Background and Issues Paper for Marine Science and Technology Group Meeting

The Commonwealth of Massachusetts | *Office of Technical Assistance* | *Executive Office of Environmental Affairs*

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1/3/06

Executive Summary

There are 300 establishments that participate in the Marine Science and Technology (MS&T) industry in Massachusetts. With sales of $3.3 billion and 18,000 workers this has grown into a robust industry sector in recent years. In 2005, The Office of Technical Assistance began a project to determine if it is possible to reduce regulatory barriers for companies in this growing industry. The project has three phases. The first was to identify and characterize establishments in the sector. The second was to survey state and federal databases for participation by these establishments in several common environmental programs. The third and final phase will be to convene a focus group representative of the industry to discuss needs of the industry in this area and get feedback on several possible ways these needs could be met.

Of the five subsectors identified in a previous study of the New England MS&T industry, two are dominant in the Massachusetts MS&T industry – marine services and marine instrumentation & equipment (MIE). MIE employs half of the MS&T workers in Massachusetts and is more likely to use lead and other toxic materials. For these reasons, OTA is interested in learning more about this subsector.

Additionally, establishments have been classified by whether or not a majority of their business is in the MS&T industrial sector. About 40% of the establishments identified have marine science & technology as their "core" business. To some extent this group may contain more of the smaller the "start-ups". The other 60% of establishments are "partially" involved in the MS&T industry. They have multiple products/markets and tend to be larger, perhaps more mature entities. A focus group could help to determine how the needs "core" establishments differ from the "partial" establishments.

OTA surveyed several databases to determine which establishments participate in any or several of five regulatory programs – TURA, TRI, Tier II, Hazardous Waste, and Air Emissions. (Wastewater was excluded because these records tend to be kept at the localities.) Most of the program participation is from establishments in the manufacturing SICs, particularly electrical and electronic equipment (36 and 38). Ten establishments were found to use Lead and/or Lead Compounds above the regulatory thresholds for reporting. About ¼ of the MS&T establishments are in these two SICs. There are several reasons for convening a focus group, one of which would be to learn if the lower level of regulatory participation by the "core" group of establishments is due to educational needs or if their environmental footprint is not yet sufficiently large to participate in these programs. It is also expected that the establishments with electrical components in their products want to and need to learn more about how best to adapt to the new international restrictions and regulations on products that now contain Lead and other toxics.

1. Introduction

MS&T Industry - The Marine Science and Technology (MS&T) has grown into a robust industry sector in the New England area within recent years. The sector employed over 55,000 thousand people in this region and generated nearly 8 billion dollars of sales in 2004. Massachusetts is home to almost two-thirds of the region's nearly 500 firms and has been ranked consistently among the top ten states nationwide in terms of business, employment and sales[1].

To support the continual growth and to reduce the environmental barriers and liabilities impeding the growth, it is the intent of the Massachusetts Executive Office of Environmental Affairs - Office of Technical Assistance (**OTA**) to hold a focus group meeting with manufacturers and suppliers of marine science and technology in this region. Although not yet in effect, the European Union's RoHS (Restriction on Use of Certain Hazardous Substances) and WEEE (Waste from Electrical and Electronic Equipment) directives are already having a dramatic impact. RoHS bans the use of cadmium, mercury, hexavalent chromium, polybrominated diphenyls, polybrominated diphenyl ethers, and lead. Of the substances, lead is the most pervasively targeted substance and has received the most attention. The metal plays a critical role in the assembly of electronics and is the most challenging of substances to be removed from the production lines.

The Marine & Oceanographic Technology Network (**MOTN**) and the Advanced Technology & Manufacturing Center at the University of Massachusetts - Dartmouth (**ATMC**) are engaged to assist OTA with this project. The goal of this project is to identify the environmental challenges and regulations that the MS&T industry faces as well as services that OTA can provide to enhance the competitiveness of the Massachusetts MS&T industry globally.

OTA - The Massachusetts Office of Technical Assistance is a non-regulatory branch of the Executive Office of Environmental Affairs (EOEA). OTA has a staff of nearly 20 including engineers and chemists to help manufacturers and industrial facilities find ways to reduce or eliminate their use of toxics and generation of hazardous byproducts.

