Docket Number: F-1999-FLEF-FFFFF

MODIFICATION OF THE HAZARDOUS WASTE PROGRAM:
HAZARDOUS WASTE LAMPS

FINAL ECONOMIC ASSESSMENT
Final Document
Post-OMB Review

Economics, Methods and Risk Analysis Division
Office of Solid Waste
U.S. EPA

March 11, 1999

Below is a summary of changes made to the Economic Assessment document in response to review by the Office of Management and Budget (OMB):

- The title of this document was changed.
- Minor editorial changes were made to this document.
- An insert was added explaining that this document covers only spent mercury-containing fluorescent lamps.
- Appendix E was added to this document. This Appendix presents a detailed review of data inputs and findings associated with comparative lamp management cost trends (See: Response to Economic Related Questions from OMB, March 4, 1999)..

Below is a summary of Agency initiated modifications to the Economic Assessment that were incorporated during the Agency's final review:

- A section was incorporated into Chapter One of the final Economic Assessment that summarizes public comments and Agency responses associated with the Economic Impact Analysis (EIA) conducted in support of the proposed action.
- The floor space growth rate presented in chapter 2 was changed from 3.8 percent to 2.4 percent. The 2.4 percent growth rate used for adjusting to 1998 floor space levels is correct. The Agency applied the 3.8 percent rate to project over the 1998 - 2007 modeling period (see chapter 4). This was an editorial oversight in previous versions.

March 11, 1999

Scope of Analysis

The final rule: Modification of the Hazardous Waste Program: Hazardous Waste Lamps, covers all hazardous waste lamps. Mercury-containing fluorescent lamps are estimated to represent 98 to 99 percent of the total annual generation of spent hazardous waste lamps. High-intensity discharge (HID) lamps represent most of the remaining quantity. Miscellaneous hazardous waste lamps covered by this rule represent a comparatively negligible proportion of the total annual generation. This document: Modification of the Hazardous Waste Program: Hazardous Waste Lamps - Final Economic Assessment, March 11, 1999, addresses only mercury-containing fluorescent lamps. Incorporation of HID and miscellaneous hazardous waste lamps into the scope of this analysis is not likely to impact the findings.

ACKNOWLEDGMENTS

The Agency recognizes ICF Incorporated for the overall organization and development of this report. ICF developed the database and analytical model that allowed for comprehensive analysis of the regulatory options presented in this report. Lyn D. Luben, Gary L. Ballard, and W. Barnes Johnson, all of the U.S. Environmental Protection Agency, Office of Solid Waste, provided guidance and review.

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EXECUTIVE SUMMARY

Each fluorescent lamp contains a small amount of mercury that emits light when electricity is passed through it. When the lamp glass breaks, mercury in the lamp is released into the environment and can cause health risks primarily through consumption of fish. Neurotoxicity is the health effect of greatest concern for humans; death, reduced reproductive success, impaired growth and development, and behavioral abnormalities are effects of concern to fish, birds, and mammals.

Without government intervention, market forces would most likely promote outcomes that cause releases of mercury. Because most fluorescent lamps have enough mercury to fail the Toxicity Characteristic (TC) test, though, they are considered hazardous wastes under RCRA, and are currently subject to manifesting and disposal requirements.

Many generators may not recognize that lamps can be hazardous waste and, thus, may not properly manage spent fluorescent lamps. To streamline the regulations affecting spent lamps, and (potentially) encourage proper management practices, EPA is taking the final action of adding mercury-containing lamps to the universal waste (UW) regulations. Under the UW action, lamps that fail the TC will be subject to streamlined UW regulations. UW regulations include requirements for the proper packaging of lamps, storage of lamps, EPA notification, and responding to releases. Under the UW regulatory scheme[1], transporters of spent lamps also face requirements similar to those encountered by generators, and sites receiving the lamps would be subject to RCRA hazardous waste regulations.

EPA selected this action over another potential option — conditional exclusion (CE) of mercury-containing lamps from regulation as hazardous waste. The CE option would have excluded spent lamps from the definition of hazardous waste, thereby exempting them from RCRA regulations, if generators met two conditions. First, the lamps would have had to be either disposed in a municipal landfill permitted by a state/Tribe with an EPA-approved municipal solid waste permitting program or sent to a registered mercury recycling facility. Second, facilities would have had to keep track of all lamp shipments. Under this option, lamps managed in compliance with CE regulations would have been shipped either to Subtitle D landfills, Subtitle C facilities, or recyclers.

This report presents the Economic Assessment for the final Mercury Lamp rule. By (1) laying out the distribution of lamp users and estimating the numbers of lamps they generate; (2) determining the nature of the actions required of them under various scenarios; and (3) estimating the costs and emissions consequences of these actions, we develop estimates of the economic impacts and mercury releases that the final action might cause in comparison to the existing regulatory framework. The same analysis was also conducted for the CE option, in order to provide comparisons to the final action.

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[1] In this report, it is necessary to distinguish between the set of regulations under which lamps are managed on the one hand, and actions taken or considered by EPA on the other. Under the authority of state programs, lamps are managed under specific sets of regulations — which could be based on full Subtitle C, or UW, or (if allowed by EPA) Conditional Exclusion. We refer to these sets of regulations as regulatory "schemes." Through its actions, EPA can influence which schemes the states choose to use. For example, EPA's final action will probably cause more states to manage lamps under the UW scheme than if it had elected to stay with the baseline. Similarly, if EPA had chosen the CE option, some states would have allowed lamps to be managed under a CE scheme. It is important to remember, though, that in analyzing the full Subtitle C baseline, not all lamps would be managed under the full Subtitle C scheme.

EPA's final action is considered deregulatory, and imposes fewer requirements on generators of spent lamps than under Subtitle C. Thus, for those who were complying with the law, it can be expected to lower total costs, and may increase emissions to some (probably slight) extent. At the same time, for those generators who may not have been managing spent lamps properly, this action is likely to encourage higher levels of compliance, thus reducing emissions to some degree. The CE option would have been deregulatory as well. The final action, as well as the CE option, is analyzed in this report using a baseline that assumes full compliance with Subtitle C, though an analysis of a sensitivity scenario considers the case of more realistic baseline and rule compliance rates.

Contents of Executive Summary

This Executive Summary briefly reviews the full report: *Modification of the Hazardous Waste Program: Mercury-Containing Lamps, Economic Assessment*. The *Economic Assessment* satisfies the regulatory analysis requirements established by the President under Executive Order 12866, "Regulatory Planning and Review," to the extent data and analytical scope allow. This Executive Summary contains the following general sections: Basic Analytical Approach, Introduction of Complexity, Analysis of Costs, Assessment of Economic Impacts, Changes in Emissions - Assessment of Benefits, Explanation of Impacts, Cost-Effectiveness, Small Entity Analysis, Regulatory Issues, and Limitations.

Basic Analytical Approach

The methodology used in the report can best be explained by describing it in a simplified form, and then introducing some of its complexities. In simplified form, we estimated the number of fluorescent lamps in use today and over the course of the ten-year time frame for the analysis. From this figure, and information on lamp life spans, we estimated the number that are disposed of every year. We also estimated the number of individual facilities that generate these spent lamps. We then constructed a list of all of the activities required for facilities that dispose of lamps under existing Subtitle C regulations. Unit costs per lamp or facility were then developed for each activity, and multiplied by the number of lamps and facilities. This analysis produced the total cost of managing lamps under the full Subtitle C baseline.

Using the Mercury Emissions Model developed by ICF for EPA, we then calculated the emissions consequences of managing spent lamps in accordance with full Subtitle C. Estimates of the amount of mercury in each lamp, combined with estimates of the percentage of that mercury released at each step in the management train, generated estimates of per-lamp emissions. Multiplying these estimates by the number of lamps yielded total emissions.

Similar analyses of the activities, unit costs, and percentages of mercury emitted under the UW regulations yielded analogous estimates of the consequences under that alternative. By subtracting the Subtitle C baseline results from the UW results, we could find the incremental costs and emissions of this regulatory change. These steps were then repeated for the CE option.

Introduction of Complexity

To be more realistic, it was necessary to add numerous layers of complexity to the simple analysis presented above. First, most fluorescent lamps are not covered by EPA's regulations: lamps used in homes are excluded, as are lamps generated at Conditionally Exempt Small Quantity Generators (CESQGs). CESQGs are facilities that generate less than 100 kgs of hazardous waste per month. To identify these facilities, we needed realistic estimates of the size distribution of facilities in terms of square feet. These estimates, combined with assumptions about lamp usage per square foot, lamp life spans, lamp weights, and relamping practices (i.e., whether lamps are replaced all at once or as they burn out) resulted in the division of the population into CESQGs and non-CESQGs. We found that a substantial majority of lamps fall into the CESQG category rather than the Small or Large Quantity Generator (SQGs or LQGs) category. Thus, most lamps are exempt from RCRA regulations, and will continue to be exempt.

Second, EPA's action changing its regulatory framework may not directly affect the *state* regulations under which lamps are managed. Though EPA can set a default set of requirements, which might be implemented automatically by states that adopt EPA's regulations by reference, states have considerable latitude in establishing their regulations. Many states have already adopted UW regulations, and more would have been likely to do so even in the baseline (i.e., with no change in EPA rules). Furthermore, it is not clear how EPA's choice will affect state decisions: if states that prefer UW to full Subtitle C can already adopt UW, the selection of UW at the federal level might not cause many additional states to change. Analogously, a federal decision to select the CE option would not necessarily have swayed states that currently show that they prefer lamps to be recycled rather than landfilled.

Third, it is apparent that many generators do not now comply with the full Subtitle C or UW provisions that apply to them. If relatively few generators would comply with any regulatory requirements, a shift by EPA to different regulations might have very little real effect. On the other hand, if EPA's action encouraged greater levels of compliance, the real-world effects could be substantial.

Fourth, changes in regulations will not occur all at once, but may be phased in over a number of years as state governments and regulatory agencies follow their established procedures. And finally, numerous changes in the regulated population can be expected over the next ten years. Even in the absence of regulatory changes, we anticipate that the amount of floor space will grow, the amount of mercury in each lamp will drop, and many facilities will shift away from the existing T12s to the smaller, brighter, more energy-efficient T8 lamps.

To allow for these complexities, we constructed a cost model that incorporated assumptions about populations of lamp generators, their size distributions and lamp usage rates (to allow for the calculations of number of CESQGs). Exhibits ES-1 and ES-2 show some of the data used in this analysis. This model also included lists of, and unit cost estimates for, the management activities required under each regulatory scheme that was analyzed: full Subtitle C; UW; and CE. The model incorporated crucial parameters for the percentage of facilities that would manage their lamps under each of these three schemes, and for the percentage of facilities that would not comply with any scheme. These parameters were allowed to change over time and under different EPA potential actions.

For example, the percentage of facilities managing lamps under the UW scheme was assumed to increase with the selection of the UW option, but was not assumed to be zero under EPA's full Subtitle C baseline or to reach 100 percent under EPA's UW final action. The cost model summed up the total costs and emissions taking all of these parameters into account. In a sense, it calculated the *weighted average* of the costs, with the weights being the fraction of facilities (and lamps) managed under each scheme.

In addition, several per-facility costs were calculated, including costs for small quantity generators (SQGs) and large quantity generators (LQGs) that operate under full Subtitle C and costs for SQGs and LQGs that operate under a UW regulatory scheme.

Exhibit ES-1: Number of Generating Facilities, by Building Size, 1998

Facility Size Range (sq.ft.)	Average Facility Size (sq.ft.)	Total Industrial and Commercial Fluorescent Illuminated Area (million sq.ft, 1998)	Number of Industrial and Commercial Facilities
1,001 to 5,000	2,755	6,600	2,399,000
5,001 to 10,000	7,397	6,700	901,000
10,001 to 25,000	16,078	9,500	593,000
25,001 to 50,000	35,840	9,300	260,000
50,001 to 100,000	69,526	7,500	108,000
100,001 to 200,000	137,971	9,100	66,000
200,001 to 500,000	307,920	7,300	24,000
500,001 and over	807,889	6,900	9,000
Total	N/A	62,900	4,360,000

Exhibit ES-2: Number of Facilities in 1998, by Building Size

Facility Size Range (sq.ft.)	Number of CESQG Facilities	Number of Non-CESQG Facilities		Total Number of Facilities
		SQG	LQG	
1,001 to 5,000	2,399,000	0	0	2,399,000
5,001 to 10,000	886,000	6,000	0	901,000
10,001 to 25,000	549,000	44,000	0	593,000
25,001 to 50,000	205,000	19,000	0	260,000
50,001 to 100,000	100,000	8,000	0	108,000
100,001 to 200,000	59,000	4,000	3,000	66,000
200,001 to 500,000	17,000	5,000	2,000	24,000
500,001 and over	1,000	5,000	3,000	9,000
Total	4,261,000*	91,000	8,000	4,360,000

*Numbers may not add due to rounding

Exhibit ES-3: Number of Lamps Generated per Year[2]

Year	**Number of Lamps** (in millions)		
	CESQG	Non-CESQG	Total
1998	756	123	879
1999	772	137	909
2000	782	150	932
2001	800	165	965
2002	812	179	991
2003	827	195	1,022
2004	844	211	1,055
2005	861	227	1,088
2006	883	245	1,128
2007	904	262	1,166
Total Lamps Generated	8,241	1,894	10,135
Average Lamps Generated per Year	824	189	1,014

Analysis of Costs

The unit costs of compliance under the three regulatory schemes that were analyzed — full Subtitle C, UW, and CE — are shown in Exhibits ES-4, ES-5, and ES-6. The high cost estimates shown in these exhibits were assigned to larger facilities. The lower costs were assigned to smaller facilities on the assumption that small organizations have simpler facilities and organizational structures.

Total National Costs

The total annual national costs of compliance and disposal under the baseline, final action, and regulatory option, under two compliance scenarios, are presented in Exhibit ES-7. In the high compliance scenario, the costs under full Subtitle C and UW are close because the transportation and disposal costs are virtually the same, and these costs account for 76 percent of the total costs. Furthermore, the federal shift to UW is assumed to result in relatively few states changing their rules for lamp management.

[2] This analysis assumes that all fluorescent lighting is by four-foot lamps. In reality, many lamps are eight feet long; in 1993, for example, roughly 20 percent of lamps were in the larger category. Because the larger lamps give twice as much light, cost twice as much to manage, and contain twice as much mercury, there were treated in the analysis as though each one was the equivalent of two four-foot lamps. This simplification should have very little effect on the analysis other than artificially inflating the data on numbers of lamps (e.g., if the analyzed universe contained 16 four-foot lamps and 4 eight-foot lamps, this analysis would assume a total of 24 lamps instead of 20) -- the calculation of tonnage, emission, and cost totals will be unaffected by this simplification.

Under the low compliance scenario, however, costs under EPA's final action are higher than under the full Subtitle C baseline because of the higher compliance rate assumed under the UW scheme. The unit costs for recycling, retorting, and Subtitle C landfilling are significantly higher than for Subtitle D land filling and waste combustion used by non-compliant facilities.

Exhibit ES-4: Facility Cost Estimates Under Full Subtitle C Scheme

Subtitle C Requirement	Unit (facility) Cost Estimates			
	Large Quantity Generators		Small Quantity Generators	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Initial Fixed Costs				
Notification of Hazardous Waste Activity	$ 150	$ 83	$ 150	$ 83
Rule Familiarization	$ 1,107	$ 332	$ 1,107	$ 130
Emergency Planning	$ 586	$ 214	$ 395	$ 116
Waste Characterization	$ 312	$ 0	$ 312	$ 0
Total Initial Fixed Costs	$ 2,155	$ 629	$ 1,964	$ 329
Annualized Initial Fixed Costs	$ 307	$ 90	$ 280	$ 47
Annual Costs				
Subtitle C Record Keeping (per year)	$ 33	$ 14	$ 33	$ 14
Biennial Reporting (annualized cost)	$ 361	$ 130	$ 0	$ 0
Personnel Safety Training (annualized costs)	$ 474	$ 208	$ 74	$ 29
Manifest Training (per year)	$ 164	$ 4	$ 34	$ 2
Subtotal Annual Costs	$ 1,032	$ 356	$ 141	$ 45
Variable Costs				
Manifesting & Landban Notification per shipment	$ 42	$ 31	$ 33	$ 30
Exception Reporting (per report)	$ 64	$ 32	$ 30	$ 17
Total Annualized Cost for New Facilities[3]				
Facilities that Group Relamp	$1,384	$447	$454	$122
Facilities that Spot Relamp	$1,424	$508	$487	$152
Total Annualized Cost for Existing Facilities				
Facilities that Group Relamp	$1,074	$387	$174	$75
Facilities that Spot Relamp	$1,117	$418	$207	$105

[3] Facilities that group relamp prepare one manifest and facilities that spot relamp prepare two manifests each year.

