Appendix:

ERP States Produce Results 2007 Report

December 2007

Document Number: EPA 100-R-07-008

The ERP States Produce Results 2007 Report (EPA 100-R-07-009), hereafter the "2007 Report," represents the first attempt to gather and assess data from multiple states on their Environmental Results Programs (ERPs). Although each ERP follows essentially the same measurement approach, based upon random inspections of facilities before and after self-certification, states have found a variety of different and useful ways to report their own data. A challenge for the U.S. Environmental Protection Agency (EPA) in developing this document was to tell a national story for ERP while taking into account each state's unique approach to presenting its data. EPA had to make many choices about how to present and analyze the data from states—choices that would be cumbersome to explain in the 2007 Report itself. As much as possible, EPA chose to minimize its own analysis of the data in order to allow the states' data to speak for itself. EPA focused its analyses on areas deemed helpful to telling the story of ERP and to presenting comparable data across states.

The purpose of this appendix is to provide more information about those background analyses and to present detailed information on the sources of data—which range from peer-reviewed, published findings on the Rhode Island auto body ERP to e-mail and telephone communications with state personnel. EPA hopes that this transparent approach will make the results presented in the 2007 Report more easily understood, while also highlighting issues worthy of further attention and discussion among states—especially as the States ERP Consortium endeavors to create minimum ERP reporting standards.

This appendix is organized topically, in the order in which analytical issues appear in the 2007 Report. Brief summaries of the findings associated with each topic are followed by discussions of analytic methodologies and a list of information sources. The list of information sources has detailed source-specific notes, as needed. Finally, the appendix closes with a description of EPA's approach to data collection, verification, and analysis. Provided with that description is a list of state personnel to whom EPA offered the opportunity to review and comment on the data and analyses presented in the 2007 Report, its executive summary, and this appendix.

1. Observed Average Indicator Improvement

ERPs produce a wealth of data. States utilize Environmental Business Practice Indicators (EBPIs) in order to focus their own attention on the most important performance issues. For an individual ERP, the results for each EBPI can be presented in a readily digestible, one-page format. However, EPA felt that presenting the results for all 135 EBPIs from the eight completed ERPs would be overwhelming. Consequently, EPA looked for a way to summarize the performance changes each state observed in its EBPIs. To that end, EPA developed a simple summary measure called the "observed average indicator improvement," which is intended to fairly represent the progress shown in individual ERPs. (It also might have been quite instructive to develop group compliance scores for all ERPs, similar to the Massachusetts group compliance scores, but the detailed analysis required to develop such scores after-the-fact was beyond the scope of the 2007 Report.)

Table A-1 below reiterates data shown in Table 2 of the 2007 Report, as well as some additional data provided to help users better understand the context in which EPA chose to present the observed average indicator improvement metric.

Table A-1: Observed Average Indicator Improvement in First ERP Self-Certification Cycle

State	Sector	# of Indicators	# Improving (# Significant)	# Worsening (# Significant)	# No Change, 100% Meeting Expectation	Avg. Pct. Pt. Change	Median Pct. Pt. Change	Min. Pct. Pt. Change	Max. Pct. Pt. Change
DE	Auto Body	19	17 (13)	1 (0)	1	30	27.5	-8.0	77.0
FL	Auto Repair	17	13 (7)	3 (0)	1	7	5.1	-12.6	26.7
MA	Dry Cleaners	15	5 (0)	5 (0)	5	5	-0.8	-11.1	55.0
MA	Photo Processors	8	3 (1)	2 (0)	3	12	4.0	-9.2	34.0
MA	Printers	25	17 (1)	6 (0)	2	13	9.0	-25.0	100.0
MD	Auto Body/Repair	5	4 (1)	1 (0)	0	12	16.0	-0.1	22.0
ME	Auto Body	22	18 (3)	4 (0)	0	10	6.8	-4.0	55.9
RI	Auto Body	24	19 (7)	3 (0)	2	21	16.0	-7.0	54.0
Average	**All Sectors**	**16.875**	**12 (4.125)**	**3.125 (0)**	**1.75**	**N/A**	**N/A**	**N/A**	**N/A**
TOTAL	**All Sectors**	**135**	**96 (33)**	**25 (0)**	**14**	**N/A**	**N/A**	**N/A**	**N/A**

For each state, the average percentage point improvement represents a simple average of the percentage point changes in indicator values after the first round of self-certification. For example, if 40% of facilities were in compliance with an indicator during the baseline round of random inspections and 60% in the post-certification round of inspections, the change would be 20 percentage points. A state's average is the mean of all these percentage point changes for all indicators, positive or negative.

The average excludes indicators that showed 100% performance levels at baseline and post-certification random samples, because improvement is not possible in that circumstance. All other indicators were included, even in instances in which the number of facilities was quite small, because by their nature some indicators measure characteristics common to only a small proportion of facilities.

Some of the important questions EPA considered in developing this summary performance table are discussed on the next few pages.

Why Present the Average in the 2007 Report? EPA chose to present the average (i.e., mean) percentage point improvement in the 2007 Report because it seemed to best and most easily represent the progress shown by states. Examining the median improvement is also important; the median is the point at which there are an equal number of data points whose values lie above and below that value. The median values presented in Table A-1 also largely suggest that the performance of ERP groups with regard to EBPIs has improved over time. In all but one case, the average improvement was larger (in some cases substantially) than the median. The minimum and maximum percentage point changes (also shown in the table) help shed light on why: because the absolute value of the maximum percentage point change is for all states substantially higher than the absolute value of the minimum percentage point change. Such large percentage point changes may represent a substantial environmental impact, even if associated with just a limited number of indicators.

Why Utilize All Observed Values? EPA decided to average all observed values, rather than just statistically significant changes, which is an approach sometimes taken in summary analyses like this. EPA chose this approach in part because it is a more conservative one. If EPA had chosen to summarize values only from significant results, the percentage point changes would have been higher, because none of the observed decreases were statistically significant and the statistically significant improvements are generally greater in magnitude than non-significant ones. Further, EPA saw value in presenting all results, especially for ERPs that saw limited statistically significant change in the first ERP cycle. Statistical significance is much less likely to be observed at a 95% confidence level, used by most states, especially with the small sample sizes most states have employed. (Sample sizes of most ERPs have ranged from 35 to 50 per round of inspections.)

