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Hazardous Air Pollutant Emissions from the Production of Flexible Polyurethane Foam --

Basis and Purpose Document for Proposed Standards

NESHAP

HAZARDOUS AIR POLLUTANT EMISSIONS FROM THE PRODUCTION OF FLEXIBLE POLYURETHANE FOAM

Basis and Purpose Document for Proposed Standards

Emission Standards Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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ENVIRONMENTAL PROTECTION AGENCY

Hazardous Air Pollutant Emissions from the Production of Flexible Polyurethane Foam - Basis and Purpose Document for Proposed Standards

1. The standards regulate hazardous air pollutant emissions from the production of flexible polyurethane foam. Only flexible polyurethane production facilities that are part of major sources under Section 112(d) of the Clean Air Act (Act) will be regulated.

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1.0 PURPOSE OF DOCUMENT

This Basis and Purpose Document provides background information on, and rationale for, decisions made by the Environmental Protection Agency (EPA) related to the proposed standards for the reduction of hazardous air pollutants (HAP) emitted during the production of flexible polyurethane foam. This source category includes both molded and slabstock flexible polyurethane foam production. This document is intended to supplement the preamble for the proposed standards.

This document is separated into 10 chapters providing a combination of background information and EPA rationale for decisions made in the standards development process. Chapters 2, 3, 5, 7, 8, and 9 provide background information; Chapter 2 is an introduction, Chapter 3 describes the affected industry, Chapter 5 presents the baseline HAP emissions, Chapter 7 presents model plants, Chapter 8 presents the predicted environmental impacts associated with the regulatory alternatives, and Chapter 9 presents the predicted cost and economic impacts associated with the regulatory alternatives. Chapters 4, 6, and 10 provide EPA rationale for subcategorization, determination of MACT "floors" and development of regulatory alternatives, and rationale for the selection of the proposed standards, respectively. Supporting information and more detailed descriptions for each technical and rationale chapter are contained in the memoranda referenced in this document and contained in the project docket.

Supporting information is located in Air Docket A-95-48. Detailed descriptions of the analyses presented in Chapters 3 through 9 are contained in a series of memoranda assembled in the Supplementary Information Document (SID), (Docket Item number II-A-3).[1]

2.0 INTRODUCTION

Section 112 of the Clean Air Act, as amended in 1990 (1990 Amendments) gives the EPA the authority to establish national standards to reduce air emissions from sources that emit one or more hazardous air pollutants (HAP). Section 112(b) contains a list of HAP to be regulated by National Emission Standards for Hazardous Air Pollutants (NESHAP), and Section 112(c) directs the EPA to use this pollutant list to develop and publish a list of source categories for which NESHAP will be developed. The EPA must list all known source categories and subcategories of "major sources" that emit one or more of the listed HAP. A major source is defined in section 112(a) as any stationary source or group of stationary sources located within a contiguous area and under common control that emits, or has the potential to emit, in the aggregate, considering controls, 10 tons per year or more of any one HAP or 25 tons per year or more of any combination of HAP. This list of source categories was published in the Federal Register on July 16, 1992 (57 FR 31576), and includes the flexible polyurethane foam source category. Flexible polyurethane foam is used in furniture, bedding, packaging, carpet cushioning, automobile interiors, medical supplies, and a variety of miscellaneous other uses.

3.0 DESCRIPTION OF THE AFFECTED INDUSTRY

The purpose of this chapter is to present a brief description of the flexible polyurethane foam industry. This chapter is arranged in several sections. Section 3.1 presents a general description of the industry, including facility location and other general statistics. Section 3.2 describes the foam chemistry. Section 3.3 describes the slabstock foam production process, including fabrication processes, followed by sections that describe where HAP emissions occur in the slabstock process, and control technologies for these emissions. The next sections present the same information for the molded foam process, from the production process to emission control. The final sections discuss the rebond foam process, emission sources, and control techniques. A more detailed industry description is provided in the SID.[2]

3.1 INDUSTRY DESCRIPTION

The flexible polyurethane foam source category is contained in the initial list of source categories for NESHAP under the amended Clean Air Act of 1990. In the Environmental Protection Agency's (EPA) initial source category listing,[3] the source category is defined as follows:

> The Flexible Polyurethane Foam Production Source category includes any facility which manufactures foam made from a polymer containing a plurality of carbamate linkages in the chain backbone (polyurethane).

Three types of polyurethane foam facilities appear to fit in this category description: slabstock flexible polyurethane foam (i.e., slabstock foam), molded flexible polyurethane foam (i.e., molded foam), and rebond foam. Slabstock foam is produced in large continuous buns that are then cut into the desired size and shape (fabricated). Slabstock foam is used in furniture, bedding, packaging, and carpet cushioning. Molded foam is produced by "shooting" the foam mixture into a mold of the desired shape and size. The major use of molded foam, by weight, is in automobile interiors, but is used in many other applications such as packaging, novelty applications, and medical supplies. Rebond foam is made from scrap foam that is converted into a material primarily used for carpet underlay.

The foam chemistry of the slabstock and molded segments of the industry is analogous; however, the equipment, production processes, emission sources, and control techniques are very different. The rebond foam segment differs from both other segments in these areas, as well as in the chemistry.

3.1.1 Slabstock Foam Facility Distribution

The EPA estimates that there are 78 slabstock foam facilities in the United States. Table 3-1 shows the distribution of foam facilities by state. Data were received from all 78 facilities through the distribution of an Information Collection Request (ICR) by the EPA.[4] Since slabstock foam is produced in large "buns," which must be cut into the desired sizes and shapes, fabrication operations are sometimes co-located with slabstock foam production facilities. Also, rebond foam production operations, which use foam scraps as the primary starting material to produce the foam product, are sometimes co-located with slabstock foam production facilities.

3.1.2 Molded Foam Facility Distribution

The EPA estimates that there are 228 molded foam production facilities in the United States. The EPA used several sources to obtain this estimate. First, ICR responses were received from 46 molded foam facilities. Using the "Polyurethane Industry Directory and Buyer's Guide - 1994",[5] an additional 182 flexible molded foam companies were identified based on company descriptions. Table 3-2 presents the distribution of these 228 molded foam facilities by state.

3.1.3 Rebond Foam Facility Distribution

The EPA estimates that there are 52 rebond foam facilities in the United States.[6] Of these rebond facilities, 21 are

TABLE 3-1. DISTRIBUTION OF SLABSTOCK FOAM FACILITIES BY STATE

State	Number of Facilities
Arkansas	2
California	8
Delaware	1
Florida	5
Georgia	4
Illinois	3
Indiana	8
Iowa	1
Kansas	1
Kentucky	1
Maryland	1
Massachusetts	1
Michigan	2
Mississippi	8
Minnesota	1
New Jersey	2
New Mexico	1
North Carolina	9
Ohio	2
Oregon	1
Pennsylvania	4
Tennessee	5
Texas	5
Virginia	1
Washington	1
Wisconsin	1
Total	**78**

TABLE 3-2. DISTRIBUTION OF MOLDED FOAM FACILITIES BY STATE

State	Number of Facilities	State	Number of Facilities
Alabama	3	Mississippi	1
Arizona	1	Missouri	7
Arkansas	1	Montana	1
California	19	Nebraska	1
Colorado	6	Nevada	2
Connecticut	8	New Hampshire	2
Delaware	2	New Jersey	11
Florida	1	New York	9
Georgia	4	North Carolina	5
Illinois	11	Ohio	23
Indiana	7	Oregon	2
Iowa	5	Pennsylvania	14
Kansas	3	Rhode Island	1
Kentucky	3	South Carolina	2
Maine	1	Tennessee	5
Maryland	5	Virginia	4
Massachusetts	4	Washington	4
Michigan	29	West Virginia	1
Minnesota	7	Wisconsin	8
		TOTAL	228

located at plant sites that also produce slabstock flexible polyurethane foam. Data were obtained from the ICR responses for these rebond operations.

3.2 SLABSTOCK AND MOLDED FOAM CHEMISTRY

This section briefly describes the chemistry involved in producing slabstock and molded flexible polyurethane foam. Section 3.3 then discusses the slabstock foam production process. The primary references for these sections are the ICI Polyurethanes Book[7] and a site visit report to a foam production facility.[8]

3.2.1 Chemistry of Flexible Polyurethane Foam: Slabstock and Molded

Polyurethanes are made by reacting a polyol with a diisocyanate. The polyol is typically a polyester or a polyether with two or more $-CH_2OH$ functional groups, and the diisocyanate is usually a mixture of 2,4- and 2,6- isomers of toluene diisocyanate (TDI). TDI is the most often used diisocyanate in slabstock foam production, while methylene diphenyl diisocyanate (MDI) is most often chosen in molded foam production.

Polyurethane foams are made by adding water to the reaction mixture. Once the ingredients are mixed, two main polymerization reactions occur. Isocyanate groups react with hydroxyl groups on the polyol to produce urethane linkages (hence the term "polyurethane"). The other main reaction is that of the isocyanate and water. The initial product of the reaction with water is a substituted carbamic acid, which breaks down into an amine and carbon dioxide (CO_2). The amine then reacts with another isocyanate to yield a substituted urea linkage.

Surfactants and catalysts are also added to the mixture. The surfactants aid in mixing incompatible components of the reaction mixture, and also help control the size of the foam cells by stabilizing the forming gas bubbles. Catalysts balance the isocyanate/water and isocyanate/polyol reactions, and assist in driving the polymerization reaction to completion.

The CO_2 formed in this reaction acts as the "blowing agent" (blowing agents will be discussed in more detail later in this section) and causes the bubbles to expand. The bubbles eventually come into close contact, forming a network of cells separated by thin membranes. At full foam rise, the cell membranes are stretched to their limits and rupture, releasing the blowing agent and leaving open cells supported by polymer "struts."

The final polymer is composed of the urethane and urea linkages formed in the isocyanate/polyol and isocyanate/water reactions. The polyol-to-isocyanate urethane linkages provide strength, and the isocyanate-to-isocyanate urea linkages give the foam its firmness.

3.2.2 Auxiliary Blowing Agents

As noted in the previous section, one result of the isocyanate-water reaction is the liberation of CO_2 gas. The blowing action of this CO_2 is termed "water-blowing," because the CO_2 blowing agent is produced from the isocyanate-water reaction. Many grades of foam can be produced using only this CO_2 gas as a blowing agent.

Increasing the amount of water in a formulation generally produces a lower-density foam, because additional CO_2 blowing agent is produced. However, there is a practical limit to the amount of water that can be used. First, an increase in the water level results in an increase in the number of urea linkages in the final polymer. These linkages tend to make the polymer stiffer because they undergo hydrogen bonding. Second, the isocyanate-water reaction is extremely exothermic. An excessive level of water can cause high temperatures that can scorch the foam, or even cause the foam to ignite.

As a result, some grades of foam require the use of an auxiliary blowing agent (ABA). The ABA is mixed with the foam reactants as a liquid when the reactant mixture is first poured. As the exothermic polymerization reactions raise the temperature of the polymer mass, the ABA vaporizes, supplementing the blowing action of CO_2 from the water-isocyanate reaction. The vaporization of the ABA also serves to remove excess heat from the foam, reducing the potential for scorching or auto-ignition.

Auxiliary blowing agents are more widely used in the production of slabstock foams than in the production of molded foams. The amount of ABA required depends on the grade of foam being produced and the ABA used. ABAs are most important for low density and soft foams. In these grades, water-blowing alone would cause problems with either overheating or with increased foam stiffness. For low-density foams, ABAs are used in conjunction with water-blowing to avoid overheating. In the case of soft foams, ABAs provide blowing action without increasing the foam's stiffness. The most common ABA used in the foam industry is a HAP, methylene chloride ($MeCl_2$).

3.3 SLABSTOCK FOAM PRODUCTION PROCESS

Figure 3-1 depicts a typical slabstock foam production process. Flexible slabstock foam is produced as a large continuous "bun" that is later cut into sections with the desired dimensions. There are variations in the design of the machines that produce the foam. They may be horizontal or vertical, with the horizontal foam line being the most common. There are several types of horizontal foam machines found in foam facilities. The most common system is called "Maxfoam", which is described below. Following the description of the Maxfoam line will be a description of the Vertifoam process, a vertical foam production process.

3.3.1 Horizontal Maxfoam Production

From bulk chemical storage, raw ingredients are moved to smaller feed tanks. The chemicals are pumped from the feed tanks to the mixing head of the foam line where they are vigorously mixed. The amount of each chemical sent to the mixing head is carefully controlled by metering pumps. The mixture is discharged through a mixing head into a trough where the reactions begin to occur (i.e., "creaming" begins). From this trough, the froth flows onto the foam tunnel. The mixture quickly spreads evenly across the width of the tunnel.

The bottom of the tunnel consists of a series of five adjustable fall-plates that are covered by paper. The foam reaches its maximum height, or "full rise" about 25 feet from the

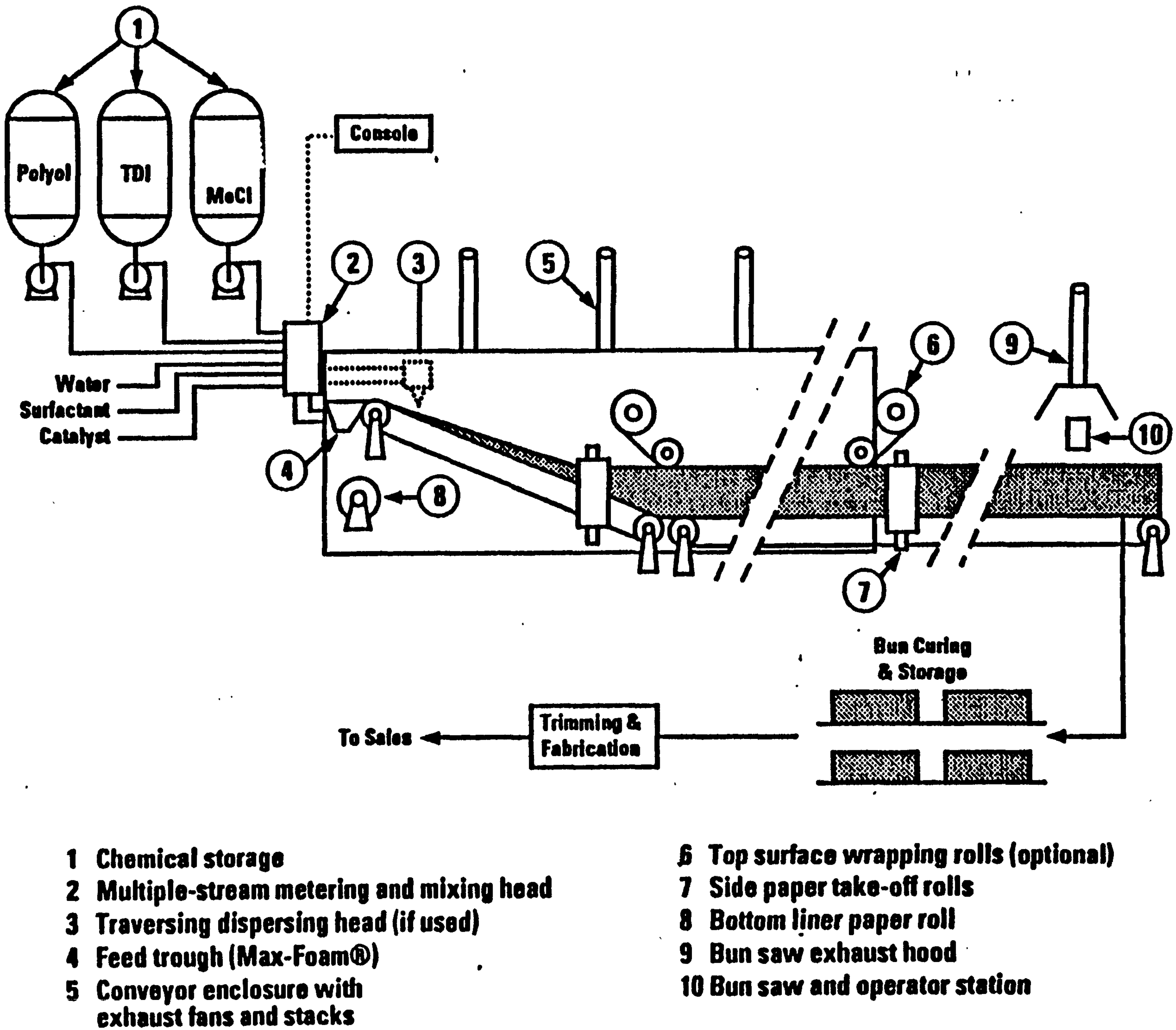

Figure 3-1. Typical Slabstock Foam Production Process

nozzle. The full rise time is dependent on the grade of foam, with lower density foams rising highest and at the fastest rate. Instead of "rising," the foam actually expands downward along the slope of the fall plates. The sides of the foam tunnel are vertical conveyors, covered with plastic, which move the foam down the tunnel. The fall plates are stationary, and it is the side plastic and the bottom paper that move the foam to the belt conveyor portion.

The belt conveyor carrying the foam block moves at an average speed of 15 to 20 feet per minute. Additional time on the conveyor after full rise is required to allow the polymerization reactions to be completed so the foam will solidify. The side papers are then removed from the bun, and the bun is sawed into the desired lengths. After sawing, the end of the bun is marked with the foam grade, and the bun moves off the belt conveyor onto a roller-type conveyor moving at a higher rate of speed. This conveyor continues through the wall of the pouring area, through the foam storage area, and then into the foam curing area.

In the curing area, the buns are removed from the conveyor with overhead cranes and placed on the floor. Typically, buns are cured 12 to 24 hours before being moved from the curing area to foam storage. In the storage area, buns are piled 4 or 5 high. The buns remain in the storage area until ready for fabrication or shipping.

3.3.2 Vertifoam Production Process Description

In the Vertifoam process, the foam reaction mixture is introduced at the bottom of a completely enclosed chamber. This chamber is lined with paper or plastic, which is drawn upwards at a controlled rate. The rate is dependent on the pressure in the chamber, the foam formulation, and the rate of production. With a controlled rate of upward pull, the rheology of the foam reaction process, combined with the effect of gravity, ensures a stable foaming front, and prevents the mixing of the still liquid reacting mixture with the partially gelling foam poured a few seconds earlier.

3.3.3 Foam Fabrication

As mentioned earlier, slabstock flexible polyurethane foam is produced in large buns which are typically 4 feet tall, 8 feet wide, and 50 to 100 feet long. Prior to being delivered to the furniture manufacturer or other end-user, the large buns are "fabricated" according to the end-use. The simplest type of fabrication is to cut the foam into the desired shape by use of specialized saws, by hand-cutting, or other techniques. However, many customers desire foam products that are more "finished" or complex. To produce such products generally requires the gluing of foam-to-foam, or foam to some other material such as cotton batting. The most commonly used adhesives contain methyl chloroform (a HAP). Since methyl chloroform has also been identified as an ozone depleting substance, fabricators have been searching for alternative adhesives. It appears that the most popular replacements have been $MeCl_2$-based adhesives.

Fabrication operations are sometimes co-located with foam production operations (i.e., are on-site). Information from the ICR's revealed that approximately 40 percent of the foam produced is fabricated on-site. Off-site fabrication facilities fabricate the remaining 60 percent of the foam produced.

3.4 HAP EMISSION SOURCES FROM SLABSTOCK FOAM PRODUCTION

This section will briefly discuss the HAP emission points for slabstock foam production and fabrication. The four main sources of HAP emissions are storage of raw materials, leaking components in HAP service, the foam tunnel and curing area, and equipment cleaning. Fabrication emission sources will be discussed in this section, as well.

3.4.1 Storage Emissions

Raw HAP chemicals are received at foam facilities by railcar, tank truck, and in drums. Emissions can occur as working losses during the unloading of the HAP from the railcar or tank truck. There can also be small amounts of HAP emitted from the storage tank due to diurnal temperature or pressure changes.

3.4.2 Equipment Leaks from Components in HAP Service

There can be small amounts of HAP releases from leaking components in HAP service. Some examples of components in HAP service that may leak are pumps, valves, and connectors.

3.4.3 Foam Tunnel and Curing

There are two HAP that are emitted from the foam tunnel and curing area: $MeCl_2$ used as an ABA, and TDI. As mentioned earlier, the TDI is a primary reactant in the polyurethane reaction. There is a small opportunity for TDI emissions at the point the foam mixture is initially poured on the conveyer. However, the TDI reacts very quickly, leaving little residual TDI to be emitted.

$MeCl_2$ is the principal ABA used, and its role is simply to volatilize and expand the foam. Therefore, all of the $MeCl_2$ that is added is eventually emitted. The $MeCl_2$ ABA is emitted in three primary areas. The first is in the foam tunnel, where the increasing temperatures from the exothermic isocyanate-water reaction cause the $MeCl_2$ to volatilize. A significant amount of $MeCl_2$ blowing agent remains in the foam after the tunnel, and is emitted when the bun is cut into sections, as well as while in the curing area. Estimates place the general distribution of these ABA emissions at 30-40 percent in the foam tunnel and 40-55 percent in the curing area.[9]

3.4.4 Equipment Cleaning

HAP are also emitted through the use of HAP cleaning solvents. Methylene chloride is used as a cleaner to rinse and/or soak foam machine parts such as mixheads and foam troughs at the end of a pour. Hardened foam residue forms on the trough, fall plates, and other equipment, and must be removed after each production run.

3.4.5 Fabrication

The HAP emissions in fabrication operations occur due to the use of HAP-based spray adhesives for gluing fabric to foam, or foam to foam. Fabrication covers the broad range of die cut parts, cut parts, and glued parts, and not all fabrication involves gluing..

3.5 CONTROL TECHNOLOGIES FOR SLABSTOCK HAP EMISSIONS

The EPA reviewed information from the ICR responses that were received from flexible polyurethane foam producers, as well as the information contained in other pertinent project files, to identify potential HAP emission reduction and control technologies. Based on their findings, the EPA created a report entitled "Flexible Polyurethane Foam Emission Reduction Technologies Cost Analysis".[10] This report will hereafter be referred to as the Cost Report. The technologies investigated in the cost report will briefly be identified and discussed in this section.

3.5.1 Control Technologies for ABA Emissions

There were several alternatives identified to either reduce or eliminate the use of $MeCl_2$ as an ABA in the manufacture of slabstock flexible polyurethane foam. The technologies identified were acetone or liquid CO_2 as an ABA, foaming in a controlled environment, forced cooling, chemical modifications, and carbon adsorption.

3.5.2 Reducing Releases From Chemical Storage and Handling, Equipment Cleaning, and Components in HAP Service

3.5.2.1 Chemical Storage and Handling

There were two methods identified for reducing HAP emissions from this source: carbon canisters and a vapor balance system. Carbon canisters control emissions by capturing the vapor released during unloading or storage. The vent systems for the storage tanks lead to this carbon canister that is filled with activated carbon.

Vapor balancing is another method frequently used on TDI storage tanks to control unloading emissions. When a TDI storage tank is filled, the vapors are vapor-balanced. That is, the vapors present in the tank are forced out by the incoming liquid and are routed back to the railcar or tank truck using piping.

3.5.2.2 Components in HAP Service

Two methods for controlling equipment leaks from components in HAP service were identified: equipment modifications and leak detection and repair (LDAR) programs. The equipment modification identified for the slabstock industry was the use of leakless pumps for TDI and $MeCl_2$. Leak detection and repair programs require the periodic monitoring of components to detect and repair leaks.

3.5.2.3 Equipment Cleaning

Methylene chloride is used as a cleaner to rinse and/or soak foam machine parts such as mixheads and foam troughs. The two alternatives for eliminating these HAP emissions which were identified were steam cleaning and non-HAP cleaners.

3.5.3 Reducing Releases From Fabrication/Repair Operations: Fabrication Adhesives and Molded Foam Repair

HAP-based adhesives are used in both slabstock and molded foam facilities. As the reduction alternatives are the same for both subcategories, they will be discussed together. In slabstock facilities, spray adhesives are used to glue fabric to foam, or foam to foam. The main use of adhesives in molded foam facilities is for the repair of voids and tears in the molded pieces. Three alternatives were identified that might eliminate HAP emissions from the use of adhesives. These are (1) hot-melt adhesive, (2) water-based adhesives, and (3) Hydrofuse.