Exhibit ES-5: Facility Cost Estimates Under the Universal Waste Scheme

Universal Waste Requirement	Unit (facility) Cost Estimates			
	Large Quantity Handlers		Small Quantity Handlers	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Initial Fixed Costs				
Notification of Hazardous Waste Activity	$ 150	$ 83	$ 0	$ 0
Rule Familiarization	$ 1,107	$ 166	$ 1,107	$ 83
Waste Characterization	$ 312	$ 0	$ 312	$ 0
Total Initial Fixed Costs	$ 1,569	$ 249	$ 1,419	$ 83
Annualized Initial Fixed Costs	$ 223	$ 35	$ 202	$ 12
Annual Fixed Costs				
Personnel Safety Training (annualized)	$ 86	$ 26	$ 33	$ 10
Variable Costs				
Shipping Record Keeping (per shipment)	$ 9	$ 9	$ 0	$ 0
Total Annualized Cost for New Facilities[4]				
Facilities that Group Relamp	$318	$70	$235	$22
Facilities that Spot Relamp	$327	$79	$235	$22
Total Annualized Cost for Existing Facilities				
Facilities that Group Relamp	$95	$35	$33	$10
Facilities that Spot Relamp	$104	$44	$33	$10

Exhibit ES-6: Facility Cost Estimates Under Conditional Exclusion Scheme

Conditional Exclusion Requirement	Unit (facility) Cost Estimates	
	High Estimate	Low Estimate
Initial Fixed Costs		
Rule Familiarization	$ 1,107	$ 83
Total Fixed Costs	$ 1,107	$ 83
Annualized Fixed Costs	$ 158	$ 12
Variable Costs		
Shipping Record Keeping (per shipment)	$ 17	$ 7
Total Annual Costs for New Facilities	$ 175	$ 19
Total Annual Costs for Existing Facilities	$ 17	$ 7

[4] Facilities that group relamp prepare one manifest and facilities that spot relamp prepare two manifests each year.

Exhibit ES-7: Total Annual National Costs

	Annualized Cost -- millions --
High Compliance **(100% Compliance in All Regulatory Schemes)**	
Full Subtitle C Baseline	$ 80.01
UW Final Action	$ 78.52
CE Option	$ 73.90
Low Compliance **(20% compliance under Full Subtitle C, 80% under UW, and 90% under CE)**	
Full Subtitle C Baseline	$ 54.37
UW Final Action	$ 56.14
CE Option	$ 52.60

Exhibit ES-8 presents the average cost per lamp for the baseline, final action, and CE option, under the two compliance scenarios. The cost per lamp for each year was calculated by dividing total national costs by the number of lamps generated by compliant generators. The average cost per lamp was calculated by averaging the cost per lamp over the ten-year time horizon.

Assessment of Economic Impacts

Based on the cost analysis, we estimated the per-facility annualized compliance costs associated with the baseline, final action, and option. Under the 100 percent compliance scenario that formed the basis of the impact analysis, we estimated that EPA's final action would result in cost *savings* to affected entities relative to the baseline. Because the rule is not expected to result in a net cost to *any* lamp generators, adverse impacts on them are not anticipated. A similar result was obtained with respect to the option that was analyzed but not selected.

Exhibit ES-8: Total Compliance Costs per Compliant Lamp

	Average Cost per Lamp
High Compliance Scenario **(100% Compliance in All Regulatory Schemes)**	
Full Subtitle C Baseline	$ 0.41
UW Final Action	$ 0.40
CE Option	$ 0.38
Low Compliance Scenario **(20% under Subtitle C, 80% under UW, and 90% under CE Scheme)**	
Full Subtitle C Baseline	$ 0.51
UW Final Action	$ 0.49
CE Option	$ 0.44

Costs could increase for entities that are not complying with current requirements but do come into compliance with the current rulemaking (as in the low compliance scenario). These costs, however, would not be attributable to the current rulemaking. In any case, EPA believes that even these costs would not result in significant impacts, as the costs per square foot of lighted space are so low that they will generally be extremely small on a per-employee or per-dollar-of revenue-basis.

We also considered whether the rule might cause other sorts of economic impacts including impacts on the following: (1) *Consolidation facilities* (i.e., facilities that collect or store used lamps prior to recycling or disposal). EPA believes that few if any consolidation facilities exist at present or will exist in the future as independent economic entities. Consequently, EPA did not assess impacts on consolidation facilities. (2) *Recycling facilities.* Recycling facilities may be indirectly affected by the rule if the rule succeeds in increasing recycling of spent lamps. In this case, the rule would generate additional revenues and profits for firms owning or operating recycling facilities. Concerns have been expressed over the impacts of the CE option, in particular, on the business of lamp recyclers. This analysis does, in fact, assume that demand for recycling services would have been somewhat lower under the CE option than under the UW final action or the baseline (assuming full compliance). The reductions in demand, however, are not likely to be dramatic. First, EPA has some evidence that many facilities that recycle their lamps currently fall below the CESQG threshold, meaning that the regulations might not be the primary driver for the decision to recycle. Second, a substantial majority of existing recycling facilities are in states that officially encourage recycling. On the assumption that these states would not have been likely to follow the federal government if it had selected the CE option, we can predict that most recycling facilities, and most recycling volume, would not have been significantly affected by a federal choice of CE. In any case, the effects of the rule on recyclers would be an indirect impact, not the direct result of new regulatory requirements placed on the recyclers themselves.

Changes in Emissions -- Assessment of Benefits

By using estimated changes in number of lamps managed in different ways and emissions factors derived from the Mercury Emissions Model, we calculated the changes in total nationwide emissions that will result from EPA's final action. Annual emission changes are shown in Exhibit ES-9 and ES-10 for the two compliance scenarios. These exhibits also show the results of the separate analysis of the CE option.

Exhibit ES-9:
Mercury Emissions, Full Compliance Scenario

Mercury Emissions (kg)				
Full Compliance	CESQG	Non-CESQG	Average Annual 1998-2007	Average Annual Incremental Change from Baseline
Baseline	747.7	42.7	790.4	--
Final Action	747.7	42.8	790.5	0.1
CE Option	747.7	50.7	798.4	8.0

Exhibit ES-10:
Mercury Emissions, Low Compliance Scenario

Mercury Emissions (kg)				
Full Compliance	CESQG	Non-CESQG	Average Annual 1998-2007	Average Annual Incremental Change from Baseline
Baseline	747.7	74.3	822.0	--
Final Action	747.7	71.5	819.2	-2.8
CE Option	747.7	84.8	832.5	10.5

Notice that, under the full compliance scenario, the selection of UW as the final action at the federal level results in higher emissions, but to an inconsequential degree. Total annual mercury emissions from all sources in the U.S. are close to 150,000 kgs. EPA's final action would add only a about a tenth of an additional kg each year, an increase of one part in a million per year. The CE option, which largely deregulates lamps, would increase emissions by less than ten kg per year.

Explanation of Impacts

The small magnitude of the emissions differences between the baseline and EPA's final action can be explained using a Venn diagram to represent different aspects of the population of lamp users. The upper panel of Exhibit ES-11 shows the universe of lamps as the lightly shaded ellipse; within that ellipse is the population of lamps that are affected by the rules because they originate at SQGs or LQGs. Within that smaller ellipse, some are regulated in states that have adopted, or will soon adopt, a UW scheme even in the baseline, and others are in states that employ the full Subtitle C scheme. (The dividing line between these groups of lamps is shown as a solid vertical line.) Not shown in the exhibit is the extent to which the affected SQG/LQG facilities actually comply with the full Subtitle C or UW scheme that apply to them, or the much larger universe of mercury sources other than fluorescent lamps.

The lower panel shows the projected effects of EPA selecting of UW as its final action. The vertical line separating the facilities operating under full Subtitle C from those under the UW scheme shifts partway to the left, showing that EPA's action will change the behavior of some but not all states. Clearly, the scheme will change for only a small fraction of all facilities and lamps. Furthermore, the fraction of lamps that are actually managed differently as a result of this change could be even smaller, depending on the fraction of compliant versus non-compliant facilities. Finally, when one considers that many of the provisions of the Subtitle C scheme are the same or similar to those of the UW scheme (e.g., lamps must be recycled or disposed of at a Subtitle C facility), it is not surprising that a shift by EPA from the full Subtitle C option to the UW final action will have little effect on either costs or emissions.

Cost Effectiveness

The following tables present the costs and emissions consequences of the final action (and the CE option) relative to the baseline and each other. This direct comparison makes it possible to see how much it costs, *per kilogram*, to prevent the emissions of additional mercury by shifting to more protective regulations.

Exhibit ES-12 presents these comparisons under the scenario that assumes 100 percent compliance with applicable regulations. The first row of the table shows the effects of shifting from the full Subtitle C baseline to the UW final action. The final action saves more than a million dollars per year, while allowing an increase in emissions of much less than a kilogram. The savings amount to over ten million dollars per kilogram, implying that it would be very expensive *per-kilogram* to keep emissions low by holding to the baseline.

The second row of Exhibit ES-12 shows that the CE option would save even more money compared to the baseline — over $6 million per year — but would allow more emissions as well. Each kilogram of emissions avoided by keeping the baseline rather than shifting to CE would cost less than a million dollars. The last row compares the final action to the CE option, and shows that the selection of UW will cost less than $5 million per year while cutting emissions by almost 8 kilograms, for a cost of $580,000 per kilogram.

Exhibit ES-13 presents the same cost-effectiveness calculations under the more realistic compliance scenario. Because the streamlined compliance requirements under UW are assumed to result in much higher compliance (80 percent for UW vs. 20 percent for the full Subtitle C regime) EPA's final action is expected to cost more than the baseline under this scenario. On the other hand, it would reduce mercury emissions by several kilogram per year, at a cost per kilogram of roughly a half-million dollars.

The CE option, on the other hand, would reduce annual costs by over two million dollars in comparison to the baseline, though along with these savings would come an increase of more than 10 kilograms per year. Thus, choosing the baseline instead of CE would keep mercury emissions down at a cost of about $200 thousand per kilogram avoided. Finally, EPA's final action will cut emissions by over 13 kilograms per year compared to the CE option, at a cost of less than a third of a million dollars each.

Small Entity Analysis

EPA estimates that the UW final action would result in savings, or no incremental costs to affected small entities relative to the current requirements to manage used lamps as hazardous waste. Costs could increase for small entities (economic definition) that may not be complying with current requirements, but even these costs would not be expected to result in significant impacts to a substantial number of small entities. A small entity analysis, in accordance with the Small Business Regulatory Enforcement and Fairness Act (SBREFA), is presented in a separate document.

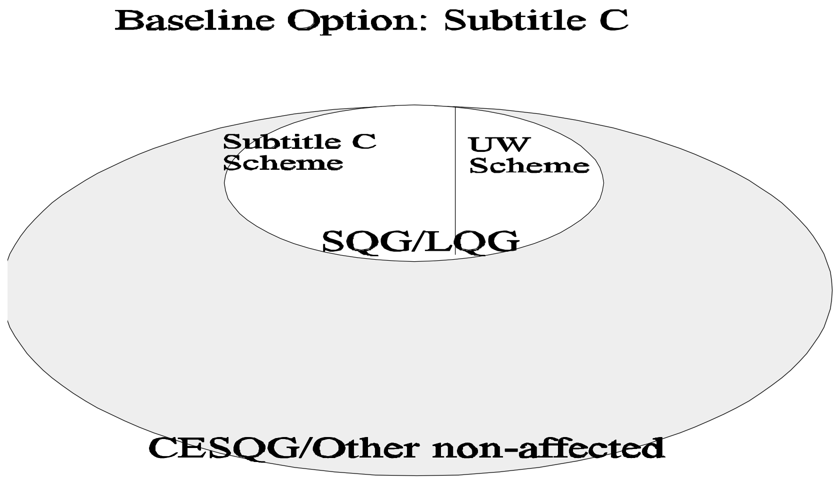
Regulatory Issues

No issues with respect to environmental justice, impacts on children, unfunded mandates, or regulatory takings were uncovered in this analysis. Chapter eight of the *Economic Assessment* contains a complete discussion and justification of the Agency's conclusion's related to these issues.

Limitations

The analysis presented in this report was made more difficult by several factors. First, data on the actual steps taken to manage lamps is difficult to find, in part because of low compliance rates at present, so there is uncertainty about management trains and cost. One possibility is that costs for lamp management (especially for new technologies like recycling) will decline significantly as more experience accumulates. Second, the lamp population is changing rapidly, and in ways that could significantly affect the number of lamps subject to regulations (due to the growth in group relamping, which results in smaller facilities crossing the threshold to SQG status). Because much of the anticipated change in still in the future, it is difficult to estimate its eventual extent. This difficulty is even more serious in the area of predicting the regulatory schemes that will be chosen by individual states, and how their choices might be affected by EPA's decisions. One particular area of concern relates to CESQG thresholds: some states have much lower thresholds than the 100 kg/month federal cut-off, which means that the adoption of the CE option at the federal level could have had a significant impact in those states. Finally, there is very little solid data on emissions rates from spent lamps, which makes modeling of the effects of regulatory changes highly uncertain.

ES-11: Illustration of Affected Populations



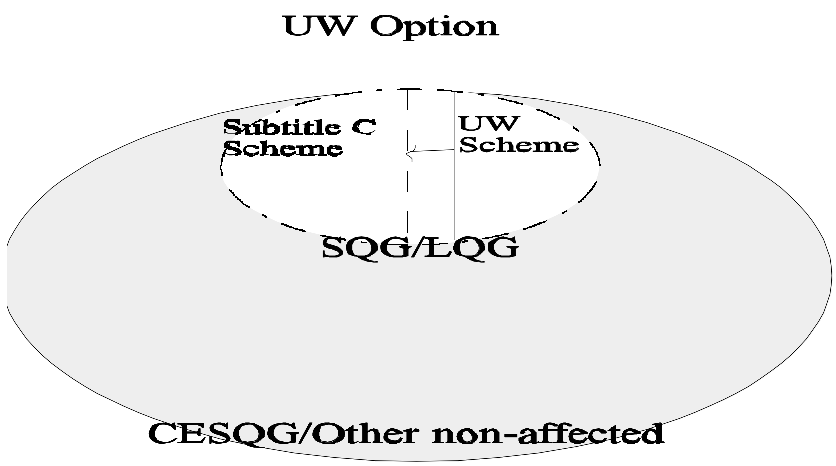


Exhibit ES-12:
Incremental Annual Average Cost, Emissions, and Cost Effectiveness
Full Compliance Scenario

	Difference in Cost	Change in Mercury Emissions (kg)	Cost/kg of Mercury
UW Action Compared to Baseline	- $ 1,490,000	+ 0.14	$10,480,000
CE Option Compared to Baseline	- $6,110,000	+ 8.04	$ 760,000
UW Action Compared to CE Option	+ $ 4,620,000	- 7.89	$ 580,000

Exhibit ES-13:
Incremental Annual Average Cost, Emissions, and Cost Effectiveness
Low Compliance Scenario

	Difference in Cost	Change in Mercury Emissions (kg)	Cost/kg of Mercury
UW Compared to Baseline	+ $1,770,000	- 2.83	$ 630,000
CE Option Compared to Baseline	- $1,770,000	+10.48	$ 170,000
UW Compared to CE Option	+ $3,540,000	- 13.31	$ 270,000

1. MODIFICATION OF THE HAZARDOUS WASTE PROGRAM: HAZARDOUS WASTE LAMPS

FINAL ECONOMIC ASSESSMENT
(Mercury-Containing Fluorescent Lamps)

Most fluorescent lamps contain quantities of mercury sufficient to fail the Toxicity Characteristic (TC) and are hazardous wastes under RCRA. As a result, lamps are currently subject to manifesting and disposal requirements. However, many generators do not recognize that lamps can be hazardous waste, and do not manage lamps as hazardous waste. To streamline the regulations affecting spent lamps, EPA is taking the final action of adding mercury-containing lamps to the universal waste (UW) regulations. Under the UW action, lamps that fail the TC would be subject to streamlined UW regulations. UW regulations include guidelines for the proper packaging of lamps, storage of lamps, EPA notification, and responding to releases. Under the UW regulatory scheme[1], transporters of spent lamps face guidelines similar to those encountered by generators, and sites receiving the lamps who would be subject to RCRA hazardous waste regulations.

EPA selected this action over another potential option — conditional exclusion (CE) of mercury-containing lamps from regulation as hazardous waste. The CE option would have excluded spent lamps from the definition of hazardous waste, thereby exempting them from RCRA regulations, if generators met two conditions. First, the lamps would have had to be either disposed in a municipal landfill permitted by a state/Tribe with an EPA-approved municipal solid waste permitting program or sent to a registered mercury recycling facility. Second, facilities would have had to keep track of all lamp shipments. Under this option, lamps managed in compliance with CE regulations would have been shipped either to Subtitle D landfills, Subtitle C facilities, or recyclers.

This report presents the Economic Assessment for the final Mercury Lamp rule. This Assessment is conducted by (1) laying out the distribution of lamp users and estimating the numbers of lamps they generate; (2) determining the nature of the actions required of them under various scenarios; and (3) estimating the costs and emissions consequences of these actions. Estimates of the economic impacts and mercury releases that the final action might cause are compared to the existing regulatory framework. The same analysis was also conducted for the CE option, in order to complete the work initiated at the proposal stage and to provided comparisons to the final action.

EPA's final action is deregulatory, and imposes reduced requirements on generators of spent lamps. Thus, it can be expected to lower total costs, and increase emissions to some (probably slight) extent. At the same time, it could encourage higher levels of compliance with the regulations, reducing emissions to some degree. The CE option would have been deregulatory as well.

