor containment (See Glossary) (ORC, Regenesis, 2003). The capital costs of this procedure are very low and there is no long-term maintenance requiring equipment that must remain on the site. Along with its low cost, it has also been known to increase property values once the clean up is complete.

United States Laws and Regulations

In the United States, there are many laws and regulations regarding dry cleaning, its machinery, emissions, chemical storage, exposure limits, and disposal methods. These are based on studies regarding the health and environmental risks of perchloroethylene. There are some states that have instituted regulations in addition to the Federal regulations. The South Coast Air Quality Management District, which is the pollution control agency for Southern California, has outlawed the use of perc in the majority of that area (Blackwood, 2002).

The United States requires that all dry cleaning machinery must meet, or surpass, the standards of a dry-to-dry machine with a refrigerated condenser, which is equivalent to at least a third generation machine. Any form of solvent transfer, such as from merchant to machine, must be closed to prevent vapor release (www.ncdsca.org/DSCAACT.htm). In Canada, perchloroethylene cannot be used in a self-service machine due to the risks to the customer. In addition, each carbon filter (See Glossary) must be fitted with an alarm that sounds when it is saturated, and a device that ceases use until a new filter has been installed (www.extox.com).

In September 1993, the EPA publicly announced a National Emission Standard for Hazardous Air Pollutants (NESHAP) for dry cleaning establishments that use perchloroethylene. These regulations, affecting both existing and new facilities that met a certain size requirement, mandate that dry cleaning establishments must use designated vapor control technologies, undertake leak detection, and have equipment repaired to prevent unnecessary emissions (USEPA, 1995). NESHAP prohibits the sale of new transfer machines, requires retrofitting of existing dry cleaning equipment with control devices, and requires new machines to be sold with such technology (USEPA, 1995). This law is located in Appendix J.

The permissible exposure limit for perchloroethylene emissions is one hundred ppm over an eight hour time weighted average (DHHS (NIOSH) Publication No. 97-156). During this time, the maximum peak of perc vapor is three hundred ppm. Table 2 demonstrates the time weighted average (TWA) and peak values for each generation of machine in parts per million. The TWA is determined by multiplying the concentration of perchloroethylene in the air by the amount of exposure time for each sample. Then these products are added and divided by the sum of exposure times. The samples are taken many times throughout a normal eight hour workday.

Table 2 shows that all generations are well under the time weighted average required, but only the fourth and fifth generations satisfy the maximum peak requirement. They are the only allowable machines in the United States by emissions standards.

Table 2: Emissions by Generation of Machine

Generation	TWA (8 hour)	Peak
First	40-60	1,000-4,000
Second	15-20	1,000-4,000
Third	15-20	1,000-4,000
Fourth	<3	10-300
Fifth	<2	10-300

Source: DHHS (NIOSH) Publication No. 97-155

Title VI of the Clean Air Act Amendments of 1990 called for a ban on trichloroethane (See Glossary) in 2002 because of its ozone depleting potential (USEPA, 1995). Trichloroethane is a chemical that is released when perchloroethylene degrades. In February of 1992, President Bush moved the effective date of the ban forward to December 31, 1995 (USEPA, 1995).

Perchloroethylene can only be stored in a closed container made of material that is compatible with perc or lined with a compatible material. Each container must be dated the day it was first used for storage (Ohio EPA, 1993). Dry cleaning facilities that use underground storage tanks to store either petroleum-based solvents or perchloroethylene are subject to the EPA's underground storage tank regulations. These regulations require that the tank must have protection from corrosion, installation of devices that prevent spills and overfills, and a leak detection method (USEPA, 1995). In some areas, pure or spent solvents (See Glossary) cannot be stored underground (www.ncdsa.org/2Rules.htm).

The Comprehensive Environmental Response, Compensation and Liability Act says that a landlord can be held liable for contamination of a site with perchloroethylene. The contamination can occur by having wastewater that contains perc leach through the sewer pipes or by perc leaks during normal operations (USEPA, 1995).

Under the Resource Conservation and Recovery Act (RCRA), dry cleaners that generate two hundred twenty pounds or more of perchloroethylene solid wastes each month must dispose of their wastes at a licensed hazardous waste facility. Examples of perc solid wastes are still bottoms, cartridge filters, and filter muck (See Glossary) (USEPA, 1995).

There must be spill containment around every container or piece of machinery that holds solvent or has solvent pass through it. The capacity of the containment area must be at least one hundred ten percent of the largest containment vessel in that area (www.ncdsca.org/2Rules.htm). It must be capable of accommodating the spill for a minimum of seventy-two hours. All floor drains in any area in which solvents are located or passed through must be removed or sealed with a solvent-compatible plug. On the premises, there must be a method to clean up a spill.

Government Policy in Costa Rica

In order to make the dry cleaning industry realize the seriousness of the solvent problems, it is necessary to establish laws that would regulate the industry. Rolando Castro Cordoba, a lawyer at Cedarena (personal communication, June 14th 2003), informed us of the procedures involved in creating laws in Costa Rica. If a law results from our project, it would need to be written and approved by the Asemblea Legislativa. This would require the support of a representative. It takes roughly two years for a law to be approved in Costa Rica. Another option that might be possible is to add to an existing law through the use of a regulation. A regulation only needs the approval of the Executive Branch of the government as well as the signature of the President. This process only takes six months to one year for approval. The government also takes the time to discuss the implications of the laws and regulations with the people that would be affected by the regulations. Mr. Castro added that it is possible that the dry cleaning industry is not being regulated because the government does not feel that there are any hazards associated with the industry. An interview with Alturo Navarra, an Industrial Chemist, and Frederico Paredes, an Agronomist, both with the Ministry of Health, reinforced this opinion (Personal Communication, June 25, 2003). Mr. Castro also pointed out that if the dry cleaning industry changed their disposal methods, the cost of wastewater treatment would probably decrease.

Alternatives to the Dry Cleaning Process

The demand for commercial dry cleaning is being reduced because more clothes are being made of launderable fabrics. Self-service coin-operated dry cleaning machinery is no longer available on the market and they are slowly being phased out (USEPA, 1995). New fabrics that are washable in water-based laundry and increased use of casual clothes in the work place have led to new washing processes and increased use of traditional laundry (USEPA, 1995).

There are other alternative methods to using perchloroethylene and petroleum-based solvents for cleaning garments. The alternatives include the GreenEarth Solution, wet cleaning, and liquid carbon dioxide (See Glossary). Wet cleaning is a safe and effective alternative, but it is expensive and labor-intensive. Cleaning with liquid carbon dioxide is promising, but it is still a new procedure.

According to the United States Environmental Protection Agency, consumers have little concern regarding what solvent is used to clean their clothes. The main concerns of a customer are that the cleaning is convenient, fast, and effective. Although the introduction and switch to launderable fabrics have reduced the demand for dry cleaning, the need for other services offered by dry cleaners such as laundering, pressing, and finishing have not been greatly affected (USEPA, 1995).

The laws and regulations create difficulties for dry cleaners because of the large amount of paperwork they require and the costliness of cleaning areas that perc may have contaminated. Due to these complications, along with the health risks of perchloroethylene, researchers sought out a new solvent and recently discovered one.

GreenEarth developed a silicone-based solvent that is currently manufactured by General Electric and Dow Chemical Companies. This chemical is odorless, non-hazardous, and biodegradable (Kennedy, 2002).

A scientist noticed that a chemical that is found in cosmetics removed fats and dirt from his hands. He thought that it might also work on laundry and discovered that he was correct (http://www.greenearthcleaning.com/eureka.asp). This chemical, which has been used for many years, is often found in deodorants and shampoos (Blackwood, 2002). According to GreenEarth, the solution is chemically inert (See Glossary), which causes there to be no chemical reaction with the laundry. The silicone solvent attaches to the clothes and rinses out the dirt and oils that the solvent traps (http://www.greenearthcleaning.com/whyBest.asp).

The process can be used to clean clothes like leather, vinyl, and garments with beads and sequins due to the fact that there are no chemical reactions (Kennedy, 2002). These items could not be dry cleaned with old techniques. The new solvent also gives the clothes a better texture and does not leave an odor on them. Unlike other chemicals, the GreenEarth Solution does not cause pain if it spills on an open wound (Kennedy, 2002).

The new solvent does not contain any organic compounds that are volatile (See Glossary). This allows the chemical to be harmless to the environment (Blackwood, 2002). The GreenEarth Solution does not contaminate ground water because it has the ability to biodegrade into sand, water, and carbon dioxide in approximately twenty-eight days (Kennedy, 2002). The process is so environmentally friendly the Metro Health Department, in Southern California, does not require a permit for the process. This allows dry cleaners to no longer have to think about disposing of hazardous wastes and filling out annual reports (Blackwood, 2002).

There are difficulties associated with the GreenEarth Solution, however. The machines are very expensive and sophisticated and require a large amount of maintenance (Blackwood, 2002). It has been said that the process is difficult to work with because of the large difference between the new procedure and techniques of the past. One dry cleaner was frustrated with the process because it required him to relearn all of the spotting (See Glossary) and cleaning techniques that he used with the old dry cleaning process (Blackwood, 2002).

Other dry cleaners disagree with the previous remarks. One dry cleaner thought that it was as easy to use as the old method and produced better results (Kennedy, 2002). Thoughts on the cost of the process also showed disagreements. Some dry cleaners claim that the process is expensive; however, once the initial costs are paid, money immediately begins to be saved. A new machine costs $75,000, or approximately ¢30.000.000. These machines hold roughly two hundred gallons of solvent and use between twenty-five and thirty gallons in each load. A load contains about fifty-five pounds of laundry. A benefit of this process is that it purifies and recycles the solvent. This reduces the amount of solvent that the dry cleaner has to add to only between fifteen and thirty gallons in a year's time. Costs are also cut because when the clothes come out of the machine, they are not as wrinkled and do not require as much finishing time as with dry cleaning with perchloroethylene (Kennedy, 2002).

Another problem that arises with the GreenEarth Solution is that it is unable to clean an article of clothing that is heavily soiled (Blackwood, 2002). In these cases, another process must be used. The process that is often chosen for this is known as wet cleaning.

Multi-process wet cleaning, which is displayed in Figure 4, uses a controlled application of water to hand clean clothes. A technician, trained in the method of wet cleaning, inspects the garment to be cleaned for the amount of soiling. The technician selects a suitable cleaning process based on the visual inspection and the fabric and fiber type. The cleaning process could be spotting, localized steaming (See Glossary), hand washing, or machine washing (USEPA, 1995).

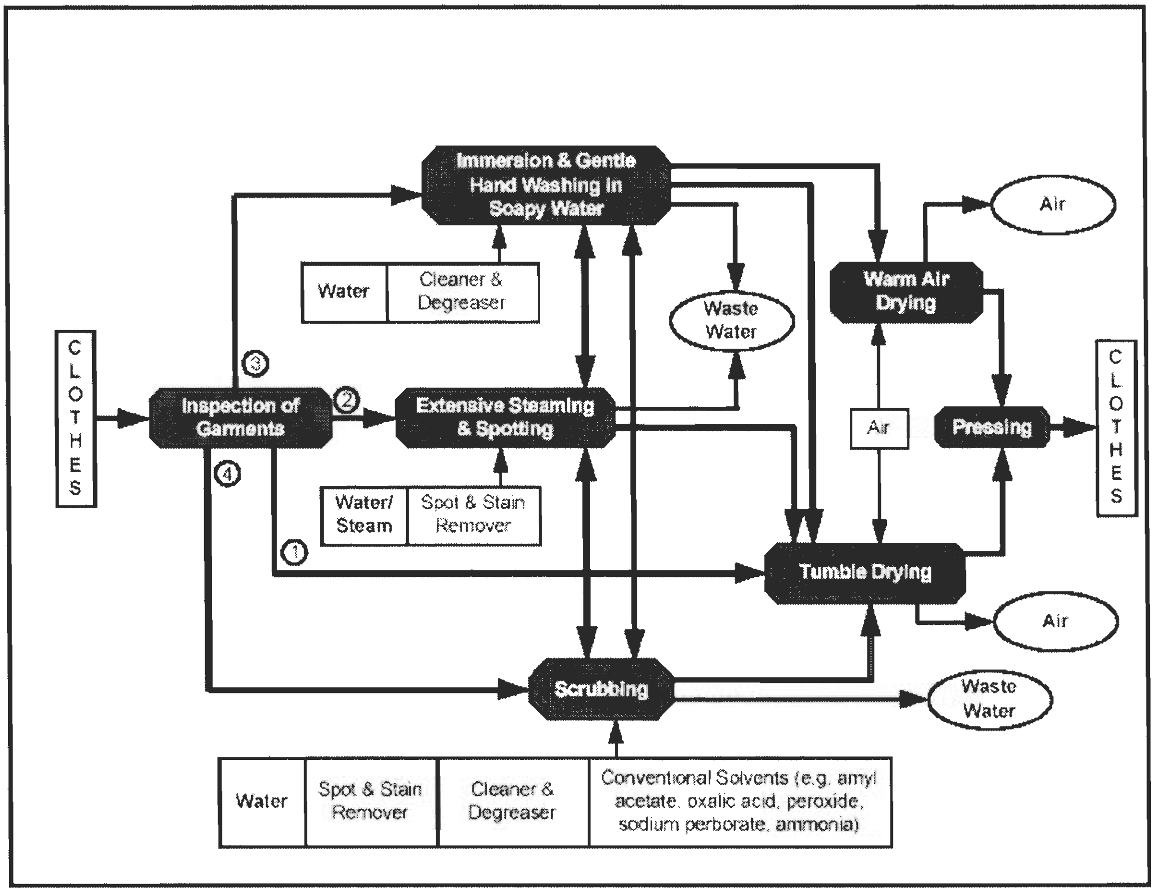

Figure 4: Flow Diagram of Multiprocess Wet Cleaning (Source: USEPA, 1995)

Another way that wet cleaning is performed is using a washing machine that has been specially designed to reduce agitation. It also adds a chemical to reduce fiber swelling (USEPA, 1995). Computers control the water temperature, the agitation, and the disbursement of the non-toxic soaps and conditioners (EFC9, 2000). These machines have been profitable in Europe and are now being introduced in the United States market (USEPA, 1995). Wet cleaning is a highly skilled process that prevents shrinking and bleeding of the garment being washed while still cleaning effectively.

Drying the garments is an involved process because the clothing needs to be reshaped and restored to prevent wrinkles and shrinkage. Wet cleaning can clean delicate fabrics such as wool, silk, cashmere, down-filled items, suede, and many other delicate fabrics (EFC9, 2000).

During the wet cleaning process, the garments are soaked in water. This can cause the fibers to swell, which results in the garment shrinking or losing shape. If a delicate garment is wet cleaned, only part of the drying is done in the machine. The garment is hung to air dry and the wet cleaning process is complete. Garments with more synthetic fibers can be dried longer in the machine. The additional air-drying adds time and work to the cleaning procedure.

Health and safety risks are much lower in the wet cleaning process. The wet cleaning process does not use toxic chemicals as the primary solvent. This causes a large decrease in environmental pollution (USEPA, 1995). However, wet cleaning produces a large amount of wastewater. It is not yet a complete replacement for cleaning with perchloroethylene because it shrinks some materials and has difficulties removing hydrophobic stains (See Glossary), such as oil and grease (DHHS (NIOSH) Publication No. 97-155). In short term testing, the multi-process wet cleaning method is more labor intensive than dry cleaning. The multi-process wet cleaning technique is cost competitive with dry cleaning (USEPA, 1995).

Liquid carbon dioxide (See Glossary) is another new technology to professionally clean garments. The clothes are immersed in liquid carbon dioxide mixed with additives, then agitated to remove the soils. Once the washing process is complete, the carbon dioxide is vaporized. Because carbon dioxide has a lower viscosity than perchloroethylene, it is better at removing small particles of stains (DHHS (NIOSH) Publication No. 97-155). It performs best with non-polar soils, such as oil and grease, due to its non-polar properties (See Glossary). The total processing time is less than that of perchloroethylene, and it releases less pollution. However, it can be more expensive and has not been around long enough to have a firm reputation. Liquid carbon dioxide also has difficulty removing protein stains (See Glossary) such as grass and chocolate (DHHS (NIOSH) Publication No. 97-155).

In a recent study done by Consumer Reports, perchloroethylene dry cleaning was compared to each of these new alternatives (http://www.consumerreports.org/main/detailv2.jsp?CONTENT%3C%3Ecnt_id=299609&FOLDER%3C%3Efolder_id=162695&bmUID=1053100360286). The method that best cleaned the clothes was liquid carbon dioxide and the worst method was perc. The silicone-based solvent, GreenEarth, also performed well. Wet cleaning was effective on some of the garments, but ruined some of the others.

Dry cleaners are skeptical that new technologies will clean as well as the current process, so the most effective way to gain leverage, in terms of pollution control, is to show that the new processes can be economically successful (USEPA, 1995). A dry cleaner can use the fact that these new methods are environmentally sound as a marketing tool to their customers. This can be used to attract customers that are environmentally conscious and hopefully increase sales for the establishment (USEPA, 1995).

Chapter 3: Procedure

The goal of our project was to determine the best economically attractive technology (BEAT) that would either reduce or eliminate the use of toxic solvents in the dry cleaning industry. Part of our goal was to also reduce or eliminate the solvents that are disposed of in a manner that is harmful to the people of Costa Rica and the environment.

Along with the goal of our project, we had specific objectives that needed to be fulfilled. The techniques that our team used in order to complete our objectives are explained in this chapter. The objectives of our project were as follows:

1. Determine the effects of the dry cleaning solvents on the people and the environment of Costa Rica and increase dry cleaners' awareness of the harmful effects of improper practices.
2. Investigate the current health and safety practices that are followed in the Costa Rican dry cleaning establishments.
3. Examine different alternatives to the current dry cleaning practices in order to determine the best alternatives for Costa Rica.
4. Develop a plan that would persuade dry cleaners of Costa Rica to adopt safe disposal methods of chemicals.

The primary procedure that we used in order to complete all of our objectives was to interview a representative at different dry cleaning establishments in San José. We needed to locate all of the dry cleaners in the city and determine if they had machinery on site before we were able to schedule interviews with the various locations. In order to obtain a list of dry cleaners in Costa Rica, we contacted the Ministry of Health; however, they were unable to provide us with this information. The Ministry of Health said to use the yellow pages of the phonebook to acquire a list of dry cleaning establishments. The phonebook listed thirty-eight dry cleaning establishments, including multiple locations within the same chain. We were not able to contact six of the dry cleaners because they did not answer their phone in spite of our numerous attempts to call them.

Fourteen of the thirty-two remaining dry cleaners had dry cleaning machines on site. Of these fourteen dry cleaning establishments, five were of the Sixaola chain and three were of the Martinizing chain. After contacting the five Sixaola locations with machines, we learned that we would need to speak with the owner of the chain to gather our needed information. Two other dry cleaners that were not listed in the phone book under Martinizing referred us to Juan Carlos Castro, the owner of the Martinizing chain in Costa Rica. Our team contacted him, but learned that we could not interview the chain due to franchise policies.

Using the information in the yellow pages, we developed a spreadsheet of the dry cleaning establishments, which can be found in Appendix I. The information in the spreadsheet included the phone number, the location of the establishment, and whether or not they have machines on site. This information was used to determine which dry cleaners we needed to visit and how to contact them.

The interviews that we conducted were completed with the owners or managers of the dry cleaning establishments that had machinery on site. We tested the interview questions, which can be found in Appendix C, at a dry cleaning establishment in the United States in order to learn if the questions were understandable to dry cleaners. When the interviews were conducted, our team observed the surroundings both inside and outside the dry cleaning shop. We looked for ventilation systems, sprinkler systems, ponds or other nearby water sources, and leaks in the dry cleaning equipment. We also observed the safety equipment and how the workers handled the chemicals.

In order to fulfill our first objective, we planned to research records regarding health problems of workers in dry cleaning establishments. We also planned to investigate health problems experienced by people who live near the dry cleaning shops. In order to find health related information dealing with dry cleaning employees, we contacted the worker health department of INS and the Caja de Seguro. We planned to find information about the health problems experienced by the citizens who live near the shops by contacting the Ministry of Health. Two important variables that we planned to focused on were the age of the person experiencing the problem as well as the number of years the person either worked in the dry cleaning industry or lived near a dry cleaning establishment. We planned to focus on these two factors because they are the common focuses of dry cleaning studies that have been completed in the past. Examples of these studies can be found in Chapter 2.

The health information that we planned to gather at the worker health department of INS and the Ministry of Health was not found. There are no studies that are particularly relevant to the dry cleaning industry. The health documents that the Ministry of Health has only lists health problems, but not the occupation associated with the problem. The petroleum-based solvents and perchloroethylene solvents that are used in dry cleaning were listed in the health books at the Caja de Seguro; however, there were no specific health cases involving the two solvents listed.

Harmful chemicals often have laws and regulations that are associated with them. To fulfill our second objective, we needed to learn if there were any regulations in Costa Rica that apply to the dry cleaning industry. We contacted the Ministry of Health and the Technical Director of the Chamber of Industries to obtain the information regarding to laws and regulations, as well as how they are enforced. We also researched online to find laws and regulations in Costa Rica and were able to find the exact laws that pertain to hazardous solvents with this method.

Another method of investigating the health and safety procedures in dry cleaning establishments was accomplished by contacting the Bomberos. They are the first people to know if there is a solvent spill. There is no national organization in Costa Rica that is specifically designed to deal with chemicals; thus chemical clean up falls under the jurisdiction of the Bomberos. We contacted them in order to learn if any chemical spills at dry cleaning establishments have ever been reported. Because the petroleum-based solvents that are most often used in Costa Rica are fire hazards, we also questioned the Bomberos about the frequency of fires at dry cleaning establishments.

The information that we obtained from the Bomberos was supposed to assist in our use of Geographic Information System (GIS). We planned to use GIS in order to organize the data that we collected and to allow the dry cleaners to see a visual display of data that could assist in persuading the dry cleaners of Costa Rica to adopt safer practices. The data that we planned to include in the map was the location of the dry cleaning facility, the amount of solvent at each dry cleaning facility, the amount of waste generated at each site, and the number of health problems near the dry cleaning facility. We then planned to use the combination of the location of the dry cleaning establishments and the amount of solvent located on the premises to display the extent of the fire hazard associated with each establishment.

There was not enough time to complete the GIS. Instead, we planned to use a Global Positioning System (GPS) in order to map the exact location of each dry cleaning establishment; however, there was also not enough time to complete this process. In the future, CNP+L would like to develop an interactive map of dry cleaning establishments with the information that we have gathered. They will use GIS to have a map that shows different aspects of each establishment such as the phone number, machinery on or off site, chemical used, and the amount of cleaning done per day.

We completed objective four by developing pamphlets through the use of Microsoft Publisher. The pamphlets, which can be found in Appendix F, will be used to raise awareness among the employees and owners of dry cleaning establishments, their customers, and local residents. A different pamphlet was created with data directed towards each target audience. We included important information about our project in each pamphlet through the means of bulleted lists and short, descriptive paragraphs. The pamphlet for the dry cleaning establishments included the history of dry cleaning, a bulleted list of the health issues that can affect employees and the environment, and a list of methods that could increase the safety of the dry cleaning establishment. The health effects and the history of dry cleaning were also included in the pamphlet for customers of dry cleaning establishments and in the pamphlet for local residents. A list of ways to reduce the risks of the chemicals was included in these two pamphlets as well.

The results of our interviews were placed in a large matrix with each of our twenty-six questions in a column and each dry cleaning establishment in a row. The answers to each of our questions filled the matrix. This created a simple way to visually observe any trends in the data that we collected. The completed matrix of our results can be seen in Appendix H.

Once the interviews with the dry cleaners were completed, we studied the findings and developed alternatives to the current dry cleaning practices in order to fulfill our third objective. Alternative methods included wet cleaning, the GreenEarth Solution, liquid carbon dioxide, and retrofitting (See Glossary). The alternative methods that we deemed most feasible were analyzed using qualitative cost-benefit analysis in order to determine the best economically attractive technology (BEAT) to implement in Costa Rica.

The technique we used to perform the cost-benefit analysis was a matrix, which is also known as a spreadsheet. A blank and a completed matrix are found in Appendix

G. Each category that we included in the analysis was based on our findings in the literature review and preliminary interviews. The categories were placed in a row and each alternative was ranked, with the best alternative in each category receiving a one. The remaining alternatives were ranked in increasing order, until the worst alternative received the highest possible number of six. Once all of the rankings were completed, the scores for each alternative were added. The alternative that received the lowest overall score was the best alternative.

A team of professionals in related fields ranked the alternatives for the matrix analysis. Our team chose the professionals by first contacting experts in the dry cleaning field. We used these experts to make connections with professionals whom we did not previously know. The professionals that we planned to have complete our matrix were a wet cleaning expert, a GreenEarth Solution expert, a liquid carbon dioxide expert, a senior chemist, a remediation expert, an environmental engineer, an EPA expert, and an owner of a dry cleaning establishment. We were unable to contact a liquid carbon dioxide expert and a dry cleaner. The EPA expert, wet cleaning expert, and GreenEarth Solution expert did not complete the matrix for unknown reasons.

The cost-benefit analysis included a section for the professionals who helped with the rankings to write down the reasons for their choices. They also had the opportunity to suggest ways in which the best alternative could be implemented. By knowing the reasoning behind their rankings, we had a better understanding of any bias that may have existed in their choices.

Chapter 4: Data and Analysis

The goal of our project was to determine the best economically attractive technology (BEAT) that would either reduce or eliminate the use of toxic solvents in the dry cleaning industry in Costa Rica. This chapter presents the data that we collected, along with an analysis of the findings. The reader must keep in mind that our sample was very small and that with a larger sample the facts would likely vary; however, it is probable that the trends in our data would remain very similar to what we have presented in this chapter. The data and facts of specific dry cleaners and dry cleaning establishments must be kept anonymous. We represent each dry cleaning establishment with a letter, which is constant throughout this document.

This project was developed due to the serious health and environmental problems that are associated with the solvents used in dry cleaning. A graph of the distribution of the solvents used in Costa Rica can be seen in Figure 5. Petroleum-based solvents, which are used in eight out of eleven of the dry cleaning establishments in Costa Rica, deplete the ability of the central nervous system and cause vomiting and diarrhea. These solvents also kill aquatic life and accumulate in soil and plants. Three out of the eleven dry cleaners that we spoke with use perchloroethylene (perc). This solvent also causes problems with the central nervous system and is a suspected carcinogen. Perc is heavier than water, which causes it to sink and kill all of the plant life at the bottom of a body of water. The solvent also evaporates easily during the dry cleaning process and the vapors deplete the ozone layer. A more detailed discussion of the hazards of these chemicals can be found in Chapter 2.

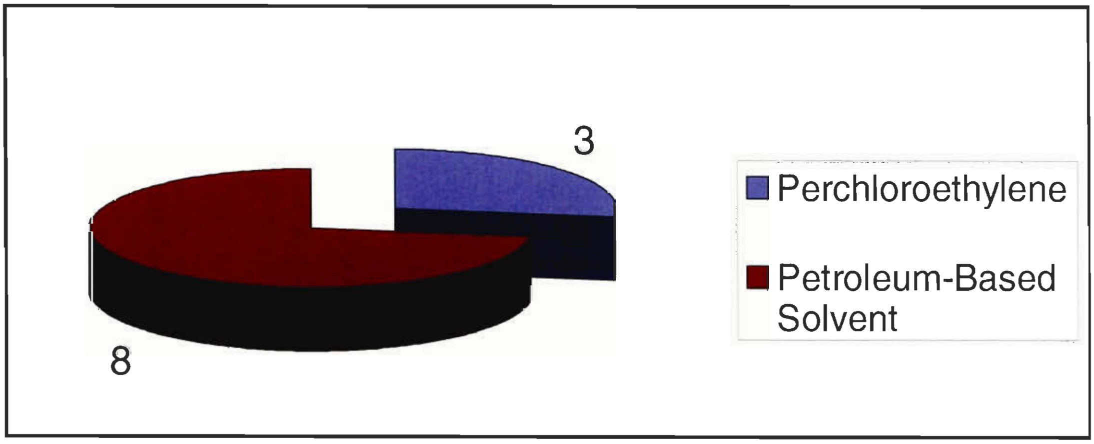

Figure 5: Distribution Graph of the Chemicals used by Costa Rican Dry Cleaners

The hazardous effects of the chemicals associated with the dry cleaning industry have caused countries such as the United States, Japan, and Mexico to create laws that regulate the chemicals used in dry cleaning. Laws from the United States are discussed in Chapter 2. In Japan, petroleum-based solvents are the major chemicals used. Recently, the number of locations that use petroleum-based solvents has increased and the number of locations that use perchloroethylene has decreased (http://www.zenkuren.or.jp/english/cij.html). This is most likely because there are more regulations that are associated with perc than there are with petroleum-based solvents (http://www.zenkuren.or.jp/english/cij.html). Japan is also increasing its number of receiving shops, which only serve as a place to drop-off soiled garments and pick-up cleaned garments, and is decreasing the number of treatment facilities (http://www.zenkuren.or.jp/english/cij.html). This limits the number of locations where a solvent spill or fire could occur. Mexico has created laws and regulations similar to those of the United States; however, the country has difficulty enforcing the regulations. Because of this, many United States dry cleaners have moved to Mexico where they can run their establishments without worrying about regulations. This has caused many problems with United States and Mexican relations (http://gurukul.ucc.american.edu/ted/CLEANER.htm).

Certain groups in Costa Rica, such as the Centro Nacional de Producción más Limpia (CNP+L) and local dry cleaners, have also shown a concern about the solvents used in dry cleaning. The owner of Dry Cleaner C (personal communication, May 22, 2003) explained that a large increase in the number of dry cleaning facilities in Costa Rica occurred five years ago. Before this time, the dry cleaning industry was mostly composed of the three dry cleaning chains: Margarita, Sixaola, and Martinizing. This increase in dry cleaning also brought about an increase in concern. According to Floría Roa, head of the Chemistry Department at the Instituto Technológico de Costa Rica (personal communication May 28th 2003), her department acknowledges that there is a problem with the dry cleaning industry. The institution is currently studying alternative methods for dry cleaning that are less hazardous, while also being affordable. The chemical that they are now focusing on is ether (See Glossary), which works in a similar way as perchloroethylene, but is not as toxic. Ether reacts with the fibers of the garments to remove the grease and then evaporates (Personal Communication with Floría Roa, May 28th, 2003).