OTA promotes pollution prevention and environmental compliance through comprehensive on site assistance and a range of outreach and education services. The office also partners with industry, universities, government agencies and others to identify, evaluate and promote innovative pollution prevention technologies and practices.

MOTN - Since 1995, the mission of Marine & Oceanographic Technology Network (MOTN) has been to employ a collaborative strategy to foster the economic & technological success of its member companies. MOTN member organizations are primarily engaged in the advancement of marine science & technology for undersea defense, ocean research and commercial oil & gas exploration and trans-oceanic telecommunications applications.

Over the past 10 years, MOTN has established itself as a successful and unique industry collaborative, geared toward improving both the economic and technological positions of its New England regional members. MOTN's diverse membership, consisting of over 75 academic, government and industrial organizations, provides the network with a very diverse and broad-based menu of options relating to economic expansion and technological

development. MOTN continues to grow and its members continue to benefit from this broad-based perspective, through a variety of shared organizational initiatives and sponsored events.

ATMC - The Advanced Technology & Manufacturing Center at the University of Massachusetts - Dartmouth is a 60,000 sq.-ft. facility with three major functions. First , the ATMC hosts and supports small, start-up venture companies. In that role, the ATMC provides space, technical expertise, support services specialized labs, and interns to help new high-tech business prosper. Second, the ATMC engages in research related to military and industrial projects. In that role, the ATMC has specialized laboratories, support staff, science and engineering faculty, and graduate and undergraduate students to work on these products and process design and engineering projects. Third and finally, the ATMC provides cost effective meeting and conferencing space to local businesses for meetings and presentations that range from four people to two hundred people. Among the eight specialized labs, the environmental chemistry lab will actively participate in this project.

2. Purpose

The goal of the focus group meeting is to initiate a discussion of key environmental issues faced by marine science and technology providers for the purpose of assisting OTA in:

1) Identifying the environmental challenges and opportunities associated with the design, manufacture and sale of the marine science and technology products and services;
2) Evaluating the impact of the implementation of WEEE and RoHS directives on U.S. marine science and technology industry;
3) Discussing the opportunities to streamline regulatory compliance in the U.S. and MA;
4) Identifying the types of services that OTA can provide to reduce the use of toxic chemicals in the marine science and technology industry.

3. The Marine Science & Technology Industry in MA

The marine science & technology sector in Massachusetts consists of a diverse range of industries and technologies, employing people from across the New England region who produce items as basic but essential as communications antennas and chain and rope for commercial fishing and as advanced and critical as undersea robotics and stabilized sensor systems for military and other uses.

Recently, a comprehensive study of the marine science & technology industry was accomplished by researchers at the University of Massachusetts Donahue Institute[1]. The study was the first time that the industry was formally quantified, classified and analyzed as a true technology cluster.

From an economic standpoint, the study found that Massachusetts is home to 298 establishments involved to some degree in marine science & technology. These establishments employ over 18,000 workers and realize annual sales of ~$3.3 billions.

[1] *The Marine Science and Technology Industry in New England,* Clyde Barrow, Rebecca Loveland, David Terkla, University of Massachusetts Donahue Institute, 2005

Because sectors of the marine science and technology industry do not have their own exclusive SIC or NAICS codes the Donahue research team also identified five primary sub sectors or categories of the MA marine science and technology cluster. These include:

A. Marine Instrumentation and Equipment (MIE):

This category contains firms producing cutting-edge marine equipment, such as transducers, various meters, remote sensing equipment, fiber optic and GPS systems, a variety of sensors and underwater power sources and generating equipment.

- Oceanographic and geophysical measuring instruments, such as magnetometers and current meters;
- Acoustics for underwater remote sensing, imaging and positioning;
- Electronics for marine instruments and platforms, which enable sensing, imaging, positioning and other instruments to function in extreme underwater conditions;
- Electronics for marine navigation and communications, which enable onboard, under and above water navigation and communication, including GPS systems and fiber optic systems to allow Internet-based communications relays.

B. Marine Services (MS)

This category contains a wide variety of marine engineering and consulting firms, marine monitoring systems, floating research facilities and marine security and/or defense firms.

