Harding Lawson Associates

December 13, 1993

26005/F21.816

Mr. Willard Hanks
Bureau of Air Regulation
Florida Department of Environmental Protection
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Foamex, L.P.
Application for Permit to Construct
a Flexible Polyurethane Foam Manufacturing Facility

Dear Mr. Hanks:

This letter is to respond to the issues raised during our meeting in Tallahassee on June 9, 1993 with yourself and Mr. Preston Lewis of FDEP, and Mr. Art Pereira, Mr. Charles Eavenson and Mr. Joseph Lunderville of Foamex, L.P. The paragraphs below provide an itemized response to each issue, however the enclosed revised application sections have also been prepared to incorporate the information required to fully address each item:

1. What is the current technology status and operational experience in Europe of foam manufacturing process changes to control or reduce blowing agent emissions?

In the Response To FDER Review Comments (April 7, 1993), a discussion was provided on the Variable Pressure Foaming (VPF) process for manufacturing flexible polyurethane foam without the use of chemical blowing agents. In this previous submittal, it was stated that Foamex is committed to the VPF system as the leading new process technology that would result in reduction of blowing agent emissions. This technology was also discussed during our meeting in June. As of the current date, a VPF unit is in operation at the RECTICEL-Holland plant in Europe. At this facility, approximately 47% is being run at less than atmospheric or vacuum conditions, and 16% of production is run under pressurized conditions, for a total of approximately 63% of production without the use of blowing agents. The remaining 27% of production is currently being run at atmospheric conditions with the use of chemical blowing agents. However, as the technology is demonstrated to be effective for a wider variety of foam grades, this distribution will change. The quality of foam grades produced under vacuum and pressure conditions has been satisfactory for sale to the customer. No adverse physical properties have been experienced while producing polyurethane foam with this technology.

Engineering and
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2. *What is the current status of similar manufacturing installations in the United States, concerning:*

(a) *emission control equipment,*
(b) *existing regulations,*
(c) *existing permits, and*
(d) *emission histories?*

An extensive review of twelve facilities representing similar manufacturing installations in the United States is included in the revised application Section 6.0, submitted along with this letter.

3. *What is the current status of air pollution control technology for control of foam blowing agent emissions?*

The revised permit application submitted along with this letter provides an extensive analysis of the available air pollution control technologies in Section 6.0 (Section VI: Supplemental Information - Best Available Control Technology).

4. *How do available air pollution control technologies compare in terms of cost, emissions and other environmental impacts?*

As stated above, the revised permit application submitted along with this letter provides an extensive analysis of the available air pollution control technologies in Section 6.0 (Section VI: Supplemental Information - Best Available Control Technology). This section provides a complete comparison of capital and operating cost, emission control efficiencies and other environmental impacts.

5. *What are the expected emissions from the facility for the next 18 months and after selection and installation of a control system and/or new process?*

Appendix 2-C included in the revised application Section 2.0 provides a summary of emission estimates correspoding to each period of the proposed permitting approach.

6. *What are the health risks associated with Methylene Chloride and 1,1,1 Trichloroethane?*

The revised permit application submitted along with this letter provides a complete air quality impact study in Section 7.0 (Supplemental Information: Section VII - Prevention of Significant Deterioration). This study identifies the maximum 8 hour, 24 hour and annual ambient concentrations of both Methylene Chloride and 1,1,1 Trichloroethane, and provides a comparison of these values with the "No Threat Levels" specified in the FDEP Air Toxics Working List, version 3.0 (July, 1992). A summary of this comparison is provided in Letter Attachment 1 and shows that the "No Threat Levels" are not exceeded in any case.

To address this issue further, HLA - C/TA reviewed the available Risk Specific Dose (RSD) and associated Unit Risk criteria specified in 40 CFR Part 266 Appendix V for Hazardous Waste Burned in Boilers and Industrial Furnaces. This section lists criteria for Methylene Chloride but does not include 1,1,1 Trichloroethane. The summary table in Letter Attachment 1 provides a comparison of the maximum ambient concentration for Methylene Chloride with the RSD specified in 40 CFR Part 266. It should be noted that this RSD represents the ambient concentration resulting in an incremental lifetime risk of 1 per 100,000 to the hypothetical maximum exposed individual (MEI). This approach assumes that the hypothetical MEI is located at the point of maximum ambient concentration, and assumes a 70-year lifetime exposure period.

Through further review of available health effects and risk data, the information included in Letter Attachment 2 for Methylene Chloride and 1,1,1 Trichloroethane was compiled from the Integrated Risk Information System (IRIS) database. IRIS is an online database created by EPA and mounted on the National Library of Medicine's Toxicology Data Network (TOXNET). This database contains health risk and EPA regulatory information on approximately 400 chemicals. The information available for Methylene Chloride identifies an ambient concentration value resulting in a lifetime risk of 1 per 100,000, similar to the RSD specified in 40 CFR Part 266 and discussed above. The summary table included in Letter Attachment 1 provides a comparison of this value with the maximum ambient concentration of Methylene Chloride from the Foamex facility.

The comparisons provided in Letter Attachment 1 show that the lifetime risk to the hypothetical MEI resulting from the Foamex facility's predicted maximum ambient concentration does not exceed 1 per 100,000.

7. *Please submit a current schedule that defines dates for the following:*

(a) *submission of various progress reports,*
(b) *selection of a control concept, and*
(c) *implementation of the selected control concept.*

Appendix 2-A included in the revised application Section 2.0 provides a current schedule for submittal of progress reports, selection of an emissions control concept and implementation of the selected strategy. This schedule represents an update of the previous schedule included in the Response to FDER Review Comments submitted on April 7, 1993.

Please be advised that the enclosed application sections have been revised to completely replace the tabbed sections 2.0 and 6.0 in the application notebook currently under your review. Also included is a revised cover page and table of contents. Should you have any questions or comments concerning the information submitted, please do not hesitate to contact Mr. Joe Tessitore or Ms. Kay Rykowski.

Yours very truly,

HLA-C/TA

Patricia Kay Rykowski

Patricia Kay Rykowski
Project Engineer

Joseph L. Tessitore

Joseph L. Tessitore, P.E.
Managing Principal

PKR/JLT/pkr
foamx10.doc/

Enclosures

cc: Mr. Dennis Nester, Orange County Environmental Protection Division (OCEPD)
Mr. Charles Collins, P.E., FDER - Central Florida District
Mr. Charles Eavenson, Foamex L.P.
Mr. Art Pereira, Foamex, L.P

LETTER ATTACHMENT 1

Foamex ISCST2 Modeling Results
And Comparison With FDEP
"No Threat Levels" and Risk Levels

Foamex ISCST2 Modeling Results and Comparison with FDEP No Threat Levels and Risk Levels

Compound	Averaging Time	Maximum Off Property Ground Level Concentration ($\mu g/m^3$)	FDEP No Threat Level ($\mu g/m^3$)	Risk Specific Dose (1 in 100,000)	
				40 CFR Part 266 ($\mu g/m^3$)	IRIS Database ($\mu g/m^3$)
Methylene Chloride	8-hour	566.923	1,740	N/A	N/A
	24-hour	88.024	417.6	N/A	N/A
	Annual	2.023	2.1	2.4	20.0
1,1,1-Trichloroethane	8-hour	1,242.027	38,200	N/A	N/A
	24-hour	180.791	9,168	N/A	N/A
	Annual	0.873	N/A	N/A	N/A
Toluene Diisocyanate	8-hour	0.32	0.36	N/A	N/A
	24-hour	0.084	0.0864	N/A	N/A
	Annual	0.0089	N/A	N/A	N/A

Letter Attachment 2

Compilation of Health Effects/Risk Information From Integrated Risk Information System (IRIS) For Methylene Chloride and 1,1,1 Trichloroethane

0070
Dichloromethane; CASRN 75-09-2 (07/01/93)

Health risk assessment information on a chemical is included in IRIS only after a comprehensive review of chronic toxicity data by work groups composed of U.S. EPA scientists from several Program Offices. The summaries presented in Sections I and II represent a consensus reached in the review process. The other sections contain U.S. EPA information which is specific to a particular EPA program and has been subject to review procedures prescribed by that Program Office. The regulatory actions in Section IV may not be based on the most current risk assessment, or may be based on a current, but unreviewed, risk assessment, and may take into account factors other than health effects (e.g., treatment technology). When considering the use of regulatory action data for a particular situation, note the date of the regulatory action, the date of the most recent risk assessment relating to that action, and whether technological factors were considered. Background information and explanations of the methods used to derive the values given in IRIS are provided in the five Background Documents in Service Code 5, which correspond to Sections I through V of the chemical files.

STATUS OF DATA FOR Dichloromethane

File On-Line 01/31/87

Category (section)	Status	Last Revised
Oral RfD Assessment (I.A.)	on-line	03/01/88
Inhalation RfC Assessment (I.B.)	pending	09/01/91
Carcinogenicity Assessment (II.)	on-line	01/01/91
Drinking Water Health Advisories (III.A.)	on-line	03/01/88
U.S. EPA Regulatory Actions (IV.)	on-line	01/01/92
Supplementary Data (V.)	no data	

_I. CHRONIC HEALTH HAZARD ASSESSMENTS FOR NONCARCINOGENIC EFFECTS

__I.A. REFERENCE DOSE FOR CHRONIC ORAL EXPOSURE (RfD)

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride
Last Revised -- 03/01/88

The Reference Dose (RfD) is based on the assumption that thresholds exist for certain toxic effects such as cellular necrosis, but may not exist for other toxic effects such as carcinogenicity. In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Please refer to Background Document 1 in Service Code 5 for an elaboration of these concepts. RfDs can also be derived for the noncarcinogenic health effects of compounds which are also carcinogens. Therefore, it is essential to refer to other sources of information concerning the carcinogenicity of this substance. If the U.S. EPA has evaluated this substance for potential human carcinogenicity, a summary of that evaluation will be contained in Section II of this file when a review of that evaluation is completed.

___I.A.1. ORAL RfD SUMMARY

Critical Effect	Experimental Doses*	UF	MF	RfD
Liver toxicity 2-Year Rat Drinking Water Bioassay National Coffee Association, 1982	NOAEL: 5.85 and 6.47 mg/kg/day for males and females, respectively LOAEL: 52.58 and 58.32 mg/kg/day for males and females, respectively	100	1	6E-2 mg/kg/day

*Conversion Factors: Doses reflect actual values and not nominal ones.

___I.A.2. PRINCIPAL AND SUPPORTING STUDIES (ORAL RfD)

National Coffee Association. 1982. 24-Month chronic toxicity and oncogenicity study of methylene chloride in rats. Final Report. Prepared by Hazleton Laboratories America, Inc., Vienna, VA. (Unpublished)

The chosen study appears to have been very well conducted, with 85 rats/ sex at each of four nominal dose groups (i.e., 5, 50, 125 and 250 mg/kg/day) for 2 years. A high-dose recovery group of 25 rats/sex, as well as two control groups of 85 and 50 rats/sex, was also tested. Many effects were monitored. Treatment related histological alterations of the liver were evident at nominal doses of 50 mg/kg/day or higher. The low nominal dose of 5 mg/kg/day was a NOAEL.

The supporting data base is limited. A NOAEL of 87 mg/cu.m was reported in one inhalation study (Haun et al., 1972). [The equivalent oral dose is about 28 mg/kg bw/day (i.e., 87 mg/cu.m x 0.5 x 0.223 cu.m/day/0.35 kg; these exposure values are for rats).]

___I.A.3. UNCERTAINTY AND MODIFYING FACTORS (ORAL RfD)

UF -- (10a x 10h) The 100-fold factor accounts for both the expected intra- and interspecies variability to the toxicity of this chemical in lieu of specific data.

MF -- None

___I.A.4. ADDITIONAL COMMENTS (ORAL RfD)

None.

___I.A.5. CONFIDENCE IN THE ORAL RfD

Study -- High
Data Base -- Medium
RfD -- Medium

The study is given a high confidence rating because a large number of animals of both sexes were tested in four dose groups, with a large number of controls. Many effects were monitored and a dose-related increase in severity was observed. The data base is rated medium to low because only a few studies support the NOAEL. Medium confidence in the RfD follows.

___I.A.6. EPA DOCUMENTATION AND REVIEW OF THE ORAL RfD

Source Document -- U.S. EPA, 1985

Other EPA Documentation -- None

Agency Work Group Review -- 06/24/85, 07/08/85, 11/06/85

Verification Date -- 11/06/85

___I.A.7. EPA CONTACTS (ORAL RfD)

Krishan Khanna / OST -- (202)260-7588

Michael L. Dourson / OHEA -- (513)569-7533

__I.B. REFERENCE CONCENTRATION FOR CHRONIC INHALATION EXPOSURE (RfC)

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride

A risk assessment for this substance/agent is under review by an EPA work group.

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_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride
Last Revised -- 01/01/91

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

__II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

___II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification --B2; probable human carcinogen

Basis -- Based on inadequate human data and sufficient evidence of carcinogenicity in animals; increased incidence of hepatocellular neoplasms and alveolar/bronchiolar neoplasms in male and female mice, and increased incidence of benign mammary tumors in both sexes of rats, salivary gland sarcomas in male rats and leukemia in female rats. This classification is supported by some positive genotoxicity data, although results in mammalian systems are generally negative.

___II.A.2. HUMAN CARCINOGENICITY DATA

Inadequate. Neither of two studies of chemical factory workers exposed to dichloromethane showed an excess of cancers (Ott et al., 1983; Friedlander et al., 1978; Hearne and Friedlander, 1981). The Ott et al. (1983) study was designed to examine cardiovascular effects, and consequently the study period was too short to allow for latency of site-specific cancers. In the Friedlander et al. (1978) study, exposures were low, but the data provided some suggestion of an increased incidence of pancreatic tumors. This study was recently updated to include a larger cohort, followed through 1984, and an investigation of possible confounding factors (Hearne et al., 1986, 1987). A nonsignificant excess in pancreatic cancer deaths was observed, which was interpreted by EPA (1987a) as neither clear evidence of carcinogenicity in humans, nor evidence of noncarcinogenicity. An update of the Ott et al. (1983) study, based on longer follow-up, indicated possible elevation of liver and biliary tract cancers (TSCA section 8(e) submission no. 8eHQ-0198-0772 FLWP et seq., 1989).

___II.A.3. ANIMAL CARCINOGENICITY DATA

Sufficient. Dichloromethane administered in the drinking water induced a significant increase in combined hepatocellular carcinoma and neoplastic nodules in female F344 rats and a nonsignificant increase in combined hepatocellular carcinoma and neoplastic nodules in male B6C3F1 mice (NCA, 1982, 1983). Two inhalation studies with dichloromethane have shown an increased incidence of benign mammary tumors in both sexes of Sprague-Dawley (Burek et al., 1984) and F344 (NTP, 1986) rats. Male Sprague-Dawley rats had increased salivary gland sarcoma (Burek et al., 1984) and female F344 rats had increased leukemia incidence (NTP, 1986). Both sexes of B6C3F1 mice developed liver and lung tumors after dichloromethane treatment (NTP, 1986).

In a 2-year study by the National Coffee Association (1982, 1983), groups of 85 F344 rats/sex/dose received 5, 50, 125, or 250 (mg/kg)/day of dichloromethane in the drinking water. Control groups consisted of 135 rats/sex. In female rats the incidence of combined hepatocellular carcinoma and neoplastic nodules was statistically significantly increased in the 50 and 250 mg/kg dose groups when compared with matched controls (0/134, 1/85, 4/83, 1/85, and 6/85 in the five dose groups 0, 5, 50, 125, and 250 (mg/kg)/day, respectively). The incidence of hepatocellular carcinoma alone was not significantly increased (0/134, 0/85, 2/83, 0/85, 2/85). The combined incidence of hepatocellular carinoma and neoplastic nodules in controls and the 4 dose groups (472 rats: 4 with carcinoma and 8 with neoplastic nodules) was similar to that for historical controls (419 rats; 5 with carcinoma, 19 with neoplastic nodules). Male rats showed no increase in liver tumors.

In the same National Coffee Association study (1982, 1983), B6C3F1 mice received 0, 60, 125, 185, or 250 (mg/kg)/day of dichloromethane in drinking water. Treatment groups consisted of 50 female mice and 200, 100, 100, and 125 male mice (low to high dose). One hundred females and 125 males served as controls. Male mice had an increased incidence of combined neoplastic nodules and hepatocellular carcinoma (24/125, 51/200, 30/100, 31/99, 35/125). The increase was not dose-related, but the pairwise comparisons for the two mid-dose groups were reported to be statistically significant (U.S. EPA, 1985a). The hepatocellular carcinoma incidence alone for male mice (which was about 55 to 65% of the total) was not significantly elevated. Female mice did not have increased liver tumor incidence. The EPA (1985b) regarded this study as suggestive but not conclusive evidence for carcinogenicity of dichloromethane.

A gavage bioassay of dichloromethane conducted by NTP (1982) has not been published because of high mortality, much of which was attributed to gavage accidents.

Inhalation exposure of 107 to 109 Syrian hamsters/sex/dose to 0, 500, 1500, or 3500 ppm of dichloromethane for 6 hours/day, 5 days/week for 2 years did not induce neoplasia (Burek et al., 1984). Sprague-Dawley rats (129/sex/dose) were exposed under the same conditions. Female rats administered the highest dose experienced significantly reduced survival from 18-24 months. Female rats showed a dose-related increase in the average number of benign mammary tumors per rat (1.7, 2.3, 2.6, 3.0), although the numbers of rats with tumors were not significantly increased. A similar response was observed in male rats, but to a lesser degree. In the male rats there was a statistically significant positive trend in the incidence of sarcomas of the salivary gland (1/93, 0/94, 5/91, 11/88); the incidence was significantly elevated at the high dose. There is a question as to whether these doses reached the MTD, particularly in the hamsters and the male rats. In another study (Dow Chemical Co., 1982), 90 Sprague-Dawley rats/sex were exposed by inhalation to 0, 50, 200, or 500 ppm dichloromethane for 20 months (male) or 24 months (female). No salivary tumors were observed, but there was an exposure-related increase in the total number of benign mammary tumors in female rats, although the increase was not statistically significant in any individual exposure group.

Groups of 50 each male and female F344/N rats and B6C3F1 mice were exposed to dichloromethane by inhalation, 6 hours/day, 5 days/week for 2 years (NTP, 1986). Exposure concentrations were 0, 1000, 2000, or 4000 ppm for rats and 0, 2000, or 4000 ppm for mice. Survival of male rats was low; however, this apparently was not treatment-related. Survival was decreased in a treatment-related fashion for male and female mice and female rats. Mammary adenomas and fibroadenomas were significantly increased in male and female rats after survival adjustment, as were mononuclear cell leukemias in female rats. Among treated mice of both sexes there were significantly increased incidences of hepatocellular adenomas and carcinomas, and of alveolarbronchiolar adenomas and carcinomas, by life table tests. Adenomas and carcinomas were significantly increased alone as well as in combination. In addition, there were significant dose-related increases in the number of lung tumors per animal multiplicity in both sexes of mice.

Two inhalation assays using dogs, rabbits, guinea pigs, and rats showed no tumors, but were not conducted for the lifetime of the animals (Heppel et al., 1944; MacEwen et al., 1972). Theiss et al., (1977) injected Strain A male mice intraperitoneally with 0, 160, 400, or 800 mg/kg of dichloromethane 16 to 17 times, over 5 to 6 weeks. Survival of the animals was poor. The animals remaining 24 weeks after the first treatment were killed and examined for lung tumors; pulmonary adenomas were found.

___II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

Dichloromethane was mutagenic for Salmonella typhimurium with or without the addition of hepatic enzymes (Green, 1983) and produced mitotic recombination in yeast (Callen et al., 1980). Results in cultured mammalian cells have generally been negative, but dichloromethane has been shown to transform rat embryo cells and to enhance viral transformation of Syrian hamster embryo cells (Price et al., 1978; Hatch et al., 1983). Although chlorinated solvents have often been suspected of acting through a nongenotoxic mechanism of cell proliferation, Lefevre and Ashby (1989) found methylene chloride to be unable to induce hepatocellular division in mice.

__II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

___II.B.1. SUMMARY OF RISK ESTIMATES

Oral Slope Factor -- 7.5E-3 per (mg/kg)/day

Drinking Water Unit Risk -- 2.1E-7 per (ug/L)

Extrapolation Method -- Linearized multistage procedure, extra risk

Drinking Water Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	5E+2 ug/L
E-5 (1 in 100,000)	5E+1 ug/L
E-6 (1 in 1,000,000)	5E+0 ug/L

___II.B.2. DOSE-RESPONSE DATA (CARCINOGENICITY, ORAL EXPOSURE)

Tumor Type -- hepatocellular adenomas or carcinomas (NTP) and hepatocellular cancer and neoplastic nodules (NCA)
Test Animals -- mouse/B6C3F1 (female, NTP; male, NCA)
Route -- inhalation (NTP); drinking water (NCA)
Reference -- NTP, 1986; National Coffee Association (NCA), 1983

Dose				
Administered (ppm)	mg/kg/day	Human Equivalent (mg/kg)/day	Tumor Incidence	Reference

0	0	0	3/50	NTP, 1986
2000	1582	122	16/48	
4000	3162	244	40/48	
	0	0	24/125	NCA, 1983
	60	4.5	51/200	
	125	9.4	30/100	
	185	14.0	31/99	
	250	18.9	35/125	

___II.B.3. ADDITIONAL COMMENTS (CARCINOGENICITY, ORAL EXPOSURE)

The slope factor is an arithmetic mean of slope factors derived from NTP(1986) and the National Coffee Association (1983) data, 2.6E-3 per (mg/kg)/day and 1.2E-2 per (mg/kg)/day, respectively. The use of liver tumor data from the NTP inhalation bioassay was considered valid since dichloromethane is rapidly absorbed following either inhalation or ingestion.

Dose conversions used the mean body weight for female mice at the midpoint of the bioassay, and an estimated inhalation rate of 0.0407 cu.m/day. To obtain estimates of unit risk for humans, an inhalation rate of 20 cu.m/day was assumed. Dichloromethane was considered to be well-absorbed as a vapor at low doses. No pharmacokinetic or metabolism data have been used to modify the oral unit risk estimate, because such analyses have not yet been carried out.

The unit risk should not be used if the water concentration exceeds 5E+4 ug/L, since above this concentration the unit risk may not be appropriate.

___II.B.4. DISCUSSION OF CONFIDENCE (CARCINOGENICITY, ORAL EXPOSURE)

Adequate numbers of animals were used in both assays. Risk estimates were based on the more sensitive sex in each study. The two risk estimates were within a factor of 5.

__II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

___II.C.1. SUMMARY OF RISK ESTIMATES

Inhalation Unit Risk -- 4.7E-7 per (ug/cu.m)

Extrapolation Method -- Linearized multistage procedure, extra risk

Air Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	2E+2 ug/cu.m
E-5 (1 in 100,000)	2E+1 ug/cu.m
E-6 (1 in 1,000,000)	2E+0 ug/cu.m

___II.C.2. DOSE-RESPONSE DATA FOR CARCINOGENICITY, INHALATION EXPOSURE

Tumor Type -- combined adenomas and carcinomas
Test Animals -- mouse/B6C3F1, female
Route -- inhalation
Reference -- NTP, 1986

	Dose			
Tumor Type	Administered (ppm)	Transformed Animal (mg/kg)/day	Human Equivalent (mg/kg)/day	Tumor Incidence
Liver	0	0	0	3/45
	2000	1582	356	16/46
	4000	3162	712	40/46
Lung	0	0	0	3/45
	2000	1582	356	30/46
	4000	3162	712	41/46

___II.C.3. ADDITIONAL COMMENTS (CARCINOGENICITY, INHALATION EXPOSURE)

The unit risk of 4.7E-7 per (ug/cu.m), which incorporates information on pharmacokinetics and metabolism of dichloromethane, is approximately nine-fold lower than the previous applied dose estimate (U.S. EPA, 1987a,b). Internal dose estimates were based on the metabolism of dichloromethane by the glutathione-s-transferase pathway, as estimated by the model developed by Andersen et al. (1987). The internal dose was corrected for interspecies differences in sensitivity by using the surface area correction factor.

Calculation of a slope factor from the unit risk is inappropriate when pharmacokinetic models are used. (When dose-response relationships are figured on the basis of internal or metabolized dose, a slope factor in terms of per (mg/kg)/day represents a back calculation using different absorption assumptions than the pharmacokinetic models. This introduces possible contradictions.)

The unit risk should not be used if the air concentration exceeds 2E+4 ug/cu.m, since above this concentration the unit risk may differ from that stated. Since the unit risk is based on a pharmacokinetic model, the risk may change with alterations in exposure patterns. Thus, the unit risk presented here may not be applicable to acute, high exposures.

___II.C.4. DISCUSSION OF CONFIDENCE (CARCINOGENICITY, INHALATION EXPOSURE)

Adequate numbers of animals were observed and tumor incidences were significantly increased in a dose-dependent fashion. Analysis excluding animals that died before observation of the first tumors produced similar risk estimates, as did time-to-tumor analysis. The use of animal and human metabolism and pharmacokinetic data reduces some of the uncertainty typically associated with dose-risk extrapolation. A great deal of uncertainty still exists, however, in the estimates of internal dose generated by the model of Andersen et al. (1987). Important uncertainties remain regarding the pharmacokinetics, pharmacodynamics, and mechanisms of carcinogenicity for dichloromethane.

__II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

___II.D.1. EPA DOCUMENTATION

Source Document -- U.S. EPA, 1985a,b, 1987a,b

The Addendum to the Health Assessment Document, the Update to the Health Assessment Document and Addendum, and the Technical Analysis of New Methods and Data for dichloromethane have received Agency and external review, including a review by the Science Advisory Board (SAB). Although the last two documents are not yet finalized and the SAB comments are not yet incorporated, these do not alter this document's analyses or conclusions.

___II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

Agency Work Group Review -- 11/12/86, 12/04/86, 04/06/89

Verification Date -- 04/06/89

___II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Lorenz Rhomberg / OHEA -- (202)260-5723

Dharm V. Singh / OHEA -- (202)260-5898

_III. HEALTH HAZARD ASSESSMENTS FOR VARIED EXPOSURE DURATIONS

__III.A. DRINKING WATER HEALTH ADVISORIES

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride
Last Revised -- 03/01/88

The Office of Drinking Water provides Drinking Water Health Advisories (HAs) as technical guidance for the protection of public health. HAs are not enforceable Federal standards. HAs are concentrations of a substance in drinking water estimated to have negligible deleterious effects in humans, when ingested, for a specified period of time. Exposure to the substance from other media is considered only in the derivation of the lifetime HA. Given the absence of chemical-specific data, the assumed fraction of total intake from drinking water is 20%. The lifetime HA is calculated from the Drinking Water Equivalent Level (DWEL) which, in turn, is based on the Oral Chronic Reference Dose. Lifetime HAs are not derived for compounds which are potentially carcinogenic for humans because of the difference in assumptions concerning toxic threshold for carcinogenic and noncarcinogenic effects. A more detailed description of the assumptions and methods used in the derivation of HAs is provided in Background Document 3 in Service Code 5.

___III.A.1. ONE-DAY HEALTH ADVISORY FOR A CHILD

One-day HA -- 1.33E+1 mg/L

LOAEL -- 1326 mg/kg/day
UF -- 1000 (allows for interspecies and intrahuman variability with the use of
a LOAEL from an animal study)
Assumptions -- 1 L/day water consumption for a 10-kg child

Principal Study -- Kimura et al., 1971

Single oral doses of dichloromethane were administered to young adult Sprague-Dawley rats. An approximate dose of 1.3 g/kg was the lowest dose to induce the first observable gross signs of toxicity.

___III.A.2. TEN-DAY HEALTH ADVISORY FOR A CHILD

Ten-day HA -- 1.5E+0 mg/L

NOAEL -- 15 mg/kg/day
UF -- 100 (allows for interspecies and intrahuman variability with the use of
a NOAEL from an animal study)
Assumptions -- 1 L/day water consumption for a 10-kg child

Principal Study -- Bornmann and Loeser, 1967

Male and female Wistar rats were administered dichloromethane in drinking water for 13 weeks at a dose of 15 mg/kg/day. No treatment-related effects were observed.

___III.A.3. LONGER-TERM HEALTH ADVISORY FOR A CHILD

Appropriate data for calculating a Longer-term HA is not available. It is recommended that a modified DWEL (adjusted for a 10-kg child) of 0.5 mg/L be used as the Longer-term HA.

___III.A.4. LONGER-TERM HEALTH ADVISORY FOR AN ADULT

Appropriate data for calculating a Longer-term HA is not available. It is recommended that the DWEL of 1.75 mg/L be used as the Longer-term HA for the 70-kg adult.

___III.A.5. DRINKING WATER EQUIVALENT LEVEL / LIFETIME HEALTH ADVISORY

DWEL -- 1.75E+0 mg/L

Assumptions -- 2 L/day water consumption for a 70-kg adult

RfD Verification Date = 11/06/85

Lifetime HA -- None

Dichloromethane is considered to be a probable human carcinogen. Refer to Section II of this file for information on the carcinogenicity of this substance.

Principal Study (DWEL) -- National Coffee Association, 1982 (This study was used in the derivation of the chronic oral RfD; see Section I.A.2.)

___III.A.6. ORGANOLEPTIC PROPERTIES

No data available

___III.A.7. ANALYTICAL METHODS FOR DETECTION IN DRINKING WATER

Analysis of dichloromethane is by a purge-and-trap gas chromatographic procedure used for the detection of volatile organohalides in drinking water.

Confirmatory analysis is by mass spectrometry.

___III.A.8. WATER TREATMENT

The available information suggests that adsorption by granular activated carbon and air stripping are feasible technologies to remove dichloromethane from drinking water.

___III.A.9. DOCUMENTATION AND REVIEW OF HAs

U.S. EPA. 1985. Final Draft of the Drinking Water Criteria Document on Dichloromethane. Office of Drinking Water, Washington, DC.

EPA review of HAs in 1985.

Public review of HAs following notification of availability in October, 1985.

Scientific Advisory Panel review of HAs in January, 1986.

Preparation date of this IRIS summary -- 06/24/87

___III.A.10. EPA CONTACTS

Krishan Khanna / OST -- (202)260-7588

Edward V. Ohanian / OST -- (202)260-7571

__III.B. OTHER ASSESSMENTS

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride

Content to be determined.

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_IV. U.S. EPA REGULATORY ACTIONS

Substance Name -- Dichloromethane
CASRN -- 75-09-2

Primary Synonym -- Methylene Chloride
Last Revised -- 01/01/92

EPA risk assessments may be updated as new data are published and as assessment methodologies evolve. Regulatory actions are frequently not updated at the same time. Compare the dates for the regulatory actions in this section with the verification dates for the risk assessments in sections I and II, as this may explain inconsistencies. Also note that some regulatory actions consider factors not related to health risk, such as technical or economic feasibility. Such considerations are indicated for each action. In addition, not all of the regulatory actions listed in this section involve enforceable federal standards. Please direct any questions you may have concerning these regulatory actions to the U.S. EPA contact listed for that particular action. Users are strongly urged to read the background information on each regulatory action in Background Document 4 in Service Code 5.

__IV.A. CLEAN AIR ACT (CAA)

No data available

__IV.B. SAFE DRINKING WATER ACT (SDWA)

___IV.B.1. MAXIMUM CONTAMINANT LEVEL GOAL (MCLG) for Drinking Water

Value -- 0 mg/L (Proposed, 1990)

Considers technological or economic feasibility? -- NO

Discussion -- The proposed MCLG for dichloromethane is zero based on the evidence of carcinogenic potential (B2).

Reference -- 55 FR 30370 (07/25/90)

EPA Contact -- Health and Ecological Criteria Division / OST /
(202) 260-7571 / FTS 260-7571; or Safe Drinking Water Hotline / (800) 426-4791

___IV.B.2. MAXIMUM CONTAMINANT LEVEL (MCL) for Drinking Water

Value -- 0.005 mg/L (Proposed, 1990)

Considers technological or economic feasibility? -- YES

Discussion -- The proposed MCL is equal to the PQL of 0.005 and is associated with a maximum lifetime individual risk of E-5.

Monitoring requirements -- All systems monitored every 3 or 5 years (dependent upon system size), except for non-vulnerable surface water systems with no detection of VOCs; vulnerable systems to be monitored quarterly; repeat monitoring dependent upon vulnerability, detection and system size.

Analytical methodology -- Purge and trap gas chromatography (EPA 503.1); purge and trap gas chromatographic/mass spectrometry (EPA 524.1): PQL= 0.005 mg/L.

Best available technology -- Packed tower aeration.

Reference -- 55 FR 30370 (07/25/90)

EPA Contact -- Drinking Water Standards Division / OGWDW /
(202) 260-7575 / FTS 260-7575; or Safe Drinking Water Hotline / (800) 426-4791

___IV.B.3. SECONDARY MAXIMUM CONTAMINANT LEVEL (SMCL) for Drinking Water

No data available

___IV.B.4. REQUIRED MONITORING OF "UNREGULATED" CONTAMINANTS

Status -- Listed (Final, 1987)

Discussion -- "Unregulated" contaminants are those contaminants for which EPA establishes a monitoring requirement but which do not have an associated final MCLG, MCL, or treatment technique. EPA may regulate these contaminants in the future.

Monitoring requirement -- Monitoring required for all water systems at a minimum frequency of once every 5 years.

Analytical methodology -- Gas chromatography (EPA 502.1, 502.2, 503.1); gas chromatographic/mass spectrometry (EPA 524.1, 524.2).

Reference -- 56 FR 25690 (07/08/87)

EPA Contact -- Drinking Water Standards Division / OGWDW /
(202) 260-7575 / FTS 260-7575; or Safe Drinking Water Hotline / (800) 426-4791

__IV.C. CLEAN WATER ACT (CWA)

___IV.C.1. AMBIENT WATER QUALITY CRITERIA, Human Health

Water and Fish Consumption: 1.9E-1 ug/L

Fish Consumption Only: 1.57E+1 ug/L

Considers technological or economic feasibility? -- NO

Discussion -- Methylene chloride is classified as a carcinogen, and under the assumption of no threshold for a carcinogen, the recommended WQC is zero. However, if zero cannot be obtained and exposure is via ingestion of water and aquatic organisms, 0.19 ug/L is associated with an upper-bound excess lifetime risk of 1.0E-6 [other risk levels to consider: 1.0E-5 (1.9 ug/L) and 1.0E-7 (0.019 ug/L)]. If exposure is only via ingestion of aquatic organisms, the WQC associated with an upper-bound excess lifetime risk of 1.0E-6 is 15.7 ug/L.
The criteria are based on halomethanes as a class.

Reference -- 45 FR 79318 (11/13/80)

EPA Contact -- Criteria and Standards Division / OWRS
(202)260-1315 / FTS 260-1315

___IV.C.2. AMBIENT WATER QUALITY CRITERIA, Aquatic Organisms

Freshwater:

Acute LEC -- 1.1E+4 ug/L
Chronic -- None

Marine:

Acute LEC -- 1.2E+4 ug/L
Chronic LEC -- 6.4E+3 ug/L

Considers technological or economic feasibility? -- NO

Discussion -- The values that are indicated as "LEC" are not criteria, but are the lowest effect levels found in the literature. LECs are given when the minimum data required to derive water quality criteria are not available. The values given represent halomethanes as a class.

Reference -- 45 FR 79318 (11/13/80)

EPA Contact -- Criteria and Standards Division / OWRS
(202)260-1315 / FTS 260-1315

__IV.D. FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

No data available

__IV.E. TOXIC SUBSTANCES CONTROL ACT (TSCA)

___IV.E.1. TSCA, SECTION 6

Status -- Advance Notice of Proposed Rulemaking (ANPR) (1985)

Discussion -- Initiated priority review under TSCA, sect. 6, of risks from cancer which may be associated with certain exposures to methylene chloride. Receipt of a positive NTP bioassay triggered an accelerated analysis under TSCA, sect. 4(f). Based on its preliminary analysis, the Agency decided that methylene chloride should be classified as a B2 probable human carcinogen under its Interim Cancer Guidelines. TSCA, sect. 4(f), requires that the Agency initiate appropriate action under sect. 5, 6, or 7 within a 180-day period of receipt of health effect information which triggers a sect. 4(f) decision. The sect. 6 ANPR initiated appropriate action.

Reference: 50 FR 42005 (10/17/85)

EPA Contact -- Chemical Control Division / OTS (202)260-3749 / FTS 260-3749

__IV.F. RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

___IV.F.1. RCRA APPENDIX IX, for Ground Water Monitoring

Status -- Listed

Reference -- 52 FR 25942 (07/09/87)

EPA Contact -- RCRA/Superfund Hotline
(800)424-9346 / (202)260-3000 / FTS 260-3000

__IV.G. SUPERFUND (CERCLA)

___IV.G.1. REPORTABLE QUANTITY (RQ) for Release into the Environment

Value (status) -- 1000 pounds (Final, 1985)

Considers technological or economic feasibility? -- NO

Discussion -- The final adjusted RQ of 1000 pounds is based upon a chronic toxicity score of 10. This substance has recently been identified for assessment of carcinogenicity, and the RQ will be reevaluated when that assessment is completed.

Reference -- 50 FR 13456 (04/04/85); 54 FR 33418 (08/14/89)

EPA Contact -- RCRA/Superfund Hotline
(800)424-9346 / (202)260-3000 / FTS 260-3000

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_V. SUPPLEMENTARY DATA

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride

Not available at this time.

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_VI. BIBLIOGRAPHY

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride
Last Revised -- 08/01/91

__VI.A. ORAL RfD REFERENCES

Haun, C.C., E.H. Vernot, K.I. Darmer Jr. and S.S. Diamond. 1972. Continous animal exposure to low levels of dichloromethane. AMRL-TR-72-13. In: Proceedings of the 3rd Annual Conference on Environmental Toxicology, Wright-Patterson Air Force Base, Ohio, Aerospace Medical Research Laboratory. p. 199-208.

National Coffee Association. 1982. 24-Month chronic toxicity and oncogenicity
study of methylene chloride in rats. Final Report. Prepared by Hazleton Laboratories America, Inc., Vienna, VA. (Unpublished)

U.S. EPA. 1985. Drinking Water Criteria Document for Methylene Chloride. Office of Drinking Water, Washington, DC.

__VI.B. INHALATION RfD REFERENCES

None

__VI.C. CARCINOGENICITY ASSESSMENT REFERENCES

Andersen, M.E., H.J. Clewell, III, M.L. Gargas, F.A. Smith and R.H. Reitz. 1987. Physiologically based pharmacokinetics and the risk assessment process for methylene chloride. Toxicol. Appl. Pharmacol. 87: 185-205.

Burek, J.D., K.D. Nitschke, T.J. Bell, et al. 1984. Methylene chloride: A two year inhalation toxicity and oncogenicity study in rats and hamsters. Fund. Appl. Toxicol. 4: 30-47.

Callen, D.F., C.R. Wolf and R.M. Philpot. 1980. Cytochrome P-450 mediated genetic activity and cytotoxicity of seven halogenated aliphatic hydrocarbons in Saccharomyces cerevisiae. Mutat. Res. 77: 55-63.

Dow Chemical Company. 1982. Methylene chloride: A two-year inhalation and oncogenicity study in rats. Toxicology Research Laboratory, Health and Environmental Sciences, Dow Chemical Company, Midland, MI.

Friedlander, B.R., F.T. Hearne and S. Hall. 1978. Epidemiologic investigation of employees chronically exposed to methylene chloride. J. Occup. Med. 20(10): 657-666.

Green, T. 1983. The metabolic activation of dichloromethane and chlorofluoromethane in a bacterial mutation assay using Salmonella typhimurium. Mutat. Res. 118(4): 277-288.

Hatch, G.G., P.D. Mamay, M.L. Ayer, B.C. Casto and S. Nesnow. 1983. Chemical enhancement of viral transformation in Syrian hamster embryo cells by gaseous and volatile chlorinated methanes and ethanes. Cancer Res. 43: 1945-1950.

Hearne, F.T. and B.R. Friedlander. 1981. Follow-up of methylene chloride study. J. Occup. Med. 23: 660.

Hearne, F.T., F. Grose, J.W. Pifer and B.R. Friedlander. 1986. Methylene chloride mortality study update. Eastman Kodak Company, Rochester, NY. June 16.

Hearne, F.T., F Grose, J.W. Pifer, B.R. Friedlander and R.L. Raleigh. 1987. Methylene Chloride mortality study: dose-response characterization and animal model comparison. J. Occup. Med. 29 (3): 217-228.

Heppel, L.A., P.A. Neal, T.L. Perrin, M.L. Orr and V.T. Porterfield. 1944. Toxicology of dichloromethane (methylene chloride). I. Studies on effects of daily inhalation. J. Ind. Hyg. Toxicol. 26(1): 8-21.

Lefevre, P.A. and J. Ashby. 1989. Evaluation of dichloromethane as an inducer of DNA synthesis in B6C3F1 mouse liver. Carcinogenesis. 10(6): 1067-1072.

MacEwen, J.D., E.H. Vernot and C.C. Haun. 1972. Continuous animal exposure to dichloromethane. AMRL-TR-72-28, Systems Corporation Report No. W-71005. Wright Patterson Air Force Base, Ohio, Aerospace Medical Research. AD746295.

NCA (National Coffee Association). 1982. Twenty-four-month chronic toxicity and oncogenicity study of methylene chloride in rats. Final Report. Prepared by Hazleton Laboratories, America, Inc., Vienna, VA. Unpublished.

NCA (National Coffee Association). 1983. Twenty-four month oncogenicity study of methylene chloride in mice. Final Report. Prepared by Hazleton Laboratories, America, Inc., Vienna, VA.

NTP (National Toxicology Program). 1982. Draft technical report on the carcinogenesis bioassay of dichloromethane (methylene chloride) (CAS No. 75-09-2) in F344/N rats and B6C3F1 mice (gavage study). Research Triangle Park, NC and Bethesda, MD. Unpublished. NTP-82-061.

NTP (National Toxicology Program). 1986. Toxicology and carcinogenesis studies of dichloromethane (methylene chloride) (CAS No. 75-09-2) in F344/N rats and B6C3F1 mice (inhalaltion studies). NTP-TRS-306.

