Report of Findings: Barriers to Eliminating Chlorinated Solvent Use In Cleaning Operations At Massachusetts Manufacturers

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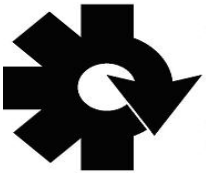

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Executive Summary

SAK Environmental, LLC (SAK) was retained by the Massachusetts Executive Office of Environmental Affairs, Office of Technical Assistance (OTA) under RFR #ENV05 OTA 06. The primary purpose of this project was to identify barriers to reducing or eliminating chlorinated solvent use for manufacturing companies in Massachusetts. The survey included the identification of 61 potential participant companies. Of these companies, 56 were contacted by telephone and 30 companies (54%) completed the survey. The predominant industry sectors surveyed included metal forming (SIC Industry Group 34) which included 13 participant companies and non-computer electrical equipment (SIC Industry Group 36) which included 6 participant companies. Together, these groups made up 63% of the completed surveys.

Findings

Of the 30 companies that had completed the survey, nine (9) had eliminated chlorinated solvents entirely, twelve (12) had reduced their use of chlorinated solvents, and nine (9) reported no elimination or reduction in use. The electrical equipment industry group (SIC group 36) had the most success in eliminating chlorinated solvent use as five (5) out of the six (6) participant companies had eliminated chlorinated solvents entirely and the remaining company had succeeded in reducing usage. In the metal forming group (SIC group 34), 23% had eliminated chlorinated solvents, 46% had reduced usage, and 31% had neither eliminated nor reduced.

In all companies surveyed, the vast majority that had reduced solvent usage did so by upgrading to more efficient vapor degreasing systems.

The primary motivators for change in chlorinated solvent usage were the cost burden and liability associated with environmental regulation, improved operating cost, and improved environmental health and safety. In all the companies surveyed, regulations were cited as an actual or potential motivator by 60% of the participant companies and cost-efficiency and better environmental health and safety were both mentioned as actual or potential motivators by 43% of the companies.

The primary barriers to change in chlorinated solvent usage included maintaining cleaning quality and increased costs associated with change. A full 87% of the participant companies mentioned maintaining quality as the primary barrier to eliminating or reducing chlorinated solvent usage. Technical barriers identified with transitioning to chlorinated solvent alternatives included ineffective cleaning where oil residues are left on the part being cleaned, ineffective cleaning where alternative cleaner residues are left on the part being cleaned, increased drying time, and ineffective cleaning of deep holes, small diameter holes, and blind holes. In addition, the wide variety of oil residues on product could not be universally cleaned using a single alternative product. Some companies reported that solvents such as TCE are still the only degreasing solvent that met all of their cleaning needs and they had neither the space nor the money to operate two different cleaning systems.

Out of all the surveyed companies, 47% also cited increased costs as a barrier to change. The increased cost barrier is primarily due to capital expenditures, which some smaller companies did not feel they were financially secure enough to assume. However, companies that had either reduced or eliminated chlorinated solvent usage often reported significant cost savings in solvent purchasing and disposal costs, and felt that the capital expenditure for the new degreasing equipment was quickly offset by reduced operating costs. Reductions in energy operating costs, if available, were not significant.

Both OTA and the Toxics Use Reduction Institute (TURI) were mentioned as good sources of information on alternatives to chlorinated solvent use. A total of 60% of the companies mentioned OTA as an often used source of information. TURI was mentioned as a source of information by 30% of the surveyed companies and several companies have used TURI's surface cleaning lab to test cleaning alternatives for them. Vendors were also mentioned as a source of information by 53% of the surveyed companies, but the reviews were mixed as some companies felt they received useful information about alternatives while other companies reported that vendors didn't really understand their needs or promoted alternatives in self interest.

The surveyed companies reported needing continued assistance in evaluating alternative cleaning technologies. Many companies expressed discomfort about making changes to technologies that were "unproven" and were concerned with maintaining cleaning quality in a cost-effective manner. Capitalizing on the experience of companies that have successfully reduced or eliminated chlorinated solvent use and have overcome the anticipated barriers (such as cost) may be a benefit. These companies could be used to help educate the other companies that have not reduced or eliminated chlorinated solvent use.

Virtually all participants expressed interest in a state sponsored grant or low interest loan program to finance their investigation in to chlorinated solvent alternatives.

Conclusions

Companies that had eliminated the use of chlorinated solvents had used a substantial volume of solvent to make its elimination cost effective. These facilities would have been subjected to substantial regulatory costs associated with the federal MACT rule, waste management disposal costs, and may presumably have incurred remediation costs associated with releases of chlorinated solvents to land and water at their facility. These are considered strong motivational factors for them to have investigated chlorinated solvent alternatives and to overcome related barriers.

Companies that reduced the quantity of chlorinated solvents had used a substantial volume of solvent which made reduction cost effective. High efficiency vapor degreasers were purchased by these companies which resulted in a dramatic decrease in the quantity of chlorinated solvent used at these facilities. Elimination of chlorinated solvents at these facilities has not occurred, because the quantity of chlorinated solvent currently used does not justify monetary and technical investments required to overcome barriers associated with transitioning to alternative cleaning systems.

Companies that neither reduced nor eliminated chlorinated solvents generally did not use a sufficient quantity of solvent, in their view, to justify the monetary and technical investment required to overcome barriers associated with changing to an alternative cleaning process.

The threshold at which a technical or cost barrier was considered insurmountable significantly dropped when put in the context of a larger capital project. The purchase of new manufacturing equipment or the relocation of a facility generally overcame the barriers to investigating and/or implementing a transition to alternative cleaning processes.

Not all barriers reported by participants were actually experienced by the company. SAK considered them as perceived barriers that were based on real experiences of others reported to the participant via colleagues in other industries or perceived barriers perpetuated within their company.