Our team began investigating the dry cleaning problems in Costa Rica by contacting the Ministry of Health in order to acquire a list of registered dry cleaning establishments; however, the Ministry did not possess a list and explained that the dry cleaning establishments are located in the yellow pages of the San José phonebook. The exact numbers of dry cleaners that we contacted can be found in Chapter 3 and a chart of the dry cleaners that we contacted can be found in Appendix I.

Our interviews revealed that the chemicals that are used in the dry cleaning industry in San José include petroleum-based solvents, perchloroethylene (perc), Hi-flo dust, soaps, and spotters. Except for perchloroethylene, all of these chemicals can be purchased locally. Many of the chemicals come from the local companies: Barson and Hi-flo. Perchloroethylene is imported from either the Netherlands or from the United States. A typical dry cleaning establishment will spend between 1.185.000 and 3.950.000 colones, or $3,000 and $10,000, a year on petroleum-based solvents. The most commonly used petroleum-based solvents in Costa Rica are

Exxsol D40 and Varsol, which are used at eight out of eleven of the dry cleaning establishments that we interviewed. A fifty-two gallon drum of Exxsol D40 costs 70,000 colones, or approximately $175. According to Dry Cleaner D, their shop uses between fifty-two and seventy drums of solvent each year, which cleans approximately 40,000 pieces of clothing (Dry Cleaner D, Personal Communication, June 11, 2003).

According to our interviews, the reason that petroleum-based solvents are the most commonly used solvent in Costa Rica is because they are available locally. Perchloroethylene needs to be imported, which can be quite costly and can cause problems at customs. One dry cleaner that uses perc spends approximately ¢7.900.000, or $20,000, annually on his chemicals, which are imported from Italy (Dry Cleaner A, Personal Communication, June 13, 2003). Another reason why it is beneficial to use locally manufactured chemicals is because they can arrive within a day. This is helpful in the event that the solvent runs out and more is needed immediately.

A significant problem with the chemicals used in Costa Rica, according to one dry cleaning chain, is that there is very poor quality control at the companies that produce the chemicals (Dry Cleaner C, Personal Communication, May 22, 2003). This lack of control causes variations in the composition of chemicals used in the dry cleaning process. The typical dry cleaner always orders the same chemicals; however, occasionally the chemicals will have a stronger odor and will be greasier because of the differences in composition. If a chemical is too greasy, the time needed to clean the clothes increases. The increase in the time of the dry cleaning process decreases the quality of the cleaning and the efficiency of the dry cleaning establishment.

In an interview with Floría Roa, we learned that there are three negative characteristics associated with halogenated solvents, such as perchloroethylene (See Glossary). The problems that are associated with these solvents are that they are heavier than water, they are not detected by mucus membranes in the throat, and that they are suspected carcinogens. When a halogenated solvent enters a water source, the solvent sinks to the bottom of the water and kills the plant life. Mucus membranes in the throat do not detect halogenated solvents that are present in the air. This prevents a person from coughing when the chemical is inhaled and allows the chemical to begin to accumulate in a person's lungs.

Although there are many medical problems that are associated with dry cleaning solvents, four out of the seven dry cleaners interviewed claimed that no workers have experienced medical problems from working with the chemicals; however, it can not be certain that employees have not experienced the long-term effects of the solvents that are explained in Chapter 2 of this document. The remaining three dry cleaning establishments have had employees occasionally experience mild symptoms. Of these three dry cleaners, two of them have considered changing their methods. However, none of the four dry cleaners who have not experienced any medical problems have considered an alternative to dry cleaning. Our interviews revealed that the alternatives that the dry cleaners are considering are perchloroethylene and wet cleaning. The reason that the dry cleaners have not changed their methods as of now is because it is too expensive to change, especially with the current economy (Dry

Cleaner C, Personal Communication, May 22, 2003 and Dry Cleaner B, Personal Communication, June 11, 2003).

The machinery that the dry cleaners currently use to do their cleaning varies between each location; however, all dry cleaning machines used by our sample were imported from other countries such as the United States, Italy, and Germany. Figure 6 displays the distribution of the machinery in Costa Rica.

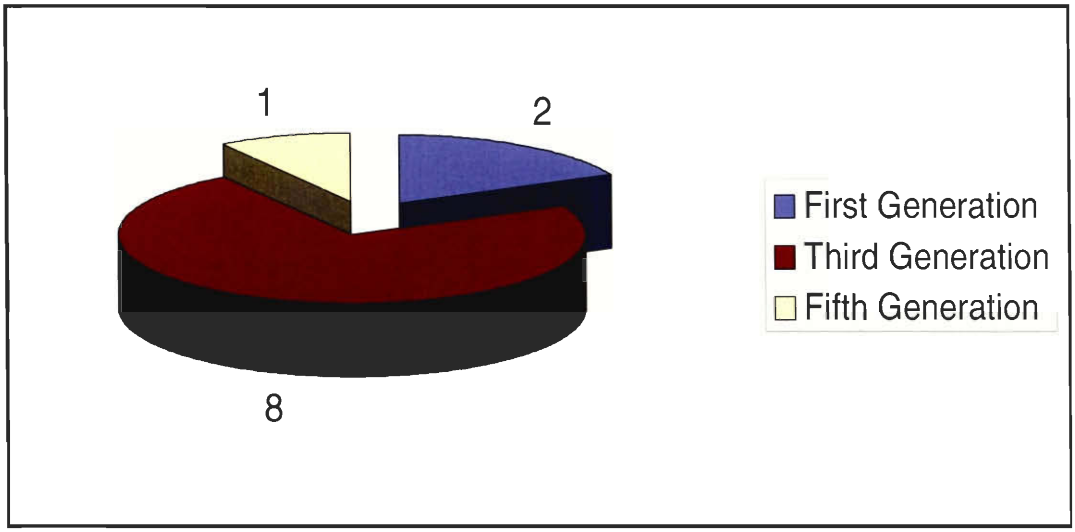

Figure 6: Distribution of the Generations of Machinery in Dry Cleaning Establishments in Costa Rica

Two of the eleven dry cleaning establishments interviewed use transfer machines, eight use third generation dry-to-dry machines, and one of the dry cleaners that were interviewed claimed to use fifth generation machinery (See Glossary). Six of the eight dry cleaners with third generation machines used petroleum-based solvents, and the other two use perchloroethylene. The third generation machines contain a refrigerated condenser (See Glossary), which allows limited amounts of the solvent to be recycled. The transfer machines, also known as first generation machines (See Machinery), have a separate washer and dryer. A full explanation of the generations of machinery is included in Chapter 2.

A majority of the machines used in San José are at least thirty years old. Figure 7 displays the distribution of the age of the machinery.

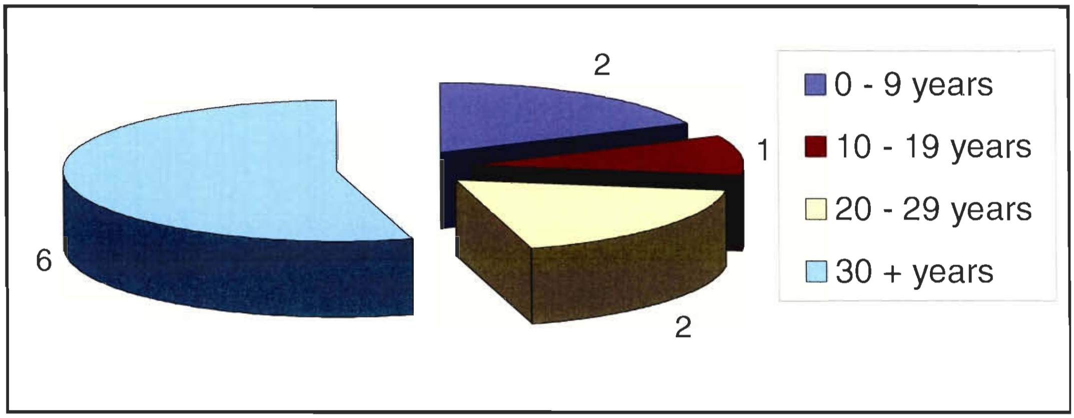

Figure 7: Distribution of the Age of the Machinery in the Dry Cleaning Establishments of Costa Rica

The old age of the machinery, along with the lower generation models of machinery, creates an excess of problems in the dry cleaning industry in Costa Rica. The transfer machines require the user to physically move the clothing from one machine to another while the clothing is soaked in the toxic solvent. Although the third generation machines are less hazardous to the worker and the environment, they still release a large amount of toxic fumes. One hundred percent of the machinery that we observed leaked some kind of fluid, an example of which can be seen in Figure 8. All of these problems make it crucial for dry cleaners to learn about new dry cleaning alternatives and techniques to clean up their current practices. Also, the dry cleaners with older machinery were more receptive to the idea of purchasing new machines for different alternatives to dry cleaning.

Figure 8: A Leaking First Generation Dry Cleaning Machine

There is a large amount of maintenance that must be done on the dry cleaning machinery in Costa Rica in order to keep them running safely and effectively because of the old age of the machinery and the humid climate of Costa Rica. Dry cleaning machine maintenance includes cleaning the lint traps at least once a week, as well as immediately following an exceptionally dirty load. Once a year, all electrical components of dry cleaning machines are checked because of the humid climate of Costa Rica, which increases the likelihood that the components will fail. The oil used for lubrication within the machine is also changed on a yearly basis. Because the machinery is old and requires a large amount of maintenance, one dry cleaner claimed that he will need new machinery and may look for a safer and more environmental model (Dry Cleaner C, Personal Communication, May 22, 2003).

Since the currently used machinery and solvents are hazardous, many safety procedures must be followed. Because petroleum-based solvents have a low flashpoint (See Glossary), they explode easily. For this reason, many dry cleaners take precautions that would lessen the impact of a possible explosion. One dry cleaner holds only enough solvent for one week's worth of cleaning. Since Costa Rica is a small country, it is possible for chemicals to be delivered to a dry cleaning establishment in one day. All of the other dry cleaners that we spoke with were not concerned with the risk of fires or spills because they have not yet experienced either.

In an interview with the Bomberos, who are explained in Chapter 3, we learned that they believe that a major reason that there are no fires at dry cleaning establishments is because the dry cleaning machines are required to have an automatic stop button (Personal Communication with Alvaro Sanchez, June 5, 2003). However, four out of six of the dry cleaners that we interviewed did not have this mechanism on their machinery, although many of the dry cleaners had fire extinguishers that had recently been inspected. We did not specifically ask the dry cleaners about fire extinguishers, but we observed them at each location.

All of the problems that are associated with the chemicals used in dry cleaning have led dry cleaners to take special precautions with the fumes of the chemicals. One hundred percent of the dry cleaning facilities that we interviewed have some sort of a ventilation system. However, not all of the dry cleaners are concerned about the gases of the solvents that are produced during the dry cleaning process. Only one out of the seven dry cleaners that we interviewed was concerned with the fumes associated with the chemicals and one dry cleaner explained that he did not worry because "the fumes are not toxic" (Dry Cleaner F, Personal Communication, June 11, 2003). Also, the ventilation systems often consisted of windows covered with chain link fencing with no fans in the establishments to blow the chemicals outside. A picture of the typical ventilation system that was seen during our interviews is displayed in Figure 9. In the dry cleaning establishment where this photo was taken, there were windows, such as the one shown, all around the room that the dry cleaning machines were located int. However, there was a strong chemical odor, which we also observed in a majority of the dry cleaning establishments that we visited. This indicates that the ventilation systems were not sufficient. These facts led us to believe that the dry cleaners that we interviewed do not know the damaging effects of the chemicals that they use.

Figure 9: Typical Ventilation System in a Dry Cleaning Establishment in San José

Another indication that the dry cleaners were not concerned or were unaware of the toxic effects associated with the chemicals was the manner in which they stored the chemicals. In one dry cleaning establishment, we observed both a chemical drum laying on its side and another being used as a table for a coffee pot. In Figure 10, a drum of perchloroethylene is used as a table for a water jug. This is especially ironic because the toxic label is clearly visible. Also, a major way of lessening the effects of toxic substances in the workplace is to avoid drinking, eating, and smoking during work. However, the presence of the coffee pot and the water jug shown in Figure 10 demonstrate the lack of knowledge that the dry cleaners have about the toxic chemicals that they work with.

Figure 10: A Drum of Perchloroethylene being used as a Table for a Water Jug

The dry cleaners also revealed a lack of knowledge when it came to disposing of chemicals. Five out of the seven dry cleaners that we spoke with claim that there is no waste product from dry cleaning because the solvent that is not recycled evaporates. One dry cleaner did report that his dry cleaning establishment, which uses Exxsol D40, disposes of spent solvent in the sewage system. This practice is directly against the recommendation of the International Occupational Safety and Health Information Center (CIS), which says that Exxsol D40 should never be put into the sewage system (ICSC 1380). In Costa Rica, there is currently no alternative method of disposing dry cleaning chemicals. Although a majority of the dry cleaners interviewed claim that their machines recycle the solvent, four out of seven dry cleaners said that they would be interested in an alternative recycling method. Two of the seven dry cleaners we posed this question to responded that they already recycle their chemicals in the most efficient way available. Figure 11 depicts the distribution of the dry cleaners' interest in recycling.

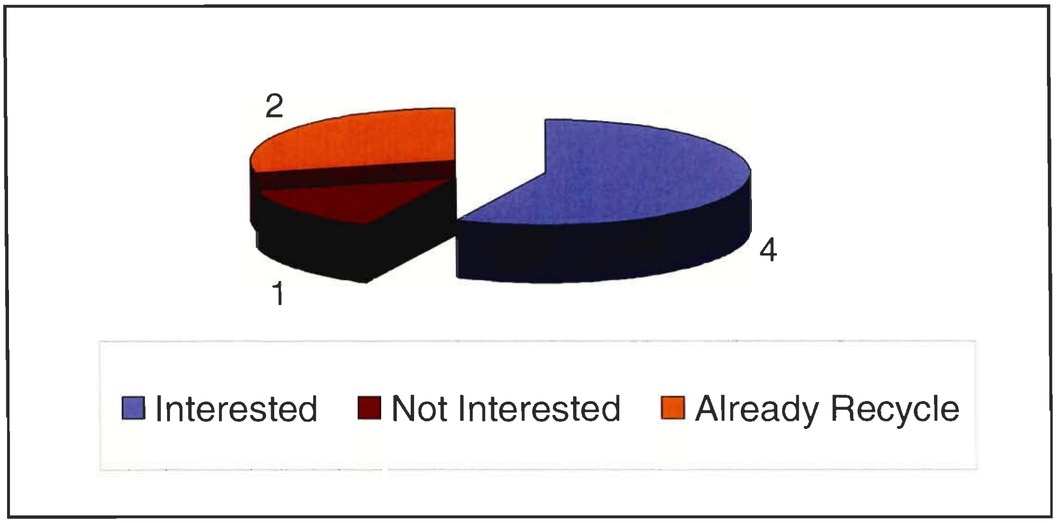

Figure 11: Distribution of Dry Cleaner Interest in Recycling

Both perchloroethylene and petroleum-based solvents are recyclable. The spent solvent from dry cleaners can be recycled in three different ways. The three types of solvent recycling are toll recycling, speculative recycling, or recycling through the use of a waste broker. If a company chooses to use toll recycling, their chemicals are taken away, recycled, and then returned to them. If a company does not wish to receive their chemicals back then they can use speculative recycling. In this process, the chemicals are taken away and then the recycling company sells the recycled chemicals. In the event that the chemicals can be resold at a high value, the recycling company will pay for the waste. Otherwise, the price to recycle the chemicals is determined by the price at which the chemicals are selling. Waste brokers, on the other hand, try and match the waste generated with a potential user of that waste (http://www.westp2net.org/facts/michfs14.htm).

From Dave Weber, Recycling Supervisor at Chemical Solvents, Inc. (personal communication, June 12th 2003), we learned that petroleum-based solvents are recycled using a process called thin film evaporation. These solvents can also be recycled using a distillation process. The price to have the chemicals recycled and returned ranges from $2.25 to $2.50 per gallon, or approximately 900 to 1.000 colones, depending on the evaporation and the recovery rate. The machines used for recycling are called Luwas and are manufactured in Germany. They range in price from $250,000 to $750,000, depending on the size, which converts to an approximate range of 100 to 300 million colones.

During the thin film evaporation recycling process, the spent solvent is heated. Once the solvent reaches its flash point (See Glossary), it flashes off. The vapors go to a separator and then the vapors are cooled and the recycled solvent condenses. The heavier waste sinks to the bottom of the spent solvent and is collected in a sludge pump.

The waste from the recycling process can be used in a variety of industries. The waste that is collected in the sludge pump can be used as an alternate fuel for boiler industrial furnaces, which are also known as kilns. The waste may be used as an additive to help make concrete. The waste can be added to cement in a kiln and because it has a lower heating point, it can increase the heat of the cement making process. The waste heats the slurry that is used to make clinker (See Glossary) which is then ground up into cement. Spent (See Glossary) petroleum-based solvent can also be used to thin black top and tar to make it easier to spread.

The only difference between recycled solvents and fresh solvent is that a recycled solvent has slightly higher moisture content. This difference will have no effect on the cleaning abilities of the solvent. A way to overcome the moisture content difference is to add fresh solvent to recycled solvent. Seventy percent of the recycled solvent is reusable in the cleaning process.

Another alternative process for reducing the hazardous waste associated with dry cleaning is through incineration. Chemicals that are considered to be hazardous waste can be incinerated and used for energy in kilns. The use of incineration destroys almost all organic waste toxicity and also reduces the volume of waste by ninety percent. The three by-products of incineration are gases, water, and ash. The gases are cleaned by air pollution control devices and then released to the atmosphere. The water is used in the air pollution control devices and then treated at a wastewater facility. The remaining ash is placed in a regulated landfill. The cost of incineration is roughly $500, or ¢200.000 per ton. Incineration, when used with air pollution control devices, is an environmentally sound way to dispose of and destroy hazardous wastes (http://www.crwi.org/textfiles/dow.htm).

Chapter 5: Conclusion and Recommendation

The goal of our project was to recommend the best economically attractive technology (BEAT) that the dry cleaning industry should implement. Part of our goal was to also reduce or eliminate the solvents that are disposed of in a manner that is harmful to the people of Costa Rica and the environment. After conducting interviews with the dry cleaners in Costa Rica, researching the dry cleaning process, and investigating the hazards that are related to dry cleaning, we have determined that many steps must be taken in order to fulfill our overall goal. This chapter includes recommendations that explain techniques that must be taken in order implement a new alternative to the currently used dry cleaning process that is less hazardous to humans and the environment. Other recommendations are made that follow conclusions that we have made about our original objectives. Smaller recommendations are also made for dry cleaners that are interested in cleaner production. This chapter also makes recommendations directed towards the Government of Costa Rica that explain the necessity of establishing laws that pertain to the dry cleaning industry.

Our first objective was to determine the effects of dry cleaning solvents on the people and the environment of Costa Rica and increase dry cleaners' awareness of the harmful effects of improper practices. We have concluded that, from our research, there are no facts or studies done in Costa Rica that deal specifically with the dry cleaning industry. This is because, according to representatives at the Ministry of Health, they are unaware of the hazards involved with the dry cleaning process.

We recommend that steps be taken in order to raise awareness of the problems associated with dry cleaning. The steps that we recommend be taken are: 1) distribute a pamphlet to dry cleaning establishments and local residents about the dangers of dry cleaning and 2) invite the Ministry of Health to our final presentation about the hazards associated with dry cleaning; however, if they do not attend we will give them a copy of our report to review. According to representatives of the Ministry of Health, if they knew that dry cleaning solvents were toxic, they would establish regulations for the industry. As of right now, they do not believe that there are any dangers related to the solvents used in dry cleaning. For more information about our pamphlets, see Chapter 3.

Our second objective was to investigate the current health and safety practices that are followed in the Costa Rican dry cleaning establishments. Our interviews allowed us to conclude that limited health and safety practices are followed because, once again, the dry cleaners are unaware of the serious dangers of the solvents that they use. Once the dry cleaners are aware of the problem, there are many steps that they can take that will increase the health and safety practices that we researched in order to fulfill objective two.

We recommend that dry cleaning establishments acquire a copy of the fire safety code* from the Bomberos, who are explained in Chapter 3, that is

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* NFPA 32 Standard for Dry Cleaning plants. National Fire protection Agency. c1996

currently used in Costa Rica. This document should be reviewed and areas that are not up to code should be immediately fixed. We also recommend that the dry cleaners become aware of and adopt different pollution prevention techniques, some of which appear in the pamphlets, and a complete list of them is located in Appendix D.

Our third objective was to examine different alternatives to the current dry cleaning practices in order to determine the best alternatives for Costa Rica. In regards to this objective and to our overall goal of determining the BEAT, we have concluded that the GreenEarth Solution is the best alternative for Costa Rica. This process is described in detail in Chapter 2.

We recommend that the following steps are taken to ensure a smooth and financially possible change: 1) when machinery needs to be replaced, they are replaced by GreenEarth machines, 2) dry cleaners' only purchase one GreenEarth machine and use an old machine for backup, and 3) once dry cleaners are financially set, they buy a wet cleaning or liquid carbon dioxide machine to replace the old one for backup.

The reason that we believe dry cleaners should wait until their machines need to be replaced and why they should only buy one new machine is because the GreenEarth Solution is not able to clean all laundry. The solvent has difficulties with heavily soiled clothes. If a dry cleaner keeps an old machine on site, he will be able to use the old method for heavily soiled clothes instead of having to refer a customer to a different dry cleaner that has not adopted a safer alternative. By using the old technique for backup only, the hazards associated with the old solvent will be cut down greatly. Ideally, step three will be reached, where the backup method is either the safe method of wet cleaning or liquid carbon dioxide, which are described in Chapter 2.

Our fourth objective was to develop a plan that would persuade dry cleaners of Costa Rica to adopt safe disposal methods of chemicals. Because the dry cleaners of Costa Rica do not have much knowledge in regards to the disposal of solid waste, we concluded that the best plan for the dry cleaners would simply begin with, once again, raising their awareness.

We recommend, once again, that pamphlets be distributed to the dry cleaners. The dry cleaners that we interviewed showed an interest in switching to techniques that are safer for the environment and humans. They also showed an interest in recycling. By increasing their awareness of the different hazards associated with dry cleaning and by informing them of techniques that would lessen the hazardous effects, dry cleaners will be more likely to initiate changes.

The second part of our goal was to reduce or eliminate the solvents that are disposed of in a manner that is harmful to the people of Costa Rica and the environment. Our team has concluded that the current method used for the disposal of hazardous waste is not safe.

We recommend that dry cleaners immediately begin to incinerate their spent solvent. The chemicals can be shipped to a local cement company and used in their kilns. With this process the chemicals could easily be collected at the dry cleaning establishments and driven to the plant for incineration. More information on incineration can be found in Chapter 4.

We recommend the creation of a recycling plant as a long-term solution to the problem of hazardous waste disposal. Currently, there are no recycling facilities for the solvents used in dry cleaning in Central America. If a facility was developed at a central location with the cooperation of the governments of Central American countries, the spent solvents from all dry cleaning establishments can be recycled. Since petroleum-based solvents are also used in other cleaning processes, such as degreasing automobile parts, other industries can benefit from having a central recycling location. Through the use of joint organizations, such as Costa Rica – United States of America Fundación para la Cooperación (CR-USA), old recycling equipment that is being replaced in the United States could possibly be purchased, at a lower price than new equipment, and put to use in Central America.

The creation of a central recycling facility would have many benefits for the countries of Central America. The chemicals could be collected at a cheap cost to the dry cleaners, recycled, and sold for a profit for the recycling company. The waste product could be used, as previously mentioned, for fuel in kilns. The waste can also be used for the making of cement and the thinning of tar and black top. Also, the opening of a chemical recycling plant would create more jobs for local citizens. Another benefit of a recycling plant is the reduction of hazardous solvents in the wastewater system. This can lower the cost of municipal water treatment. More information on recycling is located in Chapter 4.

The idea of a central recycling plant has worked in the past, which makes it even more likely that this recommendation could be implemented. In the United States, there are only two recycling plants for petroleum-based solvents. Every state must share these facilities. Also, in Central America, there is already another type of recycling plant that follows this same idea. There are only two locations in Central America where car batteries are recycled. All of these countries in Central America must ship their old car batteries to these two locations.

We recommend reducing the number of shops that have machinery on site as another way to lower the hazardous wastes produced by dry cleaners. Over fifty percent of the dry cleaning establishments in Costa Rica belong to the chains of Sixaola and Martinizing. We recommend that these two companies take the leading steps in lowering hazardous conditions. These chains should move their machines to one central location and have the remaining locations be drop-off sites. This would greatly benefit the customer by lowering their exposure to toxic fumes and increasing the convenience of having a shop nearby. It is also beneficial to the dry cleaner because the chemicals and machinery are in one central location, which makes deliveries and maintenance easier. Fewer dry cleaning establishments with machinery on site decrease the chance of leaks, fires, or the release of hazardous fumes to the local environment and citizens.

We recommend that the citizens of Costa Rica buy clothes made of fabric that does not require dry cleaning whenever possible as another technique that will lower the amount of hazardous waste produced. This will cut down on the amount of dry cleaning needed, which cuts down on the amount of hazardous chemicals used.

The option of buying clothes that do not need to be dry cleaned is already becoming more popular as dress in the work place becomes more casual (USEPA 1995).

We recommend that the citizens of Costa Rica show support for cleaner dry cleaning processes, in order for dry cleaners to take the need for changes seriously. We recommend that citizens ask local dry cleaners what steps and precautions they are taking toward lowering the hazards associated with dry cleaning. Citizens should also show their support for safer practices by frequenting dry cleaning establishments that have adopted safer dry cleaning processes.

In order for our goals, objectives, and recommendations to take effect in Costa Rica, we have concluded that it is crucial to gain the support of the Government of Costa Rica. If they view the current dry cleaning process as a problem, they would be able to partake in the creation of a better solution for the industry.

We recommend that the government begin to research the hazards associated with dry cleaning and develop studies that will show occupational hazards in the dry cleaning industry. The government could then use these studies to establish laws that would regulate the dry cleaning industry.

We recommend that the government immediately begin to inspect the individual dry cleaning establishments and make sure that they are up to date with the current fire code. In the event that a dry cleaning shop was not up to code, they could be given a time frame to make the necessary changes.

We recommend that the government begin making laws that regulate the disposal methods and the types of machines that are being used in dry cleaning. It would be important to regularly inspect the dry cleaning shops and make sure that they are abiding by the rules that have been set forth.

We recommend that the government utilize organizations that have been set up with other countries, similar to the previously mentioned CR-USA. Since many other countries are currently researching alternatives to the dry cleaning process, it would be beneficial for Costa Rica to either help with the research on the hazards of dry cleaning or to learn about the different alternatives that are being developed. It would also be beneficial to learn more about the different laws and regulations that other countries have implemented that effect the dry cleaning industry. This knowledge can be used as a stepping-stone to start making the dry cleaning industry a safer industry for everyone. For examples of laws that the United States have made, see Chapter 2. Brief descriptions of laws in Japan and Mexico are found in Chapter 4.

Overall, it is important that the people of Costa Rica become aware of the hazards associated with dry cleaning. Dry cleaners must begin updating their establishments with the correct criteria listed in the fire safety code, they need to start incinerating spent solvent, follow various pollution prevention techniques, and begin investing in the GreenEarth Solution.

The Government must begin to support the changes that are necessary for the dry cleaning establishments to become safe for humans and the environment. They can do this by helping to fund a recycling plant, utilizing other organizations to find out what changes can and should be made, and developing laws and regulations for the dry cleaning industry, along with regularly inspecting the establishments to be certain that regulations are being followed.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxological profile for Stoddard Solvent. Atlanta, GA. U.S. Department of Health and Human Services, Public Health Service.

Blackwood, S. N. Safe New Processes Result in "The Greener Cleaner". (2002, December 12). The Tennessean.

Blair, A., Petralia, S. A., & Stewart, P. A. (2003). Extended Mortality Follow-up of a Cohort of Dry Cleaners. Annals of Epidemiology, 13(1), 50-56.

Department of Health and Human Services, National Institute for Occupational Safety and Health. Control of Exposure to Perchloroethylene in Commercial Dry Cleaning (Machine Design). DHHS (NIOSH) Publication No. 97-156. Retrieved March 19, 2003 from the World Wide Web: http://www.cdc.gov/niosh/hc18.html

Department of Health and Human Services, National Institute for Occupational Safety and Health. Control of Exposure to Perchloroethylene in Commercial Dry Cleaning (Substitution). DHHS (NIOSH) Publication No. 97-155. Retrieved March 19, 2003 from the World Wide Web: http://www.cdc.gov/niosh/hc17.html

Department of Health and Human Services, National Institute for Occupational Safety and Health. Control of Exposure to Perchloroethylene in Commercial Dry Cleaning (Ventilation). DHHS (NIOSH) Publication No. 97-157. Retrieved March 19, 2003 from the World Wide Web: http://www.cdc.gov/niosh/hc19.html

Department of Health and Human Services, National Institute for Occupational Safety and Health. Control of Health and Safety Hazards in Commercial Drycleaners. DHHS(NIOSH) Publication No. 97-150. Retrieved April 7, 20003 from the World Wide Web: http://www.cdc.gov/niosh/97-150.html

Dry Cleaning Chemical Exposure Increase Risk of Some Cancers. American Journal of Industrial Medicine, 2001. 39:121-132.

Environmental Finance Center Region IX. (2000). Pocket Guide to Bay Area Professional Wet Cleaners. Retrieved March 20, 2003, from the World Wide Web: http://www.greenstart.org/efc9/publications/pdf/wetguide/wg_pgsintro_8.PDF

Hwang, I. & Batchelor, B. (2001). Reductive Dechlorination of Tetrachloroethylene in Soils by Fe(II)-Based Degradative Solidification/Stabilization. Environmental Science Technology, 35, 3792-3797.

Hydrogen Release Compound (HRC); Low Cost, Environmental Clean up of Dry Cleaning Facilities. (2003). Regenesis [Brochure].