Should the Analysis Include Indicators for Which There Are Small Sample Sizes? Some indicators may apply to only a small subset of facilities visited during random inspections. It is fair to ask whether it is appropriate to include such indicators in the average analysis. In some cases, excluding indicators with samples of under 10 facilities could noticeably change the "average percentage point improvement" for a state, either up or down. For instance, one of the indicators for Massachusetts' dry cleaners had a sample of 4 facilities in the baseline and 10 in the post-certification inspections, and contributed a 55 percentage point change that was much higher than other observed improvements. Excluding this indicator from the calculations would have resulted in an "average percentage point improvement" for the dry cleaners ERP of negative 0.8. (This slightly negative result should not be viewed in isolation. The 2007 Report provides data showing that the Massachusetts dry cleaners ERP made important progress in reducing perchloroethylene waste and emissions in the first ERP cycle; dry cleaners were already performing at high levels for 5 indicators, limiting the potential for improvement; and the "group compliance score" discussed in section 3.2 of the 2007 Report shows improvement in the second ERP cycle, after no change in the first cycle.)

EPA chose to include all indicators, regardless of sample size. Excluding any indicators would have required setting a sample size threshold, which EPA did not feel was appropriate because it would require an arbitrary determination of the threshold. Also, indicator-level sample size data were not available for Florida's auto repair ERP. Consequently, it would not have been possible to determine whether any of the Florida indicators required exclusion because of small sample sizes.

EPA also considered developing a weighted average. A weighted average could account for variations in sample sizes for individual EBPIs without excluding the results for EBPIs with small sample sizes, by giving each EBPI a weight relative to the number of facilities for which it was relevant. While EPA may consider also presenting weighted averages in future reports, this approach was not pursued in this 2007 Report, for several reasons: (1) insufficient data were available from Florida; (2) an index-based indicator for Maryland, showing its only statistically significant change, would have had to be excluded (see Maryland methodological notes for more information on the indicator); and (3) a weighted average may in some cases create an unintended bias, because it assumes that the importance of each EBPI is proportional to the number of facilities to which that EBPI applies. To the contrary, states may indeed take this issue into account when deciding upon what practices to track as EBPIs in the first place. States may also consider, in the future, developing weights for EBPIs based upon relative importance, but this requires assigning numerical values and also could inject bias.

1.1. SOURCES AND STATE-BY-STATE METHODOLOGICAL NOTES

DELAWARE, AUTO BODY. ***Source:*** Delaware Department of Natural Resources and Environmental Control. Final Report. EPA 2002 State Innovation Pilot Grant Program. December 2005. ***Notes:*** Delaware's report indicated the state was assessing the significance of performance changes using a 90% confidence level, but the significance levels of individual EBPIs were not provided in the Delaware report. Consequently, EPA utilized data in the Delaware report to assess significance at a 95% confidence level, using recognized statistical techniques for one-tailed hypothesis testing. A 95% confidence level was chosen for consistency with the data presented for other states.

FLORIDA, AUTO REPAIR. ***Source:*** Florida Department of Environmental Protection. "Compliance Certification Program (CCP). Compliance Assistance for Auto Repair. PILOT PROJECT Preliminary Results." PowerPoint presentation, Slides 36 and 37. 2003. ***Notes:*** None.

MAINE, AUTO BODY. ***Sources:*** (1) *For proportions of facilities achieving EBPIs:* Maine Department of Environmental Protection, Office of Innovation. Auto Body Environmental Results Program: Final Report. May 7, 2007. (2) *For determinations about statistical significance:* Lippert, Sara. Maine Department of Environmental Protection. "Maine EBPI Data-revised 1-07," unpublished preliminary results from Microsoft Excel spreadsheet. E-mail communication with U.S. EPA contractor. January 11, 2007. ***Notes:*** None.

MARYLAND, AUTO REPAIR/AUTO BODY. ***Source:*** McGrath, Dennis. Report of the Analysis of Self-Certification and Inspections of Park Heights Neighborhood Auto Mechanic and Auto Body Shops for the Park Heights Environmental Compliance Assistance Program. Schaefer Center for Public Policy (University of Baltimore). Received as Attachment 7 to the Maryland Department of Environment's Park Heights Project Final Report, prepared by Bernard A. Penner. June 30, 2004. ***Notes:*** **(1)** Maryland report provides results for 9 EBPIs, but EPA excluded 4 EBPIs from this analysis. Results for those EBPIs were only provided for those facilities sampled in both rounds of inspections. Results for other Maryland EBPIs (and the other ERPs presented in EPA's 2007 Report) are based upon random samples of all facilities, whether or not inspected in both rounds of inspections. Including those four EBPIs in this analysis could create an upward bias in the findings, assuming such facilities are likely to perform better than facilities that were not inspected in the initial round. **(2)** Three of Maryland's remaining five EBPIs are similar to other ERP EBPIs, in that they measure the proportion of facilities meeting a certain criterion (e.g., a compliance practice). However, two of the EBPIs incorporated in this analysis were presented as Index scores, constructed from several related dichotomous (i.e., yes/no) questions: a "hazardous waste management index" and a "painting operation compliance index." The percentage point increase associated with these index scores represents the increase in the proportion of criteria being met by the average facility, which is slightly different than the percentage point increase for individual EBPIs, but nonetheless seemed appropriate to include in the calculation of average percentage point improvement. **(3)** With regard to the EBPI tracking discharge of contaminated wastewater, the Maryland report acknowledged that three facilities in each round of inspections were found to be discharging without a permit. However, the report did not provide relevant sample size in each round. Consequently, actual proportions of facilities in compliance in each round could not be calculated. This, in turn, meant the percentage point change could not be calculated. In this special case, EPA conservatively assumed the percentage point change to be negative 0.1 to avoid potentially understating the number of EBPIs with negative performance change. If EPA had assumed a percentage point change of zero, the number of EBPIs with negative performance changes in the table would be lower. If EPA excluded the EBPI from analysis, the number of EBPIs with negative performance changes in the table would be lower and Maryland's observed average indicator improvement would be higher.