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[1] In this report, it is necessary to distinguish between the set of regulations under which lamps are managed on the one hand, and actions taken or considered by EPA on the other. Under the authority of state programs, lamps are managed under specific sets of regulations — which could be based on full Subtitle C, or UW, or (if allowed by EPA) Conditional Exclusion. We refer to these sets of regulations as regulatory "schemes." Through its actions, EPA can influence which schemes the states choose to use. For example, EPA's final action will probably cause more states to manage lamps under the UW scheme than if it had elected to stay with the baseline. Similarly, if EPA had chosen the CE option, some states would have allowed lamps to be managed under a CE scheme. It is important to remember, though, that in analyzing the full Subtitle C baseline, not all lamps would be managed under the full Subtitle C scheme.

Both the final action and the CE option are analyzed in this report using a baseline that assumes full compliance with the current rule. The assumption of full compliance is not supported by evidence, as research indicates widespread non-compliance by generators of lamps. Rather, assuming full compliance allows EPA to calculate the effects of a change in its rule holding the effectiveness of enforcement constant. Under this full-compliance assumption, generators are projected to have lower costs under the final action, whereas their costs are likely to increase if enforcement becomes more feasible or widespread due to the final action. A sensitivity analysis considers the case of more realistic compliance rates.

Contents of Report

This report satisfies the regulatory analysis requirements established by the President under Executive Order 12866, "Regulatory Planning and Review," to the extent data and analytical scope allow. This first section includes, in addition to background on the existing regulations and this report, discussions on the need for the regulations of lamps. It also presents an overview of the analysis. Section 2 briefly discusses the regulated community, and presents our methodology for estimating numbers and sizes of lamp-using facilities, as well as the number of spent lamps generated each year. Section 3 introduces the final action and the option, and the activities that are required under each. Section 4 presents costs, both on a per-unit basis for each of the activities required under the baseline, final action, and regulatory option, and as nationwide totals. The impacts of these costs are assessed in Section 5. The emissions consequences of the final action and the option are presented in Section 6, while their cost-effectiveness is presented in Section 7. Section 8 includes an assessment of Environmental Justice, Unfunded Mandates, and Regulatory Takings and an analysis of the rule's potential effect on children. Section 9 lists references used in the preparation of this report. Finally, Appendices to this report explain (A) the basis of the unit cost assumptions; (B) the basis for the report's assumptions about state responses to EPA's rule; © emissions assumptions; (D) projected changes in recycling costs.

A small entity analysis in accordance with the Small Business Regulatory Enforcement and Fairness Act (SBREFA) is presented in a separate document.

1.1 Overview of Analysis

Need for Regulation

Mercury lamps present risks to human health and the environment when improperly disposed. Without government intervention, market forces would most likely promote outcomes that cause releases of mercury. Neurotoxicity is the health effect of greatest concern for humans; death, reduced reproductive success, impaired growth and development, and behavioral abnormalities are effects of concern to fish, birds, and mammals.

<u>Problem being addressed</u>. Each fluorescent lamp contains a small amount of mercury that emits visible and ultraviolet light when electricity is passed through it. Phosphor powder on the inside of the glass tube is used to convert ultraviolet light into visible light. Most of the mercury in a spent fluorescent lamp settles in the end caps of the lamp, while the remainder is incorporated in the phosphor

powder along the length of the glass tube. When the lamp glass breaks, mercury in the lamp is released into the environment and causes health risks.[2]

Justification for government intervention. Government intervention increases the possibility that lamps will be properly managed. Without government intervention, the least costly measures would be more likely to be chosen by facilities[3] and mercury emissions would occur along the transportation and disposal route to Subtitle D landfills. The price of recovered mercury, glass, or aluminum would have to increase dramatically to make recyclers cost-competitive with Subtitle D landfills, which are more likely to be used if disposal of mercury were unrestricted.

Why non-regulatory approaches would not work. Some states have already developed rules regarding the transportation, treatment, and disposal of spent fluorescent lamps. There is a wide degree of variation in policies across states, from required recycling of lamps to straight adoption of the current federal requirements. Federal hazardous waste regulations that were adopted by states would encourage uniformity in the processing of spent lamps. Spent fluorescent lamps cross state boundaries for recycling and for disposal; therefore, having similar federal requirements makes crossing state borders less complicated for industry and therefore more attractive. Economic gains to society can be expected to result from reduced regulatory variation between states.

Background on Previous Regulations and Analyses Related to this Action

The majority of mercury-containing lamps currently fail the Toxicity Characteristic (TC) and are, therefore, hazardous wastes under RCRA. Yet, many spent lamp generators do not realize lamps need to be managed as hazardous waste. To make matters even more ambiguous for generators, lamps generated in homes or in facilities small enough to be classified as conditionally exempt small quantity generators (CESQG) are not considered hazardous waste even if the lamps fail the TC.

On July 24, 1994, in order to clarify regulations and improve compliance rates for the management of mercury-containing lamps, EPA published a proposed rule that presented two options for the management of spent lamps (58 FR 39288). Both the universal waste (UW) and conditional exclusion (CE) options would reduce the regulatory burden on spent lamp generators, potentially leading to higher compliance rates.

Under the UW option, EPA proposed that lamps failing the TC should be subject to streamlined UW regulations. UW regulations included guidelines for the proper packaging of lamps, storage of lamps, EPA notification, and responding to releases. Under this regulatory scheme, transporters of spent lamps would face guidelines similar to those encountered by generators, and destination sites receiving the lamps would be subject to RCRA hazardous waste regulations.

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[2] See Section 6, "Assessment of Benefits," for a more detailed discussion of risk.

[3] Although recycling costs over two times per ton more than sending waste to a Subtitle C landfill, some generators choose to use the service (see “Economic Analysis of Impacts to Mercury-Lamp Recyclers Under Proposed Regulatory Alternatives,” 1997). However, with disposal costs of only $44 per ton at Subtitle D landfills, it is less certain that generators would continue to choose recycling if no federal regulation were in place.

The CE option would have excluded spent lamps from the definition of hazardous waste, thereby exempting them from RCRA regulations if generators meet two conditions. First, the lamps that were not sent to a registered mercury recycling facility would have had to have been disposed in a municipal landfill permitted by a state/Tribe with an EPA-approved municipal solid waste permitting program. Second, facilities would have had to keep track of all lamp shipments. Under this option, lamps managed in compliance with CE regulations would either be shipped to Subtitle D landfills, Subtitle C facilities, or recyclers.

EPA conducted a regulatory analysis of both the UW and CE options. The regulatory analysis included a cost estimate for each alternative. The regulatory cost of each option was compared to the current cost of meeting Subtitle C regulations and incremental costs were reported. In addition, the Agency prepared a mercury emissions model designed to measure aggregate mercury emissions under each alternative. Once again, these emission estimates were compared to emissions under current conditions, and incremental emissions effects of the alternative regulation schemes were discussed.

Extensive and constructive public comments were received regarding the regulatory analysis and emissions model. The Agency has modified and updated the original regulatory analysis and emissions model in support of its final action. Public comments have been incorporated in the revised version of the regulatory analysis. The final emissions model and report, presented under separate cover, reflects both public and peer review comments.

Summary of Major Public Comments and Agency Response

The Agency received numerous public comments addressing various issues associated with the Economic Impact Analysis (EIA) conducted in support of the proposed rule. The primary issues of concern covered four major areas: estimating lamp populations, baseline assumptions, assumptions under conditional exclusion, and assumptions under universal waste. Stakeholder comments and Agency responses for each of these five major areas are summarized below.

Estimating Lamp Populations:

Comments: Commenters raised concerns about the proposed EIA's estimate of the number of conditionally exempt small quantity generator (CESQG) lamps. The commenters indicated that, although the EIA assumes that CESQG lamps are not subject to RCRA, certain states regulate lamps below the CESQG threshold. One commenter also expressed concern that the EIA, in estimating the number of CESQGs (and CESQG lamps) does not assume that certain lamp generators generate hazardous wastes other than lamps and that the EIA thereby overestimates the number of CESQG lamps under the baseline and Universal Waste (UW) option.

Response: EPA agrees with the commenters that certain states regulate CESQG and household hazardous waste. In addition, other states have established exempt thresholds below the Federal program's. For the purposes of analysis, however, the Agency has made the simplifying assumption that states with lamp programs more stringent than the Federal program (i.e., with lower exemption thresholds) would not be likely to adopt the conditional exclusion (CE) option; and therefore, there would be no savings under the CE option for small generators in those states.

Further, EPA acknowledges that its estimate of the number of CESQGs may be overstated because some facilities generate other hazardous wastes besides lamps. However, EPA does not have reliable data on generation rates for CESQGs. The Agency has made the simplifying assumption that lamp generation rates determine regulatory status for lamp generators. The Agency believes that lamp generators are generally establishments that generate low quantities of hazardous waste (e.g., office buildings); therefore, the Agency does not believe its approach to quantifying CESQGs is a major limitation in this final Economic Assessment (EA).

Comment: Commenters raised concerns about the EIA's scope in analyzing lamp populations. One commenter believes the EIA should include under the baseline, lamps generated in California, Wisconsin, and Minnesota; the commenter further believes the EIA should include under the CE and UW options lamps generated in states with regulations less stringent than UW standards. Another commenter believes the EIA should incorporate mixed waste lamps explicitly into the analysis and show associated cost savings under the CE option.

Response: This final EA accounts for variations among state programs, such as California's and Florida's. For these and other states that are unlikely to adopt EPA's de-regulatory actions, however, the Agency does not expect to see significant cost effects. EPA is confident that the final analysis properly address state variability, where relevant, in determining cost savings. In addition, this final EA estimates compliance costs for all four- and eight-foot fluorescent lamps generated from commercial and industrial floor space. For purposes of the analysis, commercial floor space encompasses government buildings, except for buildings with restricted access. Therefore, EPA believes that DOE lamps used at unrestricted sites have been included in the analysis. Further, EPA recognizes that some lamps may be subject to a variety of Federal or state regulations other than RCRA.

Baseline Assumptions:

Comment: Various commenters believe the EIA underestimated waste management responsibilities and costs under the baseline. They believe a number of requirements and activities are not fully reflected in the analysis, such as rule familiarization, testing (e.g., for LDR compliance), transportation (e.g., manifesting), storage permits, treatment, and corrective action. Many of the commenters also cited their own compliance costs in asserting that the EIA underestimates baseline costs. Based on their experience, they found fault with the EIA as follows: (i) incorrect assumption that lamp generation is sporadic, instead of routine; (ii) omission of administrative costs, special lamp waste surcharges (e.g., for broken lamps) and pre-transportation activities (e.g., packaging); and (iii) failure to account for cost impacts due to facility-specific variations in size or location.

Response: The Agency notes the commenters' concerns and has developed this revised EA to address many of their comments. This final EA includes costs to generators under the baseline and UW options for, among other things, rule familiarization, waste characterization (i.e., testing or process knowledge), transportation (e.g., packaging, manifesting and related training), and treatment by stabilization. The Agency does not believe that permit-related costs would be significantly affected by the rule. The Agency believes that most permitted lamp waste handlers manage hazardous waste types besides just mercury-containing lamps. For example, in conducting consultations with lamp recyclers, the Agency found that the overwhelming majority recycled hazardous wastes besides just lamps. Therefore, even if lamps were conditionally excluded from RCRA, the Agency believes most permitted lamp waste handlers would continue to need a RCRA permit to manage their other hazardous waste streams and would see negligible permit-related cost savings.

Further, the Agency has now accounted for many of the other concerns raised by commenters. The final EA assumes that lamp waste generation may be sporadic (e.g., spot relamping) *and* routine (i.e., group relamping) at certain sites. The final EA also accounts for certain paperwork costs, including manifesting, notification, recordkeeping, and reporting (e.g., biennial reporting). Finally, this final EA computes facility-level and national costs based on a range of facility floor space (i.e., from small to large buildings).

Comment: Some commenters raised concerns about the EIA's assumptions concerning lamp waste management and disposal rates under the baseline. They disagreed that 97 percent of lamps are being disposed of in Subtitle C landfills, as estimated in the EIA. One commenter also believes that the national lamp recycling rate is between ten and 20 percent.

Response: EPA agrees with the commenters that the Agency's preliminary estimate of Subtitle C landfilling was too high. Based on comments received and other data compiled, the Agency has developed revised estimates to reflect a 2 percent lamp Subtitle C landfilling rate and a 10 percent lamp recycling rate under the baseline.

Assumptions Under Conditional Exclusion:

Comment: One commenter stated that the EIA underestimated compliance costs under the CE option. The commenter believes the EIA underestimated the percentage of lamp generators that would opt for segregated shipment of lamps to disposal, which would increase their costs. The commenter also points out that (i) lamp recyclers would face costs for testing and managing recycling residues, (ii) transportation distances to disposal sites should be increased from 25 to 100 miles, and (iii) recycling rates should be higher than estimated in the EA.

Response: EPA notes the commenter's concerns. The Agency believes that the final EA captures the primary compliance costs to lamp waste handlers under the baseline and options. For certain cost assumptions, EPA has used its best judgment because of a lack of reliable data (e.g., national percentage of lamps being crushed, average lamp transportation distances). Further, the Agency acknowledges that a number of handling scenarios were not captured in the EIA. The Agency believes, however, that addressing all possible handling scenarios (e.g., disposing, reusing, or re-selling of lamp recycling residues) would be too labor-intensive and provide little added benefit. Finally, please note that the Agency has revised the national lamps recycling rate to 10 percent under the baseline.

Comment: Various commenters believe that, under the CE option, lamp generators would send their spent lamps to Subtitle D landfills, leading to increased out-of-state lamp shipments. One commenter suggested that "interstate wars" could result, as generators shop for cheap disposal outside their state.

Response: This final EA does not consider lamp exports from states that would remain more stringent (i.e., retain the current Federal program) under the CE option. Under existing Federal regulations, lamp generators, excluding CESQGs, are required to send their lamps to destination sites subject to RCRA Subtitle C requirements, as applicable. Because of this, the Agency believes that a general assumption can be made under the CE option that generators in states that retain the Federal program would not violate their state's laws by shipping their lamp waste across state borders to non-Subtitle C facilities.

Comment: A number of commenters expressed doubt about the cost-effectiveness of regulating lamps as hazardous waste. They believe the CE option would provide sufficient environmental protection at a significantly reduced cost over the UW option or baseline.

Response: The Agency believes that one measure of an option's benefits is the extent to which it would adequately control against mercury emissions during management and disposal of spent lamps. The Agency has finalized the mercury emissions study examining emissions from the management and disposal of mercury-containing lamps. The Agency used results form this study in preparing final cost-effectiveness estimates, as presented in this EA.

Assumptions Under Universal Waste:

Comment: A number of commenters disagreed with the EIA's cost assumptions regarding lamp waste management and disposal costs under the UW option. They identified the following areas where the EIA underestimated costs: (i) transporting lamp residues from recyclers to disposal sites; (ii) complying with land disposal restrictions (e.g., mandatory testing); and (iii) recycling lamps. One commenter also believes the UW option's prohibition of on-site crushing would increase transportation costs and risks.

Response: EPA notes the commenters' concerns. The Agency believes that the final EA captures the primary compliance costs to lamp waste handlers. For certain cost assumptions, EPA has used its best judgment because of a lack of reliable data (e.g., percentage of generators testing their lamp waste). Further, the Agency acknowledges that a number of handling scenarios are not captured in the final EA. The Agency believes, however, that addressing all possible handling scenarios would be provide little added benefit. Finally, this final EA address transportation costs for transporting lamps (broken and unbroken) to destination sites.

Comment: Many commenters believed that the CE option would be a disincentive to continued lamps recycling and cited the current growth of the recycling industry, including employment and capital investment. They also summarized other economic benefits of lamps recycling, such as increased wages, profits and tax revenues. They recommend that these economic benefits be reflected in the final analysis. One commenter suggested that, when comparing landfilling to recycling, EPA should also consider the long- and short-term liabilities associated with landfilling.

Response: The final analysis researched economic impacts to lamp recyclers under the baseline and options. The Agency found that, as of 1995, the lamp recycling industry employed more than 1,000 employees and had a gross annual revenue (from lamps recycling and all other business activities) in excess of $146 million. Therefore, the Agency is well aware of the viability of the lamps recycling industry and its value to employment, profits, and tax revenues. Further, the Agency notes that liabilities exist with landfilling *and* recycling.

However, instead of focusing on waste handler "liability" per se, the Agency has examined the protectiveness of lamp waste management and disposal practices based on the amount of mercury released to the environment. The Agency used the final emissions model in preparing the cost-effectiveness analysis.

Comment: Two commenters stated that lamp recycling prices would decrease under the UW option because of greater lamp recycling capacity, competition and operating efficiency. They believe the final analysis should take these price reductions into consideration.

Response: In considering the economic impacts on lamp recyclers, EPA conducted consultations with lamp recyclers. Based on these and other data, EPA has updated the unit costs for recycling and other waste management methods in the final EA.

In addition, EPA agrees that, as the demand for lamp recycling grows, recycling would become more cost competitive with Subtitle C landfilling. Appendix D of this final EA addresses this issue.