- Commercial marine research and consulting, which covers marine-related technical services, including applied research; design and engineering; testing and evaluation; GIS and other mapping services.
- Software and systems design for marine monitoring and operations

C. Marine Research, Education and Technology Transfer (MRE)

This category consists mainly of higher education institutions and a variety of research institutes and consulting groups, working in areas such as:

- Marine research and consulting, including applied ocean physics and engineering, marine chemistry and geochemistry and physical oceanography;
- Marine education;
- Industry and technology transfer groups.

D. Marine Materials and Supplies (MMS)

This includes much of the material input for marine activities, such as paints, engines, riggings, machinery, composites and coatings, mooring systems and packing and crating.

E. Shipbuilding and Design (SBD)

This category includes major defense-related shipbuilding operations.

4. General Characterization: SIC Identification

Of the 298 Massachusetts establishments that were identified as having some involvement in the marine science and technology industry, only 135 were shown to be involved in the industry in a core capacity. Of these 135 establishments, 129 were successfully classified by SIC 4-digit SIC codes. A summary of the number of companies involved in each of the 59 individual SIC's represented is contained in Appendix 1. Based on the research, the majority of Massachusetts' MS&T firms are in the Electronic Equipment (SIC 36) and electronic assembly, and Measuring, Analyzing, and Controlling Instrument (SIC 38) sectors.

5. Environmental Issues of MS&T Industry and Supply Chains

Manufacturers in the SIC 36 and SIC 38 sectors are involved in activities such as crystal preparation, wafer fabrication, cleaning, assembly, electroplating, electro-less plating, imaging, soldering, masking, and coating. Background information along with the environmental issues and challenges relevant to these processes will be presented to the focus group meeting to foster the discussion among the participants.

A. **Lead and lead-containing solders** – Traditionally, tin-lead solder coating is added to printed circuit board (PCB) and component leads before assembly. The solder coating involves dipping the panel into molten solder or electroplating solution. After the PCBs are manufactured, the electrical components are attached during assembly. Adhesives are applied to the boards, and then the components are attached and soldered to the board. The solder usually consists of 63% tin and 37% lead. With the increasing pressure from European Union to ban the use of lead and other toxic substances, US manufacturers should be prepared to find alternatives to the tin-lead solders and master the technologies to use them.

B. **Lead-free alternatives** – Alternative technologies to tin-lead solders are categorized into two main groups: non-lead solders and electrically conductive adhesives. One of the biggest challenges with those non-lead solders is the reflow temperature. The high reflow temperatures of high tin groups can compromise the integrity of the components during assembly. On the other hand, lower reflow temperatures of indium and bismuth alloys can result in unwanted reflow during service in high temperature applications. Since the majority of the conductive adhesives are epoxies, they are attractive from a durability point of view. However, these materials have a reputation of unstable conductivity at the interconnection junctions.

Questions Massachusetts-based manufacturers need to ask themselves about electronic assembly using lead-based solder

1. *Is your company aware of the new EU regulations prohibiting the import of electronic equipment manufactured with tin-lead solder?*
2. *What lead-free alternatives are available in the marketplace and how are they different from current manufacturing processes?*

3. *How mature and reliable are those alternative technologies? What is the economic impact of compliance to new alternative soldering processes?*
4. *Can alternatives be treated as "drop-ins" to the process or will they require modifications to equipment and component specifications?*
5. *Is progress being made toward improving the performance of the conductive adhesives?*
6. *What is the international definition of lead-free and how do I certify my products and my suppliers to be lead-free?*

C. **Organic solvents and VOCs** – Organic solvents have been used extensively in photolithography, cleaning, and drying. Many have toxicity and flammability issues and contribute to changes in atmospheric ozone. The emissions and controls for these chemicals have been stated in great detail in major environmental regulations for air, water, and waste.

Questions Massachusetts-based manufacturers need to ask themselves about organic solvents and VOCs

1. *What are available techniques and technologies to control VOC (volatile organic compounds) emissions?*
2. *What halogenated solvents are used in manufacturing marine technology equipment?*
3. *What is the common practice for electronic manufacturers to handle spent organic solvents?*

D. **Electronic scrap** – WEEE (Waste Electronic and Electrical Equipment) Directive mandates that companies selling electrical and electronic equipment to the European Union (EU) arrange and pay for the collection, treatment, recycling, recovery and disposal of electronic scrap starting as early as August 2005.