MASSACHUSETTS, DRY CLEANERS. ***Source:*** Tetra Tech EM, Inc., for Massachusetts Department of Environmental Protection. Environmental Results Program for Dry Cleaners and Photo Processors, Round 1 Versus Round 2 and Self-Certification Data Analysis. Final Report. Appendix G (detailed EBPI results) and page 8 (Table 2, listing EBPIs, direction of change, and significance associated with them). June 22, 2000. ***Notes:*** Five of Massachusetts' EBPIs for dry cleaners are classified as "No Change, High Initial Compliance" in Table 2 of this TetraTech EM, Inc., report (2000). EPA determined that classification meant that Massachusetts inspectors observed 100% performance on such EBPIs in both rounds of data collection. EPA based that determination on baseline inspection data for those EBPIs presented in Appendix A of TetraTech EM, Inc. (2001), the source cited below for EBPI data from the Massachusetts printers ERP. Exact performance levels for those EBPIs are not presented in TetraTech EM, Inc. (2000).

MASSACHUSETTS, PHOTO PROCESSORS. ***Source:*** Tetra Tech EM, Inc., for Massachusetts Department of Environmental Protection. Environmental Results Program for Dry Cleaners and Photo Processors, Round 1 Versus Round 2 and Self-Certification Data Analysis. Final Report. Page 9 (Table 4, listing EBPIs, direction of change, and significance associated with them) and Appendix K (detailed EBPI results). June 22, 2000. ***Notes:*** Three of Massachusetts' EBPIs for photo processors are classified as "No Change, High Initial Compliance" in Table 4 of this TetraTech EM, Inc., report (2000). EPA determined that classification meant that Massachusetts inspectors observed 100% performance on such EBPIs in both rounds of data collection. EPA based that determination on baseline inspection data for those EBPIs presented in Appendix A of TetraTech EM, Inc. (2001), the source cited below for EBPI data from the Massachusetts printers ERP. Exact performance levels for those EBPIs are not presented in TetraTech EM, Inc. (2000).

MASSACHUSETTS, PRINTERS. ***Source:*** Tetra Tech EM, Inc., for Massachusetts Department of Environmental Protection. Environmental Results Program for Dry Cleaners and Photo Processors, Round 2 Versus Round 3 and Self-Certification, and Printers Round 1 Versus Round 2 and Self-Certification Data Analysis. Final Report. Page 7 (Table 7, listing EBPIs, direction of change, and significance associated with them) and Appendix A (detailed EBPI results). July 16, 2001. ***Notes:*** Two of Massachusetts' EBPIs for printers are classified as "No Change, High Initial Compliance" in Table 7 of this TetraTech EM, Inc., report (2001). EPA determined that classification meant that Massachusetts inspectors observed 100% performance on such EBPIs in both rounds of data collection. EPA based that determination on baseline and post-certification inspection data for those EBPIs presented in Appendix A of TetraTech EM, Inc. (2001).

RHODE ISLAND, AUTO BODY. ***Source:*** Enander, Richard T., et al. "Environmental Health Practice: Statistically Based Performance Measurement." Pages 819-824. American Journal of Public Health. Volume 97. 2007. ***Notes:*** None.

2. Massachusetts Group Compliance Scores

Section 3.2 of the 2007 Report provides a graph (Figure 5 in the 2007 Report) showing the performance of Massachusetts ERP sectors over time, as measured by the "group compliance score." As noted in the 2007 Report, the group compliance score is a measure of the extent to which facilities are achieving compliance-related EBPIs, as observed by inspectors during random visits to facilities. A score of 80%, for instance, would mean that, on average, each facility is achieving 80% of the indicators that apply to it.

The group score is calculated by first calculating a facility-level compliance score, then averaging facility compliance scores across all inspected facilities. For instance, imagine inspectors visited 5 facilities, and evaluated the extent to which those facilities were achieving desired performance on 10 EBPIs. (Note: ERP random samples typically consist of about 35 to 50 inspections; this small number of inspections is used only for the purpose of illustrating the calculation.) Table A-2 (next page) provides example data, showing how the group compliance score would be calculated for these imaginary facilities.

Table A-2: Illustrative Calculation of Group Compliance Score

Facility ID	EBPIs Achieved	Relevant EBPIs	Compliance Score
Facility A	3	10	30%
Facility B	5	10	50%
Facility C	4	8	50%
Facility D	6	10	60%
Facility E	7	7	100%
Group Compliance Score			**58%**

Note that each facility's compliance score is based upon the EBPIs that are relevant to it. For instance, not all EBPIs are relevant to the processes utilized at facilities C and E, above, so their compliance score is based upon the relevant EBPIs they are achieving.

Readers may have encountered references to Massachusetts' group or sector "performance score" in prior documentation about Massachusetts ERPs. Massachusetts has used the term "performance score" to refer to performance on both compliance and pollution prevention (P2) EBPIs. The term "group compliance score" is used in this 2007 Report to add greater clarity about the makeup of each score. In the case of dry cleaners and photo processors, all the EBPIs are compliance-oriented, so the group compliance score and group performance score are equal. In the case of printers, however, 12 of the 26 EBPIs represent voluntary P2 practices. To enable greater comparability to the compliance-oriented performance scores of the other two sectors, Massachusetts has long reported three different performance scores for printers: (1) just compliance EBPIs; (2) just P2 EBPIs; and (3) all EBPIs combined. Table A-3 (below) presents each of those three scores over time for printers, along with the scores for dry cleaners and photo processors.

Table A-3: Massachusetts Group Performance Scores (1997-2003)

Sector	Score Type	1997	1998	1999	2000	2001	2002	2003
Dry Cleaners	Compliance	84%	84%	—	97%	—	98%	—
Photo Processors	Compliance	57%	71%	—	96%	—	98%	—
Printers	Compliance	—	82%	89%	—	—	—	86%
	Pollution Prevention (P2)	—	45%	55%	—	—	—	43%
	Total (All EBPIs)	—	60%	68%	—	—	—	61%

Readers should also recognize that changes in scores over time have not been assessed for statistical significance, nor have confidence intervals been established for individual scores. Doing so is possible, but would be resource-intensive after the fact, and was beyond the scope of this 2007 Report.