3.6 MOLDED FOAM PRODUCTION PROCESS

Figure 3-2 illustrates a typical molded foam production line. The primary references used in this section were the ICI Polyurethanes Book[6] and a site visit report to a molded foam production facility.[11] The production line includes multiple molds, with each mold consisting of top and bottom sections, joined by hinges. The molds are mounted on a circular or oval-shaped track. Both the molds and the track can vary broadly in size. The molds travel around the track, and the necessary process operations are performed at fixed stations. The following paragraphs describe a basic molding cycle.

The first step in the molding cycle is the application of mold release agent. This is a substance that is applied to the mold to facilitate removal of the foam product. After the mold release agent is applied, any special components to be molded

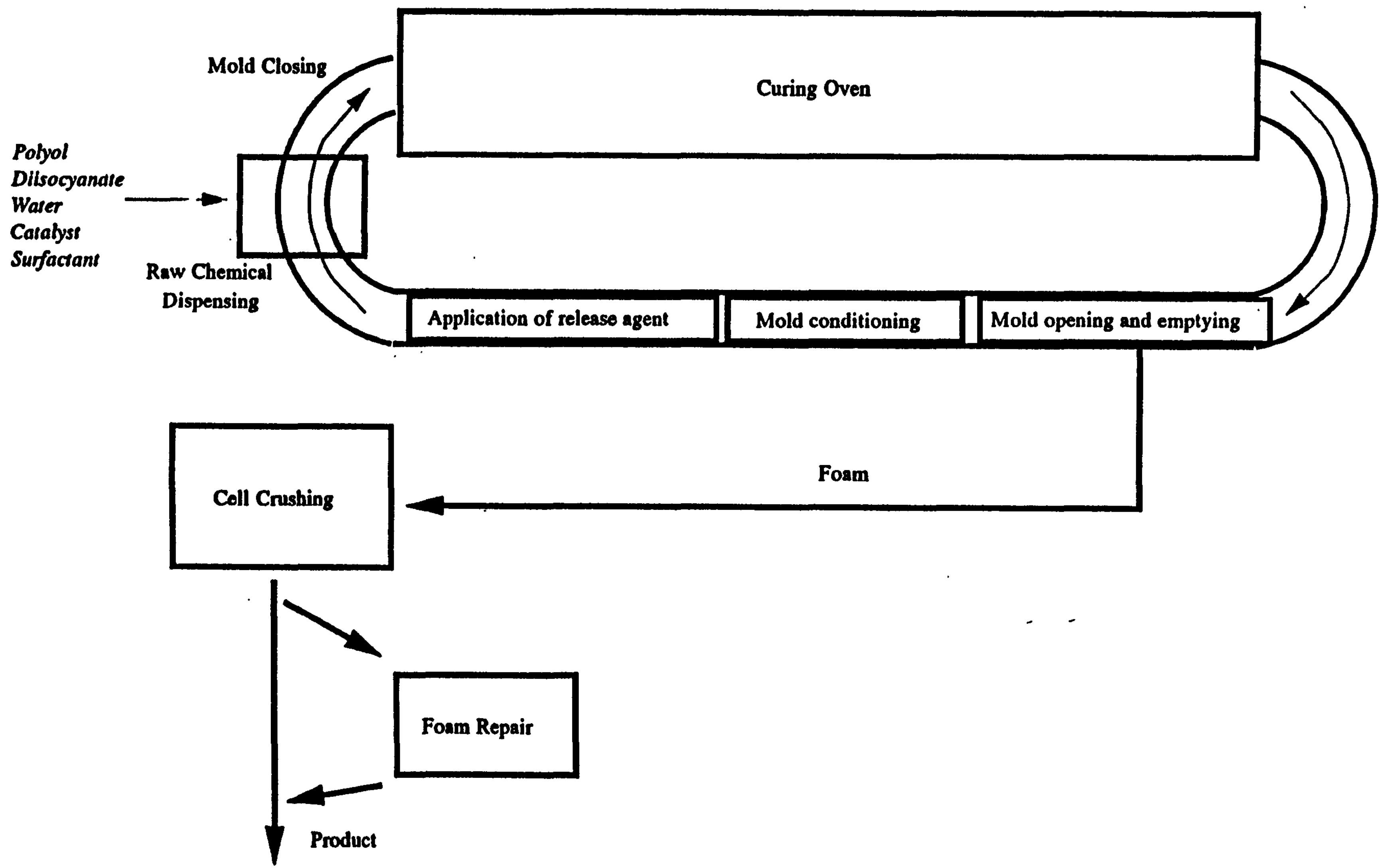

Figure 3-2. Typical Molded Foam Production Process

into the foam are placed in the mold. These might include covers, springs, or reinforcing materials.

Raw materials, including polyol, diisocyanate, water, catalyst, and surfactant are all pumped to a common mixhead in predetermined amounts. The mixhead injects a precisely measured "shot" of raw material into each mold. There are two types of mixheads used in the industry, high-pressure (HP) and low-pressure (LP). The two types of mixheads have different cleaning requirements, resulting in a dramatic difference in overall emissions from the process, which will be discussed in the HAP emission section that follows.

The mold is closed and the polymerization reaction occurs, producing a foam product that fills the mold. Most molded foams are produced without any ABA, using only the blowing action of CO_2 gas from the water-isocyanate reaction. After curing, the molds are opened and the product is removed. The mold is then cleaned and starts the circuit again.

Another important variety of molded foam is the integral skin foam, also known as a self-skinning foam. An integral skin foam is a foam with a dense, tough outer surface. The skin is produced by overpacking the mold and using an ABA, usually Freon-11. Unlike other types of molded foams, integral skin foams require an ABA. The skin production is also driven by the temperature gradient between the center of the foam mass and the relatively cooler surface of the mold. Integral skin foams are used in such products as steering wheels and footwear.

3.7 MOLDED FOAM HAP EMISSION SOURCES

This section will briefly discuss the HAP emission points for molded foam production. The three main areas of HAP emissions from molded foam production are mixhead flush, mold release agents, and repair operations (from adhesive use).

3.7.1 Mixhead Flush

Methylene chloride emissions for flushing of LP mixheads is the largest emission source for flexible molded foam manufacture. With LP mixheads, the chemical streams enter the mixing chamber at approximately 40 to 100 psi, and are blended by rotating mixer blades before being released or "shot" into the mold. Residual materials can remain in the chamber, as well as on the blades. This material needs to be cleaned out, either after every shot, or after several, depending on the conditions. Flushing is necessary because the residual froth can harden and clog the mixhead or can interfere with the necessary precision required regarding the volume of the foam shot.

3.7.2 Mold Release Agents

Mold release agents were another source of HAP emissions from molded foam. Mold release agents are sprayed on the mold surface before the foam mixture is poured into the mold, to prevent adhesion and create a smooth surface. Traditional mold release agents consist of a resin in a solvent carrier, frequently methylene chloride or 1,1,1-trichloroethylene (methyl chloroform), which are both HAP. The carrier evaporates, leaving the resin, which prevents the foam from sticking to the mold.

3.7.3 Molded Foam Repair

Once a foam piece has been removed from the mold, it is inspected for tears or holes. If repair is needed, scrap foam pieces, or the original piece that stuck to the mold, are glued to fill in the void. A HAP-based adhesive may be used for this process, with the carrier solvent being a HAP. The emissions occur when the solvent carrier evaporates after the adhesive is applied.

3.8 HAP CONTROL TECHNOLOGIES FOR MOLDED FOAM

As was discussed in the HAP control technologies section for slabstock, the EPA identified emission reduction and control techniques for the flexible molded polyurethane foam industry. Mixhead flush and mold repair emission reduction technologies are identified below. The emission reduction technologies for repair adhesives are the same as for slabstock fabrication, and were discussed in section 3.5.3. A more complete discussion of the HAP control technologies can be found in the industry description memorandum.

3.8.1 Control Technologies for Reducing Releases from Mixhead Flushing

As noted in the discussion of HAP emission sources, methylene chloride emissions for flushing of LP mixheads was the largest emission source for flexible molded foam manufacture. Several technologies were identified that could reduce or eliminate this source of HAP emissions for the molded foam producer. These technologies include non-HAP flushes, HP mixheads, self-cleaning mixheads, and solvent recovery units.

3.8.2 Control Technologies for Reducing Releases of Mold Release Agent

As mentioned in the earlier section on HAP emission sources for molded foam, emissions occurred from the evaporation of the carrier solvent from mold release agents. Alternatives being used, or being investigated, by the industry include water- or naphtha-based agents, and reduced-VOC solvent agents.

3.9 REBOND FOAM PRODUCTION

Another flexible foam product is rebond foam. Rebond foam is produced at flexible foam production facilities, as well as at stand-alone, or off-site facilities. Rebonding is a process where scrap foam is converted into a material that is used for carpet underlay and several other end-uses such as school bus seats.

3.9.1 Rebond Foam Process

The scrap foam may have been generated at the facility from its slabstock operations, or may have been shipped or bought from other foam facilities. There is such a high demand for this product that foam scrap is imported from overseas. The scraps are received in "bales." The baled foam is foam "chewed" into smaller pieces. These small pieces are loaded into a blender, where a mixture of polyol and TDI is added. The foam and binder mixture, and occasionally a dye, is poured into a cylindrical mold, that is below floor level. This mold has a central core so that there is a hole that runs the length of the cylinder. Pressure and steam are applied to the mixture in the mold, and then the roll is taken out of the mold and allowed to cool, or "set," for about 24 hours.

3.9.2 Rebond Emission Sources

Three HAP emission points were identified at rebond operations. First, a small amount of TDI emissions occur at the molding pit area where foam pieces, TDI, and polyol are subjected to pressure and steam. Also, one rebond facility reported the use of a $MeCl_2$-based mold release agent, and the use of $MeCl_2$ as an equipment cleaner.

3.9.3 Rebond Control Techniques

Since only one facility reported the use of an $MeCl_2$-based mold release agent and the use of $MeCl_2$ as an equipment cleaner, the EPA assumes that other products are available to accomplish these same functions, without emitting HAP. Further, the EPA was informed that the facility that originally reported the use of these HAP products had discontinued their use.[12] There were no methods identified to control TDI emissions from rebond operations.

4.0 SUBCATEGORIZATION OF THE LISTED SOURCE CATEGORY

The purpose of this chapter is to present considerations and conclusions regarding the subcategorization of the flexible polyurethane foam production source category. The first section identifies potential reasons for subcategorizing a source category, the second section presents brief descriptions of the operations and hazardous air pollutant (HAP) emission sources associated with flexible polyurethane foam source production and related processes, and the third section presents EPA's rationale for the selection of subcategories for this industry. The final section summarizes this subcategorization decision.

4.1 SUBCATEGORIZATION CONSIDERATIONS

Subcategories, or subsets of similar emission sources within a source category, may be defined if technical differences in emissions characteristics, processes, control device applicability, or opportunities for pollution prevention exist within the source category.[13]

There are three distinct production processes associated with flexible polyurethane foam: slabstock foam production, molded foam production, and rebond foam production. Each will be briefly discussed below, along with slabstock foam fabrication.

4.2 PROCESS AND HAP EMISSION DESCRIPTIONS

This section briefly describes the molded, slabstock, fabrication, and rebond processes, including the main HAP emission points, as well as a brief discussion of flexible polyurethane foam chemistry. More details on the foam chemistry, production processes, HAP emissions, and control technologies can be found in Chapter 3 of this document, and in the Industry Description Memorandum.[1]

4.2.1 Polyurethane Foam Chemistry

Flexible polyurethane foam is produced by mixing three major ingredients: a polyol polymer, an isocyanate, and water. When the polyol, diisocyanate, and water are mixed, two main polymerization reactions occur. Isocyanate groups react with hydroxyl groups on the polyol to produce urethane linkages (hence the term "polyurethane"). The other main reaction is that of the isocyanate and water, which forms a urea linkage and CO_2. The CO_2 formed in this reaction acts as the "blowing agent" and produces bubbles, causing the foam to expand to its full volume within minutes after the ingredients are mixed and poured. The final polymer is composed of the urethane and urea cross-linkages formed in the isocyanate/polyol and isocyanate/water reactions.

4.2.2 Slabstock Polyurethane Foam Production

Flexible slabstock foam is produced as a large continuous "bun" that is cut into sections with the desirable dimensions. The major HAP emission source at slabstock facilities is from the use of $MeCl_2$ as an ABA. Methylene chloride's role is simply to volatilize and expand the foam, not directly participate in the polyurethane reaction. Therefore, all of the methylene chloride that is added is eventually emitted. Other HAP emission sources at slabstock production facilities include unreacted TDI from the foam tunnel (very small amount), emissions from leaking TDI and $MeCl_2$ pumps, valves, and other equipment; and equipment cleaning.

4.2.3 Molded Polyurethane Foam Production

Molded foam production uses somewhat different chemical formulations from those used for slabstock foam production, although the basic polyurethane foam reaction is the same. Molded flexible foams have higher densities than the slabstock flexible foams and, therefore, seldom use an ABA. In contrast to the slabstock process, the molding method is an intermittent batch process where the raw ingredients are placed in a mold and allowed to react.

After a foam piece is removed from the mold, it is generally trimmed and inspected for tears or holes, and any tears and/or holes are repaired. Repair operations are carried out at glue stations, which may by equipped with local ventilation systems to remove solvent vapors emanating from the glue.

Methylene chloride emissions for flushing of LP mixheads is the largest emission source for flexible molded foam manufacture. Mold release agents are another source of HAP emissions from molded foam. Traditional mold release agents consist of a resin in a solvent carrier, frequently methylene chloride or 1,1,1-trichloroethylene (methyl chloroform), both HAP. If repair of the molded piece is needed, scrap foam, or the original piece that stuck to the mold, are glued to fill in the void. A HAP-based adhesive may be used for this process, with the carrier solvent being a HAP.

4.2.4 Fabrication Operations

As mentioned earlier, slabstock flexible polyurethane foam is produced in large buns which are typically 4 feet tall, 8 feet wide, and 50 to 100 feet long. Prior to being delivered to the furniture manufacturer or other end-user, the large buns are "fabricated" according to the end-use. The simplest type of fabrication is to cut the foam into the desired shape by use of specialized saws, by hand-cutting, or other techniques. However, many customers desire foam products that are more "finished" or complex. To produce such products generally requires the gluing of foam-to-foam, or foam to some other material such as cotton batting. The most commonly used adhesives are either methyl chloroform based, or $MeCl_2$-based.

4.2.5 Rebond Foam Production

Rebonding is a process where scrap foam is converted into a foam product that is used for carpet underlay and several other end-uses. The scrap foam is converted into small pieces, which are loaded into a blender, and a mixture of polyol and TDI is added. The foam and binder mixture is poured into a cylindrical mold. Pressure and steam are applied to the mixture in the mold, and then the roll is taken out of the mold and allowed to cool or "set" for about 24 hours. There is the potential for very small TDI emissions during the process, but the largest potential for

HAP emissions at rebond facilities is from the use of $MeCl_2$ as an equipment cleaner.

4.3 RATIONALE FOR SUBCATEGORIZATION WITHIN THE FLEXIBLE POLYURETHANE FOAM PRODUCTION SOURCE CATEGORY

As is evident from the information presented in the paragraphs above, the only characteristic that molded and slabstock foam share is a similar chemistry to produce a flexible polyurethane foam product. Further, the rebond foam process is a dissimilar process, with the only similarity being between the final products. Therefore, the EPA concludes that the flexible polyurethane foam production industry should be separated into three distinct subcategories, slabstock and molded flexible polyurethane foam production, and rebond foam production. While the foam chemistry and final products are similar, the equipment, emission sources, and control techniques are very different. Molded and rebond foam are manufactured in batch-type processes, while slabstock is made in a continuous method. The major emission source for slabstock foam is from the use of ABA, and there is no analogous emission point for either molded or rebond foam. The only significant HAP emission point that the three segments share is equipment cleaning (mixhead cleaning for molded), and the reasons for these emissions, and the control technologies that could be used, are very different. Therefore, the three segments are treated as three separate subcategories for the purpose of this rulemaking.

During its investigations, the EPA became aware of flexible polyurethane foam fabrication operations, which are sometimes co-located with slabstock foam production operations (i.e., are located on-site). The EPA also obtained information related to HAP emissions from fabrication operations in the ICR responses. The total reported HAP emissions from fabrication operations at the 69 facilities with on-site fabrication operations was 1,382 tons per year. Therefore, the average fabrication operation HAP emissions was around 23 tons per year of a single HAP.

As noted earlier, the ICR responses indicated that approximately 40 percent of the foam produced is fabricated on-site, meaning that the majority of slabstock foam is fabricated at sites that do not also produce slabstock foam. Given the emissions information for on-site fabrication operations noted above, the EPA concluded that the potential for HAP emissions from foam fabrication is enormous. Therefore, the Agency decided that further investigation of this segment of the foam fabrication industry is necessary.

Due to the relationship between foam production and foam fabrication, and since some information had already been collected for foam fabrication (at operations co-located with slabstock production operations), the Agency considered expanding the flexible polyurethane foam production source category to include foam fabrication. However, this option was rejected for several reasons. First, the EPA was not able to determine if the information collected for on-site facilities was representative of the entire fabrication industry. Since the information collected was for on-site fabrication operations owned by foam producers, it was believed that this information may not have been representative of smaller, independent fabricators, and it was estimated that there could be as many as 2,000 small independent fabricators in the U.S.[14] Obtaining general information on the fabrication industry in a timely manner was made more difficult, since no trade organization was identified that represents the fabrication industry. In addition, the EPA became aware of fabrication operations using HAP-based adhesives at rebond facilities, which were not represented in the original data. The EPA concluded that the investigation of the foam fabrication industry that was needed to allow the development of comprehensive and appropriate standards could not be accomplished in the schedule for the foam production source category.

Therefore, the EPA has listed flexible polyurethane foam fabrication as a separate source category. The scheduled promulgation date for the fabrication source category will be November 15, 2000. This will allow the EPA to have time to gather more information on stand-alone fabrication facilities, as well as to work with States and industry on identifying potential control options specifically for fabrication. On-site and off-site facilities and their similarities and differences can be considered during the development of the foam fabrication regulation.

4.4 SUMMARY

In summary, the EPA has separated the flexible polyurethane foam production source category into three subcategories: slabstock foam production, molded foam production, and rebond foam production. During the analysis of the foam production industry, the EPA became aware of foam fabrication operations that emit HAP, and has listed flexible polyurethane foam fabrication as a major source category. The proposed standards do not address the foam fabrication source category, as regulation of this new fabrication source category will take place on a different schedule.

5.0 BASELINE EMISSIONS

This chapter presents the baseline HAP emissions for the flexible polyurethane foam production source category. As discussed in Chapter 4, there are three subcategories of flexible polyurethane foam: molded, slabstock and rebond. Baseline HAP emissions for slabstock foam are presented in Table 5-1. The same information is provided in Table 5-2 for molded foam. As shown in these tables, the total nationwide estimated HAP emissions are over 16,500 tons per year (15,000 Mg/yr) for the slabstock subcategory, and almost 3,200 tons per year (2,900 Mg/yr) for molded foam. Therefore, over 19,700 tons per year (17,950 Mg/yr) of total HAP are emitted from the source category, including 2.5 tons per year (2.3 Mg/yr) from rebond foam production.

As described in Section 3.4, in the manufacture of slabstock foam, HAP are emitted from storage and unloading, equipment leaks, ABA usage and other emission sources involved in foam production and equipment cleaning. The use of ABA during foam production comprises the largest portion of these emissions, making up over 98 percent (16,250 tons per year) of total slabstock HAP emissions.

The HAP emitted from the manufacture of slabstock foam include $MeCl_2$, methyl chloroform, propylene oxide, and TDI. For the purpose of establishing baseline emissions, it was assumed that the use of methyl chloroform as an ABA will be phased out, and replaced by $MeCl_2$. Propylene oxide is contained in very small amounts as a stabilizer in $MeCl_2$, and was not included in the baseline emission estimates.

Section 3.7 describes the HAP emission sources for molded foam. The major emission points are mixhead flushing, mold release agents, and foam repair. The use of a HAP mixhead flush

TABLE 5-1. BASELINE HAP EMISSIONS FOR SLABSTOCK FOAM PRODUCTION

Emission Source	Baseline HAP Emissions (tons/yr)
Chemical Storage/Unloading	17
Equipment Leaks	162
Foam Production	
ABA	16,250
Other	9
Equipment Cleaning	130
TOTAL	16,568

TABLE 5-2. BASELINE HAP EMISSIONS FOR MOLDED FOAM PRODUCTION

Emission Source	Baseline HAP Emissions (tons/yr)
Chemical Unloading/Storage	10
Equipment Leaks	55
Day Tanks	25
Foam Production	
Dispensing	67
Mixhead Flush	2,561
Mold Release Agent	287
Demolding	12
In-mold Coating	32
Other Production	11
Equipment Cleaning	10
Foam Repair	116
TOTAL	3,186

is the largest emission source, making up over 80 percent (2,561 tons per year) of the total molded HAP emissions.

The HAP emitted from the manufacture of molded foam include $MeCl_2$, methyl chloroform, MDI, and TDI. Small amounts of diethanol amine (DEOA) were reported, because DEOA is used as an additive. Methyl ethyl ketone (MEK) and toluene were reported primarily by a few facilities as being used as a carrier for in-mold coatings. Methanol was predominantly reported as a mixhead flush and as an equipment cleaner. Other HAP were also reported, but in very small quantities.

The HAP potentially emitted from rebond facilities are TDI and $MeCl_2$. TDI is a reactant used to adhere the foam scraps together. $MeCl_2$ can be used as an equipment cleaner at rebond facilities, and $MeCl_2$-based mold release agents were also reported to have been used in the past.

The primary basis for baseline emission estimates for this industry was information submitted to the Environmental Protection Agency (EPA) by the flexible foam manufacturers in response to information collection activities conducted under the EPA's Section 114 authority. However, there were several instances where the direct use of the ICR response data as the nationwide baseline emissions was not appropriate. Two different methods were used: the extrapolation of model plant emission estimates for primary emission sources, and the extrapolation of ICR emission estimates for minor emission sources. A brief summary of the sources of the baseline emissions for each subcategory follows. A more detailed description of the determination of baseline emissions is provided in the SID.[15]

5.1 SLABSTOCK BASELINE EMISSION CALCULATIONS

For HAP ABA emissions and equipment cleaning, it was believed that the information provided in the ICR responses represents the nationwide emissions. For these two emission points, the combination of model plant baseline emissions and the estimate of the number of facilities represented by each model plant were determined so that the nationwide emissions calculated from the model plants matched the ICR responses as closely as possible.

For baseline HAP emissions from storage/unloading and equipment leaks, model plant emission estimates were calculated, then were multiplied by the number of facilities represented by each of the model plants to obtain nationwide estimates. For the model plants, unloading (working loss) emissions were calculated using AP-42 emission factors for chemical storage tanks.[16] Since some model plants assume storage tank controls, the baseline HAP emissions consist of a combination of controlled and uncontrolled emissions.

For equipment leaks, emission information was submitted in the ICR responses for pumps and valves. However, the assumptions made in calculating these emissions were inconsistent with typical EPA assumptions, and no information was received for other components in HAP service (flanges/connectors, open-ended lines, or pressure relief valves). Therefore, model plant emissions from components in HAP service were calculated using assumed component counts and synthetic organic chemical manufacturing industry (SOCMI) average emission factors.[17] The nationwide estimates were then calculated by multiplying the model plant emissions by the number of facilities represented by each model plant.

5.2 MOLDED BASELINE EMISSION CALCULATIONS

ICR responses were received from 46 of the estimated 228 nationwide molded foam facilities. Therefore, it was necessary to extrapolate information from these facilities to approximate nationwide HAP emissions. Two different methods were used to accomplish this estimation. The first was to calculate nationwide emissions using model plants, and the second was to extrapolate directly from the ICR response totals. Both methods are discussed briefly below.

Emissions from only three sources were consistently reported by all molded foam producers. These sources were mixhead flush, mold release agents, and adhesives used in foam repair. These were the only three emission sources included in the molded foam model plants. The model plant emissions for these three sources were then multiplied by the number of facilities represented by each model plant to obtain the nationwide baseline emission estimates.