Questions Massachusetts-based manufacturers need to ask themselves about electronic scrap

1. *With perhaps a third of sales by the Massachusetts MS&T industry to foreign markets, does the directive pose a problem to the Massachusetts MS&T industry? As producers of components or sub-assemblies? As producers of finished products? For distribution channels used for the EU or other markets?*
2. *How do I dispose of electronic scrap and does my disposal method comply with EPA State of Massachusetts and local environmental regulations?*
3. *What are my company's plans for compliance with new EU and pending state and federal electronic scrap disposal regulations?*

E. **Federal Environmental Statutes and Regulations** – Under the Clean Air Act (CAA), the National Ambient Air Quality Standards (NAAQS) have been established for six pollutants. The standard for ozone is the only one that impacts the electronics industry. While the electronics industry is not a major source of ozone, it is a significant source of regulated VOCs that contribute to the formation of ozone.

Under Clean Water Act (CWA), the National Pollution Discharge Elimination System (NPDES) permit program regulates the discharge of pollutants to the waters of the US. The electronic manufacturing facilities may need to test for any of 126 priority pollutants listed in 40 CFR 122, Appendix D. The priority pollutants likely to be discharged by facilities in the electronics industry include copper, lead, lead compounds, silver, chromium, and trichloroethylene. Massachusetts strictly regulates discharges to ground and local wastewater authorities regulate discharges to sewer.

Another federal law that affects the practice of electronic industry is the Resource Conservation and Recovery Act (RCRA). Many wastes generated by the electronics industry are considered RCRA toxicity characteristic hazardous waste due to constituents such as silver, trichloroethylene and lead.

Questions Massachusetts-based manufacturers need to ask themselves about compliance with Federal statutes and regulations

1. *Is there technical assistance available from the Commonwealth of Massachusetts to assist my company in complying with environment regulations?*
2. *Does my company have suggestions to streamline the compliance procedure or to reduce the cost of doing business in Massachusetts?*

F. **Pollution Prevention** – Several federal laws and regulations affect decisions regarding pollution prevention, with the most influential being Pollution Prevention Act of 1990, Emergency Planning and Community Right-to-Know Act (EPCRA, also known as SARA Title III), the Resource Conservation and Recovery Act, and the Clean Water Act. A major component of EPCRA is the requirement for an annual report of all routine releases of any of some 320 toxic chemicals into the air, water, or soil. These data are compiled by the community and the state and published annually as the Toxic Release Inventory (TRI). Lead, chrome, plastisizers, flame retardents, and halogenated solvents are listed TRI materials[2].

Massachusetts is one of the states that have passed laws to incorporate aspects of pollution prevention into RCRA and EPCRA reporting requirements. Generally, these laws require industrial facilities that use or generate materials listed in either EPCRA or CERCLA to develop a source reduction and waste minimization plan, including an implementation schedule, and to track and report reduction progress.

G. **WEEE and RoHS Directives** (Substances, Product Categories, Schedules)
The European Union is leading the campaign to ban the use of a list of toxic substances, including cadmium, mercury, hexavalent chromium, polybrominated diphenyls, polybrominated diphenyl ethers, and lead, in electronics and other related industries by passing the WEEE and RoHS directives. The directives were agreed on February 13th, 2003. By October 2004, a draft of the regulations and a non-statutory guidance were published. A timetable is set to achieve the goal in three and a half years. By the end of the summer in 2005, regulations for WEEE and RoHS to be made

[2] http://www.epa.gov/tri/

final. By January 2006, producer responsibility for financing commences alongside retailer take-back. RoHS substance ban commences July 1st, 2006, and by December 31st collection and recycling targets are to be achieved.

The precedent of WEEE and RoHS have triggered legislative activities in all major industrial regions to address management, reporting or elimination of hazardous substances and electronics waste collection and treatment.
Industry experts estimate that U.S. could lose approximately $240 billion over three years if the U.S. does not respond to these initiatives quickly and completely by identifying viable alternative solders that perform well and pose fewer environmental risks.

Questions Massachusetts-based manufacturers need to ask themselves about WEEE and RoHS directives

1. Are there RoHS equivalent legislative initiatives in MA or the U.S.?
2. How does the implementation of WEEE and RoHS affecting the Massachusetts MS&T industry?
3. Is the Massachusetts MS&T industry ready for the challenge?