Finally, readers should recognize that Massachusetts frequently reports these scores on a scale of 1 to 10, rather than on a percentage basis. For instance, the 1997 score for photo processors might be reported as 5.7 on a scale of 10, rather than 57%. The percentage basis is used in this 2007 Report because it was considered easier to communicate in this context.

2.1. SOURCES

PHOTO PROCESSORS AND DRY CLEANERS DATA. DeGabriele, Steven. Director, Business Compliance Division, Massachusetts Department of Environmental Protection. "Massachusetts Environmental Results Program." Slides 15–16. Presentation to Minnesota Pollution Control Agency. June 8, 2006.

PRINTERS DATA FOR BASELINE (1998) AND FIRST POST-CERTIFICATION ROUND OF INSPECTIONS (1999). Tetra Tech EM, Inc., for Massachusetts Department of Environmental Protection. Environmental Results Program for Dry Cleaners and Photo Processors, Round 2 Versus Round 3 and Self-Certification, and Printers Round 1 Versus Round 2 and Self-Certification Data Analysis. Final Report. Pages 2, 23. July 16, 2001.

PRINTERS DATA FOR SECOND POST-CERTIFICATION ROUND OF INSPECTIONS (2003). Peck, Susan. Associate Division Director, Massachusetts Department of Environmental Protection Business Compliance Division. "Re: resolution of data issues." E-mail communication to U.S. EPA contractor. April 27, 2007.

3. Massachusetts Dry Cleaners' Reductions in Perchloroethylene Emissions and Waste

Section 3.3 of the 2007 Report presents estimates of average reductions in perchloroethylene emissions and waste by dry cleaners of 32% and 28%, respectively, between the first and second self-certification cycles. These reductions equate to an estimated 135-ton reduction in annual perc emissions and a 151-ton reduction in annual perc waste. These estimates are based upon self-certification data from dry cleaners describing their perchloroethylene usage and perchloroethylene waste shipments. By subtracting the weight of waste shipments from usage weight, Massachusetts estimated air emissions.

Based on the estimated air emissions, EPA also estimated the volume of perchloroethylene air emissions that were avoided would have been enough to fill the lungs of over 3.6 million adults. The two subsections below present additional information on the estimation of perchloroethylene waste and emissions, and on the lung-related calculations.

Estimating Reductions in Perchloroethylene Emissions and Waste. The data underlying the analysis are from the "ERP Credit Matrix" documents cited below. The analysis for the 2007 Report corrected minor calculation errors found in the "ERP Credit Matrix." Tables A-4 and A-5, next page, present the detailed source data and calculations from this analysis, including how the reductions were adjusted to reflect a drop in the number of dry cleaners from 623 in 1997 to 612 in 1998.[1]

[1]Figure of 612 dry cleaners in 1998 (provided in the "ERP Credit Matrix") is different from the 1998 population of 648 dry cleaners presented in Section 5 of this appendix. Section 5's figure is based upon more recent data provided by Massachusetts. EPA was unable to resolve this inconsistency prior to publishing the 2007 Report, but the inconsistency does not have any adverse impact on the 2007 Report's findings of substantial emissions and waste reductions. Employing the figure of 648 dry cleaners for the 1998 population would signal a population increase from 1997 to 1998, rather than the population decrease the analysis is currently based upon. Therefore, normalized estimates of emissions and waste reductions would be larger than those presented here.

Table A-4: Estimated Reductions in Average Perchloroethylene Usage, Emissions and Waste among MA Dry Cleaners (1997-1998)

Amount of Usage/Waste/Emissions	1997	1998	Source of Figure
Universe of Certifiers	623	612	From "ERP Credit Matrix," p. 2. (See Sources, below.)
Perc Usage (gallons)	144,807	99,787	From "ERP Credit Matrix," p. 2.
Perc Usage (Pounds)	1,950,550	1,344,131	Calculated. Basis is 13.47 lbs/gallon, from "ERP Credit Matrix," p. 3.
Perc Usage (Tons)	975	672	Calculated.
Average Perc Usage (Gallons/Facility)	232.4	163.1	Calculated.
Percentage Reduction in Average Perc Usage (From Baseline)	**n/a**	**29.9%**	**Calculated**
Perc Waste (Pounds)	1,097,084	774,839	From "ERP Credit Matrix," p. 2.
Perc Waste (Tons)	549	387	Calculated.
Average Perc Waste (Pounds/Facility)	1761.0	1266.1	Calculated.
Percentage Reduction in Average Perc Waste (From Baseline)	**n/a**	**28.1%**	**Calculated.**
Perc Emissions (Pounds) [Usage Minus Waste]	853,466	569,292	Calculated.
Perc Emissions (Tons)	427	285	Calculated.
Average Perc Emissions (Pounds/Facility)	1369.9	930.2	Calculated.
Average Perc Emissions (Tons/Facility)	0.68	0.47	Calculated.
Percentage Reduction in Average Perc Emissions (From Baseline)	**n/a**	**32.1%**	**Calculated.**

Table A-5: Estimated, Normalized Gross Reductions in Perchloroethylene Usage, Emissions and Waste among MA Dry Cleaners (1997-1998)

Amount of Usage/Waste/Emissions	1997*	1998	Reduction (1997 minus 1998)
Perc Usage (gallons)	142,250	99,787	42,463
Perc Usage (Pounds)	1,916,110	1,344,131	571,980
Perc Usage (Tons)	958	672	286
Average Perc Usage (Gallons/Facility)	232.4	163.1	69.4
Percentage Reduction in Average Perc Usage (From Baseline)	**n/a**	**29.9%**	**n/a**
Perc Waste (Pounds)	1,077,713	774,839	302,874
Perc Waste (Tons)	539	387	151
Average Perc Waste (Pounds/Facility)	1761.0	1266.1	494.9
Percentage Reduction in Average Perc Waste (From Baseline)	**n/a**	**28.1%**	**n/a**
Perc Emissions (Pounds) [Usage Minus Waste]	838,397	569,292	269,105
Perc Emissions (Tons)	419	285	135
Average Perc Emissions (Pounds/Facility)	1369.9	930.2	439.7
Average Perc Emissions (Tons/Facility)	0.7	0.5	0.2
Percentage Reduction in Average Perc Emissions (From Baseline)	**n/a**	**32.1%**	**n/a**

* 1997 figures calculated by multiplying 1997 average usage/waste/emissions by 612, the number of dry cleaners in existence in 1998.