As mentioned earlier, there were many other minor HAP emission sources identified in the ICRs. However, the emissions were very small, and the occurrence of the emission points was too inconsistent to accurately create a model for these emissions. Therefore, baseline HAP emissions were estimated by direct extrapolation of the emission information reported in the ICR responses. This extrapolation was based on the percentage of facilities reporting emissions from each emission source, and an assumption that the same percentage of the remainder of the industry would also report comparable emissions from the same type of source.

5.3 REBOND BASELINE EMISSION ESTIMATES

The 21 rebond facilities co-located with slabstock production facilities reported a total of 1.0 tons per year of HAP emissions. As noted earlier, one facility originally reported emissions from a HAP-based mold release agent and a HAP cleaner, but it has subsequently discontinued the use of these products. Therefore, the total nationwide HAP emissions from the production of rebond foam is 2.5 tons per year, which is a linear extrapolation of the emission estimates for the 21 facilities to the estimated 52 nationwide facilities.

6.0 MACT FLOORS AND REGULATORY ALTERNATIVES

This chapter presents the results of the maximum achievable control technology (MACT) "floor" determination for the flexible polyurethane foam source category. Sections 6.1 through 6.4 discuss the determination of MACT floors. Following the presentation of the MACT floors, the control options more stringent than the MACT floors are identified. The final section discusses the construction of regulatory alternatives, and presents the regulatory alternatives considered for the flexible polyurethane foam industry.

6.1 CLEAN AIR ACT (CAA) REQUIREMENTS FOR MACT FLOORS

Section 112(d) of the CAA, as amended in 1990, defines a minimum level of control referred to as the "MACT floor," for standards established under Section 112(d). For new sources, emission standards "shall not be less stringent than the emission control that is achieved in practice by the best controlled similar source." For existing sources, the emissions standards must be at least as stringent as either "the average emission limitation achieved by the best performing 12 percent of the existing sources," or "the average emission limitation achieved by the best performing 5 sources" for categories or subcategories with less than 30 sources. The EPA has interpreted the term "average emission limitation" in the statute to mean a measure of central tendency, such as the arithmetic mean, median or mode.

6.2 CONSIDERATIONS IN DETERMINING MACT FLOORS

There are several fundamental decisions that must be made before the MACT floor can be determined. These decisions are discussed below.

6.2.1 Subcategorization

Since a separate MACT floor must be developed for each subcategory, the first thing that must be determined is if subcategorization of the industry is warranted. As discussed in Chapter 4, the flexible polyurethane foam production source category was divided into three subcategories: slabstock foam production, molded foam production, and rebond foam production.

6.2.2 Major Source Determination

The next step was to identify the major sources in each subcategory. The facility-wide hazardous air pollutant (HAP) emission totals reported in the ICR responses were used to identify the major sources within each subcategory, along with a facility's "potential to emit" (PTE).

A facility's PTE is calculated by considering all the emission source types at a facility, using assumptions that would provide the maximum emissions expected for an annual period for conditions such as highest number of operational hours, highest HAP content, etc. Inherent limitations based on a facility's operations can be considered, such as the production rate being limited by storage space. However, operational practices that reduce emissions are not considered unless they are due to a federally enforceable requirement. For example, if some facilities used a non-HAP solvent for cleaning while other, similar facilities used a HAP solvent for the same purpose, in the determination of PTE, it must be assumed that all facilities use a HAP solvent, unless a facility is prohibited from using the HAP solvent by a federally enforceable requirement.

Within the molded foam segment, all HP facilities reported HAP emissions below the major source thresholds. It is not believed that any HP facilities could be considered major sources based on their PTE. Only a conversion from HP to LP mixheads would increase these facility's PTE above the major source threshold. This conversion would be expensive, as well as impractical, requiring significant operational and equipment changes.

Five LP facilities are major sources based on reported emissions.[3] The remaining facilities are also major sources due to their PTE. While the reported HAP emissions were below the major source thresholds for these facilities, no federally enforceable requirements were reported that would prohibit any facility from switching to a HAP solvent to flush their mixhead. Based on the available information, it would be expected that the combination of the use of a HAP mixhead flush and maximum potential operation would cause HAP emissions at all LP molded facilities to be above the major source level.

Seven slabstock facilities reported actual emissions below the major source thresholds.[3] However, it is possible for these facilities to change their product mix, or types of foam produced, in a manner that would make their HAP emissions greater than the major source cutoffs. There were no federally enforceable limits identified limiting their HAP emissions. Therefore, all slabstock production facilities were considered to be major sources.

It was assumed that no rebond foam production process emitted HAP above the major source levels. However, the 21 rebond processes co-located with slabstock production operations are considered major sources, since the plant-wide emissions are above the major source thresholds. It was assumed that the remaining 31 rebond facilities were area sources.

6.2.3 Grouping of Emission Sources

After the subcategories and major sources within them were identified, the groups for which separate MACT floors were to be determined were established. Under each subcategory, individual emission points were separated into several general emission source types. Additional grouping decisions were then made in the determination of MACT floors within each emission source type. Consideration was given to the following: equipment type, equipment size, equipment contents, stream characteristics, and other elements that can affect the emission potential or the ability to reduce emissions from that point.

The following are the emission source groupings chosen for molded facilities:

- storage (including unloading emissions)
- in-process vessels (includes day and mix tanks)
- components in HAP service (e.g., pumps and valves)

- in-mold coatings
- foam reactant dispensing
- mixhead cleaning
- mold release agent application
- demolding
- foam repair

For slabstock facilities the following emission source groupings were chosen:

- storage (including unloading emissions)
- in-process vessels (includes day tanks)
- components in HAP service
- ABA related emission sources (e.g., foam tunnel, curing, or foam storage)
- equipment cleaning

In addition, MACT floors were determined for three emission sources at rebond operations.

- TDI emissions from rebond production
- equipment cleaning
- mold-release agent application

6.2.4 Approach to Determining the MACT Floor

MACT floors were identified for each emission source grouping within each subcategory. For existing sources, the MACT floor levels were established by determining some measure of central tendency of the emission control for the top 12 percent, or top 5, facilities in each emission source type in each subcategory. This "average" emission limitation is expressed in several different manners for different emission source types.

When possible, each MACT floor for existing sources was expressed as emission limits that represent the average emission limitation achieved by the top 12 percent. Where the MACT floor was determined to be a technology or work practice, performance criteria were defined that best characterized the "average" means of HAP reduction for the top 12 percent.

For new sources, the MACT floor levels were established by determining the emission control for the best controlled facility in the subcategory for each emission source type. The formats of the MACT floors for new sources are consistent with those of existing sources for each emission source type (e.g. work practice standards, equipment specifications, etc.).

6.3 MACT FLOOR CONCLUSIONS

Based on existing EPA policy and on the information presented in the ICRs, the EPA's conclusions on what the MACT floors are for all emission source types identified in each subcategory are described below. All emissions reported and used in calculating the MACT floors were taken from the ICRs, and are generally based on 1992 information.

6.3.1 Molded Foam

As mentioned previously, all HP molded facilities were identified as area sources, and all LP facilities were identified as major sources. Therefore, the MACT floors for molded foam are based only on LP facilities. In the LP molded foam subcategory, information was available for a total of 19 facilities, which reported annual HAP emissions of 256 tons of HAP per year. Since information was available for less than 30 LP facilities, the MACT floor for each emission source type was based on the top five performing facilities. The top five facilities were determined on a case by case basis for each emission source type; therefore, the same 5 facilities were not always used in the floor determinations.

6.3.1.1 Storage/unloading

HAP emissions from storage and unloading at LP molded foam facilities were reported to be less than 1 ton per year. Only 11 facilities provided information on their storage emissions, and they all reported no control for these storage and/or unloading emissions. Since all facilities reported no control, the MACT floor for storage/unloading for both new and existing LP molded foam facilities was concluded to be no control.

6.3.1.2 Mixhead flush

HAP emissions from mixhead cleaning occur when HAP solvents are used to "flush" the mixhead between foam shots to remove residual foam material. Total HAP flush emissions from this source were reported at 227 tons/year, approximately 89 percent of the total reported HAP emissions for the LP facilities.

Unlike the other emission source types for the LP molded subcategory, the identification of the five "best performing" facilities for the mixhead flush emission source type was not straightforward. The reported HAP emissions varied among facilities from less than 1 ton per year to almost 60 tons per year. In order to assist in the comparison of facilities, several approaches were considered. The first was an emission factor approach based on the reported HAP emissions per weight of product. However, this does not provide a legitimate means of comparison, because the number of flushes (and consequently, the resulting HAP emissions) is dependent on the number of "pieces" produced and not the weight of foam produced. Thus, producers of small foam parts would have artificially high HAP emission factors. Another approach was to simply consider the annual reported HAP emissions. While this is more reflective of a facility's HAP reducing activities, it does not take into account substantial differences in the operating schedules reported, or the size of a facility. Therefore, the annual flush emissions were divided by the annual hours of operation. This HAP emissions per hour of operation factor was used to identify the 5 "best performing" facilities.

None of the 5 facilities identified as the best performing reported any control techniques in the ICR responses. In each case, process-specific factors were responsible for the low emissions. For example, one facility designed its molds to be closer together than normal, reducing the frequency of flushing needed.[18] Another facility had such small pieces that the volume of flush needed per shot was very small, resulting in lowered total emissions.[19] Therefore, the EPA's conclusion for this emission source type is that the average emission limitation of the best performing 5 facilities is no control. These facilities are the best performing because of unique process considerations that are not applicable at all LP molded foam facilities.

6.3.1.3 Mold release agents

Approximately 3 percent of the reported HAP emissions from LP molded foam facilities was from the evaporation of the HAP carrier solvent from mold release agents.[3] When the mold release agents are sprayed on the mold, the carrier is designed to evaporate, leaving a waxy material on the mold to prevent the foam from sticking.

Of the 18 facilities reporting the use of mold release agents, 10 reported using a non-HAP based agent, resulting in zero HAP emissions. The remaining eight facilities reported HAP emissions, and no controls. Since the top 5 facilities all used non-HAP based mold release agents, the floor for mold release emissions for both new and existing sources was judged to be the total elimination of the use of HAP-based mold release agents.

6.3.1.4 Foam repair

The main use of adhesives in molded foam facilities is for the repair of voids and tears in the molded pieces. The adhesives used are approximately 20 to 40 percent solids, while the remainder consists of a solvent carrier, such as methyl chloroform or $MeCl_2$. The HAP emissions occur as this solvent carrier evaporates after the adhesive is applied. There were 4.5 tons of HAP emissions reported from this source at LP molded facilities (less than 2 percent of total reported HAP emissions).

Eight facilities did not report having any repair operations. Four of the remaining facilities reported HAP emissions from this activity, with no control identified. The remaining seven facilities reported repair operations, but zero HAP emissions. It was assumed these eight facilities were using a non-HAP based adhesive. Since the top 5 facilities were assumed to be using a non-HAP based adhesive, the MACT floor for foam repair for both new and existing sources was concluded to be the elimination of HAP-based adhesives in repair operations.

6.3.1.5 In-process vessels, components in HAP service, in-mold coatings, foam reactant dispensing, and demolding

In the ICRs, HAP emissions were reported for each of these emission source types. The total reported emissions for all of these combined was 25 tons/yr, which is approximately 9 percent of the total reported molded foam HAP emissions. No control was reported for any of these emission source types in the ICR responses. Therefore, the floor for both new and existing sources for these emission source types was concluded to be no control.

6.3.2 Slabstock Foam

There are 78 slabstock foam facilities in this subcategory. The MACT floor for each emission source type was based on the top 12 percent of the subcategory (top 10 facilities). The top performing facilities were determined on a case-by-case basis for each emission source type; therefore, the same facilities were not always used in the floor determinations.

6.3.2.1 Storage/unloading

HAP emissions from storage/unloading accounted for less than 1 percent of the total reported slabstock HAP emissions.[3] Of the facilities reporting HAP ABA and/or TDI storage breathing loss emissions, no control was reported for either type of HAP. For HAP ABA unloading, 17 facilities reported using vapor balancing for emission control. The remaining facilities reported no control. For TDI unloading, 29 facilities reported using vapor balancing. The remaining facilities reported using no control. The EPA concluded that the floor for TDI and HAP ABA storage/unloading at new and existing sources is vapor balancing.

6.3.2.2 Components in HAP service

HAP emissions from pumps and valves accounted for less than one percent of the reported emissions per year. Thirty-three of the 77 facilities reported using "canned pumps" (a type of sealless pump for TDI). Since more than 10 plants reported canned pumps for TDI, the new and existing source MACT floors for TDI pumps were concluded to be "sealless" pumps. Four facilities reported using canned pumps for $MeCl_2$, and no other facilities reported any type of control. A median-based approach was used to determine the existing source floor for $MeCl_2$ pumps. Since "no control" was most frequent in the top 10 list, the EPA concluded the floor was to be no control for existing sources, and sealless $MeCl_2$ pumps for new sources.

In addition, no facility reported the control of HAP emissions from any of the other components in HAP service (valves, connectors, etc.). Therefore, the new and existing source floors for all components except pumps were concluded to be no control.

6.3.2.3 Equipment cleaning

Methylene chloride is used as a cleaner to rinse and/or soak foam machine parts such as mixheads and foam troughs. This use resulted in less than 1 percent of total reported slabstock HAP emissions.[3]

Eight of the 73 slabstock facilities reporting equipment cleaning operations reported the use of non-HAP cleaning methods. The remainder used no control. A median-based approach was used to determine the existing source floor for equipment cleaning. Since 8 out of the top 10 facilities reported using a non-HAP cleaning method, the EPA concluded the floor for both new and existing sources is the use of non-HAP cleaning solvents.

6.3.2.4 ABA emission sources

Methylene chloride is the principal ABA used. The role of the methylene chloride is simply to volatilize and expand the foam; it does not directly participate in the polyurethane reaction. Therefore, all of the methylene chloride that is added to the process is eventually emitted. The use of $MeCl_2$ as an ABA was the largest emission source of HAP's for slabstock facilities reported in the ICRs, making up over 80 percent of the total HAP emissions from slabstock facilities.[3] In addition, methyl chloroform (another HAP) was used by some facilities, resulting in over twelve percent of the total reported slabstock emissions.[3] There were several alternatives identified in the ICRs that facilities are using to either reduce or eliminate the use of a HAP ABA in the manufacture of flexible slabstock polyurethane foam.

The mix of foam grades produced at a plant has a strong influence on the amount of ABA that is used and emitted. There are many grades of foam that can be produced without any ABA, while for some soft and light foams, ABA usage can be as high as 24 parts per hundred parts polyol (pph), or almost 300 pounds per ton of foam produced. Industry representatives have stressed the need to take this difference into account in determining the floor, emphasizing that low-ABA and high-ABA grades of foam are not interchangeable, either from a production cost standpoint, from an emission standpoint, or from an end-use standpoint.

6.3.2.4.1 Existing sources. The EPA agrees that some differentiation among foam grades is appropriate, and concluded that any ABA emissions limitation should be a function of the grades produced. Therefore, the EPA defined the MACT floor for HAP ABA emissions by determining a MACT floor set of HAP ABA formulation limits.

In the ICR, foam producers were asked to provide formulation information (i.e., parts HAP ABA per 100 parts polyol, or pph) for all foam grades produced at the facility. Therefore, the EPA was able to separate the formulation information by grade (where a grade is represented by its density and IFD). Foamers claimed all formulation information confidential; therefore, the actual formulation database and summary is not publicly available.

The foam grades were combined into density/IFD "groups." The Polyurethane Foam Association (PFA) suggested the following eight-group classification system:[20]

- IFD greater than 20 pounds, density greater than 1.4 pounds per cubic foot (pcf)
- IFD greater than 20, density from 1.15 to 1.4 pcf
- IFD greater than 20, density from 1.05 to 1.15 pcf
- IFD greater than 20, density from 0.95 to 1.05 pcf
- IFD greater than 20, density less than 0.95 pcf
- IFD from 15 to 20, at any density
- IFD from 10 to 15, at any density
- IFD less than 10, at any density

The EPA's initial attempt at determining the MACT floor HAP ABA formulation limits was to simply calculate the average of the lowest 12 percent of the formulations reported for each of the grade ranges suggested by the PFA. However, this approach led to inconsistent results.[21] Therefore, the approach described below was developed and used to determine the MACT floor HAP ABA formulation limitations.

This approach could simply be described as the determination of a baseline, and the application of MACT floor reductions to this baseline. The initial step in this approach was to determine baseline formulations. As part of this analysis, the EPA re-examined the PFA-recommended foam grade groupings.[22] This analysis, which used the formulation database to examine ABA usage/emission trends by IFD and density, concluded that the PFA-recommended groupings needed revisions in two areas. The PFA-recommended groupings assumed that (1) ABA usage was not dependent on density for foam grades with IFDs less than 20 pounds, and (2) ABA usage was not dependent on IFD for IFDs greater than 30 pounds. The EPA's analysis found both of these assumptions to be inaccurate. Therefore, all subsequent analysis was conducted on a 30-group grid, using the five PFA-recommended density ranges, and six IFD ranges (0-10, 11-15, 15-20, 21-25, 26-30, and 31+ pounds).

The EPA attempted to use the overall average of formulation information submitted for each grade group. As discussed above for the average of the top 12 percent, the overall average formulations often did not follow a reasonable pattern. For instance, the average ABA level would increase with increasing IFD, and with increasing density. The EPA primarily attributed this problem to the low number of data points for several density/IFD groups. Table 6-1 shows the number of plants represented in the database for the 30 density/IFD groups.

In the development of the EPA's "Flexible Polyurethane Foam Emission Reduction Technologies Cost Document," a representative facility was created.[23] The foam formulations used for this representative facility were generated in a cooperative effort between the EPA and the PFA, and the EPA believes that they represent typical formulations for the industry. Table 6-2 shows both the average (or range) of formulation information from the

TABLE 6-1. NUMBERS OF PLANTS REPRESENTED IN FORMULATION DATABASE

Table values are numbers of plants reporting formulation information in each group		Density ranges (pounds per cubic foot)				
		0-0.95	0.96-1.05	1.06-1.15	1.16-1.40	1.41+
IFD	0-10		7	4		<9
	11-15	4	17	9		12
	16-20	5	14	15	7	19
	21-25		17	15	12	23
	26-30	24	22	7	20	31
	31+	15	26	21	36	36

ICR responses, and the representative facility formulation. From this information, the EPA selected baseline formulation levels, which are shown in Table 6-3, for each foam grade grouping.

The next step was to apply reductions, representing MACT floor reductions, to these baseline formulation values. The amount of reduction achievable also varies by foam grade. Numerous technologies exist that allow the production of higher-density, higher-IFD foams with significantly less, or even no, HAP ABA. However, the amount of HAP ABA reduction that can be achieved for low-density, low-IFD foam grades of acceptable quality is much less. Therefore, the reductions had to be determined on a grade-specific basis.

The problems discussed above, associated with insufficient numbers of data points in certain density/IFD groups, would have caused similar problems if reductions were determined for individual groups. Therefore, the EPA combined groups until at least 30 data points were available. For instance, the six groups with IFDs of 20 pounds or less and densities of 1.16 pcf or less were combined. This resulted in 41 data points in this combined group.

For each combined group, the overall average formulation was calculated, as well as the average formulation for the 12 percent of the data points with the lowest HAP ABA formulations. Then the reduction from the overall average to the top 12 percent average was calculated. For example, if the overall average formulation was 9 pph and the top 12 percent average was 5 pph, the percentage reduction was calculated as follows:

$$PercentReduction = \frac{(9pph - 5pph)}{(9pph)}\,(100) = 44\ percent$$

The results of the percentage reduction determination are shown in Table 6-4. These percentage reductions were then applied to the individual density/IFD group baseline formulation levels in Table 6-2 to obtain the existing source MACT floor HAP ABA formulation limitations, which are shown in Table 6-5. It should be noted that this analysis resulted in equivalent HAP ABA

TABLE 6-2. HAP ABA FORMULATIONS FROM ICR'S

Table values in parts ABA per hundred parts polyol		Density ranges (pounds per cubic foot)				
		0-0.95	0.96-1.05	1.06-1.15	1.16-1.40	1.41+
IFD	0-10		22 *(18)*	*(20)*		*(2)*
	11-15	*(21)*	19 *(15)*	*(13-18)*	*(10)*	*(2-6)*
	16-20	*(16-18)*	14 *(11-13)*	14 *(12-14)*	*(10)*	10-13 *(6-8)*
	21-25	*(16-18)*	*(12-15)*	*(12)*	*(7-8)*	*(4-5)*
	26-30	10 *(10)*	8 *(7)*	7 *(6-8)*	5-6 *(5-6)*	6-7 *(5)*
	31+	*(9-10)*	*(7-8)*	*(4-5)*	2 *(3)*	1-2 *(2)*

NOTES: Top numbers are the estimates provided by the PFA and chemical suppliers in comments on the cost report. Numbers in parentheses and italics are from the ICR data.

TABLE 6-3. BASELINE HAP ABA FORMULATIONS

Table values in parts ABA per hundred parts polyol		Density ranges (pounds per cubic foot)				
		0-0.95	0.96-1.05	1.06-1.15	1.16-1.40	1.41+
IFD	0-10		20	20		6
	11-15	21	19	18	10	6
	16-20	18	14	14	10	6
	21-25	16	13	12	8	5
	26-30	10	8	7	6	5
	31+	9	7	5	2	2

formulation limits for more than one density/IFD group. Therefore, the result was actually 18 density/IFD groups in the MACT floor HAP ABA formulation limits table.

6.3.2.4.2 New sources. The new source HAP ABA MACT floor formulation limitations were determined by examining the lowest reported HAP ABA formulation for each of the 30 density/IFD blocks. Formulations for foam grades only produced in small amounts were not considered. This analysis found that the production of many foam grades were reported with no HAP ABA. However, the results were not always logical. For instance, all foam grades with between 0.96 and 1.05 pcf were reported to be produced with no HAP ABA (with the exception of IFDs less than 15 pounds), but there were no foam grades with densities between 1.06 and 1.15 pcf that were reported to be produced with no HAP ABA. The EPA concluded that this was more a function of the randomness of the foam grades reported, rather than the inability to produce foams of densities between 1.06 and 1.15 pcf with no HAP ABA. In fact, the Agency believes that if foam grades with densities between 0.96 and 1.05 pcf can be produced with no HAP ABA, then foam grades of corresponding IFDs with densities greater than 1.05 pcf can also be produced with no HAP ABA. The lack of sufficient data for the foam grades where the new source MACT floor was not determined to be zero led the Agency to conclude that the new source MACT floor for these grades was equal to the existing source MACT floor, as shown in Table 6-5. Therefore, the EPA concluded that the MACT floor HAP ABA formulation limitations for new sources are as shown in Table 6-6.