H. **Defense Industry Perspective** – As more commercial suppliers adapt "green" technologies, chances of lead-free materials technologies finding their way into defense equipment will increase significantly. There will be questions as to the functionality and reliability of alternative interconnection technologies under harsh service and storage conditions. The literature contains an abundant amount of data on the reliability of tin-lead solder. However, relatively little data exists for any of the alternative non-lead materials.

The U.S. Department of Defense has banned the use of chromate-based coatings used for anti-corrosion and anti-fouling of metal surfaces in order to reduce the release of chromium into sea water. The Defense Industry has scrambled to find suitable non-polluting substitutes and until very recently was using compounds with chrome -3 as the chromium substitute. Additionally, titanium is used frequently in deepwater, pressure-resistant equipment housings and is often bonded to other metals or carbon-fiber materials. Bonding requires the surface of the titanium to be etched using chromate compounds, which creates toxic waste.

In both cases above, scientists at the US Navy's Naval Undersea Warfare Center (NUWC) in neighboring Rhode Island have discovered "drop-in" substitute compounds which eliminate most of, if not all, the environmental problems associated with chromium and chromates. NUWC has transferred these technologies to industry through patent licenses. These "drop-in" chemical compounds are available to DoD marine equipment manufacturers for anti-corrosion coatings and titanium bonding applications.

Suppliers of US Navy equipment have to comply with the requirements of the Shipboard Environmental Protection Program, which includes such Solid Waste Management, Ozone Depleting Substances, Pollution Prevention Afloat, Oil Pollution Abatement, Uniform National Discharge Standards, Hazardous Material Minimization

Centers, Non-Oily Wastewater, Ballast Water, Environmental Information Management, Medical Waste Management and Hazardous Material Control and Management.

The US Navy also maintains an online Authorized Users List (AUL) for the Navy's mission-critical Ozone Depleting Substances (ODS), which includes the status of conversion of fleet air-conditioning and refrigeration plants from Class I ODS to HFC-134a and HFC-236fa. The Navy continuously analyzes proposed EPA and international ODS regulations for potential adverse impact to Navy operations. The Navy's ODS reserve database includes Chlorofluorocarbons (CFCs) 11, 12 113, 114, 502, and Halons 1211 and 1301 and ODS Fleet equipment includes USN ship refrigeration and air-conditioning plants and fire suppression systems.

Questions Massachusetts-based manufacturers need to ask themselves about supplying the DoD electronic equipment for use in the ocean or on-board USN ships.

1. *How do lead-free alternatives affect qualified electronic equipment vendors to the DOD?*
2. *Does my company use chromates or chromium-based compounds for anti-corrosion or anti-fouling coatings?*
3. *Does my company bond titanium?*
4. *Is my company aware of "drop-in" substitutes for chromates for anti- corrosion and anti-fouling coatings and for titanium etching?*
5. *Are we aware and comply with US Navy environmental regulations for shipboard equipment from the USN Shipboard Environmental Protection Program?*

6. Massachusetts MS&T Companies and Regulation Compliance

In general, there are a few large companies such as Raytheon, Lockheed-Martin and L-3 Communications with divisions or subsidiaries in Massachusetts, who produce MS&T equipment but the Massachusetts MS&T Industry is comprised mostly of small-sized manufacturers producing electronic systems, sensors, navigational equipment for use in the ocean or on-board marine vessels. Appendix 3 provides the results of survey and analysis made of the number of Massachusetts marine science and technology companies, which have filed for permits in compliance with regulations such as: Toxics Use Reduction Act (TURA), Toxic Release Inventory (TRI), Resource Conservation and Recovery Act (RCRA), Tier 2 and Clean Air and Water Quality Act. In almost all of these cases, SIC 36 and SIC 38 were in the top three for greatest number of companies, employees, and revenue, leading the study to focus on their impact in MS&T most heavily. In addition, these two SIC codes reported to TURA, TRI, and RCRA most often as well as hold the majority of air and water permits in the MS&T industry. However, reporting rates were low.