Readers should also recognize that the emissions and waste reductions occurred over the course of only one year (from 1997 to 1998), so it reduces the likelihood that intervening factors other than ERP played a significant role in the decrease. Further, certification data presented in the "ERP Credit Matrix" also show that reductions continued in subsequent years.

Volume of Perchloroethylene Emissions, Expressed in Terms of Adult Lungs. To illustrate the emissions reductions in more intuitive terms, EPA estimated the number of adults whose lungs would be filled by the volume of perc emissions reduced. To do so, EPA divided the volume of the reduction in perchloroethylene emissions (17,660 m^3) by the typical vital lung capacity of an adult male (4.8 L, or 0.0048 m^3). Volume of perchloroethylene emissions reductions is derived by dividing the estimated weight of emissions reductions (122,064 kg) by the estimated density of perchloroethylene vapor at 20°C (6.91 kg per m^3); density of perchloroethylene vapor is 5.76 times the density of air, which has a density of 1.2 kg per m^3. The exact, resulting calculation is 3,679,108 adults.

3.1. SOURCES

MASSACHUSETTS PERCHLOROETHYLENE EMISSIONS AND WASTE DATA. Massachusetts Department of Environmental Protection. "MassDEP ERP Dry Cleaner Program Description ('ERP Credit Matrix')." Corrected version of Addendum 1 to July 20, 2006, U.S. EPA memo from Granta Y. Nakayama to Robert W. Varney regarding "Approval of Recognition and Resource Flexibility Credit for the Massachusetts Environmental Results Program in the Dry Cleaner Sector." September 30, 2005 (with August 2006 edits).

VITAL LUNG CAPACITY, ADULT MALE. "Lung." Microsoft Encarta. Accessed October 8, 2007 http://encarta.msn.com/encyclopedia_761570316/Lung.html.

PERCHLOROETHYLENE VAPOR DENSITY RELATIVE TO AIR. MIDSUN Group. "Perchloroethylene Material Safety Data Sheet (MSDS)." April 4, 2006.

4. Massachusetts Printers' Reduction in VOC Emissions Due to Increased Use of UV Ink

Section 3.3 of the 2007 Report provides an estimated range for reductions in volatile organic compound (VOC) emissions related to an observed increase in the proportion of printers utilizing environmentally friendly ultraviolet (UV) inks. In 1998, Massachusetts inspectors observed that 1 out of 32 (3.1%) randomly visited, relevant printers were using UV ink. In 1999, the figure was 3 out of 34 (8.8%). In 2003, 5 out of 22 (22.7%). The difference between 1998 and 1999 is not statistically significant at a 95% confidence level, but the difference between 1998 and 2003 is.

To estimate the VOC reductions based upon the change in behavior, EPA utilized a spreadsheet tool that Massachusetts' Department of Environmental Protection (DEP) had commissioned a contractor to develop (see source notes, beginning next page). Calculations of environmental outcomes in that spreadsheet tool rely upon (1) inspector-collected data, for compliance/pollution prevention practices; (2) facility certification data, particularly for facility characteristics such as size; and (3) assumptions, based on published information or professional judgment, for such issues as emission rates associated with particular facility practices. In developing the UV ink-related emissions reduction estimate, EPA used newer data representing the change in performance, and the appropriate number of printers in the state's inventory, but did not alter any other assumptions in the Massachusetts tool.

EPA based calculations upon a population of 723 printers at the time of the 1998 random inspections. Reductions are not adjusted for population changes, but any impact is expected to be minimal, because 728 printers were in operation at the time of the 2003 random inspections. If anything, EPA's approach slightly understates potential emissions reductions.

The spreadsheet tool provided a point estimate for emissions reductions, based upon the observed change. EPA created a range, by developing a confidence interval for the difference in proportions. We can be 95% confident that the increase in performance between 1998 and 2003 was between 1.0 and 38.2 percentage points. EPA created a range of estimated emissions reductions by using the spreadsheet tool to create point estimates for a 1.0 percentage point change and a 38.2 percentage point change.

That process yielded an estimated range of reductions from 52,428 gallons to 2,002,750 gallons per year. EPA decided to convert this range into the more commonly used metric for VOC emissions—tons. The basis for this conversion is an estimate in Massachusetts' ERP compliance assistance workbook (see sources, below) that density of printers inks ranges from 6 pounds per gallon to 8 pounds per gallon. EPA multiplied the lower end of the emissions reductions range by 6 pounds per gallon, and multiplied the upper end by 8 pounds per gallon. This resulted in the estimated range of annual VOC emissions reductions of between 157 and 8011 tons.

In the process of developing Section 3.3 of the 2007 Report, EPA also explored a number of other measures of change in environmental condition offered by Massachusetts DEP. These measures related to potential changes in VOC emissions due to other printer practices, and to potential changes in discharges of heavy metals and other toxic chemicals. A number of these showed statistically significant changes (at a 95% confidence level) between 1998 and 1999, but none of these measures showed statistically significant change when comparing 2003 to 1998. EPA and Massachusetts agreed that it would be most appropriate to take a conservative approach and only report results for measures showing statistically significant change (from 1998 to 2003) at a 95% confidence level, the confidence level historically used by Massachusetts DEP.

4.1. SOURCES

METHODOLOGY FOR CALCULATING CONFIDENCE INTERVAL FOR THE DIFFERENCE IN PROPORTIONS. U.S. EPA. ResultsAnalyzer2006.xls. 2006. ***Note:*** The Results Analyzer is a tool for ERP states to calculate results. The formulas used to calculate a confidence interval for the difference are based upon the following: Kish, Leslie. Survey Sampling. p. 41. New York: John Wiley & Sons, Inc., 1965.