Basic Analytical Approach

Establish a Baseline. To evaluate the incremental economic and environmental impacts of the final action and the option for the management of spent mercury-containing lamps, a description of current spent lamp disposal practices and costs had to be created as a reference point. Currently, as stipulated by federal regulations, spent mercury-containing lamps that exhibit the TC must be disposed of according to full Subtitle C hazardous waste regulations. The costs of meeting full Subtitle C regulations for spent lamps vary from facility to facility and depend largely on facility size and the disposal method chosen. Moreover, facilities that generate less than 100 kg of lamps per month (amounting to about 400 4-foot lamps, depending on type) are exempted from full Subtitle C regulation.[4] These conditionally exempt small quantity generators (CESQGs) face virtually no regulatory burden. Therefore, calculating the number and size of all facilities that exceed the CESQG thresholds, pinpointing the number of lamps they generate, determining disposal methods chosen by these facilities, and capturing the costs associated with these regulated disposal activities was the first step in the construction of the baseline. Next, the regulatory costs faced by all the generating facilities that fall under full Subtitle C regulations across the nation were added together, yielding the aggregate cost to generating facilities to manage spent lamps under full Subtitle C.

Not all states, however, mandate that spent lamp generators follow full Subtitle C disposal requirements. At this time, approximately 14 states allow spent mercury-containing lamps to be managed as UW. To complete the baseline, lamp generation and disposal practices and costs for generators operating under a UW regulatory scheme were also produced. Once again, costs depended on facility size (as above, CESQG facilities face no significant regulatory costs) and lamp disposal practices. Next, the total cost to the nation’s facilities for the disposing of lamps under a UW scheme was estimated.

[4] This 100 kg per month limit applies to all hazardous waste. Facilities generating less than 400 lamps per month would still face full Subtitle C requirements if they generate other hazardous waste resulting in an aggregate monthly total greater than 100 kg.

The baseline analysis then incorporated an assumption regarding the percentage of spent lamp generators that currently can dispose of their spent lamps as a UW and the fraction that are mandated to follow full Subtitle C regulations. Next, the total cost to the nation's facilities under Subtitle C regulations was multiplied by the fraction of facilities that operate under full Subtitle C. Similarly, total costs to the nation's facilities under a UW scheme were multiplied by the fraction of facilities operating under the UW Rule. The summation of these two products produced total baseline costs. In other words, we calculated the weighted average of the costs under full Subtitle C and UW, with the weights being the fraction of facilities (and lamps) managed under each scheme.

In addition, several per-facility costs were calculated, including costs for small quantity generators (SQGs) and large quantity generators (LQGs) that operate under full Subtitle C and costs for SQGs and LQGs that operate under a UW regulating scheme.

Timeframe of the Analysis The analysis described above was repeated for each year from 1998 through 2007. Over the course of this period, it is assumed that several parameters affecting regulatory costs will change, leading to differences in aggregate and per-facility regulatory costs from year to year. First, we assumed that the number of facilities would grow at 2.4 percent per year.[5] Second, we assumed (in the baseline) that federal regulatory standards for mercury-containing lamps would not change, but did presume that over time more states would manage spent lamps as UW. Moreover, we assumed that more and more facilities would switch to highly efficient T8 lamps over the years. Fourth, the way spent lamps were disposed of was assumed to change over time. For example, higher percentages of lamps were assumed to be recycled in future years. Finally, the method of lamp replacement within some facilities was assumed to change as they shifted to more cost-effective lighting over time. In particular, the Agency assumed that the number of facilities engaging in "group relamping" (i.e., changing all lamps at one time, as opposed to replacing each one as it fails) will increase in proportion to the growth of facilities using T8 bulbs. Therefore, depending on the behavior of the five dynamic variables, aggregate and per facility costs changed year to year. In the end, the model used in the economic analysis summed together the costs from each of the ten years to produce a ten-year cost figure, which was annualized to yield estimated baseline costs per year.

As inputs into the analysis of mercury emissions from the disposal of spent lamps, the baseline management parameters were used to determine the annual disposed lamp volume and method of disposal. The volume of lamps disposed of by regulated facilities and the method in which they were disposed, as well as the number and fate of lamps disposed of by CESQG generators, were used to generate an estimate of mercury emissions. (The mercury emissions estimates performed for this analysis were based closely on the results of the Mercury Emissions Model, 1997.) Assumptions about the annual changes in spent lamp management categorization (i.e., growth in CESQG facilities), changes in the mix of lamp types used, growth in commercial floorspace, and changes in relamping practices affected the annual volume of spent lamps and how they were disposed. Therefore, to incorporate the effects of these changes on ten-year aggregate emissions, mercury emissions were calculated for each year in the ten- year span and then totaled. This ten-year figure was also divided by ten to yield average, or annualized, emissions.

The Regulatory Action and Option. The process described above was repeated for both the UW final action and the CE option. The final action reduces the regulatory controls placed on wastes classified as UWs; generators of UWs have more flexibility and reduced record-keeping burdens when

[5] The cost model uses a slightly higher growth rate assumption in order to more closely track the number of spent lamps projected in the Mercury Emissions Model.

disposing of UWs. This economic analysis assumed that if the federal government defined spent mercury-containing lamps as UW, more states than indicated in the baseline would adopt the UW scheme for their lamps. Therefore, beginning in 1999 (after EPA's final action), aggregate costs will diverge from baseline costs because the fraction of facilities operating under the UW scheme will increase. In other words, the weighted average of costs under full Subtitle C and UW will shift part-way toward the costs under UW, because more facilities will be subject to UW.

As in the baseline analysis, the UW analysis was done on a year-by-year basis to account for the five dynamic variables described above. The increased use of the UW scheme in this action changed the manner in which some lamps were transported and treated for disposal. These changes in lamp disposal transportation and treatment generated annual mercury emissions that were different from the baseline. By comparing mercury emissions generated under the baseline with mercury emissions caused by the UW final action, the environmental impact of the rule change was determined.

The CE option, if it had been promulgated by EPA, would have removed mercury-containing lamps from the hazardous waste categorization provided they were recycled or disposed of in a municipal solid waste landfill that meets certain requirements. In analyzing this option, we did not assume that all lamps would be managed under a CE scheme as a consequence of the federal government's selection of the CE option. Instead, we assumed that some states would shift from full Subtitle C regulations to CE, some states that are currently managing spent lamps as a UW would adopt CE, and several states would continue to maintain a full Subtitle C scheme. In addition, some states were assumed to maintain or change to a UW scheme. Thus, total nationwide costs were assumed to be a weighted average of costs under three regulatory schemes — full Subtitle C, UW, and CE — where the weights were the fractions of facilities and lamps managed under each scheme.

After the percentage of facilities operating under each scheme in the first full year of promulgation (assumed to be 1999) were multiplied by the aggregate costs for the nation's non-CESQG generating facilities under each scheme and the products were summed together, a total regulatory cost facing facilities under a CE universe after the first year of promulgation was reached. Once again, these aggregate costs were determined on a yearly basis, allowing the model to reflect changes in the five variables discussed above: the growth in the number of facilities, staggered adoption of the CE regulation, the assumed increase in the use of T8 lamps, the change in disposal methods, and the shift to group relamping. Costs per facility under each of the three regulatory schemes in this option were also determined for both SQG and LQG facilities.

Finally, disposal parameters and activities under the CE option were determined and mercury emission figures obtained (included emissions from lamps produced by CESQGs). The effect on total mercury emissions of going from full Subtitle C universe to CE universe was determined.

Analytical Scenarios

The basic economic analysis was conducted under the assumption that all facilities comply completely with the regulatory scheme under which they operate. This is an unrealistic assumption, as many facilities are apparently unaware of disposal regulations, and dispose of lamps outside of the RCRA structure. To examine the consequences of non-compliance, EPA re-estimated costs and emissions under alternative compliance rate assumptions

Limitations

The analysis presented in this report was made more difficult by several factors. First, data on the actual steps taken to manage lamps is difficult to find, in part because of low compliance rates at present, so there is uncertainty about management trains and cost. One possibility is that costs for lamp management (especially for new technologies like recycling) will decline significantly as more experience accumulates; the analysis presented in Appendix D implies that the cost of recycling might decline by 25 percent as the recycling industry becomes more mature. Second, the lamp population is changing rapidly, and in ways that could significantly affect the number of lamps subject to regulations (due to the growth in group relamping, which results in smaller facilities crossing the threshold to SQG status).

Because much of the anticipated change in still in the future, it is difficult to estimate its eventual extent. This difficulty is even more serious in the area of predicting the regulatory schemes that will be chosen by individual states, and how their choices might be affected by EPA's decisions. One particular area of concern relates to CESQG thresholds: some states have much lower thresholds than the 100 kg/month federal cut-off, which means that the adoption of the CE option at the federal level could have a significant impact in those states. Finally, there is very little solid data on emissions rates from spent lamps, which makes modeling of the effects of regulatory changes highly uncertain.

2. REGULATED COMMUNITY

2.1 Number of Industrial and Commercial Facilities

As part of an effort to characterize the community affected by changes to the regulations governing fluorescent lamp disposal, the total number of commercial and industrial facilities (including CESQG, SQG, and LQG) was estimated by building size range using the following methodology. For each size category of commercial buildings, the total square footage was divided by the total number of buildings, using 1996 national data.[1] This average area per building (listed in column 2 of Exhibit 2-1) for each size category was applied to the total area of both industrial and commercial facilities (column 3 in Exhibit 2-1). The facility size ranges used were the same as those used in the Statistical Abstract. (See Section 2-2 for a discussion of the estimation of total areas and areas by building.) The following results were obtained:

Exhibit 2-1: Number of Facilities, by Building Size

Facility Size Range [1] (sq.ft.)	Average Facility Size [2] (sq.ft.)	Total Industrial and Commercial Fluorescent Illuminated Area [3] (sq.ft, 1998)	Number of Industrial and Commercial Facilities [4]
1,001 to 5,000	2,755	6,609,370,900	2,399,027
5,001 to 10,000	7,397	6,667,952,887	901,407
10,001 to 25,000	16,078	9,540,359,968	593,379
25,001 to 50,000	35,840	9,312,646,117	259,839
50,001 to 100,000	69,526	7,489,045,569	107,715
100,001 to 200,000	137,971	9,125,561,709	66,141
200,001 to 500,000	307,920	7,254,717,623	23,622
500,001 and over	807,889	6,870,155,227	8,504
Total	N/A	62,869,810,000	4,361,632

2.2 Commercial and Industrial Area, Illuminated By Fluorescent Lamps

A multi-step process was employed to estimate the commercial and industrial area lighted by fluorescent lamps in the United States. We started with the finding that fluorescent-lighted floorspace was 37.8 billion square feet in 1986.[2] This is for commercial facilities only and does not include unlit space or space lit with high intensity discharge (HID) or incandescent lamps. The 1986 value was

[1] Statistical Abstract of the United States, 1996, U.S. Department of Commerce, Bureau of the Census, Table No. 924.

[2] Lighting in Commercial Buildings, Table D-3, Energy Information Administration, March 1992.

updated to 1998 levels using an annual growth rate of 2.4 percent per year, over the 12 years.[3] The 1998 commercial area lighted by fluorescent lamps was calculated to be 50.3 billion square feet. Fluorescent lamps were found to light 76.2 percent of all lighted floorspace.[4] Assuming a ratio between commercial and industrial floorspace of about four to one, the Agency estimated there were approximately 12.57 billion square feet of fluorescent lighted industrial floorspace in 1998. In total, the base amount of commercial and industrial floorspace lit by fluorescent lamps in 1998 is estimated at 62.87 billion square feet.

Fluorescent lighted floorspace was broken down by building size using data from the 1996 *Statistical Abstract*.[5] The following results were obtained:

Exhibit 2-2: Commercial and Industrial Fluorescent Lighted Building Area by Building Size

Building Size (sqft)	Total Commercial Area (sqft)	Total Industrial Area (sqft)
1,001 to 5,000	5,287,500,000	1,321,880,000
5,001 to 10,000	5,334,360,000	1,333,590,000
10,001 to 25,000	7,632,290,000	1,908,070,000
25,001 to 50,000	7,450,120,000	1,862,530,000
50,001 to 100,000	5,991,240,000	1,497,810,000
100,001 to 200,000	7,300,450,000	1,825,110,000
200,001 to 500,000	5,803,770,000	1,450,940,000
500,001 and over	5,496,120,000	1,374,030,000
Total	**50,295,840,000**	**12,573,970,000***

* Difference in total due to rounding

Source: Lighting in Commercial Buildings, Table C-1, D-3 Energy Information Administration, March 1992.
Statistical Abstract of the United States, 1996, U.S. Department of Commerce, Bureau of the Census, Table No. 924, 1996.

Total commercial/industrial floorspace was estimated to be 20 percent industrial, and therefore 80 percent commercial. The 20 percent figure was determined from two analyses:

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[3] Mercury Emissions from the Disposal of Fluorescent Lamps, USEPA Office of Solid Waste (OSW), June 30, 1997.

[4] Lighting in Commercial Buildings, Table C-1, Energy Information Administration, March 1992.

[5] Statistical Abstract of the United States, 1996, U.S. Department of Commerce, Bureau of the Census, Table No. 924.

- National construction statistics averaged for 1960, 1970, and 1980 indicated that 19 percent of buildings constructed were industrial.[6]
- Information regarding total industrial and commercial area from EPA's Atmospheric and Pollution Prevention Division,[7] and values of industrial floorspace area for 1995[8] updated to 1998 showed that approximately 21 percent of floorspace in 1998 is used for industrial purposes.

The analysis assumes that the percentage of floorspace lighted by fluorescent lamps at industrial facilities is identical to that at commercial sites. Estimates of total lighted areas are shown in Exhibit 2-3.

Exhibit 2-3: Commercial and Industrial Fluorescent Lighted Building Area

Building Type	Area (sq.ft.)	Percent of Area
Commercial	50,295,840,000	80%
Industrial	12,573,970,000	20%
Total	62,869,810,000	100%

2.3 Fluorescent Lamp Population

The total industrial/commercial building fluorescent lamp population was estimated in the cost model using the area data derived above in combination with estimates of lamp density (i.e., the number of lamps used per square foot). Lamp densities were available for small (1,001 - 100,000 sqft), medium (100,001 - 500,000 sqft), and large (500,000+ sqft) facilities, for both T12 and T8 lamps.[9]

Exhibit 2-4:
Weighted Average Fluorescent Lamp Densities by Building Size and Lamp Type

Building Group	T12 Lamp Density (lamps/ft^2)	T8 Lamp Density (lamps/ft^2)
Small (1,001 - 100,000 ft^2)	0.058	0.049
Medium (100,001 - 500,000 ft^2)	0.044	0.038
Large (500,000+ ft^2)	0.036	0.031

[6] Statistical Abstract of the United States, U.S. Department of Commerce, Bureau of the Census, 1971, 1988, 1996.

[7] Presentation, USEPA Atmospheric Pollution Prevention Division (APPD), C&I Quarterly Meeting, January 13, 1998.

[8] Statistical Abstract of the United States, 1997, U.S. Department of Commerce, Bureau of the Census, Table No. 1215.

[9] Mercury Emissions from the Disposal of Fluorescent Lamps, USEPA Office of Solid Waste (OSW), June 30, 1997.

For each situation presented in the model, the appropriate lamp density was used to calculate the population for each type of fluorescent lamp. The weighted average lamp density values presented in Exhibit 2-4 apply to both commercial and industrial buildings. Industrial buildings generally require dimmer lighting than commercial facilities. Industrial facilities were found to have approximately 80 per cent as many lamps per square foot, as compared to commercial buildings of similar size.[10]

The percentage of facilities using T12 and T8 lamps is projected to change over time, with T8s growing as a percentage of the total lamp population. The model assumes that these percentages will be different for small, medium and large facilities, and that large facilities will adopt T8s faster than small and medium facilities. Exhibit 2-5 presents the percentage of T12s and T8s in use over the planning horizon.

Exhibit 2-5: Lamp Populations

Facility Size & Bulb Type	**year**										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Small											
T12	87.6%	84.9%	82.2%	79.7%	77.2%	74.9%	72.7%	70.6%	68.6%	66.6%	64.6%
T8	12.4%	15.2%	17.8%	20.4%	22.8%	25.1%	27.3%	29.4%	31.5%	33.4%	35.4%
Medium											
T12	82.2%	78.9%	75.7%	72.7%	69.9%	67.2%	64.6%	62.2%	60.0%	57.8%	55.6%
T8	17.8%	21.2%	24.3%	27.3%	30.2%	32.9%	35.4%	37.8%	40.1%	42.2%	44.4%
Large											
T12	49.0%	43.0%	37.8%	33.4%	29.7%	26.4%	23.7%	21.3%	19.3%	17.5%	15.7%
T8	51.0%	57.0%	62.2%	66.6%	70.4%	73.6%	76.4%	78.7%	80.8%	82.5%	84.3%

This analysis assumes that all fluorescent lighting is by four-foot lamps. In reality, many lamps are eight feet long; in 1993, for example, roughly a 20 percent of lamps were in the larger category.[11] Because the larger lamps give twice as much light, cost twice as much to manage, and contain twice as much mercury, there were treated in the analysis as though each one was the equivalent of two four-foot lamps.[12] This simplification should have very little effect on the

[10] Audin, L., Houghton, D., Shepard, M., Hawthorne, W., E Source Technological Atlas Series, Volume I, Lighting, E Source, 1994.

[11] Audin, L., Houghton, D., Shepard, M., Hawthorne, W., E Source Technological Atlas Series, Volume I, Lighting, E Source, pp. 80- 81, 1994.

[12] Telephone conversation with Joe Howley, General Electric Lighting, January 22, 1998.

analysis other than artificially inflating the data on numbers of lamps (e.g., if the analyzed universe contained 16 four-foot lamps and 4 eight-foot lamps, this analysis would assume a total of 24 lamps instead of 20) -- the calculation of tonnage, emission, and cost totals will be unaffected by this simplification.