TABLE 6-4. MACT FLOOR PERCENTAGE REDUCTIONS

<table>
<tr><th colspan="2" rowspan="2">Table values are percentage reduction from baseline</th><th colspan="5">Density ranges (pounds per cubic foot)</th></tr>
<tr><th>0-0.95</th><th>0.96-1.05</th><th>1.06-1.15</th><th>1.16-1.40</th><th>1.41+</th></tr>
<tr><td rowspan="6">IFD</td><td>0-10</td><td rowspan="5" colspan="4">45</td><td rowspan="5">75</td></tr>
<tr><td>11-15</td></tr>
<tr><td>16-20</td></tr>
<tr><td>21-25</td></tr>
<tr><td>26-30</td></tr>
<tr><td>31+</td><td colspan="2"></td><td colspan="2">68</td><td>100</td></tr>
</table>

TABLE 6-5. MACT FLOOR HAP ABA FORMULATION LIMITATIONS FOR EXISTING SLABSTOCK SOURCES

<table>
<tr><th colspan="2" rowspan="2">Table values in parts ABA per hundred parts polyol</th><th colspan="5">Density ranges (pounds per cubic foot)</th></tr>
<tr><th>0-0.95</th><th>0.96-1.05</th><th>1.06-1.15</th><th>1.16-1.40</th><th>1.41+</th></tr>
<tr><td rowspan="6">IFD</td><td>0-10</td><td rowspan="2">12</td><td colspan="2" rowspan="2">11</td><td rowspan="3">6</td><td rowspan="3">2</td></tr>
<tr><td>11-15</td></tr>
<tr><td>16-20</td><td>10</td><td colspan="2">8</td></tr>
<tr><td>21-25</td><td>9</td><td colspan="2">7</td><td>4</td><td rowspan="2">2</td></tr>
<tr><td>26-30</td><td>6</td><td>4</td><td colspan="2">3</td></tr>
<tr><td>31+</td><td>5</td><td>4</td><td>2</td><td>1</td><td>0</td></tr>
</table>

TABLE 6-6. MACT FLOOR HAP ABA FORMULATION LIMITATIONS FOR NEW SLABSTOCK SOURCES

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="5">Density ranges (pounds per cubic foot)</th></tr>
<tr><th>0-
0.95</th><th>0.96-
1.05</th><th>1.06-
1.15</th><th>1.16-
1.40</th><th>1.41+</th></tr>
<tr><td rowspan="6">IFD</td><td>0-10</td><td rowspan="2">12</td><td colspan="2" rowspan="2">11</td><td rowspan="2">6</td><td rowspan="2"></td></tr>
<tr><td>11-15</td></tr>
<tr><td>16-20</td><td>10</td><td colspan="4" rowspan="4">0</td></tr>
<tr><td>21-25</td><td>9</td></tr>
<tr><td>26-30</td><td>6</td></tr>
<tr><td>31+</td><td>5</td></tr>
</table>

The HAP ABA formulation limitations will be used, in conjunction with the following equation, to calculate the allowable HAP ABA emissions from foam production:

$$emiss_{allow} = \sum_{i=1}^{n} \frac{(limit_i)(polyol_i)}{100}$$

where:

$emiss_{allow}$ = Allowable emissions due to use of a HAP ABA for a specified time period, Megagrams.

$limit_i$ = HAP ABA formulation limit for foam grade i, parts ABA per 100 parts polyol.

$polyol_i$ = Amount of polyol used in the time period in the production of foam grade i, pounds.

n = Number of foam grades produced in the time period.

6.3.3 Rebond Foam Production

Rebond is the process where scrap foam is cut up and placed in a mold with a small amount of TDI and treated with steam. This causes the small pieces to adhere and form a solid cylinder of foam. This cylinder is then peeled into sheets, which is mainly used as carpet padding.

No control for the TDI emissions was reported. Since all facilities reported no control for TDI, and only one of the 21 rebond operations reported other HAP emissions, the EPA concluded the floor for rebond at both new and existing sources is "no control" for TDI emissions, and the elimination of all HAP cleaners and mold release agents.

6.4 SUMMARY OF MACT FLOORS

Table 6-7 summarizes the MACT floor conclusions for both new and existing source for each emission source type.

6.5 POTENTIAL LEVELS OF CONTROL

This section discusses levels of control that could be used as the basis for developing regulatory alternatives for the flexible polyurethane foam production industry. For each emission source type, the potential levels of control are

TABLE 6-7. FLEXIBLE FOAM MACT FLOOR CONCLUSIONS

EMISSION SOURCE	MACT FLOOR - Existing Sources	MACT FLOOR - New Sources
LP Molded Foam		
Storage/unloading	No control	No control
Mixhead flush	No control	No control
Mold release agents	Elimination of HAP-based products	Non-HAP based products
Foam repair	Elimination of HAP-based products	Non-HAP based products
In-process vessels, components in HAP service, in-mold coatings, foam dispensing, demolding	No control	No control
Slabstock Foam		
Storage/unloading	Vapor balance	Vapor balance
Components in HAP service	TDI - sealess pumps other HAP - no control	TDI and $MeCl_2$ - sealess pumps other HAP - no control
Equipment cleaning	Elimination of HAP-based product	Non-HAP based product
HAP ABA emissions	Emission limitation based on HAP ABA formulation limitations	Formulation limitations
Rebond	TDI - no control Elimination of HAP cleaners and mold release agents	TDI - no control Elimination of HAP cleaners and mold release agents

identified. For both new and existing sources, the first level of control is the MACT "floor" level, which was discussed in the previous sections. Levels of control more stringent than the MACT floor level are also presented.

6.5.1 Molded Foam Facilities

HAP emissions are attributable to three predominant emission source types at molded foam facilities: (1) HAP mixhead flushes, (2) HAP-based mold release agents, and (3) HAP-based adhesives for foam repair. The control options for each of these emission source types are discussed in the following sections. As discussed below, additional emission source types have been identified at molded facilities; however, the combination of low frequency of occurrence of these sources, very low emissions, and no identified control options led the EPA to omit control options for these emission source types from all regulatory alternatives.

6.5.1.1 Mixhead Flush

The MACT floor for this emission source type was identified as no control for existing sources. For new sources, the MACT floor was identified as the prohibition of the use of HAP flush agents. There were two levels of control above the existing source MACT floor: work practices that reduce HAP emissions, and the prohibition of the use of HAP flush agents.

6.5.1.2 Mold Release Agents and Foam Repair

The MACT floor for both new and existing sources for these two emission sources was identified as the total elimination of HAP-based products. Therefore, no level of control above the MACT floor is possible.

6.5.1.3 Other Molded Emission Sources

The MACT floors for new and existing sources were identified as no control for the following emission source types: in-mold coatings, storage/unloading, in-process vessels, components in HAP service, foam froth dispensing, and demolding. No levels of control above the MACT floor were identified for these emission points at molded polyurethane foam facilities.

6.5.2 Slabstock Foam Facilities

At slabstock foam facilities, there are four HAP emission source types: (1) the storage/unloading of HAP compounds, (2) leaking components in HAP service, (3) the use of a HAP as an equipment cleaner, and (4) the use of HAP ABA's. The levels of control for each of these emission source types are discussed in the following paragraphs.

6.5.2.1 Storage/Unloading

The MACT floor for tank truck/railcar unloading of both TDI and HAP ABA at new and existing sources was identified as the use of either a vapor balance or carbon canister system. No control options that would result in a level of control above the MACT floor were reported to be in use in the industry.

6.5.2.2 Components in HAP Service (Equipment Leaks)

The MACT floor for new and existing sources for this emission source type was determined to be leakless pumps for TDI components (except for high pressure metering pumps), and no control for all other components in HAP service. There was one level of control identified above the MACT floor for new and existing sources. The level of control above the MACT floor is an LDAR program for all other components in HAP service.

6.5.2.3 Equipment Cleaning

The MACT floor for both new and existing sources for this emission source was identified as the total elimination of HAP-based products. No levels of control above the MACT floor are possible.

6.5.2.4 Auxiliary Blowing Agent

There are many "grades" of flexible polyurethane slabstock foam produced, each with slightly different end-uses that require slightly different foam properties. Different grades can require varying levels of HAP ABA. The levels of control discussed below account for this variation.

6.5.2.4.1 Existing sources. The existing source MACT floor for HAP ABA was determined to be a limit on the amount of HAP ABA emissions. The limit is based on the grades of foam and amount of each grade produced at a facility, and is determined using grade-specific HAP ABA formulation limitations.

A level of control above the MACT floor identified was the complete elimination of HAP ABA emissions. The EPA also identified an intermediate alternative based on the combination of extended grade ranges, the emission reduction achieved by the best performing three facilities in each grade range group, and the emission reduction achieved by carbon adsorption.

6.5.2.4.2 New sources. The new source MACT floor for HAP ABA emissions was determined to be a limit on the amount of HAP ABA emissions. The complete elimination of HAP ABA was an alternative identified more stringent than the new source MACT floor. In addition, there was an intermediate alternative identified between the MACT floor and the complete elimination of HAP ABA.

6.5.3 Rebond Foam

The MACT floor for both new and existing sources for rebond foam was the total elimination of HAP-based products for mold release agents and equipment cleaning. Therefore, no level of control above the MACT floor is possible. The floor level of control for TDI emissions was determined to be no control. No additional control techniques were identified for TDI emissions.

6.6 REGULATORY ALTERNATIVES

The following section presents and discusses the regulatory alternatives developed for new and existing polyurethane foam facilities. The amount of emission reduction achieved increases with each alternative above the floor. It is also expected that costs will increase with each more stringent alternative.

6.6.1 Molded Foam

For molded foam production, two existing source regulatory alternatives above the MACT floor were developed. These alternatives are summarized in Table 6-8. Alternative 1 would require facilities to use work practices to reduce the HAP emissions from mixhead flushing. The work practice requirements may take many forms, one of which may be to simply require operators to cover the barrel used to collect the HAP mixhead

TABLE 6-8. REGULATORY ALTERNATIVES FOR MOLDED FOAM - EXISTING SOURCES

Regulatory Alternative	**Mixhead Flush**	**Mold Release Agents**	**Repair Adhesives**
MACT Floor	no control	HAP prohibition	HAP prohibition
1	work practice	↓	↓
2 (P-MACT)	HAP prohibition	↓	↓

flush. The other emission sources at the facility would be required to be controlled at the MACT floor level. Alternative 2 prohibits the use of any HAP-based mixhead flush. While TDI and MDI could still be used in the foam formulation, this alternative would practically eliminate HAP emissions from molded foam facilities.

The MACT floor level of control for all applicable emission sources at new sources is the prohibition of the use of HAP-based products. Therefore, the MACT floor Regulatory Alternative, which is shown in Table 6-9, is the only one offered.

6.6.2 Slabstock Foam

Two existing source alternatives above the MACT floor were developed for slabstock production. These alternatives are presented in Table 6-10. Alternative 1a adds a unique LDAR program for equipment leak emissions, and increases the level of control for HAP ABA emissions to the intermediate emission limit.

Alternative 1b is approximately equivalent to Alternative 1a in stringency, but incorporates a novel implementation approach that would reduce the reporting, recordkeeping, and monitoring burden on the industry. During the P-MACT process, industry was concerned that the cost of controlling ABA emissions from storage/unloading and equipment leaks was unreasonable, given the relatively low emissions from these sources (around 50 tons per year, or 0.2 percent). Under Alternative 1a, the amount of HAP ABA allowed to be emitted from the entire facility would be determined using the HAP ABA emission limit equation and formulation limitations. This limit would then apply to the entire facility, rather than only to the HAP ABA added at the mixhead. In the absence of add-on control, the entire amount of HAP ABA used is emitted. Therefore, the total amount of HAP ABA used during the compliance time period would be compared to the emission limit to determine compliance. Under this alternative, the amount of ABA used could be determined using simple inventory procedures, in lieu of more expensive LDAR techniques. This approach would encourage the source to reduce storage and equipment leak emissions so more ABA would be available to be

TABLE 6-9. REGULATORY ALTERNATIVES FOR MOLDED FOAM - NEW SOURCES

Regulatory Alterative	Mixhead Flush	Mold Release Agents	Repair Adhesives
MACT Floor	HAP prohibition	HAP prohibition	HAP prohibition

TABLE 6-10. REGULATORY ALTERNATIVES FOR SLABSTOCK FOAM - EXISTING SOURCES

Reg. Alt.	Storage/ Unloading	Components in HAP Service	Equipment Cleaning	HAP ABA Emissions
MACT Floor	HAP ABA & TDI - vap bal/ carbon	TDI pumps - leakless Other HAP components - no control	HAP prohibition	Existing source MACT floor HAP ABA emission limit
1a P-MACT	↓	TDI pumps - leakless Other HAP components - unique LDAR	↓	Intermediate HAP ABA emission limit
1b	TDI - vapor balance, leakless pumps HAP ABA - Intermediate HAP ABA emission limit for total facility			
2[a]	TDI - vap bal/carbon	TDI pumps - leakless	↓	HAP ABA prohibition

[a] Since the use/emission of HAP ABA is prohibited under regulatory alternative 2, there are no requirements needed for storage/unloading of HAP ABA or for equipment leaks in HAP ABA service.

used in foam formulations, while giving them considerable flexibility.

Alternative 2 would totally eliminate HAP ABA emissions, and would require controls for TDI storage/unloading and equipment leaks.

There are also three regulatory alternatives for new slabstock sources. The first alternative represents the new source MACT floor level. The second alternative adds leak detection and repair for equipment leaks, and increases the HAP ABA to an "intermediate" level of emission reduction. There is also a source-wide compliance option for the new source Regulatory Alternative 1. The third new source alternative includes a prohibition of HAP ABA emissions. The new source slabstock alternatives are shown in Table 6-11.

6.6.3 Rebond Foam

For the reasons stated in section 6.5.3, no regulatory alternatives above the MACT floor level were developed for rebond foam.

TABLE 6-11. REGULATORY ALTERNATIVES FOR SLABSTOCK FOAM - NEW SOURCES

Reg. Alt.		Storage/ Unloading	Components in HAP Service	Equipment Cleaning	HAP ABA Emissions
MACT Floor		HAP ABA & TDI - vap bal/carbon	TDI pumps - leakless	HAP prohibition	New Source MACT floor HAP ABA emission limit
1	a	HAP ABA & TDI - vap bal/carbon	TDI pumps - leakless HAP ABA pumps -unique LDAR	HAP prohibition	New Source Intermediate HAP ABA emission limit
	b	TDI - vapor balance/carbon, leakless pumps HAP ABA & equipment cleaning - New Source MACT floor emission limit for total facility			
2 P-MACT		TDI - vap bal/ carbon	TDI pumps - leakless	HAP prohibition	HAP ABA prohibition

7.0 MODEL PLANTS

This chapter presents model plants for the flexible polyurethane foam production industry. A model plant does not represent any single actual facility, but rather it represents a range of facilities with similar characteristics that may be impacted by a standard. Each model plant is characterized in terms of facility type, size, and other parameters that affect estimates of emissions, control costs, and secondary impacts. The model plants discussed in this chapter were used to determine baseline emissions, which were discussed in Chapter 5, and to analyze cost and environmental impacts of regulatory alternatives, which are discussed in Chapters 8 and 9, respectively.

The molded and slabstock segments of the foam industry were treated separately in the development of the model plants. In both cases, model plants were developed based on available information including data in company responses to the ICR's, observations made during site visits, and information received from PFA representatives, vendors, manufacturers, and foam producers.

All 21 rebond facilities located at major source plant sites reported emission controls that would be in compliance with the proposed standards. It is estimated the remaining 31 rebond foam facilities are area sources, and would not be subject to the regulation. Therefore, since it is estimated that no rebond facilities will be subject to the standard, no rebond model plants were developed.

The following sections describe the slabstock and molded foam production model plants. A complete description of the development of the model plants is provided in the memorandum entitled "Flexible Foam Model Plants," which is contained in the SID.[24]

7.1 SLABSTOCK FOAM MODEL PLANT DESCRIPTIONS

Five basic model plants were developed for the slabstock segment of the industry, which are presented in Table 7-1. The model plants include the following operating parameters: production, number and size of storage vessels, number of components in HAP service, number of production lines and line speed. The use of a HAP (usually $MeCl_2$) as an ABA is the primary source of HAP emissions at a slabstock foam facility. However, the amount of ABA needed varies considerably depending on the "grade" of the foam being produced. Therefore, the model plants include a breakdown of foam production by grade. It is assumed that all model plants produce the same grades of foam, with variation in the amount of each grade produced. The grades produced by the model plants represent the most commonly produced grades in the industry, and the formulations are based on ICR responses and input from PFA representatives. The grade-specific information is presented in Table 7-2.

The model plants also include emission levels for TDI and $MeCl_2$ from the components mentioned above. For each of the five model plants, the average facility HAP ABA usage was determined using information from the actual facilities represented by the model plant. The amount of each grade of foam produced by the model plant was adjusted so that the total annual HAP ABA usage for the model plant equalled the average of the real plants. All HAP ABA used was assumed to be emitted. Storage emissions were calculated using AP-42 emission factors for chemical storage tanks.[16] Emissions from components in HAP service (e.g. pumps, valves, flanges, etc.) were calculated using SOCMI average emissions factors.[25]

Thirty-three percent of the slabstock facilities reported the use of $MeCl_2$ as a general equipment cleaner, including facilities represented by all five model plants. However, no correlation was found between the use of a HAP cleaner (or the amount of HAP used as a cleaner) and the amount of foam produced.

TABLE 7-1. SLABSTOCK FOAM PRODUCTION MODEL PLANT PARAMETERS

	Model Plant 1		Model Plant 2		Model Plant 3		Model Plant 4		Model Plant 5	
	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B
OPERATING PARAMETERS										
Foam Production Range (thousand tons/yr)	0-3.9	0-3.9	4.0-7.9	4.0-7.9	8.0-11.9	8.0-11.9	12.0-15.9	12.0-15.9	≥16.0	≥16.0
Average Foam Production (thousand tons/yr)	2.0	2.0	6.0	6.0	10.0	10.0	13.75	13.75	19.0	19.0
Storage Tanks[a] - (10,000 gal)	1 1	1 1	1 2	1 2	1 3	1 3	1 3	1 3	1 3	1 3
Number of Components In HAP Service[b]										
$MeCl_2$	1	1	1	1	1	1	1	1	1	1
Transfer pumps	1	1	1	1	1	1	1	1	1	1
Metering pumps	16	16	16	16	16	16	16	16	16	16
Valves	20	20	20	20	20	20	20	20	20	20
Flanges/connectors	2	2	2	2	2	2	2	2	2	2
Pressure relief valves	6	6	6	6	6	6	6	6	6	6
Open-ended lines										
TDI	1	1	2	2	3	3	3	3	3	3
Transfer pumps	1	1	1	1	1	1	1	1	1	1
Metering pumps	16	16	24	24	32	32	32	32	32	32
Valves	20	20	30	30	40	40	40	40	40	40
Flanges/connectors	0	0	0	0	0	0	0	0	0	0
Pressure relief valves	6	6	9	9	12	12	12	12	12	12
Open-ended lines										
Number of Production Lines	1	1	1	1	1	1	1	1	1	1
Speed of Line (ft/min)	15	15	15	15	15	15	15	15	15	15
Line Electricity Use (kw)	120	120	120	120	120	120	120	120	120	120
HAP ABA Used (1000 gallons $MeCl_2$)	9.9	9.9	29.8	29.8	59.6	59.6	60.5	60.5	68.6	68.6
HAP Used as Cleaner (gallons $MeCl_2$)	994	0	994	0	994	0	994	0	994	0
Number of Plants Represented Nationwide	6	13	9	19	5	9	4	7	2	4
EMISSIONS (tons/yr)										

TABLE 7-1. SLABSTOCK FOAM PRODUCTION MODEL PLANT PARAMETERS (continued)

	Model Plant 1		Model Plant 2		Model Plant 3		Model Plant 4		Model Plant 5	
	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B
OPERATING PARAMETERS										
TDI										
Storage	0	0	0	0	0	0	0	0	0	0
Equipment Leaks	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
TDI Total	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
$MeCl_2$										
Storage	0.09	0.09	0.26	0.26	0.52	0.52	0.03	0.03	0.03	0.03
ABA	55	55	165	165	330	330	335	335	380	380
Equipment Cleaning	5	0	5	0	5	0	5	0	5	0
Equipment Leaks	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
$MeCl_2$ Total	64	59	174	169	339	334	343	338	388	383
TOTAL HAP EMISSIONS	64	59	174	169	339	334	343	338	388	383
COST PARAMETERS										
Cost of ABA (thousand$/yr)	44.0	44.0	132.0	132.0	264.0	264.0	268.0	268.0	304.0	304.0
Cost of HAP Cleaner (thousand$/yr)	4.4	0	4.4	0	4.4	0	4.4	0	4.4	0
Total Chemical Cost (thousand$/yr)	2,726	2,722	8,583	8,579	14,360	14,356	19,645	19,641	26,974	26,970
ABA-blown Chemical Cost (thousand$/yr)	2,172	2,172	6,517	6,517	11,057	11,057	14,541	14,541	17,568	17,568
Total Facility Operating Costs (thousand$/yr)	3,408	3,403	10,729	10,724	17,950	17,945	24,557	24,551	33,718	33,713
Disposal Cost of waste $MeCl_2$ ($/yr)	1,450	0	1,450	0	1,450	0	1,450	0	1,450	0

[a] Model plants 1 and 2 have no control for storage or unloading of either HAP; model plant 3 has VB control (95%) for TDI; and model plants 4 and 5 have Vapor Balance control (VB) for both HAP.
[b] It was assumed that there is one transfer pump per storage vessel at each model plant, and one metering pump per HAP. Canned pumps are only available for transfer pumps, and only Model Plant 5 uses canned pumps for $MeCl_2$ transfer. Model plants 2, 3, 4, and 5 have canned pumps for TDI transfer.

Table 7-2. Slabstock Foam Production Model Plant Formulation Information

Grade	Density (pcf)	IFD (25%)	$MeCl_2$ in formulation (pph polyol)	Foam Produced (tons/yr)					Baseline $MeCl_2$ used as ABA and emitted (tons/yr)				
				MP1	MP2	MP3	MP4	MP5	MP1	MP2	MP3	MP4	MP5
0930	0.9	30	10	80	240	600	550	570	5.3	16.0	40.0	36.7	38.0
1010	1.0	10	22	40	120	300	140	190	5.9	17.6	44.0	20.5	27.9
1015	1.0	15	19	40	120	300	140	190	4.9	14.8	37.0	17.3	23.4
1020	1.0	20	14	40	120	200	140	190	3.7	11.2	18.7	13.1	17.7
1030	1.0	30	8	80	240	500	550	570	4.0	12.0	25.0	27.5	28.5
1120	1.1	20	14	40	120	200	280	190	3.6	10.8	18.0	25.2	17.1
1130	1.1	30	7	60	180	300	410	570	2.6	7.8	13.0	17.8	24.7
1230	1.2	30	5	100	300	500	690	950	3.3	10.0	16.7	23.0	31.7
1330	1.3	30	6	60	180	300	410	570	2.2	6.6	11.0	15.0	20.9
1340	1.3	40	2	60	180	200	550	570	0.8	2.4	2.7	7.3	7.6
1440	1.4	40	2	60	180	300	410	570	0.8	2.4	4.0	5.5	7.6
1520	1.5	20	13	40	120	300	280	190	3.3	10.0	25.0	23.3	15.8
1530	1.5	30	6	40	120	200	410	380	1.6	4.8	8.0	16.4	15.2
1540	1.5	40	2	120	360	500	690	950	1.6	4.8	6.7	9.2	12.7
1640	1.6	40	1	120	360	400	830	950	0.8	2.4	2.7	5.5	6.3
1740	1.7	40	1	120	360	400	830	950	0.8	2.4	2.7	5.5	6.3
1820	1.8	20	10	60	180	400	410	380	4.0	12.0	26.7	27.3	25.3
1830	1.8	30	6	60	180	300	410	570	2.2	6.6	11.0	15.0	20.9
1840	1.8	40	0	120	360	600	830	1,240	0.0	0.0	0.0	0.0	0.0
1930	1.9	30	7	60	180	300	410	570	2.8	8.4	14.0	19.1	26.6
1940	1.9	40	1	100	300	500	690	860	0.7	2.0	3.3	4.6	5.7
>2020	2.5	25	0	500	1,500	2,400	3,710	6,840	0.0	0.0	0.0	0.0	0.0
								Total	55	165	330	335	380

Therefore, each of the five model plants were separated into two smaller model plants (i.e., 1a and 1b), with one using $MeCl_2$ as a cleaner, and the other employing cleaning methods that do not use a HAP. One-third of the nationwide facilities represented by each of the five model plants were assigned to the smaller model plant, which uses a HAP cleaner.

Because many of the emission reduction technologies that will be studied for the slabstock industry will involve process changes or other pollution prevention techniques, the model plants include baseline operational costs, including the total annual chemical costs, the total annual chemical costs for ABA-blown foam, and the total annual operating costs. In addition, baseline costs associated with the use of $MeCl_2$ as a cleaner are included. The baseline costs that were developed assumed the following raw chemical costs: \$0.50 per pound for polyol, and \$1.00 per pound for TDI, and \$0.40 per pound for $MeCl_2$.

7.2 MOLDED FOAM MODEL PLANT DESCRIPTIONS

While the basic processes are similar at all molded foam facilities, there are two different types of equipment used to pour the foam, which creates large differences in their HAP emission potential. The two types of equipment are low pressure (LP) and high pressure (HP) mixheads. LP mixheads require a solvent flush between foam shots to remove residual foam, while HP mixheads do not. Consequently, HAP emissions from LP facilities are usually significantly higher than emissions from HP facilities. All of the molded foam major sources were LP facilities, and all of the HP facilities were area sources.