Ott, M.G., L.K. Skory, B.B. Holder, J.M. Bronson and P.R. Williams. 1983. Health evaluation of employees occupationally exposed to methylene chloride: Mortality. Scand. J. Work Environ. Health. 9(Suppl. 1): 8-16.

Price, P.J., C.M. Hassett and J.I. Mansfield. 1978. Transforming activities of trichloroethylene and proposed industrial alternatives. In Vitro. 14(3): 290-293.

Thiess, J.C., G.D. Stoner, M.B. Shimkin and E.K. Weisburger. 1977. Test for carcinogenicity of organic contaminants of United States drinking waters by pulmonary tumor response in strain A mice. Cancer Res. 37: 2717-2720.

Toxic Substances Control Act. 1989. Section 8(e) submission no. 8eHQ-0198-0772 FLWP et seq.

U.S. EPA. 1985a. Health Assessment Document for Dichloromethane (Methylene Chloride). Final Report. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-82/004F.

U.S. EPA. 1985b. Addendum to the Health Assessment Document for Dichloromethane (methylene chloride). Updated carcinogenicity assessment. Prepared by the Carcinogen Assessment Group, OHEA, Washington, DC. EPA/600/8-82/004FF.

U.S. EPA. 1987a. Update to the Health Assessment Document and Addendum for Dichloromethane (Methylene Chloride): Pharmacokinetics, Mechanism of Action and Epidemiology. Review Draft. Office of Health and Environmental Assessment, Washington, DC. EPA/600/8-87/030A.

U.S. EPA. 1987b. Technical Analysis of New Methods and Data Regarding Dichloromethane Hazard Assessments. Review Draft. Office of Health and Environmental Assessment, Washington, DC. EPA/600/8- 87/029A.

__VI.D. DRINKING WATER HA REFERENCES

Bornmann, G., and A. Loeser. 1967. Zur Frage einer chronisch-toxischen Wirkung von Dichloromethan. Z. Lebensm.-Unters. Forsch. 136: 14-18.

Kimura, E.T., D.M. Ebert and P.W. Dodge. 1971. Acute toxicity and limits of solvent residue for sixteen organic solvents. Toxicol. Appl. Pharmacol. 19: 699-704.

National Coffee Association. 1982. 24-Month chronic toxicity and oncogenicity
study of methylene chloride in rats. Final Report. Prepared by Hazleton Laboratories America, Inc., Vienna, VA. (Unpublished)

U.S. EPA. 1985. Final Draft of the Drinking Water Criteria Document on Dichloromethane. Office of Drinking Water, Washington, DC.

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_VII. REVISION HISTORY

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride

Date	Section	Description
04/20/87	II.C.1.	Unit Risk corrected from 4.1E-4 to 4.1E-6
05/21/87	II.A.2.	Missing text replaced in 3rd paragraph
03/01/88	I.A.1.	Dose conversion clarified
03/01/88	I.A.2.	Text revised
03/01/88	II.B.3.	Text revised
03/01/88	II.B.4.	Confidence statement revised
03/01/88	II.C.3.	Text revised
03/01/88	II.C.4.	Confidence statement revised
03/01/88	II.D.3.	Primary contact changed

03/01/88	III.A.	Health Advisory added
01/01/89	II.	Carcinogen summary noted as pending change
10/01/89	II.B.3.	Inhalation rate corrected in paragraph 1
10/01/89	II.C.2.	Dose corrections in mg/kg/day
10/01/89	II.C.3.	Inhalation rate corrected in paragraph 1
10/01/89	II.D.3.	Contacts phone number changed
08/01/90	IV.F.1.	EPA contact changed
09/01/90	II.	Carcinogen assessment revised following re-evaluation
09/01/90	II.C.1.	Inhalation unit risk changed
09/01/90	VI.	Bibliography on-line
01/01/91	II.C.1.	Paragraph moved to II.C.3.
01/01/91	II.C.1.	Inhalation slope factor removed (global change)
08/01/91	VI.C.	Citations clarified
09/01/91	I.B.	Inhalation RfC now under review
01/01/92	IV.	Regulatory actions updated

SYNONYMS

Substance Name -- Dichloromethane
CASRN -- 75-09-2
Primary Synonym -- Methylene Chloride
Last Revised -- 01/31/87

75-09-2
Aerothene MM
Chlorure de methylene
DCM
Dichlormethan, uvasol
Dichloromethane
1,1-Dichloromethane.
Freon 30
Methane dichloride
Methane, dichloro-
Methylene bichloride
Methylene Chloride
Methylene dichloride
Metylenu chlorek
Narkotil
NCI-C50102
R 30
Solaesthin
Solmethine
WLN: G1G

0197
1,1,1-Trichloroethane; CASRN 71-55-6 (07/01/93)

Health risk assessment information on a chemical is included in IRIS only after a comprehensive review of chronic toxicity data by work groups composed of U.S. EPA scientists from several Program Offices. The summaries presented in Sections I and II represent a consensus reached in the review process. The other sections contain U.S. EPA information which is specific to a particular EPA program and has been subject to review procedures prescribed by that Program Office. The regulatory actions in Section IV may not be based on the most current risk assessment, or may be based on a current, but unreviewed, risk assessment, and may take into account factors other than health effects (e.g., treatment technology). When considering the use of regulatory action data for a particular situation, note the date of the regulatory action, the date of the most recent risk assessment relating to that action, and whether technological factors were considered. Background information and explanations of the methods used to derive the values given in IRIS are provided in the five Background Documents in Service Code 5, which correspond to Sections I through V of the chemical files.

STATUS OF DATA FOR 1,1,1-Trichloroethane

File On-Line 03/31/87

Category (section)	Status	Last Revised
Oral RfD Assessment (I.A.)	withdrawn	08/01/91
Inhalation RfC Assessment (I.B.)	pending	
Carcinogenicity Assessment (II.)	on-line	09/01/90
Drinking Water Health Advisories (III.A.)	on-line	09/01/90
U.S. EPA Regulatory Actions (IV.)	on-line	04/01/93
Supplementary Data (V.)	no data	

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_I. CHRONIC HEALTH HAZARD ASSESSMENTS FOR NONCARCINOGENIC EFFECTS

__I.A. REFERENCE DOSE FOR CHRONIC ORAL EXPOSURE (RfD)

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6

The oral RfD for this substance has been withdrawn pending further review by the RfD/RfC Work Group.

Contact: Michael L. Dourson / OHEA / 513/569-7533

__I.B. REFERENCE CONCENTRATION FOR CHRONIC INHALATION EXPOSURE (RfC)

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6

A risk assessment for this substance/agent is under review by an EPA work group.

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_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6
Last Revised -- 09/01/90

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

__II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

___II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- D; not classifiable as to human carcinogenicity.

Basis -- There are no reported human data and animal studies (one lifetime gavage, one intermediate-term inhalation) have not demonstrated carcinogenicity. Technical grade 1,1,1-trichloroethane has been shown to be weakly mutagenic, although the contaminant, 1,4-dioxane, a known animal carcinogen, may be responsible for this response.

___II.A.2. HUMAN CARCINOGENICITY DATA

None.

___II.A.3. ANIMAL CARCINOGENICITY DATA

Inadequate. The NCI (1977) treated Osborne-Mendel rats (50/sex/dose) with 750 or 1500 mg/kg technical-grade 1,1,1-trichloroethane 5 times/week for 78 weeks by gavage. The rats were observed for an additional 32 weeks. Twenty rats of each sex served as untreated controls. Low survival of both male and female treated rats (3%) may have precluded detection of a significant number of tumors late in life. Although a variety of neoplasms was observed in both treated and matched control rats, they were common to aged rats and were not dose-related. Similar results were obtained when the NCI (1977) treated B6C3F1 hybrid mice with the time-weighted average doses of 2807 or 5615 mg/kg 1,1,1-trichloroethane by gavage 5 days/week for 78 weeks. The mice were observed for an additional 12 weeks. The control and treated groups had 20 and 50 animals of each sex, respectively. Only 25 to 45% of those treated survived until the time of terminal sacrifice. A variety of neoplasms were observed in treated groups, but the incidence not statistically different from matched controls.

Quast et al. (1978) exposed 96 Sprague-Dawley rats of both sexes to 875 or 1750 ppm 1,1,1-trichloroethane vapor for 6 hours/day, 5 days/week for 12 months, followed by an additional 19-month observation period. The only significant sign of toxicity was an increased incidence of focal hepatocellular alterations in female rats at the highest dosage. It was not evident that a maximum tolerated dose (MTD) was used nor was a range-finding study conducted. No significant dose-related neoplasms were reported, but these dose levels were below those used in the NCI study.

___II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

Mutagenicity testing of 1,1,1-trichloroethane has produced positive results in S. typhimurium strain TA100 (Simmon et al., 1977; Fishbein, 1979; Snow et al., 1979) as well as some negative results (Henschler et al., 1977; Taylor, 1978).

It was mutagenic for S. typhimurium strain TA1535 both with exogenous metabolic activation (Farber, 1977) and without activation (Nestmann et al., 1980). 1,1,1-Trichloroethane did not result in gene conversion or mitotic recombination in Saccharomyces cerevisiae (Farber, 1977; Simmon et al., 1977) nor was it positive in a host-mediated forward mutation assay using

Schizosaccharomyces pombe in mice. The chemical also failed to produce chromosomal aberrations in the bone marrow of cats (Rampy et al., 1977), but responded positively in a cell transformation test with rat embryo cells (Price et al., 1978).

An isomer, 1,1,2-trichloroethane, is carcinogenic in mice, inducing liver cancer and pheochromocytomas in both sexes. Dichloroethanes, tetrachloroethanes and hexachloroethanes also produced liver cancer in mice and other types of neoplasms in rats.

It should be noted that 1,4-dioxane, a known animal carcinogen that causes liver and nasal tumors in more than one strain of rats and hepatocellular carcinomas in mice, is a contaminant of technical-grade 1,1,1-trichlorethane.

__II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available.

__II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

Not available.

__II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

___II.D.1. EPA DOCUMENTATION

Source Document -- U.S. EPA, 1984a,b

The 1984 Health Effects Assessment for 1,1,1-Trichloroethane has received limited Agency review. The values in the 1984 Health Assessment Document for 1,1,1-Trichloroethane have received both Agency and public review.

___II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

Agency Work Group Review -- 08/05/87

Verification Date -- 08/05/87

___II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Charlingayya Hiremath / OHEA -- (202)260-5898

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_III. HEALTH HAZARD ASSESSMENTS FOR VARIED EXPOSURE DURATIONS

__III.A. DRINKING WATER HEALTH ADVISORIES

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6
Last Revised -- 09/01/90

The Office of Drinking Water provides Drinking Water Health Advisories (HAs) as technical guidance for the protection of public health. HAs are not enforceable Federal standards. HAs are concentrations of a substance in drinking water estimated to have negligible deleterious effects in humans, when ingested, for a specified period of time. Exposure to the substance from other media is considered only in the derivation of the lifetime HA. Given the absence of chemical-specific data, the assumed fraction of total intake from drinking water is 20%. The lifetime HA is calculated from the Drinking Water Equivalent Level (DWEL) which, in turn, is based on the Oral Chronic Reference Dose. Lifetime HAs are not derived for compounds which are potentially carcinogenic for humans because of the difference in assumptions concerning toxic threshold for carcinogenic and noncarcinogenic effects. A more detailed description of the assumptions and methods used in the derivation of HAs is provided in Background Document 3 in Service Code 5.

___III.A.1. ONE-DAY HEALTH ADVISORY FOR A CHILD

One-day HA -- 1E+2 mg/L

NOAEL -- 1400 mg/kg/day
UF -- 100 (allows for interspecies and intrahuman variability with the use of a NOAEL from an animal study)
Assumptions -- 1 L/day water consumption for a 10-kg child

Principal Study -- Vainio et al., 1976

A single oral dose of approximately 1400 mg/kg of 1,1,1-trichloroethane depressed some hepatic microsomal metabolic indices (including cytochrome P-450 and epoxide hydrase) in rats but resulted in no other adverse effects. This level can be viewed as a NOAEL in this study.

___III.A.2. TEN-DAY HEALTH ADVISORY FOR A CHILD

Appropriate data for calculating a Ten-day HA are not available. It is recommended that the Longer-term HA for the 10-Kg child of 40 mg/L be used as the Ten-day HA.

___III.A.3. LONGER-TERM HEALTH ADVISORY FOR A CHILD

Longer-term (Child) HA -- 4E+1 mg/L

NOAEL -- 350 mg/kg/day
UF -- 100 (allows for interspecies and intrahuman variability with the use of a NOAEL from an animal study)
Assumptions -- 1 L/day water consumption for a 10-kg child

Principal Study -- Bruckner et al., 1985

Rats were administered 1,1,1-trichloroethane by gavage 5 times/week for 12 weeks at levels of 0, 0.5, 2.5, or 5.0 g/kg/day. At levels above 0.5 g/kg reduced body weight gain and CNS effects were observed. Approximately 35% of these rats died during the first 50 days of the study. Also, the 5.0 g/kg/day dose group showed an increase in serum enzyme levels. The 0.5 g/kg/day level is identified as the NOAEL for this study. Based on a 7-day per week dosing regimen, this level would be equivalent to 350 mg/kg/day.

___III.A.4. LONGER-TERM HEALTH ADVISORY FOR AN ADULT

Longer-term (Adult) HA -- 1E+2 mg/L

NOAEL -- 350 mg/kg/day
UF -- 100 (allows for interspecies and intrahuman variability with the use of a NOAEL from an animal study)
Assumptions -- 2 L/day water consumption for a 70-kg adult

Principal Study -- Bruckner et al., 1985 (study described in III.A.3.)

___III.A.5. DRINKING WATER EQUIVALENT LEVEL / LIFETIME HEALTH ADVISORY

DWEL -- 1E+0 mg/L

Assumptions -- 2 L/day water consumption for a 70-kg adult

RfD Verification Date -- 05/15/86

Lifetime HA -- 2E-1 mg/L

Assumptions -- 20% exposure by drinking water

Principal Study -- McNutt et al., 1975

Male mice were continuously exposed to 1,1,1-trichloroethane via inhalation at 0, 1365 mg/cu.m, or 5460 mg/cu.m 6 hours/day for 14 weeks. Animals exposed to 5460 mg/cu.m displayed significant changes in the centrilobular hepatocytes. Based on the conditions of exposure and an assumed absorption rate of 30%, the LOAEL of 1365 mg/cu.m is equivalent to 35 mg/kg/day.

___III.A.6. ORGANOLEPTIC PROPERTIES

No information is available on the organoleptic properties of 1,1,1-trichloroethane.

___III.A.7. ANALYTICAL METHODS FOR DETECTION IN DRINKING WATER

Analysis of 1,1,1-trichloroethane is by a purge-and-trap gas chromatographic procedure used for the determination of volatile organohalides in drinking water. Confirmatory analysis is by mass spectrometry.

___III.A.8. WATER TREATMENT

Treatment technologies which will remove 1,1,1-trichloroethane from water include granular activated carbon adsorption and boiling. Air stripping is also an effective method; however, this process transfers the contaminant directly to the air stream.

___III.A.9. DOCUMENTATION AND REVIEW OF HAs

U.S. EPA. 1985. Final Drinking Water Criteria Document on 1,1,1-Trichloroethane. Office of Drinking Water, Washington, DC.

EPA review of HAs in 1985.

Public reviews of HAs folling notification of availability in October, 1985.

Science Advisory Board review of HAs in January, 1986.

Preparation date of this IRIS summary -- 08/20/90

___III.A.10. EPA CONTACTS

Charles Abernathy / OST -- (202)260-5374

Edward V. Ohanian / OST -- (202)260-7571

__III.B. OTHER ASSESSMENTS

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6

Content to be determined.

_IV. U.S. EPA REGULATORY ACTIONS

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6
Last Revised -- 04/01/93

EPA risk assessments may be updated as new data are published and as assessment methodologies evolve. Regulatory actions are frequently not updated at the same time. Compare the dates for the regulatory actions in this section with the verification dates for the risk assessments in sections I and II, as this may explain inconsistencies. Also note that some regulatory actions consider factors not related to health risk, such as technical or economic feasibility. Such considerations are indicated for each action. In addition, not all of the regulatory actions listed in this section involve enforceable federal standards. Please direct any questions you may have concerning these regulatory actions to the U.S. EPA contact listed for that particular action. Users are strongly urged to read the background information on each regulatory action in Background Document 4 in Service Code 5.

__IV.A. CLEAN AIR ACT (CAA)

No data available

__IV.B. SAFE DRINKING WATER ACT (SDWA)

____IV.B.1. MAXIMUM CONTAMINANT LEVEL GOAL (MCLG) for Drinking Water

Value (status) -- 0.2 mg/L (Final, 1985)

Considers technological or economic feasibility? -- NO

Discussion -- An MCLG of 200 ug/L (0.2 mg/L) for 1,1,1-trichloroethane is proposed based upon a DWEL and an assumed drinking water contribution of 20%. A DWEL of 1.0 mg/L was calculated based on liver toxicity in mice (inhalation study).

Reference -- 50 FR 46880 (11/13/85)

EPA Contact -- Health and Ecological Criteria Division / OST /
(202) 260-7571 / FTS 260-7571; or Safe Drinking Water Hotline / (800) 426-4791

___IV.B.2. MAXIMUM CONTAMINANT LEVEL (MCL) for Drinking Water

Value (status) -- 0.2 mg/L (Final, 1987)

Considers technological or economic feasibility? -- NO

Discussion -- EPA has set an MCL equal to the MCLG.

Reference -- 52 FR 25690 (07/08/87); 56 FR 30266 (07/01/91)

Monitoring requirements -- All systems to be monitored for four consecutive quarters; repeat monitoring dependent upon detection, vulnerability status and system size.

Analytical methodology -- Gas chromatography (EPA 502.1, 502.2, 503.1); gas chromatographic/mass spectrometry (EPA 524.1, 524.2).

Best available technology -- Packed tower aeration; granular activated carbon.

EPA Contact -- Drinking Water Standards Division / OGWDW /
(202) 260-7575 / FTS 260-7575; or Safe Drinking Water Hotline / (800) 426-4791

___IV.B.3. SECONDARY MAXIMUM CONTAMINANT LEVEL (SMCL) for Drinking Water

No data available

___IV.B.4. REQUIRED MONITORING OF "UNREGULATED" CONTAMINANTS

No data available

__IV.C. CLEAN WATER ACT (CWA)

___IV.C.1. AMBIENT WATER QUALITY CRITERIA, Human Health

No data available

___IV.C.2. AMBIENT WATER QUALITY CRITERIA, Aquatic Organisms

Freshwater:

Acute LEC -- 1.8E+4 ug/L
Chronic LEC -- None

Marine:

Acute LEC -- 3.12E+4 ug/L
Chronic LEC -- None

Considers technological or economic feasibility? -- NO

Discussion -- The values that are indicated as "LEC" are not criteria, but are the lowest effect levels found in the literature. LECs are given when the minimum data required to derive water quality criteria are not available.

Reference -- 45 FR 79318 (11/28/80)

EPA Contact -- Criteria and Standards Division / OWRS
(202)260-1315 / FTS 260-1315

__IV.D. FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

___IV.D.1. PESTICIDE ACTIVE INGREDIENT, Registration Standard

Status -- List "C" Pesticide

Reference -- 54 FR 30846 (07/24/89)

EPA Contact -- Registration Branch / OPP
(703)557-7760 / FTS 557-7760

___IV.D.2. PESTICIDE ACTIVE INGREDIENT, Special Review

No data available

__IV.E. TOXIC SUBSTANCES CONTROL ACT (TSCA)

___IV.E.1. TSCA, SECTION 6

Status -- Advance Notice of Proposed Rulemaking (ANPR) (1985)

Discussion -- EPA is developing a comprehensive and integrated strategy for a regulatory investigation of six solvents, including 1,1,1-trichloroethane.

Reference: 50 FR 42005 (10/17/85); 40 CFR 754

EPA Contact -- Chemical Control Division / OTS (202)260-3749 / FTS 260-3749

__IV.F. RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

___IV.F.1. RCRA APPENDIX IX, for Ground Water Monitoring

Status -- Listed

Reference -- 52 FR 25942 (07/09/87)

EPA Contact -- RCRA/Superfund Hotline
(800)424-9346 / (202)260-3000 / FTS 260-3000

__IV.G. SUPERFUND (CERCLA)

___IV.G.1. REPORTABLE QUANTITY (RQ) for Release into the Environment

Value (status) -- 1000 pounds (Final, 1985)

Considers technological or economic feasibility? -- NO

Discussion -- The final RQ is based on aquatic and chronic toxicity. Available data indicate a 96-hour Median Threshold Limit between 10 and 100 ppm, which corresponds to an RQ of 1000 pounds. RQ assignments based on chronic toxicity reflect two primary attributes, the minimum effect dose (MED) levels for chronic exposure (mg/day for 70-kg man) and the type of effect (teratogenicity, etc.). The composite score of these attributes for this substance is 6.0, corresponding to an RQ of 1000 pounds.

Reference -- 50 FR 13456 (04/04/85); 54 FR 33418 (08/14/89)

EPA Contact -- RCRA/Superfund Hotline
(800)424-9346 / (202)260-3000 / FTS 260-3000

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_V. SUPPLEMENTARY DATA

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6

Not available at this time.

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_VI. BIBLIOGRAPHY

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6
Last Revised -- 08/01/91

__VI.A. ORAL RfD REFERENCES

Not available at this time

__VI.B. INHALATION RfD REFERENCES

None

__VI.C. CARCINOGENICITY ASSESSMENT REFERENCES

Farber, H. 1977. Manager of Environmental Affairs, Dow Chemical letter to James Price, Chief of Air Quality Data Analysis, Texas Air Control Board, Austin, TX. (Cited in: NCI, 1977)

Fishbein, L. 1979. Potential halogenated industrial carcinogenic and mutagenic chemicals. II. Halogenated saturated hydrocarbons. Sci. Total Environ. 11: 163.

Henschler, D., E. Eder, T. Neudecker and M. Metzler. 1977. Carcinogenicity of trichloroethylene: Fact or artifact? Arch. Toxicol. 37: 233-236.

NCI (National Cancer Institute). 1977. Bioassay of 1,1,1-trichloroethane for possible carcinogenicity. Carcinog. Tech. Rep. Ser. No. 3, NCI-CG-TR-3.

Nestmann, E.R., E.G.H. Lee, T.I. Matula, G.R. Douglas and J.C. Mueller. 1980. Mutagenicity of constituents identified in pulp and paper mill effluents using the Salmonella/mammalian-microsome assay. Mutat. Res. 79: 203-212.

Price, P.J., C.M. Hassett and J.I. Mansfield. 1978. Transforming activities of trichloroethylene and proposed industrial alternatives. In vitro. 14: 290-293.

Quast, J.F., B.K.J. Leong, L.W. Rampy and P.J. Gehring. 1978. Toxicologic and carcinogenic evaluation of a methylchloroform (1,1,1-trichloroethane) formulation by chronic inhalation in rats - interim report after 24 months. Dow Chemical Co., Midland, MI.

Rampy, L.W., J.F. Quast, B.K.J. Leong and P.J. Gehring. 1977. Results of long-term inhalation toxicity studies on rats of 1,1,1-trichloroethane and perchloroethylene formulations. In: Proc. Int. Cong. Toxicol. Toronto.

Simmon, V.F., K. Kauhanen and R.G. Tardiff. 1977. Mutagenic activity of chemicals identified in drinking water. In: Progress in Genetic Toxicology, D. Scott et al., Ed. Elsevier/North Holland Biomedical Press, Amsterdam.

Snow, L.P., B.C. Nair and B.C. Castro. 1979. Mutagenesis testing of methylene chloride and 1,1,1-trichloroethane in Salmonella strains TA100 and TA98. Northrop Services, Inc., Research Triangle Park, NC.

Taylor, G. 1978. Personal communication. NIOSH, Morgantown, WV. (Cited in: U.S. EPA, 1984a)

U.S. EPA. 1984a. Health Effects Assessment for 1,1,1-Trichloroethane. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA. 1984b. Health Assessment Document for 1,1,1-Trichloroethane. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, NC. EPA-600/8-82-003F.

__VI.D. DRINKING WATER HA REFERENCES

Bruckner, J.B., S. Muralidhara, W.F.Mackenzie, G.M. Kyle and R. Luthra. 1985. Acute and subacute oral toxicity studies of 1,1,1-trichloroethane (TRI) in rats. The Toxicologist. 5(1): 100.

McNutt, N., R. Amster, E. McConnell and F. Morris. 1975. Hepatic lesions in mice after continuous exposure to 1,1,1-trichloroethane. Lab. Invest. 32: 642-654.

U.S. EPA. 1985. Final Drinking Water Criteria Document on 1,1,1-Trichloroethane. Office of Drinking Water, Washington, DC.

Vainio, H., M.A. Parkki and J.A. Marniemi. 1976. Effects of aliphatic chlorohydrocarbons on drug-metabolizing enzymes in rat liver in vivo. Xenobiotica. 6: 599.

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_VII. REVISION HISTORY

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6

Date	Section	Description
09/30/87	IV.	Regulatory Action section on-line
03/01/88	I.A.4.	Text clarified
06/30/88	IV.B.2.	Units corrected for MCL
06/30/88	I.A.7.	Contacts switched
09/07/88	II.	Carcinogen summary on-line
06/01/89	II.D.3.	Secondary contact deleted
03/01/90	VI.	Bibliography on-line
05/01/90	I.A.	Oral RfD summary noted as pending change
05/01/90	I.B.	Inhalation RfC now under review
09/01/90	I.A.	Text edited
09/01/90	II.	Text edited
09/01/90	III.A.	Health Advisory on-line
09/01/90	IV.F.1.	EPA contact changed
09/01/90	VI.C.	Snow et al. 1979 citation clarified
09/01/90	VI.D.	Health Advisory references added
08/01/91	I.A.	Withdrawn pending further review
08/01/91	VI.A.	Oral RfD references withdrawn
08/01/91	VI.C.	Citations clarified
01/01/92	IV.	Regulatory actions updated
10/01/92	IV.B.1.	MCLG value corrected
10/01/92	IV.B.2.	MCL value corrected
04/01/93	IV.C.1.	Withdrawn; mandated by National Toxics Rule

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SYNONYMS

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6
Last Revised -- 03/31/87

71-55-6
AEROTHENE TT
CHLOROETENE
CHLOROETHENE
CHLOROETHENE NU
CHLOROFORM, METHYL-
CHLOROTHANE NU
CHLOROTHENE
CHLOROTHENE NU
CHLOROTHENE VG
CHLORTEN
ETHANE, 1,1,1-TRICHLORO-
INHIBISOL
METHYLCHLOROFORM
METHYLTRICHLOROMETHANE
NCI-C04626
RCRA WASTE NUMBER U226
STROBANE
alpha-T
1,1,1-TCE
1,1,1-TRICHLOORETHAAN
1,1,1-TRICHLORAETHAN
Trichloroethane, 1,1,1-
alpha-TRICHLOROETHANE
1,1,1-TRICLOROETANO
TRI-ETHANE
UN 2831

APPLICATION TO CONSTRUCT
AIR POLLUTION SOURCE
FOAMEX, L.P.
FOAM MANUFACTURING FACILITY

Orlando, Florida
December 3, 1992
revised December 13, 1993

prepared for:

Foamex, L.P.
1351 Gemini Boulevard
Orlando, Florida 32821

for submittal to:

Florida Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Harding Lawson Associates - Cross/Tessitore & Associates, P.A.
4763 S. Conway Road
Orlando, Florida 32812
(407) 851-1484 FAX: (407) 855-0369

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1.0 APPLICATION FORM

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKE
SECRETAR

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Flexible Polyurethane Foam Manufacturing [ ] New[1] [X] Existing[1]

APPLICATION TYPE: [X] Construction [ ] Operation [ ] Modification

COMPANY NAME: Foamex, L.P. COUNTY: Orange

Identify the specific emission point source(s) addressed in this application (i.e. Lime Kiln No. 4 with Venturi Scrubber; Peaking Unit No. 2, Gas Fired) See Attached

SOURCE LOCATION: Street 1351 Gemini Boulevard City Orlando

UTM: East 461,037 North 3,142,939

Latitude 28 ° 24 ' 15 "N Longitude 81 ° 23 ' 40 "W

APPLICANT NAME AND TITLE: Charles Eavenson, Plant Manager

APPLICANT ADDRESS: 1351 Gemini Boulevard, Orlando, FL 32821

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Foamex, L.P.

I certify that the statements made in this application for a Construction permit are true, correct and complete to the best of my knowledge and belief. Further, I agree to maintain and operate the pollution control source and pollution control facilities in such a manner as to comply with the provision of Chapter 403, Florida Statutes, and all the rules and regulations of the department and revisions thereof. I also understand that a permit, if granted by the department, will be non-transferable and I will promptly notify the department upon sale or legal transfer of the permitted establishment.

*Attach letter of authorization

Signed: Charles Eavenson

Charles Eavenson, Plant Manager
Name and Title (Please Type)

Date: 12/14/93 Telephone No. 407-857-2510

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA (where required by Chapter 471, F.S.)

This is to certify that the engineering features of this pollution control project have been designed/examined by me and found to be in conformity with modern engineering principles applicable to the treatment and disposal of pollutants characterized in the permit application. There is reasonable assurance, in my professional judgment, that

[1] See Florida Administrative Code Rule 17-2.100(57) and (104)

the pollution control facilities, when properly maintained and operated, will dischar an effluent that complies with all applicable statutes of the State of Florida and the rules and regulations of the department. It is also agreed that the undersigned will furnish, if authorized by the owner, the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

Signed Joseph L. Tessitore

Joseph L. Tessitore, P.E.
Name (Please Type)

Harding Lawson Associates - Cross/Tessitore & Associates
Company Name (Please Type)

4763 South Conway Rd., Orlando, FL 32812
Mailing Address (Please Type)

Florida Registration No. 23374 Date: 12/14/93 Telephone No. 407-851-1484

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

SEE SUPPLEMENTAL INFORMATION: SECTION II

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction see Appendix 2-A Completion of Construction see Appendix 2-A

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

Warning Letter April 13, 1992 Orange County EPD (John M. Bateman, P.E.)

Consent Order October 1, 1992 Orange County EPD (John M. Bateman, P.E.)

FOAMEX, L.P.

Foam Manufacturing Facility
Orlando, Florida

Specific Emission Point Sources

I. Slabstock Polyurethane Foam Production

1) Foam Process Line Stack
2) Long Bun Storage Room Stack

II. Rebond Polyurethane Foam Production

3) Rooftop Vents

III. Tank Storage

4) Tank #10

IV. Steam Boiler

5) Boiler Stack

V. Environmental Heating

6) through 19)
13 Rooftop Heaters

VI. Foam Fabrication Operations

20) through 37)
17 Rooftop Vents

the pollution control facilities, when properly maintained and operated, will dischar
an effluent that complies with all applicable statutes of the State of Florida and the
rules and regulations of the department. It is also agreed that the undersigned will
furnish, if authorized by the owner, the applicant a set of instructions for the prope
maintenance and operation of the pollution control facilities and, if applicable,
pollution sources.

Signed Joseph L. Tessitore

Joseph L. Tessitore, P.E.
Name (Please Type)

Cross/Tessitore & Associates, P.A.
Company Name (Please Type)

4763 South Conway Rd., Orlando, FL 32812
Mailing Address (Please Type)

Florida Registration No. 23374 Date: 12/1/92 Telephone No. 407-851-1484

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

SEE SUPPLEMENTAL INFORMATION: SECTION II

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction Original - 1975 Proposed Modification 1993 Completion of Construction Original - 1976 Proposed Modificat 1994

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

Modified Exhaust System = $200,000

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

Warning Letter April 13, 1992 Orange County EPD (John M. Bateman, P.E.)

Consent Order October 1, 1992 Orange County EPD (John M. Bateman, P.E.)

SEE SUPPLEMENTAL INFORMATION: SECTION II

Requested permitted equipment operating time: hrs/day_____; days/wk_____; wks/yr_____

if power plant, hrs/yr_____; if seasonal, describe:_____

F. If this is a new source or major modification, answer the following questions. (Yes or No)

1. Is this source in a non-attainment area for a particular pollutant?	No
a. If yes, has "offset" been applied?	N/A
b. If yes, has "Lowest Achievable Emission Rate" been applied?	N/A
c. If yes, list non-attainment pollutants.	N/A
2. Does best available control technology (BACT) apply to this source? If yes, see Section VI.	Yes (1)
3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII.	No (2)
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source?	No
5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source?	No

H. Do "Reasonably Available Control Technology" (RACT) requirements apply to this source? No

a. If yes, for what pollutants? N/A

b. If yes, in addition to the information required in this form, any information requested in Rule 17-2.650 must be submitted.

Attach all supportive information related to any answer of "Yes". Attach any justification for any answer of "No" that might be considered questionable.

(1) For purposes of this application and based solely on the FDER letter of June 26, 199 from Mr. C.H. Fancy requesting a BACT determination in the completed application, BACT is assumed to be applicable for this source. However, the applicant does not necessarily agree with that determination and reserves its rights to contest same, should that be required.

(2) There are no PSD requirements for methylene chloride and by statute and Departmental Rule, methylene chloride is not considered a volatile organic compound (VOC). However, for purposes of this application, an air quality analysis was conducted based on the request included in the FDER letter of June 26, 1992. This application estimates the maximum 8-hour, 24-hour and annual ambient air concentrations of methylene chloride. The air quality impact analysis is presented in Supplemental Information: Section VII of this application. The inclusion of this information does not indicate the applicant's agreement that PSD requirements are applicable to this source and the applicant reserves its rights to contest such a determination, should that be required.

I. SLABSTOCK POLYURETHANE FOAM PRODUCTION

(SEE SUPPLEMENTAL INFORMATION: SECTION III)

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

FOR COMPLETE BREAKDOWN, SEE ITEM 1, SUPPLEMENTAL INFORMATION: SECTION V

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Process Chemicals		--	38,805	
Blowing Agent	Methylene Chloride	100%	1,320	
TOTAL			40,125	See Figure 5-2

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 40,125

2. Product Weight (lbs/hr): 36,199

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE ITEMS 2, 3 AND 5, SUPPLEMENTAL INFORMATION: SECTION V

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
FOAM LINE STACK:							
Methylene Chloride	955.8	152.04	N/A	N/A	955.8	152.04	See Fig 5-2
I,1,1 Trichloroethane	1433.7	57.02	N/A	N/A	1433.7	57.02	See Fig 5-2
141-B	955.8	152.04	N/A	N/A	955.8	152.04	See Fig 5-2
Toluene Diisocyanate	0.37	0.12	N/A	N/A	0.37	0.12	See Fig 5-2

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

I. SLABSTOCK POLYURETHANE FOAM PRODUCTION

(SEE SUPPLEMENTAL INFORMATION: SECTION III)

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

FOR COMPLETE BREAKDOWN, SEE ITEM 1, SUPPLEMENTAL INFORMATION: SECTION V

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Process Chemicals		—	38,805	
Blowing Agent	Methylene Chloride	100%	1,320	
TOTAL			40,125	See Figure 5-2

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 40,125
2. Product Weight (lbs/hr): 36,199

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE ITEMS 2, 3 AND 5, SUPPLEMENTAL INFORMATION: SECTION V

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
LBSR STACK:							
Methylene Chloride	557.55	88.69	N/A	N/A	557.55	88.69	See Fig 5-2
1,1,1 Trichloroethane	836.33	33.26	N/A	N/A	836.33	33.26	See Fig 5-2
141-B	557.55	88.69	N/A	N/A	557.55	88.69	See Fig 5-2

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

I. SLABSTOCK POLYURETHANE FOAM PRODUCTION

. **Control Devices: (See Section V, Item 4)** Not Applicable

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels NOT APPLICABLE

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: ____________ Percent Ash: ____________

Density: ____________ lbs/gal Typical Percent Nitrogen: ____________

Heat Capacity: ____________ BTU/lb ____________ BTU/gal

Other Fuel Contaminants (which may cause air pollution): ____________

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N/A Maximum N/A

G. Indicate liquid or solid wastes generated and method of disposal.

Liquid and/or solid waste generated by the plant are properly characterized as either hazard or nonhazardous waste prior to disposal. Hazardous waste is disposed of in accordance with t RCRA regulations, for example, waste toluene diisocyanate is incinerated. Nonhazardous wast is disposed of in accordance with applicable federal, state and local requirements.

I. SLABSTOCK POLYURETHANE FOAM PRODUCTION

FOAM LINE STACK:

Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

ack Height: 125 ft. Stack Diameter: 27.64 inches ~~ft.~~

Gas Flow Rate: 20,000 ACFM -- DSCFM Gas Exit Temperature: 80°F (Ambient) °F.

Water Vapor Content: Ambient % Velocity: 80 FPS

SECTION IV: INCINERATOR INFORMATION

NOT APPLICABLE

Type of Waste	Type O (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

scription of Waste ______

al Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______

I. SLABSTOCK POLYURETHANE FOAM PRODUCTION

LONG BUN STORAGE ROOM STACK:

. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

ck Height: 125 ft. Stack Diameter: 39.09 inches XXXX

Gas Flow Rate: 40,000 ACFM -- DSCFM Gas Exit Temperature: 80°F (Ambient) °F.

Water Vapor Content: ambient % Velocity: 80 FPS

SECTION IV: INCINERATOR INFORMATION

NOT APPLICABLE

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

scription of Waste _____

al Weight Incinerated (lbs/hr) _____ Design Capacity (lbs/hr) _____

Approximate Number of Hours of Operation per day _____ day/wk _____ wks/yr. _____

Manufacturer _____

Date Constructed _____ Model No. _____

	Volume $(ft)^3$	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: _____ ft. Stack Diamter: _____ Stack Temp. _____

Gas Flow Rate: _____ ACFM _____ DSCFM* Velocity: _____ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) _____

I. SLABSTOCK POLYURETHANE FOAM PRODUCTION

Brief description of operating characteristics of control devices: Not Applicable

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

Not Applicable

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

SEE SUPPLEMENTAL INFORMATION: SECTION V

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]
2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.
3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).
4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)
5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).
6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.
7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).
8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

II. REBOND POLYURETHANE FOAM PRODUCTION

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

Raw Materials and Chemicals Used in your Process, if applicable:

SEE ITEM 1, SUPPLEMENTAL INFORMATION: SECTION V

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Scrap Foam	--	--	5,608	
Polyol	--	--	459	
Toluene Diisocyanate	--	--	164	
TOTAL			6,231	See Figure 5-3

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 6,231
2. Product Weight (lbs/hr): 6,231

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE ITEMS 2, 3, AND 5, SUPPLEMENTAL INFORMATION: SECTION V

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
Toluene Diisocyanate	0.0046	0.009	N/A	N/A	0.0046	0.009	See Fig 5-3

---

[1] See Section V, item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

II. REBOND POLYURETHANE FOAM PRODUCTION

Control Devices: (See Section V, Item 4) NOT APPLICABLE

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels NOT APPLICABLE

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: ____________ Percent Ash: ____________

Density: ____________ lbs/gal Typical Percent Nitrogen: ____________

Heat Capacity: ____________ BTU/lb ____________ BTU/gal

Other Fuel Contaminants (which may cause air pollution): ____________

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N/A Maximum N/A

G. Indicate liquid or solid wastes generated and method of disposal.

Liquid and/or solid waste generated by the plant are properly characterized as either hazard
or nonhazardous waste prior to disposal. Hazardous waste is disposed of in accordance with
RCRA regulations, for example, waste toluene diisocyanate is incinerated. Nonhazardous waste
disposed of in accordance with applicable federal, state and local requirements.

II. REBOND POLYURETHANE FOAM PRODUCTION

Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

ck Height: 41 ft. Stack Diameter: 2.5 ft.

Gas Flow Rate: 1000 ACFM ------- DSCFM Gas Exit Temperature: Ambient (80°F) °F.

Water Vapor Content: Ambient % Velocity: 3.4 FPS

SECTION IV: INCINERATOR INFORMATION

NOT APPLICABLE

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

scription of Waste

l Weight Incinerated (lbs/hr) Design Capacity (lbs/hr)

Approximate Number of Hours of Operation per day day/wk wks/yr.

Manufacturer

Date Constructed Model No.

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ft. Stack Diamter: Stack Temp.

Gas Flow Rate: ACFM DSCFM* Velocity: FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: ☐ Cyclone ☐ Wet Scrubber ☐ Afterburner

☐ Other (specify)

II. REBOND POLYURETHANE FOAM PRODUCTION

Brief description of operating characteristics of control devices:

NOT APPLICABLE

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

NOT APPLICABLE

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

SEE SUPPLEMENTAL INFORMATION: SECTION V

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]

2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).

4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).

6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).

8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

III. TANK STORAGE

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

Raw Materials and Chemicals Used in your Process, if applicable:

(TANK #10) SEE ITEM 1, SUPPLEMENTAL INFORMATION: SECTION V

Description	Contaminants Type	% Wt	Utilization Rate - lbs/hr	Relate to Flow Diagram
Methylene Chloride	--	--	506,800 lbs/yr	N/A

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 506,800 lbs/yr

2. Product Weight (lbs/hr): 506,800 lbs/yr

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE ITEMS 2, 3, AND 5, SUPPLEMENTAL INFORMATION: SECTION V

Name of Contaminant	Emission[1] Maximum lbs/hr	Actual T/yr	Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission lbs/yr	T/yr	Relate to Flow Diagram
Methylene Chloride	0.67	2.92	N/A	N/A	0.67	2.92	N/A

---

[1] See Section V, item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

III. TANK STORAGE

. Control Devices: (See Section V, Item 4) Not Applicable

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels NOT APPLICABLE

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: ____________ Percent Ash: ____________

Density: ____________ lbs/gal Typical Percent Nitrogen: ____________

Heat Capacity: ____________ BTU/lb ____________ BTU/gal

Other Fuel Contaminants (which may cause air pollution): ____________

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N/A Maximum N/A

G. Indicate liquid or solid wastes generated and method of disposal.

Liquid and/or solid waste generated by the plant are properly characterized as either hazard or nonhazardous waste prior to disposal. Hazardous waste is disposed of in accordance with RCRA regulations, for example, waste toluene diisocyanate is incinerated. Nonhazardous wast is disposed of in accordance with applicable federal, state and local requirements.