International Chemical Safety Cards 0361 (ICSC 0361). International Occupational Safety And Health Information Centre (07/05/2001). Retrieved March 31st, 2003 from the World Wide Web: http://www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/_icsc

International Chemical Safety Cards 1380 (ICSC 1380). International Occupational Safety And Health Information Centre (07/05/2001). Retrieved May 16th, 2003 from the World Wide Web: http://www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/_icsc13/icsc1380.htm

Kennedy, L. Time to Clean up its Act. (2001, October 22). The Middletown Press, pp. B1, B4.

Ohio Environmental Protection Agency. 1993. (Ohio EPA, 1993). Managing and Reducing Hazardous Wastes from Dry Cleaning. Office of Pollution Prevention, Ohio Environmental Protection Agency. August.

Oxygen Release Compound (ORC) a Cost-Effective Remediation Strategy. (2003). Regenesis [Information Packet]. Obtained from the mail: April 1st, 2003.

SRRP. 1990. Source Reduction and Recycling of Halogenated Solvents in the Dry Cleaning Industry-Technical Support Document.

Stricoff, R.S. Control of Occupational Health Hazards in the Dry Cleaning Industry. U.S. Department of Health and Human Services. December 1983

U.S. Environmental Protection Agency. 1991a. (USEPA, 1991a). Dry Cleaning Facilities- Background Information for Proposed Facilities. Draft EIS. EPA-450/3-91-020a. Office of Air Quality, Planning and Standards, U.S. Environmental Protection Agency. November.

U.S. Environmental Protection Agency. 1991b. (USEPA, 1991b). Economic impact analysis of regulatory controls in the dry cleaning industry. Final. EPA-450/3-91-021. Office of Air Quality, Planning Standards, U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 1993a. Economic Analysis of Regulatory Controls in the Dry Cleaning Industry. Final. EPA 450/3-91-021b. September

U.S. Environmental Protection Agency. 1995. (USEPA, 1995). EPA Office of Compliance Sector Notebook Project- Profile of the Dry Cleaning Industry.

EPA/310-R-95-001. Office of Compliance, U.S. Environmental Protection Agency

Vaughan, T. L., Stewart, P. A., Davis, S., & Thomas, D. B. (1997). Work in dry cleaning and the incidence of cancer of the oral cavity, larynx, and esophagus. Occup. Environ. Med., *54*(9), 692-695.

Wolf, Katy, 1992. Case Study: Pollution Prevention in the Dry Cleaning Industry: A Small Business Challenge for the 1990s. Pollution Prevention Review, Summer.

Yoshioka, T., Krauser, J. A., & Guengerich, F. P. (2002). Tetrachloroethylene Oxide: Hydrolytic Products and Reactions with Phosphate and Lysine. Chem. Res. Toxicol., *15,* 1096-1105.

Appendix A

El Centro Nacional de Producción más Limpia

The Centro Nacional de Producción más Limpia (CNP+L) was created in 1994 by the Organización de Naciones Unidas para el Desarrollo Industrial (ONUDI) and the Programa de Naciones Unidas para el Medio Ambiente (PNUMA). CNP+L is one of twenty-nine National Cleaner Production Centers (NCPCs) located around the world. The mission of CNP+L is to work towards creating cleaner production, eco-efficiency, and pollution prevention in Costa Rica. Carlos Perera Heinrich, Technical Director of CNP+L (personal communication, May 19, 2003), explained that in December of 1993, the company was established in Costa Rica with the help of the Cámera de Industrias de Costa Rica (CICR), the Instituto Technológico de Costa Rica (ITCR), and the Centre for Technological Management (CEGESTI). Those three organizations requested the support of the United Nations Environmental Program (UNEP) in order to establish a program that could become a member of the ONUDI-UNEP international network of National Cleaner Production Centers. Costa Rica was able to establish a center in their country with the financial support of the Swiss Government through the State of Secretariat for Economic Affairs (SECO).

The Swiss government funds twelve National Cleaner Production Centers around the world in order to promote sustainable development. Sergio Musmanni, Executive Director of CNP+L (personal communication, May 20, 2003), explained that the Swiss government specifically concentrates on promoting social, economic, and environmental aspects of sustainable industrial development. The Swiss government chooses to fund NCPCs for varying political reasons. The political reasons that led the Swiss government to choose Costa Rica as a worthy location of funding are that Costa Rica does not have an army, it emphasizes education, and it supports environmental issues.

The specific objective of CNP+L is to support and improve the performance of the industries in Costa Rica through the concept of cleaner production while obtaining economic and environmental benefits for the industries that CNP+L supports. Cleaner production includes increasing competition within an industry, raising profits, and promoting the environmental management of chemicals and other potentially harmful materials. Cleaner production is a preventative tactic that reduces the risks associated with harmful materials to humans and the environment. CNP+L endorses the efficient use of raw materials and encourages the reduction of hazardous wastes and toxic emissions. Cleaner production applies to commercial companies that manufacture goods or perform services that result in harmful products or by-products. Examples of such companies include textile production, cleaning services, and plastic production. CNP+L also supports the competitiveness and sustainability of national industries (www.cnpml.or.cr).

The Centro Nacional de Producción más Limpia is a private, non-profit organization that provides stakeholders with a variety of services. These services include training, in-plant assessments, information dissemination, policy advice, and technology transfer. The company is aimed towards small and medium sized enterprises, rather than large industries. (www.cnpml.or.cr). This is the practice of the NCPCs worldwide.

There are twenty-nine National Cleaner Production Centers in countries all around the world. These countries include El Salvador, India, Vietnam, and Peru. Of these locations, ten are independent and function autonomously from the United Nations (UN). According to Mr. Musmanni, NCPCs choose to become independent because it is much more efficient due to the lack of bureaucracy. The UN requires a large amount of financial paperwork to be completed, which slows the process of obtaining funding for various necessities. A benefit of remaining dependent on the United Nations is that it offers a network of centers and consultants; however, an independent country is still able to access the connections, as long as the country remains active in the network. The largest benefit of being supervised by the UN is that they offer financial support. Once a country has the ability to generate funds for themselves, they are able to become independent. The base in Costa Rica is planning on becoming independent within two years.

The National Cleaner Production Center in Costa Rica is currently funded by SECO through UNIDO. CNP+L has a total budget of $1,000,000 that must last from 1998 until 2003. Mr. Musmanni explained that in order to continue to receive funding from the United Nations, CNP+L must complete a number of monetary reports each year. The Costa Rica base has been saving money for the past five years in order to assist in their change to an independent center. The income that they have been saving and plan to continually generate is mainly the result of consulting. Other sources of income are from promoting and educating workers about the concept of cleaner production through training, holding seminars, advising on policies, and completing special projects that are developed by local institutions and the government.

The budget funds the three positions of executive director, technical director, and project official, which are the core employees of CNP+L. Along with these three main positions, approximately thirty consultants work on different projects that depend on their expertise. These projects include in-plant assessments of cleaner production, which help companies to understand what cleaner production is, as well as identify opportunities for improvement within the companies that the consultants work with. Recycling is also a common focus of projects that the consultants work on. The consultants work with private and public sectors in order to incorporate techniques that allow an increase in the efficiency of cleaner production (www.cnpml.or.cr). Figure 12 shows an organization chart of the employees of CNP+L.

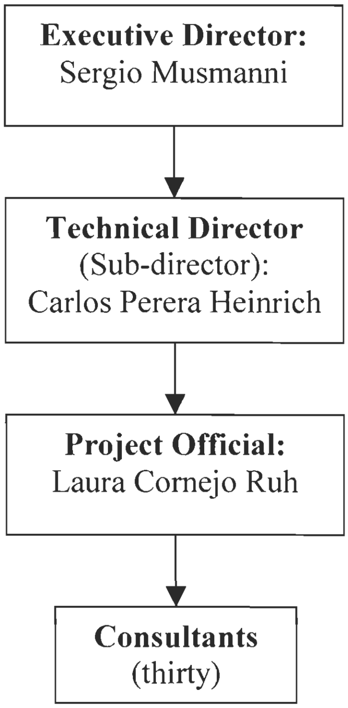


Figure 12: CNP+L Organizational Chart (Source: Personal Communication with Sergio Musmanni, May 20, 2003)

Appendix B

Glossary of Terms

Acetogens – Organisms that make all the organic molecules they require to survive using hydrogen gas for energy and carbon from carbon dioxide to build organic molecules

Adnenosine triphosphate (ATP) – Major carrier of chemical energy in organisms

Aeration – the supplying of air

Air sparging – a remedial technology that injects clean air into the conteminated soil. This results in a phase change of hydrocarbons from a dissolved state to a vapor state. The vapor is then vented

Alicyclic hydrocarbons - any aliphatic compound that contains a ring of carbons atoms

Aliphatic hydrocarbons - a major class of organic compounds where carbon and hydrogen molecules are arranged in straight or branched chains

Aromatic hydrocarbons – compounds that have at least one six membered carbon ring

Bronchitis - inflammation of mucous membranes of the two main branches from the trachea to the lungs, that provide passageway for air movement

Carbon adsorber – a filtering device used in dry cleaning machines that uses activated carbon to remove perchloroethylene vapors from the hot air that was used to dry the garments

Carbon cartridge – the unit which houses the carbon filter. carbon filter- carbon is used as a filtration device because it is extremely porous and it can be heated to increase its adsorptive properties

Cartridge filter – the replaceable filter that is placed into the carbon cartridge

Chemically inert – unreactive

Chlorinated intermediates - a compound that results during the degradation of the parent compound, that is not the final product of the degradation

Chloroform ($CHCl_3$) - a colorless volatile heavy toxic liquid used commonly as a solvent

Degradative solidification/stabilization technology (DS/S) – A specific process that removes chloride atoms from a chlorinated molecule

Dermatitis - inflammation of the skin evidenced by itching, redness and various skin lesions

Ether ($C_4H_{10}O$) - a light, volatile, flammable liquid used chiefly as a solvent

Fatty tissue (adipose tissue) – connective tissue that has been specialized to store fat

Fifth generation machine – The most recent generation of machine, used mainly in Germany. It incorporates a refrigerated condenser, carbon adsorber, and a monitor inside the machine drum that controls a lock mechanism on the door. The monitor reads the concentration of perchloroethylene and will unlock the door only when it is lower that three hundred parts per million

First generation machine – The original dry cleaning machine. A transfer machine, which has a separate washer and dryer. It was extemely dangerous, as the exposure was at a maximum due to actual transferral of solvernt soaked garments

Flash point - the lowest temperature at which vapors from a volatile combustible substance will ignite in air when exposed to flame

Fourth generation machine – A dry to dry machine with two types of recycling: a refrigerated condenser and a carbon adsorber

GreenEarth Solution – a non-toxic, silicon-based solvent used in dry cleaning

Halogenated solvents – chemical that are used for cleaning and have a molecule with a halogen atom attached. Such as fluorine, chlorine and iodine

Half-life - the time required for half the amount of a substance in an ecosystem to be eliminated by natural processes

Hepatocellular carcinomas - concerning cells of the liver, equivalent to liver cancer

Hydrocarbon - an organic compound containing only carbon and hydrogen

Hydrogen release compound (HRC) - a remediation technique that slowly releases hydrogen in order to aid in the degradation of chlorinated molecules

Hydrophobic stain – an oil based stain such as oil and grease

Indigenous anerobic microbes - microbes found in an oxygen free environment, they do not need oxygen

Ischemic heart disease - local and temporary deficiency of blood supply due to obstruction of the circulation to the part. Heart disease due to obstruction of circulation

Lactic acid ($C_3H_6O_3$) - a hygroscopic organic acid present normally in tissue, produced in carbohydrate matter usually by bacterial fermentation, and used especially in food and medicine and in industry

Laryngeal squamous cell carcinomas - flat, scaly, epithelial cell (epithelium is the layer of cells forming the epidermis of the skin and the surface layer of mucous and serous membranes). A type of cell found in this type of cancer of the larynx

Liquid carbon dioxide - non-toxic cleaning alternative that uses liquid carbon dioxide to remove stains

Localized steaming – emitting moisture in the form of vapor or mist in a confined or restricted area

Mediated reactions – chemical reactions that have an intermediate step

Microbes - organisms living on or in aquatic substrates and are too small to be seen with the naked eye

Narcosis - unconscious state due to narcotics

Necrosis - death of areas of tissue or bone surrounded by health parts

Non-polar – there exists no charge in the molecule

Non-refrigerated vapor recovery system – a device that is used to recycle solvents within a dry cleaning machine, the device does not require refrigeration for the solvent vapors to condense

Oesophageal squamous cell carcinomas - same as laryngeal squamous cell carcinomas except it is found in this type of oesophageal cancer

Oxygen release compound (ORC) – a substance used for the remediation of petroleum-based solvents, which slowly releases oxygen in order to aid the degradation of solvents

Perchloroethylene (perc) – a carbon-based compound that is often used as a dry cleaning solvent

Phytoplankton – minute, free-floating aquatic plants

Protein stains – stains such as grass and chocolate

Pure form – the cleaning solvents prior to use

Reductive dehalogenators – organisms that remove the halogens from a halogenated molecule

Refrigerated condenser – a vapor recovery system which uses refrigeration to recover solvents

Remediate – the process of cleaning up a site that has been contaminated with chemicals

Retrofitting – a process in which new components are added to a machine in order to make it more efficient

Second generation machine – The first generation of machine to incorporate the washer and the dryer in one machine. This dry to dry machine has no internal form of recycling

Serum transaminases - transanimase = an enzyme that catalyzes transamination (the transfer of an amino group from one compound to another or the transposition of an amino group within a single compound) serum transaminases are enzymes present in the blood. Tissue injury stimulates its release in the bloodstream and measurement of serum levels can indicate myocardial infarction (heart attack) or hepatic cell damage (liver damage)

Slurry - a watery mixture of insoluble matter

Spent form – the form of solvent after it has been used, but before it has been filtered or recycled

Spotting – the technique used to remove stains prior to washing the clothes in the machine. This technique utilizes special chemicals that are specified for different type of stains

Standardized Mortality Rate – the ratio of the number of deaths observed to the number of deaths expected. The number of expected deaths is determined according to national US averages for deaths for each disease, organized by age and gender

Still bottoms – the area in which the still residue is collected

Still residue – the solid waste that remains after the recycling of the solvent is complete

Stoddard solvent – a petroleum-based solvent that is used in dry cleaning, often known as Varsol

Third generation machine – A closed system dry to dry machine that first incorporated the use of a refrigetated condenser as a means to recycle solvent.

Trichloroethane – a molecule that is produced through the break down of perchloroethylene and depletes the ozone

Trichloroethylene – A by-product of perchloroethylene that is hazardous to the environment

Vapor containment –an area that is used to hold gas prior to condensation

Volatile - readily evaporates at environmental temperatures

Wet cleaning - a cleaning technique that uses a variation of soaps and water to clean garments

Zooplankton – plankton that consists of animals including corrals, rotifers, sea anemones and jellyfish. Plankton- the collection of small or microscopic organisms, including algae and protozoans, that float or drift in great numbers in fresh or salt water, especially at or near the surface, and serve as food for fish or other larger organisms

Appendix C

Interview Questions

1. What type/generation of machine do you use?
2. How old are the machines?
3. How long has the machine been in use in your shop?
4. Where did the machines come from? or Who are they manufactured by?
5. What kind of controls do you have on your machinery?
6. What maintenance have you performed on your equipment in the past year?
7. What chemicals do you use? Have you always used those chemicals?
8. Where did you buy the chemicals?
9. How much do you spend on chemicals?
10. How do you dispose of your chemicals?
11. Do you recycle your chemicals? About how much (percentage) do you recycle?
12. How do you dispose of the chemicals once they have been used?
13. What are your average yearly disposal costs?
14. How would you handle a chemical spill?
15. Do you have a ventilation system?
16. Are you concerned with the fumes associated with the chemicals you use?
17. Have you experienced any of the following condition when dealing with the machinery, garments, or chemicals: dizziness, nausea, headache, fatigue or runny nose?
18. What is your average volume of clothing that you clean per day?
19. How often do you have customer complaints about the cleaning service?
20. Have you had any problems with the quality of the chemicals used?
21. If there were a way to recycle the chemicals, would you use this process? How much would you pay to recycle the chemicals?
22. Have you considered changing to another method of dry cleaning in the future? To which method? Why haven't you changed already?
23. Do the machines have an automatic stop mechanism?
24. Is there an emergency drainage system in the room with the machines? Where do it drain to?
25. How often do you change the lint traps?

Preguntas de entrevista

1. ¿Qué tipo de máquina utiliza Usted? ¿Tiene un sistema de reciclar?
2. ¿Cuántos años tiene las máquinas?
3. ¿Cuánto tiempo tiene Usted estas máquinas?
4. ¿De dónde son las máquinas?
5. ¿Quién fabrica las máquinas?
6. ¿Qué tipo de controles tienen las máquinas? ¿Controles manuales o automáticos?
7. ¿Qué mantenimiento ha ejecutado en el año pasado?
8. ¿Qué tipo de químicos utiliza Usted? ¿Ha utilizado estos químicos siempre?
9. ¿Dónde compra los químicos?
10. ¿Cuánto colones gasta para los químicos cada año?
11. ¿Cómo se deshace de los químicos utilizados?
12. ¿Recicla Usted sus químicos? ¿Qué porcentaje de los químicos recicla Usted?
13. ¿Qué son sus costes de eliminación cada año?
14. ¿Cómo manejaría un derramando de químicos?
15. ¿Tiene un sistema de ventilación?
16. ¿Tiene preocupaciones con los gases de los químicos?
17. ¿Ha experimentado algún de los partidarios cuando tratando de la maquinaria, las prendas, o los químicos: vértigo, náuseas, dolor de cabeza, fatiga, o líquido que maquea?
18. ¿Cuál es el promedio del volumen de ropa que limpia cada día en piezas? ¿En kilos?
19. ¿Con qué frecuencia tiene quejas de clientes sobre el servicio de limpieza?
20. ¿Tiene problemas con la cualidad de los químicos que utiliza?
21. ¿Si era una manera para reciclar los químicos, utilizaría eso procedimiento? ¿Cuánto pagaría para reciclar los químicos?
22. ¿Ha considerado cambiar a otra manera de limpiar en seco en el futuro? ¿A qué manera? ¿Por qué no cambia todavía?
23. ¿Tienen las máquinas un mecanismo de parada automática?
24. En el cuarto donde están las máquinas, ¿hay un sistema de drenaje emergencia? Sí: ¿Adonde drena los químicos?
25. ¿Con qué frecuencia cambia los cedazos?

Appendix D

Pollution Prevention Techniques

The following list provides some information regarding pollution prevention techniques that can be used as a starting point for facilities interested in beginning their own pollution prevention projects (USEPA, 1995, pp38):

Improved Operating Practices- Specific to Transfer Machines

- Conduct transfer of solvent saturated clothes from washer to dryer as quickly as possible.
- Close dryer door immediately upon completion of transfer

Improved Operating Practices- All Machines

- Clean the filters that precede the carbon filters weekly.
- Clean the lint screens to avoid clogging fans and condensers.
- Open button traps and lint baskets only long enough to clean.
- Check baffle assembly in cleaning machine bi-weekly.
- Use closed containers for collection and storage of recovered or new solvent.

Equipment Maintenance

- Clean drying sensors weekly.
- Replace seals regularly on dryer deodorizer and aeration valves.
- Replace door gasket on button trap.
- Replace gaskets around cleaning machine door or tighten enclosure.
- Repair holes in air and exhaust duct.
- Secure hose connection and couplings.
- Clean lint buildup on cooling condenser coils weekly.

Equipment Modification

- Use a hamper enclosure or a room enclosure of impermeable construction to reduce solvent release during transfer. The enclosure should be a complete vapor barrier, especially if the dry cleaner is located in a mixed use residential setting.
- Use local exhaust ventilation through washer and dryer doors or exhaust hoods between washer and dryer. The exhaust velocity should be 100 feet per minute. In addition, a supplemental door fan local exhaust system should be included in third generation equipment. This should vent through a small carbon absorber designed to control PCE emission levels between 5-20 ppmv.
- Install general ventilation that changes the air every five minutes.
- Place dry cleaning equipment in separate room at negative pressure and operate a separate exhaust system to control the vapors.
- Place washer and dryer close together to minimize the solvent lose during transfer.

- Replace the cartridge filters with spin disk filters that can be cleaned without opening. This would produce fewer fugitive emissions and less hazardous waste.
- Install distillation equipment where the still bottoms can be removed without opening the still. This reduces fugitive emissions.
- Use carbon absorber that is regenerated with hot air stripping rather than steam stripping. This reduces the waste stream.
- Use double carbon waste water treatment devices to clean up PCE contaminated waste waters. Recycle the treated waste water to the process boiler.

Chemical Substitutions

- Alternative petroleum solvents are being developed with higher flash points to reduce fire hazard.
- Alternative petroleum solvents are being developed with lower Volatile Organic Compounds content (the drawback is longer drying time).
- Use wet cleaning processes.

Major Equipment Upgrades

- Add a refrigerated condenser to the machine for primary control, followed perhaps by a carbon absorber for secondary control.
- Replace a transfer machine with a dry-to-dry machine.
- Upgrade a dry-to-dry machine with additional control equipment such as a spill container that will catch and recycle solvent spills from the machine.
- Replace current machine with a dry-to-dry closed-loop-non-vented machine that contains an integral refrigerated condenser and an integral carbon absorber.

Appendix E

Ventilation

Local ventilation removes the vapor from the work area before the worker inhales it. It also minimizes the diffusion of perchloroethylene vapors throughout the shop. Internal and external ventilation are the two methods of local ventilation. Internal ventilation is built into the machine. Internal ventilation works by sucking air inward through the loading door and then venting the air to a point five feet over the roof. The rate at which the air must be sucked inward is at least one hundred feet per minute (DHHS (NIOSH) Publication No. 97-157). This prevents the vapors from reentering the shop or any adjacent buildings.

For machines without internal ventilation, a hood can be installed over the loading door to vent the vapors. This will draw the vapors up and away from where the worker breathes. The door area must be free of cross drafts in order for it to properly vent the vapors.

General ventilation, or dilution ventilation, works by supplying a continual supply of conditioned fresh air and removing the contaminated air from the work area. It will also provide temperature control and reduce the background levels of perchloroethylene in the entire shop. In order for general ventilation to be effective, the air in the workroom must change every five minutes. This process requires at least thirty cubic feet per minute of fresh air per person to be supplied to the room (DHHS (NIOSH) Publication No. 97-157). The system flows from the clean areas of offices and the front counter to the work area in order to prevent contamination of the clean areas. The exhaust moves the clean air through the work area and to the outside. Fresh air can enter through an open window or a fan in the ceiling or wall.

Emergency ventilation must be able to control the vapors in the event of a leak or spill of a solvent.

Appendix F

Pamphlets:

The pamphlets can be found in the back pocket of the cover of this docuent.

EL PROBLEMA

- Los solventes de lavado en seco son dañinos para los empleados y el medio ambiente
- Los solventes en base de petróleo son inflamables
- Los solventes usados son dispuestos en una manera impropia

LAS TÉCNICAS PARA REDUCIR LA EXPOSICIÓN DAÑINA

- Quite la bolsa plástica de la ropa inmediatamente
- Cuelgue la ropa por unos días para ventilarla antes de llevarla

- Si las cortinas son lavadas en seco, abra las ventanas o la puerta por 24 horas
- Lave sus manos después de manejar la ropa que acaba de ser lavada
- No huela la ropa que acaba de ser lavada
- Lleve su ropa de lavado en seco a tiendas que reciben en cambio de una tienda con la maquinaria para bajar su exposición a los solventes

PRODUCCION MAS LIMPIA: UNA TINTORERIA A LA VEZ

Un folleto para los clientes de las tintorerías

Creado por: Matthew Benvenuti
Katherine Labbe
Jessica Michaels

La Historia de Lavado en Seco

La historia de lavado en seco empezó con una leyenda, la cual dice que en Francia, al final del siglo diecinueve, alguien descubrió el lavado en seco cuando derramó aguarrás en un mantel. El mantel tenía muchas manchas que no podían lavar con los métodos típicos. El aguarrás elimina las manchas del mantel. Eso causó que el lavar de las fábricas con unos líquidos que no son de agua.

El aguarrás continua a ser usado en el proceso de lavar en seco junto con otros líquidos. Todos estos productos químicos son dañinos a la gente y el medio ambiente. La mayoría de esos son inflamables a temperaturas bajas y producen gases peligrosos. Los riesgos de los productos iniciaron una búsqueda una solución. Al principio del siglo vente, el solvente Stoddard fue descubierto y llegó a ser el producto químico principal.

El solvente Stoddard y otros solventes en base de petróleo ya son usados para lavar en seco, junto con otros solventes dañinos, como percloroetileno. La búsqueda de una alternativa segura y barata continua.

LOS PROBLEMAS CON LA SALUD

Los Solventes en Base de Petróleo

- Perjudican el sistema de nervios central
- Causan vértigo
- Irritan los ojos
- Hacen que las reacciones ocurran lentamente

Percloroetileno (perc)

- Perjudica la memoria
- Daña el hígado y los riñones
- Da dolor de cabeza
- Puede causar cáncer

LOS RIESGOS PARA EL MEDIO AMBIENTE

Los Solventes en Base de Petróleo

- Acumulan en la tierra y el agua
- Matan los organismos acuáticos

Percloroetileno (perc)

- Agota el ozono
- Mata los organismos acuáticos
- Contamina el agua

Pide que su Tintorería Local...

* Hay muchas alternativas modernas y seguras al proceso actual de lavado en seco. Pida a su tintorería local qué haciendo para modernizar y proteger el medio ambiente, su familia y los residentes locales.

Las Alternativas

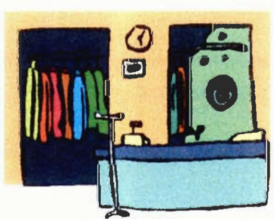
* Reconversión—Adición de componentes avanzados para hacer las máquinas más seguras
* Lavar con Agua—Usas una mezcla de jabón y agua y técnicas especiales para lavar las manchas
* La Solución GreenEarth—un solvente que no es tóxico con una base de silicio
* Reciclaje—Un proceso que puede ser disponible en el futuro si bastante tintorerías lo apoyan
* Incineración—El proceso del quemar de los solventes usados como combustibles

EL PROBLEMA

- Los solventes de lavado en seco son dañinos para los empleados y el medio ambiente
- Los solventes en base de petróleo son inflamables
- Los solventes usados son dispuestos en una manera impropia

LAS TÉCNICAS PARA REDUCIR LA EXPOSICIÓN DAÑINA

- Cuando usan máquinas con una lavadora y un secador separados, lleven los guantes y transferan la ropa muy rápido



- Lave los filtros cada semana y las entrapas de cesado cada día
- Tenga las máquinas de lavado en seco en un cuarto separado del resto de la tienda y con mucha ventilación
- No coma, beba o fume cerca de las máquinas y los solventes
- Evite las llamas abiertas en la tienda

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El Reciclaje

* Es posible que se construya un centro de reciclaje que puede reciclar muchos de los solventes de lavado en seco
* Se puede devolver los solventes reciclados a la tintorería o venderlos a otras industrias
* Los solventes reciclados funcionan como los originales

Las Alternativas

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- Los solventes usados son dispuestos en una manera impropia

LAS TÉCNICAS PARA BAJAR LA EXPOSICIÓN DAÑINA

- No juegue en el agua cerca de las tintorerías

- No permite que sus animales domésticos beban el agua cerca de las tintorerías
- Insista en que su tintorería local use las alternativas modernas y seguras de lavado en seco

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LOS RIESGOS PARA EL MEDIO AMBIENTE

Los Solventes en Base de Petróleo

- Acumulan en la tierra y el agua
- Matan los organismos acuáticos
- Causan las incautaciones en las ratas, los gatos y los perros

Percloroetileno (Perc)

- Agota el ozono
- Mata los organismos acuáticos
- Contamina el agua

Pide su Tintorería Local

* Hay muchas alternativas modernas y seguras al proceso actual de lavado en seco. Pida a su tintorería local qué haciendo para modernizar y proteger el medio ambiente, su familia y los residentes locales.