Recommendations

Conduct a technology transfer seminar, workshop, roundtable or forum between companies that have successfully eliminated chlorinated solvents and use alternatives with companies that continue to use chlorinated solvents. Participation by successful companies is critical to establish a "manufacturing" dialog in the event. The objective of the event would be for successful companies to share their experiences, challenges, and solutions when transitioning to alternatives, including dispelling perceived barriers that may have dissuaded others from eliminating chlorinated solvents. The event should broadly target facility, manufacturing, quality and environmental mangers, and company owners where applicable. One participant company (#96) mentioned a lack of such programs in the western part of the state.

The few major customer groups (i.e. defense, automotive, aerospace) who mentioned the use of chlorinated solvents for cleaning is specified in their contracts indicates there is an administrative barrier to transitioning to alternatives for some companies. Such

requirements may be either arcane specifications from old contracts or recent requirements that are inconsistent with general environmental policies associated with such industries. Government agencies and companies in the defense, automotive and aerospace industries for the most part are considered to be leaders in environmental policy. Not specifying the use of chlorinated solvents in vendor contracts would remove an administrative barrier to investigating alternatives by suppliers. Outreach to environmental, manufacturing, quality, and procurement managers would be necessary to initiate change in which the way cleaning specifications are written and/or negotiated.

Additional investigation should be performed to identify those oils and residues for which alternative cleaning processes are the most effective. Use of such material in the metal forming and electronics industries would improve the feasibility of companies to investigate and implement alternatives to chlorinated solvents.

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1. INTRODUCTION

SAK Environmental, LLC (SAK) was retained by the Massachusetts Executive Office of Environmental Affairs, Office of Technical Assistance (OTA) under RFR #ENV05 OTA 06. The primary purpose of this project was to identify barriers to reducing or eliminating chlorinated solvent use for manufacturing companies in Massachusetts. This information can be used by OTA to formulate policy options. Project objectives included:

- Collection of data on current and past chlorinated solvent use by participant companies. Participants provided the majority of data to SAK in the form of a survey questionnaire completed by phone or fax.
- Collection of pertinent company data such as size and business activity.
- Evaluation of motivations for chlorinated solvent use reduction and/or elimination.
- Evaluation of barriers to solvent use reduction and/or elimination.
- Determination of sources of information for participant companies regarding solvent use reduction and/or elimination.
- Identification of specific technical issues, innovative solutions, and suggestions to reduce and/or eliminate chlorinated solvent use by participant companies.

1.1. Survey Design

The survey was designed in conjunction with OTA to elicit as much information as possible regarding current and past usage of chlorinated solvents at each participant company and identify specific barriers and motivations for individual companies to reduce or eliminate chlorinated solvents. To the extent possible, a long term employee with responsibility for environmental management was contacted at each company. The survey was intended to be conducted via telephone with SAK in order to initiate a free flowing conversation where specific information could be obtained regarding the use of chlorinated solvents, the company history with regard to management of chlorinated solvents, and the types of external support the facility used in evaluating alternatives to chlorinated solvents. The survey was also designed to obtain specific information regarding company size, operations, and business activities. The survey template questionnaire is included in Appendix A.

1.2. Identification of Participant Companies

OTA provided SAK a database of sixty one (61) companies to contact in the survey. Each potential participant company has a unique number on this list (i.e. 3 to 108) and this number is used to identify each facility in this report. This database included a preferred contact employee for each facility and attempts were made to contact this person directly. Of this original list, two were duplicate entries in the database, one company was out of business, and two companies were unable to be contacted because there was no working telephone number. This left 56 potential companies to survey out of the original list.

Several attempts were made to contact each of these 56 companies. Of these 56 companies, one has never used chlorinated solvents and one did not have an employee who felt knowledgeable enough to complete a survey about past solvent use. There were 20 companies that were contacted multiple times by telephone and did not respond in time to be included in this report. There were four companies that wanted to complete the survey in writing, but did not respond before publication of this data. This resulted in 30 participant companies with sufficient responses to be included in the data evaluation. The contact status for the original group of potential participant companies is summarized in Table 1.

1.3 Data Collection

SAK performed a telephone survey of each participant company using the survey questionnaire template included in Appendix A. The template was completed during the phone interview with the information provided by the participating employee.

If the participant employee did not have readily available access to records or was unable to provide accurate information, estimates were obtained from the employee. In regards to certain questions such as those regarding the barriers to reducing or eliminating use of chlorinated solvents, the employee could give more than one answer. For this type of question an attempt was made to get the participant employee to focus the answer to three items.

In some instances the person who participated in the survey was unable to provide the SIC code, and in that case the facility was assigned to one main SIC industry group by SAK. If the

company was reluctant to give information over the phone, then they were asked to complete the survey via fax or e-mail, and a few companies completed the survey this way.

2. PARTICIPANTS

2.1. Participant Profiles

Thirty Massachusetts companies voluntarily participated in the survey regarding barriers to reducing or eliminating chlorinated solvent use. Participant companies are identified by numbers 3 to 108 relating to their position on the original survey list. The nature of participant operations varied from small family owned businesses to large corporations, and from small coating and plating job shops to larger manufacturing operations with military or automotive customers. Table 2 is a summary profile of the participant companies by industry type. This information was obtained, in part, from the telephone survey conducted by SAK and SIC code group designations obtained from the Occupational Health and Safety Administration (OSHA) database.

2.2. Considerations and Exceptions

The information in this survey relies exclusively on information provided by the participant companies. No attempt was made to independently verify the accuracy of information given to SAK. A good faith effort was made by SAK to obtain accurate information. If the employee did not have readily available access to detailed records they were asked to make estimates or answer to the best of their knowledge.

3. SOLVENT USE EVALUATION

A large portion of the survey consisted of discussions regarding both the current and past use of chlorinated solvents. Participant companies were asked to discuss how chlorinated solvents had been used, what the motivations and barriers have been relating to reducing or eliminating chlorinated solvent use, and which alternatives to chlorinated solvents have been explored. As much specific information as possible regarding each facility's unique challenges was obtained. It should be noted that in many instances, such as identifying barriers or the sources of outside information for alternatives, the question would result in more than one response. Because of

this, the percentage data presented in the evaluation tables will not total 100%, but instead reflects the percentage of time that answer was given by a participant company.