Four molded foam model plants were developed, one with a HP mixhead, and three with LP mixheads. They are presented in Table 7-3. Only one model plant was created for HP mixhead facilities since the other parameters and HAP emissions were not found to be linked to production. The LP model plants differ mainly in the amount of foam produced, and the amount of HAP used to flush. The model plants include the following operational parameters: production, number of carrousels, operating schedule, and type of mixhead. The model plants also include the

TABLE 7-3. MOLDED FOAM MODEL PLANT PARAMETERS

	HP Model Plant	LP Model Plant 1	LP Model Plant 2	LP Model Plant 3
Operating Parameters				
Foam production range (tons/yr)	0-15,000	0-99	100-499	≥500
Average foam production (tons/yr)	3,331	26	308	2718
Number of carrousels	2	5	5	5
Operating schedule	16 hrs/day 250 days/yr	8 hrs/day 250 days/yr	16 hrs/day 250 days/yr	16 hrs/day 250 days/yr
Type of mixheads	HP	LP	LP	LP
HAP flush amount (55-gal drums)	0	19	72	177
Waste $MeCl_2$ from flush (55-gal drums)	0	2	8	18
HAP mold release agent amount (gal/year)	0	41	32	831
HAP repair adhesive amount (gal)	581	0	0	66
HAP content of adhesive	70%	0	0	70%
Number of facilities represented nationwide	27	109	54	44
Emissions (tons/yr)				
Emissions from HAP mixhead flush/plant	0	5.14	19.69	21.31
Emissions from HAP mold release/plant	0	0.15	0.12	6.0
Emissions from HAP adhesive/plant	2.093	0	0	1.35
Cost Parameters				
Disposal cost of waste $MeCl_2$	0	$1,600	$6,400	$14,400
Cost of HAP-based mold release agent	0	$198	$154	$4,005
Cost of HAP-based adhesive	$4,939	0	0	$561

amounts of mixhead flush, mold release agent, and repair adhesive used, which determine the HAP emissions for each model plant.

As with slabstock foam, many of the emission reduction technologies that will be studied for the slabstock industry will involve pollution prevention techniques. Therefore, the model plants include baseline costs for disposal of waste $MeCl_2$ from the mixhead flush, and the cost of HAP-based mold release agent and HAP-based adhesive.

8.0 ENVIRONMENTAL AND ENERGY IMPACTS OF REGULATORY ALTERNATIVES

This chapter presents the primary environmental impacts, secondary environmental impacts, and energy impacts of the existing source regulatory alternatives described in Chapter 6. The cost and economic impacts will be discussed in Chapter 9. There are no anticipated new source impacts for this source category. The industry has stated that there is enough unused capacity at existing facilities to handle any increased demand for foam products.[26] A more detailed description of the impacts analysis is provided in the SID.[27]

8.1 PRIMARY ENVIRONMENTAL IMPACTS

Primary environmental impacts are the reductions of HAP emissions that occur as a result of application of the regulatory alternatives presented in Chapter 6. The primary emission reductions were calculated using the model plants presented in Chapter 7.

8.1.1 Primary Environmental Impacts for Molded Foam

Only major sources of HAP will be subject to the Flexible Polyurethane Foam Production NESHAP. Since the HP molded model plant and LP model plant 1 have emissions below the major source threshold, it was assumed that the facilities represented by these model plants would not be affected by the Flexible Polyurethane Foam Production NESHAP. It could be maintained that these facilities, particularly the LP facilities, have the potential to emit major source levels of HAP. However, it was assumed that these facilities would obtain federally enforceable permit requirements limiting HAP emissions below major source levels, rather than installing controls in accordance with the NESHAP. Therefore, for molded foam, the nationwide regulatory alternative impacts are based on LP model plants 2 and 3 only.

As shown in Table 8-1, the total HAP emission reductions expected for the molded regulatory alternatives ranges from 331 tons (300 Mg) to 2,332 tons (2,120 Mg) per year, depending on the alternative chosen. These levels of emission reduction represent a 10 to 73 percent reduction over the baseline emission level.

The MACT floor alternative has a reduces HAP emissions by 10 percent. The emission reduction is low because there is no attempt to control the mixhead flush emissions, which are the largest emission source. The MACT floor (and therefore subsequent alternatives) calls for the total elimination of HAP-based mold release agents and repair adhesives. The percent emission reduction from baseline presented in Table 8-1, is not 100 percent for either of these emission sources, as HP model plant 1, and LP model plant 1 have emissions from these sources. As discussed earlier, these model plants were not used for nationwide impacts, as they are assumed to represent area sources.

Regulatory Alternative 1 adds a work practice requirement to control mixhead flush emissions. Table 8-1 shows a nationwide emission reduction for this source of 59 percent. As mentioned above, the other two emission sources require total elimination of HAP-based products. The resulting emission reduction from nationwide baseline for Regulatory Alternative 1 is 58 percent.

Regulatory Alternative 2 requires total elimination of HAP-mixhead flush, resulting in a 78 percent reduction for this emission source. Again, there is not a complete elimination because of the small amount of emissions from the area source model plants. There is also the complete elimination of HAP-based mold release agents and repair adhesives. The resulting total emission reduction for Regulatory Alternative 2 is 73 percent.

8.1.2. Slabstock Foam Primary Environmental Impacts

Table 8-2 presents the primary environmental impacts for slabstock foam. As was shown in Table 6-9, three basic regulatory alternatives were developed for slabstock foam, with Regulatory Alternative 1 including two implementation options.

TABLE 8-1. MOLDED FOAM REGULATORY ALTERNATIVE HAP EMISSION REDUCTION

Regulatory Alternative	HAP Emission Reduction- tons/yr (percent of total reduction)			
	Mixhead Flush	Mold Release Agent	Repair Adhesive	Total
MACT Floor	0 (0)	271 (94)	61 (53)	332 (10)
Regulatory Alternative 1	1,501 (59)	271 (94)	61 (53)	1,832 (58)
Regulatory Alternative 2	2,001 (78)	271 (94)	61 (53)	2,332 (73)

The first option (Alternative 1a) consists of emission point specific requirements, and the second (Alternative 1b) consists of a source-wide emission limitation that allows the owner or operator to select the emission points to control, as long as the source-wide emission limitation is achieved. The HAP emission reductions presented in this section for Regulatory Alternative 1 were calculated using the emission point specific requirements of Alternative 1a. The EPA believes that the environmental impacts of Alternative 1b would be analogous to those presented for Alternative 1a.

There are two sets of impacts shown for Regulatory Alternative 2. The first only takes into account the "direct" HAP emission reductions associated with the regulatory alternative emission requirements. However, the elimination of the use and emissions of HAP ABA will also result in the elimination of HAP ABA emissions from storage and equipment leaks. The second set of impacts include these "indirect" HAP emission reductions. The storage and equipment leak alternatives specify separate requirements for TDI, which is a reactant in the formation of polyurethane foam, and HAP ABA.

As shown in Table 8-2, the HAP emission reductions expected for the slabstock regulatory alternatives range from 9,421 tons (8,564 Mg) to 16,542 tons (15,038 Mg) per year, depending on the alternative chosen. These reductions represent from 57 to over 99 percent reductions over the baseline HAP emissions level.

The MACT floor alternative has a total emission reduction of 57 percent. Storage and unloading emissions are controlled by using vapor balance or carbon canisters, resulting in approximately 88 percent reduction for this emission point. Equipment leaks are reduced by only 1 percent because the control of TDI emissions using sealless pumps is the only control required at the MACT floor level.

Regulatory Alternative 1 has a total emission reduction of 69 percent. One reason for the increase over the MACT floor reduction is that Alternative 1 reduces equipment leaks by 49 percent by requiring a unique LDAR program as well as the TDI

TABLE 8-2. SLABSTOCK FOAM REGULATORY ALTERNATIVE HAP EMISSION REDUCTION

Regulatory Alterative	HAP Emission Reduction, tons/yr (percent reduction from baseline)				
	Storage/ unloading	Equipment Leaks	Equipment Cleaning	ABA	Total
MACT Floor	15 (88)	3 (1)	130 (100)	9,273 (57)	9,421 (57)
Reg. Alt 1[a]	15 (88)	80 (49)	130 (100)	11,262 (69)	11,488 (69)
Reg. Alt 2					
Direct	0	3	130 (100)	16,250 (100)	16,383 (98)
Indirect	17 (100)	142 (94)	0	0	158
					16,541 (~100)

[a] The emission reductions presented were calculated using the emission point specific requirements of Alternative 1a.

control required at the MACT floor level. Another reason is the increased control of HAP ABA emissions (from a 57 to a 69 percent reduction).

Regulatory Alternative 2 has a total emission reduction of almost 100 percent. This is the result of both direct and indirect impacts. The prohibition of HAP ABA emissions results in complete elimination of HAP ABA storage/unloading and HAP ABA equipment leak emissions. HAP-based equipment cleaner emissions were already eliminated as in the other alternatives.

8.1.3 Rebond Foam Primary Environmental Impacts

It is predicted that no rebond facilities will be affected by the proposed regulation. Therefore, no primary environmental impacts are anticipated from this subcategory.

8.2 SECONDARY ENVIRONMENTAL IMPACTS

While the primary impact of the regulatory alternatives is to reduce HAP emissions, the application of control technologies can have other positive environmental effects such as reduction in non-HAP volatile organic compound (VOC) emissions, or a reduction in hazardous waste. However, the environmental effects can also be negative, such as the generation of additional wastewater or solid waste. In this section, the secondary impacts for both slabstock and molded foam on air pollution, water pollution, and solid and hazardous waste are discussed. As discussed earlier, it is predicted that no existing rebond operations will be affected by the proposed rule. Therefore, no secondary impacts are anticipated.

8.2.1. Air Pollution Impacts

For both slabstock and molded foam, the secondary air pollution impacts are a potential increase in VOC emissions. There could be an increase in the amount of VOC emitted from slabstock foam facilities if the non-HAP cleaner required by all the alternatives contained VOC's rather than HAP. If this is true, HAP emissions could be replaced by VOC emissions. The same situation could occur in molded foam with non-HAP based repair adhesives, mold release agents, or mixhead flushes. However, the replacement products typically have low volatility, so the amount of VOC emitted should be small.

There is also the potential for an increase in the amount of criteria pollutants as a result of the combustion of coal, oil, or natural gas, which are used to generate the additional energy needed for some control equipment. This combustion results in the emission of nitrous oxide (NO_x), carbon monoxide (CO), particulate matter (PM), and sulfur dioxide (SO_2). These off-site air impacts were not included in this analysis, although energy impacts are discussed in Section 8.3.

8.2.2. Water Pollution Impacts

Potential water pollution impacts occur in the slabstock foam subcategory for Regulatory Alternatives 1 and 2. The potential impact comes from the use of carbon adsorption as one of the control options to reduce or eliminate ABA emissions. Once the HAP ABA is captured by the carbon bed, that carbon bed is regenerated. The regeneration process is where there is a potential wastewater impact. The carbon bed is regenerated by passing steam through the bed, and condensing steam and $MeCl_2$, then distilling and recovering the $MeCl_2$. The distillation condenser bottoms can potentially contain small amounts of $MeCl_2$ that could be introduced into the wastewater. However, the Agency is aware of only one facility using a carbon adsorber to recover HAP ABA, and does not expect any additional installations.

A similar situation could occur in the solvent recovery systems that could potentially be used to collect mixhead flush emissions in the molded foam subcategory for Regulatory Alternative 2. The only difference is the size of the carbon bed, which would be smaller for the solvent recovery system.

8.2.3. Solid and Hazardous Waste Impacts

For the slabstock foam subcategory there is the potential for a slight increase in the amount of hazardous waste due to the control of storage and unloading emissions required by all the alternatives. The increase would occur when the carbon canisters used to capture the HAP ABA, or the TDI, from storing and unloading operations become saturated. These carbon canisters would be contaminated with these HAP and would be considered a hazardous waste. It is uncertain as to the frequency of saturation of these canisters and subsequent need for their disposal; however, the industry has indicated that they do not believe it will be frequent.

For the molded foam subcategory, there is the potential for a decrease in the amount of hazardous waste, although this decrease is really a shift to solid waste. A small amount of hazardous waste is generated from mixhead flushing operations when the waste flush ($MeCl_2$) is separated from any solids generated during the flush operations. The $MeCl_2$ can be regenerated, but the solids must be disposed of as a hazardous waste. However, by replacing the HAP-based mixhead flush with non-HAP based flush, these same solids can most likely now be sent to a solid waste disposal site, depending on the contaminants.

8.3 ENERGY IMPACTS

Due to the use of several control technologies in both slabstock and molded foam there will be some increase in the amount of energy used by this source category. The impact will vary depending on which control technology is chosen by each facility, and therefore cannot be accurately calculated. However, in the discussion of the cost impacts to follow in Section 9.1, the increased energy usage was evaluated as part of the annual cost for each pertinent technology.

9.0 COST AND ECONOMIC IMPACTS OF REGULATORY ALTERNATIVES

This chapter presents the cost and economic impacts of the existing source regulatory alternatives described in Chapter 6. The primary and secondary environmental impacts, as well as the energy impacts were discussed in Chapter 8. As was mentioned in Chapter 8, there are no anticipated new sources for this source category.

9.1 MODEL PLANT COSTS

The bases for the model plants are provided in Chapter 7. The Cost Document was the basis for the majority of the model plant costs.[23] There are several situations in which all or some portion of the model plant annual costs are negative (i.e., represent a cost savings). Throughout this chapter, cost savings will be denoted in parentheses. Since it is anticipated that no rebond facilities will be affected by the proposed regulation, no model plant costs were developed for rebond facilities.

9.1.1 Slabstock Foam

There are five basic model plants for slabstock foam, representing varying levels of production. Each basic model plant is separated into facilities that use $MeCl_2$ as an equipment cleaner and facilities that do not. Several sources were used to estimate costs for the slabstock foam production model plants. Information developed for other EPA efforts, supplemented by vendor quotes, was used for determining equipment leak and storage tank impacts. The HAP ABA and equipment cleaning costs were primarily derived from the Cost Document. The following sections present information for each emission source type, as well as a summary of their model plant costs.

9.1.1.1 Storage/Unloading

The MACT floor level of control for storage and unloading of both TDI and HAP ABA is an equipment standard that requires either a vapor balance system to return the displaced HAP vapors to the tank truck or railcar, or a carbon canister through which emissions must be routed prior to being emitted to the atmosphere. The subsequent regulatory alternatives do not contain more stringent requirements. However, since there are no HAP ABA emissions allowed under Regulatory Alternative 2, there will be no storage tanks containing HAP ABA under this regulatory alternative.

The model plant impacts are based on the installation of vapor balance systems. The basis for estimating vapor balance impacts was the "Background Information Document for the proposed gasoline distribution NESHAP."[28] This document asserts that the emission reduction for vapor balance is 95 percent. The bulk plant model costs in the referenced document include costs for the vapor balancing of both incoming and outgoing loads. The unloading of TDI and $MeCl_2$ at flexible polyurethane foam facilities is comparable to "incoming loads" at bulk plants.

The slabstock foam production model plant costs for storage/unloading emission control are provided in Table 9-1. There are no costs for model plants 4 and 5, because all TDI and $MeCl_2$ storage tanks for these model plants were assumed to be controlled at baseline. TDI storage tanks at model plant 3 were also assumed to be controlled.

9.1.1.2 Equipment Cleaning

The MACT floor level of control for equipment cleaning is the complete elimination of HAP emissions. The subsequent regulatory alternatives do not contain more stringent requirements. While there are several alternatives available to eliminate the use of $MeCl_2$ or other HAP for cleaning the mixhead and other equipment, model plant costs were developed for only one alternative: non-HAP cleaners.

The amount of $MeCl_2$ to clean the equipment is consistent for all model plants. Therefore, the impacts shown below are applicable for all model plants. More detail on these model plant costs is provided in the regulatory alternative impacts memorandum mentioned earlier.

TABLE 9-1. SLABSTOCK FOAM MODEL PLANT COSTS
FOR VAPOR BALANCING TO CONTROL STORAGE EMISSIONS

	Costs (1994 dollars)		
	Model Plant 1	Model Plant 2	Model Plant 3
MACT Floor and Regulatory Alternative 1[a]			
Capital Investment ($)	$8,220	$12,330	$4,110
Annual Cost ($/yr)	$1,673	$2,402	$438
Regulatory Alternative 2			
Capital Investment ($)	$4,110	$8,220	NA[b]
Annual Cost ($/yr)	$873	$1,745	NA[b]

[a] The model plant costs presented were calculated using the emission point specific requirements of Alternative 1a.

[b] Model Plant 3 was assumed to have baseline controls that would meet the requirements of Regulatory Alternative 2. Also, Model Plants 4 and 5 were assumed to have baseline controls that would meet the requirements of all regulatory alternatives.

Capital Cost - $0
Annual Cost - ($275)/yr

9.1.1.3 Equipment Leaks

The MACT floor level of control for equipment leaks was determined to be sealless pumps for TDI transfer pumps. The first regulatory alternative adds a unique LDAR program for HAP ABA components. Since Regulatory Alternative 2 does not allow the emission of any HAP ABA (which, in effect, prohibits the use of $MeCl_2$ or any other HAP as an ABA), this alternative only contains the MACT floor requirement for TDI pumps.

For the MACT floor Regulatory Alternative, the cost would simply be the cost of replacing existing TDI transfer pumps with sealless pumps for model plant 1. All other model plants have sealless TDI transfer pumps at baseline. Since there are no HAP ABA emissions allowed under Regulatory Alternative 2, there will be no components in HAP ABA service. The only direct equipment leak impacts under this regulatory alternative will be the TDI cost associated with the MACT floor Regulatory Alternative. The model plant costs for equipment leaks are presented in Table 9-2.

9.1.1.4 HAP ABA emissions

There are three levels of control for HAP ABA emissions. The MACT floor and first regulatory alternative levels are emission limits based on formulation limitations. The second regulatory alternative requires the complete elimination of HAP ABA emissions. For each level of control, model plant impacts were developed for several technologies. While there are numerous technologies available to reduce HAP ABA emissions, the effectiveness of individual technologies is widely disputed within the foam industry. Therefore, the EPA made assumptions, based on its knowledge of the industry, regarding the technologies that could be used to meet each of the three HAP ABA levels of control.

It is assumed that some technologies can be used to meet more than one level of control. In these cases, it was assumed that the technologies would only be used to the degree necessary to meet the level of the regulatory alternative. In other words,

TABLE 9-2. SLABSTOCK FOAM EQUIPMENT LEAK MODEL PLANT COSTS

	Costs (1994 dollars)				
	Model Plant 1	Model Plant 2	Model Plant 3	Model Plant 4	Model Plant 5
MACT Floor and Regulatory Alternative 2					
Capital Investment ($)	$5,000	NA[a]	NA[a]	NA[a]	NA[a]
Annual Cost ($/yr)	$1,265	NA[a]	NA[a]	NA[a]	NA[a]
Regulatory Alternative 1[b]					
Capital Investment ($)	$12,544	$7,544	$7,544	$7,544	$7,431
Annual Cost ($/yr)	$7,245	$5,980	$5,980	$5,980	$5,810

a Model Plants 2 through 5 were assumed to have baseline controls that would meet the requirements of the MACT Floor Alternative and Regulatory Alternative 2.

b The model plant costs presented were calculated using the emission point specific requirements of Alternative 1a.

although variable pressure foaming (VPF) can be used to totally eliminate the use of HAP ABA, it was assumed that at the MACT floor level, the amount of $MeCl_2$ allowed would still be used and emitted.

9.1.1.4.1 Chemical Alternatives. It is assumed that the only regulatory alternative that can be met solely by the use of chemical alternatives is the MACT floor alternative. The capital costs of the use of chemical alternatives are the same for all model plants. Therefore, the capital recovery and other indirect annual costs (which are a function of the total capital investment) are also uniform. The other contribution to the annual cost is the materials cost. This is the cost of the chemical alternatives minus the cost of the $MeCl_2$ no longer used. The model plant chemical alternative costs are summarized in Table 9-3.

9.1.1.4.2 Carbon Dioxide as an ABA. It is assumed that the HAP ABA requirements for both the MACT floor and first regulatory alternative can be met using CO_2 as an ABA. While there are other CO_2 systems available, the model plant costs presented for CO_2 as an ABA are costs of the licensed CarDio technology. The model plant costs for CarDio are summarized in Table 9-4.

The capital costs for the installation of the CarDio technology are uniform for all regulatory alternatives for all model plants. Therefore, the annual capital recovery charges are also analogous for all situations. Similarly, the CO_2 tank rental fee is the same in all situations. The material costs consist of the costs of the liquid CO_2 minus the $MeCl_2$ savings.

It was assumed that the total elimination of HAP ABA (Regulatory Alternative 2) could not be achieved using only CarDio. This was because the base formulation would need more than 3 parts $MeCl_2$ per hundred parts polyol to allow the substitution of CO_2 as an ABA. However, these low-ABA foam grades could be produced using chemical alternatives. The combination of CarDio and chemical alternatives was assumed to achieve the complete elimination of the use of HAP ABA.

TABLE 9-3. SLABSTOCK FOAM MODEL PLANT COSTS FOR CHEMICAL ALTERNATIVES HAP ABA EMISSION REDUCTION

	Model Plant Costs (1990 dollars)				
	MP1	**MP2**	**MP3**	**MP4**	**MP5**
MACT Floor					
Capital Investment ($)	$31,725	$31,725	$31,725	$31,725	$31,725
Annual Cost ($/yr)	$54,523	$151,713	$274,276	$335,202	$378,997

TABLE 9-4. SLABSTOCK FOAM MODEL PLANT COSTS FOR CARDIO HAP ABA EMISSION REDUCTION

	Model Plant Costs (1990$)				
	MP1	**MP2**	**MP3**	**MP4**	**MP5**
MACT Floor					
Capital Investment ($)	$429,300	$429,300	$429,300	$429,300	$429,300
Annual Cost ($/yr)	$69,395	$32,453	($18,512)	($14,525)	($23,505)
Regulatory Alternative 1					
Capital Investment ($)	$429,300	$429,300	$429,300	$429,300	$429,300
Annual Cost ($/yr)	$66,354	$23,254	($42,403)	($38,631)	($43,559)
Regulatory Alternative 2 - CarDio plus chemical alternatives					
Capital Investment ($)	$461,025	$461,025	$461,025	$461,025	$461,025
Annual Cost ($/yr)	$84,163	$27,660	($29,666)	$17,561	$16,227

9.1.1.4.3 Acetone as an ABA. It is assumed that acetone can be used to meet the HAP ABA requirements for all three regulatory alternatives. The model plant costs for acetone as an ABA are summarized in Table 9-5. As with CarDio, the capital costs, capital recovery, and other indirect costs are the same for all model plants and for all regulatory alternatives. The differences in annual costs are the result of the differences in material costs and licensing fees. The material costs were simply the cost of the acetone minus the MeCl2 savings.

9.1.1.4.4 Variable Pressure Foaming. It is assumed that the HAP ABA requirements for all three regulatory alternatives can be met using VPF technology. The capital costs are consistent across all model plants for all regulatory alternatives. Similarly, the utilities and labor costs, capital recovery, and other indirect annual costs are also consistent. Therefore, the only element that changes in the VPF model plant annual costs is the material costs. Since there is not a need for additional chemicals or other materials, this simply represents the cost savings from the unused $MeCl_2$. The VPF model plant costs are summarized in Table 9-6.

9.1.1.4.5 Forced Cooling. It is assumed that the HAP ABA requirements for the MACT floor and the first regulatory alternative can be met using forced cooling. While there are numerous forced cooling systems in operation or under development in the United States, the model plant costs presented are based on the costs of the licensed Envirocure technology, except that licensing fees are not included. The model plant costs for forced cooling are provided in Table 9-7. The capital costs for the installation of forced cooling are uniform for model plants 2 through 5 for all regulatory alternatives. The capital costs for model plant 1 are lower, assuming that a smaller forced cooling unit could be installed. Therefore, the annual capital recovery charges and other indirect annual costs are analogous for all regulatory alternatives. The utilities charges, which were provided by the vendor, are also the same for all regulatory alternatives.