METHODOLOGY FOR ULTRAVIOLET INK OUTCOME. Tetra Tech EM, Inc., prepared for Massachusetts Department of Environmental Protection. "Massachusetts Department of Environmental Protection Environmental Results Program Environmental Outcomes for Printers." Microsoft Excel spreadsheet. Provided by Susan Peck of Massachusetts Department of Environmental Protection by e-mail as file named "Printing Environmental Outcomes final with ERP numbers.xls." E-mail communication to U.S. EPA contractor. December 7, 2006.

PROPORTIONS OF FACILITIES UTILIZING ULTRAVIOLET INK (1998 and 1999). Tetra Tech EM, Inc., for Massachusetts Department of Environmental Protection. Environmental Results Program for Dry Cleaners and Photo Processors, Round 2 Versus Round 3 and Self-Certification, and Printers Round 1 Versus Round 2 and Self-Certification Data Analysis. Final Report. Page 7 and Appendix A. July 16, 2001. ***Note:*** Appendix provides detailed performance data, by question number. Microsoft Excel spreadsheet cited in the previous paragraph ("Printing Environmental Outcomes final with ERP numbers.xls.") identifies question 51c as the relevant question for usage of ultraviolet ink. Table 7 on page 7 of the July 16, 2001, Final Report shows that printers' performance with regard to question 51c increased from Round 1 to Round 2, and that the increase was not statistically significant.

PROPORTIONS OF FACILITIES UTILIZING ULTRAVIOLET INK (2003). Peck, Susan**.** Massachusetts Department of Environmental Protection. "cl.xls," unpublished Microsoft Excel spreadsheet. E-mail communication with U.S. EPA contractor. December 7, 2006. ***Note:*** Ultraviolet ink usage data is associated with checklist question number 64, in row 112 of the "prcy03" worksheet of the Microsoft Excel spreadsheet.

PRINTERS POPULATION IN 1998 AND 2003. Peck, Susan**.** Massachusetts Department of Environmental Protection. "erp universes by year.xls," unpublished Microsoft Excel spreadsheet. E-mail communication with U.S. EPA contractor. March 23, 2007.

RANGE OF DENSITIES OF PRINTERS INK. Massachusetts Department of Environmental Protection. Printers Environmental Certification Workbook. Page 54. May 25, 2004.

5. Comparing Massachusetts and Michigan Approaches for Regulating Dry Cleaners

Section 4.9 of the 2007 Report compares the cost-effectiveness of the approaches to regulating dry cleaners used by Massachusetts and Michigan. To do so, the 2007 Report compares 2006 baseline ERP results for Michigan to the most recent data from random inspections for Massachusetts, 2002. (Massachusetts is conducting another round of random inspections in 2007, but those data were not available for this 2007 Report. EPA is not aware of any reason that comparing data collected from the two different points in time would present a substantial bias for the purpose of this comparison—e.g., EPA is unaware of any industry or regulatory changes between 2002 and 2006 that would significantly bias performance.) The 2007 Report also compares the number of full-time equivalent (FTE) employees needed to manage the Michigan program with the number of FTEs required for the Massachusetts approach, on a per-dry-cleaner basis. Overall, the analysis found no difference in environmental performance between the two states' dry cleaners on six comparable indicators, and determined that Massachusetts uses approximately 50% of the FTEs (on a per dry cleaner basis) of Michigan in managing their dry cleaners program.

Performance Comparison. For each state, EPA examined EBPIs chosen by that state, and looked for comparable measures collected by the other state. EPA worked with staff from the two states to confirm that six measures were comparable. Measures/data were accepted for comparison if the other state had similar question language, regardless of whether the other state had selected the item as an EBPI. This examination revealed six questions that met the following characteristics:

- EBPI for Massachusetts and/or Michigan,
- Language (and therefore data) that was closely comparable,
- Both states had relevant facilities to which the question applied, and
- Each state's regulatory approach could arguably have had an impact on performance.

Four similarly worded EBPIs were excluded from the analysis. One related to compliance with a particular air requirement by 1993; it was excluded because the deadline for full compliance occurred before ERP was initiated.[2] The other three excluded indicators related to wastewater and hazardous waste issues that the Michigan Air Quality Division has not historically examined during its annual inspection process; Michigan's Department of Environmental Quality (DEQ) tracked those issues in its 2006 baseline results only because its pilot ERP effort involved multiple environmental media. Performance on these indicators, therefore, would not be reflective of Michigan's annual inspection approach. Several partially related EBPIs were also found, but these were excluded from the analysis because of comparability concerns. Readers should recognize that non-EBPI questions were not examined for comparability.

As noted in the 2007 Report, the ability to draw conclusions from the comparison is somewhat limited as a result of the small number of indicators identified as comparable. A more comprehensive analysis would be helpful in the future—for this sector and other sectors—but was beyond the scope of this 2007 Report.

For each EBPI, EPA calculated the difference between the states in observed proportions of facilities in compliance. On average, 82% of dry cleaners visited by Michigan inspectors were achieving the EBPIs in question; for Massachusetts, the figure is also 82%. A look at performance on individual EBPIs shows similar equality: each state's randomly inspected dry cleaners were performing better than those of the other state on three of the six indicators. Also, the largest observed difference in compliance proportions is six percentage points, and none of the observed performance differences are statistically significant. Significance was evaluated using one-tailed tests at a 95% confidence level. Table A-6 (next page) presents data summarizing each state's dry cleaners' performance on the selected indicators.

It is important to note that future analyses would benefit from both states having large sample sizes, although this may not be practical in the face of state resource constraints. In this comparison, the small size of Massachusetts' sample makes that state's figures much less precise than Michigan's. As an illustration, a state conducting a simple random sample of 250 facilities, out of a population of 1000, would generally expect a maximum margin of error of ±5.3 percentage points at a 95% confidence level. A state conducting a simple random sample of 25 facilities with the same population and confidence level would generally expect a maximum margin of error of ±18.0 percentage points—over three times that of the other state.[3] Such large imprecision can mean that differences in performance must be rather large in order to be deemed statistically significant.