3.1. Methods of Analysis

Data from the telephone survey was analyzed to determine common motivations and barriers for reducing or eliminating the use of chlorinated solvents and to identify other trends that would be of potential use in formulating policy in this area. The evaluation of the survey data included the following:

- Determining whether companies had, or had not, successfully reduced or eliminated chlorinated solvents and subsequently sorting them into appropriate groups. Groupings included 1) whether they had reduced use of chlorinated solvents, 2) eliminated use of chlorinated solvents, or 3) had so far not done either.
- Evaluating the motivations for reducing or eliminating chlorinated solvent use based on groupings
- Evaluation of the actual and perceived barriers to reduction in chlorinated solvent use based on groupings.
- Identifying sources of information participant companies used to help them evaluate alternatives to chlorinated solvent use.
- Identifying specific technical obstacles, innovative solutions, and suggestions the participant companies had regarding reduction of chlorinated solvent use.

3.2. Findings

Findings were based on data from the 30 participant companies. The participants were grouped according to 1) whether they had reduced use of chlorinated solvents, 2) eliminated use of chlorinated solvents, or 3) had so far not done either. It should be noted that the vast majority of participant companies that had reduced their use of chlorinated solvents had done so by moving to more efficient degreasing operations that still utilized chlorinated solvents.

3.2.1. Identified Motivations for Reducing/Eliminating Chlorinated Solvent Use

Participant companies were asked to identify motivations for reducing or eliminating chlorinated solvent use. The companies could give more than one response and most companies cited

between one and three motivators. The list of motivations identified by participant companies for reducing or eliminating chlorinated solvent use is included in Tables 3A, 3B, and 3C. Table 3A includes motivations for companies that have eliminated chlorinated solvent use, Table 3B includes the motivations for companies that have reduced chlorinated solvent use and Table 3C includes potential motivations for companies that have neither reduced nor eliminated chlorinated solvent use.

For all three groups of companies, the top three motivations for reducing chlorinated solvent use were regulations, cost efficiency, and improved environmental health and safety, although the order of importance varied. For companies that eliminated chlorinated solvent use entirely, almost 80% had cited regulations as a motivator, followed by better environmental health and safety, and finally increased cost efficiency. For companies that had reduced use and companies that had not reduced or eliminated, cost efficiency and regulations were cited as the top two motivators followed by better environmental health and safety.

It should be noted that for many companies, regulations had implications on cost efficiency as companies attempted to avoid expenses associated with regulatory reporting and waste disposal. Several participant companies that had reduced but not eliminated, said that regulations were the primary motivator, but that they had boosted their cost efficiency by moving to more efficient vapor degreasers. One company (participant #92) said that the capital outlay for a new vapor degreaser was recouped in 6 months due to lower purchase costs of solvent, reduced emissions, and lower waste disposal fees. Several companies that had reduced chlorinated solvent use mentioned that equipment upgrades were needed anyway and they looked into purchasing the most efficient equipment they could find.

Many companies mentioned environmental health and safety as a motivator and for some companies that had reduced or eliminated the use of chlorinated solvents, this was actually given as the primary motivator (participant #54, #77). Several participants mentioned that their company had a culture of wanting to be environmentally friendly and this culture was fostered and shared by management. For companies that had reduced or eliminated chlorinated solvent

use, management was sometimes mentioned as a motivator but in the companies that had neither reduced nor eliminated, nobody mentioned management as a potential motivator.

A few companies mentioned customer requirements as a potential motivator (participants # 10, #87, # 90, #92). These are primarily companies that have customers that have cleaning operations specific in their contract or in pre-approved processes and simply can't change without customer approval. One company that had eliminated chlorinated solvents (participant #31) reported that their customers require environmentally friendly alternatives and that was one of the motivations for change.

3.2.2. Identified Potential Barriers to Reducing/Eliminating Chlorinated Solvent Use

The participating companies were also asked to identify barriers to reducing or eliminating chlorinated solvent use. The companies could give more than one response and most companies cited between one and three barriers. The list of barriers identified by the companies for reducing or eliminating chlorinated solvent use are included in Tables 4A, 4B, and 4C. Table 4A includes barriers for companies that have eliminated chlorinated solvent use, Table 4B includes the barriers for companies that have reduced chlorinated solvent use and Table 4C includes anticipated barriers for companies that have neither reduced nor eliminated chlorinated solvent use.

All three groups of companies cited maintaining quality as the primary barrier to reducing or eliminating chlorinated solvent use. A full 100% of companies that had neither reduced nor eliminated the use of chlorinated solvents cited maintaining quality as a barrier. For the companies that had not reduced or eliminated, additional cost and lack of proven cleaning alternatives were the only other barriers mentioned more than once.

For the participant companies that had completely eliminated the use of chlorinated solvents, extra process time for the new system was mentioned as a barrier by 66% of the companies, and was the next most common barrier mentioned after quality. These companies had changed to alternatives including aqueous systems or systems using solvents that were not chlorinated (such as Alcohols or Acetone). Based on the percentage of facilities that cited this barrier, increased

process time is a commonly encountered barrier. However, most of the companies said that the increased process time did not have a significant effect on their operations and they were able to manage it.

All three groups had additional costs mentioned as one of the three top barriers. Also, other unique barriers mentioned such as limited space (participant #77, #92) and waste treatment issues (participant #12, #68) have cost implications for the companies. It should be noted that the cost implications vary within the entire data set depending on the unique circumstances of each company. However, a few conclusions can be drawn from the responses. First, investment in efficient vapor degreasers and centralizing cleaning processes has been found to be cost effective over the long term. However, most companies reported that alternatives to chlorinated solvents are suitable for some, but not all cleaning needs and therefore, would require operation of two cleaning systems - one that uses chlorinated solvents and a second that utilized an alternative cleaner. Few companies however, have the money or available physical space to operate two separate cleaning systems and the result is that if chlorinated solvent vapor degreasing is meets all cleaning requirements that is the system that is used, even if it would be possible to use another technology for certain processes.