Assumptions About Waste Generation Rates

Fluorescent lamps have a typical lifespan of 20,000 hours. Assuming lamps are operated between 4,000 to 5,000 hours annually, a typical lamp will operate from four to five years. However, due to numerous uncontrolled factors, many lamps will not last the full five years. For this reason, both the cost model and the Mercury Emissions Model assume a lamp lifespan of four years. If a facility is spot-relamping spent bulbs, a four-year lifespan assumption translates into an annual relamping rate of 25 percent. For example, a facility that contains a total of 16,800 lamps would be expected to need to replace 4,200 lamps annually, or, if it can be assumed that lamps are spent evenly throughout the year, 350 bulbs a month.

EPA, through its energy efficiency program, Green Lights, is encouraging facilities that use fluorescent lights to replace all their T12 lamps with highly efficient T8 lamps. If a facility undertakes this upgrade, all lamps in the facility would be replaced in the span of a few weeks. In this case the representative facility introduced above would generate 16,800 spent lamps within a very short time span. EPA estimates that 60 percent of the facilities that participate in the Green Lights program continue to group relamp after the initial upgrade. In other words, assuming a group relamping takes place every 4 years, a group relamping facility with 16,800 lamps would need to replace all their lamps all at once every four years. The facilities that reverted to spot relamping after the initial upgrade would continue to relamp at an annual rate of 25 percent. This economic and mercury emissions analysis assumes that 60 percent of the facilities that are upgrading to T8 lamps outside of the Green Lights program will also continue to group relamp after the initial lighting overhaul.

The relamping procedure a facility chooses largely determines whether they are classified as a conditionally exempt small quantity generator (CESQG), a small quantity generator (SQG) disposing of 100-1000 kgs of lamps per month, or a large quantity generator (LQG). A facility must produce no more than about 350 T12 lamps per month if it is to qualify as a CESQG and avoid full Subtitle C regulations. If 25 percent of a facility's lamps fail in one year, and there are 0.0574 lamps per square foot and 0.044 lamps per square foot in a small and medium sized facility respectively, any facility that is 381,724 square feet or less and spot relamps is a CESQG. Under this scenario, roughly 99.3 percent of all facilities would avoid full Subtitle C regulations for mercury containing lamps. Alternatively, if a facility group relamped it could only avoid full Subtitle C regulations if it were smaller than 5,935 square feet. If all facilities group relamped, 56 percent of all facilities would qualify as CESQGs, while 39 percent would be classified as SQG and 5 percent as LQG.

If regulatory status were the only consideration, facilities larger that 5,935 square feet would presumably choose to spot relamp in order to avoid the regulatory costs that accompany SQG or LQG status. However, EPA's Green Lights Program has indicated that group relamping costs (labor, parts, etc.) plus the regulatory costs of properly managing the hazardous waste under full Subtitle C regulations is lower than the costs incurred by spot relampers who avoid full Subtitle C regulatory costs. (Presumably, this result is driven by the less efficient use of labor in spot relamping.)

Under EPA's final action and the option considered in this analysis, CESQG thresholds would still hold: a facility would need to produce fewer than 350 T12 lamps a month (or somewhat more T8 lamps) to qualify for regulatory exemption. Under the UW scheme, the distinction between small and large generators would change as well as the scope of the regulated facility. Under UW, the generating facility, transporter of spent lamps, and destination receiving the spent lamps is considered one entity. A large quantity handler (LQH) results when this group of facilities at any time has more than 5,000 kg of lamps. If all facilities group relamped under UW, 56 percent of the facilities would qualify as CESQGs, 43.5 percent as SQHs, and 0.5 percent as LQHs. If all facilities spot relamped under UW, 99.3 percent would qualify as CESQGs, 0.69 percent as SQHs, and 0.01 percent as LQHs. Percentage breakdowns by generator type under CE are assumed to be the same as under the Baseline.

2.4 Consolidators and Recyclers

No evidence supporting the use of consolidation facilities by fluorescent lamp recyclers and disposal facilities was found while investigating the regulated community. Recyclers generally have the lamps shipped directly to their facilities, and may have found that direct shipment is the most cost-effective method of receiving lamps. In addition, we have found that the discounts offered by recyclers for larger volumes of lamps are relatively small (on the order of 10 to 20 percent), suggesting that there would be little incentive to establish or patronize an independent consolidation facility that existed only to "bundle" small shipments into larger ones.

While recyclers are one of the entities used to implement new fluorescent lamp disposal regulations, the costs of the regulatory change were assumed to mostly affect lamp generators. Costs to the recycling industry have therefore not been analyzed in this report.

3. REGULATORY REQUIREMENTS

This section presents the actions required by generators under full Subtitle C, Universal Waste, and Conditional Exclusion regulatory schemes. Also presented in this section are parameter values that were assumed in developing the cost model.

3.1 Baseline: RCRA Subtitle C

The baseline assumes that no action is taken by the Agency and that current trends in the management of fluorescent lamps continue. For the baseline, 100 percent compliance with Subtitle C standards for managing spent mercury-containing fluorescent lamps was assumed. The activities required under Subtitle C are summarized in Exhibit 3-1.

Exhibit 3-1: Compliance Requirements Under Subtitle C

Required Activity	CESQG	SQG		LQG	
		New Facilities	Existing Facilities	New Facilities	Existing Facilities
Notification		√		√	
Rule Familiarization		√		√	
Emergency Planning		√		√	
Waste Characterization		√		√	
Record Keeping		√	√	√	√
Safety Training		√	√	√	√
Manifest Training		√	√	√	√
Biennial Reporting				√	√

Facilities that practice spot relamping are all SQGs except for about 0.2 percent (180 facilities) of regulated facilities which are LQG. The LQGs that spot relamp are assumed to ship lamps off site two times a year to avoid holding lamps longer than 180 days, thereby avoiding the need to obtain a RCRA Part B permit for storing materials longer than 180 days. The cost model assumes that 25 percent of the installed lamps in facilities that spot relamp are replaced each year. Facilities that group relamp were assumed to relamp their facilities every four years. In addition, facilities that group relamp are assumed to spot relamp 4.8 percent of their installed lamps each year (to account for lamps that fail between group relamping occasions).

The assumed percentage of lamps generated by SQGs and LQGs and disposed in Subtitle C landfills is the difference between the compliance rate and the recycling rate. Thus, for 100 percent compliance, 90 percent of the lamps generated by compliant generators are disposed of in Subtitle C landfills. The other 10 percent are recycled. Lamps generated by non-compliant generators are disposed of in Subtitle D landfills or municipal waste combustors. Facilities that group relamp and have a total facility size greater than 120,000 square feet are considered LQGs; they account for 0.25 percent of the generators and 38 percent of the floor space. The model assumes that the only facilities that practice group relamping are those that use T8 lamps.

3.2 Final Action: Universal Waste Scheme

The requirements under the Universal Waste (UW) scheme are significantly reduced compared with the full Subtitle C requirements. The activities required for large quantity handlers of universal waste (LQHUW) under UW are notification, rule familiarization, personnel safety training and shipping record keeping. Facilities that group relamp and are LQHUW represent less than 0.1 percent of all facilities greater than 1,000 square feet. Small quantity handlers of universal waste (SQHUW) do not have notification or shipping record-keeping requirements, though they still incur costs for rule familiarization and a lower cost for personnel safety training. Given the assumption that there is full compliance under Subtitle C, the costs for notification and personnel safety training are sunk costs and are considered only for new facilities. Transportation costs under UW are reduced from Subtitle C costs, because universal waste does not have to be transported by a licensed hazardous waste transporter. The activities required under Universal Waste are summarized in Exhibit 3-2.

Exhibit 3-2: Compliance Requirements Under Universal Waste

Required Activity	**CESQG**	**SQHUW**		**LQHUW**	
		New Facilities	Existing Facilities	New Facilities	Existing Facilities
Notification				√	
Rule Familiarization		√		√	
Waste Characterization		√		√	
Record Keeping				√	√
Safety Training		√ (reduced)	√	√	√

3.3 Conditional Exclusion Scheme

The requirements under the CE scheme are that generators keep a record of their shipments, including the destination, and that they send lamps only to permitted Subtitle D landfills and not to municipal waste combustors.

3.4 Parameters and Assumptions by Regulatory Scheme and Scenario

One of the parameters that is changed over the planning horizon is the percentage of states that are assumed to be using each of the different regulatory alternatives. Appendix B of this report details how we developed these percentages, how they change over time, and the percentages used in the model.

Another parameter that is changed in the model is the compliance rate under each regulatory option. Under one scenario, we assumed a compliance rate of 100 percent for all three regulatory schemes. We also considered a more realistic scenario with compliance rates of 20 percent, 80 percent and 90 percent for the full Subtitle C, UW, and CE schemes, respectively. The model was run for both the full and low compliance scenarios under each of the regulatory schemes. Exhibit 3-3 presents the assumed compliance percentages under the three regulatory schemes.

Exhibit 3-3: Percent Compliance by Regulatory Scheme

Percent Compliance by Regulatory Scheme	High Estimate	Low Estimate
Full Subtitle C	100 %	20 %
Universal Waste	100 %	80 %
Conditional Exclusion	100 %	90 %

The portion of lamps recycled is assumed to be at least 10 percent in all scenarios and options. In cases where lamps are managed under CE and under full Subtitle C in the low compliance scenarios, the recycling rate remains at 10 percent. Under the UW scheme, and under the full Subtitle C scheme in the higher compliance scenario, recycling is assumed to rise steadily to 18 percent of all spent lamps. The remainder of lamps are disposed of in landfills or in municipal waste combustors. The annual increase in the recycling rate is assumed to be constant for the scenarios where the rate is increasing. Exhibit 3-4 contains a summary of how the recycling rates change under the different compliance scenarios.

Exhibit 3-4: Lamp Recycling Rates

Compliance Scenario	Recycling Rates		
	Subtitle C	UW	CE
Low Compliance	10%	Rising from 10% to 18%	10%
High Compliance	Rising from 10% to 18%	Rising from 10% to 18%	10%

4. ESTIMATION OF BASELINE, FINAL ACTION, AND CE OPTION COSTS

This section contains the unit costs incurred by regulated generators of mercury containing lamps. Costs that are assumed the same under all three alternatives are storage and disposal for the different disposal methods; Subtitle C landfill; Subtitle D landfill; recycling; retorting and municipal waste combustor. The unit cost for disposal at a Subtitle C landfill is assumed to be the same under both Subtitle C and the UW scheme, and the cost for disposal under the other types of disposal is assumed the same for all three schemes. The unit costs for recycling and retorting, including breakage control costs, apply only to those lamps that are reclaimed under each regulatory scheme. The transportation and disposal costs for municipal waste combustors are assumed to be the same as the costs for Subtitle D transportation and disposal. To arrive at a Universal Waste shipping cost we calculated a per ton-mile cost using the Subtitle D transportation cost and assumed a 200-mile shipping distance. Exhibit 4-1 contains the unit costs for transportation and disposal.

Exhibit 4-1: Transportation and Disposal Unit Costs

Transportation/Disposal Activity	**Unit Cost** (1997 dollars)
Subtitle C Landfill Tipping Fees (includes stabilization)	$ 489.88 /ton
Subtitle C Transportation Cost (300 mile)	$ 85.34 /ton
Subtitle D Landfill Tipping Fees	$ 42.86 /ton
Subtitle D Transportation Cost (25 mile)	$ 7.14 /ton
Subtitle D Transportation Cost (200 mile)	$ 32.00 /ton
Recycling	
Breakage Control Packaging (standard box of 117 lamps going to recyclers)	$ 8.62 /box
Transportation and Tipping Fee	$ 0.40 /lamp
Retorting	
Transportation and Tipping Fee	$ 1.31 /lamp
Lamp Crushing	$ 78.67 /ton
Drum Cost	$ 44.96 /drum

For lamps sent to retorters, the tipping fee assumes that the lamps arrive crushed and contained in 55 gallon drums with 600 lamps per drum. Transportation, crushing, and packaging costs are not included in the tipping fees for retorters. The tipping fees at recycling facilities include transportation, but do not include the costs for packaging the lamps or the packing material.[1]

[1] This analysis assumes that the cost of recycling lamps remains constant over the modeling period. However, the cost might be expected to decrease on the order of 25 percent. See Appendix D for a quantitative discussion of the learning curve associated with lamp recycling.

The entry and exit rate for new facilities generating spent lamps is assumed to be 5 percent per year. The cost of conducting waste characterization is assessed to new facilities that are medium sized and LQGs or LQHUW and to large facilities that are SQGs, LQGs, SQHUW, or LQHUW. Facilities in these categories comprise 0.3 percent of all regulated facilities. The remaining new facilities are assumed to rely on manufacturer information for waste characterization.

Initial fixed costs are amortized over the ten-year planning horizon at a 7 percent annual discount rate. The description of the costs below detail the regulatory requirements that are included in initial fixed costs.

4.1 Unit Costs for Full Subtitle C Scheme

The unit costs of compliance under Subtitle C are shown in Exhibit 4-2. The variable costs that apply to all large quantity generators of spent mercury-containing fluorescent lamps include personnel safety training, manifest training, record-keeping, manifesting, exception reporting, and biennial reporting. There is also a recurring cost for personnel safety training that is applicable to all facilities. Appendix A contains the backup calculations and sources of the unit costs.

Exhibit 4-2: Facility Cost Estimates Under Full Subtitle C Scheme, 1997

Subtitle C Requirement	**Unit (facility) Cost Estimates**			
	Large Quantity Generators		Small Quantity Generators	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Initial Fixed Costs				
Notification of Hazardous Waste Activity	$ 150	$ 83	$ 150	$ 83
Rule Familiarization	$ 1,107	$ 332	$ 1,107	$ 130
Emergency Planning	$ 586	$ 214	$ 395	$ 116
Waste Characterization	$ 312	$ 0	$ 312	$ 0
Total Initial Fixed Costs	$ 2,155	$ 629	$ 1,964	$ 329
Annualized Initial Fixed Costs	$ 307	$ 90	$ 280	$ 47
Annual Costs				
Subtitle C Record Keeping (per year)	$ 33	$ 14	$ 33	$ 14
Biennial Reporting (annualized cost)	$ 361	$ 130	$ 0	$ 0
Personnel Safety Training (annualized costs)	$ 474	$ 208	$ 74	$ 29
Manifest Training (per year)	$ 164	$ 4	$ 34	$ 2
Subtotal Annual Costs	$ 1,032	$ 356	$ 141	$ 45
Variable Costs				
Manifesting & Landban Notification per shipment	$ 42	$ 31	$ 33	$ 30
Exception Reporting (per report)	$ 64	$ 32	$ 30	$ 17
Total Annualized Cost for New Facilities[2]				

[2] Facilities that group relamp prepare one manifest and facilities that spot relamp prepare two manifests each year.

Facilities that Group Relamp	$1,384	$447	$454	$122
Facilities that Spot Relamp	$1,424	$508	$487	$152
Total Annualized Cost for Existing Facilities				
Facilities that Group Relamp	$1,074	$387	$174	$75
Facilities that Spot Relamp	$1,117	$418	$207	$105

The high and low-cost estimates under the full Subtitle C scheme were applied to small, medium and large facilities according to Exhibit 4-3. The lower costs for smaller facilities were selected on the assumption that small facilities have lower training and emergency planning costs, based on their simpler facilities and organizational structures, and do not independently characterize their lamps, because they find it more economical to rely on existing information.

Exhibit 4-3: Allocation of High and Low Unit Costs Under Full Subtitle C Scheme

Generator Category	Facility Size		
	Small	Medium	Large
SQG	Low	Low	High
LQG	Low	High	High

The costs associated with notification, rule familiarization, personnel safety training, emergency planning, and waste characterization are considered sunk costs for existing facilities and are therefore applied only to new facilities. The cost of personnel safety training and emergency planning was applied to 0.2 percent of spot relamping facilities, because only 0.2 percent of the facilities that practice spot relamping are large enough to generate more than 100 kg of lamps per month (which makes them SQGs). The cost of personnel safety training and emergency planning was applied to facilities that group relamp using in-house personnel and only in the year that they relamp.

4.2 Unit Costs for Universal Waste Rule

Exhibit 4-4 contains the requirements and estimated unit costs for UW compliance. Appendix A contains the backup calculations and sources of the unit costs.

Exhibit 4-4: Facility Cost Estimates Under the Universal Waste Scheme, 1997

Universal Waste Requirement	Unit (facility) Cost Estimates			
	Large Quantity Handlers		Small Quantity Handlers	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Initial Fixed Costs				
Notification of Hazardous Waste Activity	$ 150	$ 83	$ 0	$ 0
Rule Familiarization	$ 1,107	$ 166	$ 1,107	$ 83
Waste Characterization	$ 312	$ 0	$ 312	$ 0
Total Initial Fixed Costs	$ 1,569	$ 249	$ 1,419	$ 83

Universal Waste Requirement	Unit (facility) Cost Estimates			
	Large Quantity Handlers		Small Quantity Handlers	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Annualized Initial Fixed Costs	$ 223	$ 35	$ 202	$ 12
Annual Fixed Costs				
Personnel Safety Training (annualized)	$ 86	$ 26	$ 33	$ 10
Variable Costs				
Shipping Record Keeping (per shipment)	$ 9	$ 9	$ 0	$ 0
Total Annualized Cost for New Facilities[3]				
Facilities that Group Relamp	$318	$70	$235	$22
Facilities that Spot Relamp	$327	$79	$235	$22
Total Annualized Cost for Existing Facilities				
Facilities that Group Relamp	$95	$35	$33	$10
Facilities that Spot Relamp	$104	$44	$33	$10

The high and low-cost estimates under the UW scheme were allocated to small, medium and large facilities according to Exhibit 4-5. We assume that small facilities have lower training costs and do not independently characterize their lamps.