III. TANK STORAGE

4. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

ack Height: 7 ft. Stack Diameter: 1.25 inches ~~ft.~~

Gas Flow Rate: N/A ACFM N/A DSCFM Gas Exit Temperature: 80°F (Ambient) °F.

Water Vapor Content: N/A % Velocity: N/A FPS

SECTION IV: INCINERATOR INFORMATION

NOT APPLICABLE

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

escription of Waste ______

al Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______

III. TANK STORAGE

Brief description of operating characteristics of control devices:

Not Applicable

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

Not Applicable

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

SEE SUPPLEMENTAL INFORMATION: SECTION V

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]
2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.
3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).
4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)
5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).
6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.
7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).
8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

IV. STEAM BOILER

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

Raw Materials and Chemicals Used in your Process, if applicable:

NOT APPLICABLE

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): N/A
2. Product Weight (lbs/hr): N/A

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE ITEMS 2, 3 AND 5, SUPPLEMENTAL INFORMATION: SECTION V

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
Particulate	0.021	0.092	N/A	N/A	0.021	0.092	N/A
Sulfur Dioxide	0.0025	0.011	N/A	N/A	0.0025	0.011	N/A
Nitrogen Oxide	0.59	2.58	N/A	N/A	0.59	2.58	N/A
Carbon Monoxide	0.147	0.64	N/A	N/A	0.147	0.64	N/A
Total Hydrocarbons	0.013	0.55	N/A	N/A	0.013	0.55	N/A

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

IV. STEAM BOILER

Control Devices: (See Section V, Item 4) NOT APPLICABLE

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	
Natural Gas	4,200 cf	4,200 cf	4.2

*units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: N/A

Percent Ash: N/A

Density: N/A lbs/gal

Typical Percent Nitrogen: N/A

Heat Capacity: 1,000 BTU/lb N/A BTU/gal

Other Fuel Contaminants (which may cause air pollution): N/A

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N/A Maximum N/A

G. Indicate liquid or solid wastes generated and method of disposal.

N/A

IV. STEAM BOILER

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

[illegible]ck Height: 15.5 ft. Stack Diameter: 1.22 ft.

G[illegible] Flow Rate: 70 ACFM 36 DSCFM Gas Exit Temperature: 450 °F.

Water Vapor Content: 6.0 % Velocity: 1.0 FPS

SECTION IV: INCINERATOR INFORMATION

NOT APPLICABLE

Type of Waste	Type O (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

Description of Waste ______

[illegible]l Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______

Brief description of operating characteristics of control devices:

NOT APPLICABLE

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

NOT APPLICABLE

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

SEE SUPPLEMENTAL INFORMATION: SECTION V

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]

2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).

4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).

6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).

8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

V. ENVIRONMENTAL HEATING

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

Raw Materials and Chemicals Used in your Process, if applicable:

NOT APPLICABLE

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): N/A
2. Product Weight (lbs/hr): N/A

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE ITEMS 2, 3, AND 5, SUPPLEMENTAL INFORMATION: SECTION V

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
Particulate	0.00925	0.00185	N/A	N/A	0.00925	0.00185	N/A
Sulfur Dioxide	0.00111	0.000222	N/A	N/A	0.00111	0.000222	N/A
Nitrogen Oxide	0.259	0.0518	N/A	N/A	0.259	0.0518	N/A
Carbon Monoxide	0.06475	0.01295	N/A	N/A	0.06475	0.01295	N/A
Total Hydrocarbons	0.00555	0.00111	N/A	N/A	0.00555	0.00111	N/A

---

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

V. ENVIRONMENTAL HEATING

Control Devices: (See Section V, Item 4) NOT APPLICABLE

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	
Natural Gas	200 cf	1,650 cf	1.65

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: N/A

Percent Ash: N/A

Density: N/A lbs/gal

Typical Percent Nitrogen: N/A

Heat Capacity: 1,000 BTU/lb

N/A BTU/gal

Other Fuel Contaminants (which may cause air pollution): N/A

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N/A

Maximum N/A

G. Indicate liquid or solid wastes generated and method of disposal.

N/A

4. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

ck Height: 27.5 ft. Stack Diameter: 0.67 ft.

Gas Flow Rate: 174 ACFM 140 DSCFM Gas Exit Temperature: 190 °F.

Water Vapor Content: 1.0 % Velocity: 8.3 FPS

SECTION IV: INCINERATOR INFORMATION

NOT APPLICABLE

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

Description of Waste ______

l Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______ ______

Date Constructed ______ Model No. ______

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: ☐ Cyclone ☐ Wet Scrubber ☐ Afterburner

☐ Other (specify) ______

V. ENVIRONMENTAL HEATING

Brief description of operating characteristics of control devices:

NOT APPLICABLE

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

NOT APPLICABLE

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

SEE SUPPLEMENTAL INFORMATION: SECTION V

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]

2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).

4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).

6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).

8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Glue	1,1,1-Trichloroethane	81	3.1	See Figure 5-2

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 36,199

2. Product Weight (lbs/hr): 36,199

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

SEE ITEMS 2, 3, AND 5, SUPPLEMENTAL INFORMATION: SECTION V

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
1,1,1-Trichloroethane	2.15	9.43	N/A	N/A	2.15	9.43	See Fig 5-2
Methylene Chloride	2.89	12.67	N/A	N/A	2.89	12.67	See Fig 5-2
141-B	0.72	3.17	N/A	N/A	0.72	3.17	See Fig 5-2

[1] See Section V, item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

VI. FOAM FABRICATION OPERATIONS

Control Devices: (See Section V, Item 4) NOT APPLICABLE

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels NOT APPLICABLE

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: ____________________ Percent Ash: ____________________

Density: ____________________ lbs/gal Typical Percent Nitrogen: ____________________

Heat Capacity: ____________________ BTU/lb ____________________ BTU/gal

Other Fuel Contaminants (which may cause air pollution): ____________________

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N/A Maximum N/A

G. Indicate liquid or solid wastes generated and method of disposal.

Liquid and/or solid waste generated by the plant are properly characterized as either hazardo or nonhazardous waste prior to disposal. Hazardous waste is disposed of in accordance with t RCRA regulations, for example, waste toluene diisocyanate is incinerated. Nonhazardous waste is disposed of in accordance with applicable federal, state and local requirements.

VI. FOAM FABRICATION OPERATIONS

17 ROOFTOP VENTS [EMISSION POINTS 7) - 24)]

4. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

ck Height: Vents 7) - 23): 43 Vent 24): 52 ft. Stack Diameter: 43.7 ft.

Gas Flow Rate: 50,000 @ ACFM -- DSCFM Gas Exit Temperature: 80°F (Ambient) °F.

Water Vapor Content: Ambient % Velocity: 80 FPS

SECTION IV: INCINERATOR INFORMATION

NOT APPLICABLE

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

escription of Waste

l Weight Incinerated (lbs/hr) Design Capacity (lbs/hr)

Approximate Number of Hours of Operation per day day/wk wks/yr.

Manufacturer

Date Constructed Model No.

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ft. Stack Diamter: Stack Temp.

Gas Flow Rate: ACFM DSCFM* Velocity: FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify)

VI. FOAM FABRICATION OPERATIONS

Brief description of operating characteristics of control devices:

NOT APPLICABLE

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

NOT APPLICABLE

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

SEE SUPPLEMENTAL INFORMATION: SECTION V

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]
2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.
3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).
4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)
5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).
6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.
7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).
8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

The appropriate application fee in accordance with Rule 17-4.05. The check should made payable to the Department of Environmental Regulation.

10. With an application for operation permit, attach a Certificate of Completion of Construction indicating that the source was constructed as shown in the construction permit.

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

SEE SUPPLEMENTAL INFORMATION: SECTION VI

A. Are standards of performance for new stationary sources pursuant to 40 C.F.R. Part 60 applicable to the source?

[ ] Yes [X] No

Contaminant	Rate or Concentration

B. Has EPA declared the best available control technology for this class of sources (If yes, attach copy)

[ ] Yes [X] No

Contaminant	Rate or Concentration

C. What emission levels do you propose as best available control technology?

Contaminant	Rate or Concentration
Methylene Chloride	253.4 ton/yr
(See Footnote (1) on Page 3 of 12)	

D. Describe the existing control and treatment technology (if any). N/A

1. Control Device/System:
2. Operating Principles:
3. Efficiency:*
4. Capital Costs:

xplain method of determining

5. Useful Life:

6. Operating Costs:

7. Energy:

8. Maintenance Cost:

9. Emissions:

Contaminant	Rate or Concentration
Methylene Chloride	316.75 ton/yr

10. Stack Parameters

a. Height: ft.

b. Diameter: ft.

c. Flow Rate: ACFM

d. Temperature: °F.

e. Velocity: FPS

E. Describe the control and treatment technology available (As many types as applicable, use additional pages if necessary). SEE SUPPLEMENTAL INFORMATION: SECTION VI

1.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy [2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

2.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

---

[1] Explain method of determining efficiency.

[2] Energy to be reported in units of electrical power - KWH design rate.

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

3.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

4.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Costs:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

F. Describe the control technology selected:

1. Control Device:

2. Efficiency:[1]

3. Capital Cost:

4. Useful Life:

5. Operating Cost:

6. Energy:[2]

7. Maintenance Cost:

8. Manufacturer:

9. Other locations where employed on similar processes:

a. (1) Company:

(2) Mailing Address:

(3) City:

(4) State:

---

[1] Explain method of determining efficiency.

[2] Energy to be reported in units of electrical power - KWH design rate.

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

b. (1) Company:

(2) Mailing Address:

(3) City: (4) State:

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

10. Reason for selection and description of systems:

[1] Applicant must provide this information when available. Should this information not be available, applicant must state the reason(s) why.

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

SEE SUPPLEMENTAL INFORMATION: SECTION VII

A. Company Monitored Data

1. ____________ no. sites ____________ TSP ____________ ( ) SO^{2}* ____________ Wind spd/di

Period of Monitoring ______ / ______ / ______ to ______ / ______ / ______
month day year month day year

Other data recorded ____

Attach all data or statistical summaries to this application.

ecify bubbler (B) or continuous (C).

2. Instrumentation, Field and Laboratory

a. Was instrumentation EPA referenced or its equivalent? ☐ Yes ☐ No

b. Was instrumentation calibrated in accordance with Department procedures?

☐ Yes ☐ No ☐ Unknown

B. Meteorological Data Used for Air Quality Modeling

1. _____ Year(s) of data from ____/____/____ to ____/____/____
month day year month day year

2. Surface data obtained from (location)__________

3. Upper air (mixing height) data obtained from (location)__________

4. Stability wind rose (STAR) data obtained from (location)__________

C. Computer Models Used

1. __________ Modified? If yes, attach description.

2. __________ Modified? If yes, attach description.

3. __________ Modified? If yes, attach description.

4. __________ Modified? If yes, attach description.

Attach copies of all final model runs showing input data, receptor locations, and principle output tables.

Applicants Maximum Allowable Emission Data

Pollutant	Emission Rate
TSP	__________ grams/sec
SO^2	__________ grams/sec

E. Emission Data Used in Modeling

Attach list of emission sources. Emission data required is source name, description of point source (on NEDS point number), UTM coordinates, stack data, allowable emissions, and normal operating time.

F. Attach all other information supportive to the PSD review.

G. Discuss the social and economic impact of the selected technology versus other applicable technologies (i.e., jobs, payroll, production, taxes, energy, etc.). Include assessment of the environmental impact of the sources.

H. Attach scientific, engineering, and technical material, reports, publications, journals, and other competent relevant information describing the theory and application of the requested best available control technology.

2.0 SUPPLEMENTAL INFORMATION: SECTION II GENERAL PROJECT INFORMATION

Item A Project Description

2.1 Introduction

The subject of this application is a flexible polyurethane foam manufacturing facility owned and operated by Foamex, L.P. in Orlando, Florida. This facility was constructed in 1975-76 and has not previously been permitted by the Florida Department of Environmental Regulation (FDER). This application is submitted to fulfill two basic requirements which are detailed as follows.

On May 29, 1992, an application for a Construction Permit was submitted to FDER. This application documented the facility as an existing source and did not include any proposed modifications. FDER conducted a preliminary review of this submittal and issued a letter dated June 26, 1992 requesting additional information and requiring a BACT analysis to be conducted for proposed air pollution control systems. Subsequent to this activity, a Consent Order was executed on October 1, 1992 between Foamex, L.P. and the Orange County Environmental Protection Department (OCEPD). This order required submittal of an air permit application to FDER to complete settlement of the agreement. Thus, the current application is submitted to fulfill the requirements of both the comments issued by FDER on June 26, 1992, and the Consent Order issued by OCEPD on October 1, 1992. This application is submitted without prejudice to the applicant's belief that the PSD requirements do not apply to this source and, therefore, a BACT analysis is not required of this applicant.

As part of this application for a Construction Permit, Foamex proposes to install an enhanced exhaust system for the Slabstock process to optimize both capture of emissions inside the facility and dispersion of emissions to the atmosphere. In addition, Foamex proposes to reduce Methylene Chloride emissions through the use of alternative chemicals.

The specific course of action proposed for implementation of these measures is described as follows.

(1) The current process system will be modified to significantly increase capture efficiency of Methylene Chloride emissions in the Slabstock process and the Long Bun Storage Room.

(2) Captured Methylene Chloride emissions will be dispersed with greater efficiency by increasing the Foam Line Stack and Long Bun Storage Room Stack heights to GEP levels.

(3) Methylene Chloride emissions will be limited through a reduction in usage, on an annual basis, of approximately 20%. This reduction in usage will be accomplished either through limiting production, or by substituting 1,1,1 Trichloroethane as an alternate blowing agent.

(4) During the next eighteen (18) month period Foamex shall pursue the development of alternate processes that will eliminate and/or significantly reduce the use of blowing agents. In specific, the Variable Pressure Foaming (VPF) process will be evaluated for potential implementation at the Orlando facility.

(5) After eighteen (18) months a decision will be made concerning the applicability and availability of alternate processes. If an alternate process technology does not appear to be feasible, Foamex will proceed with the design and implementation of an add-on control system. At that time, an application will be submitted to FDEP for a permit modification to allow for construction of the selected control alternative. While the selected control option may be a process modification or an add-on control system, or a combination of both, the resulting reduction in total facility emissions of Methylene Chloride will be approximately 60% (59% as calculated in Section 6 of this application).

Appendix 2-A provides a schedule of the activities that would be conducted to effect this permitting strategy, based on an assumed Construction Permit issue date of March 1994. Appendix 2-B provides a description of the proposed content of the progress reports to be submitted during the initial Construction Permit phase as indicated in Appendix 2-A. A summary of the projected emission rates associated with each phase of this proposed permitting approach is provided in Appendix 2-C.

2.2 Process Description

The Foamex facility uses two basic process to manufacture foam product: I) Slabstock Polyurethane Foam Production, and II) Rebond Polyurethane Foam Production. These processes are used to manufacture foam product of various density, color and thickness. While the basic processes remain the same, the proportions of raw materials are modified slightly for each batch to achieve the desired product specifications. In addition to these processes, support operations including tank storage of process chemicals, steam boiler operation, environmental heating, and foam fabrication operations also exist at the facility. The table below provides a schedule outlining this proposed permitting strategy, based on an assumed permit issue date of March 1994.

I. Slabstock Polyurethane Foam Production

In the Slabstock process, a high pressure mixing head and metering pumps are used to mix the specific raw materials required for each product. These raw materials include toluene diisocyanate (TDI), polyol, water, catalysts, surfactants, additives (such as pigments or flame retardants), and Methylene Chloride, an auxiliary blowing agent. The mixed raw materials are discharged into a trough where the mixture begins to react and flows down the tunnel area. At this point, heat generated by the exothermic reaction volatilizes the Methylene Chloride thus allowing the foam to reach a predetermined density. The Methylene Chloride serves to reduce the foam density, or soften it, and to provide cooling of the mixture as it discharges energy during the exothermic reaction. The foam slab, referred to as a bun, travels down the tunnel conveyor continuing to cure (and thus to release Methylene Chloride) until it reaches the Long Bun Storage Room. In this location the bun is removed from the conveyor and placed in the room for temporary storage and completion of the cure period.

Currently, the Slabstock process is equipped with an exhaust system and housing which covers part of the mixing head, trough and conveyor line to vent the emissions which occur during the initial stages of the process. This system maintains a negative pressure along the covered portion of the process and vents the Methylene Chloride vapors to the atmosphere through an existing stack. Emissions of Methylene Chloride which occur toward the end of the conveyor and inside the Long Bun Storage Room are currently vented to the interior of the facility, and are discharged to the atmosphere through general ventilation fans located in the ceiling.

This application proposes a modified exhaust system for the Slabstock process, including a complete enclosure of the trough and conveyor line and a system to maintain a negative pressure in the Long Bun Storage Room. In specific, the process line would be ventilated by two fans supplying 9,000 acfm each from the Long Bun Storage Room into the conveyor housing. One exhaust fan would continuously pull 20,000 acfm from the housing, thus maintaining a negative pressure. The exhaust would be vented to the proposed air pollution control system and then discharged to the atmosphere through a proposed GEP stack. The Long Bun Storage Room would be ventilated by ten fans supplying approximately 3,000 acfm each for a total of 30,000 acfm. Two exhaust fans would each continuously pull 20,000 acfm from the room and discharge to the atmosphere through a proposed GEP stack. Details regarding the proposed exhaust systems are provided in Section V of this application.

II. Rebond Polyurethane Foam Production

In the Rebond process, scrap polyurethane foam, either purchased or recovered from the slabstock manufacturing process, is granulated into small pieces approximately 3/4 to one inch in size. This granulated foam is stored by grade, density, and/or by composition in large storage bins. The scrap pieces of polyurethane are combined into a blend tank where they are mixed with an adhesive binder. The binder is a mixture of toluene diisocyanate (TDI) and polyol. The mixture is then transferred from the blend tank to the mold where it is compressed under an air cylinder to a designated size. The product is steamed from the bottom of the mold, which cures the foam . This cylinder of foam is referred to as a log. The foam log is then peeled into a continuous length sheet of 1/4 to 3/4 inch thickness. The sheet product is finally bonded to a polyethylene film for packaging into small rolls as per customer order.

No modifications to this process are proposed in this application.

III. Tank Storage

The Foamex facility includes eleven above ground storage tanks for receiving and holding of various raw materials used in the foam production processes. The following provides a summary of the tanks, dimensions and products stored. Only one tank, #10, is used for storage of Methylene Chloride.

Tank Number	Product	Height (feet)	Diameter (feet)	Vent Diameter (inches)
1	Polyol	35	12	2
2	Polyol	35	12	2
3	TDI	35	12	2
4	Polyol	35	12	3
5	Polyol	35	12	3
6	TDI	35	12	1.75
7	Empty	16	10.5	2
8	Polymer	16	10.5	2

9	Empty	35	12	2
10	Methylene Chloride	37 (long)	7	1.25
11	Empty	30 (long)	7	1

IV. Steam Boiler

Foamex operates a natural gas fired industrial boiler rated at 100 HP. This boiler is used to convert an average of 1,570 gallons of water to steam each day for use in the Rebond process.

V. Environmental Heating

There are 13 indirect fired heaters existing at the Foamex facility. Of these, nine are used as needed during the winter months for heating the manufacturing and administrative areas of the facility. It is estimated that these heaters operate less than 400 hours per year. The remaining four heaters are not operational. The following provides a listing of the individual heaters and the rated capacity of each.

Heater Heat No.	Manufacturer	Model Number	Maximum Input (Btu/hr)
1	Bryant	200-341	200,000
2*	Bryant	200-341	200,000
3	Hastings	GF200XE	200,000
4*	Hastings	GF200XE	200,000
5	Hastings	GF200XE	200,000
6	Hastings	GF200XE	200,000
7	Hastings	GF200XE	200,000
8	Hastings	GF200XE	200,000
9	Hastings	GF200XE	200,000
11*	Bryant	200-341	200,000
12*	Bryant	200-341	200,000
13	Peereless	1067	250,000
		TOTAL (operational heaters only)	1,650,000

VI. Foam Fabrication Operations

During Fabrication Operations, the foam buns manufactured during the Slabstock process are cut and glued according to customer specifications. Approximately 2.5 lbs/hr of Aldobond 120 glue or equivalent is used during these operations.

Item E. Requested Permitted Operating Time

I. Slabstock Process

3 hrs/day; 4 days/wk; 52 wks/yr

II. Rebond Process

12 hrs/day; 6 days/wk; 52 wks/yr

III. Tank Storage

24 hrs/day; 7 days/wk; 52 wks/yr

IV. Steam Boiler

24 hrs/day; 7 days/wk; 52 wks/yr

V. Environmental Heating

400 hrs/yr

VI. Foam Fabrication Operations

12 hrs/day; 6 days/wk; 52 wks/yr

APPENDIX 2-A
Progress Report and Emission Control Schedule

Revision 1
December 13, 1993

PROGRESS REPORT AND EMISSION CONTROL SCHEDULE

Foamex, L.P.
Flexible Polyurethane Foam Manufacturing Facility
Orlando, Florida

FDEP Construction Permit Issued	March 1994
First Progress Report Submittal to FDEP	September 1994
Second Progress Report Submittal to FDEP	December 1994
Third Progress Report Submittal to FDEP	March 1995
Construction Permit Modification Submittal to FDEP	September 1995
FDEP Construction Permit Issued	December 1995
Begin Installation of Selected Technology	March 1997
Certificate of Completion Submittal to FDEP	June 1997

APPENDIX 2-B
Progress Report Content

PROGRESS REPORT CONTENT

**Foamex, L.P.
Flexible Polyurethane Foam Manufacturing Facility
Orlando, Florida**

First Progress Report - September 1994

The First Progress Report will be developed to include the items listed below:

a) Status of engineering/design for Capture and Disperse system modifications, including enclosure of Foam Line, installagion of centralized ventilation and exhaust system in Long Bun Storage Room, and installation of GEP stacks for both the Foam Line and Long Bun Storage Room.

b) Status of both industry and EPA developments in compiling performance data for add-on air pollution control technologies used in reducing emissions of blowing agents at foam manufacturing facilities.

c) Status of industry developments in equipment/process modifications for reduction of blowing agent emissions. (Specifically, this will include available information and/or data from the Variable Pressure Foaming (VPF) process in Mississippi.)

Second Progress Report - December 1994

The Second Progress Report will be developed to include the items listed below:

a) Preliminary engineering/design drawings for Capture and Disperse system modifications, including enclosure of Foam Line, installation of centralized ventilation and exhaust system in Long Bun Storage Room, and installation of GEP stacks for both the Foam Line and Long Bun Storage Room.

b) Status of both industry and EPA developments in compiling performance data for add-on air pollution control technologies used in reducing emissions of blowing agents at foam manufacturing facilities.

c) Status of industry developments in equipment/process modifications for reduction of blowing agent emissions. (Specifically, this will include available information and/or data from the Variable Pressure Foaming (VPF) process in Mississippi.)

Third Progress Report - March 1995

The Third Progress Report will be developed to include the items listed below:

a) Final engineering/design drawings for Capture and Disperse system modifications, including enclosure of Foam Line, installation of centralized ventilation and exhaust system in Long Bun Storage Room, and installation of GEP stacks for both the Foam Line and Long Bun Storage Room.

b) Current status of both industry and EPA developments in compiling performance data for add-on air pollution control technologies used in reducing emissions of blowing agents at foam manufacturing facilities.

c) Current status of industry developments in equipment/process modifications for reduction of blowing agent emissions. (Specifically, this will include available information and/or data from the Variable Pressure Foaming (VPF) process in Mississippi.)

d) Identification of a selected emission control strategy using any one or any combination of the concepts evaluated under b) and c). The final selection will be based on the criteria existing at the submittal date, including: 1) economics, 2) performance, and 3) current OSHA, FDEP and EPA regulations.

Construction Permit Modification - September 1995

Based on the selected process or control technology identified in the Third Progress Report, an application will be submitted requesting a modification of the Construction Permit to allow for implementation of the final system configuration.

APPENDIX 2-C
Summary of Projected Emissions

Foamex, L.P.
Flexible Polyurethane Foam Manufacturing Facility
Orlando, Florida

The information below identifies the three phases resulting from the proposed permitting strategy outined in Appendix 2-A. For each phase, the process conditions affecting emissions are stated as well as the anticipated time periods. Table 2-1 provides a summary of the projected emission rates for each phase.

Phase 1:

* Stack Configuration - Existing
* Blowing Agents - Methylene Chloride Only
* No Add-on Air Pollution Control

* Anticipated time period: March 1994 - September 1995 (assuming the FDEP Construction Permit will be issued March 1994)

Phase 2:

* Stack Configuration - GEP
* Blowing Agents - Methylene Chloride with 20% substitution of 1,1,1 Trichloroethane
* No Add-on Air Pollution Control

* Anticipated time period: September 1995 - June 1997

Phase 3:

* Stack Configuration - GEP
* Blowing Agents - Methylene Chloride with 20% substitution of 1,1,1 Trichloroethane
* Approximately 60% Reduction of Total Facility Methylene Chloride emissions

* Anticipated time period: June 1997 - Future

TABLE 2–1

Summary of Project Emissions

December 13, 1993
Application To Construct Air Pollution Source
Foamex, L.P. Foam Manufacturing Facility
Orlando, Florida

		Maximum Hourly Usage Rate (lb/hr)	Maximum Hourly Emission Rate (lb/hr)				Maximum Annual Usage (lb/yr)	Maximum Annual Emissions (lb/yr)			
Phase	Compound		Foam Line Stack (60%)	Long Bun Storage Room (35%)	Foam Fabrication Vents (5%)	Total Facility		Foam Line Stack (60%)	Long Bun Storage Room (35%)	Foam Fabrication Vents (5%)	Total Facility
1	Methylene Chloride	1,593.0	955.80	557.55	79.65	1593	633,500	380,100	221,725	31,675	633,500
2	Methylene Chloride	1,593.0	955.80	557.55	79.65	1593	506,800	304,080	177,380	25,340	506,800
	1,1,1–Trichloroethane	2,389.5	1,433.70	836.33	119.48	2389.5	190,050	114,030	66,518	9,503	190,050
3	Methylene Chloride	1,593.0	19.12	557.55	79.65	656.316	506,800	6,082	177,380	25,340	208,802
	1,1,1–Trichloroethane	2,389.5	28.67	836.33	119.48	984.474	190,050	2,281	66,518	9,503	78,301

Phase 1: Existing Stack Configuration
Methylene Chloride Only
No Control

Phase 2: Capture & Dispersion Stack Configuration
Methylene Chloride with up to 20% substitution of 1,1,1–Trichloroethane
No Control

Phase 3: Capture & Dispersion Stack Configuration
Methylene Chloride with up to 20% substitution of 1,1,1–Trichloroethane
Approximately 60% Reduction in Total Facility Blowing Agent Emissions

foamex6.wk3

6.0 SUPPLEMENTAL INFORMATION: SECTION VI BEST AVAILABLE CONTROL TECHNOLOGY

6.1 Introduction

The purpose of this section is to provide an evaluation of Best Available Control Technology (BACT) options for reduction of Methylene Chloride emissions from the Slabtock Polyurethane Foam Production process. Based on previous informal communications, it is C/TA's understanding that FDEP interprets the current regulations under Rule 17.2, F.A.C. to include this compound as a Volatile Organic Compound (VOC). The applicant disagrees with this Departmental interpretation, based upon the clear and specific provisions of Rule 17-2.100(238), F.A.C., which specifically recognizes that Methylene Chloride is not a VOC. Because the total maximum annual emission rate of Methylene Chloride is 316.75 tons/yr, the significant emission criteria for VOCs of 250 tons/yr is exceeded. Thus, based on FDER's interpretation of the current regulations, the Foamex facility is classified as a major source. This BACT analysis is therefore submitted as required for a major source and to support the air pollution control system proposed. As previously noted, the applicant does not agree that such a BACT determination is warranted or necessary for this source and reserves its rights to question such a determination should it become necessary.

Sections 6.2 through 6.5 provide detailed discussions addressing the requirements for BACT evaluations as specified in FDEP rule 17-2.630 and as summarized below:

a) *Any EPA determination of BACT and any emission limitation contained in 40 CFR Part 60 or 61;*

Section 6.2 includes a discussion of the existing emission limits specified by EPA and FDEP.

b) *All scientific, engineering, and technical material and other information available to FDER;*

Section 6.4 provides a discussion of the current technologies and industry developments concerning control of Methylene Chloride and other blowing agent emissions.

c) *The emission limiting standards or BACT determinations of any other state;*

Section 6.3 includes a discussion of the permits issued for similar facilities in other states throughout the U.S.

d) *And the social and economic impact of the application of such technology.*

Section 6.5 includes an evaluation of each control measure identified as a feasible BACT option. This evaluation addresses economic, social and environmental issues associated with implementation of each option.

6.2 Emission Limits

There are no applicable emission limits specified in FDEP Section 17.2, or 40 CFR Parts 60 and 61 for VOC or Methylene Chloride emissions from foam manufacturing facilities. The only applicable requirement for this pollutant are the No Threat Levels specified in the FDER Air Toxics Permitting Strategy guideline document. This No Threat Level "requirement" should not be construed as the applicant's belief that such NTL's constitute either a required, acceptable or achievable BACT level for the calculated emissions. To the best of our knowledge the NTL's have not been adopted by Departmental rule or regulation and are not binding in these regards and may not accurately represent higher levels of emissions that present no threat to the environment. Compliance with these maximum ambient concentration levels is demonstrated in Section 7.0 (Supplemental Information: Section VII) of this application.

6.3 Review of Similar Sources

As an initial step in conducting this analysis, a review of the current EPA BACT/LAER clearinghouse was conducted. No previously issued BACT or LAER determinations were identified for foam manufacturing facilities.

In addition, a review of available information on similar sources in other states was conducted to identify the status of emission control equipment installed, existing state regulations, permits issued, and emission rate histories for each facility. It should be noted that the facilities reviewed use a variety of blowing agents, including Methylene Chloride, 1,1,1 Trichloroethane (Methyl Chloroform), Freon (141-B) and others. However, based on information from the Polyurethane Foam Association (PFA), Methylene Chloride is now the principal blowing agent used in the industry. According to PFA, there are approximately 100 facilities in the U.S. that produce flexible polyurethane foam. The states with the most facilities are California (13 plants), North Carolina (9 plants), Texas (9 plants), Indiana (8 plants), and Mississippi (7 plants). Table 6-1 provides a summary of the current status of 12 foam manufacturing facilities across the U.S.

A review of this summary shows that none of the facilities has been required to implement BACT, and only two facilities have been required to implement any emissions control technology. Appendix 6-A contains copies of the permits referenced in Table 6-1. Table 6-2 provides a summary of Methylene Chloride emissions from each facility for 1987 through 1990, as reported to the EPA TRIS Database.

6.4 Identification of BACT Options

Foamex is currently working with other members of the industry through the PFA to identify and evaluate emission reduction strategies for blowing agent emissions. Appendix 6-B provides a copy of a recent document produced by the PFA entitled "Flexible Polyurethane Foam (Slabstock) Assessment of Manufacturing Emission Issues and Control Technology". This document was presented at the annual PFA meeting in May, 1993, and provides a discussion of both add-on air pollution control technologies and alternative process technologies for reduction of blowing agent emissions. Appendix 6-C provides a second reference document, entitled "Flexible Polyurethane Foam Manufacture - An Assessment of Emission Control Options", that was prepared by the Center for Emissions Control and contains general descriptions of several equipment and process modifications for reducing emissions from foam manufacturing.

These documents represent the ongoing efforts by the foam manufacturing industry to identify feasible, proven options for reducing blowing agent emissions. In specific, PFA is working with EPA to establish Maximum Achievable Control Technology

(MACT) for the flexible polyurethane foam production source category as required by the amended Clean Air Act. The draft source category schedule, issued by EPA on September 24, 1992, lists November 15, 1987 as the promulgation date for flexible polyurethane foam production MACT emission standards. A final schedule for promulgation of MACT standards is anticipated from EPA in November 1993.

Currently, there is much research and development activity in the industry with the goal of optimizing foam manufacturing processes that use water based chemicals or eliminate the need for hydrocarbon based blowing agents. This industry activity was a major consideration in the development of the BACT evaluation represented in this permit application.

From the information generated through these current industry efforts, three general strategies can be identified for reducing blowing agent emissions from flexible polyurethane foam manufacturing:

1) Limitation of product mixtures produced with blowing agents,

2) Capture and treatment of emissions using add-on air pollution control technologies, and

3) Implementation of equipment and/or process technology modifications that result in lower emissions of blowing agents.

These strategies were discussed briefly in the Response to FDER Review Comments submitted on April 7, 1993, however a more detailed discussion of each approach is provided below. The purpose of this discussion is to identify specific emission control measures that can be evaluated as BACT options.

1) Limitation of Product Mixtures

This strategy is based on the fact that not all foam grades require the use of auxiliary blowing agents. The flexible polyurethane foam manufacturing process produces foam stocks of various densities or grades, depending on the market requirements. Foam of varying grades is produced for use in furniture, bedding, packaging, automotive soft trim and carpet cushioning. If the manufacturing activity were limited only to product mixtures that do not require blowing agents, the market available for product sales would be severely restricted. The Foamex facility in Orlando supplies a large quantity of foam grades that do require auxiliary blowing agents, thus implementation of this emission control strategy would result in a significant loss in sales volume and would mandate reductions in the plant work force. No BACT options were identified to represent this strategy for control of emissions at the Foamex facility.

2) Capture and Treatment of Emissions

This strategy involves the optimization of emissions capture from the foam manufacturing process, and the addition of an air pollution control system for treatment of blowing agent emissions. As stated previously, of the similar facilities listed in Table 6-1, only one currently uses an add-on control device for reduction of Methylene Chloride emissions, although Texas will require a 75% reduction of all auxiliary blowing agent emissions by December 31, 1993. Based on current industry information, this compliance date may be extended. For purposes of this BACT analysis, a survey was conducted to identify various control technologies that could be used to limit Methylene Chloride emissions from the Foamex process operations. Sources of information used include the reports published by PFA and the Center for Emissions Control contained in Appendices 6-B and 6-C, the EPA Handbook entitled "Control Technologies for Hazardous Air Pollutants" (June, 1991), and various information from equipment manufacturers. Other technical resources were surveyed such as the Air Pollution Consultant published by Elsevier Science Publishing Co., Inc. and the Journal of the Air and Waste Management Association.

Through review of these information sources, four options were identified for consideration, including absorption, condensation, carbon adsorption, and thermal incineration. A complete evaluation of each of these BACT options included in Section 6.5.

In addition to evaluating add-on control systems, the current process configuration was evaluated for opportunities to optimize capture and dispersion of Methylene Chloride. While this approach would not lower emission levels, it would minimize the ambient concentrations around the facility resulting from current blowing agent emissions. As discussed in Section 6.5 below, any future addition of a control system would also require the implementation of such capture and disperse modifications.

3) <u>Equipment and/or Process Technology Modifications</u>

This strategy emphasizes pollution prevention rather than add-on control, and involves the implementation of alternate manufacturing processes that are designed with the goal of producing a wide range of flexible polyurethane foams with little or no emissions of auxiliary blowing agents. Alternate processes currently being evaluated by the industry include the following:

a) Rapid Cooling, or Rapid Cure process,
b) Environmental Cure process, and
c) Variable Pressure Foaming (VPF) process.

The Rapid Cooling process involves the use of a conditioning area that is positioned parallel to the main foam production line, providing a temporary location for the buns to cool prior to continuing along the process. This process is designed to reduce the need for auxiliary blowing agents without sacrificing product quality or the range of foam grades that can be produced. However, to achieve these goals significant reformulation of the raw materials mixture is required to maintain the structural integrity of the product and to achieve the desired softening. This reformulation has not been completed for every foam grade.

The Environmental Cure process involves the use of an enclosed conditioning area for rapid cooling of foam blocks and produces water blown foam. Both the Rapid Cooling and the Environmental Cure processes are best suited to plants in which the foam may be manufactured in short blocks to meet customer specifications. The typical Foamex plants, including the Orlando facility, manufacture foam in long buns to allow for use in a wider variety of products.

The Variable Pressure Foaming (VPF) process is a new technology and is considered by Foamex to be the most promising as a future manufacturing alternative. It is based on the concept of increasing the foam volume by reducing the air pressure within the mold, thus reducing or eliminating the need for chemical blowing agents. This process allows the production of a wide range of flexible polyurethane foams. As of the current date, a VPF unit is in operation at the RECTICEL-Holland plant in Europe. At this facility, approximately 47% is being run at less than atmospheric or vacuum conditions, and 16% of production is run under pressurized conditions, for a total of approximately 63% of production without the use of blowing agents. The remaining 27% of production is currently being run at atmospheric conditions with the use of chemical blowing agents. However, as the technology is demonstrated to be effective for a wider variety of foam grades, this distribution will change. The quality of foam grades produced under vacuum and pressure conditions has been satisfactory for sale to the customer. No adverse physical properties have been experienced while producing polyurethane foam with this technology.

In addition to these new manufacturing processes, emissions reduction can be achieved through the substitution of 1,1,1-Trichloroethane as an alternative blowing agent. A Material Safety Data Sheet for this chemical is included in Appendix 6-E. 1,1,1-Trichloroethane can be used to substitute 20% of the Methylene Chloride used on an annual basis. However, it should be noted that the use of this chemical will be limited by the requirements included in the Clean Air Act Amendments of 1990. These include provisions to freeze production at 1989 levels and begin a phase-out of 1,1,1 Trichloroethane production in 1995. This fact makes the use of 1,1,1 Trichloroethane unfeasible for long term production. In the short term, Foamex will continue to evaluate the proper implementation of a permanent process modification such as the VPF system described above. Appendix 6-F provides a cost evaluation for substitution of 1,1,1-Trichloroethane.

There are also chemical modifiers under development that will reduce or eliminate the amount of auxiliary blowing agent required for the production of flexible polyurethane foam. Several options are under development which include the following: modified polyols, and additives such as Ortegol 310 and Geolite technology. At present, use of these additives can reduce the amount of Methylene Chloride needed by approximately 25 to 30%, but they cannot entirely replace auxiliary blowing agents. Once available for cost effective replacement of blowing agents, the use of such additives would reduce the need for emission control systems. Foamex will continue to work closely with chemical suppliers to take advantage of the latest developments in this area.

As part of efforts independent of this permitting process, Foamex is actively pursuing the implementation of various equipment and process modifications described above. In the short term, Foamex is prepared to begin substitution of 1,1,1 Trichloroethane for replacement of up to 20% of the annual Methylene Chloride used at the Orlando facility. An economic analysis of this measure was conducted and is provided in Appendix 6-D, however the use of alternative blowing agents is not feasible for long term operation, due to the anticipated regulatory restrictions on usage of the substituted chemicals.

As stated above, Foamex will also continue to evaluate the potential implementation of a permanent process modification such as the VPF system, that would result in the reduction or elimination of Methylene Chloride usage and emissions at the facility. No process modifications were identified for evaluation as BACT options, because sufficient testing has not been completed to accurately define the reduction in emissions that can be expected for production of all grades of foam. Also, the actual costs of implementation of the available process modifications have not yet been identified in detail. It should be considered, however, that future implementation of such a process modification may eliminate the need for additional control measures. Any add-on control systems designed to be installed with the current process equipment may be obsolete if such a process modification is implemented in the future.

6.5 Evaluation of Feasible BACT Options

Based on the discussion in Section 6.4 above, four emission control measures were evaluated as BACT options. As recommended in the EPA "Top-Down" Best Available Control Technology Guidance Document (March 15, 1990), the following steps were used to evaluate each of these control options:

Step 1: Identify all control technologies.

Step 2: Eliminate technically infeasible options.

Step 3: Rank remaining control technologies by control effectiveness. Criteria used to establish ranking include:

- control effectiveness (percent Methylene Chloride removed)
- expected emission rate (tons per year)
- expected emission reduction (tons per year)
- energy impacts
- environmental impacts
- economic impacts

Step 4: Evaluate most effective controls and document results.

Step 5: Select BACT

It should be noted that in order to optimize the current system and enhance the effectiveness of any future add-on air pollution control device, Foamex proposes to modify the exhaust configuration of the Slabstock process. This modification consists of 1) the installation of an enclosure to completely cover the Foam Line, (currently it is only partially covered); 2) the installation of centralized ventilation and exhaust plenums in the Long Bun Storage Room; and 3) the addition of GEP stacks for both the Foam Line and Long Bun Storage Room. Although this modification by itself would not reduce emissions, it would serve to lower the air quality impact from the facility. The ventilation, exhaust and stack systems would be necessary for any future implementation of a BACT control technology as evaluated in this section, and would likely be usable for any process modifications implemented in the near future. An economic analysis of this modification is provided in Appendix 6-D. The paragraphs below provide a discussion of each of the four BACT options evaluated, as well as design and cost analyses for those options considered feasible.

A. Absorption

Absorption, or the use of a packed tower scrubber for removal of Methylene Chloride from the Foam Line Stack exhaust stream was evaluated as a BACT option. This technology uses a liquid solution for contact with the gas stream and absorption of the contaminant. The efficiency of this process is highly dependent on the solubility of the contaminant in the scrubbing liquid. Because Methylene Chloride is highly insoluble in water, an organic solvent would be required. During the absorption process, some quantity of the scrubbing liquid is normally evaporated to become part of the gas flow. The use of an organic solvent then would result in emissions of that compound to the atmosphere. In addition to the potential impact on surrounding air quality, such emissions may also result in an odor problem. In addition, spent solvent would require regeneration to be reused or may require pretreatment prior to disposal. Based on information from manufacturers, it is expected that the presence of TDI in the process exhaust stream may foul the absorbent column thus reducing the effectiveness of the control system. Information from manufacturers also indicates that the relatively low concentrations of Methylene Chloride in the process exhaust would require such a large surface area, long contact time and high liquid to gas ratio that it may not be cost effective to achieve any significant removal efficiency. Based on the disadvantages described, this option was considered unfeasible and thus no detailed economic analysis was conducted.