Specific customer requirements were the third most common barrier mentioned by facilities that had reduced but not eliminated chlorinated solvents. These companies have customers that specified cleaning to utilize chlorinated solvents and these customers are the primary reason that the company cannot consider eliminating entirely. Lack of proven alternatives was mentioned as a barrier by two of the participant companies that had neither reduced nor eliminated the use of chlorinated solvents.

3.2.3. Evaluation of Chlorinated Solvent Use and Reduction Relative to Company Conditions and Industry Type

The average condition of a company, including size and pounds of solvent used was evaluated to determine if there were any trends regarding the reduction or elimination of chlorinated solvent use. The data regarding company size and solvent usage is included in Table 5A, 5B, and 5C respectively for companies that have eliminated chlorinated solvent use, reduced chlorinated

solvent use, or so far done neither. An evaluation of chlorinated solvent use elimination, reduction, or neither based on industry group is shown in Table 5D.

The companies that had eliminated use of chlorinated solvents had an average annually use in the year prior to elimination of over 37,000 lbs per year. For companies that had reduced use, the average annual use in the year prior to significant reduction was over 31,000 lbs. per year. For companies that had reduced, the post reduction average was 3,892 lbs per year. For companies that had neither reduced or eliminated chlorinated solvents, the current average yearly usage is 4,771 lbs/year. The surveyed companies that had reduced usage had a significant reduction in levels, and now use less solvent on average than the companies that did not reduce at all.

The evaluation of industry groups relative to elimination or reduction in chlorinated solvent use is shown in Table 5D. The industry groups with the most number of participant companies were fabricated metal products (SIC group 34) with 13 participant companies, and electronic and electrical equipment (SIC group 36) with six (6) participant companies. For the fabricated metal groups, many of the respondents had reduced and several had eliminated, however four of 13 had done neither. For the electronic and electrical equipment group, five of the six had eliminated use entirely and one had reduced use of chlorinated solvents.

3.2.4. Sources of Information on Alternatives to Chlorinated Solvents

The participant companies were surveyed to determine sources of information they use to evaluate potential alternatives to chlorinated solvents. The list of sources mentioned is included in Table 6.

Sixty percent (60%) of the participant companies mentioned using OTA for information regarding chlorinated solvent alternatives. Many of the companies had worked closely with OTA in the past and mentioned that they were helpful and understood the technical issues that the companies face. The next most common source of information was product vendors and just over half of the participant companies mentioned using vendors. The companies who had used vendors for information gave mixed reviews. Some felt that they were presented with viable alternatives, but many felt that the vendors did not understand the technical cleaning

requirements in their processes and they were simply given a sales pitch. TURI was the next most commonly mentioned source of information and several of the companies had used the TURI surface cleaning laboratory or were currently using the TURI laboratory to actually test alternatives for them. Several participant companies also mentioned keeping up with potential alternative technologies through seminars given by TURI. Industry trade associations and associated publications were also mentioned as a source of information for 23% of the companies.

3.2.5. Specific Technical Obstacles, Solutions, and Suggestions

The surveyed companies are faced with a variety of unique circumstances relative to the use of chlorinated solvents or alternatives in their processes. This section discusses some of the specific technical issues mentioned by the participant companies, some of the innovative solutions companies have employed to reduce or eliminate chlorinated solvents, and some suggestions that were made by survey participants that would help in the overall management of chlorinated solvents. Table 7 summarizes the technical issues, innovative solutions, and suggestions made by the participant companies.

The most commonly cited technical issue that prevents companies from making a complete change to systems that don't use chlorinated solvents is the quality of cleaning with currently available alternatives. Six (6) companies had cited that the alternatives leave unacceptable residue. Others reported that parts were unable to be sufficiently cleaned for subsequent masking or coating, that plastic parts can absorb alternative cleaners, and that there was a difficulty in drying small, deep and blind holes. Process issues that include increased drying time required for alternative cleaning systems were also mentioned as barriers, but many companies mentioned that they were able to manage the increased process time without significant impact to operations.

Several companies with sufficient in house resources to examine their own manufacturing methods reported some innovative solutions that helped them reduce or eliminate the use of chlorinated solvents. Several companies had mentioned that one barrier they faced was the wide variety of oils and residues that coat parts scheduled for cleaning, and that chlorinated solvents

are the only method that can universally remove the variety of oils. Two companies (#87, #90) reported success with changing to oils that were easily removed using alternative cleaners and eliminating lubricating oils from certain processes that allowed them to reduce their cleaning needs. Another company had made a commitment to eliminate chlorinated solvents because of employee health concerns and used Acetone as the substitute. This required the building of a separate, explosion proof room for drying so that Acetone could be used for cleaning. The participant employee stated that they made the decision to trade a health risk for a flammability risk.