[2] Specifically, the question relates to whether all dry-to-dry machines installed before December 9, 1991, have a refrigerated condenser or a carbon adsorber that was installed prior to September 22, 1993. The removal of this question has negligible impact on the overall conclusions. Michigan observed 88.4% compliance and Massachusetts observed 90% compliance with this requirement. The difference is not statistically significant.

[3] Calculations based upon a Score confidence interval. (Agresti and Coull. "Approximate is Better than 'Exact' for Interval Estimation of Binomial Proportions." The American Statistician. Volume 52, Number 2, Pages 119-126. 1998.)

Table A-6: Michigan and Massachusetts Performance Comparison

Michigan DEQ Inspector Checklist Question Number and Language	# Relevant Sample Size*	Observed % Compliant (Weighted)**	Massachusetts DEP Inspector Checklist Question Number and Language	# Relevant Sample Size*	Observed % Compliant		Observed Difference, in Percentage Points*** (MA % minus MI %)
1.03. Is the dry cleaning machine door kept closed, except for loading and unloading?	255	98.8%	8. Are all machine doors closed immediately after transferring articles and kept closed at all times except during maintenance?	23	100.0%		**1.2**
1.04. Does facility keep a log of the gallons of perc purchased each month?	255	65.7%	1. Are previous month's perc purchases recorded on the first day of each month?	23	69.6%		**3.9**
1.07. Does facility inspect the following components of the machine weekly for leaks? (All hose and pipe connections, fittings, couplings, and valves; Door gaskets; Filter gaskets; Pumps; Solvent tanks and containers; Muck cookers, stills; Water separator; Exhaust dampers; Diverter valves; Cartridge filter housing)	253	78.6%	10. Is leak detection performed weekly, following the workbook protocol and using proper leak detection equipment?	22	72.7%		**-5.9**
1.13. Do all dry to dry machines installed after 12/9/91 have a refrigerated condenser?	230	90.3%	19. Do all dry to dry machines installed after 12/9/91 have a refrigerated condenser?	18	94.4%		**4.1**
1.16. Is the date and temperature sensor monitoring results recorded weekly?	231	65.5%	20c. Is the temperature at the end of cycle measured on the outlet side of the refrigerated condenser and recorded weekly?	21	61.9%		**-3.6**
3.10. Are containers in good condition and kept closed except when adding or removing waste?	246	93.8%	38. Are containers in good condition and kept closed?	23	91.3%		**-2.5**
Average		**82.1%**	Average		**81.7%**		**-0.5**

* "Relevant Sample Size" refers to the number of inspected facilities for whom the question was relevant, because not all regulatory issues apply to all facilities.

** Michigan DEQ conducted a stratified random sample, with each of Michigan's four inspectors visiting a random set of facilities in the geographic region assigned to that inspector. Total number of inspections conducted was 262. Because the number of sites visited by each Michigan inspector was not proportional to that region's share of the overall population, proportions have been weighted according to population share. This approach was not necessary for the Massachusetts sample, which was a simple random sample consisting of 25 inspections.

*** Readers may observe some minor discrepancies, due to rounding.

Comparison of State Effort, on a Per-Dry-Cleaner Basis. EPA developed estimates of staff hours utilized per dry cleaner regulated, using each program's estimated full-time equivalent (FTE) employees utilized in dry cleaner management and the populations of dry cleaners in each state during the time frame examined for FTE usage. The analysis found that the Massachusetts approach, on average, has utilized approximately 50% of the staffing utilized under the Michigan approach. The subsections that follow explain, in detail, how EPA arrived at this figure.

Massachusetts Hours per Dry Cleaner Estimate. Massachusetts Department of Environmental Protection (DEP) estimates it expends a maximum of 2 FTEs (as defined by that state) per year to manage its perc dry cleaners, and approximately 1.5 FTEs in years in which it does not conduct random inspections. On that basis, Massachusetts' average FTE usage for the timeframe of this comparison can be calculated as 1.83 per year, because the state conducted four rounds of random inspections during the six years from the start of ERP in 1997 through 2002, the last year for which performance data are available.

EPA then converted Massachusetts FTEs into hours worked per year, for comparability to Michigan. Based on feedback from the state, EPA assumed Massachusetts ERP personnel typically earn 20 days annual leave per year. Massachusetts personnel also receive 13 holidays per year, and earn 15 sick days and three personal days per year. EPA assumed, for both states, that personnel utilized 100% of their annual leave, 50% of their sick leave, and 33% of personal leave. Thus, out of 260 possible working days, a typical Massachusetts ERP staff person would work 218.5 days. Applying Massachusetts' standard 7.5-hour workday, the Massachusetts FTE is estimated equivalent to 1638.75 hours per year. Multiplying that times the estimated average FTE usage of 1.83 per year results in average annual staff effort of 3004.4 hours per year.

To normalize staff effort by the number of dry cleaners, EPA divided the annual staff effort by 622, which is Massachusetts' average number of perchloroethylene dry cleaners for 1997-2002. Those are the basis years for the average FTE data used in this analysis. That calculation results in an estimate of 4.828 hours per dry cleaner.

Table A-7, below, presents the number of Massachusetts perchloroethylene dry cleaners for the years 1997-2006. The population size has declined over time, but using a different population does not have a substantial impact on the findings. For instance, using 2006's population of 560 dry cleaners—the lowest since 1997—results in an estimate of 5.365 hours per dry cleaner, still just 56% of Michigan's effort estimate.[4]

Table A-7: Massachusetts Population of Perchloroethylene Dry Cleaners (1997-2006)

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Number of Dry Cleaners	623	648	650	637	633	543	571	591	571	560

[4] As noted in footnote 1 in Section 3 of this appendix, the 1998 population figure for dry cleaners presented in this section (648) is different from the number used in Section 3 of this appendix (i.e., 612), because of discrepancies in the sources used for each analysis. EPA was unable to resolve this inconsistency prior to publishing the 2007 Report. However, utilizing the alternate population figure in this analysis has a negligible impact on the findings. Specifically, using 612 dry cleaners would result in a Massachusetts effort estimate of 4.875 hours per dry cleaner (51% of Michigan's).