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Appendix G

Blank Matrix

	No Change (Stoddard)	Retrofitting	Perchloroethylene	Wet Cleaning	Green Earth Solution	Liquid CO_2
1) Non-Hazardous to the Worker						
2) Non-Hazardous to the Environment (contamination)						
3) Non-Hazardous to the Environment (emissions)						
4) Cost to Implement						
5) Not a Fire Hazard						
6) Ability to Clean (protein stains)						
7) Ability to Clean (non-polar stains)						
8) Ability to Recycle Solvent						
9) Total Time of Cleaning Process						
10) Yearly Cost of Solvents 11) Ability of the Process to not Damage Clothes						
12) Variety of Clothes that can be cleaned with the Process						
13) Cost to Dispose of the Byproducts of the Process						
14) Simplicity to Learn New Process						
TOTAL						

La Matriz en Blanco

	No Cambio (Stoddard)	Reconversión	Percloroetileno	Lavar con Aqua	La Solución Green Earth	Líquido CO_2
1) No es dañino para el trabajador						
2) No es dañino para el medio ambiente (la contaminación)						
3) No es dañino para el medio ambiente (las emisiones)						
4) El costo de la Implementación						
5) No es inflamable						
6) La Aptitud para Lavar (las manchas de proteína)						
7) La Aptitud para Lavar (las manchas que no son polar)						
8) La Aptitud para Reciclar						
9) El Tiempo Requiere para Lavar la Ropa						
10) El Costo de los Solventes cada año						
11) La Aptitud del Proceso para no hacer daño a la Ropa						
12) La Variedad de la Ropa que Puede Lavar						
13) El Costo para Deshacerse del Desecho						
14) Lo Sencillo que es Aprender el Proceso						
TOTAL						

Completed Matrix

As completed by Paul Mastrodominico

	No Change (Stoddard)	Retrofitting	Perchloroethylene	Wet Cleaning	Green Earth Solution	Liquid CO_2
1) Non-Hazardous to the Worker	5	4	6	1	2	3
2) Non-Hazardous to the Environment (contamination)	5	4	6	3	2	1
3) Non-Hazardous to the Environment (emissions)	5	4		3	2	1
4) Cost to Implement	2	4	1	3	6	5
5) Not a Fire Hazard	---	---	---	---	---	---
6) Ability to Clean (protein stains)	2	3	1	4	5	6
7) Ability to Clean (non-polar stains)	4	6	3	5	2	1
8) Ability to Recycle Solvent	5	4	6	3	1	2
9) Total Time of Cleaning Process	4	5	3	6	2	1
10) Yearly Cost of Solvents	5	4	6	1	2	3
11) Ability of the Process to not Damage Clothes	2	5	1	6	3	4
12) Variety of Clothes that can be cleaned with the Process	2	3	1	6	4	5
13) Cost to Dispose of the Byproducts of the Process	5	4	6	3	2	1
14) Simplicity to Learn New Process	2	3	1	6	5	4
TOTAL	48	53	47	50	38	37

Appendix H

Completed Matrix of Dry Cleaner Information

	gerneration of machine	recycling system	age of machines	origin of machines	brand of machines	manual or automatic	maintenance performed	chemicals used	Same chemical Always
Dry Cleaner A	3rd	in machine 80-85%	7 years	USA	Aero-tech model 410	automatic	every month	Perc	Yes
Dry Cleaner B	1st	No	20 years	USA	Hoffman	manual	twice a year no electical	Exxsol D40 Acetatos	No - Varsol 2 years ago
Dry Cleaner C	3rd	no	30-35 yrs avg 3 new	Italy	Renzacci	manual	lint filter and oil changed, electrical	Stoddard Exxsol D40	Yes
Dry Cleaner D	1st	Yes 80%	15 years	USA	Unsure	manual	continually as needed	Exxsol D40	Yes
Dry Cleaner E	3rd	Yes continuously	37 years	Germany	Bowe	manual	regular, grease change solvent	Exxsol D40	Yes
Dry Cleaner F	3rd	Yes 90%	20 years	Italy	Fibrimatic	both	regular every weekend	Perc	Yes
Dry Cleaner G	5th	Yes	1 yr & 6yrs	USA Italy	DC USA Renzacci	both	regularly	Perc	Yes

	origin of chemicals	Cost of Chemicals	Amount Purchased	Disposal Method	Would Recyle if Possible	Costs of Disposal	Spillage	Ventilation System
Dry Cleaner A	Holland	700,000 colones	-	None	No	None	None	Open Wall
Dry Cleaner B	Costa Rica	1,464,000 colones	4,896 liters	None	Yes	None	Rarely	Exterior Ventilation
Dry Cleaner C	Costa Rica, United States	$10,000/yr		Sewage System	Yes	None	Prevented by limited quantities in stock	General/Local Fume Hood
Dry Cleaner D	Disol SA – Esquipi in Costa Rica	4,900,000 colones	3640 gallons	Recycled in filter to pure solvent	Yes	None	None	Open Windows
Dry Cleaner E	Costa Rica	1,733,000 colones	953 gallons	evaporate not sewer	recycle now	None	None	roof has its own windows
Dry Cleaner F	Italy	$20,000/yr	-	recycled w/in machines	Yes, if better than current	None	None	External Extractors
Dry Cleaner G	Costa Rica	doesn't know	doesn't know	bus comes and takes it away	Already do (best way)	yes, but no sabe	None	Big area, high ceiling

	Employee Sickness	Worries of Toxic Fumes	Clothing Cleaned/Day	Customer Complaints	Chemical Quality	Would Change Methods in Future	Would Change to
Dry Cleaner A	None	None	1,200 pieces 300 kilos	10/week	Good	No	-
Dry Cleaner B	Rare Dizziness	Yes	250 Kilos 1,000 pieces	1-2/week	Good	Yes	Perc
Dry Cleaner C	Only in asthmatic employees	None	300 pieces	rarely	Bad- Differenences in Smell and Greasiness	Yes	Wet Cleaning
Dry Cleaner D	None	None	100-150 pieces	3/month	None	No	-
Dry Cleaner E	None		200-250 pieces 160 kilos	very few	wishes they were better	No	
Dry Cleaner F	Headaches at first, ok now	None	70-80 kilos	never	None bc from Italy	No bc perc is the best	-
Dry Cleaner G	None	None	600-700 pieces 300 kilos	1/month	No problems	No	-

	Reason for no Change yet	Automatic Stop	Emergency Drain in Floor	Change Filters
Dry Cleaner A	-	Yes	No	Every day
Dry Cleaner B	Bad Economy	No	Yes - Goes into a drum	15 days
Dry Cleaner C	Too Expensive			1-2/ week
Dry Cleaner D	-	No - Emergency stop button	Yes - Goes into a drum	1/week
Dry Cleaner E		No	No	Daily
Dry Cleaner F	-	Yes	No	when broken
Dry Cleaner G	-	No	No	when needed

				Martinizing
Aqua Matic Lavanderias	283-7844	Sabanilla	No	
Corporacion Inversiones Coinsa S.A.	297-2671	Tibas	No	
Corporacion Inversiones Coinsa S.A.	296-2850	Sabana N	No	
Décor Clean Lavanderia Cortinas y Dry Clearing	245-0093	Sn Ant Coronado	No	
Gonzalez Arce Franklin Antonio	221-9147	c38 a2	No	
Gonzalez Holmann Jaime	240-8574	Moravia	No	
Gonzalez Holmann Jaime Jose	253-8776	Los Yoses	No	
Lavanderia Automatics Vida Nueva	280-4432	Curridabat	No	
Lavanderia y Dry Cleaning El Trianulo	825-9340	Rohrmoser	No	
Lavanderia y Dry Cleaning Sixaola de Guadalupe	240-7667	Sn Vincente	No	
Lavolas Naiguata S.A.	288-3535	Escazu	No	
Rincon Grande S.A.	213-0434	Pavas	No	
Sixaola (Oficinas Centrales)	240-7667	Moravia	No	
Tysunn Lavanderia S.A.	204-7744	Sta Ana	No	
Lavanderia de Manteles Lee Arguedas	375-3329	Escazu		Unable to Contact
Lavanderia Isis	391-3011	Tibas		Unable to Contact
Multinversiones L y B S.A.	228-8576	Sn Raf Escazu		Unable to Contact
Multinversiones L y B S.A.	254-8639	Hatillo 3		Unable to Contact
Solorzano Pellas Rosa Argentina	220-2284	Sabana N		Unable to Contact

Appendix I

Dry Cleaner Spreadsheet

Name of Dry Cleaner	Phone Number	Location	Onsite	Notes
Dry Clean USA	296-7019	Pavas	Yes	Interviewed
Lavanderia Dry Cleaning La Margarita S.A.	226-4011	Sn Fco de Dos Rios	Yes	Interviewed
Lavanderia y Dry Cleaning Le Grand Paris	226-5718	Paso Ancho	Yes	Interviewed
Lavolas Naiguata S.A.	289-9878	Sn Raf Escazu	Yes	Interviewed
Sixaola (Centro Commerical Feria del Norte)	235-1241	Tibas	Yes	Interviewed with owner of chain
Sixaola (Local No. 6)	234-0278	Plaza del Sol	Yes	Interviewed with owner of chain
Sixaola (Novacentro Local No. 4)	225-1102 or 225-1204		Yes	Interviewed with owner of chain
Sixaola Plaza del Sol S.A.	225-1204	Guadalupe	Yes	Interviewed with owner of chain
Sixoala S.A.	223-2527	c36 y38 P Colon	Yes	Interviewed with owner of chain
Tysunn Lavanderia S.A.	234-7108	Curridabat	Yes	Interviewed
Ugalde Carvajal Franklin	223-1097	c12 a 14 y 18	Yes	Interviewed
Master Dry Clean	227-1020	Paso Ancho	Yes	Refused Interview
Rojas Trigueros Maria Rita	278-3106	Sn Diego La Un	Yes	Refused Interview
Lavanderia Martinizing	289-5201	Escazu	Yes	Refused Interview
Lavanderia Martinizing	224-4183	San Pedro	Yes	Refused Interview
Martinizing	231-6486	Pavas	Yes	Refused Interview
Corporacion Inversiones Coinsa S.A.	226-2114	Sn Fco 2 Rios	Yes	Referred us to Martinizing
Gonzalez Holmann Jaime Jose	282-3327	Sta Ana	Yes	Referred us to

Appendix J

National Emission Standard for Hazardous Air Pollutants (NESHAP) for perchloroethylene dry cleaners:

Environmental Protection Agency
RULES
Air pollutants, hazardous; national emmission standards: Perchlorethylene emissions from dry cleaning facilities, 49354
Vol. 58 No. 182 Wednesday, September 22, 1993 p 49354 (Rule) 1/3432

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 963

[AD-FRL-4732-9]
RIN 2060-AC27
National Emission Standards for Hazardous Air Pollutants for Source Categories: Perchloroethylene Dry Cleaning Facilities
AGENCY: Environmental Protection Agency (EPA).
ACTION: Final rule.
SUMMARY: National emission standards for hazardous air pollutants (NESHAP) for perchloroethylene (PCE) dry cleaning facilities were proposed in the Federal Register on December 9, 1991 (56 FR 64382). A notice of availability of new information on control of PCE emissions during clothing transfer at dry cleaning facilities that use transfer dry cleaning machines was published on October 1, 1992 (57 FR 45363). This action promulgates national emission standards for PCE dry cleaning facilities. These standards implement section 112 of the Clean Air Act (Act) and are based on the Administrator's determination that PCE is a hazardous air pollutant (HAP) and that emissions, ambient concentrations, bioaccumulation, or deposition of PCE are known to cause or may reasonably be anticipated to cause adverse effects to human health or the environment.

The intended effect of this NESHAP is to require all new and existing major source dry cleaning facilities (emitting or with the potential to emit greater than 9.1 megagrams (Mg) [10 tons] per year of PCE) to control emissions to the level of the maximum achievable control technology (MACT), as specified in section 112 of the Act.

The intended effect of this NESHAP is also to require all new and existing area source dry cleaning facilities (emitting or with the potential to emit 9.1 Mg [10 tons] per year or less of PCE) to control PCE emissions to the level achieved by generally available control technologies (GACT) or management practices.

EFFECTIVE DATE: September 22, 1993.

Judicial Review. Under section 307(b)(1) of the Act, judicial review of the actions taken by this notice is available only by filing a petition for review in the U.S. Court of Appeals for the District of Columbia Circuit within 60 days of today's publication of this rule. Under section 307(b)(2) of the Act, the requirements that are the subject of today's notice may not be challenged later in civil or criminal proceedings brought by the EPA to enforce these requirements.

ADDRESSES: Background Information Document. The background information document (BID) for the promulgated standards may be obtained from the U.S. EPA Library (MD-35), Research Triangle Park, North Carolina 27711, telephone number (919) 541-2777. Please refer to "Dry Cleaning Facilities-Background Information for Promulgated Standards," EPA-450/3-91-020b. The BID contains: (1) A summary of the public comments made on the proposed NESHAP and the notice of availability of new information and the Administrator's response to the comments; (2) a summary of the changes made to the NESHAP since proposal; and (3) the final Environmental Impact Statement, which summarizes the impacts of the standards.

Docket. Docket No. A-88-11, containing information considered by the EPA in development of the promulgated standards, is available for public inspection between 8:30 a.m. and 3:30 p.m., Monday through Friday, excluding Federal holidays, at the EPA's Air Docket (LE-131), Waterside Mall, room M1500, 1st Floor, U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460. A reasonable fee may be charged for copying.

Public Meeting. As discussed in more detail at the end of this preamble, in order to gain additional understanding of indoor air pollution, ground water contamination and solid waste generation resulting from dry cleaning facilities, the EPA will convene a public meeting at a place and time to be announced. Information also will be sought on the environmental impacts associated with the operation of wastewater evaporators. The objective of this public meeting will be to gather information on the magnitude of these problems, as well as potential solutions to these problems.

Individuals wishing to find out the date and location of the meeting or to speak at this public meeting should contact Ms. Julia Stevens at (919) 541-5578 by October 22, 1993. Individuals wishing to submit written comments in lieu of attending this public meeting should forward their comments by November 22, 1993 to: Mr. Bruce Jordan, Director; Emission Standards Division (MD-13); Environmental Protection Agency; Research Triangle Park, NC 27711.

FOR FURTHER INFORMATION CONTACT: For information concerning the standards, contact Mr. George Smith at (919) 541-1549 or Mr. Fred Porter at

(919) 541-5251, Standards Development Branch, Emission Standards Division (MD-13), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

SUPPLEMENTARY INFORMATION: The following outline is provided to aid in reading the preamble to the final rule.

I. Background

A. List of Categories and Subcategories

The Act requires, under section 112, that the EPA evaluate and control emissions of HAP's. The control of HAP's is achieved through promulgation of emission standards under sections 112(d) and 112(f) for categories of sources that emit HAP's. Section 112(c)(3) directs the Administrator to list each category or subcategory of area sources which the Administrator finds "presents a threat of adverse effects to human health or the environment." Section 112(c)(3) also directs the Administrator to list within 5 years "sufficient categories or subcategories of area sources to ensure that area sources representing 90 percent of the area source emissions of the 30 HAP's that present the greatest threat to public health in the largest number of urban areas are subject to regulation." Section 112(c)(1) directed the EPA to publish an initial list of major sources which emitted one or more of the listed 189 HAP's. As described in the proposal,

(56 FR 64382, 64383 (December 9, 1991)), the EPA identified 5 categories of major or area sources of dry cleaners for regulation. These source categories were included in the initial section 112(c)(1) list published on July 16, 1992, (57 FR 31576) as follows: Source Category and Subcategory Industrial (major)-Dry-to-dry machines; Transfer machines.

Commercial (major)-Transfer machines.

Commercial (area)-Dry-to-dry machines; Transfer machines.

All sources in the industrial category are major sources. The industrial category has two basic types of machines: Dry-to-dry and transfer. A major source includes any source that emits or has the potential to emit, considering controls, in the aggregate, 9.1 Mg/yr (10 tpy) of any HAP (section 112(a)(1) of the Act). The EPA proposed that the industrial source category and those major sources under the commercial source category be regulated under MACT. The EPA also proposed that the commercial source category, which includes area sources, be listed under section 112(c)(3) for regulation under GACT.

B. Source of Authority for National Emission Standards for Hazardous Air Pollutants Development

Title III of the Act was enacted to help reduce the increasing amount of nationwide air toxics emissions. Under title III, section 112 was amended to give the EPA the authority to establish national standards to reduce air toxics from sources that emit one or more HAP. Section 112(b) contains a list of HAP's, which are the specific air toxics to be regulated by NESHAP. Section 112(c) directs the EPA to use this pollutant list to develop and publish a list of source categories for which a NESHAP will be developed. The EPA must list all known categories and subcategories of "major sources" (defined above) which emit one or more of the listed HAP's. Area source categories selected by the EPA for NESHAP development will be based on the Administrator's judgment that the sources in a category, individually or in aggregate, pose a "threat of adverse effects to health and the environment." As noted above, the initial section 112(c)(1) list of source categories was published on July 16, 1992 (57 FR 31576) and listed 5 source categories of dry cleaners (three major and two area).

C. Criteria for Development of National Emission Standards for Hazardous Air Pollutants

The NESHAP are to be developed to control HAP emissions from both new and existing sources according to the statutory directives set out in section 112. The statute requires the standards to reflect the maximum degree of reduction in emissions of HAP's that is achievable for new or existing sources. The NESHAP must reflect consideration of the cost of achieving the emission reduction, and

any nonair quality health and environmental impacts, and energy requirements for control levels more stringent than the MACT floors (described below). The emission reduction may be accomplished through application of measures, processes, methods, systems or techniques including, but not limited to, measures which:

1. Reduce the volume of, or eliminate emissions of, such pollutants through process changes, substitution of materials or other modifications,

2. Enclose systems or processes to eliminate emissions,

3. Collect, capture or treat such pollutants when released from a process, stack, storage or fugitive emissions point,

4. Are design, equipment, work practice, or operational standards (including requirements for operator training or certification) as provided in subsection (h), or

5. Are a combination of the above (section 112(d)(2)).

To develop a NESHAP, the EPA collects information about the industry, including information on emission source characteristics, control technologies, data from HAP emission tests at well-controlled facilities, and information on the costs and other energy and environmental impacts of emission control techniques. The EPA uses this information to analyze possible regulatory approaches.

Although NESHAP are normally structured in terms of numerical emission limits, alternative approaches are sometimes necessary. In some cases, physically measuring emissions from a source may be impossible or at least impracticable due to technological and economic limitations. Section 112(h) authorizes the Administrator to promulgate a design, equipment, work practice, or operational standard, or combination thereof, in those cases where it is not feasible to prescribe or enforce an emissions standard.

Section 112(h)(2) provides that, "the phrase `not feasible to prescribe or enforce an emission standard' means any situation in which the Administrator determines that "the application of measurement methodology to a particular class of sources is not practicable due to technological and economic limitations." As described below, the Administrator has determined that it is impracticable to prescribe an emission standard for the sources subject to this rule. Accordingly, this final rule is being issued as a section 112(h) standard.

D. Categorization/Subcategorization: Determining Maximum Achievable Control Technology "Floors" for NESHAP

The Act directs the Administrator to list categories and subcategories of major sources and area sources which emit one or more of the HAP's listed in section 112(b) (section 112(c) of the Act). The Administrator shall list all major sources which emit HAP's. The Administrator shall list those area source categories and subcategories which she finds present a threat of adverse effects to human health or the environment warranting regulation. Once the EPA has identified the specific source categories or subcategories of major sources and area sources that it intends to regulate under section 112, it must set MACT standards for each and must set such standards at a level at least as stringent as the "floor," unless it regulates area sources under section 112(d)(5) as described below. Congress provided certain very specific directives to guide the EPA in the process of determining the regulatory floor.

Congress specified that the EPA shall establish standards which require "the maximum degree of reduction in emissions of the hazardous air pollutants * * * that the Administrator, taking into consideration the cost of achieving such emission reduction, and any nonair quality health and environmental impacts and energy requirements, determines is achievable * * *" (section 112(d)(2) of the Act) In addition, Congress limited the EPA's discretion by establishing a minimum baseline or "floor" for standards. For new sources, the standards for a source category or subcategory "shall not be less stringent than the emission control that is achieved in practice by the best controlled similar source, as determined by the Administrator" (section 112(d)(3) of the Act). Congress provided that existing source standards could be less stringent than new source standards but could be no less stringent than the average emission limitation achieved by the best performing 12 percent of the existing sources (excluding certain sources) for categories and subcategories with 30 or more sources or the best performing 5 sources for categories or subcategories with fewer than 30 sources (section 112(d)(3) of the Act).

Once the floor has been determined for new or existing sources for a category or subcategory, the Administrator must set MACT standards that are no less stringent than the floor. Such standards must then be met by all sources within the category or subcategory. However, in establishing the standards, the Administrator may distinguish among classes, types, and sizes of sources within a category or subcategory (section 112(d)(1) of the Act). Thus, for example, the Administrator could establish two classes of sources within a category or subcategory based on size and establish a different emission standard for each class, provided both standards are at least as stringent as the MACT floor.

In addition, the Act provides the Administrator further flexibility to regulate area sources. Section 112(d)(5) provides that in lieu of establishing MACT standards under section 112(d), the Administrator may promulgate standards which provide for the use of "generally available control technologies or

management practices." Area source standards promulgated under this authority (GACT standards) would not be subject to the MACT "floors" described above. Moreover, for source categories subject to standards promulgated under section 112(d)(5), the EPA is not required to conduct a residual risk analysis under section 112(f).

At the end of the data gathering and analysis, the EPA must decide whether it is more appropriate to follow the MACT or the GACT approach for regulating an area source category. As stated previously, MACT is required for major sources. If all or some portion of the sources emits less than 9.1 Mg/yr (10 tpy) of any one HAP (or less than 22.7 Mg/yr (25 tpy) of total HAP's), then it may be appropriate to define subcategories within the source category and apply a combination MACT/GACT approach, MACT for major sources and GACT for area sources. In other cases, it may be appropriate to regulate both major and area sources in a source category under MACT.

The next step in establishing a MACT or GACT standard is the investigation of regulatory alternatives. With MACT standards, only alternatives at least as stringent as the floor may be considered. Information about the industry is analyzed to develop model plant populations for projecting national impacts, including HAP emission reduction levels, costs, energy, and secondary impacts. Several regulatory alternative levels (which may be different levels of emissions control or different levels of applicability or both) are then evaluated to determine the most plausible regulatory alternative to reflect the appropriate MACT or GACT level.

The regulatory alternatives for new versus existing sources may be different, and separate regulatory decisions must be made for new and existing sources. For both source types, the selected alternative may be more stringent than the MACT floor. However, the control level selected must be technically achievable. In selecting a regulatory alternative to represent MACT or GACT, the EPA considers the achievable reduction in emissions of HAP's (and possibly other pollutants that are co-controlled), the cost and economic impacts, energy impacts, and other environmental impacts. The objective is to achieve the maximum degree of emission reduction without unreasonable economic or other impacts.

The selected regulatory alternative is then translated into a proposed regulation. The regulation implementing the MACT or GACT decision typically includes sections of applicability, standards, test methods and compliance demonstration, monitoring, reporting, and recordkeeping. The preamble to the proposed regulation provides an explanation of the rationale for the decision. The public is invited to comment on the proposed regulation during the public comment period. Based on an evaluation of these comments, the EPA reaches a final decision and promulgates the NESHAP.

E. Historical Development of the Standards

On November 25, 1980 (45 FR 78174), the EPA proposed new source performance standards (NSPS) to limit emissions of volatile organic compounds (VOC's) from new, modified, and reconstructed PCE dry cleaners under the authority of section 111 of the Act. On December 26, 1985 (50 FR 52880), the EPA published a Notice of Intent to List PCE as a potentially toxic air pollutant to be regulated under section 112 of the Act and solicited information on the potential carcinogenicity of PCE. Perchloroethylene is the predominant solvent used in dry cleaning. It has chemical and physical properties which make it the most desirable solvent available for the dry cleaning of fabrics. Information was also requested on applicable emission control equipment and the associated level of control achievable.

Subsequent to the EPA's issuance of the 1980 proposed rule and to the EPA's Notice of Intent to List and possible regulation of PCE emissions from dry cleaners under section 112, a private citizens group from Oregon, Francis P. Cook, et al., brought suit against the Administrator of the EPA to compel him to issue a final rule regulating emissions from PCE dry cleaners under the authority of section 111 of the Act. The EPA and plaintiffs negotiated a settlement of the lawsuit whereby the EPA agreed to enter into a Consent Decree. The U. S. District Court for the District of Oregon entered the Consent Decree on March 16, 1990, (Cook v. Reilly, No. 89-630 7E (D. Ore)). In the Consent Decree, the EPA Administrator agreed to sign proposed NESHAP for PCE dry cleaning facilities within 1 year and promulgate the standards within 2 years following enactment of the new amendments to the Act. In accordance with the Consent Decree, on November 15, 1991, the Administrator, William K. Reilly, signed the proposed rulemaking. That notice appeared in the Federal Register on December 9, 1991, (56 FR 64382).

In that notice, the EPA proposed to regulate PCE emissions from dry cleaners under authority of section 112 of the Act because PCE is included on the list of HAP's found in section 112(b).

A notice announcing the withdrawal of the proposed NSPS for regulating VOC emissions from PCE dry cleaners under section 111 was also published at that time (56 FR 64382). The Consent Decree was amended twice to provide the EPA additional time to complete this action, with the current decree requiring the Administrator to sign a final rulemaking notice not later than September 13, 1991. This action completes the EPA's obligations to take regulatory action in compliance with the Consent Decree.

II. Summary

A. Summary of Promulgated Standards

The standards being promulgated today will reduce emissions of PCE from new and existing dry cleaning facilities in the industrial and commercial sectors of the dry cleaning industry. Coin-operated dry cleaning machines are exempt from the standards. The requirements of the standards are discussed below. The process vent control requirements of the standards are presented in table 1.

Table 1.-Requirements of the PCE Dry Cleaning NESHAP

Requirement	Small area source	Large area source	Major source
Applicability:	Consuming less than:	Consuming between:	Consuming more than:
Dry Cleaning Facilities with:			
(1) Only Dry-to-Dry Machines.......	140 gallons PCE/year.....	140-2,100 gallons PCE/year	2,100 gallons PCE/year
(2) Only Transfer Machines...........	200 gallons PCE/year....	200-1,800 gallons PCE/year	1,800 gallons PCE/year
(3) Both Dry-to-Dry and Transfer Machines.	140 gallons PCE/year....	140-1,800 gallons PCE/year	1,800 gallons PCE/year
Process Vent Controls:			
Existing Facilities...........................	None...........................	(1).. ..	(1)
New Facilities.................................	(2)	(2).. ..	Refrigerated condenser followed by small carbon adsorber (or equivalent)
Fugitive Controls:			Room enclosure
Existing Facilities..........................	(3)............................... (4)............................... (5)............................... (6)............................... (7)...............................	(3).. .. (4).. ..	
New..		(5).. .. (6).. .. (7).. ..	

{1} Refrigerated condenser (or equivalent) Existing carbon adsorbers can remain.
{2} Refrigerated condenser (or equivalent).
{3} Leak detection/repair.
{4} Store all PCE solvent & waste in sealed containers.
{5} Leak detection/repair.
{6} Store all PCE solvent & waste in sealed containers.
{7} No new transfer machine systems allowed.

Owners and operators of all new dry cleaning machines and existing uncontrolled dry cleaning machines located at major sources, as well as those of many area sources, are required to install and operate refrigerated condensers to control PCE emissions from process vents. Owners and operators of existing dry cleaning machines controlled with carbon adsorbers that were installed prior to today's date are not required to replace the carbon adsorber with a refrigerated condenser. These owners and operators may continue to operate their carbon adsorbers to control PCE emissions from process vents. Owners and operators of all dry cleaning machines are required to operate their PCE emission control equipment and dry cleaning machines according to the manufacturer's recommendations. New transfer machine systems are effectively banned through a requirement prohibiting any PCE emissions from clothing transfer between the washer and dryer of transfer machine systems.

Additional controls are required for new dry-to-dry machines and existing transfer machine systems located at major sources. Owners or operators of new dry-to-dry machines located at major sources are required to install a carbon adsorber in addition to a refrigerated condenser. The PCE saturated air remaining in the dry cleaning drum after completion of the refrigerated condenser cycle must be passed through this carbon adsorber immediately before the door of the dry cleaning machine is opened or as the door is opened. Owners or operators of existing transfer machine systems located at major sources are required to contain their transfer machine systems inside a room enclosure. This room enclosure must be vented to a carbon adsorber to control PCE emissions captured by the room enclosure.

To determine if a dry cleaning facility is a major source emitting over 9.1 Mg (10 tons) per year, total annual PCE consumption of all of the dry cleaning machines at a facility is used to determine PCE emissions. For the purpose of these standards, PCE consumption during any period is defined as the PCE purchased during that period. A facility with only dry-to-dry machines consuming 8,000 liters (2,100 gallons) per year would emit 9.1 Mg (10 tons) per year of PCE and is considered a major source. Similarly, a facility with only transfer machine systems consuming 6,800 liters (1,800 gallons) per year would emit 9.1 Mg (10 tons) per year of PCE and is considered a major source. Finally, a facility with both dry-to-dry machines and transfer machine systems consuming 6,800 liters (1,800 gallons) per year would emit 9.1 Mg (10 tons) per year and is also considered a major source.

The standards include yearly low solvent consumption exemption levels for existing area sources (these low solvent consumption levels do not apply to new sources). The low consumption exemption level is 530 liters (140 gallons) per year for an existing area source that contains only dry-to-dry machines. The low consumption exemption level is 760 liters (200 gallons) per year for an existing area source that contains only transfer machine systems. Finally, the low consumption exemption level is 530 liters (140 gallons) per year for an existing area source that contains both dry-to-dry machines and transfer machine systems. Existing area sources with a yearly PCE consumption below these low solvent consumption exemption levels are not required to install process vent controls. To determine appropriate compliance requirements based on PCE consumption, owners or operators of all dry cleaning facilities must calculate a yearly rolling total of PCE consumption (based on purchase receipts) on the first day of each month.

The owner or operator of each dry-to-dry machine, transfer machine dryer, or reclaimer using a refrigerated condenser is required to monitor and record the temperature on the outlet side of the refrigerated condenser once per week. The owner or operator of each transfer machine washer using a refrigerated condenser is required to monitor and record the temperature on both the inlet side and the outlet side of the refrigerated condenser once per week. The owner or operator of each existing dry cleaning machine using an existing carbon adsorber for process vent control, which was installed prior to today, or each new major source dry-to-dry machine using a supplemental carbon adsorber to control PCE remaining in the machine drum, is required to monitor the concentration of PCE in the carbon adsorber exhaust outlet once per week.

All owners or operators of dry cleaning facilities are subject to pollution reduction requirements for all dry cleaning machines as well as auxiliary equipment (such as emission control devices, pumps, filters, muck cookers, stills, solvent tanks, solvent containers, water separators, diverter valves, and interconnecting piping, hoses, and ducts). To prevent liquid and vapor leaks from these sources, a weekly leak detection and repair program is required at all facilities except existing facilities with annual receipts less than $75,000, where biweekly leak detection and repair is required. All leaks detected must be recorded in a log, must have their necessary repair parts ordered, and must be repaired within 5 working days of receiving the necessary part. Storage of waste containing PCE in tightly sealed containers is also required to reduce PCE emissions before disposal. Owners or operators of all dry cleaning facilities must maintain monthly records of PCE consumption, based on purchase receipts. Each month, the annual PCE consumption for the preceding 12 months must also be calculated and recorded.

Initial reports certified by a responsible official are required, which include a brief description of and the design capacity of all dry cleaning machines at the facility, annual facility PCE consumption and, where appropriate, the type of emission control device to be used to achieve compliance for each machine at the facility. An existing dry cleaning machine that commenced construction prior to December 9, 1991 (the date of proposal of the PCE dry cleaning NESHAP), must comply with pollution prevention and recordkeeping-and-reporting requirements starting 90 days from today. An existing machine must comply with other requirements within 36 months of today's date. In general, a new dry cleaning machine for which construction commenced on or after December 9, 1991, must achieve compliance with this rule upon startup. However, a new dry cleaning machine that was constructed after December 9, 1991, but prior to today's date may comply immediately with the final rule or comply with section 112(i)(2) of the Act. (Section 112(i)(2) allows qualifying new sources 3 years from promulgation to comply with the final rule, if they comply with the proposed rule in the interim.) A statement signed by a responsible official certifying that

compliance is being achieved is required 30 days following the date of compliance.