TABLE 9-5. SLABSTOCK FOAM MODEL PLANT COSTS FOR ACETONE HAP ABA EMISSION REDUCTION

	Model Plant Costs (1990 dollars)				
	MP1	MP2	MP3	MP4	MP5
MACT Floor					
Capital Investment ($)	$194,000	$194,000	$194,000	$194,000	$194,000
Annual Cost ($/yr)	$35,121	$8,783	($31,165)	($36,497)	($47,473)
Regulatory Alternative 1					
Capital Investment ($)	$194,000	$194,000	$194,000	$194,000	$194,000
Annual Cost ($/yr)	$32,455	$330	($48,503)	($55,223)	($68,797)
Regulatory Alternative 2					
Capital Investment ($)	$194,000	$194,000	$194,000	$194,000	$194,000
Annual Cost ($/yr)	$25,306	($22,633)	($99,520)	($101,750)	($121,840)

TABLE 9-6. SLABSTOCK FOAM MODEL PLANT COSTS FOR VARIABLE PRESSURE FOAMING HAP ABA EMISSION REDUCTION

	Model Plant Costs (1990 dollars)				
	MP1	**MP2**	**MP3**	**MP4**	**MP5**
MACT Floor					
Capital Investment ($)	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
Annual Cost ($/yr)	$774,400	$724,400	$652,240	$642,720	$623,120
Regulatory Alternative 1					
Capital Investment ($)	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
Annual Cost ($/yr)	$769,120	$708,480	$621,280	$609,280	$585,040
Regulatory Alternative 2					
Capital Investment ($)	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
Annual Cost ($/yr)	$755,440	$667,486	$535,531	$531,546	$495,679

TABLE 9-7. SLABSTOCK FOAM MODEL PLANT COSTS FOR FORCED COOLING HAP ABA EMISSION REDUCTION

	Model Plant Costs (1994 dollars)				
	MP1	**MP2**	**MP3**	**MP4**	**MP5**
MACT Floor					
Capital Investment ($)	$1,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Annual Cost ($/yr)	$162,500	$305,180	$243,300	$243,418	$237,310
Regulatory Alternative 1					
Capital Investment ($)	$1,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Annual Cost ($/yr)	$157,220	$289,260	$212,340	$209,978	$199,230
Regulatory Alternative 2 forced cooling plus chemical alternatives					
Capital Investment ($)	$1,031,725	$2,031,725	$2,031,725	$2,031,725	$2,031,725
Annual Cost ($/yr)	$161,441	$308,350	$227,636	$241,513	$239,989

It was assumed that the total elimination of HAP ABA (Regulatory Alternative 2) could not be achieved using forced cooling only. This assumption was made due to the many doubts within the industry that low density, low IFD foams of acceptable quality can be made using forced cooling without any ABA. However, it was assumed that these foam grades could be produced using the combination of forced cooling and chemical alternatives. The capital costs, capital recovery, and other indirect annual costs for this combination were simply the sum of the capital costs of forced cooling and chemical alternatives.

9.1.2 Molded Foam

There are four molded foam production model plants. One of these model plants represents larger molded foam facilities using HP mixheads, primarily to produce automobile seats. The remaining three model plants represent smaller producers that use LP mixheads to produce a variety of foam products.

The molded foam production model plant costs were developed directly from the Cost Document, except that the costs were adjusted to the characteristics of the model plants. All technologies, except for work practices to reduce mixhead flushing emissions, totally eliminate HAP emissions. The following sections present information for each emission source type, as well as a summary of their model plant costs. More details regarding the molded foam model plant costs can be found in the regulatory alternative impacts memorandum mentioned earlier.

9.1.2.1 Mixhead Flushing

Model plant impacts were developed for four technologies to reduce or eliminate mixhead flushing emissions: work practices for Regulatory Alternative 1; and non-HAP flushes, HP mixheads, and self-cleaning mixheads for Regulatory Alternative 2. Costs were developed for the work practice of an emission suppression and solvent recovery system for the $MeCl_2$ used to flush the mixhead. Table 9-8 presents a summary of the model plant costs for mixhead flushing for these technologies.

TABLE 9-8. MOLDED FOAM MODEL PLANT COSTS FOR TECHNOLOGIES TO REDUCE MIXHEAD FLUSHING HAP EMISSIONS

Technology	Costs (1994 dollars)			
	HP Model Plant	LP Model Plant 1	LP Model Plant 2	LP Model Plant 3
Non-HAP Flush				
Capital Investment ($)	$0	$0	$0	$0
Annual Cost ($/yr)	$0	($920)	($3,823)	($8,065)
High-pressure Mixhead				
Capital Investment ($)	$0	$658,125	$658,215	$658,125
Annual Cost ($/yr)	$0	$163,815	$146,107	$112,535
Self-Cleaning Mixhead				
Capital Investment ($)	$0	$225,688	$225,688	$225,688
Annual Cost ($/yr)	$0	$34,938	$17,231	($16,341)
Solvent Recovery System				
Capital Investment ($)	$0	$47,250	$47,250	$47,250
Annual Cost ($/yr)	$0	$23,412	$10,131	($15,048)

9.1.2.2 Mold Release Agents

The MACT floor level of control for mold release agents is the prohibition of the use of HAP-based mold release agents, resulting in a 100 percent emission reduction. Model plant impacts were developed for three technologies that can achieve this level: reduced VOC mold release agents, naphtha-based mold release agents, and water-based mold release agents. A summary of mold release agent model plant costs is in Table 9-9.

9.1.2.3 Repair Adhesives

The MACT floor level of control for repair adhesives is also the prohibition of the use of HAP-based adhesives, resulting in a 100 percent emission reduction. Model plant impacts were developed for three technologies that can achieve this level: hot-melt adhesives, water-based adhesives, and hydrofuse adhesive. Table 9-10 provides a summary of the repair adhesive model plant costs.

9.2 NATIONWIDE COST IMPACTS

This section presents the nationwide costs and HAP emission reductions associated with the existing source regulatory alternatives. The basic approach used to estimate these nationwide impacts was to apply the model plant impacts presented in the previous section to those facilities represented by the model plants. As was mentioned in Chapter 7, in several instances more than one technology could be used to achieve the level of control required by the regulatory alternative. In these cases, the EPA made assumptions regarding the number of facilities represented by each model plant that would use the various technologies.

In addition to costs of the technologies to control HAP emissions, facilities will also incur costs for the associated monitoring, recordkeeping and reporting (MRR). For the purposes of this analysis, these MRR costs were estimated to be 8 percent of the control costs. Therefore, the total control costs calculated using the model plant costs was multiplied by 108 percent to obtain the total cost of control for each regulatory alternative.

TABLE 9-9. MOLDED FOAM MODEL PLANT COSTS FOR TECHNOLOGIES TO REDUCE MOLD RELEASE AGENT HAP EMISSIONS

Technology	Costs (1994 dollars)			
	HP Model Plant	**LP Model Plant 1**	**LP Model Plant 2**	**LP Model Plant 3**
Reduced-VOC Agent				
Capital Investment ($)	$0	$0	$0	$0
Annual Cost ($/yr)	$0	$50	$39	$1,023
Naphtha-Based Agent				
Capital Investment ($)	$0	$0	$0	$0
Annual Cost ($/yr)	$0	$375	$293	$7,599
Water-Based Agent				
Capital Investment ($)	$0	$0	$0	$0
Annual Cost ($/yr)	$0	$48	$38	$981

TABLE 9-10. MOLDED FOAM MODEL PLANT COSTS FOR TECHNOLOGIES TO REDUCE HAP EMISSIONS FROM THE USE OF FOAM REPAIR ADHESIVES

Technology	Costs (1994 dollars)			
	HP Model Plant	LP Model Plant 1	LP Model Plant 2	LP Model Plant 3
Hot-Melt Adhesive				
Capital Investment ($)	$6,804	$0	$0	$6,804
Annual Cost ($/yr)	$6,377	$0	$0	$1,869
Hydrofuse Adhesive				
Capital Investment ($)	$5,670	$0	$0	$5,670
Annual Cost ($/yr)	$738	$0	$0	$1,001
Water-Based Adhesive				
Capital Investment ($)	$0	$0	$0	$0
Annual Cost ($/yr)	($854)	$0	$0	($97)

As was also mentioned in Chapter 7, only major sources of HAP will be subject to the Flexible Polyurethane Foam Production NESHAP. All slabstock foam facilities were considered to be major sources. However, as was discussed, since the HP molded model plant and the smallest LP molded model plant have emissions below the major source thresholds, it was assumed that the facilities represented by this model plant would not be affected by the Flexible Polyurethane Foam Production NESHAP. Therefore, the nationwide regulatory alternative impacts are based on LP model plants 2 and 3. Further, it is predicted that all stand-alone rebond facilities are area sources, and all co-located rebond facilities are already in compliance with the proposed requirements. Therefore, no impacts are predicted for rebond foam production operations. The following sections briefly discuss how the model plant cost impacts were used to estimate nationwide impacts. Complete details on the application of the model plant costs, and assumptions made regarding the numbers of facilities utilizing various technologies can be found in the regulatory alternative impacts memorandum referenced earlier in this chapter.

9.2.1 Slabstock Foam Nationwide Cost Impacts

The following sections briefly describe the derivation of impacts for each of the four slabstock foam production emission sources. As was shown in Table 6-9, three basic regulatory alternatives were developed for slabstock foam, with Regulatory Alternative 1 including two implementation options. The first option (Alternative 1a) consists of emission point specific requirements, and the second (Alternative 1b) consists of a source-wide emission limitation that allows the owner or operator to select the emission points to control, as long as the source-wide emission limitation is achieved. The model plant costs presented in this section for Regulatory Alternative 1 were calculated using the emission point specific requirements of Alternative 1a.

9.2.1.1 Storage/Unloading, Equipment Leaks, and Equipment Cleaning

As discussed earlier, model plant costs and HAP emission reductions were only developed for one technology for each of these emission sources. Therefore, the nationwide regulatory alternative costs were simply determined by multiplying the model plant costs for each technology by the number of facilities represented by each model plant.

9.2.1.2 HAP ABA Emissions

As was discussed in the model plant cost section, there are a variety of technologies that reduce or eliminate the use of HAP ABA. In estimating the nationwide regulatory alternative costs, it was necessary to make assumptions regarding the number of facilities that would use each available technology to comply with the HAP ABA requirements. The distribution of technologies used to estimate the HAP ABA slabstock foam nationwide regulatory alternative costs by model plant is provided in Table 9-11.

For the MACT floor regulatory alternative, it was assumed that the majority of the facilities represented by the smaller model plants would choose to comply through the use of chemical alternatives. It was assumed that most of the facilities not using chemical alternatives would comply through the use of either CarDio or forced cooling. The reduction of HAP ABA usage through forced cooling is a technology that has already penetrated the industry to a large degree.

For Regulatory Alternative 1, the technologies available to meet this level were acetone, forced cooling, VPF, and CarDio. Due to the relatively low costs, it was assumed that the majority of smaller facilities would select CarDio. For model plants 3 and 4, where it was assumed that capital costs were less of a problem, a smaller percentage were assumed to choose the CarDio technology over acetone and forced cooling. For model plant 5, it was assumed that the four technologies would be used equally.

The rationale for the Regulatory Alternative 2 assumptions was basically the same as that for Regulatory Alternative 1 (noting of course that CarDio and forced cooling also use

TABLE 9-11. DISTRIBUTION OF ABA EMISSION REDUCTION TECHNOLOGIES USED TO ESTIMATE THE SLABSTOCK FOAM NATIONWIDE REGULATORY ALTERNATIVE COSTS BY MODEL PLANT

Technology	Number of Facilities Using the Technology				
	MP1	**MP2**	**MP3**	**MP4**	**MP5**
MACT Floor					
CarDio	4	9	4	4	1
Acetone	1	1	1	1	0
VPF	0	0	0	0	2
Forced cool	2	4	3	3	2
Chem Alts	12	14	6	3	1
Reg Alt I					
CarDio	13	18	6	5	1
Acetone	3	4	3	2	1
VPF	0	0	0	0	2
Forced cool	3	6	5	4	2
Reg Alt II					
CarDio + Chem Alts	10	15	5	3	1
Acetone	3	3	2	2	1
VPF	0	1	1	2	2
Forced cool + Chem Alts	6	9	6	4	2

chemical alternatives for Regulatory Alternative 2). The one exception is that it was assumed that a few more large facilities would choose to spend the resources to install VPF under Regulatory Alternative 2.

9.2.2 Nationwide Cost Impact Summary for Slabstock Foam

The nationwide regulatory alternative impacts for slabstock foam production are provided in Table 9-12. The table includes the emission reductions that were discussed in Chapter 8, as well as their incremental cost effectiveness. As discussed earlier, the impacts shown for Regulatory Alternative 1 were developed assuming compliance with the emission point specific requirements of Alternative 1a. The EPA believes that the cost and economic impacts of Alternative 1b would be slightly less than those of Alternative 1a, since the owner or operator could select the most cost-effective controls for their facility. However, for the purpose of this analysis, the EPA assumes that the costs presented in this section are representative of both Alternative 1a and 1b.

There are two sets of impacts shown for Regulatory Alternative 2. The first only takes into account the "direct" HAP emission reductions associated with the regulatory alternative emission requirements. However, as discussed earlier, the elimination of the use and emission of HAP ABA will also result in the elimination of HAP ABA emissions from storage and equipment leaks. The second set of impacts include these "indirect" HAP emission reductions.

The cost effectiveness of all three regulatory alternatives are less than $2,000 per ton of emission reduction, with the highest being the MACT floor level of control at $1,262 per ton. Due to the incremental annual cost savings for the Regulatory Alternative 1 HAP ABA requirements, the overall incremental cost effectiveness from the MACT floor to Regulatory Alternative 1 is negative. The incremental cost effectiveness from Regulatory Alternative 1 to Regulatory Alternative 2 is $800 per ton, considering the indirect emission reductions.

TABLE 9-12. NATIONWIDE SLABSTOCK FOAM REGULATORY ALTERNATIVE COSTS

	Impacts by Emission Source				
	Storage/ Unloading	Equipment Leaks	Equipment Cleaning	ABA	Total
MACT Floor					
Capital Investment ($)	$558,960	$95,000	$0	$46,362,700	$47,016,660
Annual Cost[a] ($/yr)	$113,096	$25,859	($7,693)	$11,754,542	$11,885,803
Emission Reduction (tons/yr)	15	3	130	9,273	9,422
Cost Effectiveness ($/ton)	$7,342	$8,006	-[b]	$1,268	$1,262
Regulatory Alternative 1[c]					
Capital Investment ($)	$558,960	$682,754	$0	$66,981,900	$68,223,614
Annual Cost[a] ($/yr)	$113,096	$526,596	($7,693)	$6,714,951	$7,346,949
Emission Reduction (tons/yr)	15	80	130	11,262	11,488
Cost Effectiveness ($/ton)					
Overall	$7,342	$6,552	-[b]	$596	$640
Incremental	NA[d]	$6,491	NA[c]	-[e]	-[e]
Regulatory Alternative 2					
Capital Investment ($)	$308,250	$95,000	$0	$93,665,425	$94,068,675
Annual Cost[a] ($/yr)	$70,413	$25,859	($7,693)	$11,307,363	$11,395,943
Emission Reduction (tons/yr)	0	3	130	16,250	16,383
Cost Effectiveness ($/ton)					
Overall	$5 x 10^6	$8,006	-[b]	$696	$696
Incremental	NA[d]	NA[d]	NA[d]	$921	$827
With Indirect Emission Reductions					
HAP ABA Emission Reduction	17	141	-[f]	-[f]	158 16,451 (total)
Cost Effectiveness					
Overall	-[g]	-[g]	-[f]	-[f]	$689
Incremental					$801

Footnotes for Table 9-12

[a] Annual costs include monitoring, recordkeeping, and reporting costs, which were assumed to be 7.6 percent of the total control costs.

[b] Cost effectiveness not calculated because net annual cost is a negative quantity (cost savings).

[c] The impacts presented were calculated using the emission point specific requirements of Alternative 1a.

[d] There are no incremental impacts since the requirements of the regulatory alternative for the emission source are identical to the requirements of the previous alternative.

[e] Incremental cost effectiveness not calculated because incremental annual cost is a negative quantity.

[f] There are no indirect emission reductions associated with regulatory alternative 2 for this emission source.

[g] Since regulatory alternative 2 prohibits the emission of HAP ABA, there are no storage/unloading or equipment leak requirements under this alternative for HAP ABA storage vessels or components in HAP ABA service. Therefore, the incremental cost effectiveness for these emissions is not appropriate.

9.2.3 Molded Foam Nationwide Cost Impacts

The distribution of technologies used to estimate the molded foam nationwide regulatory alternative costs by model plant is provided in Table 9-13.

9.2.3.1 Mixhead Flush

Regulatory Alternative 1 requires work practices to reduce mixhead flush emissions. As discussed earlier, the EPA developed model plant costs for four technologies: one for Regulatory Alternative 1 (solvent recovery) and three for Regulatory Alternative 2 (non-HAP flushes, HP mixheads, and self-cleaning mixheads). While the three technologies that totally eliminate mixhead flush emissions could also be used to comply with Regulatory Alternative 1, it was assumed that no facility would totally eliminate HAP mixhead flushes to comply with the work practice standard. Therefore, the cost for HAP mixhead flushes for Regulatory Alternative 1 are entirely based on the application of the solvent recovery model plant impacts to the 98 facilities represented by LP model plants 2 and 3.

Regulatory Alternative 2 prohibits the use of HAP mixhead flushes. As noted above, model plant costs were developed for three technologies that could be used to meet this requirement. To determine nationwide costs, self-cleaning mixheads were not considered an option, because they have significant limitations and are currently not in use in the industry. It was assumed that 90 percent of LP model plant 2 facilities (49 facilities) and 80 percent of LP model plant 3 facilities (35 facilities) would utilize non-HAP flushes, and the remainder would install HP mixheads.

9.2.3.2 Mold Release Agents

The emission limitation for mold release agents was the prohibition of HAP-based mold release agents for all three regulatory alternatives. As discussed earlier, model plant costs were developed for three technologies that meet this level: naphtha-based release agents, reduced-VOC release agents, and water-based release agents. It was assumed that the majority of facilities would choose either water-based or reduced-VOC release

TABLE 9-13. DISTRIBUTION OF TECHNOLOGIES USED TO ESTIMATE THE MOLDED FOAM NATIONWIDE REGULATORY ALTERNATIVE COSTS BY MODEL PLANT

	Number of Facilities Using the Technology	
Emission Source/Technology	**Low-Pressure Model Plant 2**	**Low-Pressure Model Plant 3**
Mixhead Flush		
Reg Alt I		
Solvent recovery	54	44
Reg Alt II		
Non-HAP flush	54	35
HP mixheads	0	9
Mold Release Agents		
MACT Floor		
Reduced VOC agents	18	15
Naphtha-based agents	18	14
Water-based agents	18	15
Repair Adhesives		
MACT Floor		
Hot-melt adhesives	N/A	22
Water-based adhesives	N/A	22

agents. For each model plant it was assumed that 1 percent would use naphtha-based agents, and the remainder would be split evenly between the other two options.

9.2.3.3 Repair Adhesives

The emission limitation for repair adhesives was the prohibition of the use of HAP-based adhesives for all three regulatory alternatives. There were three technologies for which model plant costs were developed that meet this level: hot-melt adhesives, water-based adhesives, and hydrofuse. Hydrofuse was not considered in the regulatory cost analysis, because there are no known facilities in this industry using this technology. Since no other information was available regarding industry preference, it was assumed that 50 percent of the facilities would use water-based adhesives, and 50 percent would use hot-melt adhesives.

9.2.4 Nationwide Cost Impact Summary for Molded Foam

The nationwide regulatory alternative impacts for molded foam production are provided in Table 9-14. The table includes the emission reductions that were discussed in Chapter 7, in order to show the overall cost effectiveness of the regulatory alternatives, as well as their incremental cost effectiveness.

TABLE 9-14. NATIONWIDE MOLDED FOAM REGULATORY ALTERNATIVE COSTS

Regulatory Alternative	Impacts by Emission Source			
	Mixhead Flush	Mold Release Agent	Repair Adhesive	Total
MACT Floor				
Capital Investment ($)	$0	$0	$149,688	$149,688
Annual Cost ($/yr)	$0	$153,965	$41,492	$195,907
Emission Reduction (tons/yr)	0	270	61	331
Cost Effectiveness ($/ton)	$0	$569	$693	$592
Regulatory Alternative 1				
Capital Investment ($)	$4,630,500	$0	$149,688	$4,780,188
Annual Cost ($/yr)	($123,767)	$153,965	$41,942	$72,140
Emission Reduction (tons/yr)	1,501	270	61	1,832
Cost Effectiveness ($/ton)				
Overall	-[b]	$569	$693	$39
Incremental	[c]	NA[d]	NA[d]	-[b]
Regulatory Alternative 2				
Capital Investment ($)	$5,923,125	$0	$149,688	$6,072,813
Annual Cost ($/yr)	$563,867	$153,965	$41,942	$759,775
Emission Reduction (tons/yr)	2,001	270	61	2,332
Cost Effectiveness ($/ton)				
Overall	$282	$569	$693	$326
Incremental	$1,375	NA[d]	NA[d]	$1,375

[a] Annual costs include monitoring, recordkeeping, and reporting costs, which were assumed to be 7.6 percent of the total control costs.

[b] Cost effectiveness not calculated because net annual cost is a negative quantity (cost savings).

[c] Incremental cost effectiveness not calculated because incremental annual cost is a negative quantity.

[d] There are no incremental impacts since the requirements of the regulatory alternative for the emission source are identical to the requirements of the previous alternative.

9.3 ECONOMIC IMPACTS

An economic impact analysis of the proposed regulatory options was prepared to evaluate primary and secondary impacts on (1) the slabstock and molded foam sectors of the flexible polyurethane foam industry, (2) consumers, and (3) society.

As shown in Table 9-15 for the slabstock foam sector of the industry, the total annualized social cost (in 1994 dollars) of the each of the regulatory alternatives is $11.9 million for the MACT floor, $7.18 million for Regulatory Alternative 1 (the proposed standard), and $10.9 million for Regulatory Alternative 2. Market price is estimated to increase by 2.28 percent, 2.20 percent, and 3.82 percent under each of the regulatory alternatives respectively. Corresponding decreases in market output are estimated to be 1.12 percent, 1.08 percent, and 1.86 percent respectively. Employment losses are estimated to be 1.12, 1.09, and 1.86 percent (i.e., 99, 96, and 164 jobs) respectively. These economic factors indicate that Regulatory Alternative 1 has the lowest cost estimate and lower economic impacts than the MACT floor.

As shown in Table 9-16 for the molded foam sector, impacts on price and output are estimated to be smaller than those predicted for the slabstock market. The total annualized social cost (in 1994 dollars) of the each of the molded foam regulatory alternatives is $0.19 million for the MACT floor, $0.06 million for Regulatory Alternative 1, and $0.71 million for Regulatory Alternative 2 (the proposed standard). Price is estimated to increase by 0.07 percent, 0.84 percent, and 1.14 percent under each of the regulatory alternatives. Corresponding decreases in market output are estimated as 0.04 percent, 0.42 percent, and 0.56 percent respectively. Employment losses in the molded sector are estimated to range from 0.04 to 0.67 percent (2 to 37 jobs).

Given the predicted changes in market price and output, the industry will experience *increases* in the value of shipments (i.e., industry profits) under all regulatory scenarios, because estimated price increases more than offset the lower production

TABLE 9-15. SUMMARY OF REGULATORY ALTERNATIVE ECONOMIC IMPACTS FOR SLABSTOCK FOAM

	MACT Floor	Regulatory Alternative 1	Regulatory Alternative 2
Price Increase (percent)	2.28	2.22	3.82
Production Loss (percent)	1.12	1.09	1.86
Employment Loss (jobs lost)	99	96	164
Emission Reduction (percent)[a]	57.6	70.4	100
Total Economic Costs (MM$, 1994)[b]	11.86	7.46	10.92
Economic Cost Effectiveness ($/ton)[c]	1213	624	644
Plant Closures	2	3	4

[a] Includes emission reductions achieved from control, plus reductions attributable to closures.

[b] Incorporates material cost savings, but does not include opportunity cost of lost foam quality from formulation changes.

[c] Differs from engineering cost effectiveness due to dynamics in the market (price and quantity produced changes) resulting from regulation implementation.