Two suggestions were offered that may be avenues to explore for the continued reduction in chlorinated solvent use. One suggestion was that an effort be made to reduce government specifications that chlorinated solvents be used. This survey participant felt that the use of chlorinated solvents was often specified in the technical contract even though viable alternatives exist. This participant company cited the military contracts as being particularly problematic with regards to using solvents and reported that some times these contracts go as far as specifying where the solvent must be purchased. Another suggestion was to establish standardized types of lubricating oils that can be used and are suitable for cleaning by alternatives to chlorinated solvents. This participant employee suggested that the end users often had no choice but to use chlorinated solvents to manage all their cleaning and that the problem actually starts because the wide variety of cutting and lubricating oils that are used leave hard to clean residues on parts.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

Based on the above information, the following conclusions are made:

a. Companies that had eliminated the use of chlorinated solvents had used a substantial volume of solvent to make its elimination cost effective. These facilities would have been subjected to substantial regulatory costs associated with the federal MACT rule, waste management disposal costs, and may presumably have incurred remediation costs associated with releases of chlorinated solvents to land and water at their facility. These are considered strong

motivational factors for them to have investigated chlorinated solvent alternatives and to overcome related barriers.

b. Companies that reduced the quantity of chlorinated solvents had used a substantial volume of solvent which made reduction cost effective. High efficiency vapor degreasers were purchased by these companies which resulted in a dramatic decrease in the quantity of chlorinated solvent used at these facilities. Elimination of chlorinated solvents at these facilities has not occurred, because the quantity of chlorinated solvent currently used does not justify monetary and technical investments required to overcome barriers associated with transitioning to alternative cleaning systems.

c. Companies that neither reduced nor eliminated chlorinated solvents generally did not use a sufficient quantity of solvent, in their view, to justify the monetary and technical investment required to overcome barriers associated with changing to an alternative cleaning process.

d. Technical barriers identified with transitioning to chlorinated solvent alternatives included ineffective cleaning where oil residues are left on the part being cleaned, ineffective cleaning where alternative cleaner residues are left on the part being cleaned, increased drying time, and ineffective cleaning of deep holes, small diameter holes, and blind holes. In addition, the wide variety of oil residues on product could not be universally cleaned using a single alternative product.

e. The threshold at which a technical or cost barrier was considered insurmountable significantly dropped when put in the context of a larger capital project. The purchase of new manufacturing equipment or the relocation of a facility generally overcame the barriers to investigating and/or implementing a transition to alternative cleaning processes.

f. Not all barriers reported by participants were actually experienced by the company. SAK considered them as perceived barriers that were based on real experiences of others reported to the participant via colleagues in other industries or perceived barriers perpetuated within their company.

g. The Massachusetts Office of Technical Assistance was cited at the primary source of unbiased information relating to chlorinated solvent alternatives. The Toxics Use Reduction Institute (TURI) surface cleaning laboratory was cited at the primary venue where trial tests using alternative cleaners were performed. SAK considers both OTA and TURI as important factors in continuing education, outreach and technical assistance.

h. Virtually all participants expressed interest in a state sponsored grant or low interest loan program to finance their investigation in to chlorinated solvent alternatives.

4.2. Recommendations

The following recommendations are made based on the conclusions above:

a. Conduct a technology transfer seminar, workshop, roundtable or forum between companies that have successfully eliminated chlorinated solvents and use alternatives with companies that continue to use chlorinated solvents. Participation by successful companies is critical to establish a "manufacturing" dialog in the event. The objective of the event would be for successful companies to share their experiences, challenges, and solutions when transitioning to alternatives, including dispelling perceived barriers that may have dissuaded others from eliminating chlorinated solvents. The event should broadly target facility, manufacturing, quality and environmental mangers, and company owners where applicable. One participant company (#96) mentioned a lack of such programs in the western part of the state.

b. The few major customer groups (i.e. defense, automotive, aerospace) who mentioned the use of chlorinated solvents for cleaning is specified in their contracts indicates there is an administrative barrier to transitioning to alternatives for some companies. Such requirements may be either arcane specifications from old contracts or recent requirements that are inconsistent with general environmental policies associated with such industries. Government agencies and companies in the defense, automotive and aerospace industries for the most part are considered to be leaders in environmental policy. Not specifying the use of chlorinated solvents in vendor contracts would remove an administrative barrier to investigating alternatives by suppliers. Outreach to environmental, manufacturing, quality,

and procurement managers would be necessary to initiate change in which the way cleaning specifications are written and/or negotiated.

c. Additional investigation should be performed to identify those oils and residues for which alternative cleaning processes are the most effective. Use of such material in the metal forming and electronics industries would improve the feasibility of companies to investigate and implement alternatives to chlorinated solvents.

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TABLES

Table 1

Inventory of targeted companies for survey	
61	= Companies provided by OTA
-2	= Duplicate entries in database
-1	= Company out of business
-2	= Companies had no working telephone or was not listed in the online SuperPages.com
56	= Number of eligible companies to contact
-1	= Company that never used chlorinated solvents
-1	= Company that doesn't use chlorinated solvents and doesn't have an employee that can discuss past use
-4	= Companies that wanted to complete the survey in writing via fax or e-mail, but did not respond before publication of this data
-20	= Companies that were contacted by telephone and did not respond before publication of this data
30	= Number of companies that completed the survey
54%	= Completion rate of eligible companies

Table 2

	Participant Companies by Industry Group		
SIC Group	**Description**	**# of Companies**	**Company IDs in Group**
34	Fabricated Metal Products/Except Machinery and Transportation Equipment	13	3,11,16,37,44,63,68,77,80,90,96,101,108
36	Electronic and Electrical Equipment and Components/except computers	6	4,6,30,31,54,87
38	measuring and controlling instruments	3	39,41,52
33	Primary Metal Industries	2	12,32
37	Transportation Equipment (both of these are aircraft components)	2	10,92
38	Miscellaneous Manufacturing (both of these are jeweled ornamental)	2	43,49
32	stones, clay, glass, and concrete products	1	5
28	chemicals and allied products	1	76
	TOTAL	30	

Table 3A

List of motivations for companies that have eliminated chlorinated solvents					
	company ID# cited	company IDs in this group	number of responses	total in group	% citing motivator
Regulations	4,16,30,31,41,54,101	4,6,16,30,31,41,54,77,101	7	9	78%
Environmental H&S	4,6, 41,54,77	4,6,16,30,31,41,54,77,101	5	9	56%
Cost efficiency	6,30	4,6,16,30,31,41,54,77,101	2	9	22%
Management	16,77	4,6,16,30,31,41,54,77,101	2	9	22%
Customer Requirements	31	4,6,16,30,31,41,54,77,101	1	9	11%
Equipment upgrades needed anyway		4,6,16,30,31,41,54,77,101	0	9	0%
considering outsourcing		4,6,16,30,31,41,54,77,101	0	9	0%
Notes:	1. The same company can respond in more than 1 category				