If a dry cleaning facility that initially met the requirements for an area source exceeds the PCE consumption level for an area source and becomes a major source, that dry cleaning facility is required to achieve compliance with the requirements for a major source by 180 days from the date that the PCE consumption level is exceeded, or within 36 months following today's date, whichever date is later.

If an existing dry cleaning facility initially below the low solvent consumption exemption level for an existing area source exceeds this low solvent consumption exemption level, that dry cleaning facility is required to achieve compliance with the process vent requirements for an area source above the low solvent consumption exemption level by 180 days from the date that the PCE consumption level is exceeded, or within 36 months following today's date, whichever date is later.

The recordkeeping requirements include documentation of the volume of PCE purchased each month, results and calculations of the yearly PCE consumption as determined each month, results of weekly or biweekly PCE liquid and vapor leak inspections and, where appropriate, results of weekly control device monitoring (refrigerated condenser outlet temperature, or refrigerated condenser inlet and outlet temperatures, or carbon adsorber exhaust concentration). All records must be retained for 5 years and made available for inspection upon request. Owners and operators of all dry cleaning facilities must retain onsite a copy of the design specifications and operating manuals for all dry cleaning machines and control devices.

Equivalent pollution prevention or emission control technology may be used to achieve compliance with the standards in lieu of the control devices required by the standard if certain information is submitted to and approved by the Administrator. The EPA notes that a dry cleaner could, by replacing perchloroethylene with other cleaning agents if available, be exempt from process vent controls or the entire NESHAP. An alternative standard may be approved through the section 112(l) approval process if the State meets certain requirements as discussed in more detail in section V. This information includes diagrams; documentation of emission quantification; solvent mileage information; identification of maintenance and monitoring requirements to ensure proper operation; an explanation of why the data regarding emission control is accurate and representative of both short and long term performance; an explanation of why the information supplied can be extrapolated to dry cleaning systems other than the specific systems examined; and documentation of cross-media (water, solid waste) impacts. Upon approval, the Administrator will publish a notice in the Federal Register.

Dry cleaners subject to today's rule should be aware of a separate rule known as the "general provisions." The general provisions, which were proposed in the Federal Register on August 11, 1993 (58 FR 42760), are generic requirements that sources subject to section 112 standards must meet. Among other things, the proposed general provisions rule contains a procedure for existing sources to apply for a one-year compliance extension, preconstruction review requirements for major sources, and definitions of terms that will be used in many or all section 112 standards. The EPA currently plans to promulgate the final general provisions in March 1994.

B. Selection of Basis of Standards for New and Existing Sources-Selection of MACT or GACT

As prescribed by section 112(c)(1), the promulgation of these standards was preceded by the development and publication of a list with all the categories and subcategories of major and area sources emitting any of the HAP's listed in section 112(b) of the Act. An initial list of such categories (required under section 112(c)(1)) was published in the Federal Register on July 16, 1992 (57 FR 31576). Three perchloroethylene dry cleaning major source categories were included on this list: (1) Commercial dry cleaning (perchloroethylene)-transfer machines; (2) industrial dry cleaning (perchloroethylene)-transfer machines; and (3) industrial dry cleaning (perchloroethylene)-dry-to-dry machines. Two dry cleaning area source categories were included on this list: (1) Commercial dry cleaning (perchloroethylene)-transfer machines; and (2) commercial dry cleaning (perchloroethylene)-dry-to-dry machines. The Administrator found that these categories present "a threat of adverse effects to human health or the environment."

As described above, the dry cleaning industry subject to the NESHAP is subcategorized into major and area source dry cleaners. The dry cleaning industry is also subcategorized into industrial and commercial sectors. All industrial dry cleaners are major sources. Commercial dry cleaners can be either major or area sources. The dry cleaning industry is further subcategorized into dry-to-dry and transfer machines. Although two subcategories of coin-operation dry-to-dry machines (plant and self-service) were included in the preliminary source category list published June 21, 1991 (56 FR 28548), these two subcategories were deleted from the final source category list published July 16, 1992 (57 FR 31576). These two subcategories are exempt from this final NESHAP.

There were no differences in the types of control technologies identified for the subcategories of industrial and commercial dry cleaners; however, differences in control technologies were identified between major and area sources, and

dry-to-dry and transfer machines. These differences were used in determining the requirements of the NESHAP.

The rule requires new and existing dry-to-dry machines, and transfer machine dryers, that are controlled with refrigerated condensers to be closed-loop-in other words, the gas-vapor mixture within the machine cannot be vented to the atmosphere while the dry cleaning machine drum is rotating. Although the refrigerated condenser can be external or internal, the gas-vapor stream must be routed back to (or contained within) the machine in a closed-loop configuration, without venting to the atmosphere. This ensures that the gas-vapor stream passes multiple times through the refrigerated condenser and that high control efficiency can be achieved. The EPA wishes to emphasize that the rule does not prohibit fan-and-vent systems which operate when the machine door is open to reduce worker exposure to PCE vapors left inside the drum at the end of the drying cycle.

The selection of the standards for this NESHAP based upon the subcategorization of the dry cleaning industry discussed above is summarized as follows.

1. Major Sources

Section 112 of the Act defines a major source as any stationary source that emits 9.1 Mg/yr (10 tpy) or more of any one HAP or 22.7 Mg/yr (25 tpy) or more of total HAP's. The Act states that new major sources must achieve the MACT, which is the level of emission control already achieved in practice by the best controlled similar source. The Act further states that emission standards promulgated for existing major sources may be less stringent than standards for new sources; however, standards for existing major sources must not be less stringent than the average level of emission reduction achieved by the average of the best performing 12 percent of the existing major sources.

For new major dry cleaning facilities, the only significant factor for determining similarity in sources is the type of machine used. Two basic types of machines are used in the dry cleaning industry: Dry-to-dry machines and transfer machines. For dry-to-dry machines, it has been demonstrated that the maximum degree of PCE emission reduction from machine vents and exhausts can be achieved by installing a refrigerated condenser.

At proposal, the EPA believed the performance of carbon adsorbers to be equal to that of refrigerated condensers when used to control emissions from dry-to-dry machines, and proposed to allow major source dry-to-dry machines to install either control device. Following proposal, however, new information was provided to the EPA from a survey of dry cleaners in California, which disputes these conclusions. A more detailed discussion of this finding is presented in section V.B.

The use of a refrigerated condenser and small carbon adsorber together is considered MACT for new source dry-to-dry machines. At present, both of these control devices are used widely in the dry cleaning industry. They are readily available and economically feasible as methods of control.

The emissions remaining in a conventional dry-to-dry machine, controlled with a refrigerated condenser, at the end of the dry cleaning cycle can be further controlled by drawing the air remaining in the machine through a small carbon adsorber either before the door to the machine is opened or venting the air through a carbon adsorber to the atmosphere as the door is opened. Information was made available to the EPA after proposal indicating that several conventional vented dry-to-dry machines equipped with refrigerated condensers currently operate in this manner (i.e., the air remaining in the machine at the end of the dry cleaning cycle is vented to a carbon adsorber as the door to the machine is opened).

Use of a carbon adsorber for process vent control represents the MACT floor for existing dry-to-dry machines because this is the average level of emission reduction achieved by the best-performing 12 percent of existing major sources. In considering whether to require controls above this floor, EPA distinguished between classes of machines. As noted earlier, the maximum achievable control technology for existing uncontrolled dry-to-dry machines is refrigerated condensers. However, MACT for existing dry-to-dry machines equipped prior to promulgation with carbon adsorbers is either a refrigerated condenser or a carbon adsorber. The final rule does not require the replacement of these carbon adsorbers with refrigerated condensers. The Administrator could not conclude, based on currently available information, that requiring replacement of a well-operated carbon adsorber with a refrigerated condenser was justified.

For transfer machine systems located at a major source, the NESHAP must be based on MACT. The Act states that MACT for new sources must be no less stringent than the best controlled similar source. The MACT may be more stringent, however, if the Administrator believes the balance between the additional economic, energy, and environmental impacts of a more stringent requirement is reasonable. A transfer machine system with a refrigerated condenser and a room enclosure represents the best controlled similar source. The only option more stringent than a transfer machine system with a room enclosure is a new dry-to-dry machine.

Dry-to-dry machines provide complete control of clothing transfer emissions (i.e., emissions released by transfer of clothing from the washer to the dryer of a transfer machine system). Dry-to-dry machines eliminate these emissions by eliminating the need to transfer clothing from a washer to a dryer (achieving 100 percent reduction of clothing transfer emissions).

The MACT for new transfer machine systems located at a major source is based upon the use of dry-to-dry machines, thereby requiring new major source transfer machine systems to eliminate all emissions from clothing transfer between the washer and the dryer. Such a requirement effectively bans or prohibits new transfer machine systems because no technology has been identified to date (including the use of hamper enclosures or room enclosures) that could be added to a new transfer machine system to totally eliminate all PCE emissions from clothing transfer. A more detailed discussion of this finding is presented in section V.B.

For existing major source transfer machine systems, it has been demonstrated that the maximum degree of PCE emission reduction from machine vents and exhausts can be achieved by installing a refrigerated condenser. At proposal, the EPA believed carbon adsorbers outperformed refrigerated condensers on transfer machine systems and proposed to require carbon adsorbers on uncontrolled transfer machine systems. Following proposal, however, new information was provided to the EPA from a survey of dry cleaners in California, which disputes these conclusions. A more detailed discussion of this finding is presented in section V.B.

Use of a carbon adsorber for process vent control represents the MACT floor for existing transfer machines because this is the average level of emission reduction achieved by the best-performing 12 percent of existing major sources. In considering whether to require controls above this floor, the EPA distinguished between classes of machines. As noted earlier, the maximum achievable control technology for existing uncontrolled transfer machines is refrigerated condensers. However, MACT for existing transfer machines equipped prior to promulgation with carbon adsorbers is either a refrigerated condenser or a carbon adsorber. The final rule does not require the replacement of these carbon adsorbers with refrigerated condensers. The Administrator could not conclude, based on currently available information, that requiring replacement of a well-operated carbon adsorber with a refrigerated condenser was justified. Room enclosures capture and vent the fugitive PCE emissions from clothing transfer between the washer and the dryer at transfer machine systems to a carbon adsorber. Since clothing transfer emissions are a significant portion of overall transfer machine system emissions, control of these through a room enclosure would achieve additional emission reductions. Section V provides a more detailed discussion of these control devices.

Based on the results of further analysis, it was considered reasonable to go beyond the floor to require room enclosures for fugitive emission control in addition to refrigerated condensers for process vent control for transfer machine systems located at a major source.

2. Area Sources

Section 112 of the Act defines an area source as any stationary source of HAP's that is not a major source. Based on this definition, a dry cleaning facility that emits less than 9.1 Mg/yr (10 tpy) of any one HAP would be considered an area source. In section 112(d)(5), the Act further states that the Administrator may elect to promulgate a standard based on GACT or management practices to control HAP emissions from area sources instead of applying the MACT.

Section 112(c)(3) requires a "finding" of a threat of adverse effects to human health or the environment (by such sources individually or in the aggregate warranting regulation) in order to regulate area sources under NESHAP. The large number of area source dry cleaning facilities nationwide emit, in aggregate, a significant amount of PCE emissions and, therefore, have the potential to have an adverse effect on health and the environment.

Unlike MACT, no stringency "floor" is required for GACT; and costs, economic impacts, and the technical capabilities of dry cleaning facility owners and operators to operate emission control equipment may be considered in determining GACT. For the most part, the technology used to achieve the level of emission control determined to achieve MACT is also used widely by area source dry cleaning facilities and could be considered GACT.

The GACT approach can be less stringent than MACT and can consider costs and economic impacts. At proposal, GACT for all area sources, except for existing refrigerated condenser controlled transfer machines was determined to be the use of either a refrigerated condenser or a carbon adsorber. Subsequent to proposal, the EPA learned that carbon adsorbers may not be operated as well as refrigerated condensers. Based on this finding, all new and existing uncontrolled area sources are required to install refrigerated condensers for process vent control. However, the Administrator determined that, based on existing information, a requirement to replace existing carbon adsorbers with refrigerated condensers is not justified at this time. No new transfer machines are allowed. These requirements were determined to be reasonable for area sources and are identical to MACT requirements. The EPA determined that the economic impacts of requiring the owner or operator of a new area source dry-to-dry machine to install a supplemental carbon adsorber to control PCE emissions in the dry cleaning machine drum is not reasonable. Further, the Administrator determined that the economic impacts of requiring the owner or operator of an existing area source transfer machine system to install a room enclosure to capture transfer emissions are unreasonable. Additional discussion of these findings is presented in section V.

Therefore, GACT for area sources would be identical to MACT for major sources except that the owner or operator of a new dry-to dry machine would not be required to install a supplemental carbon adsorber and the owner or operator of an existing transfer machine system would not be required to install a room enclosure.

C. Selection of Format for the Final Rule

1. Equipment Exhausts and Vents.

Emission standards for controlling PCE allow for some flexibility in complying with the standards because any control technique may be used if it achieves the level of emission reduction represented by the standards. An emission limitation format could be a concentration limit, a percent reduction level, or a mass emission rate limit.

Both the concentration limit and the percent reduction level would require periodic performance testing by the owner or operator to demonstrate that the dry cleaning facility is achieving compliance. Because the cost of requiring an owner to conduct even a single periodic performance test is expensive ($3,000 to $5,000) compared to the cost of control equipment ($6,000 to $8,000), it would be economically unreasonable to require either of these two emission limit formats for these standards.

A mass emission limit format would place a limit on the total consumption of HAP per unit of articles cleaned, also known as "solvent mileage." Some members of the dry cleaning industry use the "solvent mileage," method to compute the pounds of articles that can be cleaned per drum of solvent. To determine "solvent mileage," a record of gallons of solvent bought and amount of clothes cleaned would have to be kept. However, the amount of recordkeeping necessary to compute solvent mileage to comply with this type of format (such as weighing each load of clothes prior to cleaning and tracking the amount of solvent consumed) would be burdensome for a small facility owner or operator.

In addition to being impractical and an economic burden on dry cleaner owners or operators to measure emissions or to compute solvent mileage for these sources, it would be difficult to enforce emission standards at several thousand dry cleaning facilities across the country, ensuring that each dry cleaner is achieving the emission standards. For these reasons, as authorized under section 112(h), an equipment standard requiring the use of a refrigerated condenser, or an equivalent control device was selected to limit emissions from these sources.

2. Equipment Leaks.

Based on dry cleaning machine test data, as much as 25 percent of the PCE emissions from an uncontrolled dry cleaning facility can be attributed to leaks from the dry cleaning equipment. Two possible formats for a standard to control these leaks are an emission limit standard or a work practice standard under section 112(h).

To require an emission limit for a leak standard, the leak sources would need to be enclosed so that the actual emission rate could be measured. Because this procedure would be impractical on the many potential leak sources on dry cleaning equipment, an emission limit format is not the preferred format for leaks.

Because control of fugitive equipment leaks requires maintenance of the dry cleaning equipment, the EPA is proposing a work practice with a program to detect and repair leaks as the logical format. The work practice would specify the inspection time intervals and an inspection method to locate the leaks, and would limit the time period allowed to perform the required maintenance and repairs. The proposed inspection method requires only a quantitative determination of the presence of a leak (i.e., visual or use of a portable halogenated-hydrocarbon detector). Although the effectiveness of this work practice cannot be quantified precisely, the EPA believes it would result in a substantial reduction of fugitive emissions. The work practice format has been selected for the proposed equipment leak standard because less time is required for demonstrating compliance, and the recordkeeping and economic impacts associated with this format are not burdensome.

D. Summary of Changes Since Proposal

Since proposal, several changes have been made to the regulation. The changes affect new and existing dry cleaning machines located at major and area sources. At proposal, owners or operators of new dry-to-dry machines located at major or area sources were given a choice of installing carbon adsorbers or refrigerated condensers as process vent control. At promulgation, all new dry cleaning machines located at major or area sources are required to install refrigerated condensers.

The owner or operator of a new dry-to-dry machine located at a major source is also required to install a carbon adsorber to control the PCE emissions remaining in the dry cleaning machine drum at the end of the dry cleaning cycle.

At proposal, new transfer machine systems were allowed and control requirements for these systems were specified. At promulgation, new transfer machine systems are prohibited through a regulatory requirement prohibiting PCE emissions from clothing transfer between the washer and the dryer. This

requirement cannot be met by new transfer machine systems even if these systems are enclosed in room enclosures.

At proposal, existing uncontrolled dry-to-dry machines located at major or area sources were given a choice of installing carbon adsorbers or refrigerated condensers as process vent control. Existing uncontrolled transfer machine systems located at area sources were required to install carbon adsorbers. At promulgation, existing uncontrolled dry-to-dry machines and transfer machine systems are required to install refrigerated condensers. Existing controlled machines that already have a carbon adsorber, however, are not required to install a refrigerated condenser for process vent control.

At proposal, existing uncontrolled transfer machine systems located at major sources were required to install carbon adsorbers. At promulgation, existing uncontrolled transfer machine systems located at major sources are required to install refrigerated condensers as process vent control. Existing controlled transfer machine systems at major sources that already have a carbon adsorber, however, are not required to install a refrigerated condenser for process vent control. For control of fugitive emissions, all existing transfer machine systems located at major sources must be enclosed within a room enclosure that exhausts to a carbon adsorber.

At proposal, the low solvent consumption exemption for process vent control at area sources was 220 gallons of PCE per year for a dry-to-dry machine and 300 gallons of PCE per year for a transfer machine system. At promulgation, the low solvent consumption exemption for process vent control has been lowered and now applies to the total PCE solvent consumption of all machines at the dry cleaning facility rather than on a per machine basis. At promulgation, the low solvent consumption exemption for process vent control is 140 gallons of PCE per year for a dry cleaning facility with only dry-to-dry machines or both dry-to-dry machines and transfer machine systems, and 200 gallons of PCE per year for a dry cleaning facility with only transfer machines systems.

The levels of PCE consumption distinguishing major from area sources have been lowered from the proposed levels and now apply to the total PCE consumption of all machines at the facility rather than on a per machine basis. The levels of PCE consumption distinguishing a major source from an area source are 2,100 gallons of PCE per year for a source with only dry-to-dry machines, and 1,800 gallons of PCE per year for a source with only transfer machine systems or both dry-to-dry machines and transfer machine systems. To track PCE consumption, the owner or operator of any dry cleaning facility subject to this rule is required on the first day of each month to compute an annual PCE consumption by summing PCE purchases over the previous 12 months.

At proposal, pollution prevention practices (such as leak detection and repair) were required only for those dry cleaning machines above the low solvent consumption exemption for process vent control. At promulgation, all PCE dry cleaning facilities must implement pollution prevention practices and operate their dry cleaning equipment according to the manufacturer's specifications.

There were no monitoring requirements included at proposal. The promulgated standards now require periodic monitoring of process vent control equipment. When operating a refrigerated condenser on a dry-to-dry machine, a transfer machine system dryer, or a reclaimer, the temperature on the outlet side of the refrigerated condenser must be measured and recorded once per week. When operating a refrigerated condenser on a transfer machine system washer, the difference between the inlet and outlet temperatures of the exhaust from the washer as it passes through the refrigerated condenser must be measured and recorded once per week.

When operating an existing carbon adsorber to control process vent emissions, a colorimetric detector tube must be used to measure and record the PCE level in the carbon adsorber exhaust once per week. Periodic desorption for carbon adsorbers is no longer specifically required. Instead, the owner or operator must follow the manufacturer's specifications for the proper operation of a carbon adsorber.

The proposed rule would have required compliance within 18 months of publication of the final rule for existing dry cleaning machines with a design capacity larger than 22.7 kilograms (50 lbs). The compliance deadline for smaller machines would have been 36 months from promulgation. The final rule requires each existing dry cleaning system to be in compliance within 36 months of publication of the final rule, except that compliance with pollution prevention requirements and recordkeeping and reporting requirements is required starting 90 days after the rule's publication.

Section 112(i) of the Clean Air Act requires the EPA to set compliance dates for existing sources that provide for compliance as expeditiously as practicable, and no later than 3 years after promulgation of the final rule (with certain exceptions). As explained in the background information document cited at the beginning of this notice, the EPA is allowing 36 months for control technology to be installed on all dry cleaning machines because of questions about the market availability of an adequate supply of refrigerated condensers. On the other hand, the EPA has concluded that the pollution prevention requirements of the rule do not require significant capital expenditures and are feasible for dry cleaners to implement within 90 days. These requirements consist of "good housekeeping" practices such as inspecting for leaks and keeping the machine door closed during operation. The earlier compliance date in the final rule will result in earlier emissions reductions.

The 90-day applicability date for recordkeeping and reporting requirements will enhance the enforceability and effectiveness of the rule. One reason is that the applicability of control technology requirements in the rule depends on a facility's solvent consumption over a 12-month period. If documentation of a facility's solvent consumption was not required until 3 years after promulgation, it would be impossible to determine reliably which control technology requirements apply to a dry cleaning facility. Second, requiring an initial report from existing sources within 90 days will encourage these sources to begin planning for compliance with the rule's control technology requirements at an early date. This requirement also will provide regulatory agencies with information about regulated facilities in time to promote and monitor compliance effectively.

E. Potential to Emit

The annual major-source consumption levels (8,000 liters (2,100 gallons) per year for dry-to-dry machines and 6,800 liters (1,800 gallons) per year for transfer machine systems) represent the EPA's determination of the volumes of PCE that are used and consumed by the two different types of machine in order to emit 10 tons of PCE per year. Because it is not economically and technically feasible to precisely monitor and measure yearly PCE emissions at each of the dry cleaning facilities affected by this rule, PCE consumption is an appropriate surrogate measure. The EPA has found that PCE emissions to ambient air are closely and predictably related to the volume of PCE used and consumed in the dry cleaning process. Accordingly, this rule does not require each dry cleaning facility to test and calculate the maximum annual rate of PCE stack and fugitive emissions for each particular dry cleaning machine regulated under this rule. Instead, the consumption level assigned to each type of dry cleaning machine determines whether a facility is a major source (that is, whether it emits or has the potential to emit 10 tons or more of PCE).

The consumption levels differ between dry-to-dry (8,000 liters) and transfer machine systems (6,800 liters) because the use of a dry-to-dry machine results in lower fugitive emissions than the use of a transfer machine system. Stated another way, a dry-to-dry machine is more efficient in its use of PCE from an air emission perspective. This higher efficiency means that for each liter of PCE used for dry cleaning, a dry-to-dry machine emits less PCE to the ambient air than a transfer machine system. Accordingly, a dry-to-dry machine can use or consume a greater volume of PCE than a transfer machine system before emitting 10 tons or more of PCE to the ambient air. Amounts of PCE used and consumed in dry cleaning processes but not emitted to the ambient air at a dry cleaning facility include amounts of PCE transferred offsite as solid waste in used filters and spent carbon, amounts transferred to wastewater streams, and amounts that remain in cleaned clothing at the time of customer pickup.

The major source consumption levels established in the final rule differ from the major source consumption levels in the proposed dry cleaning rule of December 9, 1991. The proposed major source PCE consumption levels were 11,700 liters (3,100 gallons) for dry-to-dry machines, and 7,600 liters (2,000 gallons) for transfer machine systems. The difference is due to the EPA's determination that the major source consumption levels for PCE established in the final rule (8,000 liters or 2,100 gallons for dry-to-dry machines and 6,800 liters or 1,800 gallons for transfer machine systems) more accurately reflect the volume of PCE that each type of machine uses or consumes in emitting 10 tons of PCE.

Under the rule, a dry cleaning facility will be classified as a major or area source in the following manner. As previously mentioned, a facility has the potential to emit more than 10 tons of PCE only if its solvent consumption exceeds the rule's solvent use cut-off levels that divide major sources from area sources. The owner or operator must certify to the regulating agency whether or not the facility's solvent consumption will exceed the cut-off level. If solvent consumption is greater than or equal to this cut-off level, the facility is to be considered a major source and must comply with all major sources requirements. If solvent consumption is less than the cut-off level, the facility is considered an area source.

If a facility is found to be an area source, the next determination is whether or not the facility must install area-source technology controls. To be exempt from technology controls, the facility's certification must guarantee that solvent use is less than the low-solvent-use exemption level. Otherwise, area-source control technology requirements apply to the facility.

The rule's requirements are intended to ensure that all dry cleaning facilities that have the potential to emit 10 tons of PCE considering controls are regulated as major sources. If regulated as an area source, a facility will be required to observe the limit on solvent consumption to which it certified, as well as meet other requirements for area sources. These are Federally enforceable requirements that will prevent area sources from emitting more than 10 tons of PCE in a year. After its compliance date, if an area source wishes to increase operations or add a dry cleaning machine, and the result would be to increase solvent consumption above the major-source cutoff level, the facility must first comply with the rule's requirements for major sources. Failure to do so would result in a violation of the rule.

In this rule, the EPA is not establishing any precedents or policies concerning the determination of a facility's "potential to emit" or its classification as a major or area source under section 112. The EPA believes it would be unwise and inappropriate to resolve these complex issues solely in the context of the

PCE dry cleaning NESHAP because the result could create numerous unforeseen problems and inequities in regulation of other categories of sources. The EPA is considering these issues in a comprehensive fashion in light of the broad range of sources for which NESHAP will be developed. The EPA is presently continuing to consider these issues and will take whatever appropriate actions that are necessary to resolve them.

III. Summary of Environmental, Energy, and Economic Impacts

A. Affected Facilities

The number of new and existing machines in 1996 (5 years from the date of proposal) were projected in order to calculate the 5-year impacts of the standards. Industry estimates indicate a zero growth rate for commercial dry cleaning facilities. For this reason, the only new facilities projected to be constructed during the 5 years following the date of proposal (between 1991 and 1996) are an estimated 7,700 new commercial facilities which replace those that retire. Industrial dry cleaning facilities are declining because many of these facilities are switching from the use of PCE to the use of water to wash linens and uniforms. For this reason, no new industrial facilities are projected between 1991 and 1996. Approximately 28 industrial facilities would retire during this period.

In 1996, based on the estimates of machine retirement, approximately 17,400 existing commercial and industrial facilities will be subject to the standards. Taking into account the low solvent consumption exemption levels for existing area sources, approximately 9,700 of these existing facilities would be required to install process vent control devices. Of these facilities, however, approximately 6,500 are expected to decide to install process vent control devices to comply with State or local regulations. Thus, in 1996 approximately 3,200 existing facilities are estimated to have to install process vent control devices solely to comply with the standards promulgated today.

As mentioned above, between 1991 and 1996, 7,700 new facilities are projected. All of these facilities are required to install process vent controls. Of these new facilities, approximately 7,300 are expected to decide to install process vent control devices to comply with State or local regulations. Thus, in 1996 approximately 400 new facilities are estimated to install process vent control devices solely to comply with the standards promulgated today.

The following discussion presents the projected environmental, energy, and economic impacts for 1996 based on the estimated 3,200 existing and 400 new facilities that would be required to install process vent control devices solely to comply with the standards promulgated today.

B. Air Impacts

In 1996, the standards are expected to reduce nationwide emissions of PCE from existing dry cleaning facilities by a maximum of some 5,500 Mg (6,000 tons) from process vent control and some 18,000 Mg (19,800 tons) from leak detection and repair. This emission reduction is based on projected nationwide PCE emissions from existing facilities in 1996 of 42,000 Mg (46,500 tons) in the absence of the standards. This emission reduction corresponds to approximately 44 percent of the total PCE emissions from all existing dry cleaning facilities. This reduction is in addition to reductions achieved by controls already in place in many of these facilities, and reductions anticipated in the absence of the NESHAP.

In 1996, the standards are expected to reduce nationwide emissions from new dry cleaning facilities by a maximum of some 1,100 Mg (1,200 tons) from process vent control and some 7,800 Mg (8,600 tons) from leak detection and repair. This emission reduction is based on projected nationwide PCE emissions in 1996 of 15,800 Mg (17,400 tons) from new dry cleaning facilities in the absence of the standards. This emission reduction corresponds to about 43 percent of the total PCE emissions from all new dry cleaning facilities.

In 1996, annual emissions of PCE from a typical new or existing dry cleaning facility located at an area source with annual receipts of $200,000 operating a typical size dry-to-dry machine with capacity of 15.9 kilograms (kg) (35 pounds (lb)) controlled with a refrigerated condenser are projected to be 0.77 Mg (0.85 tons) from process vent control and 0.8 Mg (0.88 tons) from leak detection and repair. This represents greater than 50-percent reduction in emissions from an uncontrolled dry-to-dry machine of this same size and receipt level.

C. Water, Solid Waste, Noise, and Radiation Impacts

The requirement for use of refrigerated condensers minimizes the impact on water quality resulting from the standards. The projected impact on water quality results from the PCE contained in aqueous wastes generated by the control devices. When using a refrigerated condenser, a small amount of PCE is generated and collected in the separator water. A typical refrigerated condenser controlled dry-to-dry machine is estimated to generate about 0.03 kg (0.07 lb) of PCE in wastewater per year. Owners or operators of all new dry cleaning machines and those existing uncontrolled dry cleaning machines that are above the low solvent consumption exemption levels would be required to install refrigerated condensers.

When using a carbon adsorber, PCE is collected in the steam condensate generated during desorption of the carbon. A typical existing dry-to-dry machine with an existing carbon adsorber is estimated to generate 0.85 kg (1.9 lb) of PCE in wastewater per year. However, only owners or operators of

existing dry cleaning machines with existing carbon adsorbers installed prior to the date of promulgation would be allowed to continue to use a carbon adsorber as primary process vent control.

In addition to process vent control, owners or operators of existing transfer machine systems located at major sources would be required to install a room enclosure with a carbon adsorber. A carbon adsorber on the room enclosure is estimated to be approximately one-third the size of a typical carbon adsorber used to control process vent emissions. A typical transfer machine system located at a major source with a carbon adsorber on the room enclosure is estimated to generate 0.28 kg (0.60 lb) of PCE in wastewater per year. This amount is in addition to the 0.85 kg (1.9 lb) of PCE in wastewater generated if the transfer machine system has a carbon adsorber controlled process vent.