TABLE 9-16. SUMMARY OF REGULATORY ALTERNATIVE ECONOMIC IMPACTS FOR MOLDED FOAM

	MACT Floor	Regulatory Alternative 1	Regulatory Alternative 2
Price Increase (percent)	0.07	0.84	1.36
Production Loss (percent)	0.04	0.42	0.67
Employment Loss (jobs lost)	2	23	37
Emission Reduction (percent)[a]	11.2	62.3	78.6
Total Economic Costs (MM$, 1994)	0.19	0.06	0.71
Economic Cost Effectiveness ($/ton)[b]	568	30	305
Plant Closures	0	3	0

[a] Includes emission reductions achieved from control, plus reductions attributable to closures.

[b] Differs from engineering cost effectiveness due to dynamics in the market (price and quantity produced changes) resulting from regulation implementation.

volumes. Since no significant export or import markets exist for the industry (due to prohibitive transportation costs), no impacts on foreign trade are expected.

The analysis also predicts the number of plant closures that may result from the imposition of compliance costs on a facility. For the analysis, a worst-case assumption is adopted that the facilities with the highest emission control costs are the least efficient producers in the market. Actual plant closures will be less than that predicted if plants with the highest emission control costs are not the least efficient producers in the industry. In addition, the outcome of predicted closures is sensitive to the wide variety of emission control technologies assigned to the model plants. If the control technology assigned to the representative model plant is different than that which would be chosen by an actual facility, the analysis could overestimate the number of predicted plant closures. Therefore, a sensitivity analysis was performed to test the outcome of closures based on the assignment of control technology to model plants. Economic impacts of the sensitivity analysis are provided in Table 9-17. For the slabstock sector, plant closures are estimated to range from 1 to 2 facilities for the MACT floor, 1 to 3 facilities for Regulatory Alternative 1 and 1 to 4 facilities for Regulatory Alternative 2. For the molded foam sector, closures are estimated to be zero for the MACT floor, 3 for Regulatory Alternative 1, and zero for Regulatory Alternative 2 (a sensitivity analysis was not performed for the molded foam production subcategory). Given the significant amount of restructuring currently occurring in the industry (mergers, buy-outs, and shut-downs), the number of facility closures that will result from the proposed regulation is likely to be minimal.

TABLE 9-17. SUMMARY OF REGULATORY ALTERNATIVE ECONOMIC IMPACTS FOR SLABSTOCK FOAM - SENSITIVITY ANALYSIS

	MACT Floor	Regulatory Alternative 1	Regulatory Alternative 2
Price Increase (percent)	2.28	2.22	2.49
Production Loss (percent)	1.12	1.09	1.22
Employment Loss (jobs lost)	99	96	108
Emission Reduction (percent)[a]	57.6	70.4	100
Total Economic Costs (MM$, 1994)[b]	11.75	7.31	10.11
Economic Cost Effectiveness ($/ton)[c]	1202	612	596
Plant Closures	1	1	1

[a] Includes emission reductions achieved from control, plus reductions attributable to closures.

[b] Incorporates material cost savings, but does not include opportunity cost of lost foam quality from formulation changes.

[c] Differs from engineering cost effectiveness due to dynamics in the market (price and quantity produced changes) resulting from regulation implementation.

10.0 SELECTION OF THE STANDARDS

The purpose of this chapter is to provide the rationale for the selection of the standards for the flexible polyurethane foam production source category. In order to provide background for the subsequent discussions, the first section of this chapter is a summary of the proposed rule. This is followed by a discussion of the rationale for the selection of various aspects of the standards, including the source category and pollutants to be regulated, the level and format of the standards, and the compliance, reporting, and recordkeeping provisions.

10.1 SUMMARY OF THE PROPOSED STANDARDS

This section provides a summary of the proposed regulation. The full regulatory text is available in Docket No. A-95-48, directly from the EPA, or from the Technology Transfer Network (TTN) on the EPA's electronic bulletin boards. More information on how to obtain a copy of the proposed regulation is provided in the preamble for the proposed standards.

10.1.1 Applicability and Compliance Schedule

The proposed standards would regulate HAP emissions from facilities that produce slabstock, molded, or rebond flexible polyurethane foam, provided that a facility is a major source or is located at a plant site that is a major source. Flexible polyurethane foam processes meeting one of three criteria are exempted from the regulation: (1) a process located at a plant site where the plant site is limited by a federally enforceable limit to emissions less than 10 tons per year of any single HAP and less than 25 tons per year of all HAP; (2) a process exclusively dedicated to the fabrication of flexible polyurethane foam; and (3) a research and development process.

Processes subject to the proposed regulation would be required to comply within three years of the effective date of the regulation.

10.1.2 Standards for Molded Flexible Polyurethane Foam Production

At molded foam facilities subject to the proposed rule, emissions from three emission sources are covered by the proposed rule: mixhead flushing, mold release agent usage, and the use of adhesives to repair molded foam. For each of these emission sources, the proposed rule prohibits the use of HAP or HAP-based products at the new and existing sources. Other than the initial notification and notification of compliance, there are no associated monitoring, reporting, or recordkeeping requirements for molded foam producers.

10.1.3 Standards for Rebond Foam Production

The proposed regulation prohibits the use of HAP-based cleaners or mold release agents in the production of rebond foam at new and existing sources. Other than the initial notification and notification of compliance, there are no associated monitoring, reporting, or recordkeeping requirements for rebond foam producers.

10.1.4 Standards for Slabstock Flexible Polyurethane Foam Production

At slabstock foam facilities subject to the proposed rule, emissions from four emission sources are covered by the proposed rule: storage vessels, equipment leaks, HAP ABA use, and equipment cleaning. The requirements are separated into two basic categories corresponding to the two major uses of HAP in the slabstock process: (1) diisocyanate used as a reactant in the foam process, and (2) HAP ABA. The diisocyanate used in the production of slabstock foam is almost always TDI, and the HAP ABA used is almost always $MeCl_2$.

10.1.4.1 Diisocyanate emissions

Emissions of diisocyanate from storage vessels and equipment leaks are covered by the proposed standards. For new and existing sources, there are two compliance options for storage vessels. The vessel can be equipped with a vapor return line that returns vapors displaced during storage vessel filling to the tank truck or railcar. The second option is to equip the storage vessel with a system in which displaced vapors are routed through a carbon adsorption system prior to being discharged to the atmosphere. Storage vessels equipped with carbon adsorption systems must monitor the outlet of the carbon system to detect breakthrough.

Transfer pumps in diisocyanate service must be either sealless pumps, or submerged pump systems that are visually monitored weekly to detect leaks. Any transfer pump leaks detected must be repaired within 15 calendar days. Diisocyanate leaks for other components in diisocyanate service (valves, connectors, and pressure-relief valves) detected by visual, audible, olfactory, or any other detection method must be repaired within 15 calendar days, as well.

10.1.4.2 HAP ABA storage and equipment leak emissions, HAP ABA emissions from the production line, and equipment cleaning HAP emissions

HAP ABA emissions from three emission sources - storage vessels, equipment leaks, and the production line - are covered by the proposed regulation. In addition, HAP emissions from equipment cleaning are covered.

The proposed regulation requires that owners or operators comply with requirements for each of the four types of emission points (HAP ABA emissions from storage vessels, equipment leaks, and the production line, and HAP emissions from equipment cleaning).

However, since methylene chloride is the primary HAP used as an ABA and as an equipment cleaner, the proposed rule allows flexibility in compliance with the HAP ABA and equipment cleaning provisions. As an alternative to the emission point specific limitations, the owner or operator can elect to comply with a source-wide emission limitation. Owners or operators selecting the source-wide emission limitation must maintain the combined emissions from all of these sources below the required level.

While this option is slightly more stringent than the emission point specific limitations, the EPA believes the flexibility it provides will prove to be beneficial for sources selecting this alternative. The emission point specific limitations are described below in sections 10.1.4.2.1 through 10.1.4.2.4. Owners or operators selecting the source-wide emission limitation must maintain the combined emissions from all of these sources below the required level. This option is described below in section 10.1.4.2.5.

10.1.4.2.1 HAP ABA storage vessel requirements. The requirements for HAP ABA storage vessels are identical to the diisocyanate storage vessel requirements discussed above in section 10.1.4.1. Storage vessels can be equipped with either a vapor return line to the tank truck or railcar, or a carbon adsorption system. The requirements for new and existing sources are identical.

10.1.4.2.2 HAP ABA equipment leaks. The proposed standards contain requirements for pumps, valves, connectors, pressure-relief devices, and open-ended valves or lines in HAP ABA service.

Pumps and valves must be monitored quarterly for leaks using EPA Method 21, where a leak is defined as an instrument reading of 10,000 parts per million (ppm) or greater. Leaks must be repaired within 15 calendar days after their detection. Alternatively, leakless pumps can be used. Valves that are designated as unsafe-to-monitor must be monitored as frequently as possible, and difficult-to-monitor valves must be monitored once per year.

Connectors must be monitored annually, unless the connector has been opened or the seal broken. In these cases, the connector must be monitored within 3 months after being returned to HAP ABA service. As with the other components, a leak is defined as an instrument reading of 10,000 ppm or greater, and a leak must be repaired within 15 calendar days. Connectors can also be designated as unsafe-to-monitor, in which case they must be monitored as frequently as possible.

Pressure-relief devices must be monitored using Method 21 if evidence of a potential leak is found by visual, audible, olfactory, or any other detection method. If a leak is found (10,000 ppm), it must be repaired within 15 calendar days.

Each open-ended valve or line in HAP ABA service must be equipped with a cap, blind flange, plug, or a second valve.

10.1.4.2.3 HAP ABA Emissions from the production line. Compliance with the proposed provisions for HAP ABA emissions from the production line is determined by comparing actual HAP ABA emissions to an allowable emission level for a 12-month period. Compliance would be determined each month for the previous consecutive 12-month period.

The proposed regulation recognizes the variability in HAP ABA emissions for different grades of foam, where a grade of foam is determined by its density and IFD. Therefore, the allowable emission level is dependent on the mix of foam grades produced during the 12-month compliance period. The nucleus of the HAP ABA emission limitation provisions is the HAP ABA formulation limitation equation, which determines an allowable amount of HAP ABA for each grade of foam. This equation is:

$$ABA_{limit} = -0.25(IFD) - 19.1\left(\frac{1}{IFD}\right) - 16.2(DEN) - 7.56\left(\frac{1}{DEN}\right) + 36.5$$

where:

ABA_{limit} = HAP ABA formulation limitation, parts HAP ABA allowed per hundred parts polyol (pph).

IFD = Internal force deflection, pounds.

DEN = Density, pounds per cubic foot.

Therefore, for each foam grade produced during the 12-month period, the owner or operator must determine the HAP ABA formulation limitation.

For new sources, the equation is used to determine the HAP ABA formulation limitation for a limited number of grades. However, for foam grades with a density greater than 0.95 pounds per cubic foot and an IFD greater than 15 pounds, and foam grades with a density greater than 1.40 pounds per cubic foot, the formulation limitation is automatically set to zero.

The allowable HAP ABA emissions for a consecutive 12-month period are calculated as the sum of allowable monthly HAP ABA emissions for each of the individual 12 months in the period. Allowable HAP ABA emissions for each individual month are calculated using the following equation.

$$emiss_{allow,month} = \sum_{j=1}^{m}\left(\sum_{i=1}^{n}\frac{(limit_i)(polyol_i)}{100}\right)_j$$

where:

$emiss_{allow,month}$ = Allowable HAP ABA emissions from the slabstock foam production process for the month, pounds.

m = Number of slabstock foam production lines.

n = Number of foam grades produced in the month on foam production line j.

$limit_i$ = HAP ABA formulation limit for foam grade i, parts HAP ABA per 100 parts polyol.

$polyol_i$ = Amount of polyol used in the month in the production of foam grade i on foam production line j, pounds.

The amount of polyol used is a key component of this determination, and it must be determined by continuously monitoring the amount of polyol added to the slabstock foam production line at the mixhead. The monitoring requirements are discussed in section 10.1.5.2.

Actual HAP ABA emissions are determined by continuously monitoring the HAP ABA added to the slabstock foam production line at the mixhead. The allowable monitoring methods for HAP ABA are exactly the same as for polyol.

The proposed regulation also contains provisions to allow for the use of HAP ABA recovery devices. If a recovery device is used, the actual HAP emissions are the difference between the uncontrolled HAP ABA emissions and the HAP ABA recovered. The uncontrolled HAP ABA emissions are determined by monitoring the HAP ABA added to the slabstock foam production line at the mixhead, as discussed above. The amount of HAP ABA recovered is required to be monitored, as discussed in section 10.1.5.3.

As an alternative to the rolling annual compliance approach, owners or operators can elect to take a monthly compliance approach. If this approach is selected, actual and allowable emissions are determined as discussed above. However, compliance is determined by comparing allowable and actual emissions for each month, rather than for the 12 previous months. This alternative is allowed because it is more stringent than the rolling annual average approach.

10.1.4.2.4 <u>Equipment cleaning HAP emissions</u>. Affected sources complying with the emission point specific limitations are prohibited from using a HAP, or a HAP-based product, as an equipment cleaner. There are no associated monitoring, reporting, or recordkeeping requirements.

10.1.4.3 <u>Source-wide emission limitation</u>

This alternative allows the owner or operator to choose which of the HAP ABA emission sources to control. In other words, an owner or operator could choose not to control HAP ABA storage vessels and equipment leaks, and achieve a slightly higher HAP ABA emission reduction from the production line. Alternatively, an owner or operator could choose to control emissions from equipment leaks and storage to "save" as much HAP ABA as possible for use in the production line. In addition, under the source-wide alternative, a facility could utilize a HAP equipment cleaner, as long as the HAP used as the equipment cleaner is the same chemical as the HAP ABA. However, the equipment cleaning HAP emissions must be offset by emission reductions from one of the HAP ABA emission sources.

An owner or operator electing to comply with the source-wide emission limitation for HAP ABA and equipment cleaning determines compliance by comparing actual emissions from the three HAP ABA emission sources and from equipment cleaning with an allowable emissions level. Compliance is determined each month for the previous 12-month period.

The allowable emissions level is determined using the same procedures discussed above in section 10.1.4.2.3. Therefore, the total HAP ABA and equipment cleaning HAP emissions allowed under this alternative are equivalent to the allowed HAP ABA emissions from the production line if the emission point specific alternatives were selected.

The actual HAP ABA and equipment cleaning emissions are determined by performing a material balance at the HAP ABA storage vessel, using the following equation:

$$PWE_{actual} = \sum_{i}^{n} (ST_{i,begin} - ST_{i,end} + ADD_i)$$

where:

PWE_{actual} = Actual source-wide HAP ABA and equipment cleaning HAP emissions for a month, pounds/month.

$ST_{i,begin}$ = Amount of HAP ABA in storage tank i at the beginning of the month, pounds.

$ST_{i,end}$ = Amount of HAP ABA in storage tank i at the end of the month, pounds.

ADD_i = Amount of HAP ABA added to storage tank i during the month, pounds.

n = Number of HAP ABA storage vessels.

Weekly monitoring of the level of HAP ABA in the storage vessels is required, thus providing the beginning and end of month amounts to be used in the above equation. In addition, the amount of each HAP ABA delivery must be determined. The requirements for the monitoring of HAP ABA storage vessel levels and the amount of HAP ABA added during each delivery is discussed later in this section. Emission reductions achieved by recovery devices can be accounted for by monitoring the amount of HAP ABA recovered, as described above in section 10.1.3.2.3.

As with the emission point specific limitation for HAP ABA from the production line, the source-wide emission limitation includes a monthly compliance alternative.

10.1.5 Monitoring Requirements

The proposed regulation contains monitoring requirements for five situations: (1) storage vessels complying using carbon adsorption systems, (2) polyol and HAP ABA added to the production line at the mixhead, (3) recovered HAP ABA when a recovery device is used, (4) the amount of HAP ABA in a storage vessel, and (5) the amount of HAP ABA added to a storage vessel..

10.1.5.1 Storage vessel monitoring

Storage vessels equipped with carbon adsorption systems must monitor either the concentration of HAP or the concentration of total organic compounds (TOC) at the exit of the adsorption system. Measurements of HAP or TOC concentration must be made using Method 18 or 25A of Appendix A of 40 CFR 60. Outlet concentration measurements must be made monthly (or each time the vessel is filled, if filling occurs less frequently than monthly), or the owner or operator can install a monitoring system that continuously monitors HAP or TOC concentrations during vessel filling.

10.1.5.2 Polyol and HAP ABA monitoring at the mixhead

All slabstock facilities must monitor the amount of polyol added to the slabstock foam production line at the mixhead to allow the calculation of allowable emissions. The regulation contains two options for continuously monitoring the polyol added: (1) a device installed and operated to continuously monitor and record pump revolutions per minute, or (2) a flow rate monitoring device installed and operated to measure the amount of polyol added at the mixhead. Either of these devices must be calibrated weekly, and must have an accuracy to within +/- 2 percent. The owner or operator can develop an alternative monitoring program to monitor the amount of polyol added at the mixhead. In addition, if an owner or operator elects to comply with the emission point specific limitations, the amount of HAP ABA added to the slabstock foam production line at the mixhead must be monitored. The requirements for monitoring the amount of HAP ABA added are exactly the same as discussed above for polyol.

10.1.5.3 <u>Recovered HAP ABA monitoring</u>

The final monitoring requirement is for slabstock facilities using a recovery device to reduce HAP ABA emissions. The amount of HAP ABA recovered is determined by using a device that continuously monitors the cumulative amount of HAP ABA recovered by the recovery device. This device must be installed, calibrated, maintained, and operated according to the manufacturer's specifications, and must be certified by the manufacturer to be accurate to within +/- 2.0 percent.

10.1.5.4 <u>Monitoring to determine the amount of HAP ABA in a storage vessel</u> The amount of HAP ABA in a storage vessel must be determined by monitoring the HAP ABA level in the storage vessel using a device that has been certified by its manufacturer to be at least 99 percent accurate, that has either a digital or printed output, and that is calibrated at least once a year. The level of HAP ABA in each storage vessel must be measured and recorded at least once per week.

10.1.5.5 <u>Monitoring to determine the amount of HAP ABA added to a storage vessel</u> The amount of HAP ABA added to a storage vessel during a delivery must be determined using any one of three options. The first option requires that the volume of HAP ABA added to the storage vessel be determined by monitoring the flow rate using a device with an accuracy of 98 percent or greater, and which is calibrated at least once every six months. The second option allows the owner or operator to calculate the weight of HAP ABA added by determining the difference between the full weight of the transfer vehicle prior to unloading into the storage vessel and the empty weight of the transfer vehicle after unloading has been completed. The third option of determining the amount of HAP ABA added to a storage vessel allows the owner or operator to develop an alternative monitoring program. The alternative monitoring program must include, at a minimum, a description of the parameter to be monitored to determine the amount of the addition, a description of how the results of the monitoring will be recorded and converted into the amount of HAP ABA added, data demonstrating the accuracy of the monitoring measurements, and procedures for ensuring that the accuracy of the monitoring measurements is maintained.

10.1.6 Testing Requirements

There are two instances where the use of test methods is required. First, for slabstock owners or operators complying with the source specific HAP ABA equipment leak requirements, testing must be conducted using Method 21 of 40 CFR part 60, subpart A.

Second, all slabstock processes must test each grade of foam to verify the IFD and density, as these are integral inputs into the equation to determine the HAP ABA formulation limitation. The proposed rule requires these parameters to be determined using ASTM D3574, using a sample of foam cut from the center of the foam bun. The maximum sample size for which the IFD and density is determined shall not be larger than 24 inches by 24 inches by 4 inches.

10.1.7 Alternative Means of Emission Limitation

The proposed regulation also contains provisions to allow an owner or operator to request approval to use an alternative means of emission limitation. The request, which may be submitted in the precompliance report for existing sources, the application for construction or reconstruction for new sources, or at any other time after the initial compliance, must include a complete description of the alternative means of emission limitation and documentation demonstrating equivalency with the requirements in the regulation. The owner or operator can begin using the alternative means of emission limitation upon approval of the request by the Administrator.

10.1.8 Applicability of General Provisions

The General Provisions for Part 63; 40 CFR 63, Subpart A; create the technical and administrative framework for implementing national emission standards established under section 112 of the Clean Air Act. The General Provisions establish baseline applicable requirements for activities such as performance testing, monitoring, notifications, and recordkeeping and reporting, and they also implement statutory provisions such as compliance dates for new and existing sources and preconstruction review requirements. The General Provisions apply to all sources that are affected by Part 63 standards, including the proposed standard for flexible polyurethane foam production. However, certain requirements in the General Provisions may be overridden in individual standards. The proposed regulation contains a table outlining the sections of the General Provisions that are applicable to subpart III, and outlining the General Provisions' sections that are being overridden or not incorporated.

10.1.9 Reporting Requirements

The proposed regulation requires the submittal of six types of reports: (1) initial notification, (2) application for approval of construction or reconstruction, (3) precompliance report, (4) notification of compliance status, (5) semi-annual compliance reports, and (6) other reports. These reports are briefly described below in sections 10.1.9.1 through 10.1.9.6.

10.1.9.1 Initial notification

Each owner or operator of a flexible polyurethane foam production process must submit an initial notification to the Administrator within 120 days after promulgation of the rule. This initial notification must contain an identification of the facility that is subject to the regulation, the name and address of the owner or operator of the subject facility, and a brief description of the process.

10.1.9.2 Application for approval of construction or reconstruction

Owners or operators constructing a new flexible polyurethane foam production process, or reconstructing an existing process, must submit an application for approval of construction or reconstruction. This application must contain identification information such as location, owner/operator, and the anticipated completion and start-up dates. The application must also contain a description of the planned process and how compliance will be achieved. The application must be submitted as soon as practicable before the construction or reconstruction is planned to commence. A permit application can take the place of this report.

10.1.9.3 Precompliance report

One year before the compliance date, each slabstock owner or operator must submit a precompliance report. This report must contain notification of whether compliance will be achieved using the emission point specific HAP ABA and equipment cleaning emission limitation or the source-wide emission limitation. The report must also indicate if either of the following compliance options are going to be utilized:

- If compliance will be achieved on a monthly basis for either the emission point specific limitation for HAP ABA emissions from the production line or the source-wide emission limitation.
- If a recovery device will be used to reduce HAP ABA emissions.

This report must also contain a description of how the amount of polyol and HAP ABA (if required) added at the mixhead will be monitored. If the owner or operator is developing an alternative monitoring plan, the plan must be submitted with the precompliance report. In addition, slabstock flexible polyurethane processes using a recovery device to reduce HAP ABA emissions must include a description of the HAP ABA monitoring and recordkeeping program to determine the amount of HAP ABA recovered in the precompliance report.

10.1.9.4 Notification of compliance status

Each slabstock owner or operator must submit a notification of compliance status report 180 days after the compliance date. This report must contain notification of the compliance status of diisocyanate storage vessels and diisocyanate transfer pumps. In addition, for processes complying with the emission point specific limitations for HAP ABA, this report must contain compliance information for HAP ABA storage vessels and equipment in HAP ABA service. Molded and rebond affected sources must submit a statement that compliance is being achieved with the standards.

A flexible polyurethane foam or rebond foam process that is committing to an enforceable limit to maintain emissions below major source levels must submit an affidavit stating that annual HAP emissions will not exceed the major source levels in the notification of compliance status. This affidavit must be signed by the owner, operator, or other responsible individual.

10.1.9.5 Semi-annual compliance reports

Each slabstock owner or operator must submit semi-annual compliance reports. For processes complying with the rolling annual compliance provisions (for either the emission point specific HAP ABA limitations or the source-wide emission limitation), the report must contain the allowable and actual HAP ABA emissions (or allowable and actual HAP ABA and equipment cleaning HAP emissions) for each of the 12-month periods ending on each of the six months in the reporting period. For processes complying with the monthly compliance alternative, the report must contain the allowable and actual HAP ABA emissions (or allowable and actual HAP ABA and equipment cleaning HAP emissions) for each of the six months in the reporting period.

10.1.9.6 Other reports

A slabstock owner or operator must provide a report to the Administrator indicating the intent to change the selected compliance alternative (emission point specific limitations or source-wide emission limitation). This report must be submitted at least 180 days prior to the change.