Conclusions

Several databases were surveyed to determine the establishments on record as participating in any of six regulatory programs – TURA, TRI, Tier II, Hazardous Waste, Air Emissions, and

Wastewater. Data quality of TURA and TRI is good. Data for wastewater programs was scant and not easily searchable with the available databases. Data for the other three programs is acceptable quality for this level of analysis.

If all 263 establishments participated in all 5 regulatory areas (discounting wastewater) there would have been potentially 1315 (263 X 5) "program participations". The survey number was found to be 92 (e.g., 42 X 2) or 7% of the potential maximum. There is a lower participation rate by the smaller "Core" establishments. Forty percent of MS&T establishments are "Core", but they account for only 1/4 of the program participations. Overall, the highest participation rates were in the TURA, TRI and RCRA programs. As would be expected, consulting and educational SICs normally don't have a high rate of participation in these regulatory programs. There are ten establishments filing for Lead or Lead Compounds under TURA. The biggest difference between "Core" and "Partial" MS&T establishments was in the Tier II program with one and twelve participants respectively.

Most participation in these programs is from establishments in the manufacturing SICs, particularly electrical and electronic equipment (36 and 38). About ¼ of the MS&T establishments are in these two SICs. Nearly half of program participations were also from this group.

In 2006, OTA will convene a focus group. There are several reasons for convening a focus group from the industry. There are ten known users of Lead and probably several others that don't exceed the quantity or employee thresholds for reporting. These companies could benefit from learning more about technical alternatives and the developing domestic and international restrictions on Lead in products. There is also significant participation in hazardous waste programs and it would be important to learn the most pressing concerns for recycling and disposing of electronic wastes and byproducts. There is a lower level of participation in programs for air emissions, however, in recent years DEP has been inspecting and registering even the smallest painting and printing operations. Since it was difficult to obtain data on wastewater programs which are often regulated at the local level, it would be useful to learn more clearly how water is used in this unique industry and if there are common concerns that could be addressed through education or regulatory streamlining.

Appendix 1
MA Marine Science & Technology Industry SIC Summary

SIC	Industry Description	No. Establishments
28	**Chemicals & Allied Products**	
2819	Industrial Inorganic Chemicals	1
2851	Paints and Allied Products	3
30	**Rubber & Miscellaneous Plastic Products**	
3053	Gaskets; Packing and Sealing Devices	1
3089	Plastic Products	2
32	**Stone, Clay, Glass and Concrete Products**	
3271	Concrete Block and Brick	1
3296	Mineral Wool	1
33	**Primary Metal Industries**	
3316	Cold Finishing of Steel Shapes	1
3357	Non-Ferrous Wiredrawing and Insulating	2
34	**Fabricated Metal Products Except Machinery and Transportation Equipment**	
3429	Hardware	1
3469	Metal Stamping	1
35	**Industrial & Commercial Machinery and Computer Equipment**	
3511	Turbines and Turbine Generator Sets	1
3519	Internal Combustion Engines	1
3531	Construction Machinery	2
3545	Machine Tool Accessories	1
3559	Special Industry Machinery	1
3568	Power Transmission Equipment	1
3571	Electronic Computers	1
3572	Computer Storage Devices	1
3577	Computer Peripheral Equipment	1
3599	Industrial Machinery	1
36	**Electronic & Other Electrical Equipment & Components, Except Computer Equipment**	
3625	Relays and Industrial Controls	1
3651	Household Audio and Video Equipment	1
3663	Radio and TV Communications Equipment	3
3669	Communications Equipment	2
3674	Semiconductors and Related Devices	2
3679	Electronic Components	8
3699	Electrical Equipment and Supplies	3
37	**Transportation Equipment**	
3731	Shipbuilding and Repairing	2
3732	Boat-building and Repairing	1