Owners or operators of new dry-to-dry machines at major sources would be required to install a carbon adsorber to control the PCE remaining in the dry cleaning machine drum at the end of the dry cleaning cycle. This carbon adsorber is also estimated to be approximately one-third the size of a typical carbon adsorber used to control process vent emissions. A typical dry-to-dry machine with a refrigerated condenser controlled process vent and a carbon adsorber to control the PCE emissions remaining in the machine drum is expected to generate about 0.31 kg (0.68 lb) of PCE in wastewater per year.

It is projected that the total amount of PCE in wastewater generated on a national basis by dry cleaning facilities in the absence of the standards in 1996 would be 5.9 Mg (6.5 tons). With the standards, the amount of PCE in wastewater generated on a national basis by dry cleaning facilities is projected to be about 6.1 Mg (6.7 tons) in 1996, an increase of about 0.2 Mg (0.2 ton) per year (corresponding to an increase of about 3 percent).

The solid waste impact of the standards is considered minimal. The main types of solid waste generated from controlled dry cleaning machines are spent carbon from carbon adsorbers, spent carbon from cartridge filters, solvent sludge (muck), and still bottoms. Neither a carbon adsorber nor a refrigerated condenser would affect muck, still bottom, or cartridge filter carbon generation, so no impact due to the control alternatives was calculated for these waste types.

Periodic replacement of the carbon bed associated with a carbon adsorber is necessary to maintain the performance of a carbon adsorber in controlling PCE emissions. According to carbon vendors, the carbon is likely to need replacement approximately every 5 years.

For a typical 15.9 kg (35 lb) existing area source dry-to-dry machine controlled with an existing carbon adsorber installed prior to today's date, the amount of solid waste generated from spent carbon is estimated to be approximately 25 kg

(55 lb) per year. For a typical 113 kg (250 lb) existing major source dry-to-dry machine controlled with an existing carbon adsorber, the amount is estimated to be approximately 90 kg (198 lb) per year. These are the same amounts that would be generated in the absence of the standards.

New major source dry-to-dry machines with refrigerated condenser and carbon adsorber control would also require periodic replacement of the carbon bed. For a typical major source dry-to-dry machine with both refrigerated condenser and carbon adsorber control, the amount of solid waste generated from spent carbon is estimated to be approximately 8.4 kg (19 lb) per year.

Existing major source transfer machine systems with carbon adsorbers on their room enclosures would also require periodic replacement of the carbon bed. For a typical major source transfer machine system with refrigerated condenser process vent control and carbon adsorber control on the room enclosure, the amount of solid waste generated from spent carbon is estimated to be about 8.4 kg (19 lb) per year. For a typical major source existing transfer machine system with carbon adsorber process vent control and carbon adsorber control on the room enclosure, the amount of solid waste generated from spent carbon is estimated to be about 98 kg (217 lb) per year.

It is projected that the amount of carbon discarded every 5 years in the absence of the standards would be 880 Mg (970 tons) or an average of 175 Mg (193 tons) per year. With the standards, the amount of carbon discarded on a national basis every 5 years would be 890 Mg (980 tons) or an average of 177 Mg (195 tons) per year. This corresponds to an increase in national solid waste impacts from both new and existing dry cleaning facilities of about 10 Mg (10 tons) of carbon discarded approximately every 5 years, or an average of about 2 Mg (2 tons) of carbon every year (corresponding to an increase of about 1 percent).

There are no noise or radiation impacts associated with these standards.

D. Energy Impacts

The energy impacts resulting from the standards on a nationwide basis are considered minimal. Electricity is required for cooling the coils of the refrigerated condenser and for operating fans and generating steam for desorbing existing carbon adsorbers. The total increase in annual electricity use for existing dry cleaning facilities in 1996 resulting from the standards would be about 2,454,500 kilowatt-hours per year (KW-hr/yr) (390,000 British thermal units per year (Btu/yr)). The total increase in annual electricity use for new dry cleaning facilities in 1996 resulting from the standards would be about 276,600 KW-hr/yr (44,000 Btu/yr). The total increase in annual electricity use for all facilities nationwide would be about 2,731,100 KW-hr/yr (430,000 Btu/yr).

This increase in electricity requirement is equivalent to about 700,000 liters (3,400 barrels (bbl)) of fuel oil per year for electricity generation for existing facilities and about 79,000 liters (380 bbl) of fuel oil per year for new facilities. The total increase for all facilities would be about 780,000 liters (3,800 bbl) of fuel oil per year, corresponding to an increase of 0.7 percent.

By installing a refrigerated condenser as required by the standards, the electricity requirement for a typical uncontrolled dry cleaning facility with one 15.9 kg (35 lb) dry-to-dry machine is expected to increase by about 600 KW-hr/yr (95 Btu/yr) in 1996.

E. Cost Impacts

The nationwide cumulative 5-year capital costs in 1996 of complying with the standards would be about $35 million. The cumulative 5-year capital costs for existing facilities would be about $32 million and about $3 million for new facilities.

The total nationwide annualized costs in 1996 of complying with the standards for process vents would be about $9 million. This estimate does not include credit for solvent savings. If a credit for solvent savings is included, the total nationwide annualized cost is about $4 million. The annualized costs in 1996 including a credit for solvent savings for existing facilities complying with the standards would be about $3.4 million, and about $0.5 million for new facilities.

The total nationwide annualized costs in 1996 for both new and existing facilities complying with the standards for pollution prevention, leak detection and repair, monitoring, reporting and recordkeeping would be about $10 million. This estimate does not include credit for solvent savings. If a credit for solvent savings is included in this estimate, these facilities would have a total annual cost savings of $7.6 million.

For a typical new area source facility with annual receipts of $200,000 with a 15.9 kg (35 lb) dry-to-dry machine, the capital cost of a refrigerated condenser is $6,300, and the resulting annualized cost of this process vent control is $1,000. The resulting annualized cost for the above typical new area source to perform pollution prevention, leak detection and repair, monitoring, reporting, and recordkeeping is about $460. This estimate does not reflect credit received from solvent savings. If a credit for solvent savings is included, this typical facility would have a total cost of about $350.

F. Economic Impacts

The economic impact assessment includes a market component and a financial component. The market component focuses on the adjustment of market prices and quantity of dry cleaning as a result of complying with the standards. The financial component focuses on the ability of firms to obtain the money to buy the control equipment.

The upward price adjustments are projected to range between 0.15 and 2.3 percent in various markets, with the largest increases being found in small rural markets. The downward adjustment in total dry cleaning is projected to be about 0.5 percent. If the whole quantity adjustment were translated into closures rather than reduction in output at many cleaners, the net closures would be projected to be just under 260.

The financial analysis indicates that firms in below-average financial condition may face difficulty in obtaining the required funds to purchase control equipment from traditional loan sources such as banks. The analysis projects between 0 and 830 firms will be in this category. These firms will either obtain other financing (vendor-aided, relatives, personal assets, etc.), close, or sell their firm.

The environmental, energy, and economic impacts are discussed in greater detail in the BID's and the economic impact analyses for the proposed and promulgated standards: "Dry Cleaning Facilities-Background Information for Promulgated Standards," EPA-450/3-91-020b; "Dry Cleaning Facilities-Background Information for Proposed Standards," EPA-450/3-91-020a; "Economic Impact of Regulatory Controls in the Dry Cleaning Industry," EPA-450/3-91-021; and "Economic Impact of Regulatory Controls in the Dry Cleaning Industry," EPA-450/3-91-021b. Additional information on impacts is found in supporting information for the notice of availability of new information, "Information Package on Transfer Enclosures," (Docket No. A-88-11, Item No. IV-M-1).

In addition to the economic impact analysis, the cost effectiveness of alternative standards was also evaluated to determine the least costly way to reduce emissions and to ensure that the controls required by this rule are reasonable relative to other regulations. In this case, the promulgated standards would reduce the PCE dry cleaner's operating costs and produce an average 5-year total cost effectiveness of $550 per Mg ($500 per ton) of PCE emissions reduced. Additional details on costs can be found in the BID's.

IV. Public Participation

Prior to proposal of the standards, interested parties were advised by public notice in the Federal Register (56 FR 1186), January 11, 1991, of a meeting of the National Air Pollution Control Techniques Advisory Committee to discuss the

NESHAP being developed for the PCE dry cleaning industry. This meeting was held on January 30, 1991. The meeting was open to the public and each attendee was given an opportunity to comment on the NESHAP recommended for proposal.

The standards were proposed and published in the Federal Register on December 9, 1991 (56 FR 64382). The preamble to the proposed standards discussed the availability of the BID and the economic impact analysis: "Dry Cleaning Facilities Background Information for Proposed Standards, EPA-450/3-91-020a" and "Economic Impact of Regulatory Controls in the Dry Cleaning Industry EPA-450/3-91-021," which described in detail the regulatory alternatives considered and the impacts of those alternatives. Public comments were solicited at the time of proposal, and copies of the BID were distributed to interested parties.

As a result of public comments received on the proposed standards, additional information became available about transfer enclosures used to control PCE emissions during the transfer step for transfer machine systems. A notice of availability of new information was published in the Federal Register on October 1, 1992, describing this information and requesting public comments.

Because no persons requested the opportunity for oral presentation of data, views, or arguments concerning either the proposed NESHAP or the notice of availability of new information, a public hearing was not held.

The public comment period for the proposal NESHAP was from December 9, 1991, to February 9, 1992. A total of 32 comment letters were received in response to the proposed NESHAP. The public comment period was reopened for the notice of availability of new information from October 1, 1992, to November 2, 1992. A total of seven comment letters were received in response to the notice. All comments have been carefully considered and, where determined to be appropriate by the Administrator, changes have been made in the proposed standards.

V. Significant Comments and Changes to the Proposed Standards

Comments on the proposed NESHAP and the notice of availability of new information were received mainly from industry; State and local air pollution control agencies; trade associations; and environmental groups. A detailed discussion of these comments and responses can be found in the promulgation BID, which is referred to in the ADDRESSES section of this preamble. The summary of comments and responses in the BID serves as the basis for the revisions that have been made to the standards between proposal and promulgation. The major comments and responses are summarized in this preamble and, for ease of discussion, have been divided into the following areas:

A. Regulatory Approach 1. MACT vs. GACT 2. Collocation
B. Emission Control 1. Performance of Refrigerated Condensers and Carbon Adsorbers 2. Low Solvent Consumption Exemption Levels 3. MACT for New Dry-to-Dry Machines at Major Sources 4. Banning Transfer Machine Systems and Reclaimers 5. Room Enclosures on Transfer Machine Systems 6. Vapor Barriers 7. Dry Cleaning Ventilation Requirements
C. Monitoring and Equivalency 1. Monitoring Control Devices 2. Determining Equivalency 3. Delegation of Authority to Determine Equivalency
D. Other Issues and Follow-up to Today's Action 1. New York Study 2. California Well Investigation Program 3. Follow-up to Today's Action

A. Regulatory Approach

1. MACT vs. GACT

Several commenters remarked on the use of maximum achievable control technology (MACT) versus generally available control technology (GACT) for regulating dry cleaners. Most of these commenters believed that MACT should be used to regulate all dry cleaners. One commenter, however, believed that GACT was the appropriate basis of regulation.

The commenters who felt MACT should be applied to all dry cleaners argued that there is sufficient and compelling health effects information regarding PCE to warrant application of MACT to all dry cleaning machines regardless of type or size, and that section 112(c)(3), (i.e., a threat to human health and the environment by sources individually, or in the aggregate) warrants the application of MACT controls for all area source dry cleaners.

As stated in the proposal, the EPA has concluded that area source dry cleaners present a threat of adverse effects to health or the environment. For this reason, commercial dry cleaning facilities that are area sources were added to the list of source categories under section 112(c)(3) to be regulated under the Act. Listing an area source category under section 112(c)(3), however, does not require that regulations developed for this source category must be based on MACT. These regulations may be based on MACT or they may be based on GACT.

The EPA does not agree that the health effects information regarding PCE is so compelling that it warrants application of MACT to all small area source dry cleaners. There are a range of opinions in the scientific community as to the potential for PCE to cause cancer in humans. Further, to the extent that PCE may be a human carcinogen, existing evidence indicates that its potency is relatively low.

During development of the regulation, the EPA concluded that many small area source dry cleaning facilities may experience adverse economic impacts as a result of imposing a regulation based on MACT. For this reason, the GACT

approach was selected as the basis for regulating small area source dry cleaning facilities.

In commenting on the choice of GACT to regulate area source dry cleaners, several commenters acknowledged that section 112(k) of the Act outlines a comprehensive strategy to reduce HAP's from area sources. These commenters did not, however, believe that such a strategy would reduce PCE emissions sufficiently from area source dry cleaning facilities. Consequently, these commenters asserted that residual risk review should be required for all dry cleaners to ensure that public health is adequately protected. They argued that it is bad public policy to apply GACT to the vast majority of dry cleaning facilities, thus precluding a residual risk assessment at a later date. Based on knowledge gained on public exposure to PCE from dry cleaning facilities, they maintained that it is absolutely necessary that such a risk assessment be conducted for this source category.

Section 112(k) of the Act directs the EPA to develop a strategy to control HAP emissions from area sources in urban areas. The strategy, among other things, must achieve area source emissions reductions from the 30 HAP's that pose the greatest threat to public health and achieve at least a 75-percent reduction in cancer incidence from all stationary sources. Consequently, the need for emission controls beyond GACT at dry cleaners will be reconsidered in the context of the overall urban air strategy and the relative contribution of PCE emissions from dry cleaning facilities to urban exposures.

Although a residual risk analysis is required for sources regulated under MACT, those sources regulated under GACT may also receive a residual risk analysis. Section 112(f)(5) of the Act states that residual risk analysis is not required for area sources regulated under GACT. This section, however, does not preclude area sources from a residual risk analysis and, if warranted, the EPA will undertake a residual risk analysis for the area source dry cleaning source category.

The one commenter who agreed with the EPA's decision to use GACT to regulate small area source dry cleaners stated that much evidence exists in the Senate Committee report and the legislative history of the 1990 Clean Air Act Amendments to indicate that dry cleaning was considered an example of an area source category for which regulations based on GACT were appropriate.

2. Collocation

Commenters recommended that the criteria for determining a major source be based on the PCE solvent consumption of the entire dry cleaning facility instead of each dry cleaning machine. They mentioned that the definition of source used in the proposed NESHAP referred only to the consumption of PCE for an

individual dry cleaning machine and that under this proposed definition only certain machines would be considered major sources. The commenters believe that the EPA should consider the total consumption of PCE from all machines located within a contiguous area under common control.

The final rule has been revised to base the applicability of the NESHAP on the total annual PCE consumption of all machines located at a dry cleaning facility. For the purpose of these standards, PCE consumption during any period is defined as the PCE purchased during that period. The definition of a major source in the Act includes sources "located within a common area and under common control." Because multiple units located at a single dry cleaning facility would be under common control, the applicability of this NESHAP for major sources has been revised to be consistent with the language of the Act.

B. Emission Control

1. Performance of Refrigerated Condensers and Carbon Adsorbers

At proposal, the EPA believed the performance of carbon adsorbers to be equal to that of refrigerated condensers when used to control emissions from dry-to-dry machines, and proposed to allow dry-to-dry machines to install either control device. In addition, the EPA believed carbon adsorbers outperformed refrigerated condensers on transfer machine systems and proposed to require carbon adsorbers on uncontrolled transfer machine systems. Following proposal, however, new information was provided to the EPA from a survey of dry cleaners in California, which disputes these conclusions.

In 1989, the California Air Resources Board (CARB) conducted a voluntary survey of all dry cleaners in California. The results of this survey indicate that dry cleaning machines controlled by refrigerated condensers achieve solvent mileages approximately twice as high as machines controlled by carbon adsorbers.

Solvent mileage is the ratio of clothes cleaned to the amount of solvent consumed. Although air emissions are only one of several factors that determine solvent mileage, significantly better solvent mileage is likely to be indicative of lower air emissions. Although the data do not provide detailed information on how well the carbon adsorbers were operated and maintained (for example, frequency of desorbing the carbon bed), the EPA believes this information indicates that refrigerated condensers will achieve lower air emissions in actual practice than carbon adsorbers.

Therefore, the final rule requires refrigerated condensers for new major and area source dry-to-dry machines. The EPA has also concluded that all existing

uncontrolled dry-to-dry machines and transfer machine systems must install and operate refrigerated condensers.

The final rule does not require the replacement of existing carbon adsorbers with refrigerated condensers. The Administrator concluded, based on currently available information, that the replacement of well-operated carbon adsorbers with refrigerated condensers was not justified at this time.

These sources are largely small businesses and could face severe financial costs to replace these units. In addition, the final rule includes additional monitoring to ensure proper carbon adsorber operation. While replacement of well-operated carbon adsorbers with refrigerated condensers provides limited air benefits, EPA has recently obtained additional information that suggests that there may be other environmental impacts (for example, potential groundwater contamination and solid waste generation) associated with the use of carbon adsorbers over refrigerated condensers (see section V.D). At this time, those data are uncertain. EPA believes that these data and their implications deserve further consideration. A public meeting has been scheduled to discuss these issues. (See ADDRESSES section at the beginning of this preamble.) If appropriate, the EPA may revisit the requirements of this rule in the future.

2. Low Solvent Consumption Exemption Levels

Several commenters believed that although the economic impact of regulating small existing area source dry cleaners can be significant, the proposed low solvent consumption exemption levels would exempt existing small area source facilities they believed pose the largest health threat to individuals. These commenters stated that, as a result of their location in proximity to human populations, more people are exposed to air toxics from small existing area source dry cleaners than from large industrial complexes, such as chemical plants, which are not usually located in the midst of population centers. Some believed that virtually all small existing area source dry cleaners contributing to this problem would be exempted under the proposed NESHAP. They requested that the EPA reevaluate the low solvent consumption exemption levels to ensure that a larger number of small existing area source dry cleaning facilities is subject to the NESHAP.

Neither the proposed nor the final NESHAP includes low solvent consumption exemption levels for new area source dry cleaning facilities. The proposed, as well as the final NESHAP, however, includes low solvent consumption exemption levels for existing area sources.

At proposal, the impacts of requiring the use of refrigerated condensers or carbon adsorbers to control process vent emissions from dry cleaning machines were judged to be unreasonable for area sources consuming less than 760 and

1,000 liters (200 and 300 gallons) of PCE per year for dry-to-dry machines and transfer machine systems, respectively (corresponding to annual receipts of $100,000). In response to comments, the EPA reconsidered these low solvent consumption exemption levels. The EPA concluded that lowering the exemption levels to 530 and 760 liters (140 and 200 gallons) per year for dry-to-dry and transfer machines, respectively (corresponding to annual receipts of $75,000) was warranted and reasonable.

In 1996, this change would require approximately 500 more dry cleaners to install refrigerated condensers to control process vent emissions from dry cleaning machines and would reduce PCE emissions by an additional 450 Mg (500 tons) per year. The cost of controlling those facilities with annual receipts between $75,000 and $100,000 is $0.9 million. As many as 165 additional financial failures are estimated to result from lowering the low solvent consumption exemption levels. Also, there could be as many as 65 additional business closures. The EPA judged this change in the requirement to be generally achievable. The EPA considered it unreasonable, however, to further lower the low solvent consumption exemption levels due to the high costs and excessive financial failures and closures (up to 3,800 financial failures and 1,400 closures) that would result. The decision to exempt certain low solvent consumption facilities was based on the evaluation of the potential economic impact of regulation. Many of the smaller businesses are individually operated, single family-owned establishments.

In addition to lowering the low solvent consumption exemption levels for existing area source dry cleaning facilities, the EPA reevaluated the impacts of extending additional pollution prevention practices, such as leak detection and repair, to all dry cleaning facilities and concluded that these impacts are reasonable. Thus, in the final NESHAP, all dry cleaning facilities are required to implement additional pollution prevention practices, such as leak detection and repair.

3. MACT for New Dry-to-Dry Machines at Major Sources.

Commenters stated that additional controls should have been considered as MACT for dry-to-dry machines. A new German machine, the Permac Consorba(R), was mentioned by one commenter. This machine uses a carbon adsorber in conjunction with a refrigerated condenser for process vent control. The commenter indicated that it made sense that a dual control system would achieve better control than a machine with one control device.

In the simplest sense, a Permac Consorba(R) may be described as a dry-to-dry machine equipped with two control devices in series-a refrigerated condenser followed by a carbon adsorber. The reported advantage of this system over a conventional dry-to-dry machine equipped with only a refrigerated condenser is

that it reduces the PCE concentration in the air remaining in the machine once the dry cleaning cycle is complete.

Conventional dry-to-dry machines vent or release the vapors remaining in the machine at the end of the dry cleaning cycle. The Permac Consorba(R) controls these vapors with a carbon adsorber before the machine door is opened.

The emissions remaining in a conventional machine at the end of the dry cleaning cycle can be controlled by drawing the air remaining in the machine through a small carbon adsorber either before the door to the machine is opened (similar to the Permac Consorba(R)) or venting the air through a carbon adsorber to the atmosphere as the door is opened. Indeed, information was made available to the EPA after proposal indicating that several conventional vented dry-to-dry machines equipped with refrigerated condensers currently operate in this manner (i.e., the air remaining in the machine at the end of the dry cleaning cycle is vented to a carbon adsorber as the door to the machine is opened).

There is no difference in PCE emissions between a Permac Consorba(R) and a conventional vented dry-to-dry machine equipped with a refrigerated condenser and a small carbon adsorber on the vent. Similarly, there would be no difference in emissions between a Permac Consorba(R) and a conventional no-vent dry-to-dry machine equipped with a refrigerated condenser that passed the air remaining in the machine at the end of the dry cleaning cycle through a carbon adsorber, before the door to the machine is opened.

Under the Act, MACT for new major sources must be no less stringent than the best-controlled similar source. As a result, the final NESHAP requires that new major source dry-to-dry machines be equipped with a refrigerated condenser and that the air remaining in the machine at the end of the dry cleaning cycle be passed through a carbon adsorber prior to opening the machine door or that the air remaining in the machine be passed through a carbon adsorber as soon as the door to the machine is opened. Thus, the level of control required for major new source dry cleaning facilities is equivalent to that achieved by the Permac Consorba(R) technology.

The MACT is also required for existing dry-to-dry machines located at major sources. Under the Act, MACT for existing sources must be no less stringent than the average emission limitation achieved by the best 12 percent of existing sources. Less than 12 percent of existing major source dry-to-dry machines are using a refrigerated condenser in combination with a carbon adsorber to control PCE process vent emissions. However, MACT can be more stringent if the Administrator determines that the balance of costs, energy, and environmental impacts of choosing a more stringent level of control are reasonable.

Assuming a 95-percent emission reduction for a carbon adsorber, the incremental cost effectiveness of the additional emission reduction achieved by requiring conventional dry-to-dry machines with a refrigerated condenser to also install a carbon adsorber would be in the range of approximately $7,700 per Mg ($7,000 per ton) of PCE for a typical existing dry-to-dry machine located at a major source. If the efficiency of the carbon adsorber is less than 95 percent (as the California survey data mentioned earlier suggests), the cost effectiveness would be even higher. Because this additional cost of control is quite high for the additional amount of emission reduction achieved, the EPA does not consider this level of control reasonable for an existing dry-to-dry machine located at a major source.

4. Room Enclosures on Transfer Machine Systems

Commenters suggested that the EPA consider vapor containment and control systems, commonly referred to as "room enclosures," as MACT for transfer machine systems.

Room enclosures capture and vent the fugitive PCE emissions from clothing transfer between the washer and the dryer at transfer machine systems to a carbon adsorber. Since clothing transfer emissions are a significant portion of overall transfer machine system emissions, control of these through a room enclosure would achieve additional emission reductions.

The only type of control device that could effectively control PCE emissions on a room enclosure is a carbon adsorber. As stated previously, however, new information (i.e., the California survey) indicates that carbon adsorbers achieve a lower level of emission reduction in actual practice within the dry cleaning industry than originally thought.

Assuming a carbon adsorber achieves a 95-percent reduction in PCE emissions, the incremental cost effectiveness of requiring room enclosures with carbon adsorbers on existing major source transfer machine systems would be as low as $330 per Mg ($300 per ton) of PCE. In fact, even if the control efficiency of the carbon adsorber was as low as 20 percent, the incremental cost effectiveness of requiring room enclosures on major source transfer machine systems would be about $1,900 per Mg ($1,700 per ton) of PCE.

Although the EPA does not believe the control efficiency of carbon adsorbers within the dry cleaning industry is as low as 10 percent, making such an assumption for the purpose of calculations effectively indicates that, even at low control efficiencies, the use of room enclosures at major source transfer machine systems is reasonable. Consequently, the final NESHAP requires the use of room enclosures with carbon adsorbers at existing major source transfer machine systems.

Requiring existing major source transfer machine system dry cleaners to use room enclosures is not estimated to result in any additional financial failures or closures. Initially, due to the limited number of vendors of room enclosures, the EPA was concerned with the creation of a market for these devices. With few vendors and a large demand, the price of room enclosures could rise significantly. However, if required only for those few existing major source transfer machine systems, the demand for room enclosures is not judged sufficient to cause a significant rise in the price of a room enclosure.

For existing area sources, the impacts of requiring a room enclosure are considered unreasonable. The incremental cost effectiveness of requiring a room enclosure for a typical area source could be as high as $9,800 per Mg ($8,900 per ton) of PCE, even if the carbon adsorber is achieving a high percent emission reduction efficiency (e.g., 95 percent). If the carbon adsorber is operating at a lower control efficiency, the resulting incremental cost effectiveness would be even higher. The number of additional financial failures could be as high as 1,100 with as many as 260 additional closures if room enclosures were required on all existing area source transfer machine systems. Up to 500 additional financial failures and as many as 5 additional closures would result from such a requirement on only the largest area sources (e.g., those with annual receipts over $100,000). In addition, with only a few vendors of room enclosures, the EPA remains concerned with the impact that extending a requirement for room enclosures to all existing transfer machine system area sources would have on the price of room enclosures. For these reasons, the Administrator considers room enclosures unreasonable for existing transfer machine system area sources.

5. Banning Transfer Machine Systems and Reclaimers

Commenters recommended that the EPA impose a ban on the sale of new or used transfer machine systems. One commenter believed that transfer machine systems are still being offered and sold to dry cleaners, and that only a ban on the sale of transfer machine systems would prevent dry cleaners from purchasing these systems.

Prior to proposal, the EPA believed that no new transfer machine systems were being sold or had been sold in recent years due primarily to the adoption of the OSHA permissible exposure limit (PEL) of 25 parts per million (ppm) (January 19, 1989). The OSHA PEL was intended to reduce worker exposure to PCE. Based on the level of PCE emitted during the clothing transfer step at transfer machine systems, transfer machine systems were viewed as incapable of meeting the OSHA PEL. Consequently, the EPA believed it was not necessary to develop regulations that effectively banned or prohibited the use of new transfer machine systems.

Following proposal of the NESHAP for dry cleaners, however, the Eleventh Circuit Appeals Court remanded the PEL to OSHA. In addition, information provided to the EPA following proposal indicates that many owners or operators of transfer machine systems were meeting the OSHA PEL by increasing ventilation or rotating the placement of their workers. Moreover, it was learned that transfer machine systems, manufactured for use with petroleum solvents could be used as PCE transfer machine systems.

Finally, information provided to the EPA following proposal made it clear that, in some cases, reclaimers were being sold for use with dry-to-dry machines to increase the clothing throughput of the machines. A reclaimer is essentially a dryer, and its use with a dry-to-dry machine effectively converts the dry-to-dry machine to a washer, thus creating a new transfer machine system.

Consequently, the EPA has reconsidered its position at proposal, that a ban or prohibition of new transfer machine systems is unnecessary.

For transfer machine systems located at a major source, the NESHAP must be based on MACT. The Act states that MACT for new sources must be no less stringent than the best controlled similar source. A transfer machine system with a room enclosure represents the best controlled similar source. The MACT may be more stringent, however, if the Administrator believes the balance between the additional economic, energy, and environmental impacts of a more stringent requirement is reasonable. The only option more stringent than a transfer machine system with a room enclosure is a new dry-to-dry machine.

Dry-to-dry machines provide complete control of clothing transfer emissions (i.e., emissions released by transfer of clothing from the washer to the dryer of a transfer machine system). Dry-to-dry machines eliminate these emissions by eliminating the need to transfer clothing from a washer to a dryer (achieving 100 percent reduction of clothing transfer emissions).

The MACT for new transfer machine systems could be based on the use of new dry-to-dry machines, thereby requiring new major source transfer machine systems to eliminate all emissions from clothing transfer between the washer and the dryer. Such a requirement would effectively ban or prohibit new transfer machine systems because no technology has been identified to date (including the use of hamper enclosures or room enclosures) that could be added to a new transfer machine system to totally eliminate all PCE emissions from clothing transfer. Dry-to-dry machines offer an effective pollution prevention alternative to transfer machines. Promoting use of this equipment is consistent with the Agency's commitment to pollution prevention.

The benefits associated with a requirement based on new dry-to-dry machines would be 100 percent control of clothing transfer emissions. Clothing transfer is

estimated to contribute up to as much as 25 percent of the PCE emissions from an uncontrolled transfer machine system. For a typical major source, the annualized costs for requiring a dry-to-dry machine would be a net savings ($300) because overall PCE consumption is lower with a dry-to-dry machine. This lower cost is due to the increased amount of PCE that is recovered and recycled within the machine.

The EPA believes it is reasonable to require new transfer machine systems located at major sources to meet the same level of control of clothing transfer emissions as achieved by new dry-to-dry machines. Thus, the final NESHAP prohibits any emissions between the washing and drying step of the dry cleaning cycle for new transfer machine systems located at major sources. This requirement effectively bans or prohibits the use of new transfer machine systems at major sources.