Michigan Hours per Dry Cleaner Estimate. Michigan DEQ utilized approximately 4.75 FTEs (as defined by that state) in 2006 to manage its dry cleaners program, inspecting each facility once a year (including both facilities that use perc and those using other solvents). EPA understands 2006 to have been a historically typical year of FTE usage for the Michigan dry cleaners program. (Note: The Michigan dry cleaners program experienced budget cuts in late 2007.)

As it did with the Massachusetts data, EPA converted Michigan FTEs into hours worked per year. Based on feedback from the state, EPA assumed Michigan dry cleaners personnel earn 19.5 days annual leave per year. Just like Massachusetts, Michigan personnel receive 13 holidays per year. Michigan personnel also earn 13 sick days and no personal days per year. As with Massachusetts, EPA assumed that Michigan dry cleaners personnel utilized 100% of their annual leave and 50% of their sick leave. Thus, out of 260 possible working days, a typical Michigan dry cleaners program staff person would work 221 days each year. Applying Michigan's standard 8-hour workday, the Michigan FTE for the purpose of this analysis is estimated equivalent to 1768 hours per year. Multiplying that times the 2006 estimated FTE usage of 4.75 results in an estimated 2006 staff effort of 8398 hours.

To normalize staff effort by the number of dry cleaners, EPA first accounted for the fact that only 810 of Michigan's 878 dry cleaning establishments in 2006 (92.3%) utilized perchloroethylene. EPA assumed that staff time is proportionally distributed across all dry cleaners, so that 92.3% of the total staff effort, or 7747.6 hours, is directed at dry cleaners using perchloroethylene. Dividing this figure by the number of perchloroethylene dry cleaners results in an estimate of 9.565 hours per dry cleaner.

Comparison of State Effort per Dry Cleaner. EPA completed the analysis by dividing the Massachusetts normalized effort (4.828 hours per dry cleaner) by the Michigan normalized effort (9.565 hours per dry cleaner), with a result of 50.48%, rounded down to 50% for the purposes of the 2007 Report. Looked at another way, the Massachusetts perchloroethylene dry cleaners population would have to drop to 314, without any change in Massachusetts effort, for the per-dry-cleaner effort in each state to be the same.

5.1. SOURCES

MASSACHUSETTS DRY CLEANERS 2002 PERFORMANCE DATA. Peck, Susan**.** Massachusetts Department of Environmental Protection. "cl.xls," unpublished Microsoft Excel spreadsheet. E-mail communication with U.S. EPA contractor. December 7, 2006.

MASSACHUSETTS FTE ASSUMPTIONS. Peck, Susan**.** Massachusetts Department of Environmental Protection. "Re: FTE definition assumptions." E-mail communication with U.S. EPA contractor. March 7, 2007.

MASSACHUSETTS FTE ESTIMATE. Peck, Susan**.** Massachusetts Department of Environmental Protection. "Re: outstanding information for Biennial Report." E-mail communication with U.S. EPA contractor. February 16, 2007.

MASSACHUSETTS NUMBER OF DRY CLEANERS. Peck, Susan**.** Massachusetts Department of Environmental Protection. "erp universes by year.xls," Microsoft Excel spreadsheet. E-mail communication with U.S. EPA contractor. March 23, 2007.

MICHIGAN EBPI LIST, FTE ESTIMATE, AND NUMBER OF DRY CLEANERS. Ostrowski, James A. Michigan Department of Environmental Quality. Michigan Department of Environmental Quality Dry Cleaning Program 2006 Inspection Summary. January 19, 2007.

MICHIGAN FTE ASSUMPTIONS. Ostrowski, James. Michigan Department of Environmental Quality. "Re: working hours per FTE." E-mail communication with U.S. EPA contractor. March 7, 2007.

MICHIGAN RESULTS DATA (2006). (1) *Information on each stratum and sample size, by inspector:* Ostrowski, James. Michigan Department of Environmental Quality. "Michigan ERP Baseline Inspection Results Summary Table." Unpublished document provided via e-mail communication with U.S. EPA contractor. November 30, 2007. (2) *Performance data for each question, by inspector:* Ostrowski, James. Michigan Department of Environmental Quality. "ERP-Total Summary BY INSPECTOR.xls," unpublished Microsoft Excel spreadsheet. E-mail communication with U.S. EPA contractor. November 27, 2007.

6. EPA's Data Collection and Verification Process

EPA requested from states the most up-to-date data for use in the development of the 2007 Report. As much as possible, EPA utilized existing state data and analysis, as reported by states, because re-analyzing all results was beyond the scope of the 2007 Report and appendix. For the limited number of data inconsistencies that were identified, EPA worked closely with states to resolve them, when possible. When EPA was not able to resolve inconsistencies, EPA in some cases chose not to utilize such data. Whether or not data with unresolved inconsistencies were utilized, EPA strived to transparently identify such inconsistencies for readers and (where such data were utilized in the 2007 Report) to note how EPA handled such inconsistencies in its analyses.

All data presented in the 2007 Report, its executive summary, and this appendix underwent a quality assurance process to ensure calculations were properly conducted and to ensure data were appropriately characterized and accurately transcribed from state sources. Further, EPA provided several opportunities for review and comment to each of the seven states whose ERP data are presented in the 2007 Report, its executive summary, and this appendix: Delaware, Florida, Maine, Maryland, Massachusetts, Michigan, and Rhode Island. Their input is reflected in these documents. Reviewers from each state are identified below.

Delaware.
Kimberly Chesser
Small Business Ombudsman
Department of Natural Resources and Environmental Control

Florida.
Michael Redig
Bureau of Solid and Hazardous Waste
Department of Environmental Protection

Maine.
Sara Lippert
Office of Innovation
Department of Environmental Protection

Maryland.
Bernard Penner
Environmental Crimes Unit
Office of the Attorney General
Formerly of Department of the Environment

Massachusetts.
Steven DeGabriele, Susan Peck and Paul Reilly
Business Compliance Division
Department of Environmental Protection

Michigan.
James Ostrowski
Environmental Science and Services Division
Department of Environmental Quality

Karen Kajiya-Mills
Air Quality Division
Department of Environmental Quality

Rhode Island.
Richard Enander, Ph.D.
Office of Technical and Customer Assistance
Department of Environmental Management