Appendix 1
(continued)
MA Marine Science & Technology Industry SIC Summary

SIC	Industry Description	No. Establishments
38	**Measuring, Analyzing & Controlling Instruments; Photographic, Medical and Optical Goods, Watches and Clocks**	
3812	Search and Navigation Equipment	21
3821	Laboratory Apparatus and Furniture	2
3823	Process Control Instruments	2
3825	Instruments to Measure Electricity	4
3826	Analytical Instruments	1
3827	Optical Instruments and Lenses	1
3829	Measuring and Controlling Devices	5
3841	Surgical and Medical Instruments	2
3842	Surgical Appliances and Supplies	1
3845	Electro-medical Equipment	1
3861	Photographic Equipment and Supplies	1
50	**Wholesale Trade – Durable Goods**	
5023	Home Furnishings	1
5043	Photographic Equipment and Supplies	1
5049	Professional Equipment	2
5063	Electrical Apparatus and Equipment	1
5065	Electronic Parts and Equipment	3
5072	Hardware	1
5084	Industrial Machinery and Equipment	2
5085	Industrial Supplies	1
51	**Wholesale Trade – Non-Durable Goods**	
5162	Plastic Materials and Basic Shapes	1
5169	Chemicals and Allied Products	1
55	**Automotive Dealers & Gasoline Service Stations**	
5551	Boat Dealers	1
5731	Radio, Television and Electronic Stores	1
87	**Engineering, Accounting, Research, Management & Related Services**	
8711	Engineering Services	5
8731	Commercial Physical Research	11
8732	Commercial Non-Physical Research	2
8733	Non-Commercial Research Organizations	2
8734	Testing Laboratories	1
8742	Management Consulting Services	1
8748	Business Consulting	2

Appendix 2
Rate of Environmental Reporting by Massachusetts MS&T Companies

1. Summary and Results

The MS&T industry is separated into two groups, a collection of core companies and a collection of partial companies. (Both of these designations have been described previously). The top three SIC code groups within the core sector that have the largest number of inclusive companies and employ the highest number of people are SIC 87, SIC 38, and SIC 36 although SIC 38 employs slightly more people than SIC 87. The three largest revenue generators in the core sector are SIC 38, SIC 44, and SIC 36. In the partial sector, the top three SIC codes with the greatest number of companies and with the largest revenue are SIC 87, SIC 38, and SIC 73. SIC 36 follows close behind. SIC 38, SIC 87, and SIC 36, have the highest number of employees. All of the above SIC codes were given in decreasing order. To better illustrate:

Rank	# Core	# Core Emps.	$ Core	# Partial	# Partial Emps.	$ Partial
1	SIC 87	SIC 38	SIC 38	SIC 87	SIC 38	SIC 87
2	SIC 38	SIC 87	SIC 44	SIC 38	SIC 87	SIC 38
3	SIC 36	SIC 36	SIC 36	SIC 73	SIC 36	SIC 73
Close behind				SIC 36		SIC 36

In almost all of these cases, SIC 36 and SIC 38 were in the top three for greatest number of companies, employees, and revenue, leading the study to focus on their impact in MS&T most heavily. In addition, these two SIC codes reported to TURA, TRI, and RCRA most often as well as hold the majority of air and water permits in the MS&T industry. However, reporting rates were low.

	SIC 36	SIC 38
Core	25% - 37.5 %	5.8% - 11.7%
Partial	13.3% - 20%	4.7% - 19%

Appendix 2 (continued)
Rate of Environmental Reporting by Massachusetts MS&T Companies

SIC	Description	"App. 1" # Est	Core # Est	Core # Emps	Core Sales $ mm	Partial # Est	Partial # Emps	Partial Sales #mm
17	Contractors					2	6	0.3
28	Chemicals & Allied Products	4	1	23	3.7	3	120	21.3
30	Rubber & Misc Plastic Products	3				3	230	148.4
32	Stone,Clay,Glass,Concrete Prds	2				1	12	9.5
33	Primary Metals Industries	3				3	333	51.9
34	Fabricated Metal Products	2				3	146	22.8
35	Indus&Comm.Mach,Computers	11	4	105	22.2	9	918	296.8
36	Electronic & Electrical Equipment	20	8	285	34.8	15	1700	252.8
37	Transportation Equipment	3	2	35	3.9	1	10	1
38	Measure, Analyze, Control Equip.	41	17	699	61.8	21	5641	818.1
39	Miscellaneous Manufacturing		1	4	0.2	1	75	30
44	Water Transportation		2	152	56.0	1	6	0.1
48	Communications					1		
50	Wholesale Trade - Durables	12	9	109	20.5	6	33	7.3
51	Wholesale Trade - Non-Durables	2				1	400	
52	Building Materials					1	1	0.1
55	Automotive Dealers & Service Stations	1				1	130	
57	Home Furnishings, & Equipment	1				1	12	1.3
63	Insurance					1	3	0.6
67	Holding & Other Investment Offices		1	70	0.1			
73	Business Services		2	6	0.5	17	1040	320.8
76	Miscellaneous Repair Services		1	5	0.3			
82	Educational Services		8	85				
86	Membership Organizations		1	54				
87	Engineering,Acct,Research,Mgt	24	24	633	15.3	57	3753	919.6
89	Miscellaneous Services					3	9	1.2
	Totals	129	81	2265	219	152	14578	2904
	Master List Totals		107	2620	331	156	14605	2904
3812	Search & Navigational Instruments	21	12	449	57.3	7	4669	685