Exhibit 4-5: Allocation of High and Low Unit Costs Under Universal Waste Scheme

Generator Category	Facility Size		
	Small	Medium	Large
SQHUW	Low	Low	High
LQHUW	Low	High	High

4.3 Unit Costs for Conditional Exclusion (CE) Scheme

The only fixed cost assumed under the CE scheme is rule familiarization. This cost is assumed to apply to new facilities. The variable cost under CE relates to keeping shipping records. Exhibit 4-6 contains the requirements and estimated unit costs for CE compliance.

[3] Facilities that group relamp prepare one manifest and facilities that spot relamp prepare two manifests each year.

Exhibit 4-6: Facility Cost Estimates Under Conditional Exclusion Scheme, 1997

Conditional Exclusion Requirement	Unit (facility) Cost Estimates	
	High Estimate	Low Estimate
Initial Fixed Costs		
Rule Familiarization	$ 1,107	$ 83
Total Fixed Costs	$ 1,107	$ 83
Annualized Fixed Costs	$ 158	$ 12
Variable Costs		
Shipping Record Keeping (per shipment)	$ 17	$ 7
Total Annual Costs for New Facilities	$ 175	$ 19
Total Annual Costs for Existing Facilities	$ 17	$ 7

4.4 Lamps Generated Under Baseline, Final Action, and CE Option

The number of lamps generated by CESQG and non-CESQG generators each year is shown in Exhibit 4-7. The number of lamps generated each year does not change under the different compliance scenarios, because the same assumptions are made regarding the number of facilities and the lighted floorspace. However, the number of T12 and T8 lamps generated does change over the planning horizon. The percentage of lamps disposed at the different disposal locations changes based on the regulatory regime and the assumed compliance rate. The average total tons of lamps generated per year is 205,000 tons generated by CESQG generators, and 48,230 tons generated by non-CESQG generators.

Exhibit 4-7: Number of Lamps Generated per Year

Year	Number of Lamps (million four-foot lamp equivalents)		
	CESQG	Non-CESQG	Total
1998	756	123	879
1999	772	137	908
2000	782	150	932
2001	800	165	965
2002	812	179	991
2003	827	195	1,022
2004	844	211	1,055
2005	861	227	1,088
2006	883	245	1,128
2007	904	262	1,166
Total Lamps Generated	8,241	1,894	10,135
Average Lamps Generated	824	189	1,014

4.5 Total National Costs

The total annual national costs of compliance and disposal under the baseline and final action, under the high and low compliance scenarios, are presented in Exhibit 4-8. Costs for the CE option are shown in the exhibit as well. In the high compliance scenario, the costs under the baseline and UW final action are close because the transportation and disposal costs are virtually the same, and these costs account for 76 percent of the total costs. Furthermore, the federal shift to UW is assumed to result in relatively few states changing their rules for lamp management.

Exhibit 4-8: Total Annual National Costs

Scenario	Annualized Costs, 1997 – millions –
High Compliance **(100% Compliance in All Regulatory Schemes)**	
Full Subtitle C Baseline	$ 80.01
UW Final Action	$ 78.52
CE Option	$ 73.90
Low Compliance **(20% under Subtitle C, 80% under UW, 90% Compliance under CE Scheme)**	
Full Subtitle C Baseline	$ 54.37
UW Final Action	$ 56.14
CE Option	$ 52.60

Under the low compliance scenario, however, costs under the final action are higher than under the baseline because of the higher compliance rate assumed under the UW scheme. The unit costs for recycling, retorting, and Subtitle C landfilling are significantly higher than for Subtitle D landfilling and waste combustion used by non-compliant facilities.

Exhibit 4-9 contains the average cost per lamp under the baseline, UW final action, and CE option and the two compliance scenarios. The cost per lamp for each year was calculated by dividing the national aggregate cost by the total number of compliant lamps generated. The average cost per lamp was calculated by averaging the cost per lamp for each year over the ten-year planning horizon. During this time period the cost per lamp increases from year to year. The average cost per lamp for the UW final action in the low compliance scenario is less than the full Subtitle C average cost per lamp, despite the UW scheme having a higher total annual cost, because the number of compliant lamps generated under the UW scheme is higher than under the full Subtitle C scheme. This results because of the higher compliance assumed under UW than under full Subtitle C.

Exhibit 4-9: Total Costs per Compliant Lamp

	Average Cost per Lamp
High Compliance Scenario	
Full Subtitle C Baseline	$ 0.41
UW Final Action	$ 0.40
CE Option	$ 0.38
Low Compliance Scenario	
Full Subtitle C Baseline	$ 0.51
UW Final Action	$ 0.49
CE Option	$ 0.44

Exhibit 4-10 presents the number of facilities per year that are CESQG and non-CESQG, and the total number of facilities each year. The total number of facilities grows at a rate of 3.8 percent per year, which is the assumed rate of commercial and industrial floorspace growth over the 1998 to 2007 planning horizon[4]. The number of non-CESQG facilities is growing at an average rate of 14.7 percent because of the growth in the use of T8 lamps. During the planning horizon more facilities are assumed to switch to T8 lamps, and when they do 60 percent are assumed to continue to group relamp. Group relamping puts facilities above the CESQG threshold at a much smaller facility size than does spot relamping. Thus if the management practice of group relamping increases, as it will when more facilities switch to T8s, then the number of non-CESQG facilities will also increase. Exhibit 4-11 presents the number of facilities in 1998 by building size and generator category.

[4]Whereas this analysis assumes a 3.8 percent annual floorspace growth rate for the planning horizon, the Agency's Mercury Emissions Model assumes a 2.4 percent growth rate. EPA does not believe the models' growth rates need to coincide. The Emissions Model analyzes only commercial floorspace for four-foot lamps, while the economic model analyzes commercial and industrial floorspace for both four and eight-foot lamps. Furthermore, the economic model applies simplified assumptions about lamp failure rates at facilities that group relamp, as discussed elsewhere in this document. Given available data, EPA believes that a 3.8 percent growth rate for commercial plus industrial floorspace is reasonable.

Exhibit 4-10: Total Number of Facilities

Year	Number of Facilities		
	CESQG	Non-CESQG	Total
1998	4,260,985	98,648	4,359,634
1999	4,407,655	122,161	4,529,816
2000	4,551,444	145,817	4,697,261
2001	4,709,469	171,054	4,880,523
2002	4,864,630	196,520	5,061,149
2003	5,030,677	222,786	5,253,463
2004	5,203,108	249,885	5,452,993
2005	5,382,355	277,840	5,660,196
2006	5,573,632	307,526	5,881,158
2007	5,761,387	337,156	6,098,543

Exhibit 4-11: Number of Facilities in 1998, by Building Size

Facility Size Range (sq.ft.)	Number of CESQG Facilities	Number of Non-CESQG Facilities		Total Number of Facilities
		SQG	LQG	
1,001 to 5,000	2,399,027	0	0	2,399,027
5,001 to 10,000	885,705	5,701	0	901,407
10,001 to 25,000	549,231	44,147	0	593,379
25,001 to 50,000	204,507	19,332	0	259,839
50,001 to 100,000	99,701	7,605	409	107,715
100,001 to 200,000	59,077	4,262	2,801	66,141
200,001 to 500,000	17,185	4,923	1,514	23,622
500,001 and over	551	5,158	2,796	8,504
Total	4,260,985	91,129	7,519	4,359,634

Appendix E of this assessment presents a comprehensive review of the comparative lamp management cost trend analysis.

5. ASSESSMENT OF ECONOMIC IMPACTS

This section of the report describes the methodology used to evaluate economic impacts on entities affected by the rulemaking, as well as the results of the analysis. In brief, the analysis concludes that neither the UW final action nor the CE option considered in the rulemaking will result in significant economic impacts.

5.1 Methodology

We calculated the ratio of annualized compliance costs as a percentage of facility-specific sales, operating revenues, or expenditures for, respectively, affected businesses, governments, and non-profit organizations. To do this, we first identified the entities that may be affected by the rule. We then estimated annualized costs per facility and also estimated the total sales, operating revenue, or expenditures of businesses, governments, and non-profit entities affected by the rule. We then calculated the ratio of costs as a percentage of sales, operating revenues, or expenditures for these entities and compared it to a threshold value for significant impacts of 3 percent (and, for sensitivity purposes, to an alternative threshold of 1 percent).

5.2 Results

The final rule will affect all entities, including businesses, local governments, and non-profit organizations, that generate more than 100 kg (roughly 350 - 450 spent lamps) per month. Entities that will be directly affected by the rule can be divided into the following categories:[1]

- Operators of non-residential buildings (SIC 6512 or NAICS 53112); and
- Other businesses, local governments, and non-profit organizations that own or rent commercial or industrial space and that conduct their own relamping. (These entities are expected to include most other industrial codes.)

Based on analyses described in previous sections of this document, EPA estimated the per-facility annualized compliance costs associated with the UW final action, as well as the CE option. As shown in Exhibit 5-1 below, EPA estimates that either the final action or the option would result in cost *savings* to affected entities relative to the current requirements to manage used lamps as hazardous waste. Because the rule is not expected to result in a net cost to *any* affected entities, adverse impacts are not anticipated.

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[1] Used lamp recycling facilities may also be affected by the rule, although any impacts on these facilities would be indirect impacts. This possibility is discussed on the last page of this section.

Exhibit 5-1:
Average Savings Per Facility Relative to Baseline Costs
(High Compliance)

	Small Facilities					Medium Facilities		Large Facilities
Facility Size Range	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-200,000	200,001-500,000	>500,000
UW Final Action	$0	$32	$33	$36	$57	$504	$489	$520
CE Option	$0	$44	$56	$83	$145	$637	$796	$1,185

Costs could increase for entities that are not complying with current requirements but do come into compliance with the current rulemaking. These costs, however, would not be attributable to the current rulemaking. In any case, EPA believes that even these costs would not result in significant impacts, as explained below. Exhibit 5-2 shows the average cost per facility under the current requirements and under the final action. This exhibit also shows costs under the CE option.

Exhibit 5-2:
Average Baseline and Post-Rule Costs Per Facility
(High Compliance)

	Small Facilities					Medium Facilities		Large Facilities
Facility Size Range	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-200,000	200,001-500,000	>500,000
Baseline	$0	$73	$117	$219	$409	$1,037	$1,771	$3,204
UW Final Action	$0	$41	$84	$183	$352	$533	$1,282	$2,684
CE Option	$0	$29	$61	$136	$264	$401	$975	$2,019

In order for these costs to result in significant impacts, the annual gross sales (for businesses), annual governmental revenues (for governments), and/or annual operating expenditures (for non-profit organizations) would have to be less than the cost divided by the 3 percent threshold for significant impacts (1 percent for sensitivity purposes). Exhibit 5-3 shows the minimum annual sales, operating revenues, or expenditures required to avoid significant impacts.

Exhibit 5-3:
Minimum Sales, Revenues, or Expenditure Required to Avoid Significant Impacts of Rule, Assuming Non-Compliance in the Baseline
(Annual Dollars per Facility)

	Small Facilities					Medium Facilities		Large Facilities
Facility Size Range	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-200,000	200,001-500,000	>500,000
Assuming a Three Percent Threshold for Significant Impacts								
UW Final Action	$0	$1,367	$2,800	$6,100	$11,733	$17,767	$42,733	$89,467
CE Option	$0	$967	$2,033	$4,533	$8,800	$13,367	$32,500	$67,300
Assuming the Alternative Threshold of One Percent for Significant Impacts								
UW Final Action	$0	$4,100	$8,400	$18,300	$35,200	$53,300	$128,200	$268,400
CE Option	$0	$2,900	$6,100	$13,600	$26,400	$40,100	$97,500	$201,900

EPA believes that these minimum sales, revenues, or expenditures are lower than can reasonably be expected to occur. The annual sales of operators of non-residential buildings (SIC 6512) consists of the rent they collect from their tenants. Using the assumption that rent is charged at an annual rate of $10 per square foot, no impacts would arise under either the 3 percent threshold or the sensitivity threshold of 1 percent. (In reality, the average rent for commercial real estate is believed to exceed $10 per square foot.[2])

Similarly, other types of businesses as well as governments and non-profit organizations can reasonably be expected to have sales, operating revenues, or expenditures in excess of the total wages paid to employees. Under the conservative assumption that these businesses employ at least one person per 1,000 square feet of floor space and pay these staff at least $10,000 per person per year (i.e., $5 per hour), then total sales, operating revenues, and/or expenditures can be estimated to exceed $10 per square foot of floor space (i.e., $10,000 per employee divided by 1,000 square feet per employee). Again, no impacts would arise under either the 3 percent threshold or the sensitivity threshold of 1 percent.

Using these assumptions, EPA calculated the implied level of sales, operating revenues, or expenditures for each building size category. These levels, which are presented in Exhibit 5-4, exceed the minimum levels required to avoid significant impacts (as presented in Exhibit 5-3).[3]

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[2] Based on current rates reported by real estate management firms in five selected U.S. markets, EPA believes that rent for most commercial space ranges from $15 to $25 per square foot.

[3] Estimated sales, revenues, or expenditures are based on an assumed median facility within each size range. This approach is consistent with the approach used to estimate facility compliance costs.

Exhibit 5-4:
Minimum Estimated Sales, Revenues, or Expenditure

	Small Facilities					Medium Facilities		Large Facilities
Facility Size Range	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-200,000	200,001-500,000	>500,000
Implied Level of Sales	$30,000	$75,000	$175,000	$375,000	$750,000	$1,500,000	$3,500,000	$10,000,000

EPA also considered whether the rule might cause other sorts of economic impacts including impacts on the following: (1) *Consolidation facilities* (i.e., facilities that collect or store used lamps prior to recycling or disposal). EPA believes that few if any consolidation facilities exist at present or will exist in the future as independent economic entities. Consequently, EPA did not assess impacts on consolidation facilities. (2) *Recycling facilities.* Recycling facilities may be indirectly affected by the UW final action if this action succeeds in increasing recycling of spent lamps. In this case, the rule would generate additional revenues and profits for firms owning or operating recycling facilities.

Concerns have been expressed over the impacts of the CE option on the business of lamp recyclers. This analysis does, in fact, assume that the percentage of total lamps that are recycled would be lower under the CE option than under the UW final action, or the baseline (assuming full compliance). The reduction in lamp supplies to recyclers, however, are not likely to be dramatic. First, the Agency has anecdotal evidence that many facilities currently recycling their lamps fall below the CESQG threshold, meaning that the regulations might not be the primary driver for the decision to recycle. Second, a substantial majority of existing recycling facilities are in states that officially encourage recycling. On the assumption that these states would have been unlikely to follow the federal government if it had shifted to the CE option, we can predict that most recycling facilities, and most recycling volume, would not have been affected by a federal choice of CE. Furthermore, even with a reduction in the percentage of total spent lamps going to recycling, actual quantities would likely remain generally equivalent, or increase beyond the baseline, as a result of the projected annual growth rate in spent lamp generation. In any case, the effects of the rule on recyclers would be an indirect impact, not the direct result of new federal regulatory requirements placed on the recyclers themselves.

6. ASSESSMENT OF BENEFITS

This section begins by discussing the nature and overall magnitude of the health and environmental threat from mercury-containing lamps, in the context of all mercury emissions. This discussion is followed by an explanation of the methodology used to calculated emissions and emissions changes under various regulatory schemes and scenarios. Quantitative estimates of emissions for the baseline, the UW final action, and the CE option, by compliance scenario, are included at the end of the section.

Because none of the regulatory schemes that were considered for the disposal of mercury-containing lamps would have completely exempted industry from the responsible handling of mercury-containing lamps, health effects resulting from the deregulation would probably have been extremely small in any case. As shown below, the UW final action will have considerably less impact than the CE option.

6.1 The Nature of Benefits from the Regulation of Mercury-Containing Lamps

Health and environmental effects of mercury releases from lamps. Mercury emissions from disposal of spent mercury-containing lamps account for less than 1 percent of the estimated national mercury emissions. In 1994-1995, lamps added 0.8 tons (0.8 Mg) into the air through breakage, combustion, and other release categories. Roughly 90 percent of mercury emissions come from combustion sources, including waste and fossil fuel combustion.[1] Non-compliant lamps under the full Subtitle C, UW, and CE schemes may be incinerated. Exhibit 6-1 shows the levels of mercury emissions from sources, including lamp emissions.

Exhibit 6-1: Selected Sources of Mercury Emissions

Source of Mercury	1994-1995 metric tons per year	1994-1995 short tons per year	% of Total Inventory
Lamps	< 0.8	< 0.8	0.5%
Landfills[2]	< 0.1	< 0.1	0.0%
Utility Boilers	47.2	52.0	32.8%
*Coal Boilers**	*46.9*	*51.6*	*32.6%*
MWCs[3]	26.9	29.6	18.7%
Hazardous Waste Combustors	6.4	7.1	4.4%
Other	62.6	68.4	43.5%
Total Emissions	**144**	**158**	**100%**

* Coal boiler emissions shown are included within the Utility Boiler category.