B. Condensation

Condensation was also considered as a BACT system for control of Methylene Chloride emissions from the Foam Line Stack. This technology involves the removal of solvent vapors, accomplished by cooling the solvent laden gas stream below the condensation point of the compound. Depending on the product quality requirements for the process, the recovered solvent is often reused. While this technology is widely used for VOC control in other industries, it is most effective when the contaminant concentration is greater than one percent by volume in the process exhaust gas. Considering the relatively low concentrations typical of the Foam Line Stack exhaust, the Methylene Chloride removal efficiency achievable at the Foamex facility would be low. In addition, condensation of Methylene Chloride requires refrigeration to temperatures below -100°F. EPA's design and costing procedures as outlined in the handbook for HAP control systems referenced above do not provide for such extreme conditions. Based on various communications with equipment manufacturers, the Foamex facility Foam Line Stack conditions are not suitable for efficient condensation. Thus, this technology was not considered as a feasible BACT option, and a design and economic analysis was not conducted

C. Thermal Incineration

Thermal incineration was the fourth technology considered as a BACT option. Based on discussions with equipment manufacturers, thermal incineration has been widely used in the pharmaceutical industry for control of Methylene Chloride emissions, however there are no installations to date in the foam manufacturing industry. Thermal incineration is a proven technology for control of a wide range of organic compounds, and would be appropriate for reduction of Methylene Chloride emissions as well as emissions of process additives such as TDI, and alternative blowing agents such as 1,1,1 Trichloroethane and 141-B. However, the use of an incineration system would necessitate an absorber for removal of hydrogen chloride emissions generated through combustion of Methylene Chloride. It is estimated that the use of a thermal incinerator would result in a 98% reduction in Methylene Chloride emissions from the Foam Line stack, with a reduction in the total facility emissions of Methylene Chloride of 59%, or approximately 60%.. A summary of the design and economic analyses conducted for evaluation of this option are provided in Appendix 6-E.

D. Carbon Adsorption

Carbon adsorption systems are commonly used in various industrial processes for control of a wide range of organic emissions. As identified in Section 6.3 above, it is the only control technology that has been installed to date for control of emissions from a flexible polyurethane foam manufacturing process. However, the carbon adsorption system permitted at the facility, located in Verona, Mississippi, is only required to comply with a limit on TDI emissions, not Methylene Chloride.

In this technology, the contaminant laden gas stream passes through a carbon bed, and the contaminant molecules adsorb onto the surface of the carbon granules. The adsorbed compound is then stripped, or desorbed from the carbon bed using steam. To allow for continuous operation, multiple carbon beds can be used with a staggered cycle for desorption. Based on information from the PFA document contained in Appendix 6-B, carbon adsorption has been proven technically feasible for removal and subsequent recovery of Methylene Chloride emissions from flexible polyurethane foam production on a pilot scale as well as on a full scale. A precondition however, is the significant reduction of the volume of air used for process ventilation in the Foam Line tunnel. This indicates that a process modification similar to the capture and disperse approach proposed by Foamex above would be required prior to implementation of an effective carbon adsorption system.

Based on discussions with equipment manufacturers, this technology has been used in other industries for control of Methylene Chloride emissions. When applied to the foam manufacturing process however, the presence of TDI and amine catalysts in the process exhaust stream would require special design considerations and may make the regeneration of the carbon beds infeasible. It should also be considered that wastewater produced from the desorbing process may require treatment prior to disposal.

At the maximum Foam Line stack emission rate of approximately 956 lbs/hr, the use of a carbon adsorption system should achieve an estimated 95% control efficiency. A summary of the design and economic analyses conducted for evaluating this option are provided in Appendix 6-F.

6.6 Summary and Conclusions

As stated above, the complete analyses are included in Appendices 6-E and 6-F. Table 6-3 provides a summary of the comprehensive "Top-Down" evaluation of BACT alternatives, including a comparison of emission level achieved, and the economic impacts of each option.

Based on this summary, incineration is selected as BACT for the Foamex facility. Incineration is the most cost effective alternative, and, along with carbon adsorption represents the highest available control efficiency for Methylene Chloride emissions. Adverse environmental impacts associated with incineration such as hydrogen chloride emissions, can be controlled with the use of a liquid absorber scrubber.

However, although incineration is selected as BACT, Foamex proposes to integrate the implementation of this control option with the evolving developments in manufacturing process technology. Rather than committing to implement incineration technology at the Orlando facility based on the current process design, Foamex would continue to pursue implementation of a process modification that would serve as a pollution prevention measure, and that may result in the elimination of the need for an incineration system. During the interim, or investigation period, Foamex would implement control measures discussed above that would reduce Methylene Chloride emissions and result in compliance with the FDEP "No Threat Limit". In specific, Foamex proposes the following course of action:

(1) The current process system will be modified to significantly increase capture efficiency of Methylene Chloride emissions in the Slabstock process and the Long Bun Storage Room.

(2) Captured Methylene Chloride emissions will be dispersed with greater efficiency by increasing the Foam Line Stack and Long Bun Storage Room Stack heights to GEP levels.

(3) Methylene Chloride emissions will be limited through a reduction in usage, on an annual basis, of approximately 20%. This reduction in usage will be accomplished either through limiting production, or by substituting 1,1,1-Trichloroethane as an alternate blowing agent.

(4) During the next eighteen (18) month period Foamex shall pursue the development of alternate processes that will eliminate and/or significantly reduce the use of blowing agents. In specific, the Variable Pressure Foaming (VPF) process will be evaluated for potential implementation at the Orlando facility.

(5) After eighteen (18) months a decision will be made concerning the applicability and availability of alternate processes. If an alternate process technology does not appear to be feasible, Foamex will proceed with the design and implementation of an add-on control system. At that time, an application would be submitted to FDEP for a permit modification to allow for construction of the selected control alternative. While the selected control option may be a process modification or an add-on control system, or a combination of both, the resulting reduction in total facility emissions of Methylene Chloride will be approximately 60% (59% as calculated in Section 6 of this application).

TABLE 6-1
Review of Similar Sources
Flexible Polyurethane Foam Manufacturing

Foamex, L.P.
Application To Construct Air Pollution Source
December 13, 1993

Facility Name	Location	Permit Number	Issue Date	Expiration Date	Blowing Agents Used	Permitted Blowing Agent Emission Limits	Other Conditions	BACT Required	Control Technology Required
Foamex, L.P.	Eddysone, PA	23-313-029B	12-Feb-92	31-Mar-92	Isotron-141b	120 lb/hr	.	No	No
						50 ton/yr			
Foamex, L.P.	Conyers, GA	3086-122-10652	16-Nov-90	None Specified	Methylene Chloride	0.0378 lb/lb foam	12,250 lb foam/hr	No	No
						463.05 lb/hr	2 hr/day		
						115 ton/yr			
Foamex, L.P.	Morristown, TN	030115P	17-Nov-90	01-May-95	Methylene Chloride	None Specified	20% Opacity	No	No
Foamex, L.P.	Verona, MS	1540-00022	25-May-93	01-Jun-98	Methylene Chloride (AA-001) Foam Machine No. 1 & Cure Area	208.3 lb/hr (24-hr Avg)		No	No
						5,000 lb/day			
						291.5 ton/yr (rolling)			
					TDI (AA-001) Foam Machine No. 1	0.332 lb/hr		No	No
						1.45 ton/yr			
					TDI (AA-005) Foam Machine No. 2	0.004 lb/hr		No	Activated Carbon Bed Filter (1)
						0.02 ton/yr			
					Methylene Chloride (AA-002) Assembly Process, Glue, & Clean	24.8 lb/hr (24-hr Avg)		No	No
						595 lb/day			
						50 ton/yr (rolling)			
Foamex, L.P.	Elkhart, IN	Let. of Registration	02-Apr-91	N/A	Methylene Chloride	None Specified		No	No
Foamex, L.P. (f/k/a Recticel Foam Corp.)	Laporte, IN	Let. of Registration	13-Mar-86	N/A	Methylene Chloride	Exempt		No	No
Foamex, L.P. (f/k/a Scott Paper Co.)	Fort Wayne, IN	Let. of Registration	17-Nov-82	N/A	Methylene Chloride	None Specified		No	No
Foamex	Mesquite, TX	R-18113	23-Dec-91	31-Dec-93	Freon 11	1,222 lb/hr	Annual Rates based on rolling 12 month period	No	Must reduce Emissions by 75% by 12/31/93 (2)
						305.5 ton/yr			
					1,1,1-Trichloroethane	1,222 lb/hr			
						305.5 ton/yr			
					Methylene Chloride	17.5 lb/hr			
						4.2 ton/yr			
					Acteone	397 lb/hr			
						99.2 ton/yr			
					HFFC 141b	293 lb/hr			
						73.2 ton/yr			
					HFFC 123	370 lb/hr			
						92.5 ton/yr			
					Total Blowing Agent	1,222 lb/hr			
						305.5 ton/yr			
					Total Acetone & HCFCs 141b & 123	99 ton/yr			
					TDI	0.4 lb/hr			
						0.1 ton/yr			
Foamex, L.P.	Milan, TN	028376F	20-Sep-89	01-Apr-98	Methylene Chloride	None Specified		No	No
Foamex, L.P.	Santa Teresa, NM	Permit Exemption	20-Sep-89	N/A	141 B				
Foamex, L.P. (f/k/a Great Western Foam Products Corp.)	Orange, CA	Application No. 231957	18-Jul-90	N/A	1,1,1-Trichloroethane	Exempt		No	No
		118168 / M 52989 (Appl./Permit)	01-Oct-86	01-Nov Annually	Freon II	4,000 lb/day		No	No
					Carbon Dioxide	None Specified			
		10522A / S 08148 (Appl./Permit)	16-Apr-82	22-Sep-82	Freon II and Methylene Chloride	3,000 lb/day		No	No
Foamex, L.P.	San Bernardino, CA	D45201	26-Nov-91	16-Mar Annually	Methylene Chloride	53,650 lb/yr	Usage excluding amount reclaimed	No	No

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(1) Control system required for TDI emissions only, not for blowing agent emissions.

(2) Based on current industry information, this compliance deadline may be extended.

TABLE 6-2
Summary of Reported Blowing Agent Emissions
Flexible Polyurethane Foam Manufacturing Facilities

Foamex, L.P.
Application To Construct Air Pollution Source
December 13, 1993

Location of Foam Production Facilities		Air Permit Status			1992 Blowing Agent Use (lbs/yr)			
Region	City	Permit	Exemption	Other	Methylene Chloride	1,1,1-Tri-chloroethane	141 B	Freon
Northeast	Corry, PA			Note 1	684,400			
	East Providence, RI			Note 2	4,100			700
	Eddystone, PA	Yes					235,200	
	Montreal, Canada			Note 3	184,281			13,150
	Toronto, Canada			Note 3	139,298			13,197
Southeast	Conyers, GA	Yes			126,042			
	Cornelius, NC			Note 4	386,973			
	Morristown, TN	Yes			300,150			
	Orlando, FL			Note 5	577,676			
	Verona, MS	Yes			630,626			
Midwest	Auburn, IN		No	Note 6	72,890			
	Elkhart, IN		Yes		679,268			
	Fort Wayne, IN		Yes		107,000			
	Laporte, IN		Yes		196,182			
West	Mesquite, TX	Yes				61,000	2,665	27,558
	Milan, TN	Yes			786,700			
	Orange, CA	Yes				1,108,915		
	San Bernardino, CA	Yes			16,019	420,135		
	Santa Teresa, NM		Yes				20,999	

Note 1: Corry, PA
Production activities at the Corry plant began operation prior to 1972, and were grandfathered under the Pennsylvania Air Pollution Control Act.

Note 2: East Providence, RI
The Rhode Island Department of Environmental Management is reviewing Foamex's air permit application.

Note 3: Montreal and Toronto, Canada
Foamex is working with a Canadian consultant and legal firm to obtain permits for the Montreal and Toronto plants, if necessary.

Note 4: Cornelius, NC
The facility was instructed by Mecklenberg County officials to await a permit application request.

Note 5: Orlando, FL
The facility has submitted a permit application and is currently operating under a Consent Order.

Note 6: Auburn, IN
IDEM advised Foamex to submit an application after the new air toxics regulations are issued.

TABLE 6-3
Summary of Top-Down BACT Impact Analysis Results

Foamex, L.P.
Application To Construct Air Pollution Source
December 13, 1993

	Foam Line Stack Emissions		Total Facility Emissions	Emissions Reduction	Control Efficiency Achieved		ECONOMIC IMPACTS	
					Foam Line Stack	Total Facility	Total Annualized Cost	Cost Effectiveness
Control Alternative	(lb/hr)	(ton/yr)	(ton/yr)	(ton/yr)			($/yr)	($/ton)
Incineration/Absorption	19.12	3.80	130.50	186.25	98%	59%	$548,923.00	$2,947.25
Carbon Adsorption	95.58	19.01	145.71	171.04	90%	54%	$513,659.00	$3,003.15
Alternative Blowing Agents	955.80	152.04	278.74	38.01	20%	12%	$181,814.50	$4,783.33
Baseline	955.80	190.05	316.75	0.00	0%	0%	$0.00	$0.00

foamex4.wk3

Appendix 6-A

Compilation of Air Permits Issued For Flexible Polyurethane Foam Manufacturing Facilities

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
FIELD OPERATIONS - AIR QUALITY CONTROL

OPERATING PERMIT

In accordance with provisions of the Air Pollution Control Act, the Act of January 8, 1960, P.L. 2119, as amended, and after due consideration of an application received under Chapter 127 of the rules and regulations of the Department of Environmental Resources, the Department hereby issues this permit for the operation of the air contamination source(s) described below.

Permit No. 23-313-029B

Owner Foamex, L.P.

Address 1500 East Second Street
Eddystone, PA 19022

Attention Mr. Michael S. Kazio
Plant Manager

Source(s) Foam Machine

Air

Cleaning

Device

Location 1500 East Second Street
Eddystone
Delaware County

This permit is subject to the following conditions:

1. That the source(s) and any associated air cleaning devices are to be:
   - a. operated in such a manner as not to cause air pollution;
   - b. in compliance with the specifications and conditions of the plan approval issued under the same number;
   - c. operated and maintained in a manner consistent with good operating and maintenance practices.
2. This permit is valid only for the specific equipment, location and owner named above.

(SEE THE ATTACHED ADDITIONAL CONDITIONS)

Failure to comply with the conditions placed on this permit is a violation of Section 127.25. Violation of this or any other provision of Article III of the rules and regulations of the Department of Environmental Resources will result in suspension or revocation of this permit and/or prosecution under Section 9 of the Air Pollution Control Act.

Issued 02/12/92

Expires 03/31/93

THOMAS J. MCGINLEY
Chief, Engineering Services

cc: Central Office
Southeast Regional Office

Operating Permit Conditions
Application No. 23-313-029B
Foamex

Conditions (continued):

3. This condition is to denote a change in the company name from Scotfoam Corporation to Foamex, L.P.

4. The source covered under this Operating Permit is a foam machine having a capacity of 54,000 CFM.

5. The modification covered under this Operating Permit consists of substituting Isotron 141b for Freon 11 as the foaming agent.

6. **The maximum emissions of Isotron-141b shall be limited to 120 lbs/hr and 50.0 tons/yr.**

7. The company shall keep records of the Isotron-141b used for the operations of the source covered under this Plan Approval. The company shall keep these records for a period of two years and make these available to the Department upon request.

8. The company shall not impose conditions upon or otherwise restrict the Department's access to the aforementioned source(s) and/or any associated air cleaning device(s) and shall allow the Department to have access at any time to said source(s) and associated air cleaning device(s) with such measuring and recording equipment, including equipment recording visual observations, as the Department deems necessary and proper for performing its duties and for the effective enforcement of the Air Pollution Control Act.

9. If at any time the permittee causes, permits or allows any modification (as that term is defined in Chapter 121 of Title 25, the Rules and Regulations of the Department of Environmental Resources) of the aforementioned air contamination source(s), the operation and use of which is authorized by this permit, or causes, permits or allows any modifications, malfunction or removal of any air pollution control device required as a condition of this permit, then and in that event, this permit shall be suspended, and the permittee shall not thereafter continue to operate or use said air contamination source(s).

10. This operating permit is valid for a limited time only and may be renewed pursuant to 25 PA Code §127.24 before its expiration. Requests for an operating permit renewal must be in writing and must be accompanied by a permit fee in the amount of $200.00 (two hundred dollars) payable to the "Clean Air Fund" pursuant to 25 PA Code §127.34. The request should be made on the attached form and must be received by the Department no later than March 31, 1992.

The source may not be operated without a valid operating permit. Operation without an appropriate permit from the Department may be subject to enforcement action.

(23-1)2

State of Georgia
Department of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION

AIR QUALITY PERMIT

Permit No. 3086-122-10652

Effective Date
NOV 16 '90

In accordance with the provisions of Georgia's Air Quality Act of 1978 and the Rules, Chapter 391-3-1, adopted pursuant to or in effect under that Act,

FOAMEX L.P.
823 Waterman Avenue, East Providence, RI 02914

is issued a Permit for the following: The operation of a polyurethane foam block manufacturing facility including the use of methylene chloride.

location:
1705 Rockdale Industrial Boulevard
Conyers, Georgia

This Permit is conditioned upon compliance with all provisions of Georgia's Air Quality Act of 1978, the Rules, Chapter 391-3-1, adopted or in effect under that Act, or any other condition of this Permit.

This Permit may be subject to revocation, suspension, modification or amendment by the Director for cause including evidence of noncompliance with any of the above; or for any misrepresentation made in the application(s) dated Sept. 26, 1990, supporting data entered therein or attached thereto, or any subsequent submittals or supporting data; or for any alterations affecting the emissions from this source.

This Permit is further subject to and conditioned upon the terms, conditions, limitations, standards, or schedules contained in or specified on the attached 2 page(s), which page(s) are a part of this Permit.

Lonice C. Barrett
Director
Environmental Protection Division

STATE OF GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

PERMIT NO. 3086-122-10652 PAGE 1 OF 2

General Requirements

1. At all times, including periods of startup, shutdown, and malfunction, the Permittee shall to the extent practicable maintain and operate this source, including associated air pollution control equipment, in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Division which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures, and inspection of the source.

2. The Permittee shall dispose of all solid waste and/or wastewater in a manner acceptable to the Division.

3. The Permittee shall cause to be conducted a performance test at any specified emission point when so directed by the Division. The test results shall be submitted to the Division within 30 days of the completion of testing. Any tests shall be performed and conducted using methods and procedures which have been previously approved by the Division.

Process and Control Equipment

4. The Permittee shall not exceed a production rate of 12,250 pounds per hour for polyurethane foams containing methylene chloride.

5. The Permittee shall not use methylene chloride at a rate higher than 0.0378 pounds per pound of foam containing methylene chloride produced, on an hourly basis.

Fugitive Emissions

6. The Permittee shall take all reasonable precautions with any operation, process, handling, transportation, or storage facilities to prevent fugitive emissions of air contaminants.

Notification, Reporting and Recordkeeping

7. The Permittee shall maintain records of hours of operation, hourly polyurethane foam production rates, and hourly methylene chloride usage rates. This information shall be recorded in a permanent form suitable and available for inspection. These records shall be retained for at least tow years following date of entry.

STATE OF GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

PERMIT NO. 3086-122-10652 PAGE 2 OF 2

Circumvention

8. The Permittee shall not build, erect, install or use any article, machine, equipment or process the use of which conceals an emission which would otherwise constitute a violation of an applicable emission standard. Such concealment includes, but is not limited to, the use of gaseous diluents to achieve compliance with an opacity standard or with a standard which is based on the concentration of a pollutant in the gases discharged into the atmosphere.

Modifications

9. The Permittee shall give written notification to the Division when there is any modification to this source. This notice shall be submitted sufficiently in advance of any critical date involved to allow sufficient time for review, discussion, and revision of plans, if necessary. Such notice shall include, but not be limited to, information describing the precise nature of the change; modifications to any emission control system; production capacity of the plant before and after the change; and the anticipated completion date of the change.

Special Conditions

10. At any time that the Division determines that additional control of emissions from the facility may reasonably be needed to provide for the continued protection of public health, safety and welfare, the Division reserves the right to amend the provisions of this Permit without prior notice.

11. The Permittee shall not operate the facility more than two hours per day.

12. The Permittee shall not discharge, or cause the discharge, of methylene chloride emissions in excess of 115 tons per year.

TENNESSEE AIR POLLUTION CONTROL BOARD
NASHVILLE, TENNESSEE 37247-3101

OPERATING PERMIT Issued Pursuant to Tennessee Air Quality Act

Date Issued: NOV 17 1990

Date Expires: May 1, 1995

Permit Number: 030115P

Issued To:

Foamex L. P.

Installation Address:

Hamblen Ave.
Morristown

Installation Description:

Urethane Foam Production

Emission Source Reference No:

32-0113-01

Pet 1

The holder of this permit shall comply with the conditions contained in this permit as well as all applicable provisions of the Tennessee Air Pollution Control Regulations.

CONDITIONS:

1. This permit does not cover any air contaminant source that does not conform to the conditions of this permit and the information given in the approved application.

2. Visible emissions shall not exceed 20% opacity as specified in Rule 1200-3-5-.01 of the Tennessee Air Pollution Control Regulations (aggregate count). Visible emissions from stacks will be determined by Tennessee Visible Emission Evaluation Method 2 as adopted by the Tennessee Air Pollution Control Board on August 24, 1984.

3. Sixty (60) days prior to the expiration of this permit, permittee shall submit a new set of applications for permit renewal of this source. Application forms may be obtained by contacting a representative of Air Pollution Control at the Regional Health Office in Knoxville.

Harold R. Hodges

TECHNICAL SECRETARY

F2040305

No Authority is Granted by this Permit to Operate, Construct, or Maintain any Installation in Violation of any Law, Statute, Code, Ordinance, Rule or Regulation of the State of Tennessee or any of its Politi Subdivisions.

6-A-7

NON TRANSFERABLE

POST OR FILE AT INSTALLATION ADDRESS

STATE OF MISSISSIPPI
AIR POLLUTION CONTROL
PERMIT
TO OPERATE AIR EMISSIONS EQUIPMENT
THIS CERTIFIES THAT

Foamex LP
Lipford Road
Lee Industrial Park South
Verona, Mississippi

has been granted permission to operate air emissions equipment in accordance with emission limitations, monitoring requirements and conditions set forth herein. This permit is issued in accordance with the provisions of the Mississippi Air and Water Pollution Control Law (Section 49-17-1 et. seq., Mississippi Code of 1972), and the regulations and standards adopted and promulgated thereunder.

Issued this 25th day of May, 1993

Effective Date: As specified herein.

MISSISSIPPI ENVIRONMENTAL QUALITY PERMIT BOARD

Charles Chisolm

HEAD, OFFICE OF POLLUTION CONTROL
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

Expires 1st day of June, 1998

Permit No. 1540-00022

PART I
GENERAL CONDITIONS

1. All emissions authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any air pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions or modifications which will result in new, different, or increased emission of air pollutants must be reported by submission of a new application.

2. The permittee shall at all times maintain in good working order and operate as efficiently as possible all air pollution control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

3. Solids removed in the course of control of air emissions shall be disposed of in a manner such as to prevent the solids from becoming windborne and to prevent the materials from entering state waters without the proper environmental permits.

4. Any diversion from or bypass of collection and control facilities is prohibited except (i) where unavoidable to prevent loss of life or severe property damage or (ii) when approved by the Mississippi Environmental Quality Permit Board.

5. Whenever any emergency, accidental or excessive discharge of air contaminants occurs, the Mississippi Department of Environmental Quality Office of Pollution Control shall be notified immediately of all information concerning cause of the discharge, point of discharge, volume and characteristics, and whether discharge is continuing or stopped.

6. Should the Executive Director of the Mississippi Department of Environmental Quality declare an Air Pollution Emergency Episode, the permittee will be required to operate in accordance with the permittee's previously approved Emissions Reduction Schedule.

7. The permittee shall allow the Mississippi Department of Environmental Quality Office of Pollution Control and the Mississippi Environmental Quality Permit Board and/or their authorized representatives, upon the presentation of credentials:

   a. To enter upon the permittee's premises where an air emission source is located or in which any records are required to be kept under the terms and conditions of this permit, and

   b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any air emission.

8. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to:

    a. Violation of any terms or conditions of this permit.

    b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

    c. A change in any condition that required either a temporary or permanent reduction or elimination of authorized air emissions.

9. For renewal of this permit the applicant shall make application not less than one-hundred eighty (180) days prior to the expiration date of the permit substantiated with current emissions data, test results or reports or other data as deemed necessary by the Mississippi Environmental Quality Permit Board.

10. Except for data determined to be confidential under the Mississippi Air & Water Pollution Control Law, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Mississippi Department of Environmental Quality Office of Pollution Control.

11. The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

12. Nothing herein contained shall be construed as releasing the permittee from any liability for damage to persons or property by reason of the installation, maintenance, or operation of the air cleaning facility, or from compliance with the applicable statutes of the State, or with local laws, regulations, or ordinances.

13. This permit may only be transferred upon approval of the Mississippi Environmental Quality Permit Board.

14. This permit is for air pollution control purposes only.

15. This permit is not a Federally approved operating permit under Title V of the Federal Clean Air Act as amended in 1990. This permit is a transitional operating permit to satisfy the requirements of State Law only. After new State operating permit regulations are developed and adopted to satisfy the conditions of Title V of the Federal Act, the permittee will be required to submit an updated application to comply with said regulations and this permit may be modified, suspended, or revoked as necessary to comply with said regulations.

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Beginning May 25, 1993, and lasting until June 1, 1998, the permittee is authorized to operate air emissions equipment and emit air contaminants from the Varimax Foam Machine No. 1, Emission Point AA-001.

Such emissions shall be limited by the permittee as specified below:

EMISSION LIMITATIONS

Methylene Chloride*	208.3 lbs/hr (24-hour average), not to exceed 291.5 tons/year, as determined by EPA Reference Method 18, 40 CFR 60, Appendix A.
Toluene diisocyanate (TDI)	0.332 lbs/hr, not to exceed 1.45 tons/year as determined by EPA Reference Method 18, 40 CFR 60, Appendix A.

All test methods specified above shall be those versions, or their approved equivalents, which are in effect May 25, 1993.

*The methylene chloride emission limitation is for emissions from Foam Machine No. 1 and the Curing Area.

OPERATING LIMITATIONS

The permittee shall limit use of methylene chloride to no more than 5,000 pounds in any calendar day and no more than 583,000 pounds (291.5 tons) in any consecutive 365-day period.

EMISSION MONITORING REQUIREMENTS

The permittee shall monitor emissions of methylene chloride via the monitoring of usage. The permittee shall determine the total pounds of methylene chloride used each calendar day and each consecutive 365-day period ending with the current day.

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Continued from Previous Page

RECORDKEEPING & REPORTING REQUIREMENTS

The permittee shall maintain records of the total pounds of methylene chloride used each calendar day and each consecutive 365-day period. These records shall be maintained on site for at least two (2) years and shall be made available upon request by Office of Pollution Control personnel.

The permittee shall submit quarterly (calendar) reports which indicate any exceedences of the operating limitations during the reporting period. If no exceedences occurred, the report shall indicate the highest usage for a calendar day and a consecutive 365-day period and the date on which each occurred.

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Beginning May 25, 1993, and lasting until June 1, 1998, the permittee is authorized to operate air emissions equipment and emit air contaminants from the assembly process, including the application of glue with glue guns and the cleaning of glue guns, Emission Point AA-002.

Such emissions shall be limited by the permittee as specified below:

EMISSION LIMITATIONS

Methylene Chloride*	24.8 lbs/hr (24-hour average), not to exceed 50.0 tons/year, as determined by EPA Reference Method 18, 40 CFR 60, Appendix A.

All test methods specified above shall be those versions, or their approved equivalents, which are in effect May 25, 1993.

OPERATING LIMITATIONS

The permittee shall limit use of methylene chloride to no more than 595 pounds in any calendar day and no more than 100,000 pounds (50 tons) in any consecutive 365-day period.

EMISSION MONITORING REQUIREMENTS

The permittee shall monitor emissions of methylene chloride via the monitoring the usage. The permittee shall determine the total pounds of methylene chloride used each calendar day and each consecutive 365-day period ending with the current day.

RECORDKEEPING & REPORTING REQUIREMENTS

The permittee shall maintain records of the total pounds of methylene chloride used each calendar day and each consecutive 365-day period. These records shall be maintained on site for at least two (2) years and shall be made available upon request by Office of Pollution Control personnel.

The permittee shall submit quarterly (calendar) reports which indicate any exceedences of the operating limitations during the reporting period. If no exceedences occurred, the report shall indicate the highest usage for a calendar day and a consecutive 365-day period and the date on which each occurred.

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Beginning May 25, 1993, and lasting until June 1, 1998, the permittee is authorized to operate air emissions equipment and emit air contaminants from the 13.4 MMBTUH gas-fired Cleaver Brooks Model CB700 Boiler, Emission Point AA-003.

This boiler is subject to the emission limitations and other requirements of New Source Performance Standards, 40 CFR 60, Subparts A and Dc, and the emission limitations and monitoring requirements specified below:

EMISSION LIMITATIONS

Particulate Matter	0.006 lbs/MMBTU, not to exceed 0.08 lbs/hr and 0.35 tons/year, as determined by EPA Reference Methods 1-5, 40 CFR 60, Appendix A.
PM_{10}	0.006 lbs/MMBTU, not to exceed 0.08 lbs/hr and 0.35 tons/year as determined by EPA Reference Method 201 or 201A in conjunction with Reference Method 202, 40 CFR 51, Appendix M.
Sulfur Dioxide	0.0006 lbs/MMBTU, not to exceed 0.003 lbs/hr and 0.004 tons/year, as determined by EPA Reference Method 6, 40 CFR 60, Appendix A.
Nitrogen Oxides	0.14 lbs/MMBTU, not to exceed 1.9 lbs/hr and 8.3 tons/year, as determined by EPA Reference Method 7, 40 CFR 60, Appendix A.
Carbon Monoxide	0.035 lbs/MMBTU, not to exceed 0.47 lbs/hr and 2.1 tons/year, as determined by EPA Reference Method 10, 40 CFR 60, Appendix A.
Volatile Organic Compounds	0.006 lbs/MMBTU, not to exceed 0.08 lbs/hr and 0.35 tons/year, as determined by EPA Reference Method 25, 40 CFR 60, Appendix A.
Opacity	10% (maximum), as determined by EPA Reference Method 9, 40 CFR 60, Appendix A.

All test methods specified above shall be those versions, or their approved equivalents, which are in effect May 25, 1993.

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Continued from Previous Page

RECORDKEEPING & REPORTING REQUIREMENTS

The permittee shall comply with the reporting provisions of 40 CFR 60.48c (a), (g), & (i).

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Beginning May 25, 1993, and lasting until June 1, 1998, the permittee is authorized to operate air emissions equipment and emit air contaminants from the 1.25 MMBTUH gas-fired American Standard Kewanee Type F Model KSR7-G-05 Boiler, Emission Point AA-004.

Such emissions shall be limited by the permittee as specified below:

EMISSION LIMITATIONS

Particulate Matter	0.005 lbs/MMBTU, not to exceed 0.006 lbs/hr and 0.03 tons/year, as determined by EPA Reference Methods 1-5, 40 CFR 60, Appendix A.
PM_{10}	0.005 lbs/MMBTU, not to exceed 0.006 lbs/hr and 0.03 tons/year, as determined by EPA Reference Method 201 or 201A in conjunction with Reference Method 202, 40 CFR 51, Appendix M.
Sulfur Dioxide	0.0006 lbs/MMBTU, not to exceed 0.0008 lbs/hr and 0.004 tons/year, as determined by EPA Reference Method 6, 40 CFR 60, Appendix A.
Nitrogen Oxides	0.10 lbs/MMBTU, not to exceed 0.13 lbs/hr and 0.57 tons/year, as determined by EPA Reference Method 7, 40 CFR 60, Appendix A.
Carbon Monoxide	0.021 lbs/MMBTU, not to exceed 0.03 lbs/hr and 0.13 tons/year, as determined by EPA Reference Method 10, 40 CFR 60, Appendix A.
Volatile Organic Compounds	0.006 lbs/MMBTU, not to exceed 0.008 lbs/hr and 0.04 tons/year, as determined by EPA Reference Method 25, 40 CFR 60, Appendix A.
Opacity	10% (maximum), as determined by EPA Reference Method 9, 40 CFR 60, Appendix A.

All test methods specified above shall be those versions, or their approved equivalents, which are in effect May 25, 1993.

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Beginning upon receipt of certification of construction, and lasting until June 1, 1998, the permittee is authorized to operate air emissions equipment and emit air contaminants from the Varimax Foam Machine No. 2, which is equipped with two AMEG Model AM 5000 Activated Carbon Bed Filters for pollution abatement, each of which discharges to atmosphere via its own stack, Emission Point AA-005.

Such emissions shall be limited by the permittee as specified below:

EMISSION LIMITATIONS

Toluene Diisocyanate (TDI)	0.004 lbs/hr and 0.02 tons/year, as determined by EPA Reference Method 18, 40 CFR 60, Appendix A.

All test methods specified above shall be those versions, or their approved equivalents, which are in effect May 25, 1993.

PERFORMANCE TESTING REQUIREMENTS

The permittee shall demonstrate compliance with the emission limitation for toluene diisocyanate by stack testing in accordance with EPA Reference Method 18 and submittal of the stack test report. For the purpose of compliance demonstration, the permittee shall operate the foam machine at the maximum production rate.

The permittee shall demonstrate compliance within 180 days of startup, but not later than 60 days of attaining maximum production rate, and biennially thereafter.

PART III
OTHER REQUIREMENTS

(1) The emission limitations for methylene chloride established in this permit are subject to revision if and when more stringent regulatory requirements become applicable.

(2) The operator of the equipment covered by this permit shall operate and maintain this equipment to assure that the emission rates will not, at any time, exceed the rates allowed by the Mississippi Air Emission Regulations.

(3) For Emission Point AA-005, the permittee must provide in writing the date of startup and the date maximum production rates are reached. Each date must be provided no later than ten days after the actual date.

(4) A pretest conference at least thirty (30) days prior to the scheduled test date is needed to ensure that all test methods and procedures are acceptable to the Office of Pollution Control. Also, the Office of Pollution Control must be notified prior to the scheduled test date. At least TEN (10) DAYS notice should be given so than an observer may be scheduled to witness the test(s).

STATE OF MISSISSIPPI
AIR POLLUTION CONTROL
PERMIT
TO CONSTRUCT AIR EMISSIONS EQUIPMENT
THIS CERTIFIES THAT

Foamex LP
Lipford Road
Lee Industrial Park South
Verona, Mississippi

has been granted permission to construct air emissions equipment to comply with the emission limitations, monitoring requirements and other conditions set forth herein. This permit is issued in accordance with the provisions of the Mississippi Air and Water Pollution Control Law (Section 49-17-1 et. seq., Mississippi Code of 1972), and the regulations and standards adopted and promulgated thereunder.

Issued this 25th day of May, 1993

MISSISSIPPI ENVIRONMENTAL QUALITY PERMIT BOARD

Charles Chisolm

HEAD, OFFICE OF POLLUTION CONTROL
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

Permit No. 1540-00022

PART I
GENERAL CONDITIONS

1. The plans, specifications, schedules, dates and other data submitted to the Permit Board are filed with and considered as a part of this permit.

2. All air pollution control facilities shall be designed and constructed such as to allow proper operation and maintenance of the facilities.

3. The necessary facilities shall be constructed so that solids removed in the course of control of air emissions may be disposed of in a manner such as to prevent the solids from becoming windborne and to prevent the materials from entering State waters without the proper environmental permits.

4. The air pollution control facilities shall be constructed such that diversion from or bypass of collection and control facilities is not needed except (i) where unavoidable to prevent loss of life or severe property damage or (ii) when approved by the Mississippi Environmental Quality Permit Board.

5. The construction of facilities shall be performed in such a manner as to reduce both point source and fugitive dust emissions to a minimum.

6. The permittee shall allow the Mississippi Department of Environmental Quality Office of Pollution Control and the Mississippi Environmental Quality Permit Board and/or their representatives upon presentation of credentials:

   a. To enter upon the permittee's premises where an air emission source is located or in which any records are required to be kept under the terms and conditions of this permit; and

   b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any air emissions.

7. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to:

   a. Violation of any terms or conditions of this permit.

   b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts, or

   c. A change in any condition that requires either a temporary or permanent reduction or elimination of authorized air emissions.

8. Except for data determined to be confidential under the Mississippi Air & Water Pollution Control Law, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Mississippi Department of Environmental Quality Office of Pollution Control.

9. The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. Nothing herein contained shall be construed as releasing the permittee from any liability for damage to persons or property by reason of the installation, maintenance, or operation of the air cleaning facility, or from compliance with the applicable statutes of the State, or with local laws, regulations, or ordinances.

11. This permit may only be transferred upon approval of the Mississippi Environmental Quality Permit Board.

12. This permit is for air pollution control purposes only.

13. Approval to construct will expire should construction not begin within eighteen (18) months of the issuance of this permit, or should construction be suspended for eighteen (18) months.

14. Prior to startup of air emissions equipment at this source, the permittee must obtain a Permit to Operate and submit certification that construction was completed in accordance with the approved plans and specifications.

PART II
EMISSION LIMITATIONS AND MONITORING REQUIREMENTS

Beginning May 25, 1993, the permittee is authorized to construct air emissions equipment for the emission of air contaminants from the Varimax Foam Machine No. 2, which is equipped with two AMEG Model AM 5000 Activated Carbon Bed Filters for pollution abatement, each of which discharges to atmosphere via its own stack, Emission Point AA-005.

The air emissions equipment shall be constructed to comply with the emission limitations and monitoring requirements specified below.

EMISSION LIMITATIONS

Toluene Diisocyanate (TDI)	0.004 lbs/hr and 0.02 tons/year, as determined by EPA Reference Method 18, 40 CFR 60, Appendix A.

All test methods specified above shall be those versions, or their approved equivalents, which are in effect May 25, 1993.

PERFORMANCE TESTING REQUIREMENTS

The permittee shall demonstrate compliance with the emission limitation for toluene diisocyanate by stack testing in accordance with EPA Reference Method 18 and submittal of the stack test report. For the purpose of compliance demonstration, the permittee shall operate the foam machine at the maximum production rate.

PART III
OTHER REQUIREMENTS

None.

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

105 South Meridian Street
P.O. Box 6015
Indianapolis 46206-6015
Telephone 317/232-8603

VIA CERTIFIED MAIL P 730 172 475 April 2, 1991

FOAMEX L.P.
ATTN: Frank Lima, Plant Manager
603 Industrial Parkway
Elkhart, Indiana 46516

Re: Change of Ownership/
Registered Operation Status

Gentlemen:

This will acknowledge receipt of your letter of December 21, 1990. We have changed our records to reflect the transfer of ownership of facilities registered on September 18, 1984, from Foamex Products, Inc. to FOAMEX L.P.

Based on data submitted with the previous registration, it has been determined that the following, located at 603 Industrial Parkway, in Elkhart, Indiana are classified as registered: the flexible polyurethane foam manufacturing facilities, the 200 HP natural gas-fired boiler and the 200 HP No. 2 fuel oil-fired boiler.

Emissions shall be at a level acceptable to 326 IAC 6-2.1. There are no limits in 326 IAC 8 applicable to the facilities listed herein.

There will be no fee assessed for this change of ownership of a registered source.

Please maintain this letter as your record that a permit to operate the above facilities is not required at this time. However, prior to any change in your operation which may result in an increase in potential emissions, the proposed changes must be submitted to the Office of Air Management for approval.

Sincerely,

Timothy J. Method

Timothy J. Method
Assistant Commissioner
Office of Air Management

GDW/nlb
cc: ✓Linda Spellman-823 Waterman Avenue
E. Providence, RI 02914

STATE of INDIANA

INDIANAPOLIS 46206

AIR POLLUTION CONTROL BOARD
1330 WEST MICHIGAN STREET

(317) 633-~~4480~~ 0000

NOV 17 1982

Mr. J. C. Shoustal, Environmental Engineer
Scott Paper Company
3005 Commercial Road
Fort Wayne, IN 46309

Dear Mr. Shoustal:

Re: Registered Operation Status

Your application has been reviewed. Based on data submitted and the provisions in Sections 1 and 2 of 325 IAC 2-1.1, it has been determined that the following, located at 3005 Commercial Road, Fort Wayne, are classified as registered: a) the two (2) Maxfoam Units producing polyurethane foam consisting of the foam machines, thermal reticulator, hot wire cutter, vinyl laminator and fabric laminator; and b) the two (2) 350 hp natural gas or No. 2 fuel oil-fired boilers.

Rule 325 IAC 8 does not have limits applicable to the Maxform facilities listed herein. Rule 325 IAC 10-1 does not have limits applicable to the boiler facilities listed herein.

Please maintain this letter as your record that a permit to operate the above is not required at this time. However, any change in your operation which may result in a change in emissions, exceeding those specified in 325 IAC 2-1.1-1, must be submitted to the Board.

Very truly yours,

Harry D. Williams

Harry D. Williams
Technical Secretary

AJS/jb
Old Permit No. 02-03-82-0521 and 02-03-82-0522
cc: MJD
Allen County Health Department

STATE OF INDIANA

AIR POLLUTION CONTROL BOARD
1330 WEST MICHIGAN STREET
P.O. BOX 1964

INDIANAPOLIS, 46206

Rev Copy K. DeRolf
8/28/87

MAR 13 1986

Recticel Foam Corporation
Attention: Mr. Don Weatherbee
P.O. Box 369
LaPorte, IN 46350

Gentlemen:

Re: Registered Operation Status

Your application has been reviewed. Based on data submitted and the provisions in Sections 1 and 2 of 325 IAC 2-1.1, it has been determined that the following, located at 401 Darlington Street, LaPorte, Indiana, are classified as registered: the two spray adhesive operations with particulate emissions from the non-automatic spray booth controlled by dry filters and the 600 hp and 300 hp natural gas-fired boilers, at the urethane foam manufacturing and fabricating facility.