Table 3B

List of motivations for companies that have reduced chlorinated solvents					
	company ID # cited	company IDs in this group	number of responses	total in group	% citing motivator
Cost efficiency	10,39,80,90,92,96,108	10,32,39,63,68,76,80,87,90,92,96,108	7	12	58%
Regulations	32,68,76,80,92,108	10,32,39,63,68,76,80,87,90,92,96,108	6	12	50%
Environmental H&S	10,68,76,80	10,32,39,63,68,76,80,87,90,92,96,108	4	12	33%
Customer Requirements	76,80,87	10,32,39,63,68,76,80,87,90,92,96,108	3	12	25%
Management	32, 39,87	10,32,39,63,68,76,80,87,90,92,96,108	3	12	25%
Equipment upgrades needed anyway	32,39,63	10,32,39,63,68,76,80,87,90,92,96,108	3	12	25%
considering outsourcing		10,32,39,63,68,76,80,87,90,92,96,108	0	12	0%
Notes:	1. The same company can respond in more than 1 category				

Table 3C

List of motivations anticipated by companies that have not reduced or eliminated chlorinated solvents					
	company ID # cited	company IDs in this group	number of responses	total in group	% citing motivator
Regulations	3,5,37,49,52	3,5,11,12,37,43,44,49,52	5	9	56%
Cost efficiency	3,12,37,52	3,5,11,12,37,43,44,49,52	4	9	44%
Environmental H&S	3,11,37,52	3,5,11,12,37,43,44,49,52	4	9	44%
Customer Requirements	44	3,5,11,12,37,43,44,49,52	1	9	11%
need to upgrade equipment or change process soon anyway	43	3,5,11,12,37,43,44,49,52	1	9	11%
considering outsourcing	43	3,5,11,12,37,43,44,49,52	1	9	11%
Management		3,5,11,12,37,43,44,49,52	0	9	0%
Notes:	1. The same company can respond in more than 1 category				

Table 4A

List of barriers for companies that have eliminated chlorinated solvents					
	company ID # cited	company IDs in this group	number of responses	total in group	% citing obstacle
maintaining quality	4,16,30,31,41,54,101	4,6,16,30,31,41,54,77,101	7	9	78%
extra process time required for new system	16,31,41,54,77,101	4,6,16,30,31,41,54,77,101	6	9	67%
additional cost	4,6,41	4,6,16,30,31,41,54,77,101	3	9	33%
employee training needs	6,101	4,6,16,30,31,41,54,77,101	2	9	22%
specific customer requirements	30	4,6,16,30,31,41,54,77,101	1	9	11%
space required for alternate	77	4,6,16,30,31,41,54,77,101	1	9	11%
ability to use existing custom equipment	4	4,6,16,30,31,41,54,77,101	1	9	11%
management cooperation		4,6,16,30,31,41,54,77,101	0	9	0%
unique process/product		4,6,16,30,31,41,54,77,101	0	9	0%
lack of proven alternative		4,6,16,30,31,41,54,77,101	0	9	0%
lack of in house expertise		4,6,16,30,31,41,54,77,101	0	9	0%
too busy to look into alternatives		4,6,16,30,31,41,54,77,101	0	9	0%
waste management issues		4,6,16,30,31,41,54,77,101	0	9	0%
Notes:	1. The same company can respond in more than 1 category				

Table 4B

List of barriers for companies that have reduced chlorinated solvents					
	company ID # cited	company IDs in this group	number of responses	total in group	% citir obstac
maintaining quality	10,32,39,68,80,87,90,92,96,108	10,32,39,63,68,76,80,87,90,92,96,108	10	12	83
additional cost	32,63,68,76,80,90,96	10,32,39,63,68,76,80,87,90,92,96,108	7	12	58
specific customer requirements	10,76,90,92	10,32,39,63,68,76,80,87,90,92,96,108	4	12	33
employee training needs	80,92,108	10,32,39,63,68,76,80,87,90,92,96,108	3	12	25
unique process/product	32,80	10,32,39,63,68,76,80,87,90,92,96,108	2	12	17
lack of proven alternative	39	10,32,39,63,68,76,80,87,90,92,96,108	1	12	8
extra process time required for system	63	10,32,39,63,68,76,80,87,90,92,96,108	1	12	8
limited space	92	10,32,39,63,68,76,80,87,90,92,96,108	1	12	8
waste management issues	68	10,32,39,63,68,76,80,87,90,92,96,108	1	12	8
management cooperation		10,32,39,63,68,76,80,87,90,92,96,108	0	12	0
lack of in house expertise		10,32,39,63,68,76,80,87,90,92,96,108	0	12	0
too busy to look into alternatives		10,32,39,63,68,76,80,87,90,92,96,108	0	12	0
ability to use existing custom equipment		10,32,39,63,68,76,80,87,90,92,96,108	0	12	0
Notes:	1. The same company can respond in more than 1 category				

Table 4C

List of barriers anticipated by companies that have not reduced or eliminated chlorinated solvents					
	company ID # cited	company IDs in this group	number of responses	total in group	% citing obstacle
maintaining quality	3,5,11,12,37,43,44,49,52	3,5,11,12,37,43,44,49,52	9	9	100%
additional cost	5,11,12,52	3,5,11,12,37,43,44,49,52	4	9	44%
lack of proven alternative	37,49	3,5,11,12,37,43,44,49,52	2	9	22%
management cooperation	49	3,5,11,12,37,43,44,49,52	1	9	11%
specific customer requirements	5	3,5,11,12,37,43,44,49,52	1	9	11%
unique process/product	37	3,5,11,12,37,43,44,49,52	1	9	11%
too busy to look into alternatives	3	3,5,11,12,37,43,44,49,52	1	9	11%
process time for new system	43	3,5,11,12,37,43,44,49,52	1	9	11%
waste management issues	12	3,5,11,12,37,43,44,49,52	1	9	11%
lack of in house expertise		3,5,11,12,37,43,44,49,52		9	0%
employee training needs		3,5,11,12,37,43,44,49,52		9	0%
space required for alternate		3,5,11,12,37,43,44,49,52		9	0%
ability to use existing custom equipment		3,5,11,12,37,43,44,49,52		9	0%
Notes:	1. The same company can respond in more than 1 category				