[1] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards and Office of Research and Development. Mercury Study Report to Congress. Volume 1: Executive Summary. December 1997 (page 3-6 in the 12/16 draft).

[2] Includes some emissions from lamps.

[3] Includes some emissions from lamps.

Most of the mercury in the atmosphere is mercury vapor, which circulates in the atmosphere for up to a year, and can be widely dispersed from the original source of emission.[4] Emissions of mercury accumulate most efficiently in the aquatic food web. Predatory organisms accumulate higher concentrations of mercury in their tissues.

Human Health Impacts

The largest health effects from mercury result from dietary ingestion, primarily from fish. Dietary methyl mercury is almost completely absorbed into the blood and distributed to all tissues including the brain; it also readily passes through the placenta to the fetus and fetal brain.[5] Neurotoxicity is the greatest human health concern resulting from mercury emissions.

Environmental Impacts

Fish, birds, and mammals that consume mercury-exposed fish (or birds and mammals that eat those fish, birds, or mammals), are the populations most highly exposed to mercury. Adverse effects of mercury on fish, birds, and mammals include death, reduced reproductive success, impaired growth and development, and behavioral abnormalities.[6]

Effects of mercury releases from power plants, and energy impacts. Power plants are a major source of total mercury emissions (almost a third of the total in 1994-1995, see Exhibit 6-1 above). As generators of spent lamps switch to more efficient T8 lamps from higher energy consuming T12 lamps, mercury reductions from utilities will follow. In addition, fuel savings, and accompanying reductions in emissions of pollutants other than mercury, will result as well.[7]

Location of emissions. Bulb breakage causes the majority of mercury emissions from fluorescent bulbs. To the extent that mercury bulbs are transported, disposed, recycled, or incinerated in urban versus suburban or rural areas, there will be variations in the human health impacts on populations of interest. Mercury emissions travel across widespread areas; mercury is considered a global pollutant. To the extent that there are localized effects of mercury emissions, consideration of the land use patterns and demographics surrounding the localized emissions is relevant. For more discussion on these points, see the discussion in the Environmental Justice Analysis and the Analysis of Impacts on Children in Section 8.

6.2 Quantitative Analysis of Changes in Emissions

As outlined above, mercury has the potential to cause significant environmental damage and engender health problems in humans and animals. Thus, along with calculating the potential economic effects of alternative regulatory promulgation, EPA is interested in determining the environmental impacts of the final action (and CE option) presented in this analysis. To this end, parameters from the Mercury

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[4] ibid., page ES-1.

[5] ibid., page ES-2.

[6] ibid., page ES-3.

[7] The degree of emissions reduction will depend on knowing the proportion of power generated at plants destined for use in powering fluorescent lamps.

Emissions Model were entered into the economic analysis to quantify the impacts of the alternative regulations. A detailed description of the Mercury Emissions Model and its incorporation into the economic model is discussed in Appendix C. Estimates of mercury emissions from runs of the economic model are discussed below.

Calculation of Total Emissions by Regulatory Scheme and Scenario

Mercury emissions were calculated annually from 1998-2007 for two scenarios under the three regulatory schemes. The first scenario assumed full regulatory compliance under each scheme and the second scenario considered partial regulatory compliance: 20 percent for non-CESQG lamps under full Subtitle C, 80 percent for non-CESQG lamps under the UW scheme, and 90 percent for non-CESQG lamps under the CE scheme. This mercury emission analysis assumed all T12 lamps possessed 21 mg of mercury and that all T8 lamps contained 10.085 mg. These numbers correspond to T12 lamps that were originally produced in 1997. Some T12 lamps disposed in the first few years of this analysis will have been produced before this date when mercury content per lamp was higher. A T8 lamp with mercury content of 10.085 mg is not projected to be produced until year 2000. These lamps may not be seen in the waste stream until the middle of next decade. Therefore, all emission estimates in this analysis are likely to be understated. The difference between the baseline and the final action (and between each of these and the CE option) should be relatively insensitive to the mercury content assumption.

Exhibit 6-2: Mercury Emissions, Full Compliance Scenario

Mercury Emissions (kg)					Representative Years		
Full Compliance	Total for 1998-2007	Incremental Change from Baseline	CESQG	Non-CESQG	1999	2003	2007
Baseline	7904	--	7477	427	758	791	844
UW Final Action	7905	1	7477	428	758	792	844
CE Option	7984	79	7477	507	759	801	857

Exhibit 6-3: Mercury Emissions, Low Compliance Scenario

Mercury Emissions (kg)					Representative Years		
Low Compliance	Total for 1998-2007	Incremental Change from Baseline	CESQG	Non-CESQG	1999	2003	2007
Baseline	8220	--	7477	744	784	822	884
UW Final Action	8192	-28	7477	715	783	819	879
CE Option	8325	105	7477	848	785	835	900

Assuming full compliance, the final action will result in an additional kilogram of mercury emissions over the 10 year analytical period when compared to the baseline. Assuming low compliance, the final action will result in mercury emission reductions when compared to the baseline, specifically 28 kg over the 10-

year analytical period, or 2.8 kg per year. This reduction is largely due to rising compliance rates after the introduction of the final action.

7. COST EFFECTIVENESS

This section presents the costs and emissions consequences of the UW final action relative to the baseline. Also presented are the costs and emissions of the CE option relative to the baseline and final action. This direct comparison makes it possible to see how much it costs, *per kilogram*, to prevent the emissions of additional mercury by shifting to more protective options.

Exhibit 7-1 presents these comparisons under the scenario that assumes 100 percent compliance with applicable regulations. The first row of the table shows the effects of shifting from the current full Subtitle C baseline to the UW final action. The UW final action saves more than a million dollars per year, while allowing an increase in emissions of much less than a kilogram. The savings amount to over ten million dollars per kilogram, implying that it would be very expensive *per kilogram* to keep emissions low by holding to the baseline.

Exhibit 7-1:
Incremental Annual Average Cost, Emissions, and Cost Effectiveness
Full Compliance Scenario

	Difference in Cost	**Change in Mercury Emissions (kg)**	**Cost/kg of Mercury**
UW Final Action Compared to Baseline	- $ 1,490,000	+ 0.14	$10,480,000
CE Option Compared to Baseline	- $6,110,000	+ 8.04	$ 760,000
UW Final Action Compared to CE Option	+ $ 4,620,000	- 7.89	$ 580,000

The second row of Exhibit 7-1 shows that the CE option would save even more money compared to the baseline — over $6 million per year — but would allow more emissions as well. Each kilogram of emissions avoided by keeping the baseline rather than shifting to the CE option would cost less than a million dollars. The last row compares the UW final action to the CE option, and shows that EPA's final action will cost almost $5 million per year while cutting emissions by almost 8 kilograms, for a cost of $580,000 per kilogram.

Exhibit 7-2 presents the same cost-effectiveness calculations under the more realistic low compliance scenario. Because the streamlined compliance requirements under UW are assumed to result in much higher compliance (80 percent for UW vs. 20 percent for the baseline), the UW final action is expected to cost more than the baseline under this scenario. On the other hand, it would reduce mercury emissions by several kilograms per year, at a cost per kilogram of roughly a half-million dollars.

Exhibit 7-2:
Incremental Annual Average Cost, Emissions, and Cost Effectiveness
Low Compliance Scenario

	Difference in Cost	Change in Mercury Emissions (kg)	Cost/kg of Mercury
UW Final Action Compared to Baseline	+ $1,770,000	- 2.83	$ 630,000
CE Option Compared to Baseline	- $1,770,000	+10.48	$ 170,000
UW Final Action Compared to CE Option	+ $3,540,000	- 13.31	$ 270,000

The CE option, on the other hand, would reduce annual costs by over two million dollars in comparison to the baseline, though along with these savings would come an increase of more than 10 kilograms per year. Thus, choosing the baseline instead of the CE option would keep mercury emissions down at a cost of about $200 thousand per kilogram avoided. Finally, the UW final action will cut the emissions that would have occurred under the CE option by over 13 kilograms per year, at a cost of less than a third of a million dollars each.

8. REGULATORY ISSUES

8.1 Environmental Justice

In response to Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," February 11, 1994, regulatory initiatives should be accompanied by an environmental justice analysis, looking at potentially disproportionate impacts of the action on minority and low-income communities.

EPA conducted a qualitative analysis of the environmental justice issues under the rule. The approach entailed (1) identifying the major potential environmental justice benefits and disbenefits to minority and low-income populations under the rule (e.g., effects on health), and (2) analyzing them qualitatively to determine the extent to which they may be realized. Potential environmental justice benefits and disbenefits are identified consistent with the EPA's Environmental Justice Strategy and the OSWER Environmental Justice Action Agenda. These documents discuss environmental justice issues, concerns, and goals identified by EPA and environmental justice advocates in relation to regulatory actions. The public comments received on the 1994 proposal that relate to environmental justice were reviewed for the following analysis.

Review requirements

On February 11, 1994, President Clinton issued Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," focused on the environmental and human health conditions of minority and low-income populations. The Order requires federal agencies to consider the impact of programs, policies, and activities on minority populations and low-income populations. Disproportionate adverse impacts on these populations should be avoided. Agencies are to consider if minority or low-income populations face risks or rate of hazard exposures that are significant (as employed by NEPA) and "appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group."[1]

Identify issues

The transient nature of mercury emissions results in less concern to the location of minority and low-income populations than might be expected. Since atmospheric mercury can travel thousands of miles (and beyond U.S. borders), an environmental justice analysis does not require a detailed geographic analysis. However, populations immediately surrounding transportation, incineration, recycling, crushing, or disposal sites may be exposed to a higher concentration of emissions than those populations living further away from the exposed sites. If incineration, landfill, or recycling facilities are located more often in communities characterized by low-income or minority populations, there may be disproportionate impacts to those populations from the promulgation of the final rule. If the location of the emissions is random with respect to race or income, disproportionate impacts could be said not to exist.

Health effects resulting from increases in mercury emissions as a result of the CE option may have disproportionately affected minority or low-income communities. For example, populations consuming

[1] US EPA. *Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses.* July 12, 1996. (Review Draft)

large quantities of fish are at higher risk of the negative health effects of mercury.[2] To the extent that those populations tend to be identified as minority or low-income, there may be environmental justice issues.

Conduct assessments

The wide dispersion of mercury emissions from lamps leads to the conclusion that there are not direct environmental justice consequences as a result from the reduction in regulatory requirements. As particular populations tend to eat higher quantities of fish, the potential impact of the final rule may increase. However, the change in emissions is not expected to be substantial, particularly compared to all nationwide sources of mercury. Exhibit 8-1 shows the estimated mercury emissions for different sources under the full Subtitle C baseline, the UW final action, and the CE option. The "Low Compliance" scenario has been selected because it is believed to mirror "real world" practice more accurately than the high compliance scenario.

Exhibit 8-1:
Mercury Emissions from Fluorescent Lamps*
(in kilograms), 1998-2007

	CESQG	Non-CESQG							All Lamps
	All Lamps	Compliant Lamps				Non-Compliant Lamps			
	All Treatments	Subtitle C Landfill	Subtitle D Landfill	Recycle	Subtotal	Subtitle D Landfill	MWC	Subtotal	Total
Baseline	7476.6 (90.9%)	198.4 (2.4%)	0	33.7 (0.4%)	232.1 (2.8%)	277.6 (3.4%)	233.8 (2.8%)	511.4 (6.2%)	8220.1 (100%)
UW Final Action	7476.6 (91.3%)	214.7 (2.6%)	0	34.5 (0.4%)	249.2 (3.0%)	252.3 (3.1%)	213.7 (2.6%)	466.0 (5.7%)	8191.8 (100%)
CE Option	7476.6 (89.8%)	128.7 (1.5%)	157.9 (1.9%)	51.4 (0.6%)	338.0 (4.1%)	216.6 (2.6%)	293.6 (3.5%)	510.2 (6.1%)	8324.8 (100%)

*Low Compliance Scenario

Total emissions are expected to decrease slightly under the UW final action (28.3 kg over the 10-year modeling period, a 0.34% decrease); they would be projected to increase moderately (104.7 kg over the 10-year modeling period, 1.30% increase) under the CE option. The emissions from CESQG generated lamps, which represent the majority of the emissions (91% under the baseline) would remain constant in all cases. The emissions from municipal waste combustors (MWCs) will decrease under the UW final action; they would have increased under CE option. Emissions from recycling facilities will increase under the UW final action, and would have increased under the CE option as well. The impact of the final rule on neighboring populations will be minor.

To determine if a disproportionate impact will be imposed on minority or low-income populations, EPA analyzed the locations of existing MWCs and recycling facilities and compared the surrounding county population to national totals. Nationwide, 24.2 percent of the population is minority and 13.1

[2] The primary exposure pathway for mercury is through fish consumption, and therefore, the populations of greatest concern are the developing fetus, children, and people who eat greater than average amounts of locally caught fish. To the extent that EPA's final action encourages greater compliance with hazardous waste management regulations, there could be a small decrease in health risks for populations that consume large amounts of locally caught fish.

percent is low-income.[3] Exhibit 8-2 shows the distribution of counties with demographics matching the designated thresholds. Exhibits 8-3 and 8-4 show the number of municipal waste combustors and recycling facilities located in counties with over 50 percent minority (see CEQ guidance); those located in counties with at least 150 percent above the national average for minority or low-income population (36.4 percent and 19.7 percent, respectively); and those located in counties with any percentage of populations of concern exceeding the national averages.

Exhibit 8-2:
National Low-Income and Minority Statistics, County Data
(1990 Census)

	Minority	**Low-Income**
National	**24.2%**	**13.1%**
Number of Counties Exceeding National	*765 (24.4%)*	*1,994 (63.5%)*
1.5 * National	**36.4%**	**19.7%**
Number of Counties Exceeding 36.4 Percent Minority/ 19.7 Percent Low Income	*434 (13.8%)*	*887 (28.2%)*
Number of Counties Exceeding 50 Percent Minority/50 Percent Low Income	*186 (5.9%)*	*10 (0.3%)*

Exhibit 8-3:
MWC Facilities in Minority or Low-Income Counties[4]

Description	**Number (% of total)**
Total Number of MWC Facilities	**129 (100%)**
Minority Summary	
Facilities in counties with more than 50% minority (CEQ guidance)	9 (7%)
Facilities in counties with more than 36.4% minority (150 %* national)	15 (12%)
Facilities in counties with more than 24.2% minority (national)	34 (26%)
Low-Income Summary	
Facilities in counties with more than 50% low-income (CEQ guidance)	0 (0%)

[3] US Census Bureau statistics, 1990 Census. A minority person is anyone who is non-white and non-Hispanic. Low-income is a person who has an income below the designated poverty level for their household type.

[4] See Attachment 8A for a list of MWC facilities and the corresponding county demographic statistics.

Exhibit 8-3:
MWC Facilities in Minority or Low-Income Counties[5] (continued)

Description	**Number (% of total)**
Facilities in counties with more than 19.7% low-income (150%* **national)**	11 (9%)
Facilities in counties with more than 13.1% low-income (national)	40 (31%)

Exhibit 8-4:
Recycling Facilities in Minority or Low-Income Counties[6]

Description	**Number (% of total)**
Total Number of Recycling Facilities	**78 (100%)**
Minority Summary	
Facilities in counties with more than 50% minority (CEQ guidance)	6 (8%)
Facilities in counties with more than 36.4% minority (150%* national)	13 (17%)
Facilities in counties with more than 24.2% minority (national)	31 (40%)
Low-Income Summary	
Facilities in counties with more than 50% low-income (CEQ guidance)	0 (0%)
Facilities in counties with more than 19.7% low-income (150%* national)	2 (3%)
Facilities in counties with more than 13.1% low-income (national)	22 (28%)

Analysis of Activities Under Full Subtitle C Scheme, UW Scheme. And CE Scheme

Crushing on-site

Under the full Subtitle C regulatory scheme, crushing is allowed by regulated entities. Under the CE scheme, crushing could continue. Under the UW scheme, on-site crushing would generally not be allowed. At present, it is difficult to quantify the frequency of crushing at specific locations because any building is a potential source. Therefore, specific impacts on low-income or minority populations are not estimated. EPA expects crushing to decrease under the UW final action; it would also decrease under the CE option compared to the baseline (but to a lesser extent).

[5] See Exhibit 8A for a list of MWC facilities and the corresponding county demographic statistics.

[6] See Exhibit 8B for a list of recycling facilities and the corresponding county demographic statistics.

Transportation

EPA believes that mercury emissions during transportation would not be a major contributor to protected communities through which lamps are transported. Under the full Subtitle C scheme and the UW scheme, lamps broken during transportation would be contained in their packaging. Any mercury emissions escaping the packaging would likely remain in the truck; EPA acknowledges that there may be some increased risk to transportation workers. Under the CE option, emissions during transportation would not be controlled and therefore lamps hauled in municipal waste trucks (often with an open back) and transported through protected communities could result in increased mercury emissions. EPA also acknowledges the additional risk to municipal waste truck operators but has not quantified the risk.