In compliance with 325 IAC 1-1.1 and 2-1.1, the following facilities are exempt from any volatile organic compound emission requirements: the urethane foam production line using Freon 11 and the adhesive spray operation using 1,1,1-Trichloroethane.

Emissions shall be at a level acceptable to 325 IAC 6-2 and 6-3. There are no limits in 325 IAC 8 applicable to the facilities listed herein.

Please maintain this letter as your record that a permit to operate the above is not required at this time. However, prior to any change in your operation which may result in a change in emissions, exceeding those specified in 325 IAC 2-1.1-1, the proposed changes must be submitted to the Board for approval.

Very truly yours,

Harry D. Williams
Technical Secretary

KLD/mam
Old Permit No. 46-06-85-0153

TEXAS AIR CONTROL BOARD
12124 PARK 35 CIRCLE, AUSTIN, TEXAS 78753, 512/908-1000

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MARY ANNE WYATT

December 23, 1991

Mr. Regis J. Martin
Plant Manager
FOAMEX
3210 Curtis Boulevard
Mesquite, Texas 75149

Re: Permit Amendment
Permit No. R-18113
Polyurethane Foam Machine
Mesquite, Dallas County
Account ID No. DB-1736-H

Dear Mr. Martin:

This is in response to your permit application, Form PI-1, concerning the proposed amendment to Permit No. R-18113. We understand that you propose to use other blowing agents such as 1,1,1-trichloroethane, methylene chloride, acetone, hydrochlorofluorocarbons 141b, and 123 in addition to Freon 11, but keeping the same total emissions.

Pursuant to Rule 116.5 of Regulation VI of the Texas Air Control Board, Permit No. R-18113 is hereby amended. This information will be incorporated into the existing permit file. Enclosed is a revised emission allowable table and special provisions pages. Please return the previously issued table and provisions pages to this office.

This amendment will be automatically void upon the occurrence of any of the following:

a. Failure to begin construction of the changes authorized by this amendment within 18 months from the date of this authorization.
b. Discontinuance of construction of the changes authorized by this amendment for a period of 18 consecutive months or more.
c. Not completing the changes authorized by this amendment within a reasonable time.

Your cooperation in this matter is appreciated. If you have further questions, please contact Ms. Louise Ngo of our Permits Program.

Sincerely,

Lawrence E. Pewitt
for Steve Spaw, P.E.
Executive Director

Enclosures

cc: Mr. Melvin Lewis, Regional Director, Fort Worth

GENERAL PROVISIONS

R-18113

1. Equivalency of Methods - It shall be the responsibility of the holder of this permit to demonstrate or otherwise justify the equivalency of emission control methods, sampling or other emission testing methods and monitoring methods proposed as alternatives to methods indicated in the provisions of this permit. Alternative methods shall be applied for in writing and shall be reviewed and approved by the Executive Director prior to their use in fulfilling any requirements of this permit.

2. Sampling Requirements - If sampling of stacks or process vents is required, the holder of this permit must contact the Quality Assurance Division of the Texas Air Control Board (TACB) prior to sampling to obtain the proper data forms and procedures. The holder of this permit is also responsible for providing sampling facilities and conducting the sampling operations at his own expense.

3. Appeal - This permit may be appealed pursuant to Rule 103.81 of the Procedural Rules of the TACB and Section 382.032 of the Texas Clean Air Act. Failure to take such appeal constitutes acceptance by the applicant of all terms of the permit.

4. Construction Progress - Start of construction, construction interruptions exceeding 45 days and completion of construction shall be reported to the appropriate regional office of the TACB not later than 10 working days after occurrence of the event.

5. Recordkeeping - Information and data concerning production, operating hours, sampling and monitoring data, if applicable, fuel type and fuel sulfur content, if applicable, shall be maintained in a file at the plant site and made available at the request of personnel from the TACB or any local air pollution control program having jurisdiction. The file shall be retained for at least two years following the date that the information or data is obtained.

6. Maintenance of Emission Control - The facilities covered by this permit shall not be operated unless all air pollution emission capture equipment and abatement equipment are maintained in good working order and operating properly during normal facility operations.

SPECIAL PROVISIONS

R-18113

1. This permit covers only those emissions listed in the attached table entitled "Emission Sources - Maximum Allowable Emission Rates," and those sources are limited to the emission limits and other conditions specified in that attached table. The annual rates are based on a rolling 12-month period.

2. Opacity of emissions from the facility shall not exceed 5% averaged over a 6-minute period as determined by Environmental Protection Agency Method 9 except for those periods described in Rule 111.111 of TACB Regulation I.

3. Blowing agent usage from the plant must comply with the following conditions:

   A. Total blowing agent usage shall not exceed 305.5 tons per year (tpy).

   B. This permit authorizes the use of no more than 99 tpy of hydrochlorofluorocarbons (HCFC) 141b, 123, and acetone combined.

   C. Each compound shall not exceed the following limits:

Blowing Agent	Pounds/hour	Tons/year
Freon 11	1222.0	305.5
1,1,1 trichloroethane	1222.0	305.5
methylene chloride	17.5	4.2
acetone	397.0	99.2
HCFC 141b	293.0	73.2
HCFC 123	370.0	92.5

4. Information and data concerning the usage of all materials containing potential air contaminants shall be maintained in a central location at the plant site on a two-year rolling retention basis and made immediately available at the request of personnel from the TACB or any air pollution control program having jurisdiction. The holder of this permit shall implement an air contaminant emission recordkeeping system which demonstrates compliance with the maximum allowable emission rates as represented in the permit application and meets the following requirements:

   A. Records shall be maintained showing daily materials used and potential air contaminants associated with each material from the plant.

B. Records of potential air contaminants shall be kept for a minimum of 24 months with cumulative tons-to-date for each consecutive 12 months. Any consecutive 12-month data shall not exceed the yearly limitations specified in Special Provision No. 1.

C. Material Safety Data Sheets containing potential air contaminants for all materials currently in use and those in use for the two previous years shall be kept at the plant site.

5. The holder of this permit shall submit an amendment application to add abatement equipment or adopt an equivalent control alternative so that the overall plant wide blowing agents are reduced by 75% of the current permitted emission levels before December 31, 1993. The abatement equipment or the equivalent control alternative shall be in place and operational 6 months after the amendment is approved by the TACB.

Revised 12/23/91

EMISSION SOURCES - MAXIMUM ALLOWABLE EMISSION RATES

R-18113

This table lists the maximum allowable emission rates and all sources of air contaminants on the applicant's property covered by this permit. The emission rates shown are those derived from information submitted as part of the application for permit and are the maximum rates allowed for these facilities. Any proposed increase in emission rates may require an application for a modification of the facilities covered by this permit.

AIR CONTAMINANTS DATA

Emission Point No. (1)	Source Name (2)	Air Contaminant Name (3)	Emission Rates * lb/hr	Emission Rates * TPY
1-6	Foam Building Exhaust Stacks	TDI	0.4	0.1
		non-VOC, VOC, and HCFC	1222.0	305.5(4)

(1) Emission point identification - either specific equipment designation or emission point number from plot plan.
(2) Specific point source name. For fugitive sources use area name or fugitive source name.
(3) VOC - volatile organic compounds as defined in General Rule 101.1
non-VOC - Freon-11 (trichlorofluoromethane)
1,1,1-trichloroethane (methyl chloroform)
TDI - Toluene Diisocyanate
HCFC - Hydrochlorofluorocarbons
(4) See Special Provision No. 3 for breakdown of individual emissions.

* Emission rates are based on and the facilities are limited by the following maximum operating schedule:

Hrs/day 24 Days/week 7 Weeks/year 52 or Hrs/year 8736

Revised 12/23/91

TEXAS AIR CONTROL BOARD
6330 HWY. 290 EAST, AUSTIN, TEXAS 78723, 512/451-5711

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WARREN H. ROBERTS
MARY ANNE WYATT

August 13, 1990

Mr. Jack S. Snyder, Plant Manager
FOAMEX, A DIVISION OF KIHI
3210 Curtis Blvd.
Mesquite, Texas 75149

Re: Permit Amendment
Permit No. R-18113
Polyurethane Foam Machine
Mesquite, Dallas County
Account ID No. DB-1736-H

Dear Mr. Snyder:

This will acknowledge receipt of your application for the above referenced permit amendment. We understand that you wish to use 1,1,1-trichloroethane in addition to freon-11. Enclosed you will find a draft copy of the proposed special provisions for your comment. Due to the limit in production and consumption of freon-11 regulated under the Montreal Protocol and EPA Federal Register 40 CFR Part 82 to protect the stratospheric ozone layer, please note that Special Provision No. 6 will require you to submit an amendment approximately two years from now to adopt a plan to control the emissions from your facility. Due to the phasing out of certain chlorofluorocarbon (CFC) compounds and the uncertain future of other CFCs, you may want to consider changing to a non-CFC blowing agent. ✓If you have no objections, I would like to propose a special provision in which for you to submit an annual report to us on any research you may have done in the past or presently examine it or any future technology that is in the study that you know of that can help to solve this problem.

I await to hear of your comments. Please let me know if you have any questions.

Sincerely,

Louise A. Ngo

Louise A. Ngo
Permits Program

Enclosure

cc: Mr. Melvin Lewis, Regional Director, Fort Worth

SPECIAL PROVISIONS

R-18113

1. This permit covers only those sources of emissions listed in the attached table entitled "Emission Sources - Maximum Allowable Emission Rates," and those sources are limited to the emission limits and other conditions specified in that attached table.

2. Opacity of emissions from the facility shall not exceed 5% as determined by Environmental Protection Agency Method 9, except for those periods described in Rule 111.111 of TACB Regulation I.

3. The usage rate of freon-11 and/or 1,1,1-trichloroethane shall not exceed 1222 pounds/hour and 305.5 tons per year. The blowing agent emission rate shall be based upon the assumption that 100 percent of the freon-11 and/or 1,1,1-trichloroethane used is evaporated to the atmosphere.

4. The following records of usage from Special Provision No. 3 shall be kept at the plant site on a two-year rolling retention basis and be made available at the request of personnel from the TACB or any air pollution control agency with jurisdiction.

   ✓A. Records of material usage in pounds and hours of operation shall be recorded daily.

   B. Records from the daily usage in (A) shall be incorporated into a monthly file with total per month and total per most recent 12 months in tons.

   C. Any consecutive 12-months data from (B) shall not exceed the yearly limitations in Special Provision No. 4.

5. The recordkeeping required in Special Provision No. 4 shall constitute the method of demonstrating compliance with the limits specified in Special Provision No. 1.

6. The holder of this permit shall submit an amendment application to add abatement equipment or adopt an equivalent control alternative so that the overall plant-wide freon-11 and/or 1,1,1-trichloroethane is reduced by 75 percent of the current emission level before January 31, 1993 if the holder of this permit plans to continue using these compounds. The abatement equipment or the equivalent control alternative shall be in place and operational 6 months after the amendment is approved by the TACB.

DRAFT

EMISSION SOURCES - MAXIMUM ALLOWABLE EMISSION RATES

R-18113

This table lists the maximum allowable emission rates and all sources of air contaminants on the applicant's property covered by this permit. The emission rates shown are those derived from information submitted as part of the application for permit and are the maximum rates allowed for these facilities. Any proposed increase in emission rates may require an application for a modification of the facilities covered by this permit.

AIR CONTAMINANTS DATA

Emission Point No. (1)	Source Name (2)	Air Contaminant Name (3)	Emission Rates* #/hr	Emission Rates* TPY
1-6	Foam Building Exhaust Stacks	VOC	0.4	0.1
		non-VOC	1222.0	305.5

(1) Emission point identification - either specific equipment designation or emission point number from plot plan.

(2) Specific point source name. For fugitive sources use area name or fugitive source name.

(3) VOC - volatile organic compounds as defined in General Rule 101.1
Non-VOC - Freon-11 (trichlorofluoromethane)
1,1,1-trichloroethane (methyl chloroform)

* Emission rates are based on and the facilities are limited by the following maximum operating schedule:

Hrs/day 2 Days/week 5 Weeks/year 50 or Hrs/year 500

DRAFT

TENNESSEE AIR POLLUTION CONTROL BOARD
NASHVILLE, TENNESSEE 37219-5403

[illegible]RATING PERMIT Issued Pursuant to Tennessee Air Quality Act

Date Issued:	SEP 20 1989	Permit Number:	
Date Expires:	April 1, 1998		028376P

Issued To:

Foamex - A Division of KIHI

Installation Address:

Kefauver Road
Milan

Installation Description:

Natural Gas Fired Air Make-up Units
7.75 MMBtu/Hr

Emission Source Reference No:

27-0012-02

The holder of this permit shall comply with the conditions contained in this permit as well as all applicable provisions of the Tennessee Air Pollution Control Regulations.

CONDITIONS:

1. This permit does not cover any air contaminant source that does not conform to the conditions of this permit and the information given in the approved application.

2. Visible emissions shall not exceed 20% opacity as specified in Rule 1200-3-5-.01 of the Tennessee Air Pollution Control Regulations (aggregate count). Visible emissions from stacks will be determined by Tennessee Visible Emission Evaluation Method 2 as adopted by the Tennessee Air Pollution Control Board on August 24, 1984.

3. Sixty (60) days prior to the expiration of this permit, permittee shall apply for permit renewal.

Harold E. Hodges

TECHNICAL SECRETARY F5039240

No Authority is Granted by this Permit to Operate, Construct, or Maintain any Installation in Violation of any Law, Statute, Code, Ordinance, Rule or Regulation of the State of Tennessee or any of its Political Subdivisions.

6-A-36

NON-TRANSFERABLE POST OR FILE AT INSTALLATION ADDRESS

TENNESSEE AIR POLLUTION CONTROL BOARD
NASHVILLE, TENNESSEE 37219-5403

[illegible]ATING PERMIT Issued Pursuant to Tennessee Air Quality Act

Date Issued:	SEP 20 1989	Permit Number:	
Date Expires:	April 1, 1998		028377P

Issued To:

Foamex - A Division of KIHI

Installation Address:

Kefauver Road
Milan

Installation Description:

Polyurethane Foam Pour-Line
PES #003
15,300 Lb/Hr. PWR

Emission Source Reference No:

27-0012-06

The holder of this permit shall comply with the conditions contained in this permit as well as all applicable provisions of the Tennessee Air Pollution Control Regulations.

CONDITIONS:

[illegible]. This permit does not cover any air contaminant source that does not conform to the conditions of this permit and the information given in the approved application. This includes compliance with the following operating parameters:

   a. Capacity shall not exceed 15,200 pounds per hour.

2. Visible emissions shall not exceed 20% opacity as specified in Rule 1200-3-5-.01 of the Tennessee Air Pollution Control Regulations (aggregate count). Visible emissions from stacks will be determined by Tennessee Visible Emission Evaluation Method 2 as adopted by the Tennessee Air Pollution Control Board on August 24, 1984.

3. The issuance of this permit does not exempt the permittee from any requirements of the Environmental Protection Agency pertaining to the emissions from the operation of this source.

4. Sixty (60) days prior to the expiration of this permit, permittee shall apply for permit renewal.

Harold E. Hodges

TECHNICAL SECRETARY F5069240

No Authority is Granted by this Permit to Operate, Construct, or Maintain any Installation in Violation of any Law, Statute, Code, Ordinance, Rule or Regulation of the State of Tennessee or any of its Political Subdivisions.

6-A-37

NON-TRANSFERABLE POST OR FILE AT INSTALLATION ADDRESS

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

PERMIT TO CONSTRUCT/OPERATE

9150 FLAIR DRIVE, EL MONTE, CALIFORNIA 91731

Permit No.
D45201
A/N 257175
Page 1

This initial permit must be renewed by 03/16 ANNUALLY unless the equipment is moved, or changes ownership. If the billing for annual renewal fee (Rule 301.f) is not received by the expiration date, contact the District.

ID 081892

Legal Owner
Or Operator: FOAMEX L.P.
823 WATERMAN AVENUE
EAST PROVIDENCE, RHODE ISLAND 02914
ATTN: DANIEL C. DOBRATZ

Equipment
located at: 1400 EAST VICTORIA AVENUE, SAN BERNARDINO, CA 92408

Equipment Description:

SLABSTOCK FLEXIBLE URETHANE FOAM PLANT, PERIPHLEX USA, CONSISTING OF NOT MORE THAN THE FOLLOWING:

1. 1,1,1 TRICHLOROETHANE METERING PUMP, 5 H.P.
2. TOLUENE DIISOCYANATE FEED PUMP, 5 H.P.
3. POLYOL METERING PUMP, 5 H.P.
4. THREE POLYOL METERING PUMPS, EACH 15 H.P.
5. TWO FILLED POLYOL METERING PUMPS, EACH 20 H.P.
6. TOLUENE DIISOCYANATE METERING PUMP, 30 H.P.
7. TEN ACTIVATOR METERING PUMPS, EACH 1 H.P.
8. EIGHT ACTIVATOR METERING PUMPS, EACH 2 H.P.
9. TWO ACTIVATOR METERING PUMPS, EACH 3 H.P.
10. TEN PIGMENT METERING PUMPS, EACH 1 H.P.
11. PIGMENT PUMP, 1 H.P.
12. METHYLENE CHLORIDE/1,1,1 TRICHLOROETHANE METERING PUMP, 5 H.P.
13. SILICONE UNLOADING PUMP, 5 H.P.
14. SILICONE TRANSFER PUMP, 2 H.P.
15. ACTIVATOR AGITATOR, 1 H.P.

CONTINUATION OF PERMIT TO CONSTRUCT/OPERATE

16. CHILLED WATER PUMP, 5 H.P.
17. ICEMAKER/CHILLER DRIVE, 28 H.P.
18. HOT WATER PUMP, 5 H.P.
19. THREE POLYOL COOLING WATER PUMPS, EACH 7-1/2 H.P.
20. TOLUENE DIISOCYANATE COOLING WATER PUMP, 5 H.P.
21. WATER METERING PUMP, 3 H.P.
22. HYDRAULIC MIXING HEAD MOTOR, 25 H.P.
23. TWO BOTTOM PLASTIC ADJUSTMENT MOTORS, EACH 1/5 H.P.
24. TWO BOTTOM PLASTIC TRIM MOTORS, EACH 1 H.P.
25. BOTTOM PLASTIC TRIM TAKEUP MOTOR, 2/5 H.P.
26. TWO HEIGHT ADJUSTMENT MOTORS, EACH 1/4 H.P.
27. FOUR FALL PLATE DRIVE MOTORS, EACH 1/2 H.P.
28. SIDE WALL ADJUSTMENT MOTOR, 1-1/2 H.P.
29. TWO SIDE WALL DRIVE MOTORS, EACH 1-1/2 H.P.
30. SIX EXHAUST FANS, EACH 3 H.P.
31. TWO AIR INLET FANS, EACH 3 H.P.
32. MAIN CONVEYOR DRIVE, 5-1/2 H.P.
33. TWO SIDE PLASTIC MOTORS, EACH 1 H.P.
34. AIR COMPRESSOR, 20 H.P.
35. CHILLER AERATOR MOTOR, 1 H.P.
36. FIVE ACTIVATOR TRANSFER PUMPS, EACH 1 H.P.
37. FIVE DYE METERING PUMPS, EACH 2 H.P.

CONTINUATION OF PERMIT TO CONSTRUCT/OPERATE

Conditions:

1. OPERATION OF THIS EQUIPMENT SHALL BE CONDUCTED IN COMPLIANCE WITH ALL DATA AND SPECIFICATIONS SUBMITTED WITH THE APPLICATION UNDER WHICH THIS PERMIT IS ISSUED, UNLESS OTHERWISE NOTED BELOW.

2. THIS EQUIPMENT SHALL BE PROPERLY MAINTAINED AND KEPT IN GOOD OPERATING CONDITION AT ALL TIMES.

3. THIS EQUIPMENT SHALL NOT USE A VOC (AS DEFINED IN RULE 1175) AS A BLOWING AGENT.

4. THE TOTAL QUANTITY OF METHYLENE CHLORIDE USED AT THIS FACILITY, EXCLUDING THE AMOUNT RECLAIMED, SHALL NOT EXCEED 53,650 POUNDS PER YEAR.

5. THE OPERATOR SHALL KEEP ADEQUATE RECORDS TO VERIFY YEARLY METHYLENE CHLORIDE CONSUMPTION, INCLUDING AMOUNTS RECLAIMED. SUCH RECORDS SHALL BE RETAINED FOR A PERIOD OF AT LEAST TWO YEARS AND BE MADE AVAILABLE TO DISTRICT PERSONNEL UPON REQUEST.

6. THE OPERATOR OF THIS EQUIPMENT SHALL KEEP A DAILY RECORD OF OPERATIONS, AS REQUIRED BY RULE 1175.

NOTICE

IN ACCORDANCE WITH RULE 206, THIS PERMIT TO OPERATE OR COPY MUST BE POSTED ON OR WITHIN 8 METERS OF THE EQUIPMENT.

THIS PERMIT DOES NOT AUTHORIZE THE EMISSION OF AIR CONTAMINANTS IN EXCESS OF THOSE ALLOWED BY DIVISION 26 OF THE HEALTH AND SAFETY CODE OF THE STATE OF CALIFORNIA OR THE RULES OF THE AIR QUALITY MANAGEMENT DISTRICT. THIS PERMIT CANNOT BE CONSIDERED AS PERMISSION TO VIOLATE EXISTING LAWS, ORDINANCES, REGULATIONS OR STATUTES OF OTHER GOVERNMENT AGENCIES.

EXECUTIVE OFFICER

Dorris M Bailey

By Dorris M. Bailey/fa
November 26, 1991

SOUTH COAST AIR QUALITY [illegible]

INVOICE

Invoice No. 081892-18-92

For Information Call -714-396-2900

PO BOX 4943 Mail Remittance To: [redacted] DIAMOND BAR CA 91765-09

California Health and Safety Code Section 40510 and South Coast Air Quality Management District Rule 301 authorizes the District to charge permit fees on the equipment identified below.

EQUIPMENT LOCATED AT:
1400 E VICTORIA AV
SAN BERNARDINO CA 92408-2924

INVOICE DATE 01/16/92

ANNUAL BILL MONTH
MARCH

CO. ID. 081892

LEGAL OWNER OR OPERATOR:
FOAMEX L.P.
823 WATERMAN AVEAVE
EAST PROVIDENCE RI 02914

TRANSACTION NUMBER	TRANSACTION DATE	REFERENCE NUMBER	DESCRIPTION	TRANSACTION AMOUNT	TRANSACTION BALANCE
01630258	011692	036331	POLYPROPYLENE & PROPYLENE BLE ANNUAL BILLING	150.00	150.
01630259	011692	036332	BAGHOUSE, AMBIENT TEMP (>500 ANNUAL BILLING	500.00	500.
~~01630260~~	~~011692~~	~~036333~~	~~POLYURETHANE, REACTION~~ ~~ANNUAL BILLING~~	~~500.00~~	~~500.~~
01630261	011692	036334	STORAGE TANK 1,1,1 TRICHLOROE ANNUAL BILLING	150.00	150.
01630262	011692	036335	STORAGE TANK ORGANIC CHEMICAL ANNUAL BILLING	150.00	150.
01630263	011692	036336	STORAGE TANK HYDROCARBONS MIS ANNUAL BILLING	150.00	150.
~~01630264~~	~~011692~~	~~036337~~	~~STORAGE TANK CHLORINATED HAL~~ ~~ANNUAL BILLING~~	~~150.00~~	~~150.~~
01630265	011692	D45201	POLYURETHANE FOAM MANUFACTURI ANNUAL BILLING	500.00	500.
01630266	011692	D45202	STORAGE TANK METHYLENE CHLORI ANNUAL BILLING	150.00	150.

NOTE:
1. D45201 REPLACES D36333
2. D45202 REPLACES D36337

REMARKS: PLEASE RETURN THE DUPLICATE COPY OF THIS INVOICE WITH YOUR REMITTANCE TO ENSURE PROPER CREDIT TO YOUR ACCOUNT.
IF YOU HAVE ANY QUESTIONS PLEASE CALL (714) 396-2900

6-A-41

BALANCE NOW DUE ~~$2,400.0~~ $1,950.0

If payment not received by 03/16/92 application/permit will be delinquent.

application/permit will expire. Operation of equipment witho

State of New Mexico
ENVIRONMENT DEPARTMENT
AIR QUALITY BUREAU
Harold Runnels Building
1190 St. Francis Drive, P.O. Box 26110
Santa Fe, New Mexico 87502
(505) 827-0070

BRUCE KING
GOVERNOR

JUDITH M. ESPINOSA
SECRETARY

RON CURRY,
DEPUTY SECRETARY

April 24, 1992

<u>**CERTIFIED MAIL NO. P 783 952 975**</u>
<u>**RETURN RECEIPT REQUESTED**</u>

Mr. Arthur R. Pereira
Manager/Engineering
Foamex L. P.
823 Waterman Ave.
East Providence, Rhode Island 02914

Re: Permit Application No. 624-M-1 - Santa Teresa Facility

Dear Mr. Pereira:

This letter acknowledges the receipt of your air quality permit application dated March 27, 1992 to expand the polyurethane manufacturing facility in Santa Teresa, New Mexico. The application was received by the Department on March 30, 1992.

Based on a preliminary review of the information provided we have determined that the potential uncontrolled emission rates will be less than ten (10) pounds per hour and/or twenty-five (25) tons per year for each criteria pollutant, therefore in accordance with AQCR 702, Part Two a permit is not required. This expansion does not constitute a modification or reconstruction of an existing facility, under AQCR 702 Part Three, therefore a permit for toxic air pollutants is not required. Because the potential uncontrolled TSP emissions are greater than ten (10) tons per year the submitted application will serve as the company's Notice of Intent in accordance with AQCR 703.1.

We have also determined that new source performance standards (NSPS) or national emission standards for hazardous air pollutants (NESHAPS) do not apply to this facility.

Future changes or changes in the method of operation may constitute a modification and should be preceded with an application for our review.

6--A-42
New Mexico ///

RECEIVED
MAY 4 1992

In the event there is a change in control or ownership of the facility Foamex shall notify the Department in writing within fifteen (15) days of that change.

Sincerely,

Jim Shively

Jim Shively
New Source Review Unit
Technical Analysis & Permits Section
Air Quality Bureau

js

xc: David Vackar, Director, Environmental Protection Division
Ken Smith, District III Manager, Manager
Gian Bacigalupa, Program Manager, Surveillance & Enforcement

GREAT WESTERN

Great Western Foam Products
2060 North Batavia Street
Orange, California 92665
(714) 637-0110 (800) 331-2

June 21, 1990

South Coast Air Quality
Management District
9150 Flair Drive
El Monte, Ca. 91731

Re: Rule 1175 sections (c) (1) and (c) (3)

In order to comply with the above rule, enclosed find the following:

1. Bid requests and responses for exempt blowing agent compounds.
2. Application and fee for our Methylene Chloride/ Chlorofluorocarbon emission reduction plan.

If further information is required, do not hesitate to contact me at (714) 637-0110.

Sincerely,

Vincent A. Bonaddio

Vincent A. Bonaddio

VAB/rsp

5. APPLICATION HEREBY SUBMITTED FOR: (continued)

Both methylene chloride and cfc's have been eliminated from our manufacturing methods. We have effectively switched to an alternative non-regulated blowing agent- 1,1,1 trichloroethane.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive, El Monte, CA 91731

APPLICATION FOR PLANS REQUIRED BY THE EXECUTIVE OFFICER
FOR INSTRUCTIONS AND FEE INFORMATION SEE REVERSE SIDE

1\. BUSINESS LICENSE NAME: (APPROVAL TO BE ISSUED TO)
Great Western Foam Products Corporation(Orange)
Great Western Carpet Cushion Co., Inc.

1a. CO. ID. NUMBER: (IF YOU HAVE AN EXISTING PERMIT ENTER ID NUMBER, IF NO PERMIT LEAVE BLANK) 1615

1b. NAME OF OPERATOR OF EQUIPMENT: (IF DIFFERENT FROM 1) (Same)

2\. MAILING ADDRESS:
2060 N. Batavia Street Orange, California 92665

3\. EQUIPMENT LOCATION: (IF SAME AS MAILING ADDRESS, ENTER "SAME") (Same)

4\. CONTACT PERSON: Vincent A. Bonaddio

CONTACT PHONE NUMBER: (714) 637-0110

5\. APPLICATION HEREBY SUBMITTED FOR:
Methylene Chloride and chlorofluorocarbon (CFC) emission reduction plan (See attached)

6\. RULE NUMBER WHICH THIS APPLICATION APPLIES TO: Rule 1175 section (c) (3)

7\. TYPE OF PLAN APPLICATION:

COMPLIANCE PLAN ☒ ALTERNATIVE EMISSION CONTROL PLAN (AECP) ☐
EXCAVATION PLAN ☐ EXTREME PERFORMANCE COATING CLASSIFICATION ☐
OTHER ☐ ____________________

8\. IF THIS APPLICATION IS ASSOCIATED WITH CERTAIN DISTRICT APPLICATION(S)/PERMIT(S), STATE THE APPLICATION/PERMIT NUMBER(S):
Application No./Permit No. 118168/ M 52989

9\. OPERATING SCHEDULE: (IF APPLICABLE)
8 HOURS/DAY 5 DAYS/WEEK 52 WEEKS/YEAR

10\. DO YOU CLAIM CONFIDENTIALITY OF DATA? YES ☐ NO ☒

IF YES, STATE NATURE OF DATA ON SEPARATE SHEET

11\. HAS A CEQA DOCUMENT BEEN PREPARED FOR THIS PROJECT? YES ☐ NO ☒

12\. GENERAL NATURE OF BUSINESS: Manufacture of polyurethane slabstock foam

13\. PRINCIPAL PRODUCT: Polyurethane foam

14\. SIGNATURE OF RESPONSIBLE MEMBER OF ORGANIZATION: Vincent A. Bonaddio

15\. OFFICIAL TITLE OF SIGNER: Technical Director

15\. TYPED OR PRINTED NAME OF SIGNER: Vincent A. Bonaddio

16\. PHONE NO.: (714) 637-0110

17\. DATE: 20 June 19

SCAQMD USE ONLY

EQUIP CAT NO.: ____/____ TYPE: B C SCH/STEP: ____

CO. ID #: APPLICATION NO.: ASSIGNMENT: UNIT: ENGINEER:

VALIDATION: FILING FEE: CHECK OR MONEY ORDER NUMBER:

6-A-46

7-18-90

application no. 231957

GREAT WESTERN FOAM PRODUCTS CORP.
2060 N. BATAVIA ST.
ORANGE, CA, 92665

Attn: Vincent Bonaddio

Dear Mr. Bonaddio,

In compliance with Rule 1175, you submitted copies of bids to manufacturers for yearly purchases of exempt compounds.

After reviewing the bids and the plan accompanying the 400-P form it is determined to be satisfactory for compliance with Rule 1175.

If you have any questions, please call me at the number shown below.

Very truly yours,

William J. Dennison
Director of Engineering

Kathy Gee

Kathy L. Gee
Asst. A.Q. Engineer
(818) 307-3513

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

PERMIT to OPERATE

9150 FLAIR DRIVE, EL MONTE, CALIFORNIA 91731

M 5298

on under this permit must be conducted in compliance with all information included with the initial application and the initi
ditions. The equipment must be properly maintained and kept in good operating condition at all times. In accordance with Ru
rmit to Operate or copy must be posted on or within 8 meters of equipment.

APPL. NO. 118168 ✓

OWNER
ERATOR: JOHN RALLIS DBA
GREAT WESTERN CARPET CUSHION COMPANY

ENT
D AT: 2060 NORTH BATAVIA STREET
ORANGE, CALIFORNIA

ENT DESCRIPTION AND CONDITIONS:

POLYURATHANE FOAM MANUFACTURING SYSTEM CONSISTING OF:

1. FOAM MACHINE, PERIPHLEX MAX FOAM, MODEL VARI MAX 750, WITH A 20-HP HYDRAULIC DRIVE PIN HEAD MIXER.
2. FORMATION TUNNEL, 8'-0" W. X 130'-0" L. X 6'-0" H., WITH TWO 1-HP SIDE WALL DRIVES, ONE 3-H CONVEYOR DRIVE, A COMPRESSED AIR PAPER WIND UP UNIT, AND WITH FOUR 5-HP EXHAUST STACK FANS.
3. FORMATION TUNNEL, 4'-2" DIA. X 50'-0" L., 42.2 KVA ELECTRICALLY HEATED, WITH TWO 1-1/2 HP ADJUSTMENT DRIVES, ONE 7-1/2 HP CONVEYOR DRIVE, AND THREE 2-HP EXHAUST STACK FANS.

PAGE 1 OF 3

itial permit must be renewed by 11/01 ANNUALLY unless the equipment is moved, or changes ownership. If billing for annual rene
301.f) not received by expiration date, contact office above.

ermit [illegible]s not authorize the emission of air contaminants in excess of those allowed by
en [illegible] the Health and Safety Code of the State of California or the Rules of the Air
[illegible]ment District. This permit cannot be considered as permission to violate existing
ordinances, regulations or statutes of other government agencies.

EXECUTIVE OFFICER

BY RAQUEL M. PUERTA

DATE 10/01/86

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

M 52989

ON OF PERMIT NO.

DISPLAYED WITH PERMIT)

APPL. NO. 118168

4. THREE POLYOL PLATE HEAT EXCHANGERS EACH WITH A 15-HP PUMP; HOT WATER HEATED.
5. TDI SURGE TANK, 4'-0" DIA. X 5'-6" H., 500-GALLON CAPACITY (COMMON TO LME MACHINE SO 8148) WITH A 20-HP TRANSFER PUMP.
6. FIVE TANKS, PIGMENT, EACH 1'-10" DIA. X 6'-0" H., 105-GALLON CAPACITY, EACH WITH A 2- TRANSFER PUMP.
7. THREE TANKS, SILICONE, EACH 1'-10" DIA. X 6'-0" H., 105-GALLON CAPACITY, EACH WITH A 2-HP TRANSFER PUMP.
8. FOUR AMINE TANKS, EACH 1'-10" DIA. X 6'-0" H., 105-GALLON CAPACITY, TWO WITH A 2-HP TRANSFER PUMP AND TWO WITH A 1-HP TRANSFER PUMP.
9. TWO TIN CATALYST TANKS, EACH 1'-10" DIA. X 6'-0" H., 105-GALLON CAPACITY, WITH A 3-HP TRANSFER PUMP.
10. WATER TANK, 1'-10" DIA. X 6'-0" H., 105-GALLON CAPACITY, WITH A 3-HP TRANSFER PUMP.
11. CHLORIDE SOLUTION TANK, 1'-10" DIA. X 6'-0" H., 105-GALLON CAPACITY.
12. FREON-II FEED TRANSFER PUMP, 3-HP.
13. METHYLENE CHLORIDE FEED TRANSFER PUMP, 3-HP.
14. CUT-OFF SAW.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

ON OF PERMIT NO. M 52989
DISPLAYED WITH PERMIT)

APPL NO. 118163

-CONDITIONS-

1. ONLY FREON-II AND/OR CARBON DIOXIDE MAY BE USED AS BLOWING AGENTS IN THIS EQUIPMENT.

2. THE TOTAL QUANTITY OF FREON-II USED AS A BLOWING AGENT IN FOAM PROCESSED IN THIS EQUIPMENT MUST NOT EXCEED 4,000 POUNDS IN ANY ONE DAY.

PAGE 3 OF 3 PAGES

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

PERMIT to OPERATE

ANAHEIM OFFICE - 1610 E. Ball Road, Anaheim, California 92805

SO

peration under this permit must be conducted in compliance with all information included with the initial application and t
it conditions. The equipment must be properly maintained and kept in good operating condition at all times. In accordance
his Permit to Operate or copy must be posted on or within 8 meters of equipment.

LEGAL OWNER OR OPERATOR: GREAT WESTERN CARPET CUSHION CO., INC.

APPLICATION NO. 10522A
PREVIOUS PERMIT NO. 001668

EQUIPMENT LOCATED AT: 2060 NORTH BATAVIA STREET, ORANGE, CALIFORNIA 92665

EQUIPMENT DESCRIPTION AND CONDITIONS:

POLYURETHANE FOAM MANUFACTURING SYSTEM CONSISTING OF:

1. FOAM MACHINE, LME, MODEL NO. 750/1000, H-15-96-140, SERIAL NO. 13878, WITH A 20 H.P. MIXING HEAD AND A 10 H.P. HYDRAULICALLY DRIVEN TRAVERSE UNIT.
2. FORMATION TUNNEL, 7'-0" W. x 78'-0" L. x 8'-0" H., WITH A 1 1/2 H.P. SIDEBOARD MOTO AND THREE PAPER/POLYURETHANE FILM TAKE-OFF UNITS, TWO 1 1/2 H.P. AND ONE 5 H.P.
3. DRYING/CURING TUNNEL, 10'-4" W. x 52'-0" L. x 8'-2" H., WITH EIGHTEEN CHROMALOX QUARTZ HEATER UNITS, 45 KW TOTAL.

(CONTINUED ON PAGE 2)

his initial permit must be renewed by September 22, 1982 or an earlier date if equipment is moved, altere
nership. If billing for annual renewal fee (Rule 301.f) not received by expiration date, contact Zone office a

his permit does not authorize the emission of air contaminants in excess of those allowed by ivision 26 of the Health and Safety Code of the State of California or the Rules of the Air uality Management District. This permit cannot be considered as permission to violate existing aws, ordinances, regulations or statutes of other government agencies.

EXECUTIVE OFFICER

BY Virginia Moy

DATE 4/16/82

PERMIT FEE COVERED BY TRANSFER FEE

gb VOID UNLESS VALIDATED

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

CONTINUATION OF PERMIT NO. S08148
(MUST BE DISPLAYED WITH PERMIT)

4. CUT-OFF SAW, 5 H.P.
5. TWO POLYOL SURGE TANKS NOS. 1 & 2, EACH 6'-0" DIA. x 7'-0" H., 1625 GALLONS CAPACITY, EACH WITH A 3 H.P. AGITATOR AND A COMMON 15 H.P. SUPPLY/TRANSFER/CIRCULATING PUMP.
6. TWO POLYOL SURGE TANKS NOS. 3 & 4, EACH 6'-0" DIA. x 7'-0" H., 1,500 GALLONS CAPACITY, EACH WITH A 3 H.P. AGITATOR AND A COMMON 10 H.P. SUPPLY/TRANSFER/CIRCULATING PUMP.
7. TWO SILICONE SURGE TANKS NOS. 1 & 2, EACH 4'-0" DIA. x 3'-6" H., 400 GALLONS CAPACITY, WITH THREE 1-1/2 H.P. SUPPLY/TRANSFER PUMPS.
8. TWO DEIONIZED WATER TANKS NOS. 1 & 2, EACH 3'-6" DIA. x 6'-0" H., 400 GALLONS CAPACITY, WITH A COMMON 1 H.P. SUPPLY/TRANSFER PUMP.
9. TDI SURGE TANK, 4'-0" DIA. x 5'-6" H., 500 GALLON CAPACITY, WITH A 5 H.P. TRANSFER PUMP.
10. FLAME RETARDANT SURGE TANK, 3'-6" DIA. x 4'-0" H., 300 GALLONS CAPACITY.
11. TIN CATALYST SURGE TANK, 3'-6" DIA. x 4'-4" H., 300 GALLONS WITH A 1/2 H.P. TRANSFER PUMP.

(CONTINUED ON PAGE 3)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

CONTINUATION OF PERMIT NO. S08148
(MUST BE DISPLAYED WITH PERMIT)

12. SLURRY SURGE TANK, 6'-0" DIA. x 7'-0" H., 1,500 GALLONS CAPACITY, WITH A 7 1/2 H.P. AGITATOR.
13. BARYTES SURGE TANK, 6'-0" DIA. x 7'-0" H., 1,500 GALLONS CAPACITY, WITH A 7 1/2 H.P. AGITATOR.
14. TWO POLYOL METERING PUMPS, EACH 15 H.P.
15. TWO SILICONE METERING PUMPS, EACH 2 H.P.
16. DEIONIZED WATER METERING PUMP, 2 H.P.
17. TDI METERING PUMP, 10 H.P.
18. FLAME RETARDANT METERING PUMP, 10 H.P.
19. TIN CATALYST METERING PUMP, 2 H.P.
20. SLURRY METERING PUMP, 10 H.P.
21. BARYTES METERING PUMP, 10 H.P.
22. THREE FOAM TINT UNITS, EACH WITH A 1/4 H.P. MOTOR.
23. TWO MYERS MIXERS, EACH 3'-4" DIA. x 3'-6" H., 200 GALLONS CAPACITY, WITH A COMMON 40 H.P. AGITATOR.
24. TWO TDI FEED TRANSFER PUMPS, EACH 5 H.P..
25. FIVE POLYOL FEED TRANSFER PUMPS, TWO 5 H.P. EACH, ONE 7-1/2 H.P. AND TWO 15 H.P. EACH.

(CONTINUED ON PAGE 4)

APPL. 10522A

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

CONTINUATION OF PERMIT NO. S08148
(MUST BE DISPLAYED WITH PERMIT)

26. FREON FEED TRANSFER PUMP, 5 H.P.
27. METHYLENE CHLORIDE FEED TRANSFER PUMP, 1-1/2 H.P.
28. FLAME RETARDANT FEED TRANSFER PUMP, 7-1/2 H.P.
29. SILICONE FEED TRANSFER PUMP, 3 H.P.
30. TEN BELT CONVEYORS, 32-1/2 H.P. TOTAL.
31. SEVEN TUNNEL EXHAUST FANS, FIVE 3 H.P. EACH AND TWO 5 H.P. EACH.

CONDITIONS:

1. THE TOTAL QUANTITY OF FREON II AND METHYLENE CHLORIDE BLOWING AGENTS USED IN THIS EQUIPMENT MUST NOT EXCEED 3000 POUNDS IN ANY ONE DAY.