Table 5A

Average conditions for companies that have eliminated chlorinated solvent use

company ID #	pounds of chlorinated solvent used a year prior to elimination	notes #	# of employees
4	49,400	1	250
6	11,312	1	100
16	16,857	1	45
30	38,078	2	195
31	1,229	1	45
41	19,096	3	300
54	65,090	2	150
77	130,000	1	766
101	9,999	4	40
AVERAGE =	**37,896**		**210**

Notes:

1. Quantities of solvent indicated by respondent in gallons was converted to pounds by SAK where the specific gravity of individual solvents was obtained from Material Safety Data Sheets available on the internet. S.G. are as follows:
   Trichloroethylene = 1.47
   Perchloroethylene = 1.62
   Methylene Chloride = 1.32
   1,1,1-Trichloroethane = 1.34
   and the density of water = 8.34 pounds per gallon.
2. Quantity taken from MADEP TURA "1990 Extract File"
3. Quantity taken from MADEP TURA "1995 Extract File"
4. Quantity assumed to be 9,999 lbs. and not subject to TURA reporting.

Table 5B

Average conditions for companies that have reduced chlorinated solvent use

company ID#	pounds of chlorinated solvent used prior to reduction	notes #	pounds of chlorinated solvent used following reduction in year 2004	notes	# of employees
10	10,000	4	4,800	1	165
32	50,284	2	7,431	1	400
39	25,000	1	2,000	1	80
63	17,000	1	1,056	1	25
68	10,560	2	4,000	1	28
76	30,000	2	325	1	80
80	9,999	3	5,000	1	65
87	200,000	1	10,000	4	1500
90	700	1	600	1	30
92	20,000	1	9,999	3	75
96	8091	1	140	1	10
108	1,800	2	1,349	1	28
AVERAGE=	**31,953**		**3,892**		**207**

Notes:

1. Quantities of solvent indicated by respondent in gallons was converted to pounds by SAK where the specific gravity of individual solvents was obtained from Material Safety Data Sheets available on the internet. S.G. are as follows:
   - Trichloroethylene = 1.47
   - Perchloroethylene = 1.62
   - Methylene Chloride = 1.32
   - 1,1,1-Trichloroethane = 1.34

   and the density of water = 8.34 pounds per gallon.
2. Quantity taken from MADEP TURA "1990 Extract File"
3. Respondent indicated somewhat more than 5,000 or less than 10,000 was used, so 9,999 lbs. assumed.
4. Respondent didn't have exact number but reported it was over 10,000 lbs.

Table 5C

Average conditions for companies that have not reduced or eliminated chlorinated solvents						
company ID#	pounds of chlorinated solvent used in year 2004	# of employees				
3	1,349	6				
5	5,400	170				
11	1,226	150				
12	1,167	18				
37	1,200	20				
43	3,359	30				
44	4,046	6				
49	674	300				
52	24,520	700				
AVERAGE =	**4,771**	**156**				
Notes:	1. Quantities of solvent indicated by respondent in gallons was converted to pounds by SAK					
	where the specific gravity of individual solvents was obtained from Material Safety					
	Data Sheets available on the internet. S.G. are as follows:					
	Trichloroethylene = 1.47					
	Perchloroethylene = 1.62					
	Methylene Chloride = 1.32					
	1,1,1-Trichloroethane = 1.34					
	and the density of water = 8.34 pounds per gallon.					

Table 5D

PARTICIPANT COMPANIES BY INDUSTRY GROUP COMPARED TO SOLVENT USAGE STATUS						
SIC Group	**Description**	**# of Companies**	**Company IDs in Group**	**Eliminated**	**Reduced**	**Neither**
34	Fabricated Metal Products/ Except Machinery and Transportation Equipment	13	3,11,16,37,44,63 ,68,77,80,90,96, 101,108	16,77,101	63,68,80, 90,96,108	3,11,37,44
36	Electronic and Electrical Equipment and Components/ except computers	6	4,6,30,31,54,87	4,6,30,31,54	87	
38	measuring and controlling instruments	3	39,41,52	41	39	52
33	Primary Metal Industries	2	12,32		32	12
37	Transportation Equipment (both of these are aircraft components)	2	10,92		10,92	
38	Miscellaneous Manufacturing (both of these are jeweled ornamental)	2	43,49			43,49
32	stones, clay, glass, and concrete products	1	5			5
28	chemicals and allied products	1	76		76	
	TOTAL	30				

Table 6

Sources of Information on Chlorinated Solvent Alternatives				
	company IDs citing source	# responses	Total Sample	% citing source
Mass OTA	4,5,6,10,12,16,30,31,37,41,43,49,52,54,68,77,80,90,92	18	30	60%
Vendor Assistance	4,5,6,10,11,12,16,31,32,37,41,44,54,76,80,108	16	30	53%
Toxics Use Reduction Institute	4,10,16,39,43,44,49,77,108	9	30	30%
Industry Trade Associations	16,30,31,32,39,49,54	7	30	23%
Private Consultants	3	1	30	3%
USEPA Performance track	30	1	30	3%
Notes:	1. The same company can respond in more than 1 category			