Appendix 2
(continued)
Rate of Environmental Reporting by Massachusetts MS&T Companies

SIC		Core # Est TURA	Core # Est TRI	Core # Est Tier 2	Core # Est RCRA	Core # Est Air	Core # Est Water	Partial # Est TURA	Partial # Est TRI	Partial # Est Tier 2	Partial # Est RCRA	Partial # Est Air	Partial # Est Water
17	Contractors												
28	Chemicals & Allied Products	1	1	1	1	1		1	1	1	1	1	
30	Rubber & Misc Plastic Products							1	1	1	1	1	1
32	Stone,Clay,Glass,Concrete Prds							1	1		1		
33	Primary Metals Industries							3	3	1	3	2	1
34	Fabricated Metal Products												
35	Indus&Comm.Mach,Computers					1		1	1	1	1	1	1
36	Electronic & Electrical Equipment	2	2		3	2		2	2	2	3		
37	Transportation Equipment							1	1	1			
38	Measure, Analyze, Control Equip.	1	2		1	2		4	4	3	4	2	1
39	Miscellaneous Manufacturing									1			
44	Water Transportation												
48	Communications												
50	Wholesale Trade - Durables												
51	Wholesale Trade - Non-Durables							1	1		1		
52	Building Materials												
55	Automotive Dealers & Service Stations							1	1		1		
57	Home Furnishings, & Equipment												
63	Insurance												
67	Holding & Other Investment Offices												
73	Business Services												
76	Miscellaneous Repair Services												
82	Educational Services		1										
86	Membership Organizations												
87	Engineering,Acct,Research,Mgt							1	1	1	1		
89	Miscellaneous Services												
	Totals	4	6	1	5	6	0	17	17	12	17	7	4
3812	Search & Navigational Instruments	1	1		1	2		2	2	2	2	1	1

Appendix 2
(continued)
Environmental Compliance Survey of Massachusetts MS&T Companies

2. Clarification of Appendix 3 Column Headings Above

"**App 1 Est**." is the data from the original report by the contractor MOTN which breaks down each SIC code industry
"**Core/Partial # Est**." is the number of core/partial establishments within each SIC code
"**Core/Partial # Emps**." is the number of employees within the core/partial sector for each SIC code
"**Core/Partial sales $mm"** is the amount of revenue (in millions of dollars) produced in the core/partial sector for each SIC code
"**Core/Partial # Est. TURA**" is the number of core/partial companies within each SIC code that are TURA (Toxics Use Reduction Act) filers
"**Core/Partial # Est. TRI**" is the number of core/partial companies within each SIC code that are TRI (Toxics Release Inventory) filers
"**Core/Partial # Est. Tier 2**" is the # of core/partial companies within each SIC code that are Tier 2 filers (storage of reportable quanties of listed toxics on site
"**Core/Partial # Est. RCRA**" is the number of core/partial companies within each SIC code that are RCRA (Resource Conservation and Recovery Act) filers
"**Core/Partial # Est. Air**" is the number of core/partial companies within each SIC code that are air permit holders
"**Core/Partial # Est. Water**" is the number of core/partial companies within each SIC code that are water permit holders

2. Sources of Information

The appendix was compiled using information from several different databases. The EPA website (http://www.epa.gov/enviro/html/multisystem_query_java.html) was used to access information regarding TRI and RCRA filers. TURA filers were accessed using the Massachusetts Toxics Use Reduction Act website (http://www.turi.org/turadata). Air and Water permit holders were found in the Massachusetts Department of Environmental Protection FMF database (http://dep-app-bos-007.dep.govt.state.ma.us/dephtml/epics.html).