APPL. NO. 10522A

Appendix 6-B

Flexible Polyurethane Foam (Slabstock) Assessment of Manufacturing Emission Issues and Control Technology (Polyurethane Foam Association, May 1993)

Polyurethane Foam Association

Flexible Polyurethane Foam (Slabstock) Assessment of Manufacturing Emission Issues and Control Technology

May 17, 1993

COPY 191

FLEXIBLE POLYURETHANE FOAM (SLABSTOCK)
ASSESSMENT OF MANUFACTURING EMISSION ISSUES AND CONTROL TECHNOLOGY

CONTENTS

INTRODUCTION

FLEXIBLE POLYURETHANE FOAM (SLABSTOCK) ASSESSMENT OF MANUFACTURING EMISSION ISSUES AND CONTROL TECHNOLOGY

1. INTRODUCTION

1.1 Preface

Flexible polyurethane foam manufactured via the slabstock technique is by far the most significant segment of the U.S. polyurethane industry. Data provided by the SPI Polyurethane Division illustrates the manner in which market share is divided among the various types of polyurethane products. This information is shown below in Table 1.

TABLE 1

U.S. POLYURETHANE INDUSTRY
(1989, MILLIONS OF POUNDS)

Foam	Flexible (Slabstock)	1,300
	Flexible (Molded)	435
	Rigid	870
Non-Foam	Coatings	180
	Adhesives/Sealants	198
	Elastomers	312
	TOTAL	**3,295**

Different sectors of the polyurethane industry share some common features, but others remain unique to foam products. Di- and poly-isocyanates are an essential and irreplaceable feedstock for the manufacture of all polyurethane products. Polyurethane foam (PUF) is unique, however, in that it utilizes carbon dioxide (CO_2) generated during the reaction process to form a cellular structure.

The manufacture of certain flexible PUF (slabstock) grades currently requires the use of an additional blowing agent to supplement the action of carbon dioxide. These auxiliary blowing agents (ABAs) are used so that the resulting foam may have certain physical properties (softness, low density, etc.). The ABAs also remove heat from the reaction, thus improving process safety. The manufacture of flexible foams raises unique issues since the emission of these blowing agents constitutes an essential process feature.

The U.S. Environmental Protection Agency (EPA) has recognized the unique characteristics of this manufacturing process and has listed flexible polyurethane foam (PUF) as a separate source category for regulation under the 1990 Clean Air Act Amendments (CAA-A). The EPA has indicated that the flexible PUF source category will be subject to emission standards that are scheduled for issue in 1997.[1] The EPA surveyed the flexible PUF industry in 1980,[2] 1982,[3] and 1987.[4,5] In recent years, the industry has undergone significant changes.

The overall objective of this document is to provide a status report concerning emission control options for the flexible slabstock polyurethane foam industry. Specific goals of this document are as follows:

1) Present the current status of commercially available control technologies.

2) Identify developments which may lead to significant new manufacturing techniques/control technologies that should become available in the upcoming years.

3) Continue a dialogue with the EPA's Office of Air Quality Planning and Standards to provide EPA with information which will facilitate its decision making process in the following areas:

   a) determination of the technology(ies) that will constitute Maximum Achievable Control Technology (MACT); and

   b) development of emission standards for the flexible PUF (slabstock) industry.

This document was prepared by the Polyurethane Foam Association (PFA). The document begins with a portrayal of the PFA and its charter and is followed with a description of the production process for flexible PUF (slabstock). Section 2 describes process emissions, and Sections 3 and 4 summarize the properties of methylene chloride and toluene diisocyanate, respectively.

It is important to note that after a given technology is developed and proven via successful industrial experience, sufficient time must be allowed for the manufacturing infrastructure to implement the use of these new, complex systems.

1.2 The Polyurethane Foam Association (PFA)

The PFA is the trade association for the flexible PUF industry. PFA members represent producers of 75 to 80% of the flexible polyurethane foam (slabstock) which is manufactured in the United States. The PFA Mission Statement is as follows:

> "To provide a forum in which the Association can act on public and industry issues that affect the manufacture, application, and use of flexible polyurethane foam."

In the areas of Environment, Health, and Safety (EH&S) compliance, the PFA successfully coordinated numerous activities of its members on issues of mutual interest. For example, while working in close cooperation with the EPA's Office of Air and Radiation, the PFA facilitated the virtual phase-out of chlorofluorocarbon (CFC-11) use in the production of flexible PUF far ahead of any regulatory schedule.

In another case, the PFA worked with the EPA on the preparation of a manual which evaluated a number of phase-out options for CFCs.[6] That manual, which is entitled "Handbook for Reducing and Eliminating Chlorofluorocarbons in Flexible Polyurethane Foams," continues to be used in technology transfer workshops throughout the world.

The PFA formed task forces to assist members in the development of their strategic plans for compliance with the CAA-A. Preparation of this document is one part of that overall effort.

1.3 Product and Process Description

Since its commercial introduction in the late 1940s, flexible polyurethane foam has become an important cushioning material used throughout the world. Flexible PUF (slabstock) products are used in a variety of finished products, including furniture, beds, carpet underlay, and automobiles.

The manufacturing process for flexible PUF (slabstock) consists of a series of closely controlled chemical reactions during which the polymeric product being formed is simultaneously expanded by a blowing agent.

The basic ingredients, either polyether polyol and toluene diisocyanate (TDI) or polyester polyol and TDI, are mixed in carefully controlled ratios along with water, catalysts, and surfactants. The resulting polymeric structure is expanded by the carbon dioxide formed in the reaction between water and TDI. The carefully balanced polymerization and simultaneous expansion yields the foam product. This basic process, from the mixing of the liquid chemicals to the formation of fully expanded foam, occurs in less than three minutes.

In addition to the use of catalysts and surfactants to control and aid the chemical reaction, the foam manufacturer may include additives in the process to alter the resulting foam characteristics. These include colorants, combustion modifiers, fillers, static dissipative agents, and auxiliary blowing agents.

Auxiliary blowing agents (ABAs) are used because there are limits on the foam properties that can be achieved with carbon dioxide as the sole blowing agent and because of the exothermic nature of the water/TDI reaction. Excessive heat development from the exothermic process can lead to scorch or even auto-ignition of the foam during the manufacturing process and subsequent curing. High water levels also tend to produce firmer and more brittle polymers. About 60 % of slabstock foam in the USA is manufactured utilizing an auxiliary blowing agent.

It is estimated that in 1989, the total consumption by PUF manufacturers of ABA was about 35 million pounds:

Methylene Chloride	20 million pounds	(57%)
CFC-11	12 million pounds	(34%)
Methyl Chloroform/Acetone	3 million pounds	(9%)

It is further estimated that in 1990 the PUF market for ABA was about 33 million pounds:

Methylene Chloride	24 million pounds	(73%)
CFC-11	3 million pounds	(9%)
Methyl Chloroform/Acetone	6 million pounds	(18%)

In 1991, the market continued to evolve with regard to ABA usage. The use of CFC-11 was reduced to less than 0.3 million pounds (1%). The physical volume of total ABA was estimated to be less than 30 million pounds, and the Methyl Chloroform/Acetone category was estimated to be greater than 7.5 million pounds (25%). Evolving technologies are responsible for the decreased use of ABA and will be discussed later in this document.

Methylene chloride is currently considered the most economical ABA and is only replaced where local or state regulations do not allow its use.

There are different slabstock manufacturing processes in use. All are basically modifications of one general manufacturing process (Figure 1).

A chemical mixture, as previously described, is continuously transferred to a conveyor where the foam expands to a continuous slab, up to 4 feet high and 8 feet wide. Near its maximum expansion, it starts to release its blowing agents and some unreacted chemicals. A ventilated tunnel is used to exhaust these emissions and thereby controls workplace concentrations. After the chemical reaction has sufficiently progressed to allow dimensional stability, the slab is cut to size (as short as 3 feet, as long as 200 feet) and transferred to a curing area where the exothermic chemical reaction is completed. The generated heat slowly dissipates, and atmospheric air replaces any residual blowing agent.

It is estimated that about 30 to 40% of the blowing agent is emitted on the production conveyor. Another 40 to 55% is released in the curing area with the remainder emitted during cut-off and transportation to the curing area.[6,7]

PROCESS EMISSIONS

2. PROCESS EMISSIONS

2.1 General Overview

There are compounds that might be present in emissions from flexible PUF (slabstock) with an alleged potential to cause adverse health effects. Available information centers on only a few substances and speculates on the existence of others. In addition, much information is related to workplace concentrations, which are not necessarily identical to stack emissions.

The following substances are qualitatively and quantitatively identified in emissions from flexible PUF (slabstock) plants:[8]

- Toluene diisocyanate (0.3 to 1.0 ppm)
- Auxiliary blowing agents (methylene chloride, methyl chloroform, CFC-11, acetone or pentane; < 4,000 ppm)
- Tertiary amines (< 0.1 ppm)

Compounds that may be emitted in the PUF production are:[8]

- Solvents (impurities in raw materials, or diluents)
- Antioxidants
- Surfactants
- Combustion modifying additives

In addition, reaction by-products could be formed. One of those, Toluenediamine (TDA), is often mentioned, but it has not been detected in process emissions.[9,10,11] Individual manufacturers may use other compounds that could lead to additional emissions not common for this industry.

The European Federation of Flexible PUF manufacturers (EUROPUR), together with the International Isocyanate Institute (III) and the European Association of Isocyanate Manufacturers (ISOPA), is funding a detailed analytical study on emissions from PUF slabstock plants. Results are not yet available.[8]

The emission of tertiary amines may be of some significance on the fate of TDI.[10] However, the low level of emission and the existing lack of regulatory concern do not warrant further consideration in this document as the compounds do not appear on the list of hazardous air pollutants (HAP) to be regulated under the Air Toxics Program.

Acetone and pentane are not listed as HAPs. These substances are, however, photochemically active[8] and subject to regulation under Title I of the CAA-A.

Methylchloroform (MCF), HCFCs, and CFC-11 are listed as ozone depleting substances regulated under Title VI of the CAA-A. MCF is also listed as a HAP, however, the future use restrictions make it seem unnecessary to consider this substance for regulatory action under Title III.

2.2 Emissions of Methylene Chloride

The foam industry assumes 100% emission of the methylene chloride (MC) used as ABA. This is inherent to the process that is designed to create an open cell foam. Consequently, the 1990 emissions of MC, from its utilization as an auxiliary blowing agent, were:

24 million pounds

The emissions occur at several locations:

Raw Material Handling

- During storage and material transfer

Foam Production

- From the foam tunnel
- During cut-off and in-plant transportation
- In the curing process

Fugitive emissions from storage and transfer of MC, prior to flexible PUF production, are thought to be small. While exact industry data are not available, information from other industries[12] and from individual foam manufacturers suggests 3 to 5% (about 1 million pounds).

Emissions from the foam production tunnel are controlled by ventilation. The amount emitted will depend on several factors:

- tunnel length
- airflow from the ventilation process
- foam formulation
- manufacturing process
- capture efficiency

The industry estimates that an average of 30 to 40% will be emitted in this stage (about 9.5 million pounds).

Emissions during the cut-off of the foam and subsequent transportation to the curing area counts for about 15% (4 million pounds) of the overall MC emissions, with the remainder (40 to 55%) released during the 24 hour curing time (9.5 million pounds). The emissions during the cure time are not uniformly distributed either by area (there is significant pocketing) or by height (Methylene Chloride is heavier than air). Therefore, meaningful monitoring of potential exposure is quite difficult.

Figure 2[13] indicates the general emission profile for Methylene Chloride showing a decay curve of emission after the flexible PUF has entered the cure phase. The asymptotic nature of this decay curve should be noted. The emission profile is not linear with time.

2.3 Emissions of Toluene Diisocyanate

The diisocyanate called toluene diisocyanate (TDI) is an integral part of the chemical reaction used to make flexible PUF. The TDI most widely used is an 80/20 ratio of two isomers, 2,4-TDI and 2,6-TDI.

It should be noted that measured emissions of TDI are generally of a different isomer ratio than the 80/20 ratio of the raw material.

There is extensive historical information available concerning TDI emissions from flexible PUF slabstock plants.[14,15,16] Emission levels of 0.3 to 1.1 ppm are reported. One of the studies (the "Stuttgart" study[14]) estimates the amounts of TDI emitted at a figure of 50 grams of TDI per 1,000 kilograms of TDI used in the foaming process (0.005%). Over the years, this figure has been used by industries and agencies as an accepted guideline.

The PFA collected TDI emission data from its members in 1989[17] with the following results:

- Less than 9,680 pounds of TDI were emitted from a total consumption of 285,796,000 pounds
- The average emission reported was 34 grams per 1,000 kilograms TDI used or:

0.003%

There are several reasons for the lower than expected emissions:

- The block height has increased considerably since the publication of the Stuttgart study (1979). This leads to less emission surface per foam weight, and consequently to lower emissions.
- Some current square block techniques and some curing techniques include the covering of the block surface, thus reducing TDI emissions.
- The prevailing equipment in the U.S., "Maxfoam," is reported to allow for about 10% less emissions than the conventional equipment analyzed in the Stuttgart study.
- Many manufacturers have minimized excess TDI use (over indexing), which is thought to lead to proportional decreases in TDI emissions.

It is reported that the two isomers of TDI are not emitted in the ratio of use. Emissions from the 80:20 ratio TDI used to make the majority of flexible PUF (slabstock) appear in a 50:50 ratio in workplace emissions and in a 25:75 ratio in stack emissions.[16,18] It should also be noted that OSHA's PEL for TDI applies only to the 2,4-isomer. The same is true for the registration as a HAP; only the 2,4-isomer appears on the list.

The theoretical emission locations are identical to those for methylene chloride. However, based on the much lower volatility of TDI and its reactivity, emissions from storage and transfer of the raw material are low (0.3 grams per 1,000 kilograms TDI[17]) and from a PUF curing area expected to be even lower.

Taking into account that the PFA represents 75 to 80% of the flexible PUF (slabstock) manufacturers, TDI emissions are estimated to be:

about 13,000 pounds

of both isomers for the entire industry.

PROPERTIES OF METHYLENE CHLORIDE

3. PROPERTIES OF METHYLENE CHLORIDE

3.1 Physical/Chemical Properties

Methylene chloride's combination of properties, such as a low boiling point, relative inertness, and non-flammability, have led to its use as an auxiliary blowing agent in the flexible PUF (slabstock) industry. Its low photochemical ozone creation potential (PCOP) and lack of ozone depletion potential (ODP) has increased its use dramatically in recent years, making it the number one CFC-replacement technology in the manufacture of flexible PUF (slabstock). The EPA has recognized this by mentioning MC under the Agency's Significant New Alternatives Program (SNAP) as an acceptable alternative to ozone depleting solvents.

Methylene chloride, or dichloromethane, is a clear, colorless liquid with a penetrating ether-like odor. Typical properties can be found in Table 2.

TABLE 2

PHYSICAL PROPERTIES OF METHYLENE CHLORIDE

Molecular weight	84.93
Freezing point	-95°C
Boiling point (760 mm Hg)	40°C
Density (25°C)	1.32 g/cc
Refractive index (25°C)	1.421
Viscosity (25°C)	0.41 cp
Flash point (closed cup)	none
LEL (25°C)	14%
UEL (25°C)	22%
Ignition temperature in air	605°C

Pure, dry methylene chloride is very stable and will not produce corrosion in mild or galvanized steel, copper, nickel, lead or tin. In the presence of water, however, it may undergo very slow hydrolysis to produce small quantities of hydrogen chloride that can lead to corrosion. This process is accelerated by elevated temperatures and the presence of alkalies or metals. Commercially available methylene chloride is normally inhibited with trace amounts of stabilizers to avoid this process. Typical stabilizers are 0.5 to 1.0% propylene oxide and 50 to 200 ppm cyclohexane or cyclohexene.

In the vapor phase, under abnormal conditions (elevated temperatures, flame, sparks, etc.), methylene chloride may decompose to form small amounts of hydrogen chloride, carbon monoxide, and phosgene.

3.2 Environmental Impact

Currently, almost all of the methylene chloride used in the USA is emitted into the air (1984: 86%). The atmospheric background concentrations for methylene chloride are very low (0.02 to 0.04 ppb), with levels in industrial areas ranging from 0.4 to 4 ppb. The average atmospheric lifetime is about 6 months but can be as low as 2 months in industrial areas. Because of this relatively short lifetime, MC has a negligible ozone depletion potential (0.007). Also, MC does not significantly contribute to either smog formation (POCP: 0.9) or global warming.

Water borne concentrations of MC will quickly be reduced due to its high volatility (90 to 95% reduction within 0.5 to 1.5 hours[19]). Both aerobic and anaerobic biodegradation have been demonstrated.[19,20] As a consequence, very low concentrations of MC are present in the hydrosphere and indeed often cannot be detected.

3.3 Health Effects

3.3.1 Disposition and Metabolism

The most likely routes of human exposure are inhalation and skin contact. MC is absorbed through the lungs and through the skin. It may, of course, be absorbed through the intestines if ingested. It is excreted quite rapidly, primarily through the lungs, and without undergoing any chemical change. The remainder is metabolized to carbon monoxide (CO), carbon dioxide (CO_2), and inorganic chloride. There are two pathways for this metabolism:

- A cytochrome P450 pathway, also called "mixed function oxidase (MFO)," which generates CO and CO_2
- A glutathione-S-transferase (GST) pathway, which generates only CO_2.

The MFO route is predominant at relatively low doses; however, saturation occurs at approximately 500 ppm. Increasing the dose above the saturation level does not lead to additional metabolism by this route. The GST route does not seem to be used very much in the human system. In other species (e.g., the mouse), the GST pathway can become the major route at sufficiently high doses.

The generation of CO in the body is of significance. It can combine with hemoglobin in the blood, forming carboxy-hemoglobin (COHb), which reduces the oxygen carrying capacity of the blood.

3.3.2 Acute Effects

Methylene Chloride has a relatively low acute toxicity. High exposure (> 1,000 ppm) triggers anesthetic effects and a depressant effect on the central nervous system (CNS). The CNS effect is additive with those from other CO sources, e.g., cigarette smoking.

Some reversible effects on sensory and psychomotor function have been observed from acute exposures of 300 to 500 ppm but not at lower concentrations.

Little evidence is available on oral toxicity. Accidental ingestion is unlikely. Liquid MC is a slight skin irritant due to the removal of natural oils in the skin.

3.3.3 Chronic Effects

Long term behavioral and neurological studies have shown no significant adverse effects. There is no evidence that MC causes the irreversible chronic CNS damage sometimes diagnosed as "Danish Painters Syndrome" (solvent induced encephalopathy).

The potential carcinogenicity of MC is a topic which has been subject to varying scientific interpretations. There is one study, performed for the National Toxicology Program (NTP), that suggests carcinogenic effects from high lifetime doses in mice[21]. Other bioassays with different animals (rat, hamster) and those at lower concentrations did not confirm these findings,[22] indicating that the association between MC exposure and carcinogenicity may be unique to mice, and even then, concentration related. This was supported by subsequent research,[23,24] which concluded that important differences exist in metabolism between the mice, rats, hamsters, and humans. Evidence was provided that the GST metabolic pathway is linked to the carcinogenic response observed in mice.[25] Since humans show a very limited ability to metabolize MC via the GST pathway, the mouse is a poor surrogate for assessing human hazard.

The above mentioned research efforts led to the development of a physiologically based pharmacokinetic (PB-PK) model to evaluate the carcinogenic risk to man from exposure to methylene chloride. Application of this model to experimental animal data results in the conclusion that there is no significant carcinogenic risk to man from methylene chloride when used in accordance with current hygiene standards.[26]

The U.S. EPA accepted the PB-PK model and used it in its draft Update to the Health Assessment Document (HAD) for MC. Also, EPA's Science Advisory Board indicated approval. OSHA, however, indicated reservations and has based its proposed revision of the occupational exposure standard for MC on the before mentioned NTP study. The industry has submitted critical comments to this proposal.[27,28,29] The effective date for the new standard has been delayed.

3.3.4 Epidemiology

Industrial mortality studies have shown no evidence that methylene chloride represents a carcinogenic or cardiovascular ischemic risk to humans.[30,31] These studies were based on typical exposure ranges of 100 to 350 ppm and peak values of up to 10,000 ppm.

In summary, methylene chloride is a highly volatile, non-flammable solvent with a relatively low acute toxicity. Due to its high volatility, careful handling is required to avoid over exposure. Long term repeated exposure to doses below current hygiene standards does not appear to lead to any adverse human health effects. The weight of all available scientific evidence suggests that under these circumstances, MC does not produce mutagenic, carcinogenic, teratogenic, or irreversible neurotoxic effects in humans.

PROPERTIES OF TOLUENE DIISOCYANATE

4. PROPERTIES OF TOLUENE DIISOCYANATE

4.1 Physical/Chemical Properties

Toluene Diisocyanate (TDI) is one of the most important organic isocyanates produced on a commercial scale. It is essential for current production of slabstock flexible PUF which is at the same time the largest industrial application with about 70% of its total volume. Commercially available TDI is generally a mixture of the 2,4- and 2,6-isomer in a ratio by weight of 80% to 20%. Smaller amounts of the 65:35 ratio are used in the manufacture of polyester foams.

TDI is a colorless to pale yellow liquid with a characteristic, pungent odor. Physical properties for the 80:20 ratio are detailed in Table 3.

TABLE 3

PHYSICAL PROPERTIES OF TDI (80:20)

Molecular Weight	174.2
Freezing point	14°C
Boiling point (760 mm Hg)	250°C
Density (25°C)	1.22 g/cc
Refractive index (25°C)	1.5662
Viscosity (25°C)	2.5 cst
Flash point (closed cup)	135°C
LEL (118°C)	0.9%
UEL (150°C)	9.5%
Ignition temperature in air	277°C

CAS NUMBERS

Number	Product Description
584-84-9	Toluene 2,4-diisocyanate
91-08-7	Toluene 2,6-diisocyanate
26471-62-5	Toluene diisocyanate, mixed isomers

TDI has a high reactivity towards components with an active hydrogen atom (e.g., hydroxyl groups, amine groups). This reactivity is not only the basis for the poly-addition process for preparation of polyurethane plastics and foams but also for the reaction with moisture and proteins in the body. TDI will react with water, producing insoluble organic urea and carbon dioxide. The urea and the low solubility of TDI itself will limit the rate of reaction.

TDI will also, sometimes violently, react with chemicals such as sodium hydroxide, ammonia, amines, and acids or alcohols. It is generally not corrosive.

4.2 Environmental Impact

The fate of TDI in the environment has been the subject of many studies, frequently sponsored by the International Isocyanate Institute, which have been reviewed and summarized.[32,33]

Emissions from a pool of TDI are limited because of its relatively low vapor pressure. Environmental impact is therefore largely restricted to occupational exposure and accidental release.

Airborne TDI does not have a lasting effect on the environment because of rapid reaction to form non-toxic compounds (urea, CO_2). A loss rate of 36% per hour has been reported.[10] Concerns about a potential conversion to TDA are not confirmed[9,10,11] and not expected based on theoretical considerations.[33]

TDI decomposition in water and soil will occur relatively slowly if not enhanced by heat, mixing, or catalysis due to potential solidification at the TDI/water interface and a slow reaction of the solid/liquid compound with water based on low solubility of TDI as well as the resulting polyurea.[33] Marine toxicity studies have shown, in general, no detrimental effects from TDI spillage.[34,35,36] However, there are diverging reports that have triggered additional ecotoxicity studies that are currently in progress. Potential yield of TDA, which is classified as an animal carcinogen, is reported to be so low as to be undetectable.[33,37]

4.3 Health Effects*

Typically, there are four routes of possible or potential exposure:

- Inhalation
- Skin Contact
- Eye Contact
- Ingestion

Inhalation - The vapor pressure of TDI is such that at typical room temperature (i.e., 70°F) the concentration of vapor in the air can exceed the STEL (short term exposure limit). Thus, protective measures, including the use of an approved respiratory protective device, must be taken whenever there is any possibility of exposure to unknown concentrations of TDI. Exposure to **heated** TDI can be extremely hazardous, not only because high vapor concentrations are formed, but also because condensation may result in airborne particulate which can injure the eyes, skin, and respiratory tract. Similarly, spray mists impose a significant health hazard. Also, tests have shown that the lowest detectable odor level of TDI is approximately 0.2 to 0.4 ppm. Because this odor threshold is significantly higher than the OSHA Permissible Exposure Limit (PEL), **vapor levels must be carefully monitored using equipment specifically designed for that purpose.** In short, if an individual can smell diisocyanates, overexposure has already occurred.

Airborne TDI vapors and aerosol mists are irritating to the upper and lower respiratory tracts. Individuals may also become sensitized to TDI and experience severe asthma-like attacks whenever they are subsequently exposed to even minute amounts of vapor. Once sensitized, these individuals must avoid any further exposure to diisocyanates. Symptoms of overexposure to TDI vapors may include tightness of the chest and difficult or labored breathing. Headache, nausea, and vomiting have been reported in workers exposed to 0.1 ppm diisocyanate concentrations. Exposure to higher concentrations may result in chemical bronchitis, pneumonitis, and pulmonary edema.[41,42]

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* Society of Plastics Industry, Polyurethanes Division, Technical Bulletin AX-142, October, 1992, "TDI Based Polyurethane Foam Systems and Guidelines for Safe Handling and Disposal"

Effects may be immediate or delayed for hours after exposure. Symptoms may increase or intensify for a few hours, but usually disappear within a day or two. However, a decrease in ventilatory function, as indicated by reduced Forced Expiratory Volume/1 second (FEV/1) and Forced Vital Capacity (FVC), may last up to a month. In very exceptional cases, severe overexposure may lead to chronic bronchitis and/or immunologic lung disease. Chronic or repeated inhalation of vapor concentrations below recommended exposure limits (i.e., 0.005 ppm {0.035 mg/m^3} as an 8 hour TWA should not ordinarily affect healthy individuals.[39,40] Chronic overexposure may lead to permanent pulmonary injury, including a reduction in lung function, breathlessness, chronic bronchitis and immunologic lung disease.[38] Some articles in the published literature report accelerated loss of lung function following repeated exposure at concentrations below levels which cause irritation.

Skin Contact - Repeated or prolonged contact with diisocyanates may discolor the skin or cause redness, swelling, blistering, and burns. Also, skin contact may produce contact dermatitis and possibly skin sensitization. Recent studies on laboratory animals demonstrate that direct skin contact with diisocyanate can lead to respiratory sensitization. Thus, skin contact with TDI should be avoided.

Eye Contact - While brief eye contact with low concentrations of TDI vapor may cause only mild tearing or a slight burning sensation, contact with high concentrations of vapors or aerosol mists may cause pain, tearing, and irritation. Direct contact with liquid TDI may be extremely painful and may cause severe irritation and possible corneal injury.

Ingestion - Although TDI has a relatively low level of oral toxicity (the single dose oral toxicity of LD50 in rats is greater than 4,000 mg/kg),[43] ingestion of the product can cause irritation, burns or ulceration of the mucous membranes of the mouth, esophagus, and stomach.

4.3.1 Carcinogenicity and Other Effects

For hazard communication purposes under OSHA Standard 29 CFR Part 1910.1200, TDI is listed as a potential carcinogen by the National Toxicology Program (NTP)[44] and the International Agency for Research on Cancer (IARC).[45] Both agencies based their evaluation of TDI as a potential carcinogen primarily on an oral study in which high doses of TDI were reported to cause cancer in animals.[46] This study, in which rats and mice were fed high doses of TDI in corn oil, has been found to contain numerous deficiencies which compromise its validity.[47] TDI did not cause cancer in laboratory animals exposed by inhalation, by far the most likely route of exposure. One study was conducted to determine whether TDI is mutagenic or is a reproductive toxin. Results indicate that TDI has little, if any, mutagenic activity and shows no adverse effects on reproduction.[48,49]

CONTROL TECHNOLOGIES

5. CONTROL TECHNOLOGIES

5.1 Introduction

The flexible PUF (slabstock) industry and its suppliers have been, for more than one decade, involved in efforts to reduce emissions. Initially, the emphasis was on TDI, but in the mid to late eighties, the attention turned to the control of emissions from the use of auxiliary blowing agents.

A flood of new technologies has been proposed lately. Many have triggered high expectations but have still failed to meet the standards of acceptance.

Requirements for Acceptance:

- Proven technology
- Commercially available
- Control efficiency
- Environmental acceptability (i.e. no hazardous secondary discharges)
- Economical viability
- Acceptable PUF product quality

This section is an attempt to describe all available or proposed options. It will evaluate the viability in the slabstock process and report on existing experience. Cost, related to the achieved emission reduction, will be provided wherever possible.

The options will be discussed by substance, however, many control technologies are not compound specific. These will be discussed as "combined control technologies." In addition, evolving technologies that are considered potential future options will be discussed.

5.2 Control of Methylene Chloride Emissions

A great deal of information is available on control options for ABAs in flexible PUF:

- EPA's Office of Air and Radiation, in cooperation with the PFA, published in April, 1991, a summary of available technologies to reduce or to eliminate the use of CFCs.[6]
- The Center for Emission Control issued an assessment of control options in October, 1991.[12]
- The Montreal Protocol's "1991 Assessment" describes, in some detail, options to CFCs and therefore to MC.[50]
- Several BACT studies from flexible PUF manufacturers describe, in detail, the (at that time) available control technologies and resulting cost consequences.[51,52]

Control technology can be categorized as follows:

- Best Management Practices
- Vapor Recovery
- Vapor Treatment
- Alternative ABAs
- Chemical Modifications
- Alternative Manufacturing Technologies

Vapor recovery and vapor treatment and alternative manufacturing technologies control both MC and TDI and will be discussed later.

5.2.1 Best Management Practices

Best management practices can be applied to both raw material handling as well as to the foam production area. The use of closed loop unloading systems and closed loop feed systems to the mixing head can save up to 5% of the current methylene chloride emissions.

Flushing systems that are closed loop or that use alternative cleaning materials can also save on methylene chloride emissions.

Prudent formulation management in the foam production area includes:

- Avoidance of the use of methylene chloride for viscosity adjustments
- Minimization of the TDI index

5.2.2 Alternative ABAs

CFC-11

CFC-11 use in the United States as an ABA for flexible PUF was effectively halted in accordance with the Montreal Protocol and the CAA-A but well in advance of the deadlines associated with that Protocol. In 1992, the flexible PUF industry had reduced the use of CFC-11 by more than 99.8% compared to the base year of 1986.

Methylchloroform (MCF)

More than 10% of the ABA used in flexible PUF (slabstock) is currently MCF. It is particularly used in areas where the use of MC is restricted. However, MCF is classified as an ozone depleting substance and subject to future phase out. It is, therefore, at most an interim solution. Taxation, a higher use factor, and a high price make this compound less attractive even as an interim solution. At current time (early 1993), it will cost about $ 1,500 per net ton of MC replaced.[52]

Hydrochlorofluorocarbons (HCFCs)

HCFC-123 and HCFC-141b can be used in the flexible PUF manufacturing process. However, both substances are currently in limited supply. The CAA-A prohibits the use of HCFCs in plastic products after December 31, 1993. It seems realistic to disregard these materials as viable options.

Acetone

Acetone is reported to be fully capable of replacing MC as an ABA[53]. Precautions must be taken in view of its flammability. Only about 55% of MC level is needed. Capital outlays and license fees will put the costs close or equal to those of MC. Acetone is considered a VOC in several states. VOC regulations will impair the potential use in the industry.

Pentane

This substance is reportedly used by one company. Details are not published. The same restrictions as acetone will apply.

AB Technology

This technology utilizes the reaction between TDI and formic acid to create an ABA consisting of equal amounts of CO and CO_2.[54] The reaction is exothermic, and a complete replacement of MC is not feasible. In addition, equipment adjustments (ventilation, encapsulation, stainless steel or appropriate plastic vessels, pumps and piping) and CO monitoring equipment are required. A replacement of up to 40% of MC could be achieved,[52] however, creating at the same time appreciable amounts of carbon monoxide emissions and safety concerns. This technology is used in several plants in Europe but has not found acceptance in the U.S.

5.2.3 Chemical modifications

Chemical modifications were successfully applied in foam softening technologies. They have, however, fallen short in foam density reduction. Some novel technologies reportedly also allow the use of lower TDI indexes[55,56,57] in conjunction with suitable additives and will therefore lower the foam exotherm without compromising the structural integrity of the foam. This allows some reduction of the foam density without the use of MC. However, a complete replacement of MC, while maintaining the full range of PUF physical properties, is not yet possible.

Extended Range Polyols

These polyols are able to provide a larger range of foam hardness and in that way, able to partially replace MC. Flexible PUF made with these polyols have exhibited less than desirable physical properties, particularly with regard to compression set. To implement this technology, additional metering systems and tanks will be required. Extended range polyols are higher priced, and replacement of methylene chloride will lead to somewhat higher chemical costs. At the current level of technology, replacement will be limited to about 30 to 50%. The polyol/additive approach may be capable of achieving further replacement.

Softening additives

Several additives were developed to modify the chemistry of the flexible PUF (slabstock) production process.[57,58,59] These additives lower the foam hardness or increase the blowing efficiency but do not provide a cooling effect. Conversion is reported to cost between $600 to 700 per net ton MC replaced,[51] and replacement of MC is expected to be limited to 40 to 50%.[52]

Table 4 summarizes the available control technologies for MC. Taking into account the limited application of or restrictions on the use of MCF, CFC-11, HCFCs, and acetone, and the limited success of chemical modifications in reducing foam densities, the industry expects that control technologies utilizing these options can provide or replace, at a maximum, 50% of the historical use of auxiliary blowing agents (35 million pounds, 1989).

The use of combinations of the above described control technologies in conjunction with the Alternative Manufacturing Technologies (Section 5.4.4) may provide the best approach to emission control.

5.3 Control of Toluene Diisocyanate Emissions

The use of isocyanates in the manufacture of flexible PUF (slabstock) is fundamentally different from the use of ABAs in that the use of isocyanates is essential. Where ABAs can be eliminated, at considerable expense, isocyanates cannot. In addition, the reactivity of isocyanates excludes recycling options and, finally, the emission levels, several magnitudes lower than ABA, require different approaches. TDI is currently the isocyanate of choice in the manufacture of flexible PUF (slabstock).

In the middle to late seventies, the PUF industry started to investigate potential reduction of TDI emissions. The original approach centered around liquid scrubbers. Several scrubbers were built at that time in the UK.

Reported efficiencies varied from 65 to 100%. Most scrubbers used caustic soda as scrubbing liquid. A problem associated with this is the loss of efficiency because of reaction with the carbon dioxide generated from the TDI/water reaction. A further problem is the disposal of the effluents, requiring careful pH control, settling of solids, and examination of the emission reaction products.[60]

In 1977, the International Isocyanate Institute (III) examined several control methods, including the use of activated carbon. This led to the sponsoring of a pilot installation at a Dunlop facility at High Wycombe (later Hirwaun), England.[61] This project was aborted after mechanical problems caused the initial 99% efficiency to drop to 25 to 30%. Later, industrial scale installations showed similar problems.[62,63]

In all cases, the installation of sacrificial prefilters increased the efficiency dramatically. These prefilters could contain any material with a large surface area. Flexible PUF showed a remarkable efficiency and life time as a prefilter.[61,63]

Other methods, such as spraying with catalysts and UV assisted scrubbers, are described but have not yet resulted in industrial or pilot installations in the PUF industry.[10]

Best management practices have recently received more attention. Emissions in raw material storage and transfer can be avoided with closed loop unloading systems and/or sacrificial filters. Modern production methods (Maxfoam, Varimax, Vertifoam) show reduced emissions. Lower TDI indexes, often in combination with new raw materials, have further contributed to emission reductions. As stated before, there is evidence that in this way, the emissions in the industry have already been reduced by 40% from those of the mid-1970s.

There are currently 5 industrial installations known throughout the world that are practicing TDI emission control in the manufacture of flexible PUF (slabstock). Three others have been decommissioned lately. Installations that combine TDI and ABA emission control will be discussed later.

Liquid Scrubbers

- One multiple venturi jet scrubbing system in the UK is reported to show no less than 90 % efficiency. Water and energy use are very high.[60]
- One single venturi installation in the UK shows approximately 50% efficiency.[60]
- One liquid scrubber of unknown design is in operation in the U.S.
- One decommissioned "Cleme" (alkaline liquid) scrubber in the UK reportedly operated at a removal efficiency of 65 to 75%.[65]

Activated Carbon Systems

- One system in Canada is newly installed, and still under evaluation. Preliminary results showed a poor efficiency but a dramatic increase after the installation of PUF prefilters. The company plans to exchange all the carbon filters with PUF.[63]
- One system in the UK is designed for an efficiency of 99.5% as a replacement for an existing alkaline scrubber.[66] The system is considerably oversized to allow the subsequent addition of a recovery system for MC. The actual efficiency is > 99.9%.[67]
- One system in the USA was decommissioned in 1990 after a plant closing. The system operated initially at 99.6% efficiency but deteriorated rapidly. Installation of pre-filters and annual replacement of the carbon, far before saturation, restored the unit to an efficiency of > 90%. The problems are reported to be related to the choice of carbon and "clogging" of the system by polyurea[62]). The latter may well explain problems in other facilities.

Table 5 provides an overview of industrial scale experience with TDI control technologies.

In summary, it can be concluded that:

- The PUF industry, by implementing changes in process and formulations, has decreased the TDI emissions by about 40% compared to the mid-1970s.
- No control technology has yet proven itself beyond reasonable doubt.
- Liquid scrubbing has shown high operational costs combined with environmental side effects.
- Activated carbon has shown promise but also process deficiencies that are not yet overcome.
- Sacrificial filters, like flexible PUF, show promise and are worth pursuing.
- Waste materials generated in liquid scrubbing, spent carbon beds or saturated PUF prefilters, must be disposed of in an environmentally safe manner.

5.4 Combined Control Technologies

Several control technologies are not substance specific. These offer the potential to control MC and TDI in one process. In general, it can be stated that emission control of ABAs rather than replacement will affect TDI emissions. The opposite is not true because of TDI's specific properties (reactivity, adsorption affinity), and because of its much lower emission levels.

Combined control technologies are based on adsorption/absorption or incineration. Some of them include important innovative approaches to process parameters, such as curing and airflow, and will therefore be categorized separately.

The following categories will be discussed:

- Incineration
- Liquid absorption
- Carbon adsorption
- Alternative manufacturing technologies

5.4.1 Incineration

The use of thermal or catalytic oxidation is a technically viable process for the destruction of organic vapors. The applicability to MC emissions from flexible PUF production is described in detail.[51,52] The process can presently only be applied to emissions originating from the foam tunnel (40 to 55%). Costs are reported to exceed $4,000 per net ton of MC emission reduced.[51] Hydrogen chloride formed in the oxidation of MC must be captured and treated.

5.4.2 Liquid absorption

Generally speaking, the use of liquid absorption to remove organic vapors from a gas stream is technically feasible. However, the equilibrium between MC in the water phase and MC in the gas phase is weighted heavily towards the gas phase. This makes this method economically and physically impractical.[51]

5.4.3 Carbon adsorption

Carbon adsorption was proven technically feasible for the retention and subsequent recovery of MC emissions from flexible PUF (slabstock) production on pilot scale as well as on full industrial scale. A precondition is a significant reduction of the volume of air used for process ventilation in the foam tunnel. The current large volume of air used, 50 to 100,000 feet^3 per minute, is necessary to achieve workplace conditions established by OSHA for worker safety in the United States.

There are currently three full scale units operating in Europe but none in the United States. The units in Europe demonstrated virtually complete elimination of TDI emissions and approximately 90% efficiency on capture and recovery of ABA, primarily CFC-11 emitted in the foam production tunnel. Remember that the emissions in the foam production tunnel are 30 to 40% of the total emissions. The recovered ABA has been reused in the production of flexible PUF. The ABA has been CFC-11.

Application of the process to MC would require additional work to insure that the captured MC was reinhibited prior to its reuse in the production of flexible PUF. Installation and operation are in one case reported to be about $3,000 per net ton ABA reduced[51]. These costs are highly dependent on the size of the plant. Figure 3 shows the layout of such a unit.

A European installation that will include the curing area is currently in construction. This installation is designed for 75% recovery[68] of CFC-11. Significant changes in the process ventilation, reduction from 50,000 m^3/hr to 5,000 m^3/hr on the foam line, and introduction of 10,000 m^3/hr for 15 to 16 hours in the curing area, as well as the fact that local regulations may force the utilization of HCFC-141b, makes the application of future results in USA facilities doubtful. The potential problems in the OSHA controlled workplace, because of the greatly reduced air flow for ventilation, contribute to this doubt for use in the United States.

Desorption of the carbon bed occurs in all industrial installations by steam or nitrogen regeneration. A newer, more efficient recovery technique employs the reversed Brayton cycle.[69] Figure 4 shows a layout of this process. One foam manufacturer has performed extensive pilot trials with this technology[70] and reports an expected investment of about $3 million and costs of about $2,100 per net ton MC reduced, for a full scale installation.[71]

5.4.4 Alternative Manufacturing Processes

The traditional capture and treatment emission control technologies were developed to meet the needs of industries other than slabstock polyurethane foam production. These traditional systems would allow the treatment of process exhausts with varying degrees of efficiency but were not designed for use with air streams which have much lower concentrations of contaminants.

A number of innovative solutions to this problem are currently being commercialized. They are described in both this section and Section 5.5. The types of systems include process chemistry modifications, foam manufacturing equipment which is fundamentally different from that currently in use, and countercurrent air heat exchanger systems which provide rapid cooling and curing of the foam block.

E-Max

The E-Max process combines the production and curing steps by encapsulating the production tunnel and conveyor belt in a mold as the reactants are introduced to the foam line.[72] This process would allow emissions to be controlled and collected utilizing low air flow rates, and therefore, at a lower capital cost. There is currently one pilot unit in Europe and one full scale E-Max unit in the United States.

Results from the pilot scale unit were reported to be an 85% recovery of ABA emissions.[72] The auxiliary blowing agents used were CFC-11 and methylene chloride. Reports which show duplication of these results on an industrial scale have not yet been released.

Enviro-Cure

The Enviro-Cure process is designed to eliminate the need for an auxiliary blowing agent for either cooling purposes or density reduction.[73] The remaining function of an auxiliary blowing agent, softening of the foam, can be duplicated through the use of chemical softening agents as discussed in Section 5.3. Additional testing must be done, however, to verify that foam blocks which are manufactured with this system have the required physical properties.