Table 7

LIST OF TECHNICAL ISSUES, SOLUTIONS, AND SUGGESTIONS	
Technical issues relating to quality of degreasing with alternatives to chlorinated solvents	
Company ID#	Detail
6	Revised method of racking to improve drainage improved cleaning
10, 30, 31, 43, 44, 54	Alternative leaves residue
32, 52, 92	Parts that will function electronically or that will be coated were not sufficiently cleaned with alternative
12, 39	Plastic parts can absorb alternative cleaners, which is unwanted
16, 31, 41	Increased drying time required
12, 39, 49	Difficult drying in small, deep, or blind holes
Technical solutions that provided for successful use of alternatives	
Company ID#	Detail
4	"Made product change on oil that coated part to improve effectiveness of alternative cleaner"
87,90	"Made changes to manufacturing to reduce the use of lubricating oils on parts to be cleaned"
77	"Switched to non-chlorinated solvent (i.e. Acetone) and built explosion proof room to air dry parts"
Suggestions for assisting in reducing chlorinated solvent use:	
Company ID#	Detail
92	"Reduce federal government specifications requiring use of chlorinated solvent.
	Sometimes alternatives would work just as well, but they'd be off specification."
68	"Help standardize oils used in machine tooling. A wide variety of oils are used
	and trichloroethylene is the only thing that gets them all off."

APPENDIX A
SURVEY QUESTIONNAIRE TEMPLATE

SAK Environmental, L.L.C.

Final Questionnaire Survey
Barriers to Reducing or Eliminating Chlorinated Solvent Use

This questionnaire was conducted by SAK Environmental, LLC on behalf of OTA. Participants were interviewed by telephone. The purpose of the questionnaire was to collect information regarding the company's use of chlorinated solvent cleaners, identification of barriers that may be preventing reduction or elimination, and solutions to overcome barriers for company's that have successfully reduced or eliminated chlorinated solvent use. The questions below are specific, but it is intended to collect responses from a free-flowing conversation from participants.

1. Company Profile

Company name:	
Address:	
Telephone:	
Person Interviewed:	
Title:	
Years at company:	
Date of Interview:	
Primary business activity:	
Standard Industrial Classification (SIC) code:	
Total number of employees:	
Days of operation, # of shifts:	

2. Profile Of Chlorinated Solvent Use

Do you currently use chlorinated solvents? (If yes, continue survey. If no, but used in the past continue survey. If never used solvents, end survey.)	
What solvent(s) are used?	
How is/was solvent cleaning performed (vapor degreaser, cold dip, aerosol, rag wiping)?	
At how many locations in the facility is/was chlorinated solvent cleaning performed?	
How many people perform(ed) cleaning in each shift, total in company?	
What was the quantity of chlorinated solvent purchased in CY2004?	
Is your facility required to implement a Toxics Use Reduction Plan (TURP)?	
Are chlorinated solvents used at the facility subject to TUR planning?	
Is your facility ISO 14001 registered?	

3. Challenges To Reducing/ Eliminating Chlorinated Sovlent Use For Companies That Have *Not Done So*

If your company has not reduced or eliminated use of chlorinated solvents, what will prompt the effort/interest? For example: - Cost, regulations, customer requirements, management, other. Explain.	
If your company has not reduced or eliminated use of chlorinated solvents, indicate the challenges. For example: - Support and cooperation from management. - Maintaining product quality. - Customer would not allow change. - Unique process or product. - Lack of proven options for alternative technologies/products. - Lack of in-house expertise to modify process or product. - Training employees. - Cost. - No time. - Other. Explain in detail. What to do consider the top 3 challenges?	

If your company has not reduced or eliminated use of chlorinated solvents, have you sought outside assistance to do so or to track alternative and/or emerging technologies? From: – Massachusetts OTA. – Toxics Use Reduction Institute. – Industry trade associations. Who and specify assistance. – Private consultants. – Chemical or equipment vendor services. Specify vendor and assistance. Explain. If not, why?	
If no technical solution available now, are you watching any particular emerging technology? What?	
If outside funding were available, would your company consider a grant or low interest loan?	
If technical solution identified, but cost is prohibitive, would a reduced solvent using system that provides energy (cost) benefits solve the cost barrier?	
Additional significant information by subject company not addressed in this section.	

4. Challenges To Reducing/ Eliminating Chlorinated Sovlent Use For Companies That Have *Successfully Done So*

If your company has already reduced or eliminated use of chlorinated solvents, what prompted the effort/interest? For example: - Cost, regulations, customer driven, cleaner environment policy, other. What was the biggest driver for change? Explain.	
If your company has already reduced or eliminated use of chlorinated solvents, When did that occur? How much solvent use did you reduce or eliminate per year? What process or produce did you use as the alternative?	
If your company has already reduced or eliminated use of chlorinated solvents, indicate the challenges and the solutions. For example: - Support and cooperation from management. - Maintaining product quality. - Customer would not allow change. - Unique process or product. - Lack of proven options for alternative technologies/products. - Lack of in-house expertise to modify process or product. - Training. - Cost. - No time. - Other. Explain. What were the top 3 challenges?	

If your company has already reduced or eliminated use of chlorinated solvents, did you rely on outside assistance for direct assistance or to track emerging technologies from: - Massachusetts OTA. - Toxics Use Reduction Institute. - Industry trade associations. Who and specify assistance. - Private consultants. - Chemical or equipment vendor services. Specify vendor and assistance. Explain. If not, how did you identity the reduced solvent system.	
If your company has already reduced or eliminated use of chlorinated solvents, were there: Any changes or problems with cleaning quality? Changes in process time? A cost savings?	
If your company has reduced, but could not eliminate use of chlorinated solvents, explain why. Are there plans to eliminate?	
Did you use outside funding from a grant or low interest loan? If yes, specify.	
Did the alternative system offer a reduced energy consumption benefit? If yes, did the cost savings significantly justify putting a reduced solvent system in place?	
Additional significant information by subject company not addressed in this section.	

5. <u>OTHER</u>

Is there any other information you'd like to add that was not addressed above?	