Similarly, the intent to switch the compliance method (rolling annual or monthly) must be reported. This report must be submitted at least 12 months prior to the change.

10.1.10 Recordkeeping Requirements

Records must be recorded in a form suitable and readily available for expeditious inspection and review, and must be kept for a period of 5 years. At a minimum, the most recent 2 years of data must be retained on-site.

Records are required for storage vessels, equipment leaks, and HAP ABA. If the owner or operator complies with the source-wide emission limitation, no records are required for HAP ABA storage vessels or equipment in HAP ABA service.

10.1.10.1 Storage vessel records

All slabstock processes must maintain records listing all diisocyanate storage vessels and the type of control utilized to comply with the regulation. For the storage vessels complying through the use of a carbon adsorption system, the records must include the design parameters of the system and the monitoring records.

10.1.10.2 Equipment leak records

All slabstock processes must maintain a list of components in diisocyanate service, and a description of the control utilized for each transfer pump. If the process is complying with the emission point specific limitations, then records listing each component in HAP ABA service must also be maintained.

When a leak, as defined in the proposed rule, is detected for any component, the component must be marked with a readily visible identification until the leak is repaired. For valves, the identification must remain until 2 successive months have passed where no leak is detected. Records must be kept specifying when the leak was detected and when it was repaired.

10.1.10.3 HAP ABA records

All slabstock processes must keep records integral to the calculation of allowable emissions. These include a daily log of foam runs, and daily records of the amount of polyol added at the mixhead for each grade of foam, and the results of the density and IFD testing for each grade. Monthly, a cumulative record must be maintained listing the foam grades produced during the month, along with the total amount of polyol used for each foam grade, and the corresponding allowable HAP ABA (or HAP ABA and equipment cleaning) emissions level. If complying on an annual rolling basis, the allowable HAP ABA (or HAP ABA and equipment cleaning) emissions level for the previous 12 consecutive months must also be recorded each month.

For processes complying with the emission point specific HAP ABA emission limitation, records must be kept regarding the amount of HAP ABA added at the mixhead each day. In addition, there must also be a cumulative HAP ABA usage record for each month, and a cumulative record for the previous 12 consecutive months (if complying on an annual rolling basis).

For processes complying with the source-wide emission limitation, monthly records must be kept regarding the actual HAP ABA and equipment cleaning emissions, as measured at the storage vessel. If complying on an annual rolling basis, monthly records must be kept of the actual cumulative HAP ABA and equipment cleaning emissions for the previous 12 months.

If a process uses a recovery device to reduce HAP ABA emissions, records must be kept regarding the amount of HAP ABA recovered. In addition, records of all required calibrations must be maintained.

10.1.10.3 <u>Records for area sources</u>

A flexible polyurethane foam or rebond foam process that is committing to an enforceable limit to maintain emissions below major source levels must keep records documenting HAP emissions. These records can consist of basic inventory records and engineering calculations.

10.2 RATIONALE FOR THE SELECTION OF THE SOURCE CATEGORY

The source category selected for the development of this proposed rule was listed in the source category list published on July 16, 1992 (57 FR 31576). The way in which source categories or subcategories are defined is important, because it dictates the basis upon which the MACT floor is to be determined. The definition of the source category or subcategory describes the "pool" of facilities that can be used to define the MACT floor. This means that the MACT floor must be determined on the same basis upon which the source category is defined. The definition of the source category or subcategory is also important in that it limits the scope of emissions averaging: collocated emission points cannot be averaged unless they belong to the same affected source.

As discussed in Chapter 4, the flexible polyurethane foam production source category was separated into three subcategories due to differences in the processes, the manner in which HAP emissions occur, characteristics of the emission points, and the applicability of various control technologies. These subcategories are slabstock and molded flexible polyurethane foam production, and rebond foam production. Information gathered during the development of this proposed rule indicated that facilities in these subcategories are major sources, or are located at major source plant sites. Therefore, the EPA selected the slabstock, molded, and rebond subcategories to be covered by the proposed regulation.

In defining the affected source for the regulation, the EPA had two options. One option was to define an affected source on a subcategory basis. The second option was to define the affected source to include both molded and slabstock foam processes located at the same plant site. Due to the technical differences between molded and slabstock foam noted above and in Chapter 4, and due to the fact that few slabstock and molded foam processes are located at the same plant site, the EPA defined the affected source on a subcategory basis. This definition is consistent with the MACT floor analyses.

10.3 RATIONALE FOR THE SELECTION OF POLLUTANTS AND EMISSION POINTS TO BE COVERED BY THE PROPOSED STANDARDS

At slabstock foam production processes, significant emissions of four HAP were reported: methylene chloride, methyl chloroform, TDI, and propylene oxide. There were also emissions of other HAP reported in small quantities (less than one-tenth of one percent of the total HAP emissions). The four primary HAP were reported to be emitted from four sources: chemical unloading/storage, equipment leaks, the foam production tunnel and curing area, and from equipment cleaning. The proposed regulation covers HAP emissions from all of these emission points, with one exception. There are no proposed requirements for emissions of TDI from the foam production line. While TDI emissions were reported from this source, the MACT floor was defined as no control. Further, since there were no emission controls identified for TDI emissions from the foam production line, the Agency could not evaluate control levels more stringent than the floor.

At molded foam facilities, emissions of over 10 HAP were reported from 13 emission sources. However, around 90 percent of the total emissions were from three sources: mixhead flushing, mold release agent usage, and the use of adhesives to repair foam. The proposed regulation prohibits HAP emissions from each of these three sources. For each of the remaining 10 emission sources, the MACT floor was defined as no control, and no additional control techniques were identified. Therefore, the EPA concluded that no control would be required for the emissions from these 10 sources in the proposed rule. It was further noted that these emission sources were sporadically reported, suggesting that the reporting of HAP emissions from these sources was often due to unique facility considerations.

Three emission sources were identified at rebond foam production facilities: (1) TDI emissions from the rebond foam production, (2) the application of HAP-based mold release agents, and (3) the use of a HAP as an equipment cleaner. No control options were identified for TDI emissions. The proposed regulation covers the remaining two emission sources.

10.4 RATIONALE FOR THE SELECTION OF THE LEVELS OF THE PROPOSED STANDARDS

The approach for determining the MACT floors and creating regulatory alternatives is discussed in Chapter 6. This section presents the rationale for the selection of the level of the proposed standards for new and existing sources.

10.4.1 Selection of the Levels of the Proposed Standards for Existing Sources

The discussion of the rationale for the selection of the levels of the proposed standards for existing sources in this section is separated by the three subcategories.

10.4.1.1 Slabstock foam production

As discussed in Chapter 6, there were three regulatory alternatives considered for slabstock foam production. The level of control for equipment leaks and HAP ABA from the production line increases with each alternative. The cost effectiveness values of the three alternatives shown in Table 9-12 [$1,262/ton ($1,150/Mg) for the MACT floor, $640/ton ($580/Mg) for Regulatory Alternative 1, and $696/ton ($630/Mg) for Regulatory Alternative 2] are all within the range considered to be reasonable by the EPA. The incremental cost effectiveness in going from the MACT floor to Regulatory Alternative 1 is negative, making the MACT floor alternative an inferior alternative. The incremental cost effectiveness in going from Regulatory Alternative 1 to 2 is $800/ton ($725/Mg). This incremental cost effectiveness, in conjunction with the minimal non-air environmental and energy impacts discussed in Chapter 7, could lead to the selection of Regulatory Alternative 2. However, there were several non-quantifiable issues associated with the total elimination of the use HAP ABA at slabstock foam facilities that were considered by the Agency in the selection of the regulatory alternative to be proposed.

First, there is substantial concern within the industry that a complete range of foams of acceptable market quality can be produced without any HAP ABA. The manufacturers of the HAP ABA reduction technologies maintain that the foam quality does not suffer with the use of these technologies. However, the use of these technologies in the total absence of the use of HAP ABA, while still producing a complete product line, is very limited.

A second consideration is the issue of plant safety. Use of a flammable solvent (acetone) as an ABA, and dangers associated with the extremely exothermic nature of the foam polymerization reaction, create potential fire hazards. While the designs of these systems include safeguards against potential hazards, industry representatives have consistently expressed reservations about their use, due to these potential hazards.

Therefore, the EPA selected Regulatory Alternative 1 as the basis for the proposed regulation for slabstock flexible polyurethane foam.

10.4.1.2 Molded foam production

As was shown in Chapter 6, three regulatory alternatives were developed and considered for the molded foam subcategory, with the stringency of the mixhead flush control level being the only difference between the alternatives. As was shown in Table 9-14, the highest overall cost effectiveness for any alternative was the MACT floor alternative at $590 per ton of HAP emission reduction ($536/Mg). Therefore, the cost effectiveness values of all three alternatives per ton were in the range considered to be reasonable by the Agency. The incremental cost effectiveness from Regulatory Alternative 1 to 2 ($1,375/ton or $1,250/Mg) was also in the reasonable range. Considering these cost impacts, as well as the non-air environmental and energy impacts discussed in Chapter 7, the EPA judged that the Regulatory Alternative 2 level of control was reasonable. Therefore, the EPA selected this regulatory alternative as the level of the proposed standards for molded foam production.

10.4.1.3 Rebond foam production

Since the MACT floor alternative for rebond includes the complete elimination of HAP emissions from the use of mold release agents and equipment cleaners, and no control options for TDI were identified, only one regulatory alternative was developed for rebond foam production. As discussed in Chapters 8 and 9, it is anticipated that there will be no impact on the rebond industry from this regulatory alternative, which was selected for proposal by the EPA.

10.4.2 Selection of the Levels of the Proposed Standards for New Sources

The 1990 Amendments require that standards be set for new sources that are no less stringent than the level represented by the best controlled similar source, which is referred to as the new source MACT floor. The EPA constructed the new source regulatory alternatives for both subcategories by including in them the best level of control identified for each emission source type within the subcategory.

10.4.2.1 Slabstock foam production

There were two new source regulatory alternatives for the slabstock foam production subcategory. The first was equivalent to the new source MACT floor, and the second includes the complete elimination of HAP ABA emissions. Since it was estimated that there will be no new sources in this subcategory, an impacts analysis was not conducted. However, due to the obstacles discussed above, the EPA selected the new source MACT floor alterative and not the complete elimination of HAP ABA alternative (Regulatory Alternative 1).

10.4.2.2 Molded foam production

Since the new source MACT floor is the complete elimination of HAP emissions from the three covered emission sources, the possibility for more stringent regulatory alternatives does not exist. Therefore, the EPA selected the new source MACT floor alternative for molded foam production.

10.4.2.3 Rebond foam production

Since the new source MACT floor for rebond includes the complete elimination of HAP emissions from the use of mold release agents and equipment cleaners, and no control options for TDI were identified, this was the new source regulatory alternative selected for rebond foam production.

10.5 RATIONALE FOR THE SELECTION OF THE FORMATS OF THE PROPOSED STANDARDS

In general, the formats selected for the proposed regulation are unique to this rulemaking. The EPA did not identify State or local regulations for this industry from which an established format could be emulated. The format of the MACT floor determinations, presented in Chapter 6, determined the format of the proposed regulation for most emission sources.

10.5.1 Molded Foam Production

The proposed requirements for molded foam production require the complete elimination of the use (and emission) of HAP mixhead flushing agents, HAP-based mold release agents, and HAP-based adhesives to repair foam. Given these requirements, the only format considered was a prohibition of the use of these HAP-based products.

10.5.2 Slabstock Foam Production

The format of the proposed requirements for slabstock foam production varies, depending on compliance alternatives selected by the owner or operator. The initial choice is whether to comply with emission point specific limitations and a source-wide emission limitation. Sections 10.5.2.1 through 10.5.2.3 describe the proposed requirements.

10.5.2.1 Storage vessels

The format for the proposed slabstock storage vessel requirements is an equipment standard. Owners or operators can either utilize a vapor return line that returns displaced vapors back to the railcar or tank truck, or can install a carbon canister system through which the displaced vapor is vented. The primary reason for the selection of this format was that it was consistent with the data used to determine the MACT floor. Typically, the level of detail reported was a brief description of the storage vessel control technique utilized. No facility reported emission tests or other data to allow the quantification of the control effectiveness. Therefore, the EPA selected the equipment standard format.

10.5.2.2 Equipment leaks

The format for the proposed requirements for diisocyanate transfer pumps is an equipment standard, which is based on the format of the data provided by the industry. The format for the proposed requirements for other components in diisocyanate and HAP ABA service is based on existing federal regulations,. specifically 40 CFR 63, subpart H (National Emission Standards for Organic Hazardous Air Pollutants for Equipment Leaks) and 40 CFR 60, Subpart VVV (Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry). However, since slabstock flexible polyurethane production facilities have significantly fewer components than the industries covered by these subparts, the proposed standards for equipment leaks are much simpler.

10.5.2.3 Equipment cleaning

The proposed emission point specific requirements for equipment cleaning prohibit the use of HAP-based products to clean slabstock foam equipment. Therefore, the only format considered was a prohibition of the use of HAP-based cleaners.

10.5.2.4 HAP ABA emissions from the production line

10.5.2.4.1 Emission limitation format. The EPA considered several formats for limiting HAP ABA emissions from the production line. The key considerations in the selection of the format for HAP ABA emissions were: (1) the format needed to recognize the varying emission potential for different grades of slabstock foam, (2) the format needed to incorporate current industry practices to the extent possible, and (3) the format needed to allow flexibility to allow for the use of varying types of control or pollution prevention methods. The format for HAP ABA can be somewhat simplified by the fact that 100 percent of the HAP ABA used is emitted, unless an add-on control device is used (the Agency is aware of only one facility in the United States using add-on control to reduce HAP ABA emissions).

The first format considered was an emission factor, where the allowable HAP ABA emissions level was based on the total amount of foam produced. However, this format failed two of the three key considerations listed above. First, basing the allowable emissions on the total foam produced does not recognize varying product mixes, and the resulting varying need to use HAP ABA in the formulations. Second, there is not a common unit of measure used in the foam industry for the amount of foam produced. Some facilities measure production by board-feet, while others measure production by foam weight, both of which would be difficult to monitor. A more logical method would be to base HAP ABA usage/emissions on the amount of polyol used, since foamers almost always establish formulations on this basis. This type of approach would not present a bias toward any specific technology, thus satisfying consideration criteria number 3.

The second format considered was a HAP ABA usage/emission limitation based on the amount of raw materials used (i.e., polyol) for each foam grade. This satisfies consideration criteria number 2 by corresponding with existing practices in the industry. By considering the different grades in the calculation of the allowable emissions, it would also account for the varying HAP ABA potential for different grades. Finally, it would allow the use of a variety of pollution prevention techniques. A slight modification would be necessary to account for the emission reduction achieved by add-on control.

The final format considered was a percent reduction requirement, where compliance was based on the reduction from an uncontrolled level. This format could also satisfy all three considerations. However, this format would necessitate the creation of a standard uncontrolled emissions/formulation level for every foam grade produced in the United States, from which the uncontrolled HAP ABA emissions could be calculated. The regulation would potentially need to contain uncontrolled emission/formulation limitations for hundreds of grades of foam. This format would need the same information as the second format, but would require an extra calculation step. Therefore, while it satisfies all three considerations, the EPA concluded that this format would result in more cumbersome requirements. In conclusion, the EPA selected the second format discussed above for the HAP ABA emissions from the production line.

10.5.2.4.2 Averaging time format. Another consideration for the HAP ABA emission limitation was the averaging time for compliance. The Agency believes that the determination of compliance must occur no less frequently than monthly. The EPA considered two averaging time formats: (1) compliance determined monthly for the previous 12 months (i.e., a rolling annual compliance determination), and (2) compliance determined for each individual month.

Seasonal variations in production are common for the slabstock industry. The rolling annual compliance format would allow for these seasonal variations. The Agency determined that the rolling annual compliance format was most appropriate for this industry.

However, while the slabstock industry was interested in the flexibility of the rolling annual compliance format, they were particularly concerned about enforcement implications. Specifically, the concerns were (1) that a facility could be fined for 365 days of noncompliance for each violation, and (2) that a particularly abnormal month could cause violations for several subsequent months.

Due to seasonal variations, the EPA selected the 12-month rolling averaging period. However, the monthly averaging period is still being allowed, because the EPA considers it to be more stringent than the 12-month rolling averaging period. The EPA is specifically requesting comments from State and local agencies, as well as the industry, on the burdens caused by the inclusion of this choice in the proposed regulation.

10.5.2.5 <u>Source-wide HAP ABA and equipment cleaning HAP emission limitation</u>

The EPA had to determine if this alternative format for HAP ABA and equipment cleaning emissions was viable. The EPA was very interested in this option, as it would provide considerable flexibility to the regulated industry. While this option could be considered a form of emissions averaging, it is substantially more simple and straightforward than recent emissions averaging programs proposed and promulgated by the EPA. This is due to several facts, including: (1) only one HAP would be allowed to be included in the source-wide limitation, (2) the vast majority of the HAP is used for one purpose (HAP ABA), and (3) all HAP that is used is emitted (in the absence of add-on control).

The EPA had one predominant concern regarding the feasibility of this alternative format. The point of compliance for the emission point specific HAP ABA emission limitation is at the mixhead, where the HAP ABA is added to the formulation. At this point, the HAP ABA is accurately metered as it is added. The point of compliance for the source-wide limitation would be the HAP ABA storage vessel, where a monthly material balance would be performed to determine the amount of HAP ABA and HAP equipment cleaner used/emitted. The Agency is concerned about the accuracy of the common methods used to determine the amount of HAP ABA in the storage vessel (such as sight glasses), and the methods to determine the amount of HAP ABA delivered by tank truck or railcar (often simply based on delivery receipts). The proposed regulation contains requirements for the validation of storage tank inventory measurements. However, this strays from the common practices in the industry, and the accuracy of these measurements is still somewhat in question.

The EPA concluded that the desire to provide flexibility to the industry was greater than the concern over the accuracy of these inventory measurement techniques. Therefore, the EPA elected to include the source-wide emission limitation format in the proposed regulation. However, the EPA is specifically requesting comments on the storage vessel inventory requirements, the availability of technologies to meet these requirements, and the accuracy of these technologies.

The discussion of the selected emission limitation and averaging time formats for the emission point specific HAP ABA limitation also applies to the source-wide emission limitation.

10.5.3 Rebond Foam Production

The proposed requirements for rebond foam production require the complete elimination of the use (and emission) of HAP-based mold release agents and HAP equipment cleaners. Given these requirements, the only format considered was a prohibition of the use of these HAP-based products.

10.6 SELECTION OF EMISSION TEST METHODS

There are two instances in the proposed regulation where testing is required. When complying with the emission point specific equipment leak provisions, testing for leaks is required using Method 21. This is the test method required by all EPA equipment leak programs, and the Agency believes it is appropriate for this regulation.

The second test method cited in the proposed regulation is the method to determine the density and IFD of a foam sample.

The proposed regulation incorporates ASTM Method D3574 for this testing. This method is the method already used in the industry, and the EPA concluded that it was appropriate to incorporate it into this rule.

For the other emission sources, performance testing is not required. As mentioned above, the amount of HAP ABA used is equivalent to the amount emitted. Therefore, the need for expensive performance testing is unnecessary, as only the amount used needs to be determined. The proposed format for storage vessels is an equipment standard, meaning that compliance is achieved by the installation and maintenance of the proper equipment. Finally, no test is needed to verify that HAP equipment cleaners are not being used.

10.7 SELECTION OF MONITORING REQUIREMENTS

As discussed in section 10.1.5, the proposed regulation contains monitoring requirements for five situations: (1) monitoring of storage vessel carbon adsorption systems for breakthrough, (2) polyol and HAP ABA monitoring at the mixhead, (3) recovered HAP ABA monitoring, (4) the amount of HAP ABA in a storage vessel, and (5) the amount of HAP ABA added to a storage vessel.

The monitoring of storage vessel carbon adsorption systems for breakthrough is necessary to ensure that the system has retained its effectiveness in reducing diisocyanate or HAP ABA emissions. The selected monitoring requirements are common requirements for nonregenerable systems.

The monitoring of polyol at the mixhead is an integral part of the calculation of allowable HAP ABA (or HAP ABA and equipment cleaning HAP) emissions. For slabstock processes complying with the emission point specific HAP ABA emission limitation, the monitoring of the amount of HAP ABA added at the mixhead is used to determine the actual HAP ABA emissions. For both these situations, the selected monitoring requirements are based on common monitoring techniques used in the slabstock industry.

For facilities using a recovery device, the amount of HAP ABA recovered must be monitored to adjust the actual HAP ABA emissions to account for the effects of the recovery device. The monitoring requirements for recovered HAP ABA were selected to ensure accuracy in the measurement of the HAP ABA recovered, while also providing flexibility to the slabstock process in how the specific monitoring will take place.

Affected slabstock sources complying with the source-wide emission limitation for HAP ABA storage and equipment leak emissions, HAP ABA emissions from the production line, and equipment cleaning HAP emissions, must perform a monthly material balance around the HAP ABA storage vessel to determine source-wide HAP ABA emissions. The data needed to perform this balance are the amount of HAP ABA in the storage vessel at the beginning of the month, the amount of HAP ABA added to the storage vessel during the month, and the amount of HAP ABA in the storage vessel at the end of the month. The proposed regulation requires that the amount of HAP ABA in the storage vessel be monitored weekly. While only the beginning and end of the month amounts are used in the source-wide monthly emission estimation equation, the EPA believes that weekly monitoring is necessary to verify the accuracy of the beginning- and end-of-month amounts. The amount of HAP ABA added to the storage vessel during each delivery is also required to be monitored.

10.8 SELECTION OF RECORDKEEPING AND REPORTING REQUIREMENTS

10.8.1 Recordkeeping Requirements

The reporting and recordkeeping requirements for the proposed regulation were summarized in section 10.1.9 and 10.1.10. The HAP ABA recordkeeping requirements were designed to correlate, to the extent possible, with the existing recordkeeping requirements in the slabstock industry. The Agency believes that detailed records of polyol and HAP ABA usage are already maintained in a manner similar to the recordkeeping requirements in the proposed regulation.

For the equipment standard provisions of the proposed regulation, records of the installation of the equipment are required to document compliance. If a carbon adsorption system is used for a storage vessel, records must be kept of the required monitoring results, as well as records of when the carbon or carbon system is replaced. These recordkeeping requirements were selected to demonstrate compliance.

Similarly, records to demonstrate compliance with the equipment leak provisions are required. Records of the detection and repair of leaking components must be maintained.

10.8.2 Reporting Requirements

As discussed in section 10.1.9, the proposed regulation requires the submittal of six types of reports. The purpose of the initial notification, the application for approval of construction or reconstruction, and the precompliance report are to inform the Administrator of information prior to the compliance date. The notification of compliance status and semi-annual compliance reports are to report the source's success in complying with the regulation.

10.9 MODIFICATION AND RECONSTRUCTION CONSIDERATIONS

The anticipated extensive use of pollution prevention process modifications to comply with this regulation is cause for special consideration. The EPA does not believe that it would be appropriate for a process modification undertaken to meet the existing source standards to trigger the new source standards because the modification meets the definition of reconstruction in subpart A. Therefore, the proposed regulation defines a reconstructed source as a process that meets the definition of reconstruction, except that process modifications designed to reduce the use and emission of HAP ABA are not considered part of reconstruction.

10.10 OPERATING PERMIT PROGRAM

Under Title V of the 1990 Amendments, all HAP-emitting facilities subject to this rule will be required to obtain an operating permit. Oftentimes, emission limits, monitoring, and reporting and recordkeeping requirements are scattered among numerous provisions of State implementation plans (SIP's) or Federal regulations. As discussed in the proposed rule for the operating permit program published on May 10, 1991 (58 FR 21712), this new permit program would include, in a single document, all of the requirements that pertain to a single source. Once a State's permit program has been approved, each facility containing that source within that State must apply for and obtain an operating permit. If the State wherein the source is located does not have an approved permitting program, the owner or operator of a source must submit the application under the General Provisions of 40 CFR part 63.

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16. ABSTRACT

This document provides background information on, and rationale for, decisions made by the EPA related to the proposed standards for the reduction of HAP emitted during the production of flexible polyurethane foam.

17 KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Hazardous air pollutants Emission reduction Flexible Polyurethane Foam	Hazardous air pollutants	
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