The Enviro-Cure process uses an enclosed conditioning area designed to rapidly cool foam blocks. It is reported that this process has been successfully adapted to all of the Vertifoam units belonging to one U.S. foam producer. This company is also in the process of developing an Enviro-Cure system for one of its Varimax units. The application of the Enviro-Cure process to the traditional (horizontal) Varimax systems should be considered as a future alternative. The process is patented, and its use will entail a license fee of 1.5% of the raw material costs.

The economic consequences of the utilization of this process are not yet clear. In states where proposed regulations may well forbid the use of auxiliary blowing agents altogether, the inventor claims significant potential savings compared to the alternative of operating at higher density levels on conventional equipment. Compared to the use of methylene chloride, the process will result in higher raw material, capital, and operating costs but will provide reduce the floor space requirements for a curing area.

Feedback must be obtained from Enviro-Cure licensees in order to determine whether this system truly fulfills the criteria of commercial availability.

"Rapid Cure" Process

The "Rapid Cure" process is designed to completely eliminate the need for auxiliary blowing agents without sacrificing either product quality or the range of foam grades which can be produced. To achieve these dual goals, a multi-stage cooling device is attached directly to the foam production tunnel and replaces the conventional foam curing/cooling area.[74]

Significant reformulation is required to provide softening and maintain the structural integrity of the product. This reformulation effort has not yet been completed for all foam grades.

The "Rapid Cure" process is patented, and its use will entail license fees, the amount of which has yet to be disclosed. Raw material costs are reported to be very close to those of formulations which require the use of methylene chloride. Capital costs are expected to be approximately $500,000.

The process is currently in use at one facility. The "Rapid Cure" process has not yet been licensed outside the inventor's company.

5.5 Future Options

Methylene Diphenyl Diisocyanate (MDI) Technology

Development is in progress to produce slabstock flexible polyurethane foam, which is manufactured with MDI rather than TDI. One manufacturer began to offer such a system in Europe during 1992.[75] It is premature to evaluate the response from flexible slabstock PUF manufacturers and users. MDI technology is currently used in manufacturing processes for molded flexible polyurethane foam.

Features of interest in MDI technology include the following:

1) Use of an auxiliary blowing agent is not necessary to achieve product softness

2) MDI technology provides a significant reduction in isocyanate emissions.

3) This technology provides a significant rapid curing of the product.

4) A lower exotherm (maximum temperature) is reached during processing, thus it is possible to use formulations having a higher water content.

A thorough evaluation of this option is not possible at this time; however, it appears that this technology is not yet capable of producing very low densities of flexible PUF while simultaneously meeting the required physical properties.

Variable Pressure Foaming Process

It is well known that expansion of the foam network is increased under conditions of decreased atmospheric pressure. For this reason, many types of foam can be manufactured at higher altitudes with little or no auxiliary blowing agent. This principle can be applied under standard atmospheric conditions through encapsulation of the foam line and subsequent reduction of pressure during foam production.

It was reported in the April/May, 1993, issue of *Urethanes Technology* that a European foam producer has brought on-line the world's first reduced-pressure polyurethane foam production unit.[67] The article gives this manufacturing system the name Variable Pressure Foaming process or VPF. This firm also mentioned that the low volumes of exhaust gases which are created can easily be treated with carbon filters, thus bringing emissions to an absolute minimum.

Dialkyl Dicarbonates as Auxiliary Blowing Agent

The experimental product, E-90018T, a dialkyl dicarbonate, was recently introduced.[76] This material undergoes a hydrolysis reaction with other formulation components and generates carbon dioxide and other by-products. Work to develop this potential auxiliary blowing agent is in the early stages.

5.6 Summary

It is apparent that short term solutions to address process emissions from the slabstock polyurethane industry are not yet available. Many technologies appear to be nearing full-scale industrial trials however.

Significant differences in the quantity and type of process emissions exist between the low density supersoft foams produced for the furniture industry and higher density foams sold to the automotive sector. Other distinctions which may also be significant include packaging foam and specialty products.

Certain foam types require large amounts of methylene chloride for their manufacture. For this reason, treatment technologies for these processes must account for the large quantity of auxiliary blowing agent (ABA) emissions that occur within approximately the first 24 hours of manufacture, curing, and storage. The problem of controlling TDI emissions is of much smaller magnitude.

Uses of the Alternative Manufacturing Processes in combination with modifications of process chemistry appear to offer the best long term solutions to the emission control problem. These systems are currently under development. Detailed environmental and economic data are not available at the present time.

The large differences in production rate that exist among various foam plants also indicate that separate solutions may be appropriate for high and low volume producers.

For these reasons, it appears likely that a range of acceptable emission control technologies may emerge to serve the individual needs of various foam producers.

CONCLUSIONS AND RECOMMENDATIONS

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Substances To Be Regulated

In 1990, the flexible PUF (slabstock) industry emitted three substances that are listed in the 1990 Clean Air Act Amendments (CAA-A) as Hazardous Air Pollutants (HAPs). These substances, listed in Table 6, are subject to regulation under a standard to be promulgated for the flexible PUF source category.

TABLE 6

HAP EMISSIONS IN 1990

CAS number	Chemical name	Emissions, pounds
75092	Methylene chloride	24,000,000
71556	Methyl chloroform	6,000,000
584849	2,4-toluene diisocyanate	4,500

The hazardous air pollutants (HAPs) above were evaluated to determine whether they would be likely candidates for control under the MACT standards. The PFA has drawn the following conclusions:

1) Methyl chloroform will not be available for use by this industry after 1995 since it is subject to the accelerated phase out of ozone depleting substances.

2) Toluene Diisocyanate emissions are on the order of 1% of the quantity that mandates regulation under MACT (10 tons per year). Therefore, it is expected that any TDI control measures would be addressed at some future time under the residual risk standards. It is possible that this may not be necessary since many of the systems under development will include the capture and treatment of TDI emissions.

6.2 Residual Risk Standards

Regulation of methylene chloride and or toluene diisocyanate under residual risk standards of the 1990 Clean Air Act Amendments will be addressed at some future time. MACT emission controls must first be developed and implemented, and then residual emissions can be quantified and controlled, if necessary.

The following should be taken into account with regard to residual risk:

- There are considerable differences of opinion on existing health effects, specifically concerning carcinogenicity, for both substances
- The emissions of 2,4-toluene diisocyanate are only a portion of the total TDI emissions
- There are currently no standardized stack test procedures for TDI emissions
- The promulgation of an emission standard on methylene chloride will almost certainly affect TDI emissions so that these emissions may be sharply reduced.

The industry would like to cooperate with the EPA in an early stage in the development of reliable data that would allow fair assessments.

6.3 Maximum Achievable Control Technology (MACT)

Based on the evaluation of information available at present, the Polyurethane Foam Association (PFA) has reached the following conclusions:

- Sub categorization of the (slabstock) industry should be considered to more clearly define the wide variation in MC emissions from various foam production operations
- Direct thermal and catalytic incineration should not be considered
- Liquid absorption should not be considered

- Carbon adsorption could be considered for existing sources, allowing for 40 to 45% emission reduction

- Chemical modifications could be considered for existing sources, allowing for 40 to 50% emission reduction

- A combination of carbon adsorption and chemical modifications could be considered for existing sources allowing for 65 to 80% emissions reduction

- New manufacturing technologies could be considered for new and existing sources allowing a strong reduction of hazardous air pollutants.

Future developments carry the promise of higher emission reductions for existing sources and will be carefully monitored. The PFA, representing the U.S. flexible PUF industry, will do so and communicate significant developments to the EPA's Office of Air Quality Planning Standards.

REFERENCES

7. REFERENCES

1. USEPA, "Source Category Schedule for Standards," Presentation to NAPCTAC, November 19, 1991.
2. Mooz, W. E., Quinn, T., "Flexible Urethane Foams and Chlorofluorocarbon Emissions," Rand Corporation, 1980.
3. Mooz, W. E. et al, "Technical Options for Reducing Chlorofluorocarbon Emissions," 1982.
4. Farmer, R. W., Nelson, T. P., "Control Technology Overview Report: CFC-11 Emissions from Flexible Polyurethane Foam Manufacturing," Radian Corporation, 1987.
5. Farmer, R. W., Nelson, T. P., Rueter, C. O., "Final Report: Preliminary Concepts for Methylene Chloride Emissions from Flexible Polyurethane Foam Manufacturing," 1987.
6. USEPA, "Handbook for Reducing and Eliminating Chlorofluorocarbons in Flexible Polyurethane Foams," a joint project of the USEPA and the PFA, 1991.
7. Vreenegoor, N. C., "Environmental Considerations in the Production of Flexible Slabstock," Polyurethanes World Congress, 1987.
8. Hurd, R., "Some Actions Taken by Flexible Foam Producers in Europe to Meet the Requirements of Legislation on Health and Environment," Polyurethanes World Congress 1991.
9. Boeninger, M. F., "Non-isocyanate Exposures in Three Flexible Polyurethane Manufacturing Facilities," Appl. Occup. Environ. Hyg. 6(11), November 1991
10. Duff, P. B., "Fate of Toluene Diisocyanate in Air. Phase II Study," Proceedings of the 29th Annual SPI Technical/Marketing Conference, 1985.
11. Keller, J., Abele, L., "Emission of Toluene Diisocyanate (TDI) and Toluene Diamine (TDA) in Flexible Polyurethane Foam Production Lines," International Isocyanate Institute, Inc. 1978.

12. Center for Emission Control, "Flexible Polyurethane Manufacture, an Assessment of Emission Control Options," Page 9, Washington, 1991.

13. Docket No. H-71: Public Hearing, Testimony of (Mr. Jerry Pool), on behalf of the Polyurethane Foam Association (PFA), September 16, 1992.

14. Tu, D., Fetsch, R., "Emission of Air Contaminating Harmful Substances during the Manufacture and Processing of Polyurethane Products," University of Stuttgart, Germany, 1980.

15. Grey, P. J., Chadwick, D., Institute of Chemical Engineers Symposium (57), Salford University, U.K., 1979.

16. Grieveson, B. M., Reeve, B., "Isocyanate Emissions: A Review of Work on Environmental Aspects of Handling Toluene Diisocyanate," Cellular Polymers (2), 1983.

17. Docket Number A-90-49, "Comments of The Polyurethane Foam Association on EPA's Preliminary Draft List of Source Categories," 1991.

18. Rando, R. J. et al, "Isomeric Composition of Airborne TDI in the Polyurethane Foam Industry," Am. Ind. Hyg. Assoc. J. 45, 1984.

19. European Chlorinated Solvent Association, "Methylene Chloride, Its Properties, Uses, Occurrence in the Environment, Toxicology and Safe Handling," 1989.

20. Davis, J. W., Madsen, S. S., "The Biodegradation of Methylene Chloride in Soils," Env. Tox. and Chem, (10), 1991.

21. NTP. Technical Report on the Toxicology and Carcinogenesis Studies of Dichloromethane in F344/N Rats and B6C3F1 Mice, Final Report," TR306, 1986.

22. ECETOC No. 26 provides a listing and a summary of the mentioned bioassays, August 19, 1987.

23. Reitz et al, "Physiologically Based Pharmacokinetics and the Risk Assessment Process for Methylene Chloride," Toxicol. Appl. Pharmacol. 87: p185-205 (1987).

24. ECETOC, "The Assessment of Carcinogenic Hazard for Human Beings Exposed to Methylene Chloride," Technical Report No. 26, 1987.

25. ECETOC, "Methylene Chloride (Dichloromethane): An Overview of Experimental Work Investigating Species, Differences in Carcinogenicity and their Relevance to Man," Technical Report No. 34, 1989.

26. ECETOC, "Methylene Chloride (Dichloromethane): Human Risk Assessment Using Experimental Animal Data," Technical Report No. 32, 1988.

27. OSHA Docket No. H-71: Occupational Exposure Standard for Methylene Chloride, Comments of the HSIA, April 6, 1992.

28. Docket No. H-71: Supplemental Testimony of Terry Hearne on OSHA's Proposed Standard for Methylene Chloride, August 24, 1992.

29. OSHA Docket No. H-71: Occupational Exposure Standard for Methylene Chloride, Comments of the HSIA, August 24, 1992.

30. "The Mortality of Workers Employed at a Cellulose Acetate and Triacetate Fibers Plant in Cumberland, Maryland," Hoechst Celanese Corporation, 1992.

31. "Health Assessment of Dichloromethane," Eastman Kodak Company, 1988.

32. Gilbert, D. S., "Fate of TDI and MDI in Air, Soil, and Water," Polyurethane World Congress, 1987.

33. Bailey, R. E. et al, "Environmental Aspects of TDI," Polyurethane World Congress, 1991.

34. Caspers, N. et al, "Ecotoxicity of Toluene Diisocyanate, Diphenylmethane Diisocyanate, Toluene Diamine and Diphenylmethane Diamine," Report to the International Isocyanate Institute, 1986.

35. Brochhagen, F. K., Grieveson, B. M., "Environmental Aspects of Isocyanates in Water and Soil," Cellular Polymers (3), 1984.

36. Bayer A. G., "Reaction of TDI with Wet Sand," Report to the International Isocyanate Institute, Inc., 1976.

37. Martens, R., Domsch, K. H., "Microbial Degradation of Polyurethane Foams and Isocyanate Based Polyureas in Different Media," Air and Soil Pollution (15), 1981.

38. USEPA, Environmental Criteria and Assessment Office, "Health Assessment Document for Toluene Diisocyanate," Preliminary Draft, 1988.

39. Diem, J. E., et al, "Five-year Longitudinal Study of Workers Employed in a New Toluene Diisocyanate Manufacturing Plant," Am. Rev. Respir. Dis.,(126), 1982.

40. Bugler, J., et al, "The Acute and Long-term Respiratory Effects of Aromatic Di-isocyanates," Medical Research Council, U.K. 1991.

41. International Isocyanate Institute (III), "Environmental and Occupational Health Conference," Pittsburgh, 1987.

42. Diller, W. F., "Occupational Health Aspects of Isocyanates," Polyurethanes World Congress, 1987.

43. Dow Chemical, "Safe Handling and Storage of VORANATE T-80 Toluene Diisocyanates," 1988.

44. NTP, "Fourth Annual Report on Carcinogens," 1985.

45. IARC Monograph on the Evaluation of Carcinogenic Risks to Humans (39), 1986.

46. NTP Technical Report "Toxicity and Carcinogenesis Studies of Commercial Grade 2,4 (80%) and 2,6 (20%) TDI in F344/N Rats and B6C3F1 Mice (Gavage Studies)," 1986.

47. Ashby, E. J., Paton, D., "Stability of Toluene Diisocyanate (TDI) in Corn Oil," Internal Report, ICI, 1987.

48. Ader, A. W., et al, "Risk Evaluation of Chronic Exposure to Toluene Diisocyanate Based on Long-Term Animal Studies," Polyurethane World Congress, 1987.

49. Loeser, E., "Long Term Toxicity and Carcinogenicity Studies with 2,4/2,6-Toluene Diisocyanate (80/20) in Rats and Mice," Toxicology Letters (15), 1983.

50. Montreal Protocol, "1991 Assessment, Flexible and Rigid Foams," Technical Options Committee, 1992.

51. Recticel Foam Corporation, "Best Available Control Technology (BACT) Analysis," 1990.

52. Leggett & Platt Inc., "BACT Methylene Chloride," 1990.

53. Walmsley, G., "Non Chlorinated Auxiliary Blowing Agents," PFA Spring Meeting, 1990.

54. Hull, G. K., "An Alternative to Fluorocarbon 11," Plastics and Rubber Institute Symposium, 1982.

55. Hicks, J. S. et al, "Manufacturing Flexible Slabstock Foams with Technology that Allows the Reduction or Elimination of Auxiliary Blowing Agents," 34th Annual Polyurethane Technical/Marketing Conference, 1992.

56. Hicks, J. S., "ABA Reduction Technology for the U.S. Flexible Slabstock Industry," PFA Fall Meeting, 1992.

57. Desnier, M. C., "Optimization of Geolite formulations for Low Density Foams," Proceedings of the UTECH conference, 1992.

58. Hennington, R. M., "Soft Flexible Polyurethane Foam without Auxiliary Blowing Agents," Proceedings of the SPI 33rd Annual Technical/Marketing Conference, 1990.

59. Vandichel, J. C. N. E., Appleyard, P., "Reduction of CFC-11 Usage in Flexible Polyurethane Foams through Modifications to Polymer Morphology," Proceedings of the SPI 33rd Annual Polyurethane Technical/Marketing Conference, 1990.

60. Hurd, R., "Scrubbing of Isocyanate and CFC Emissions in Flexible Foam Plants," Polyurethanes World Congress, 1987.

61. Nutt, A. R., "III Clean Stack Air Project," 1986.

62. Booth, K. S. et al, "An Evaluation of an Activated Carbon Adsorber System for Removal of Toluene Diisocyanate (TDI) Vapors," III Project NA-E-55, 1991.

63. Private Communication Dr. W. Mackay, Domfoam International, Montreal, Canada, 1992.

64. Eta Ltd, "Gas Scrubbing using UV/Ozone," (brochure), 1990.

65. I. Chem. E. Symposium Series No. 57.

66. Private Communication, Mr. B. Naylor, Beaverfoam, UK, 1991.

67. Private Communication, Dr. H. Creyf, Recticel International, Belgium 1992.

68. Private Communication, Mr J. Warmerdam, Draka, NL, 1992.

69. Kovach, J. L., "Utilization of the Brayton Cycle Heat Pump for Solvent Recovery," Industrial Solvent Recycling Conference, 1990.

70. Kaufman, C. M. et al, "Waste Minimization in the Manufacture of Flexible Polyurethane Foams," North Carolina State University, 1992.

71. Private Communication, Mr. Jerry Pool, Vitafoam, USA, 1992.

72. Stoute, J., "E-Max, Environmental Friendly Foam Production," Technical Program, PFA Fall Meeting, 1992.

73. Ricciardi, M. A., Dai, D. G., "Crain Industries Enviro-Cure Technology Applied to the Vertifoam and Maxfoam Processes," PFA Fall Meeting, 1992.

74. Stone, H. et al, "Low Density Foams Without Auxiliary Blowing Agents for Use with Standard Foam Machines," PFA Fall Meeting, 1992.

75. Casey, M. et al, "The `Waterlily' Range of Quality Comfort Materials from ICI's MDI Based Flexible Slabstock Technology," Proceedings of the SPI 34th Annual Technical/Marketing Conference, 1992.

76. Bradford, L., et al, "A New Reactive Blowing Agent For Flexible Polyurethane Foam," Technical Program, PFA Fall Meeting, 1992.

FIGURES

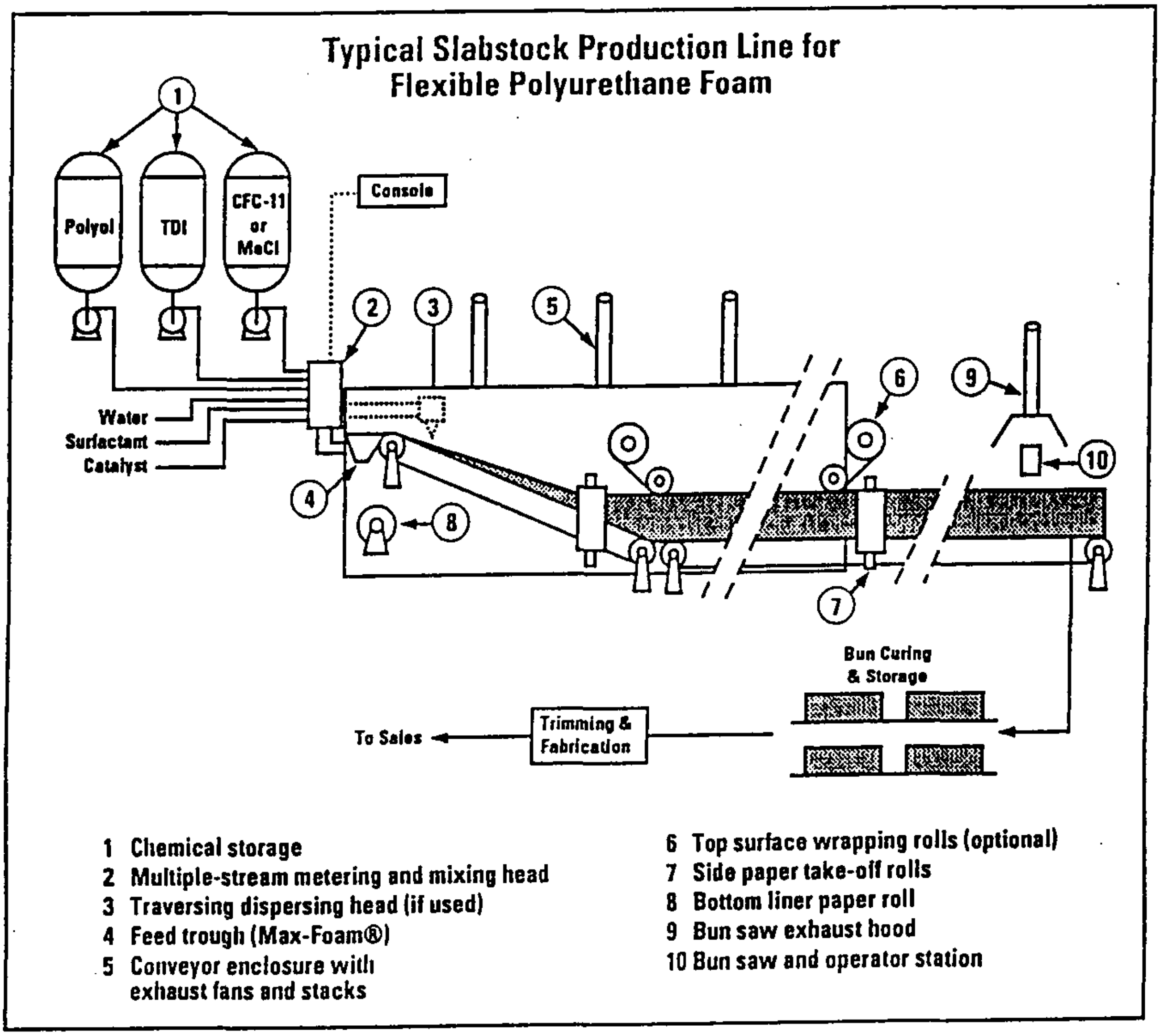

Typical Slabstock Production Line for Flexible Polyurethane Foam
1
Polyol
TDI
CFC-11 or MeCl
Console
2
3
5
Water
Surfactant
Catalyst
4
8
6
9
10
7
Bun Curing & Storage
To Sales
Trimming & Fabrication
1 Chemical storage
2 Multiple-stream metering and mixing head
3 Traversing dispersing head (if used)
4 Feed trough (Max-Foam®)
5 Conveyor enclosure with exhaust fans and stacks
6 Top surface wrapping rolls (optional)
7 Side paper take-off rolls
8 Bottom liner paper roll
9 Bun saw exhaust hood
10 Bun saw and operator station

Figure 1

METHYLENE CHLORIDE DECAY CURVE

TYPICAL AT END OF ONE-HOUR POUR

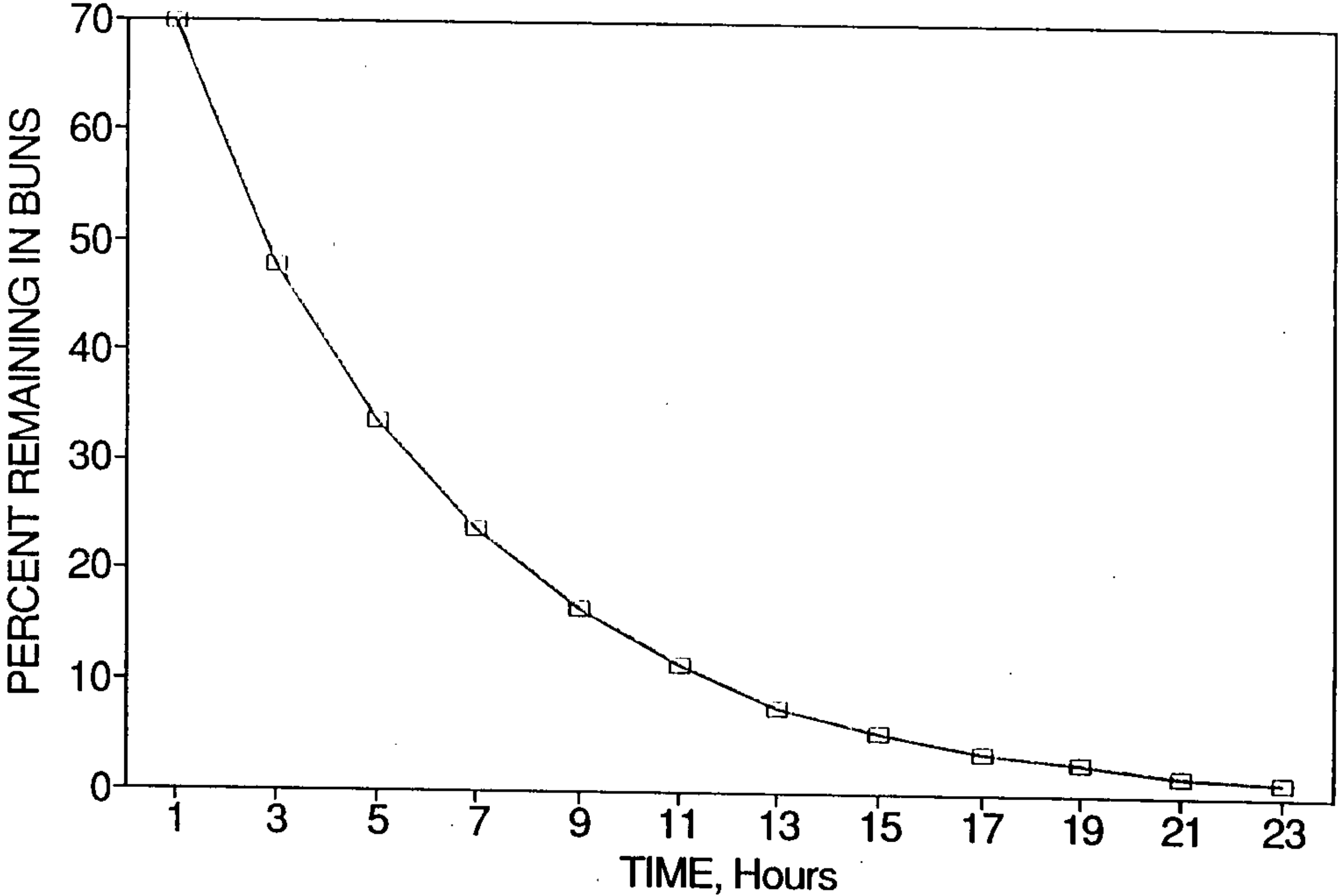


Figure 2.

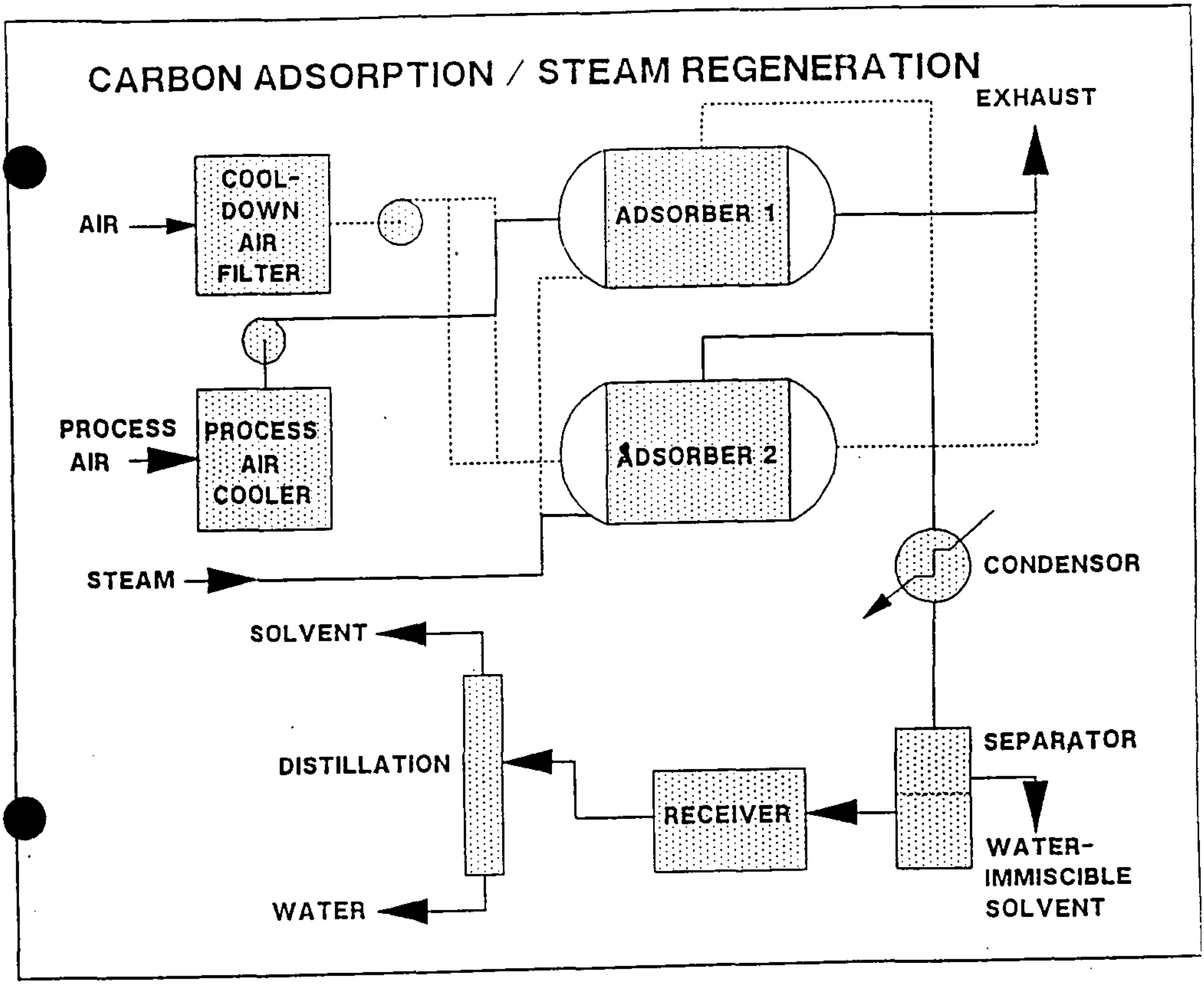
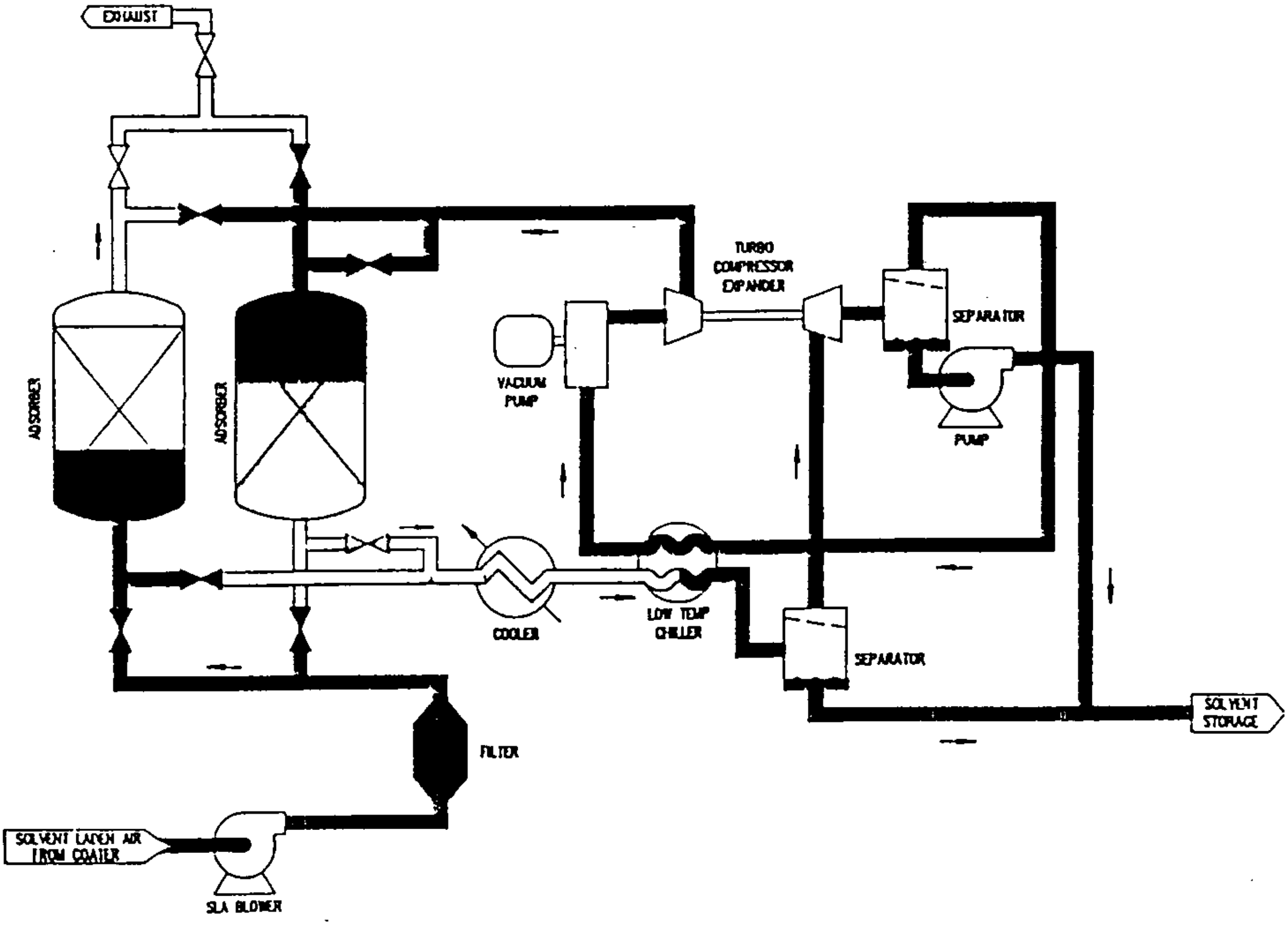


Figure 3. Schematic of the Carbon Adsorption Process.



Source: Nucon International, Inc.

Figure 4. The reversed Brayton Cycle System.

TABLES

TABLE 4

POTENTIAL ALTERNATIVES TO METHYLENE CHLORIDE

Options	% Methylene Chloride Replaced	Ozone Depletion Potential	Density Range	Equipment Modifications	License Needed	Limitations/ Concerns
Methyl Chloroform[1]	100%	0.10	Same as MC range	None	No	Phase out by 1995
HCFCs	100%	HCFC 141b = 0.12 HCFC 123 = 0.02	Same as CFC range	None	No	Insufficient quantities commercially produced; increased price; banned as a non-essential use.
Acetone, Pentane	100%		Same as CFC range	Improved ventilation; explosion proof equipment and additional safety features are required.	Yes	flammability; regulated as a VOC.
AB Technology	Up to 40%		15kg/m^3 minimum	Improved ventilation and corrosion protection required	Yes	Corrosive chemistry carbon monoxide emissions; no experience in USA.
Softening Agents[2,3]	50% avg.		21kg/m^3 minimum	Minimal	Yes for some	Does not provide cooling.
Extended Range Polyols[2,3]	Variable		21kg/m^3 minimum	Extra Tankage likely	No	Mainly for foam softening

1) Processing at high levels of auxiliary blowing agent is difficult.
2) Maximum replacement approximately 7 php MC.
3) Not applicable in cases where the auxiliary blowing agent is used to reduce the exotherm.

TABLE 5

TDI CONTROL TECHNOLOGY

STACK EMISSIONS TREATMENT	DEVELOPMENTAL STATUS/DESCRIPTION	TDI EMISSIONS
Caustic/Water Scrubbing	Several commercial units operated during the past 15 years.	Can be used with lo concentrations of TDI ar high volumes of air. Wi multiple plate scrubber 90-95% efficiency in TD removal has been observe Urea end product is no toxic, but caustic sludg formation and disposal a serious drawback.
Water Scrubbing	Experimental units have been evaluated. One commercial unit in operation.	Sludge problem of caust scrubbing is reduced, bu lower efficiency TDI removal has bee observed. Very expensiv low efficiency.
Carbon Adsorption	Technology available from several sources. Problems with filter clogging unless pre filter used.	Has been shown to effective at TDI remova References showin 100% removal to 0.5 pp are available.
Physical Filters	Fiberglass or other physical barrier with high surface area to increase residence time of TDI in air stacks. TDI converted to urea.	Has been shown to effective in T removal in conjunctio with carbon adsorptio systems. Some data a available.
Experimental		
Steam Injection	Direct steam injection into air stacks to convert TDI to non-hazardous urea.	Data on efficiency n available.
Water Spray on Foam Surface	Provides moisture in stack to convert TDI to urea.	Data not availabl

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Appendix 6-C

Flexible Polyurethane Foam Manufacture - An Assessment of Emission Control Options (Center for Emissions Control)

Center for Emissions Control

FLEXIBLE POLYURETHANE FOAM MANUFACTURE

An Assessment of Emission Control Options

October 1991
Washington, D.C.

6-C-2

Center
for
Emissions
Control

FLEXIBLE
POLYURETHANE FOAM
MANUFACTURE

An Assessment of
Emission Control Options

October 1991
Washington, D. C.

The Center for Emissions Control is an independent not-for-profit organization established in October 1990 to provide and act as a clearinghouse for information about, and to encourage the development and safe use of, safe and effective work practices, process modifications, control technologies, and other methods to reduce emissions of chlorinated solvents. As part of its activities, the Center is developing control options documents for the following solvent applications: adhesives, aerosols, chemical intermediates, coatings, dry cleaning, electronics, flexible polyurethane foam, food industry, paint removal, pharmaceuticals, solvent cleaning (degreasing), and textiles.

The Center also may undertake and support research and development projects intended to result in the creation or application of new technologies or products that will reduce emissions of chlorinated solvents.

This document is intended to serve as a general source of information on emission control options for various chlorinated compound applications. In publishing this document, neither the Center for Emissions Control, Inc. (CEC), the CEC member company representatives, nor the member companies —

- endorse the performance, safety, or environmental acceptability of any of the technologies or products discussed. Those employing control technologies should consider the safety and proper disposal of contaminants and waste products generated from processes used.
- purport to be an exclusive source of current information regarding control options. Over time more information may become available regarding the health and safety effects of the technologies or products described. Readers are encouraged to consult other sources.
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duction controls placed on 1,1,1-trichloroethane,[4] increased use may be limited to those areas of the country where methylene chloride use is restricted.

* * * * *

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[4] Under the Clean Air Act Amendments of 1990, CFC-11 production will be phased out in 2000, and 1,1,1-trichloroethane production will be phased out in 2002. The Clean Air Act, as amended, also imposes interim production cuts between 1990 and the phase-out date.

Description of Process

The flexible foam manufacturing process produces a urethane polymer by reacting an isocyanate (i.e., toluene diisocyanate) with a polyol. A subsequent reaction of the isocyanate and water produces urea and carbon dioxide (CO_2). The CO_2 formed in this reaction expands the cells of the foam, thereby reducing its density. The urea gives the foam its rigidity or firmness.[5] In higher density foams (densities greater than 1.5 pounds per cubic foot, or lbs/ft^3),[6] carbon dioxide often is the sole blowing agent.[7] These "water-blown" foams compose about 40 percent of the total amount of slabstock foam that is produced (EPA, 1991).

While increasing the amount of water in the foam formula can produce less dense foam, it also will increase the foam's firmness. To produce lower density, soft foams, an auxiliary blowing agent like methylene chloride is used to further expand the cells of the foam without simultaneously making it stiff or rigid (**Figure 1**). The auxiliary agent also helps to control the reaction temperature. Otherwise the temperature could reach sufficiently high levels (>165°C) to result in combustion or scorching of the foam interior (UNEP, 1989).

Several process control agents also are necessary in the foam formulation. These include amine catalysts to increase the isocyanate/water reaction, tin catalysts for the polyol/isocyanate reaction, and surfactants to control the size of the foam cells and to stabilize the foam as it rises (Sayad and Williams, 1979a; 1979b). In addition, melamine, graphite, or alumina trihydrate is added to combustion-resistant foams to improve their performance in fire tests (UNEP, 1989).

Slabstock flexible foam is produced as a large continuous bun

---

[5] Foam firmness is expressed as the indentation force deflection, or IFD. IFD is a measure of the force, expressed in pounds or newtons, required to compress the original foam height by 25 or 65 percent.

[6] Equivalent to about 24 kilograms per cubic meter (kg/m^3).

[7] In the case of soft foams (25% IFD< 30 pounds), an auxiliary blowing agent may be required regardless of the density.