For new area source transfer machine systems, the NESHAP is based on GACT. The GACT is a balance between environmental, economic, and energy impacts the Administrator considers reasonable. The incremental cost of requiring a new dry-to-dry machine over a new transfer machine system with a room enclosure at a typical new area source is approximately $600 per year. The EPA does not believe that the additional costs of purchasing a new dry-to-dry machine over purchasing a new transfer machine system with a room enclosure would deter entry (or expansion) into the dry cleaning market. If a business venture is viable and attractive with the purchase of a new transfer machine system and room enclosure, the EPA believes that the business venture would also be viable and attractive with the purchase of a new dry-to-dry machine. Consequently, requiring new area source transfer machine systems to eliminate all clothing transfer emissions (i.e., purchase a new dry-to-dry machine) is considered generally achievable. Thus, the final NESHAP also prohibits any emissions between the washing and drying step of the dry cleaning cycle for new transfer machine systems located at area sources. As mentioned above for major sources, this requirement effectively bans or prohibits the use of new transfer machine systems at area sources. Thus, all new transfer machines are effectively banned. Under the rule, the addition of a reclaimer to an existing dry-to-dry machine would constitute reconstruction of the dry cleaning system. As a result, the addition of a reclaimer to a dry-to-dry machine would be banned effective on today's date. Reclaimers added to a dry-to-dry machine after December 9, 1991 (the date of the proposed dry cleaning NESHAP) and prior to today's date are allowed to operate for up to three years from today's date, if the dry cleaning system complies in the interim with the proposed rule.

In addition to requiring that all new dry cleaning machines be dry-to-dry machines, phasing out or replacing existing transfer machine systems with dry-to-dry machines was also considered. Commenters questioned why there was no discussion of immediate or gradual replacement of existing transfer

machine systems in the proposal. They stressed that the EPA cannot rely upon OSHA rules for a prompt phase out of transfer machine systems.

There is little difference between the impacts of immediate replacement of existing transfer machine systems and replacement within three years, the maximum compliance period for existing sources under the statute. In both cases, the capital cost of the transfer machine system is a "sunk" cost that has been incurred and is not a factor in the analysis.

This "sunk" cost makes the analysis of replacing existing transfer machine systems quite different from that of banning or prohibiting new transfer machine systems. For existing transfer machines systems, the cost of replacing the existing system is the full cost of a new dry-to-dry machine. For a new system, the cost of banning or prohibiting the system is the difference in cost between a new transfer machine system and a new dry-to-dry machine. Consequently, the costs are much higher in the analysis of replacing existing transfer machine systems than they are in the analysis of banning or prohibiting new transfer machine systems. The emission reduction achieved is the same for either option.

The EPA analyzed the costs of requiring replacement of existing transfer machine systems with dry-to-dry machines in comparison with the additional fugitive emissions of PCE that result from transfer machine systems. The incremental cost effectiveness for replacing a typical existing major source transfer machine systems with a dry-to-dry machine is approximately $12,200 per ton of PCE reduced. For area sources, the incremental cost effectiveness for replacing the transfer machine system with a dry-to-dry machine is approximately $41,000 per ton of PCE reduced. The EPA has determined that based on this comparison, which relies on currently available information, requiring replacement of these transfer machine systems with dry-to-dry machines is not justified at this time. However, the EPA is aware that additional environmental impacts may be associated with the continued use of transfer machine systems in certain situations. For example, the impact on indoor air quality may be of concern. At this time, however, the data are insufficient to determine whether considering these other impacts it may be appropriate to further limit the use of transfer machine systems. The EPA will address this issue further in the public meeting (see ADDRESSES section at the beginning of this preamble) and will continue to examine this issue. If appropriate, the EPA may revisit the determinations made in this rule.

Commenters agreed with the EPA that use of a reclaimer with a dry-to-dry machine effectively creates a new transfer machine system. Therefore, they recommended a ban on the sale of new or used reclaimers.

Accordingly, the NESHAP has been revised to define a dry-to-dry machine used with a reclaimer as a transfer machine system. In addition, the NESHAP does not allow clothing transfer emissions to occur between the washing and the drying step of the dry cleaning cycle for a new transfer machine system. This requirement effectively bans or prohibits new transfer machine systems. It also effectively bans or prohibits the use of new reclaimers with new or existing dry-to-dry machines, because adding a reclaimer to a new or an existing dry-to-dry machine creates a new transfer machine system.

6. Vapor Barriers

In addition to room enclosures, some commenters requested that vapor barriers be required to prevent seepage of PCE to adjacent apartments. It was also suggested that dry cleaning facilities located in close proximity to residential buildings or food service establishments be required to have vapor barriers on all floors, walls, and ceilings to separate the dry cleaning facility from other areas in the building and to deter migration of PCE emissions.

Installing vapor barriers to prevent seepage of PCE emissions into adjacent living or working areas merely contains the emissions in the dry cleaning facility. Installing vapor barriers could lead to elevated PCE concentrations in the work areas and public areas of the dry cleaning facility, resulting in increased worker and public exposure at the dry cleaner. Vapor barriers could also be very expensive for a dry cleaning owner or operator to install. Estimates indicate that installation of a vapor barrier in a 30 by 50 by 20 foot dry cleaning facility would cost approximately $6,500. Based on available information, vapor barriers are considered unreasonable for a national standard due to their high cost and their failure to control or reduce PCE emissions.

The Administrator agrees with the concerns expressed by many commenters about the potential impact of fugitive emissions. As mentioned earlier, to address these concerns, the final NESHAP requires control of fugitive emissions by leak detection and repair. As a result, the NESHAP will significantly reduce fugitive PCE emissions from all dry cleaning facilities.

In a few cases, local agencies may find situations where they believe the use of vapor barriers may be warranted, such as the situation of a very large dry cleaning establishment without adequate ventilation located in an apartment complex. Cases such as this are best handled on a site-specific basis at the local level.

7. Dry Cleaning Ventilation Requirements

Commenters recommended including dry cleaning ventilation requirements in the final NESHAP. Specific dry cleaner exhaust or ventilation requirements were recommended, such as adopting the National Fire Protection Association (NFPA) Standard 32 for dry cleaning plants (1990 edition). This would require an air change within the dry cleaning plant every 5 minutes. In addition, commenters recommended that all dry cleaning machines install a ventilation system capable of maintaining a minimum air velocity of 0.6 meters per second (100 feet per minute) through the loading door of the dry cleaning machine, whenever the door is open.

Ventilation requirements in and of themselves would not reduce fugitive emissions. From the perspective of the NESHAP, the EPA believes it is more appropriate to focus on the use of equipment or techniques that prevents or controls emissions rather than to focus on ventilation requirements that merely divert, rather than reduce, emissions.

If dry cleaning plant ventilation systems were installed and the resulting exhaust routed through a control device, such as a carbon adsorber, this would reduce fugitive emissions; however, it could be prohibitively expensive. The NESHAP, therefore, does not include dry cleaning plant ventilation requirements. On the other hand, the NESHAP does not preclude a dry cleaning plant from installing ventilation systems. Moreover, where local authorities consider a ventilation system necessary, the NESHAP does not prevent or hinder local authorities in any way from requiring additional measures such as ventilation systems.

The NESHAP requires the implementation of a leak detection and repair program, to control fugitive PCE emissions. These measures will achieve a substantial reduction in fugitive emissions at dry cleaning facilities.

C. Monitoring and Equivalency

1. Monitoring Control Devices

Many commenters stated that the NESHAP should contain some type of emission limit and performance testing. They asserted that requiring the dry cleaning owner or operator to install certain equipment and follow work practices without a performance test will not necessarily reduce emissions. The commenters felt the only way to ensure emission reductions was to establish and enforce an emission limit through performance testing.

As discussed in the proposal preamble, the cost of requiring an owner or operator to undertake a full-fledged performance test to demonstrate compliance with emission limits based on the use of a refrigerated condenser or a carbon adsorber would be expensive ($3,000 to $5,000), especially compared to the cost of this emission control equipment ($6,000 to $8,000). The additional

cost of such a performance test, therefore, would create a significant impact by almost doubling the cost that the NESHAP would impose.

The economic analysis conducted prior to proposal indicated that many operators will likely experience difficulty in obtaining capital to purchase emission control equipment. To preclude unreasonable economic impacts, the NESHAP does not require vent controls on existing sources with an annual PCE consumption of less than 530 liters (140 gallons) per year for facilities with dry-to-dry machines or 760 liters (200 gallons) per year for facilities with transfer machine systems. Imposing additional costs by requiring a full-fledged performance test to determine compliance would add significantly to the economic impact of the NESHAP and would result in raising the low solvent consumption exemption levels for existing sources and decrease the emission reductions achieved by the NESHAP.

Several commenters believed that the NESHAP should include emission limitations and performance testing for carbon adsorbers. They believed that an emission limit for carbon adsorbers is necessary because operating requirements alone are not enough. Examples were cited of carbon adsorbers with damaged prefilters or leaking dampers drastically reducing emission control efficiency.

The concerns of the commenters regarding poor operation and maintenance of equipment are well founded. There is, however, incentive for an owner or operator to properly operate and maintain dry cleaning emission control equipment. Having invested what for most dry cleaning facilities will be a substantial sum of money in this equipment, properly operating and maintaining it will provide some return in terms of recovered PCE. Proper operation and maintenance will result in lower PCE consumption and reduce the dry cleaner's operating costs attributable to PCE purchases.

Beyond this economic incentive, however, the final NESHAP requires the owner or operator to follow the equipment manufacturer's specifications regarding proper operation and maintenance of equipment. In addition, the NESHAP requires the owner or operator to maintain a log containing information on the proper operation and maintenance of control devices.

To help dry cleaners determine that the control devices are operating properly, periodic monitoring is also required in the final NESHAP. If the control device used to achieve compliance is a refrigerated condenser, the owner or operator is required to measure the temperature of the vapor stream passing through the refrigerated condenser. For refrigerated condensers used with transfer machine system washers, the temperature on the inlet side and outlet side of the refrigerated condenser must be measured. For refrigerated condensers used with transfer machine system dryers or reclaimers, or dry-to-dry machines, the temperature of the exhaust gas stream exiting the refrigerated condenser must

be measured. Measurements must be taken once per week at the end of the cool down cycle prior to door opening. Records of this temperature measurement must be kept in a log maintained onsite.

If the control device used to achieve compliance is a carbon adsorber, the owner or operator is required to measure the PCE concentration at the exit of the carbon adsorber. Measurements must be taken once per week during the last aeration cycle prior to a scheduled desorption using a colorimetric detector tube. Records must be kept in a log (maintained on site) of the date and PCE concentration measured using the colorimetric detector tube.

The NESHAP requires that copies of the equipment manufacturer's operation and maintenance specifications be retained onsite. All of the above requirements will ensure proper operation and maintenance of equipment and will also ensure this equipment achieves the emission control performance it is capable of achieving.

2. Determining Equivalency

Guidance was requested regarding what type of information must be included with any request for a determination of equivalency (i.e., that the equipment a dry cleaner proposes to use is equivalent to that required by the NESHAP). Information was requested on the type and duration of emission data needed and the method for determining the control efficiency of the particular technology.

It is difficult to specify what information must be submitted for a determination of equivalency without knowing some details of the emission control technology or system for which the determination is requested. A description of this type of information must be broad and general in nature to accommodate all possibilities. It is possible, however, to be more specific regarding some requirements and the final NESHAP specifies that the following information must be submitted:

a. Diagrams, as appropriate, illustrating the emission control technology or system, its operation and integration into or function with dry-to-dry machines or transfer machine systems during each portion of the normal dry cleaning cycle.

b. Information quantifying vented PCE emissions from the dry-to-dry machines or transfer machine systems during each portion of the dry cleaning cycle with and without the use of the candidate emission control technology or system.

c. Information on solvent mileage achieved with and without the candidate emission control technology. Solvent mileage is the average weight of articles cleaned per volume of PCE used.

d. Identification of maintenance requirements and parameters to monitor to ensure proper operation and maintenance.

e. Explanation of why this submitted information is considered accurate and representative of both the short-term and long-term performance of the candidate emission control technology on the specific dry cleaning system examined.

f. Explanation of why this information can be extrapolated to dry cleaning systems other than the specific system(s) examined.

g. Information on the cross-media impacts (to water and solid waste) of the candidate emission control technology and demonstration that the cross-media impacts are less than or equal to the cross-media impacts of a refrigerated condenser.

3. Delegation of Authority to Determine Equivalency

Concern was expressed by some commenters that States were not delegated authority in the proposal to determine equivalency. Commenters strongly opposed limiting the authority for approving alternative control equipment and procedures proposed by individual dry cleaning sources to the EPA alone. It was believed that the EPA's retention of this delegation of authority would negatively impact the operating permit process. The emphasis in comments was that States must retain the right to take appropriate actions to implement effective emission control strategies to protect public health within their jurisdictions.

The EPA agrees that States should be allowed to implement effective emission strategies to protect public health within their jurisdictions. In some cases, States may feel it is necessary to implement more protective air pollution control measures than those adopted in national standards to control local problems.

The EPA also agrees that provisions limiting the authority to the EPA alone for making judgments regarding the equivalency of different equipment to control PCE emissions with the same or better performance than the control equipment required by the NESHAP are not warranted because section 112(l) of the Act would allow a State to request approval of a State's program that permits a source to seek permission to use an alternative means of emission limitation under section 112(h)(3), provided that the State demonstrated that its program would be no less stringent and that certain conditions were met. Section 112(l) of the Act authorizes States to submit programs to the

Administrator for approval for implementing and enforcing emission standards. Section 112(l) also goes on to state that such programs may provide for partial, as well as complete, delegation of the EPA's authorities and responsibilities. The approval and delegation process is addressed in detail in the EPA's notice of proposed rulemaking: "Approval of State Programs and Delegation of Federal Authorities; Proposed Rule," published on May 19, 1993, (58 FR 29296).

As a result, the provision limiting the authority to judge the equivalency of different equipment to the EPA has been deleted from the final standards. Doing so, however, does not mean that these provisions will be "automatically" delegated to States upon application. In addition, delegating these provisions will not preclude the EPA from considering petitions submitted by various equipment suppliers or vendors and making equivalency determinations on a national level.

D. Other Issues and Follow-up to Today's Action

The NESHAP promulgated in today's Federal Register will achieve significant reductions in PCE emissions from new and existing dry cleaning facilities. There remain, however, several major issues associated with dry cleaning facilities that merit further attention. These include: (1) Indoor air pollution in residences located above dry cleaning facilities; and (2) groundwater pollution resulting from dry cleaning facilities. These issues were brought to light following proposal of the NESHAP by the New York Study (indoor air pollution) and the California Study (ground water pollution).

1. New York Study

The New York Study, performed by the State of New York, is an assessment of indoor air pollution in residences located above dry cleaners. Many States and environmental groups referred to this study in their public comments on the NESHAP, and several commenters submitted copies of the study as attachments to their comments. They believed that the study shows that the risk to public health from exposure to PCE emissions from dry cleaners is significant and should be targeted for regulation. They mentioned that, although the Act does not specifically address indoor air pollution, indoor air emissions eventually become ambient air emissions.

The New York Study focuses on dry cleaners located in Albany, New York. All 102 dry cleaners listed in the Albany telephone directory were contacted. Of these 102 dry cleaners, 67 cleaned or pressed clothes on the premises. Of these 67, 6 had occupied residences above them.

The levels of PCE in the indoor and outdoor air at residences located above the 6 dry cleaners were measured over a 24-hour period. Identical measurements were taken at the same time at 6 control residences located at least 100 meters

(330 feet) away from each dry cleaner. The control residences were selected based on their similarity to the study residences in terms of building type, age, and neighborhood.

The study found indoor air concentrations of PCE ranging from 100 to 55,000 micrograms per cubic meter (mcg/^{3}) [15 to 8,000 parts per billion (ppb)] in the 6 residences located above dry cleaners. The cancer risk estimate associated with these levels, based on the EPA's unit cancer risk estimate for PCE and lifetime exposure, is 1 in 100,000 to 1 in 100 (10^{-5} to 10^{-2}). Control residences had indoor air PCE concentrations ranging from 6 to 100 mcg/m^3 (1 to 15 ppb). The cancer risk associated with these levels is 1 in 1,000,000 to 1 in 100,000 (10^{-6} to 10^{-5}).

The New York study indicates that PCE emissions can accumulate in residences located above dry cleaning facilities, resulting in increased public exposure to PCE. While not definitive, in the EPA's opinion, based on various observations included in the New York study, the major contributor to the elevated PCE levels measured in the residences located above these dry cleaners seems to be fugitive emissions.

2. California Well Investigation Program

The California Well Investigation Program is an assessment of ground water contamination undertaken by the State of California. The study contends that PCE contaminated discharges into sewer lines by dry cleaning facilities has contaminated ground water in several areas.

The California Study focuses on wells in the Central Valley Region, which supply drinking water to municipal water systems. Water drawn from 215 out of some 2,000 wells tested contained detectable levels of PCE. Of these 215 wells, water drawn from 47 wells contained levels of PCE above the maximum contaminant level (MCL) of 5 parts per billion (ppb) in the National Revised Primary Drinking Water Regulations.

Soil gas surveys and ground water movement around 21 of the 47 wells with levels of PCE above the MCL indicate the source of PCE contamination in these wells to have originated from sewer lines. In 20 out of these 21 wells, dry cleaning facilities were identified as the sole users of PCE connected to the sewer lines. Soil gas surveys along the main sewer lines downstream from sewer laterals connecting the dry cleaners to the main sewer lines also showed relatively high concentrations of PCE. As a result, the study concludes that dry cleaning facilities are the source of the observed PCE contamination.

Recovery of PCE for reuse within the dry cleaning process generates wastewater contaminated with PCE. Most of the PCE contained in this wastewater is recovered in a water separator. Water from the water separator,

however, is routinely discharged to the sewer at many dry cleaning facilities. Separator water generally contains about 150 ppm of PCE; but it may contain as much as 30 percent PCE, if the water separator is poorly operated.

Dry cleaning machines that use a refrigerated condenser for process vent control generate about 190 liters (50 gallons) per year of separator water; those with no process vent control generate even less. Dry cleaning machines that use a carbon adsorber for process vent control, on the other hand, generate about 7,600 liters (2,000 gallons) per year of separator water-40 times that generated by a refrigerated condenser.

The California study concludes that PCE discharged to sewers from dry cleaning facilities can contaminate ground water. Whether the primary source of PCE discharged to sewers by dry cleaning facilities is the result of leaking equipment, accidental spills, or PCE contaminated wastewater generated by dry cleaning or that generated by emission control equipment installed to control process vent emissions, however, is unclear.

The use of carbon adsorbers for process vent control significantly adds to the amount of PCE contaminated wastewater generated by dry cleaning facilities. While not conclusive, this suggests the use of carbon adsorbers for process vent control may be a primary contributor to ground water pollution resulting from dry cleaning facilities.

3. Follow-up to Today's Action

The EPA believes, based on information received to date, that PCE contamination of indoor air and ground water may present problems that warrant additional Federal actions. The EPA considered seeking an extension of the court deadline for the final rule to deal fully with these issues. This course of action, however, would have postponed the health and environmental benefits of the rule for an extended period of time. The EPA determined that the best environmental protection would be achieved by issuing today's rule as expeditiously as possible, and deciding subsequently how to address remaining indoor air pollution and ground water contamination associated with PCE dry cleaners.

Today's rule, while targeted primarily at reducing PCE contamination of outdoor air, may reduce indoor air contamination in some locations through requirements reducing fugitive and process vent emissions from dry cleaners. In addition, the rule requires uncontrolled machines to be controlled with refrigerated condensers, which will minimize generation of wastewater and solid waste.

In order to gain additional insight and understanding into the issues of indoor air pollution and ground water pollution associated with dry cleaning facilities, the EPA will convene a public meeting (see Public Meeting under ADDRESSES at the beginning of this preamble). The objective of this public meeting will be to gather additional information and solicit public comment on the magnitude and severity of the problems highlighted by the New York and the California studies and potential solutions or approaches for dealing with these problems. Copies of the New York and California studies are included in Docket No. A-88-11 (see Docket under ADDRESSES). (The New York Study is Docket No. A-88-11, Item No. IV-D-5 with additional information in Item No. IV-J-40; the California Study is also part of Item No. IV-J-40.) The EPA also would like to be informed of other studies conducted by States (or others) that address the relative efficiency of carbon adsorbers and refrigerated condensers, and their impact on air emissions. Anyone wishing to speak and make presentations at the public meeting and/or wishing to submit written comments, please see the section Public Meeting under ADDRESSES at the beginning of this preamble.

The EPA will use the information received from the public meeting, as well as written comments, in deciding whether additional actions should be taken to reduce health and environmental risks from dry cleaners. The EPA will, at a minimum, publish and distribute the information presented at the public meeting. The EPA may then use this information to develop guidance for States and local agencies; and/or develop additional regulations. At the meeting, the EPA will explore the desirability and feasibility of using a regulatory negotiation or other consensus-building approach to address these issues.

With respect to indoor air pollution, the EPA specifically requests States and the public to provide their views and any available information on:

a. The number of dry cleaners co-located in buildings with residences or businesses.

b. The extent and severity of indoor air contamination with PCE from dry cleaners, and the adequacy of existing data on this problem.

c. The extent and severity of PCE contamination of fatty foods in residences, restaurants, and food stores that are co-located with or located near dry cleaners.

d. The extent to which PCE indoor air contamination results from fugitive emissions or process vent emissions.

e. The amount of fugitive emissions from different types of dry cleaning machines, and from the various pieces of ancillary equipment associated with the dry cleaning process.

f. Methods for reducing PCE contamination of indoor air, including but not limited to:

(1) Improved maintenance involving the use of instruments to inspect dry cleaning equipment for leaks of PCE.

(2) Increased room ventilation and/or ducting of emissions outdoors.

(3) Collection of steam press emissions.

(4) The use of vapor barriers.

(5) Improved training of dry cleaning workers, or other information dissemination activities.

(6) A phaseout of existing transfer machine systems (today's rule effectively bans new transfer machine systems but does not limit the period of time that existing transfer machine systems can remain in service).

(7) Other strategies, control technologies, and pollution prevention methods that can reduce fugitive emissions, especially at small dry cleaners.

g. The extent to which evaporators are in use, and their impact on air quality as well as wastewater contamination.

h. The relative performance of vented versus ventless machines in reducing PCE emissions.

i. The relative effectiveness, cost, and affordability of the available options, as well as key advantages and drawbacks, including information on:

(1) The economic impact of a requirement to replace existing carbon adsorbers with refrigerated condensers.

(2) The economic impact of a requirement to replace existing transfer machines with dry-to-dry equipment.

j. The appropriate Federal role in encouraging or requiring steps to reduce PCE contamination of indoor air.

k. The proposition that the EPA should voluntarily conduct a residual risk analysis for area source dry cleaners, as well as a statutorily mandated risk analysis for major sources, to assess remaining health and environmental risks after installation of MACT and GACT technology. (Based on the results of this

analysis, the EPA could assess whether more stringent, health-based standards are warranted).

l. Examination of coin-operated dry cleaners exempt from this NESHAP to evaluate their potential contribution to indoor air pollution.

m. Evaluation of appropriate operator training and certification methods.

With respect to ground water contamination and solid waste generation by dry cleaners, the EPA specifically requests that States and the public provide their views and any available information on:

(1) The extent and severity of contamination of ground water with PCE from dry cleaners, and the degree of health threat posed by this contamination;

(2) The relative contribution of wastewater discharges, accidental spills, equipment leaks, and improper hazardous waste disposal to this ground water contamination;

(3) Costs of treating well water contaminated with PCE to make it safe for drinking, and the costs and feasibility of cleaning up ground water contaminated with PCE;

(4) The degree of solid or hazardous waste generation associated with the prevention/control technologies, information on how these wastes are managed and their environmental impact.

(5) Potential measures to prevent or minimize further contamination of ground water with PCE, including but not limited to:

(a) Use of wastewater evaporators by dry cleaners.

(b) Required replacement of existing carbon adsorbers used for process-vent control with refrigerated condensers, perhaps through a gradual phaseout. (The EPA particularly solicits comment on how the EPA could use its legal authorities to require a gradual phaseout, the environmental benefits of a phaseout, and the economic feasibility of potential phase-out schedules);

(c) Improved maintenance of dry cleaning equipment through improved training of dry cleaning workers or other information dissemination activities;

(d) Encouragement of emerging PCE emission control technologies that use adsorption but do not generate wastewater because regeneration is performed through heat desorption rather than steam stripping;

(e) Spill prevention and control measures;

(f) A ban or limit on the discharge of PCE-contaminated wastewater to sewers;

(g) Disposal of dry cleaner wastewater at hazardous waste facilities;

(h) The practical use of dry cleaner wastewater in boilers; and

(i) The relative effectiveness, costs, and affordability of the available options, as well as key advantages and drawbacks.

(6) The appropriate Federal role in encouraging or requiring steps to reduce the threat of ground water contamination from dry cleaners.

While examining these issues, the EPA, as part of its Design for the Environment (DfE) program is investigating potential substitutes for PCE in dry cleaning and developing an incentive program to encourage all dry cleaners to use control measures and work practices that minimize health and environmental risks.

The DfE program, which is operated by the EPA's Office of Pollution Prevention and Toxics, fosters cooperative study on a voluntary basis with businesses and trade associations in specific industries to evaluate the risks, performance, and costs of alternative chemicals, processes, and technologies. The DfE program is currently evaluating a variety of alternatives to the current use of PCE in dry cleaning, as well as emission control technologies for dry cleaning equipment, through its Cleaner Technologies Substitute Assessment (CTSA).

As part of the CTSA, the DfE program in conjunction with the Neighborhood Cleaners Association (NCA), the International Fabricare Institute (IFI), and a commercial vendor, conducted a 4-week study to test the economic feasibility and performance aspects of a potential alternative wet-cleaning process that does not use PCE. The alternative process primarily uses steam cleaning, spotting, tumble drying, soaps, and limited amounts of water to clean clothes. The EPA expects to release the results of the study in Fall 1993 and will address whether there may be circumstances under which wet-cleaning may be technically and economically feasible.

In addition to evaluating the wet-cleaning process, the DfE Dry Cleaning Project is assessing other pollution prevention and control options. The analysis will include evaluation of environmental and human health risks, and the performance and costs of various prevention and control technologies. This assessment, which is expected to be completed in Spring 1994, will provide the dry cleaning industry with valuable information when considering options for compliance, risk reduction, and pollution prevention.

For information on the Design for the Environment Dry Cleaning Project contact Jean E. (Libby) Parker, EPA, Office of Pollution Prevention and Toxics, mail code TS-779, 401 M Street, SW., Washington, DC 20460, telephone number (202) 260-0880.

As part of the EPA's focus on pollution prevention at this time, the Administrator strongly encourages those dry cleaners currently using carbon adsorbers for primary process vent control to replace them with refrigerated condensers as early as possible.

While the EPA conducts follow-up activities related to dry cleaners, the EPA notes that there are opportunities for State and local government to take action as well. For example, State and local governments may wish to investigate whether indoor air or ground water in their jurisdictions is being contaminated with PCE from dry cleaning. If a State or local government finds an indoor air pollution problem, for example, the government may wish to consider whether collocation of a dry cleaner in the same building with residences is appropriate.

V. Administrative Requirements

A. Docket

The docket is an organized and complete file of all the information considered by EPA in the development of this rulemaking. The docket is a dynamic file, since material is added throughout the rulemaking development. The docketing system is intended to allow members of the public and industries involved to readily identify and locate documents so that they can effectively participate in the rulemaking process. Along with the statement of basis and purpose of the proposed and promulgated standards and the EPA's responses to significant comments, the contents of the docket, except for interagency review materials, will serve as the record in case of judicial review (section 307(d)(7)(A)).

B. Paperwork Reduction Act

Information collection requirements given in this regulation have been approved by the Office of Management and Budget (OMB) under the provisions of the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 et seq. and have been assigned OMB control number 2060-0234.

This collection of information is estimated to have a public reporting burden averaging 3.2 hours per response, and to require 49 hours per recordkeeper annually. This estimate includes time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

In an Information Collection Request Action Notice dated June 5, 1992, OMB disapproved two of the information collection provisions for the PCE Dry Cleaning NESHAP. The first was the weekly records of leak detection and repair, and the second was the 5-year record retention period. The OMB questioned whether these provisions represented the least burdensome approach necessary to attain the goal of the standards. These concerns are addressed below.

With respect to the weekly leak detection and repair: The capture and reuse of PCE is the goal of the NESHAP. To the extent that there are fugitive emissions from leaks into the dry cleaning facility, the surrounding businesses, and the environment, the goal of the NESHAP cannot be attained. Leak detection is especially crucial for dry cleaning establishments located in mixed-use buildings, where fugitive PCE emissions tend to migrate into and build up in adjoining residences, restaurants, banks, and shops. (This is the conclusion of the New York Study which became available after the rule was proposed on December 9, 1991.)

Leaks result from unequal pressure in the system, and are also a function of the age, construction, and design of the system. A simple periodic inspection of the dry cleaning facility will alert the owner or operator of any leaks. The leaks can then be repaired on a timely basis, both meeting the goals of the NESHAP and saving the owner and operator the cost of replacing the PCE otherwise lost through leaks in the system. Therefore, frequent periodic inspections at all facilities are needed to ensure that the goal of the NESHAP is attained. However, to address concerns for those existing facilities with annual receipts below $75,000, these facilities are required to perform leak detection on a biweekly, rather than a weekly, basis.

With respect to the second issue, the 5-year retention period for records: The types of records required to be kept require very little storage space and are of great practical utility for purposes of determining compliance and following through with any necessary enforcement action. The recordkeeping required is so minimal that the records for a 5-year period literally could be kept in one notebook. The usefulness of the 5-year record retention period for the EPA results from the fact that dry cleaning facilities are so numerous and the EPA's inspection and audit resources so limited that inspections of any given facility will, of necessity, be rare. Congress recognized this, and granted a 5-year statute of limitations for NESHAP. A record retention period of less than 5 years would prevent the EPA from enforcing its regulations for fewer years than Congress has specifically mandated. The retention of records over 5 years also allows the EPA to establish a source's history and patterns of compliance for purposes of determining the appropriate level of enforcement action. In many cases, the additional information could benefit the source.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Chief, Information Policy Branch (PM-223Y); U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA."