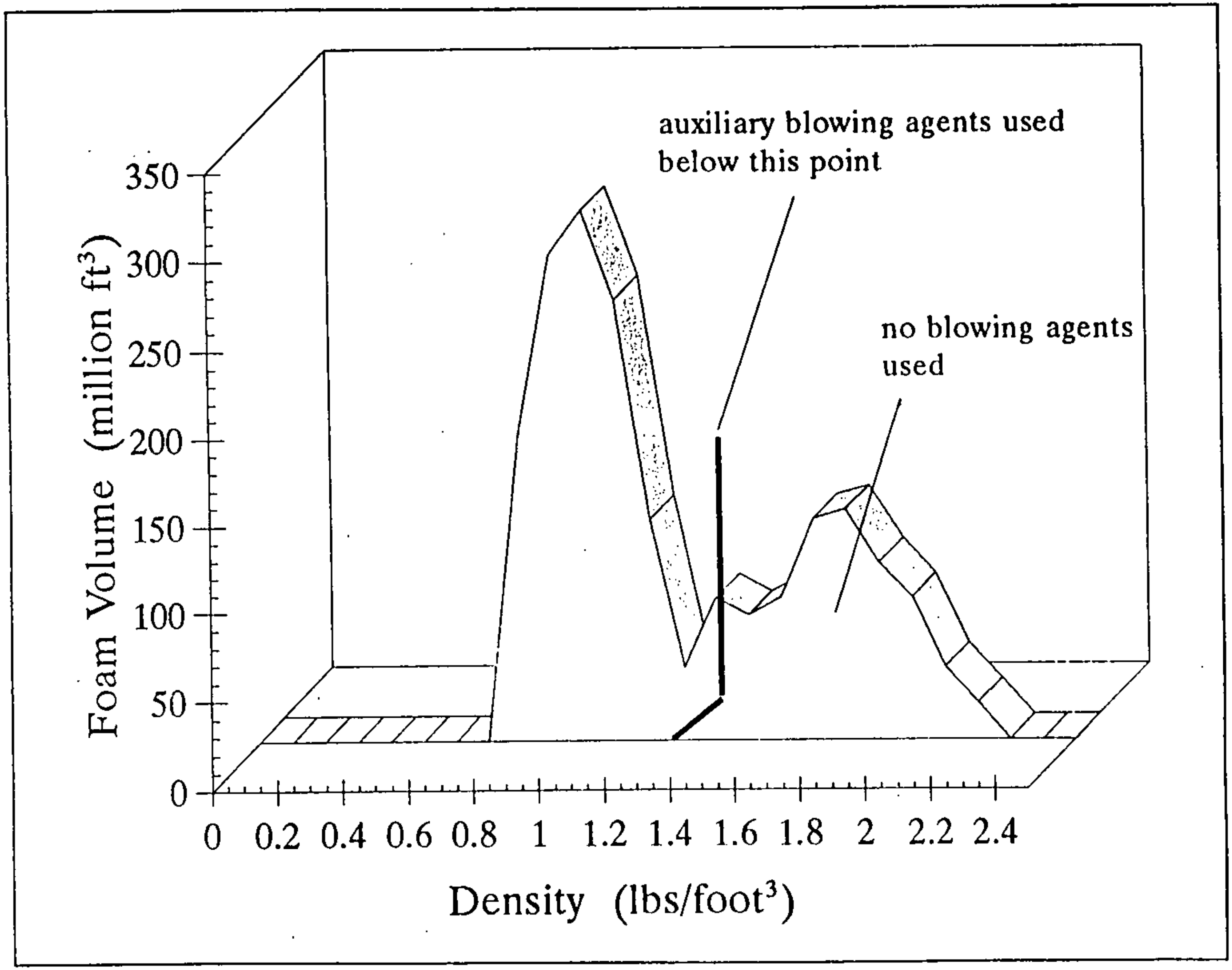


Figure 1. Density Distribution of Flexible Slabstock Polyurethane Foam in 1990 (Simmons, 1990).

that is cut into pieces with desirable dimensions (**Figure 2**). The ingredients of the foam formulation are pumped to a mixing head and discharged through the nozzle onto the front of a conveyor belt, called the foam line. The conveyor first passes through an enclosed, ventilated section, or tunnel, where the ingredients react quickly to form the foam "bun." From its maximum expansion, the foam begins to release blowing agent and unreacted chemicals. These emissions are exhausted from the enclosed section. As the bunstock leaves the conveyor, it is sawed into sections and transported to a curing and storing area.

* * * * *

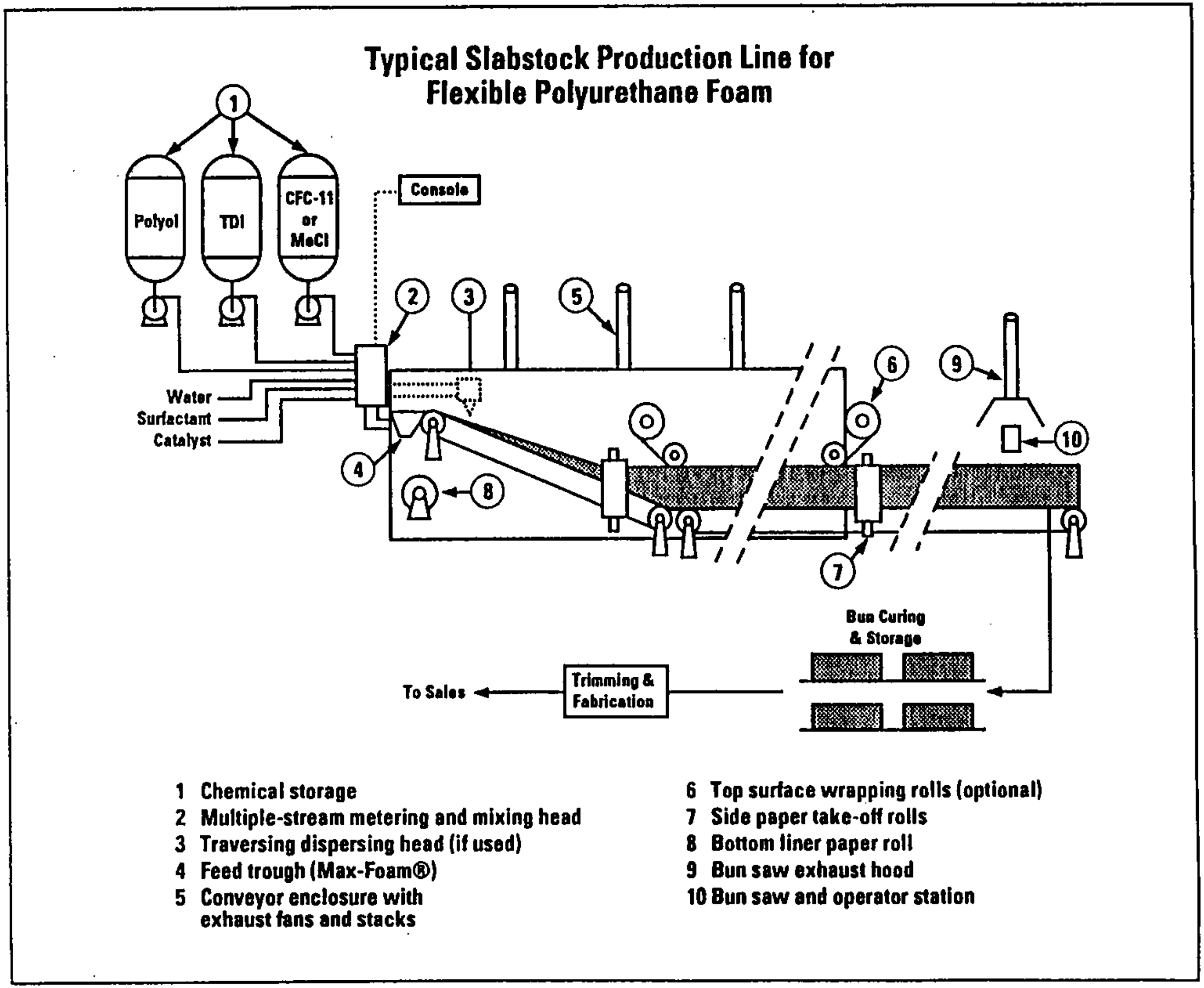


Figure 2. Typical Slabstock Production Line for Flexible Polyurethane Foam (EPA, 1991).

Emission Control

The bulk of losses of auxiliary blowing agent in the foam production process occur as atmospheric emissions. For operations using methylene chloride, the largest quantity of emissions will occur in the first 2 to 4 minutes (at "blow-off") and about half of the emissions will occur within 10 to 20 minutes (Simmons, 1990). The remainder of the emissions occur in the curing area over the next 12 to 24 hours (**Figure 3**). Several options have been suggested for reducing losses of methylene chloride to the atmosphere including work practice changes, vapor recovery or treatment, equipment and process modification, and chemical substitution. In addition, recovery of the quantity of the substance used as a solvent for cleaning operations has been suggested. Each of these options is discussed below.

Work Practice

Methylene chloride emissions cannot be greatly reduced by changes in the work practices in flexible foam production, but certain housekeeping and maintenance activities will help to minimize blowing agent emissions. These activities include the routine maintenance of pumps, pipe fittings and flanges, pressure relief devices, sampling and delivery connections, storage tanks, and dispensing lines to detect and fix leaks (SRRP, 1990).

In addition, work practices have been implemented to minimize the use of methylene chloride for maintenance flushing of the mixing head, delivery hoses, and trough of the foam machine (Leggett and Platt, 1990; SRRP, 1990). For example, use of a disposable liner can eliminate

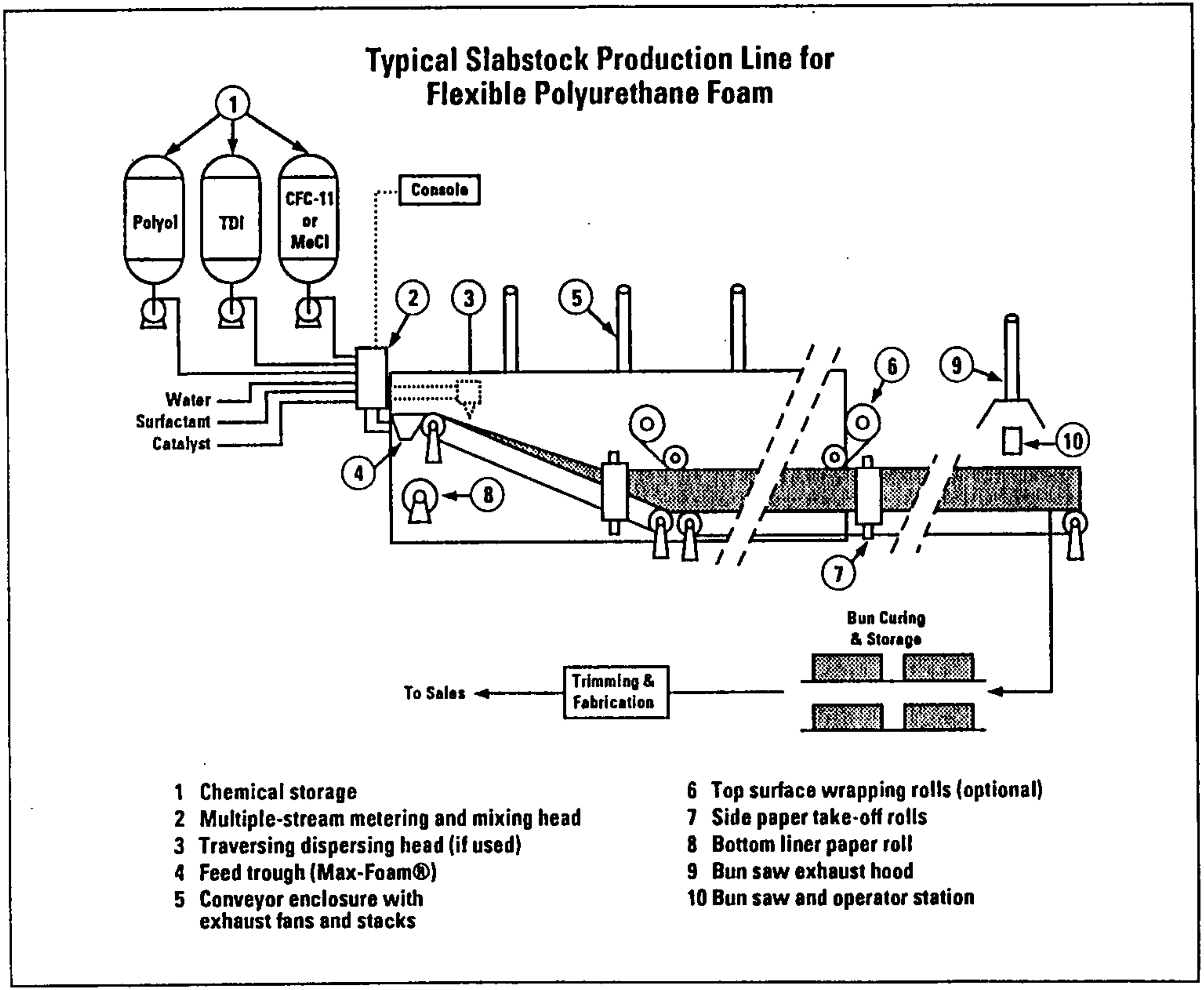


Figure 2. Typical Slabstock Production Line for Flexible Polyurethane Foam (EPA, 1991).

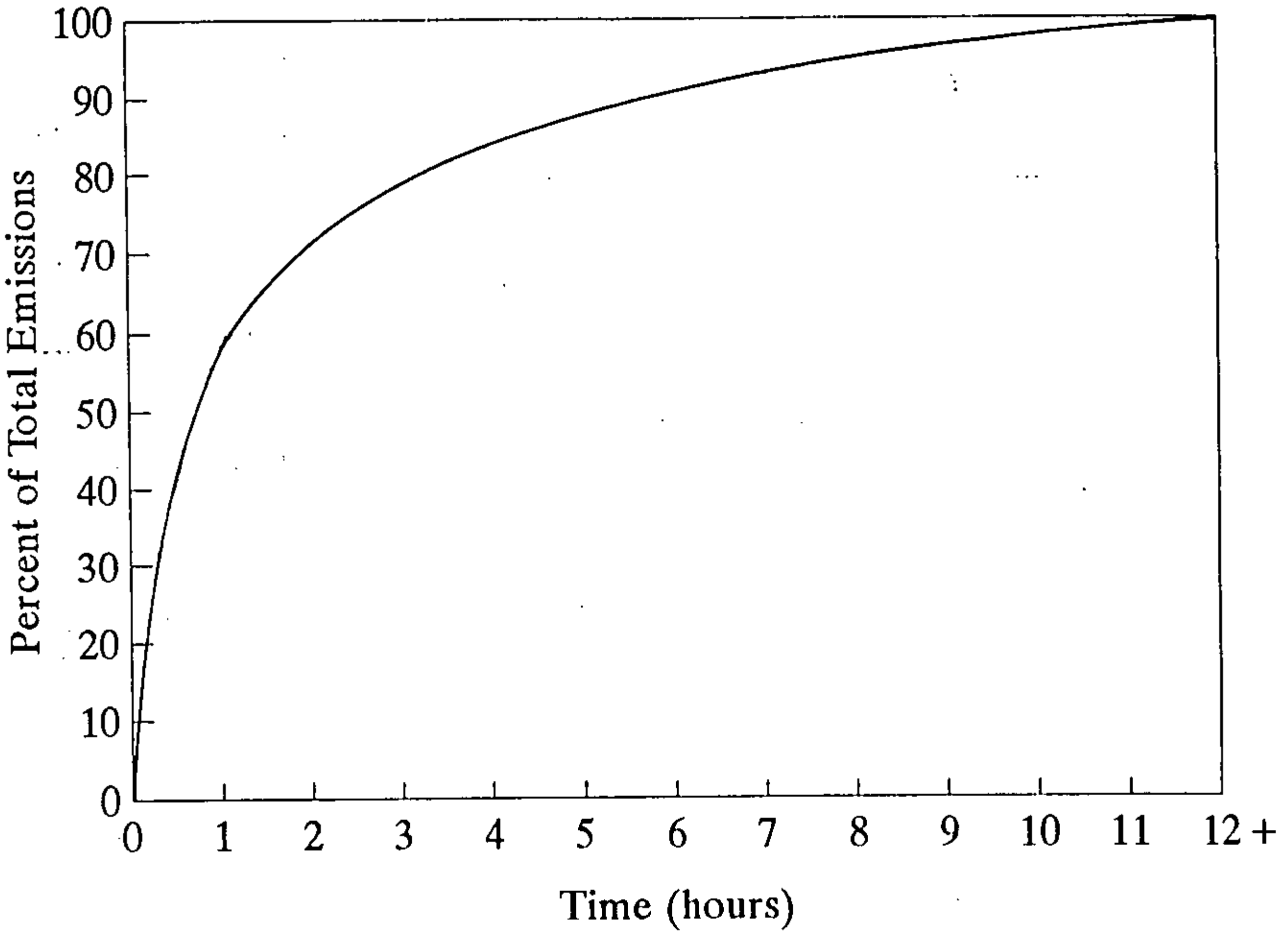
Emission Control

The bulk of losses of auxiliary blowing agent in the foam production process occur as atmospheric emissions. For operations using methylene chloride, the largest quantity of emissions will occur in the first 2 to 4 minutes (at "blow-off") and about half of the emissions will occur within 10 to 20 minutes (Simmons, 1990). The remainder of the emissions occur in the curing area over the next 12 to 24 hours (**Figure 3**). Several options have been suggested for reducing losses of methylene chloride to the atmosphere including work practice changes, vapor recovery or treatment, equipment and process modification, and chemical substitution. In addition, recovery of the quantity of the substance used as a solvent for cleaning operations has been suggested. Each of these options is discussed below.

Work Practice

Methylene chloride emissions cannot be greatly reduced by changes in the work practices in flexible foam production, but certain housekeeping and maintenance activities will help to minimize blowing agent emissions. These activities include the routine maintenance of pumps, pipe fittings and flanges, pressure relief devices, sampling and delivery connections, storage tanks, and dispensing lines to detect and fix leaks (SRRP, 1990).

In addition, work practices have been implemented to minimize the use of methylene chloride for maintenance flushing of the mixing head, delivery hoses, and trough of the foam machine (Leggett and Platt, 1990; SRRP, 1990). For example, use of a disposable liner can eliminate



This graph is intended to provide a general indication of methylene chloride emissions. It does not reflect actual measurements.

Figure 3. General Emission Profile for Foam Production and Curing.

solvent cleaning of the foam trough. Solvent used to flush the mixing head and delivery hoses can be collected, distilled, and returned to the system for reuse rather than being allowed to evaporate to the atmosphere.

Storage Tank Controls

While data are not available for the flexible foam industry, estimates from pharmaceutical manufacture indicate that storage tank emissions comprised three percent of total emissions, or about 5,000 pounds annually (EPA, 1986). These losses, while not a major contributor to total emissions, can be controlled effectively through the application of available control technology.

Storage tanks for organic liquids are categorized into five basic designs: fixed roof, external floating roof, internal floating roof, variable vapor space, and pressure (high and low). For the purposes of this document variable vapor space and pressure tanks are assumed to have insignificant emissions (EPA, 1986).

Because of changes in temperature and solvent level, the volume of air in a fixed-roof storage tank is almost constantly changing. These change can result in solvent emissions when vapors are released from the tank to relieve excess pressure. These losses can be controlled with either floating roofs or vapor condensation (**Figure 4**).

Floating roof tanks have a floating deck which rests on the surface of the organic liquid and adjusts according to the pressure within the tank. The floating deck may be the roof of the tank (external floating roof tanks) or the tank may have a permanent roof with a floating deck inside (internal floating roof). For internal floating roof tanks, the space between the floating deck and permanent roof is vented to the outside to prevent the possibility of explosion. The internal floating deck either floats directly on the liquid surface or rests on pontoons several inches above the liquid surface.

The floating deck restricts the evaporation of the organic liquid. Evaporation losses may occur, however, between deck fittings, seams, and the space between the deck and the tank wall. Consequently, the floating roof generally is equipped with primary and secondary seals.

Floating roofs can reduce emissions from fixed roof tanks by as much as 85 percent, but are more cost effective in larger tanks with frequent changes in fluid level (EPA, 1986). In smaller tanks, refrigerated condensation (discussed below) is estimated to be a more cost-effective option (EPA, 1986; Waldrop, 1990).

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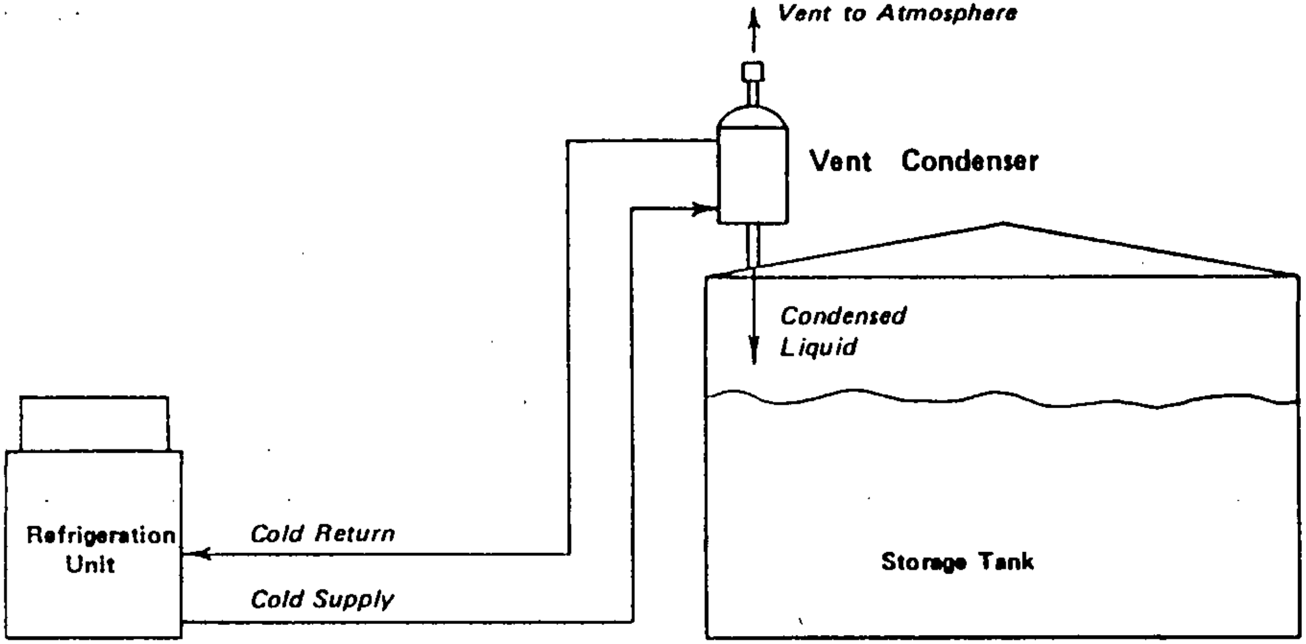


Figure 4. Control of Fixed-Roof Storage Tank Emissions (Waldrop, 1990).

Vapor Recovery

Auxiliary blowing agent emissions from flexible foam production are divided about equally between the actual production process and the curing phase. Concentrations are low in the production area, because of the high volumes of air required to achieve the workplace standards for toluene diisocyanate (TDI), used to produce the polyurethane (SRRP, 1990). While air volumes are lower in the curing area, concentrations likely also are lower.

In assessing the applicability of available add-on emissions control equipment, these concentrations and air volume constraints must be taken into consideration. For vapor recovery techniques, the amount of blowing agent that is potentially recoverable is a function of the total emissions and the efficiency of the exhaust system of the particular facility (UNEP, 1989).

Carbon Adsorption

Granular activated carbon has been employed for several years in industrial processes to trap organic compound vapors from air streams. As the air stream from the process passes through the carbon bed, the compound molecules adsorb to the surface of the carbon granules. The compound is then stripped, or desorbed, from the carbon bed using steam. Carbon adsorption systems generally employ multiple carbon beds to allow for continuous operation (**Figure 5**).

The generally high air flows in foam production plants would require relatively large quantities of carbon (Leggett and Platt, 1990). In addition, the presence of TDI and amine catalysts can deactivate the carbon bed, such that regeneration of the carbon may not be feasible (SRRP, 1990). One suggested solution to this problem is to

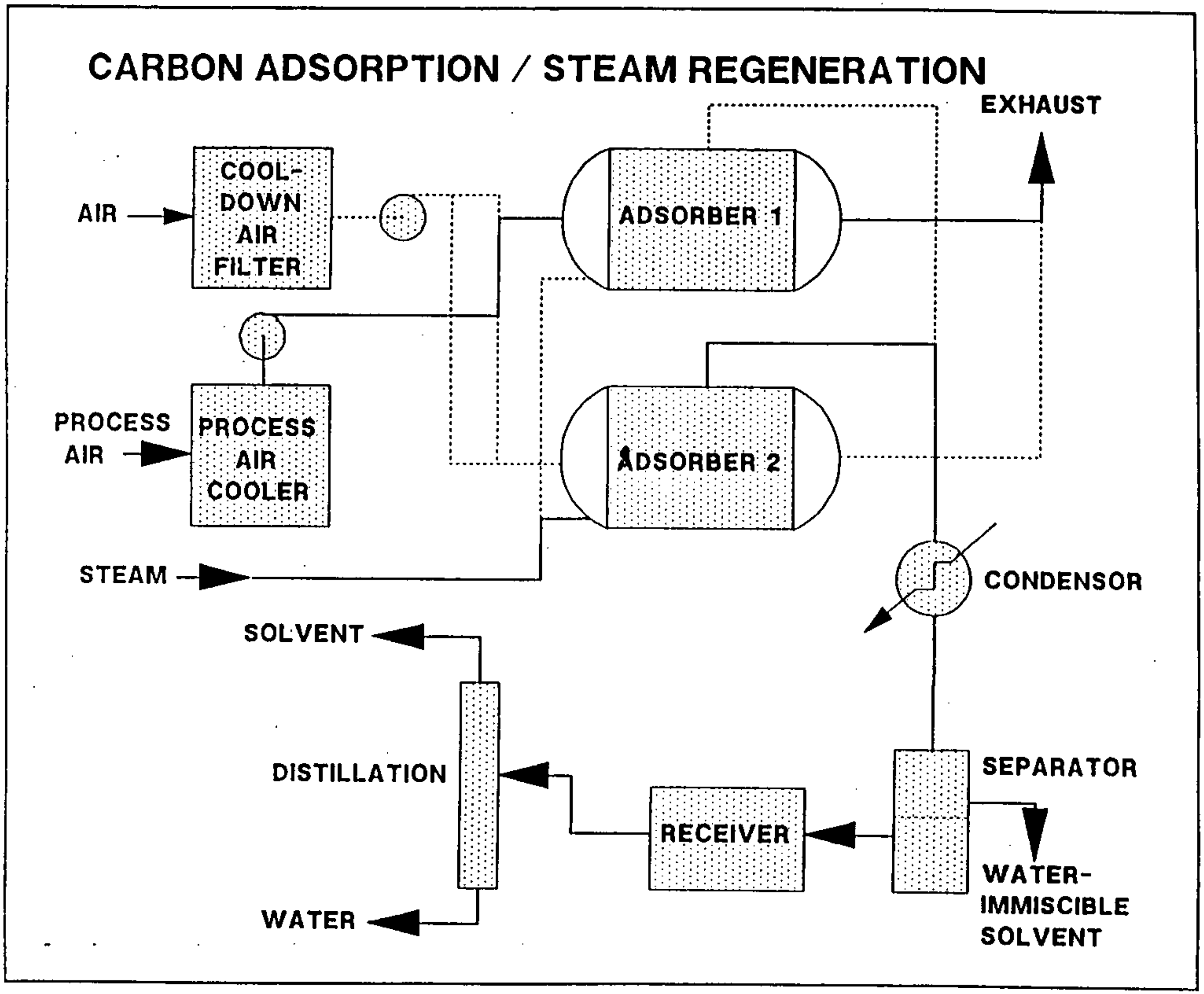


Figure 5. Carbon Adsorption System Using Dual Beds and Steam Regeneration.

use a sacrificial carbon bed between the foam tunnel and the main carbon beds to adsorb the TDI. The methylene chloride would bypass this bed and adsorb to the carbon in the main bed. While the air volumes and TDI levels are lower in the curing area, the lower concentrations and the challenge of enclosing the space make effective carbon adsorption difficult in the curing area (SRRP, 1990).

Recovery of auxiliary blowing agent from the foam tunnel can result in an emission reduction of about 30 to 40 percent or less, since only about half of the emissions occur in the tunnel (Sporon-Fielder, 1986; Nutt and Skidmore, 1987). Some increased efficiency can be achieved by extending the foam tunnel to increase the residence time and by better enclosing the tunnel to prevent fugitive emissions (Leggett and Platt, 1990).

Additional considerations in the use of carbon adsorption are the requirement for steam production on-site, and the potential for hydrolysis of the methylene chloride or 1,1,1-trichloroethane in the presence of moisture (SRRP, 1990). Alternative stripping methods do exist, however, and are described below.

Vapor Condensation

Direct condensation of methylene chloride vapors can be accomplished by cooling the air stream below the condensation point of the compound (**Figure** 6). This technology is particularly applicable when concentrations in the gas stream are relatively high (i.e., greater than one percent). As a consequence, the recovery efficiency of a vapor condensation system in a flexible foam operation likely would be low (Leggett and Platt, 1990).

Recovery of methylene chloride requires condenser temperatures of -100 °F (-73°C) or less. These temperatures can be achieved with either CFC refrigeration or liquid nitrogen (N_2) systems.

Condensation of the vapor stream from a flexible foam plant will produce methylene chloride and water. In addition, however, TDI and trace amines may be condensed with the water. Stabilizers present in the methylene chloride formulation may not be condensed, on the other hand, and reblending of the reclaimed material may be necessary.

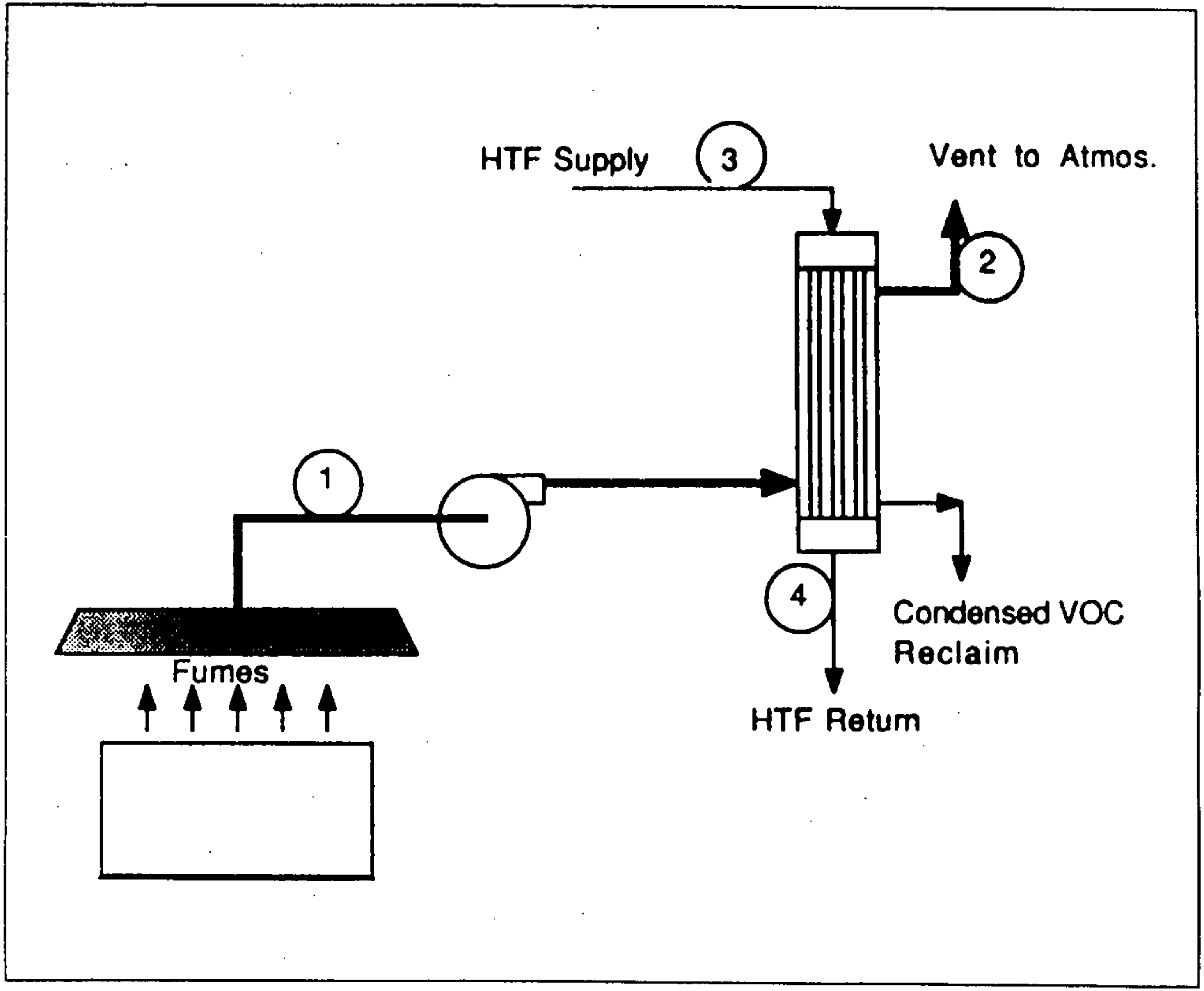


Figure 6. The Vapor Condensation Process
(Hall, 1990).

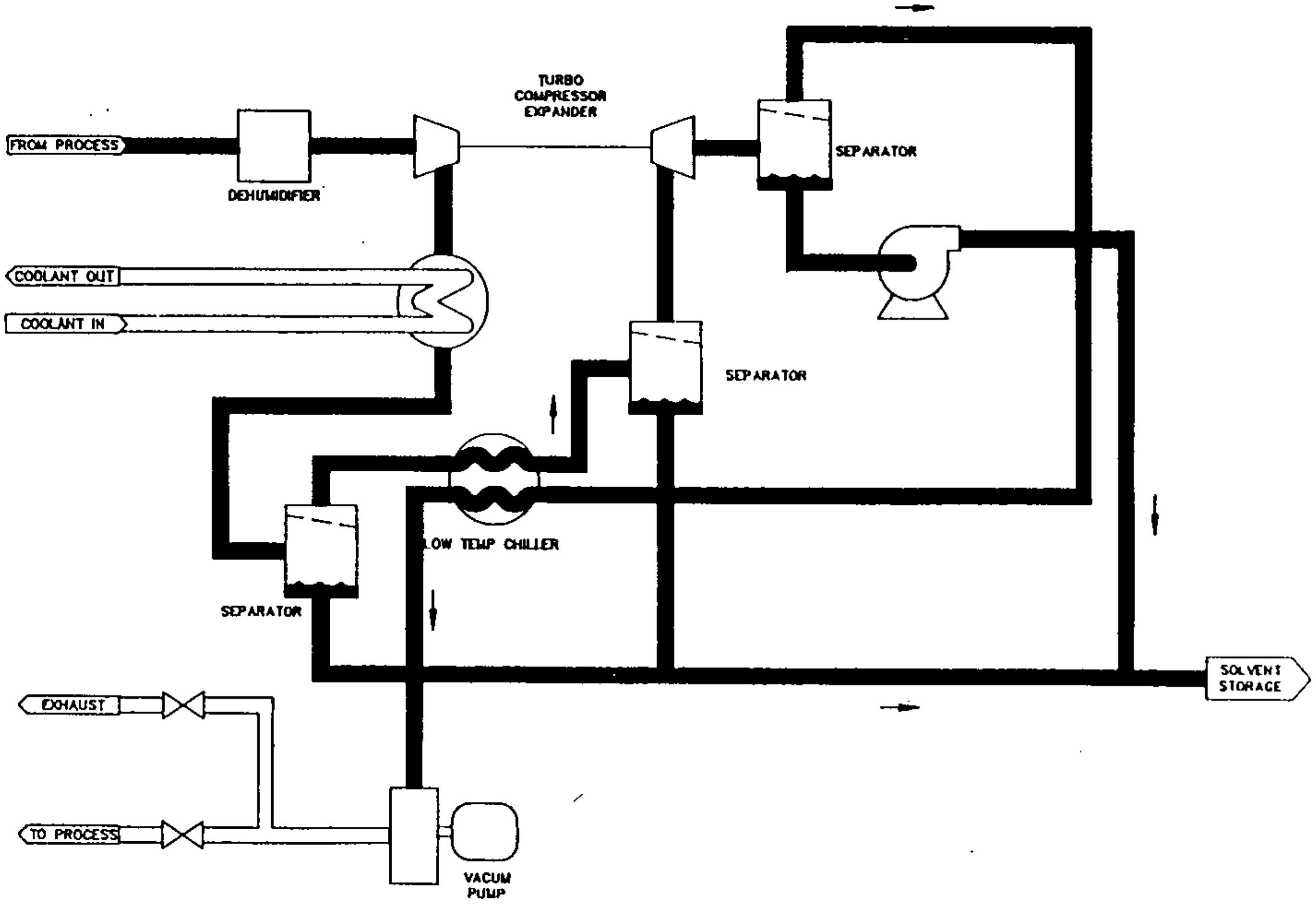
Brayton Cycle Heat Pump (BCHP)

A newer vapor condensation technique employs the Brayton cycle heat pump to achieve a lower temperature (-150°F, or -101°C) to condense the organic vapors (Priebe, 1989). The BCHP technology has been used historically for cabin temperature control in virtually all commercial, business, and military airplanes. It uses a reverse Brayton refrigeration cycle to achieve very low temperatures, providing two thermodynamic advantages over more traditional condensation methods (DOE/OIP, 1990). First, it operates under increased pressure, thus increasing the condensation temperature of the substance to be recovered (**Figure 7**). As a result, the recovery efficiency is significantly higher compared to condensation at atmospheric pressure. Second, by combining the compression and expansion equipment onto one spindle, it reduces the amount of energy required (Kovach, 1990).

The BCHP technology also can be used in conjunction with standard carbon adsorption methods to remove emissions from a gas stream (**Figure 8**). In such a configuration, hot nitrogen replaces steam for desorbing the organic compound and regenerating the carbon bed. The compound-laden inert gas is cooled, compressed, and cooled further. The condensed material is separated and the inert gas is heated and returned to the carbon bed.

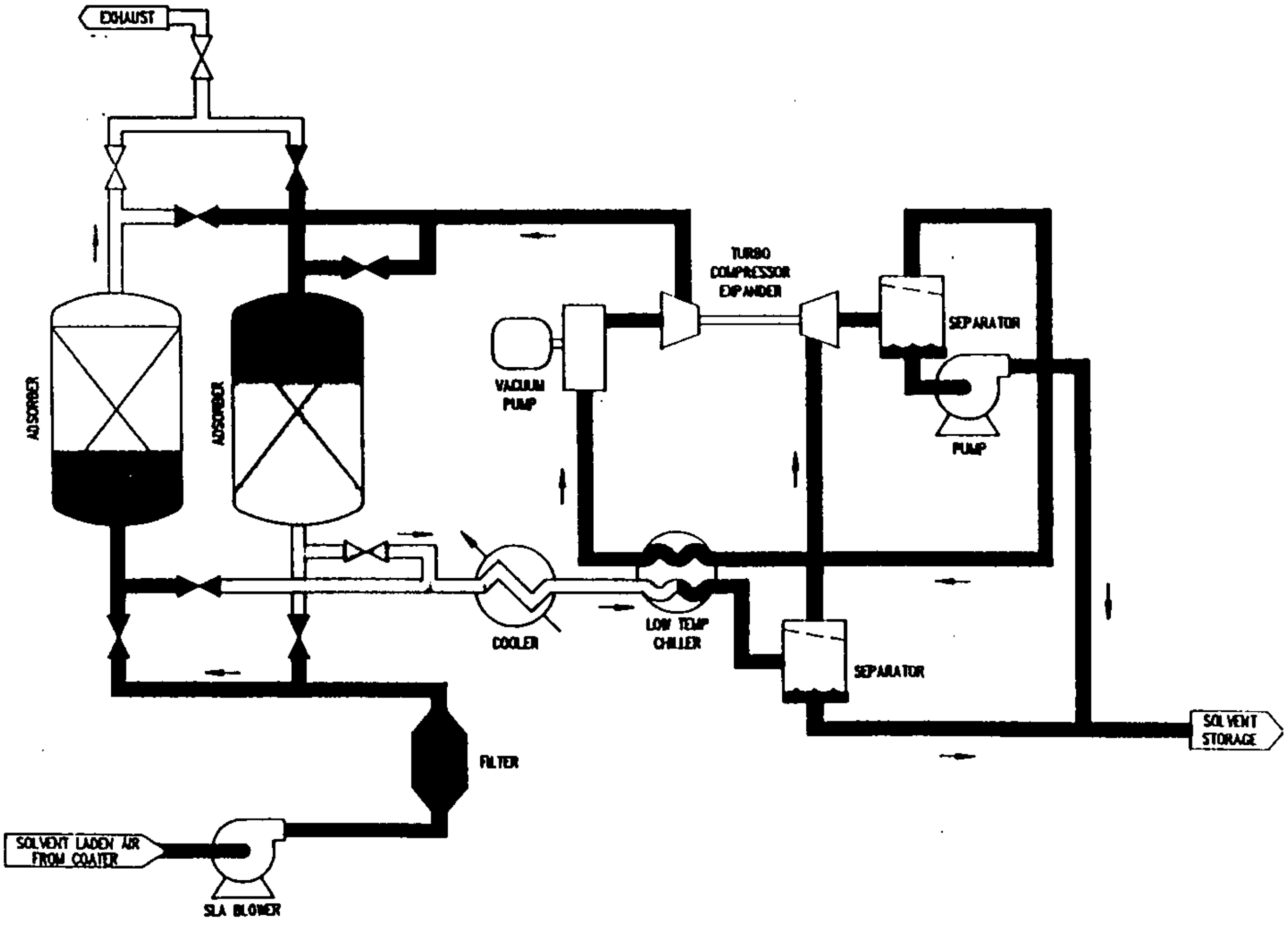
The Brayton cycle provides several advantages to traditional methods of vapor recovery for methylene chloride and 1,1,1-trichloroethane (Kovach, 1990). These advantages stem from the virtual elimination of water from the process, either by completely eliminating the adsorption step or by removing the need for steam regeneration of the adsorption bed. Trace quantities of water vapor, however, likely will condense from the stream (SRRP, 1990).

The production of "dry" quantities of the compound can significantly reduce the need for the water separation step, and may reduce the need for restabilization of the recovered material. The elimination of water and oxygen from the process can significantly reduce any decomposition that can occur at elevated temperatures. Use of regenerated inert gases at elevated temperatures also may greatly reduce the amount of the organic compound remaining on the adsorption medium after regeneration, and may permit a significant size reduction of adsorbent beds. Since water can



Source: Nucon International, Inc.

Figure 7. Vapor Condensation Using Brayton Cycle Heat Pump Technology.



Source: Nucon International, Inc.

Figure 8. Use of Brayton Cycle Technology for Desorption of Carbon Beds.