C. Executive Order 12291

Under Executive Order (E.O.) 12291, the EPA is required to judge whether a regulation is a "major rule" and therefore subject to the requirements of a regulatory impact analysis (RIA). The criteria set forth in section 1 of E.O. 12291 for determining whether a regulation is a major rule are as follows: (1) The rule is likely to have an annual effect on the economy of $100 million or more; (2) the rule is likely to cause a major increase in costs or prices for consumers, individual industries, Federal, State, or local governments, or geographic regions; or (3) the rule is likely to result in significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.

This promulgated regulation is not a major rule because it would result in none of the adverse effects mentioned above. The total annual cost is estimated to be less than $14 million a year, far below the $100 million criterion set forth in E.O. 12291. The price impacts are estimated to range from 0.5 and 2.5 percent. The economic impact analysis on the industry indicated that output adjustments are about a 0.5 percent decrease. These small market adjustments indicate that no significant adverse effects on competition, employment, investment, productivity, innovation, or international trade are expected. Therefore, this regulation is not subject to an RIA.

This promulgated rulemaking was submitted to the OMB for review as required under E.O. 12291.

D. Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 et seq) requires the EPA to consider potential impacts of promulgated regulations on small business "entities." A regulatory flexibility analysis is required if preliminary analysis indicates that a promulgated regulation is expected to have a significant economic impact on a substantial number of small entities.

Firms in the dry cleaning industry are classified as small or large based on annual sales receipts. Commercial firms are classified as small if they earn less than $2.5 million per year. By this definition, over 99 percent of commercial dry cleaning firms are small (U. S. Department of Commerce, 1990b).

The economic impacts of the regulatory alternatives were analyzed based on consumption of PCE but described in terms of dry cleaning revenues.

For the commercial area source categories, the economic analysis did indicate that many firms within the class of sources with annual receipts of less than $75,000 would be affected significantly by the promulgated standard. Below this annual receipt level are found the very smallest family-operated businesses with low annual PCE consumption and few employees. Due to economic considerations, only pollution prevention measures (i.e., leak detection and repair) are required for this class of sources under GACT-no process vent control is required.

For the class of sources with annual receipts of $75,000 or greater, the economic impacts are much smaller. Less than 260 net closures due to the promulgated regulation are projected. The analysis indicates that firms in below-average financial condition may face difficulty in obtaining the required funds to purchase control equipment from traditional loan sources, such as banks. The analysis projects between 0 and 830 firms will be in this category. These firms will either obtain other financing (vendor-aided, relatives, personal assets, etc.), close, or sell their firm. For more detail see "Economic Impact Analysis of Regulatory Controls in the Dry Cleaning Industry" (EPA-45/3-91-021b) and "Dry Cleaning Facilities-Background Information for Promulgated Standards" (EPA-450/3-91-020b).

In summary, excluding requirements for process vent control for the class of sources with annual gross receipts of $75,000 or less drastically reduces the impacts on the commercial dry cleaning sector.

E. Miscellaneous

Under the operating permit regulations codified at 40 CFR Part 70, any source that is a major source under the Act or any nonmajor source subject to a standard under sections 111 or 112 of the Act must obtain an operating permit. (See § 70.3(a)(1).) The part 70 regulations also provide that a State may, at its discretion, defer all nonmajor sources from the obligation to obtain a part 70 permit until such time as the EPA finishes a rulemaking regarding the applicability of the part 70 program to nonmajor sources. Part 70 further provides that, for nonmajor sources subject to a future standard promulgated under section 111 or 112, "* * * the Administrator will determine whether to exempt any or all such applicable sources from the requirements to obtain a part 70 permit at the time that the new standard is promulgated." (See § 70.3(b) (1) and (2).)

Today's final dry cleaning rule does not exempt area source dry cleaners from permitting requirements. The EPA believes that permitting these nonmajor sources will enhance the implementation and enforcement of the rule by clarifying how the rule applies to a particular source, and how relevant parts of the to-be-promulgated general provisions apply to dry cleaners. The general provisions, which were proposed in the Federal Register on August 11, 1993 (58 FR 42760), are generic requirements that sources subject to section 112 standards must meet.

However, under the existing provisions of part 70, States may choose to defer the obligation of all nonmajor sources to obtain a permit until the EPA "completes a rulemaking to determine how the program should be structured for nonmajor sources and the appropriateness of any permanent exemptions * * *." In promulgating the permits rule, the EPA committed to complete that rulemaking within 5 years after the approval of the first State part 70 program that defers permitting of nonmajor sources.

The EPA believes, for the same reasons stated in the preamble to the operating permits rule, that the benefits to be gained from the permitting of nonmajor sources subject to this rule are not likely to accrue during the early stages of the permit program when permitting authorities will be occupied with the task of issuing permits to major sources. Once this task is complete, however, permitting authorities should be able to process permits for nonmajor sources subject to this rule on a relatively expedited basis. This expedited review should be the case, in part, because of the presumptive suitability of these sources for general permits.

In accordance with section 117 of the Act, publication of these promulgated standards was preceded by consultation with appropriate advisory committees, independent experts, and Federal departments and agencies.

This regulation will be reviewed 8 years from the date of promulgation as required by the Act. This review will include an assessment of such factors as the need for integration with other programs, the existence of alternative methods, enforceability, improvements in emission control technology, and reporting requirements.

List of Subjects

40 CFR Part 9

Reporting and recordkeeping requirements.

40 CFR Part 63

Air pollution control, Intergovernmental relations, Reporting and recordkeeping requirements.

Dated: September 13, 1993.
Carol M. Browner, Administrator.

For the reasons set out in the preamble, title 40, chapter I, of the Code of Federal Regulations is amended as set forth below:

PART 9-[AMENDED]

1. The authority citation for part 9 continues to read as follows:

Authority: 7 U.S.C. 135 et seq., 136-136y; 15 U.S.C. 2001, 15 U.S.C. 2003, 15 U.S.C. 2005, 15 U.S.C. 2006, 2601-2671; 21 U.S.C. 331j, 21 U.S.C. 346a, 348; 31 U.S.C. 9701; 33 U.S.C. 1251 et seq., 1311, 1313d, 1314, 1321, 1326, 1330, 1344, 1345(d) and (e), 1361; E.O. 11735, 38 FR 21243, 3 CFR, 1971-1975 Comp. p. 973; 42 U.S.C. 241, 42 U.S.C. 242b, 42 U.S.C. 243, 42 U.S.C. 246, 42 U.S.C. 300f, 42 U.S.C. 300g, 42 U.S.C. 300g-1, 42 U.S.C. 300g-2, 42 U.S.C. 300g-3, 42 U.S.C. 300g-4, 42 U.S.C. 300g-5, 42 U.S.C. 300g-6, 42 U.S.C. 300j-1, 42 U.S.C. 300j-2, 42 U.S.C. 300j-3, 42 U.S.C. 300j-4, 42 U.S.C. 300j-9, 1857 et seq., 6901-6992k, 7401-7671q, 7542, 9601-9657, 11023, 11048.

2. Section 9.1 is amended by adding a new entry to the table under the indicated heading to read as follows:

§ 9.1 OMB approvals under the Paperwork Reduction Act. * * * * *

40 CFR citation	OMBcontrol No.
* * * * *	
National Emission Standards for Hazardous Air Pollutants for Source Categories	
* * * * *	
63.322-63.325	2060-0234

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PART 63-NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS FOR SOURCE CATEGORIES

3. The authority citation for part 63 continues to read as follows:

Authority: 42 U.S.C. 7401, 42 U.S.C. 7412, 42 U.S.C. 7414, 42 U.S.C. 7416, and 7601.

4. Part 63 is amended by adding subpart M to read as follows:

Subpart M-National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities

Subpart M-National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities

§ 63.320 Applicability.

(a) The provisions of this subpart apply to the owner or operator of each dry cleaning facility that uses perchloroethylene.

(b) Each dry cleaning system that commences construction or reconstruction on or after December 9, 1991, shall be in compliance with the provisions of this subpart beginning on September 22, 1993 or immediately upon startup, whichever is later, except for dry cleaning systems complying with section 112(i)(2) of the Clean Air Act.

(c) Each dry cleaning system that commenced construction or reconstruction before December 9, 1991, shall comply with §§ 63.322(c), (d), (i), (j), (k), and (l), 63.323(d), and 63.324(a), (b), (d)(1), (d)(2), (d)(3), (d)(4), and (e) beginning on December 20, 1993, and shall comply with other provisions of this subpart by September 23, 1996.

(d) Each existing dry-to-dry machine and its ancillary equipment located in a dry cleaning facility that includes only dry-to-dry machines and each existing transfer machine system and its ancillary equipment, as well as each existing dry-to-dry machine and its ancillary equipment, located in a dry cleaning facility that includes both transfer machine system(s) and dry-to-dry machine(s) is exempt from §§ 63.322, 63.323, and 63.324, except §§ 63.322(c), (d), (i), (j), (k), (l), and (m), 63.323(d), and 63.324(a), (b), (d)(1), (d)(2), (d)(3), (d)(4), and (e) if the total perchloroethylene consumption of the dry cleaning facility is less than 530 liters (140 gallons) per year. Consumption is determined according to § 63.323(d).

(e) Each existing transfer machine system and its ancillary equipment located in a dry cleaning facility that includes only transfer machine system(s) is exempt from §§ 63.322, 63.323, and 63.324, except §§ 63.322(c), (d), (i), (j), (k), (l), and (m), 63.323(d), and 63.324(a), (b), (d)(1), (d)(2), (d)(3), (d)(4), and (e) if the perchloroethylene consumption of the dry cleaning facility is less than 760 liters (200 gallons) per year. Consumption is determined according to § 63.323(d).

(f) If the total yearly perchloroethylene consumption of a dry cleaning facility determined according to § 63.323(d) is initially less than the amounts specified in paragraph (d) or (e) of this section, but later exceeds those amounts, the existing dry cleaning system(s) in the dry cleaning facility must comply with §§ 63.322, 63.323, and 63.324 by 180 calendar days from the date that the facility determines it has exceeded the amounts specified, or by September 23, 1996, whichever is later.

(g) A dry cleaning facility is a major source if the facility emits or has the potential to emit more than 9.1 megagrams per year (10 tons per year) of perchloroethylene to the atmosphere. In lieu of measuring a facility's potential to emit perchloroethylene emissions or determining a facility's potential to emit perchloroethylene emissions, a dry cleaning facility is a major source if:

(1) It includes only dry-to-dry machine(s) and has a total yearly perchloroethylene consumption greater than 8,000 liters (2,100 gallons) as determined according to § 63.323(d); or

(2) It includes only transfer machine system(s) or both dry-to-dry machine(s) and transfer machine system(s) and has a total yearly perchloroethylene consumption greater than 6,800 liters (1,800 gallons) as determined according to § 63.323(d).

(h) A dry cleaning facility is an area source if it does not meet the conditions of paragraph (g) of this section.

(i) If the total yearly perchloroethylene consumption of a dry cleaning facility determined according to § 63.323(d) is initially less than the amounts specified in paragraph (g) of this section, but then exceeds those amounts, the dry cleaning facility becomes a major source and all dry cleaning systems located at that dry cleaning facility must comply with the appropriate requirements for major sources under §§ 63.322, 63.323, and 63.324 by 180 calendar days from the date that the facility determines it has exceeded the amount specified, or by September 23, 1996, whichever is later.

(j) All coin-operated dry cleaning machines are exempt from the requirements of this subpart.

§ 63.321 Definitions.

Administrator means the Administrator of the United States Environmental Protection Agency or his or her authorized representative (e.g., a State that has been delegated the authority to implement the provisions of this part).

Ancillary equipment means the equipment used with a dry cleaning machine in a dry cleaning system including, but not limited to, emission control devices, pumps, filters, muck cookers, stills, solvent tanks, solvent containers, water separators, exhaust dampers, diverter valves, interconnecting piping, hoses, and ducts.

Articles mean clothing, garments, textiles, fabrics, leather goods, and the like, that are dry cleaned.

Area source means any perchloroethylene dry cleaning facility that meets the conditions of § 63.320(h).

Biweekly means any 14-day period of time.

Carbon adsorber means a bed of activated carbon into which an air-perchloroethylene gas-vapor stream is routed and which adsorbs the perchloroethylene on the carbon.

Coin-operated dry cleaning machine means a dry cleaning machine that is operated by the customer (that is, the customer places articles into the machine, turns the machine on, and removes articles from the machine).

Colorimetric detector tube means a glass tube (sealed prior to use), containing material impregnated with a chemical that is sensitive to perchloroethylene and is designed to measure the concentration of perchloroethylene in air.

Construction, for purposes of this subpart, means the fabrication (onsite), erection, or installation of a dry cleaning system subject to this subpart.

Desorption means regeneration of a carbon adsorber by removal of the perchloroethylene adsorbed on the carbon.

Diverter valve means a flow control device that prevents room air from passing through a refrigerated condenser when the door of the dry cleaning machine is open.

Dry cleaning means the process of cleaning articles using perchloroethylene.

Dry cleaning cycle means the washing and drying of articles in a dry-to-dry machine or transfer machine system.

Dry cleaning facility means an establishment with one or more dry cleaning systems.

Dry cleaning machine means a dry-to-dry machine or each machine of a transfer machine system.

Dry cleaning machine drum means the perforated container inside the dry cleaning machine that holds the articles during dry cleaning.

Dry cleaning system means a dry-to-dry machine and its ancillary equipment or a transfer machine system and its ancillary equipment.

Dryer means a machine used to remove perchloroethylene from articles by tumbling them in a heated air stream (see reclaimer).

Dry-to-dry machine means a one-machine dry cleaning operation in which washing and drying are performed in the same machine.

Exhaust damper means a flow control device that prevents the air-perchloroethylene gas-vapor stream from exiting the dry cleaning machine into a carbon adsorber before room air is drawn into the dry cleaning machine.

Existing means commenced construction or reconstruction before December 9, 1991.

Filter means a porous device through which perchloroethylene is passed to remove contaminants in suspension. Examples include, but are not limited to, lint filter (button trap), cartridge filter, tubular filter, regenerative filter, prefilter, polishing filter, and spin disc filter.

Heating coil means the device used to heat the air stream circulated from the dry cleaning machine drum, after perchloroethylene has been condensed from the air stream and before the stream reenters the dry cleaning machine drum.

Major source means any dry cleaning facility that meets the conditions of § 63.320(g).

Muck cooker means a device for heating perchloroethylene-laden waste material to volatilize and recover perchloroethylene.

New means commenced construction or reconstruction on or after December 9, 1991.

Perceptible leaks mean any perchloroethylene vapor or liquid leaks that are obvious from:

(1) The odor of perchloroethylene;

(2) Visual observation, such as pools or droplets of liquid; or

(3) The detection of gas flow by passing the fingers over the surface of equipment.

Perchloroethylene consumption means the total volume of perchloroethylene purchased based upon purchase receipts or other reliable measures.

Reclaimer means a machine used to remove perchloroethylene from articles by tumbling them in a heated air stream (see dryer).

Reconstruction, for purposes of this subpart, means replacement of a washer, dryer, or reclaimer; or replacement of any components of a dry cleaning system to such an extent that the fixed capital cost of the new components exceeds 50 percent of the fixed capital cost that would be required to construct a comparable new source.

Refrigerated condenser means a vapor recovery system into which an air-perchloroethylene gas-vapor stream is routed and the perchloroethylene is condensed by cooling the gas-vapor stream.

Refrigerated condenser coil means the coil containing the chilled liquid used to cool and condense the perchloroethylene.

Responsible official means one of the following:

(1) For a corporation: A president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or a duly authorized representative of such person if the representative is responsible for the overall operation of one or more dry cleaning facilities;

(2) For a partnership: A general partner;

(3) For a sole proprietorship: The owner; or

(4) For a municipality, State, Federal, or other public agency: Either a principal executive officer or ranking official.

Room enclosure means a stationary structure that encloses a transfer machine system, and is vented to a carbon adsorber or an equivalent control device during operation of the transfer machine system.

Source, for purposes of this subpart, means each dry cleaning system.

Still means any device used to volatilize and recover perchloroethylene from contaminated perchloroethylene.

Temperature sensor means a thermometer or thermocouple used to measure temperature.

Transfer machine system means a multiple-machine dry cleaning operation in which washing and drying are performed in different machines. Examples include, but are not limited to:

(1) A washer and dryer(s);

(2) A washer and reclaimer(s); or

(3) A dry-to-dry machine and reclaimer(s).

Washer means a machine used to clean articles by immersing them in perchloroethylene. This includes a dry-to-dry machine when used with a reclaimer.

Water separator means any device used to recover perchloroethylene from a water-perchloroethylene mixture.

Year or Yearly means any consecutive 12-month period of time.

§ 63.322 Standards.

(a) The owner or operator of each existing dry cleaning system shall comply with either paragraph (a)(1) or (a)(2) of this section and shall comply with paragraph (a)(3) of this section if applicable.

(1) Route the air-perchloroethylene gas-vapor stream contained within each dry cleaning machine through a refrigerated condenser or an equivalent control device.

(2) Route the air-perchloroethylene gas-vapor stream contained within each dry cleaning machine through a carbon adsorber installed on the dry cleaning machine prior to September 22, 1993.

(3) Contain the dry cleaning machine inside a room enclosure if the dry cleaning machine is a transfer machine system located at a major source. Each room enclosure shall be:

(i) Constructed of materials impermeable to perchloroethylene; and

(ii) Designed and operated to maintain a negative pressure at each opening at all times that the machine is operating.

(b) The owner or operator of each new dry cleaning system:

(1) Shall route the air-perchloroethylene gas-vapor stream contained within each dry cleaning machine through a refrigerated condenser or an equivalent control device;

(2) Shall eliminate any emission of perchloroethylene during the transfer of articles between the washer and dryer(s); and

(3) Shall pass the air-perchloroethylene gas-vapor stream from inside the dry cleaning machine drum through a carbon adsorber or equivalent control device immediately before or as the door of the dry cleaning machine is opened if the dry cleaning machine is located at a major source.

(c) The owner or operator shall close the door of each dry cleaning machine immediately after transferring articles to or from the machine, and shall keep the door closed at all other times.

(d) The owner or operator of each dry cleaning system shall operate and maintain the system according to the manufacturers' specifications and recommendations.

(e) Each refrigerated condenser used for the purposes of complying with paragraph (a) or (b) of this section and installed on a dry-to-dry machine, dryer, or reclaimer:

(1) Shall be operated to not vent or release the air-perchloroethylene gas-vapor stream contained within the dry cleaning machine to the atmosphere while the dry cleaning machine drum is rotating;

(2) Shall be monitored according to § 63.323(a)(1); and

(3) Shall be operated with a diverter valve, which prevents air drawn into the dry cleaning machine when the door of the machine is open from passing through the refrigerated condenser.

(f) Each refrigerated condenser used for the purpose of complying with paragraph (a) of this section and installed on a washer:

(1) Shall be operated to not vent the air-perchloroethylene gas-vapor contained within the washer to the atmosphere until the washer door is opened;

(2) Shall be monitored according to § 63.323(a)(2); and

(3) Shall not use the same refrigerated condenser coil for the washer that is used by a dry-to-dry machine, dryer, or reclaimer.

(g) Each carbon adsorber used for the purposes of complying with paragraphs (a) or (b) of this section:

(1) Shall not be bypassed to vent or release any air-perchloroethylene gas-vapor stream to the atmosphere at any time; and

(2) Shall be monitored according to the applicable requirements in § 63.323 (b) or (c).

(h) Each room enclosure used for the purposes of complying with paragraph (a)(3) of this section:

(1) Shall be operated to vent all air from the room enclosure through a carbon adsorber or an equivalent control device; and

(2) Shall be equipped with a carbon adsorber that is not the same carbon adsorber used to comply with paragraph (a)(2) or (b)(3) of this section.

(i) The owner or operator of an affected facility shall drain all cartridge filters in their housing, or other sealed container, for a minimum of 24 hours, or shall treat such filters in an equivalent manner, before removal from the dry cleaning facility.

(j) The owner or operator of an affected facility shall store all perchloroethylene and wastes that contain perchloroethylene in solvent tanks or solvent containers with no perceptible leaks.

(k) The owner or operator of a dry cleaning system shall inspect the following components weekly for perceptible leaks while the dry cleaning system is operating:

(1) Hose and pipe connections, fittings, couplings, and valves;

(2) Door gaskets and seatings;

(3) Filter gaskets and seatings;

(4) Pumps;

(5) Solvent tanks and containers;

(6) Water separators;

(7) Muck cookers;

(8) Stills;

(9) Exhaust dampers;

(10) Diverter valves; and

(11) Cartridge filter housings.

(l) The owner or operator of a dry cleaning facility with a total facility consumption below the applicable consumption levels of § 63.320(d) or (e) shall inspect the components listed in paragraph (k) of this section biweekly for perceptible leaks while the dry cleaning system is operating.

(m) The owner or operator of a dry cleaning system shall repair all perceptible leaks detected under paragraph (k) of this section within 24 hours. If repair parts must be ordered, either a written or verbal order for those parts shall be initiated within 2 working days of detecting such a leak. Such repair parts shall be installed within 5 working days after receipt.

(n) If parameter values monitored under paragraphs (e), (f), or (g) of this section do not meet the values specified in § 63.323(a), (b), or (c), adjustments or repairs shall be made to the dry cleaning system or control device to meet those values. If repair parts must be ordered, either a written or verbal order for such parts shall be initiated within 2 working days of detecting such a parameter value. Such repair parts shall be installed within 5 working days after receipt.

§ 63.323 Test methods and monitoring.

(a) When a refrigerated condenser is used to comply with § 63.322(a)(1) or (b)(1):

(1) The owner or operator shall measure the temperature of the air-perchloroethylene gas-vapor stream on the outlet side of the refrigerated condenser on a dry-to-dry machine, dryer, or reclaimer weekly with a temperature sensor to determine if it is equal to or less than 7.2 °C (45 °F). The temperature sensor shall be used according to the manufacturer's instructions and shall be designed to measure a temperature of 7.2 °C (45 °F) to an accuracy of ± 1.1 °C (±2 °F).

(2) The owner or operator shall calculate the difference between the temperature of the air-perchloroethylene gas-vapor stream entering the refrigerated condenser on a washer and the temperature of the air-perchloroethylene gas-vapor stream exiting the refrigerated condenser on the washer weekly to determine that the difference is greater than or equal to 11.1 °C (20 °F).

(i) Measurements of the inlet and outlet streams shall be made with a temperature sensor. Each temperature sensor shall be used according to the manufacturer's instructions, and designed to measure at least a temperature range from 0 °C (32 °F) to 48.9 °C (120 °F) to an accuracy of ± 1.1 °C (± 2 °F).

(ii) The difference between the inlet and outlet temperatures shall be calculated weekly from the measured values.

(b) When a carbon adsorber is used to comply with § 63.322(a)(2) or exhaust is passed through a carbon adsorber immediately upon machine door opening to comply with § 63.322(b)(3), the owner or operator shall measure the concentration of perchloroethylene in the exhaust of the carbon adsorber weekly with a colorimetric detector tube, while the dry cleaning machine is venting to that carbon adsorber at the end of the last dry cleaning cycle prior to desorption of that carbon adsorber to determine that the perchloroethylene concentration in the exhaust is equal to or less than 100 parts per million by volume. The owner or operator shall:

(1) Use a colorimetric detector tube designed to measure a concentration of 100 parts per million by volume of perchloroethylene in air to an accuracy of ± 25 parts per million by volume; and

(2) Use the colorimetric detector tube according to the manufacturer's instructions; and

(3) Provide a sampling port for monitoring within the exhaust outlet of the carbon adsorber that is easily accessible and located at least 8 stack or duct diameters downstream from any flow disturbance such as a bend, expansion, contraction, or outlet; downstream from no other inlet; and 2 stack or duct diameters upstream from any flow disturbance such as a bend, expansion, contraction, inlet, or outlet.

(c) If the air-perchloroethylene gas-vapor stream is passed through a carbon adsorber prior to machine door opening to comply with § 63.322(b)(3), the owner or operator of an affected facility shall measure the concentration of perchloroethylene in the dry cleaning machine drum at the end of the dry cleaning cycle weekly with a colorimetric detector tube to determine that the perchloroethylene concentration is equal to or less than 300 parts per million by volume. The owner or operator shall:

(1) Use a colorimetric detector tube designed to measure a concentration of 300 parts per million by volume of perchloroethylene in air to an accuracy of ±ÿ75 parts per million by volume; and

(2) Use the colorimetric detector tube according to the manufacturer's instructions; and

(3) Conduct the weekly monitoring by inserting the colorimetric detector tube into the open space above the articles at the rear of the dry cleaning machine drum immediately upon opening the dry cleaning machine door.

(d) When calculating yearly perchloroethylene consumption for the purpose of demonstrating applicability according to § 63.320, the owner or operator shall perform the following calculation on the first day of every month:

(1) Sum the volume of all perchloroethylene purchases made in each of the previous 12 months, as recorded in the log described in § 63.324(d)(1).

(2) If no perchloroethylene purchases were made in a given month, then the perchloroethylene consumption for that month is zero gallons.

(3) The total sum calculated in paragraph (d) of this section is the yearly perchloroethylene consumption at the facility.

§ 63.324 Reporting and recordkeeping requirements.

(a) Each owner or operator of a dry cleaning facility shall submit an initial report signed by a responsible official before a notary public certifying that the information provided in the initial report is accurate and true to the

Administrator within 90 calendar days after September 22, 1993, which includes the following:

(1) The name and address of the owner or operator;

(2) The address (that is, physical location) of the dry cleaning facility;

(3) A brief description of the type of each dry cleaning machine at the dry cleaning facility;

(4) Documentation as described in § 63.323(d) of the yearly perchloroethylene consumption at the dry cleaning facility for the previous year to demonstrate applicability according to § 63.320; or an estimation of perchloroethylene consumption for the previous year to estimate applicability with § 63.320; and

(5) A description of the type of control device(s) that will be used to achieve compliance with § 63.322 (a) or (b) and whether the control device(s) is currently in use or will be purchased.

(6) Documentation to demonstrate to the Administrator's satisfaction that each room enclosure used to meet the requirements of § 63.322(a)(3) meets the requirements of § 63.322(a)(3) (i) and (ii).

(b) Each owner or operator of a dry cleaning facility shall submit a statement signed by a responsible official in the presence of a notary public to the Administrator by registered letter on or before the 30th day following the compliance dates specified in § 63.320 (b) or (c), certifying the following:

(1) The yearly perchloroethylene solvent consumption limit based upon the yearly solvent consumption calculated according to § 63.323(d);

(2) Whether or not they are in compliance with each applicable requirement of § 63.322; and

(3) All information contained in the statement is accurate and true.

(c) Each owner or operator of an area source dry cleaning facility that exceeds the solvent consumption limit certified in paragraph (b) of this section shall submit a statement signed by a responsible official in the presence of a notary public to the Administrator by registered letter on or before the 30th day following the compliance dates specified in § 63.320(f) or (i), certifying the following:

(1) The new yearly perchloroethylene solvent consumption limit based upon the yearly solvent consumption calculated according to § 63.323(d);

(2) Whether or not they are in compliance with each applicable requirement of § 63.322; and

(3) All information contained in the statement is accurate and true.

(d) Each owner or operator of a dry cleaning facility shall keep receipts of perchloroethylene purchases and a log of the following information and maintain such information on site and show it upon request for a period of 5 years:

(1) The volume of perchloroethylene purchased each month by the dry cleaning facility as recorded from perchloroethylene purchases; if no perchloroethylene is purchased during a given month then the owner or operator would enter zero gallons into the log;

(2) The calculation and result of the yearly perchloroethylene consumption determined on the first day of each month as specified in § 63.323(d);

(3) The dates when the dry cleaning system components are inspected for perceptible leaks, as specified in § 63.322(k) or (l), and the name or location of dry cleaning system components where perceptible leaks are detected;

(4) The dates of repair and records of written or verbal orders for repair parts to demonstrate compliance with § 63.322(m) and (n);

(5) The date and temperature sensor monitoring results, as specified in § 63.323 if a refrigerated condenser is used to comply with § 63.322(a) or (b); and

(6) The date and colorimetric detector tube monitoring results, as specified in § 63.323, if a carbon adsorber is used to comply with § 63.322(a)(2) or (b)(3).

(e) Each owner or operator of a dry cleaning facility shall retain onsite a copy of the design specifications and the operating manuals for each dry cleaning system and each emission control device located at the dry cleaning facility.

§ 63.325 Determination of equivalent emission control technology.

(a) Any person requesting that the use of certain equipment or procedures be considered equivalent to the requirements under § 63.322 shall collect, verify, and submit to the Administrator the following information to show that the alternative achieves equivalent emission reductions:

(1) Diagrams, as appropriate, illustrating the emission control technology, its operation and integration into or function with dry-to-dry machine(s) or

transfer machine system(s) and their ancillary equipment during each portion of the normal dry cleaning cycle;

(2) Information quantifying vented perchloroethylene emissions from the dry-to-dry machine(s) or transfer machine system(s) during each portion of the dry cleaning cycle with and without the use of the candidate emission control technology;

(3) Information on solvent mileage achieved with and without the candidate emission control technology. Solvent mileage is the average weight of articles cleaned per volume of perchloroethylene used. Solvent mileage data must be of continuous duration for at least 1 year under the conditions of a typical dry cleaning operation. This information on solvent mileage must be accompanied by information on the design, configuration, operation, and maintenance of the specific dry cleaning system from which the solvent mileage information was obtained;

(4) Identification of maintenance requirements and parameters to monitor to ensure proper operation and maintenance of the candidate emission control technology;

(5) Explanation of why this information is considered accurate and representative of both the short-term and the long-term performance of the candidate emission control technology on the specific dry cleaning system examined;

(6) Explanation of why this information can or cannot be extrapolated to dry cleaning systems other than the specific system(s) examined; and

(7) Information on the cross-media impacts (to water and solid waste) of the candidate emission control technology and demonstration that the cross-media impacts are less than or equal to the cross-media impacts of a refrigerated condenser.

(b) For the purpose of determining equivalency to control equipment required under § 63.322, the Administrator will evaluate the petition to determine whether equivalent control of perchloroethylene emissions has been adequately demonstrated.

(c) Where the Administrator determines that certain equipment and procedures may be equivalent, the Administrator will publish a notice in the Federal Register proposing to consider this equipment or these procedures as equivalent. After notice and opportunity for public hearing, the Administrator will publish the final determination of equivalency in the Federal Register.

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