Municipal Waste Incinerators

EPA would expect emissions at MWCs to increase by approximately 26 percent under the CE option. By contrast, emissions will decrease by approximately 9 percent under the UW final action (because of the anticipated increase in compliance under the final action compared to the baseline). To the extent that MWCs are more often located in minority or low-income populations, there may have been disproportional impacts from the CE option. Exhibit 8-3 shows that these disproportionate impacts would have been unlikely. The absolute numbers and the percentage of affected counties do not exceed reference levels for country data for either low-income or minority populations.

Recycling Facilities

The quantity of emissions from recycling facilities is a small percentage (0.4 percent) of the total emissions from lamps. EPA expects emissions at recycling facilities to increase approximately 2 percent under the UW final action, compared to an increase of over 50 percent under the CE option. This small increase in emissions is likely to cause no adverse health or environmental effects. Further, Exhibit 8-4 shows that the 78 recycling facilities are not located in predominantly minority or low-income communities (though 40 percent of the facilities are in counties that exceed the national average of minorities), and no disproportionate health or environmental effects can be expected as a result of the UW final action.

Conclusions

No disproportional impacts for low-income or minority communities are expected as a result of the final action for the following reasons:

(1) The environmental impact of the final action is benign, and relatively small. The 10-year modeling period shows the net expected decrease in emissions as just under 30 kg under the UW final action. The CE option would have shown an increase (100 kg) in mercury emissions over 10 years. In either case, the wide distribution of mercury emissions is unlikely to create significant impacts on any particular community.

(2) The distribution of the MWC and recycling facilities does not suggest a pattern for location around low-income or minority counties. Therefore, slight changes in emissions at those locations is not likely to cause disproportional impacts to those populations.

8.2 Unfunded Mandates

Review requirements

Under section 202 of the Unfunded Mandates Reform Act of 1995 (the Act), P.L. 104-4, which was signed into law on March 22, 1995, EPA generally must prepare a written statement for rules with federal mandates that may result in estimated costs to state, local, and tribal governments in the aggregate, or to the private sector, of $100 million or more in any one year. When such a statement is required for EPA rules, section 205 of the Act requires EPA to identify and consider alternatives, including the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. EPA must select that alternative, unless the Administrator explains in the final rule why it was not selected, or if the alternative is inconsistent with law. Before EPA establishes regulatory requirements that may significantly or uniquely affect small governments, section 203 of the Act requires it to develop a small government agency plan. The plan must provide for notifying potentially affected small governments, giving them meaningful and timely input in the development of EPA regulatory proposals with significant federal intergovernmental mandates, and informing, educating, and advising them on compliance with the requirements.

Conduct assessments

The Act generally excludes from the definition of "federal intergovernmental mandate" (in sections 202, 203, and 205) duties that arise from participation in a voluntary federal program. Adopting the federal requirement if it is less stringent is optional, therefore this could be interpreted as voluntary and therefore not subject to the Unfunded Mandates Analysis requirement.

Further, EPA's final action is deregulatory, and therefore will not impose additional costs in excess of $100 million to industry or to state and local governments. The additional cost for rule familiarization for facilities is expected to be near $10 million for all generators. Currently, generators incur costs between $130 and $1,200 for rule familiarization (new generators only, approximately 5 percent of the universe per year). Under the final action, the costs for rule familiarization are expected to decrease, to between $83 and $1,200 per generator.

8.3 Regulatory Takings

In order to assess whether takings legislation would affect its final action, EPA reviewed recently introduced takings[7] legislation in Congress. The House of Representatives and the Senate have proposed new takings legislation. Since the proposed takings legislation is more restrictive of the federal government than the currently effective Executive Order (see below), EPA assessed the potential impact of the mercury lamp rule in the context of the Executive Order. The Agency concludes that the Order will not pose a barrier to EPA's final action.

Review requirements — Existing Requirements

"Executive Order 12630, "Government Actions and Interference with Constitutionally Protected Property Rights" (March 15, 1988), directs federal agencies to consider the private property takings

[7] A "taking of private property" is any action whereby private property is taken in such a way as to require compensation under the fifth amendment to the United States Constitution.

implications of proposed regulation. Under the Fifth Amendment of the U.S. Constitution, the government may not take private property for public use without compensating the owner. Though the exact interpretation of this takings clause as applied to regulatory action is still subject to an ongoing debate, guiding principles for identifying regulatory takings have been established by legal precedent through a series of prominent court cases."[8,9]

Review requirements — Proposed Requirements

There are seven pieces of legislation pending in Congress regarding takings policies. These pending actions retain the requirement for takings analyses.

Citizens Access to Justice Act of 1997, S. 1256

The Act would enable parties claiming property rights violations as a result of federal or state government actions to bypass local and state court processes and to bring takings claims directly to federal district court or the Federal Court of Claims. The Act would declare a takings claim eligible for review in federal court once a single permit application has been denied (or similar final decision by state or federal government agency made). The Act would require federal agencies taking action that limits the use of private property to give notice to property owners explaining their rights and the procedures for obtaining any compensation potentially available under this Act. *(Pending in Senate Judiciary Committee, 10/6/97.)*

Omnibus Property Rights Act of 1997, S. 781

The Act would set forth expanded circumstances under which compensation is required for the regulatory taking of private property, including when the regulatory action results in the property owner being deprived temporarily or permanently of 33 percent or more of the value of the property. The Act would broaden the definition of "property" to be considered for regulatory takings claims to include personal or intangible property (e.g., security interests) as well as portions of property (versus the amount in whole). The Act would prohibit filing takings claims against a state agency for carrying out a regulatory program mandated or delegated by a federal program. The Act would require that federal agency regulatory actions likely to result in the taking of private property be preceded by a written impact analysis. *(Pending in Senate Judiciary Committee, 11/7/97.)*

Private Property Protection Act of 1997, H.R. 95

The Act would declare that no forthcoming federal regulation will become effective until the issuing agency is certified by the Attorney General to be in compliance with Executive Order 12630 or similar procedures to assess the potential for the taking of private property in the course of regulatory activity. *(Pending in House Judiciary Committee-Subcommittee on the Constitution, 1/28/97.)*

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[8] See, for instance, *Pennsylvania Coal Co. v. Mahon,* 260 U.S. 393 (1922), *Penn Central Transportation Co. v. City of New York* 438 U.S. 104 (1978), *Lucas v. South Carolina Coastal Council* 112 S. Ct. 2886 (1992), *Dolan v. City of Tigard* 114 S. Ct. 2309 (1994), and *Nollan v. California Coastal Commission* 483 U.S. 825 (1987).

[9] Memorandum, 13 April 1998, To: Lyn Luben, U.S. EPA, From: Emily Noah, Alice Yates, and Tom Walker, Industrial Economics, Inc., Subject: Regulatory Takings Analysis of the Hazardous Waste Combustion MACT

Private Property Rights Act of 1997, S. 709

The Act would direct federal agencies to complete private property taking impact analyses before issuing any regulation likely to result in a taking of private property and would enable parties claiming property rights violations as a result of federal government action to bring takings claims in either federal district court or the Federal Court of Claims. *(Pending in Senate Governmental Affairs Committee, 5/7/97.)*

Private Property Rights Implementation Act of 1997 (Reported to Senate as Citizens Access to Justice Act of 1998), H.R. 1534

The Act would enable parties claiming property rights violations as a result of federal or state government actions to bypass local and state court processes and to bring takings claims directly to federal district court or the Federal Court of Claims and would declare a takings claim eligible for review in federal court once a single permit application has been denied (or similar final decision by state or federal government agency made. The Act would require federal agencies taking action that limits the use of private property to give notice to property owners explaining their rights and the procedures for obtaining any compensation potentially available under this Act. *(Passed House, 10/22/97; Pending in Senate Judiciary Committee, 2/26/98.)*

Property Owners Access to Justice Act of 1997, S. 1204

The Act would enable parties claiming property rights violations as a result of federal or state government actions to bypass local and state court processes and to bring takings claims directly to federal district court or the Federal Court of Claims and declare a takings claim eligible for review in federal court once a single permit application has been denied (or similar final decision by state or federal government agency made). *(Pending in Senate Judiciary Committee, 10/7/97.)*

Tucker Act Shuffle Relief Act of 1997, H.R. 992

The Act would allow parties claiming property rights violations as a result of federal government action the choice of bringing takings claims to either the Federal Court of Claims or any federal district court. *(Passed House, 3/12/98; Pending in Senate Judiciary Committee, 3/12/98.)*

<u>Conduct assessments</u>

It is highly unlikely that EPA's final action will affect property owners in ways that would require compensation under Executive Order 12630 or any of the pending legislation. No takings analysis is necessary.

8.4 Effects on Children

<u>Review Requirements</u>

On April 21, 1997, President Clinton signed Executive Order 13045 (62 FR 19885), "Protection of Children From Environmental Health Risks and Safety Risks," establishing an interagency task force to address regulatory and policy issues regarding children, outlining agency analytical responsibilities for plans and policies that may disproportionately affect children, and directing the Office of Management and

Budget to produce an annual compendium of the most important indicators of the well being of the nation's children.

The Order states that each Federal agency shall:

(a) make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and

(b) ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

Regulatory actions covered under the Executive Order include any substantive action in a rulemaking initiated after April 23, 1997 or for which a Notice of Proposed Rulemaking is published one year after the date of this order, that is likely to result in a rule that may

(a) be "economically significant" under Executive Order 12866 (a rulemaking that has an annual effect on the economy of $100 million or more or would adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities); and

(b) concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children.

Though EPA's final action is intended to be deregulatory and may not strictly require analysis under Executive Order 13045, an analysis of the potential effects of deregulatory actions on children's health would seem to be in the spirit of these requirements.

The task force, co-chaired between the Secretary of Health and Human Services and the Administrator of the EPA, shall recommend to the President strategies and approaches for children's health and the accompanying analysis for the Order.

Identify issues

Given the same exposure, children absorb more mercury from the atmosphere as a percent of their body weight than do adults. Children are, therefore, more susceptible to the negative health effects of mercury emissions. The total emissions from regulated lamps will not change substantially under the final action, so there is unlikely to be a widespread impact on children. However, to the extent that emissions are shifted from localities with fewer children to those with more children, there may be determined to be disproportional impacts on those communities with more children than average. EPA has identified the county location of municipal waste combustors and recycling facilities (where emissions are expected to increase under the UW final action and/or the CE option) and analyzed the age composition of the county to assess any disproportional impacts on children. Exhibit 8-5 shows the distribution of counties in the nation exceeding the thresholds designated in this analysis.

Exhibit 8-5:
National Statistics on Children, County Data
(1990 Census)

	Children (Under 18 years)
National (Total Number)	**25.6%**
Number of Counties Exceeding National	*2,067 (65.8%)*
Five Percentage Points Above National	**30.6%**
Number of Counties Exceeding National plus 5%	*355 (11.3%)*
Number of Counties Exceeding 50% Children	*0 (0%)*

Disproportional impacts may occur if a particular county with a significant increase in emissions has a higher than average proportion of children residents. Exhibit 8-6 shows the number of counties with MWCs that have higher proportions of youth than the national average (the difference must exceed the national average by 5 percent). Exhibit 8-7 presents similar information for recycling facilities.

Exhibit 8-6:
MWC Facilities in Counties with Higher than Average Proportion of Children

Description	**Number (% of total)**
Total Number of MWC Facilities	129 (100%)
Facilities in counties with more than 30.6% children (national + 5%)	6 (5%)
Facilities in counties with more than 25.6% children (national average)	54 (42%)

Exhibit 8-7:
Recycling Facilities in Counties with Higher than Average Proportion of Children

Description	**Number (% of total)**
Total Number of Recycling Facilities	78 (100%)
Facilities in counties with more than 30.6% children (national + 5%)	1 (1%)
Facilities in counties with more than 25.6% children (national average)	30 (38%)

Exhibits 8-6 and 8-7 show that MWCs and recycling facilities tend to be less likely to be located in counties with higher than average numbers of children. Therefore, a disproportionate impact on those populations is not expected as a result of either the UW final action or the CE option.

Conduct assessments

Although Exhibits 8-6 and 8-7 show that MWCs and recycling facilities will not likely pose increased mercury hazards to children under the UW final action (and would not have posed a hazard under the CE option), to the extent that children are more susceptible to the health effects of mercury, the absolute increase in mercury emissions under the CE option should be noted. EPA's final UW action, however, is expected to result in lower mercury emissions over the 10-year modeling period. Arguably, the localized effects of increased emissions will likely be in the industrial areas where bulbs are disposed of or recycled. Workers will be at greater risk of the emissions because of their proximity to the source. Since very few children are found in industrial environments, there is not sufficient concern to warrant an analysis of the localized emissions effects.

Mercury is considered a global pollutant; emissions travel great distances through the air and may bioaccumulate through fish and birds. To the extent that a regulatory option would increase the amount of mercury in circulation and thus pose an increased risk to children, analysis is required under Executive Order 13045. The UW final action is expected to result in a slight decrease in overall emissions, and therefore causes no concern. The CE option would have resulted in a slight increase, of approximately 107 kg over a 10-year period, or 1.3 percent of the total mercury emissions currently attributable to lamps. Over the 1994-1995 period approximately 144,000 kg mercury were released annually from U.S. sources. The projected annual incremental increase from lamps under the CE option is 10.7 kg, or approximately 0.007 percent of this total. An increase of this level is unlikely to be considered significant by most standards.

Exhibit 8A: MWCs

Unit Name	County	State	1995 Hg Emissions (metric tons/yr)[a]	County % Minority	County % Low-Income	County % Children
Juneau RRF	Juneau Burough	AK	0.023587	20.4%	5.6%	29.5%
Sitka WTE Plant	Sitka Borough	AK	0.020774	27.0%	4.8%	30.5%
Huntsville Refuse-Fired Steam	Madison/Limestone	AL	0.172546	23.4%	14.0%	25.2%
Batesville	Independence	AR	0.033747	2.7%	17.1%	26.4%
Blytheville Incinerator	Mississippi	AR	0.023587	29.8%	26.2%	31.4%
Osceola	Mississippi	AR	0.016874	29.8%	26.2%	31.4%
Stuttgart Incinerator	Arkansas	AR	0.021319	22.2%	20.4%	27.9%
Commerce Refuse-to-Energy Fac.	Los Angeles	CA	0.095073	59.0%	15.1%	26.2%
Long Beach (SERRF)	Los Angeles	CA	0.345365	59.0%	15.1%	26.2%
Stanislaus (Modesto)	Stanislaus	CA	0.200125	29.2%	14.1%	30.5%
Bridgeport RESCO	Fairfield	CT	0.562817	19.9%	6.1%	22.7%
Bristol RRF	Hartford	CT	0.162567	19.6%	7.9%	22.6%
Mid-Connnecticut Project	Hartford	CT	0.103691	19.6%	7.9%	22.6%
Southeastern Connecticut RRF	New London	CT	0.150048	9.8%	6.4%	23.4%
Town of New Canaan Volume Reduction Plant	Fairfield	CT	0.051891	19.9%	6.1%	22.7%
Wallingford RRF	New Haven	CT	0.105052	17.3%	7.9%	22.7%
Bay Resource Mgt. Center	Bay	FL	0.211555	14.9%	14.4%	25.4%
Broward Co. RRF North	Broward	FL	0.562817	24.9%	10.2%	20.4%
Broward Co. RRF South	Broward	FL	0.562817	24.9%	10.2%	20.4%
Dade Co. RRF	Dade	FL	1.156116	69.6%	17.9%	24.2%
Hillsborough Co. RRF	Hillsborough	FL	0.498044	27.1%	13.3%	24.2%
Lake Co. RR	Lake	FL	0.132086	12.4%	11.0%	19.6%
Mayport NAS	Duval	FL	0.020774	28.8%	12.8%	25.9%
McKay Bay REF	Hillsborough	FL	0.368680	27.1%	13.3%	24.2%
Miami International Airport	Dade	FL	0.020230	69.6%	17.9%	24.2%
North Co. Region RR Project	West Palm Beach	FL	0.103782	20.7%	9.3%	19.6%
Pasco Co. Solid Waste RRF	Pasco	FL	0.262630	5.9%	11.6%	17.9%
Southernmost WTE	Monroe	FL	0.062233	18.6%	10.8%	17.3%
Wheelabrator Pinellas RRF	Pinellas	FL	0.968420	11.3%	9.5%	17.7%
Savannah RRF	Chatham	GA	0.207564	40.4%	17.2%	26.5%
Honolulu Resource Recovery	Honolulu	HI	0.112128	70.1%	7.5%	24.5%
Burley	Cassia	ID	0.016874	14.7%	14.5%	36.8%
Northwest WTE	Cook & DuPage	IL	0.664059	42.6%	14.2%	26.4%
Indianapolis RRF	Marion	IN	0.590849	23.4%	12.1%	25.5%
Fall River Incinerator	Bristol	MA	0.248931	6.0%	9.1%	24.4%
Haverhill Lawrence RDF	Essex	MA	0.273607	10.1%	9.3%	23.6%
Haverhill RRF	Essex	MA	0.412769	10.1%	9.3%	23.6%
North Andover RESCO	Essex	MA	0.622510	10.1%	9.3%	23.6%
Pittsfield RRF	Berkshire	MA	0.099609	3.5%	8.7%	22.7%
Saugus RESCO	Essex	MA	0.622510	10.1%	9.3%	23.6%
SEMASS RRF	Plymouth	MA	0.140160	7.6%	6.6%	26.2%
Springfield RRF	Hampden	MA	0.149413	18.0%	13.0%	24.9%
Wheelabrator Millbury	Worcester	MA	0.375212	8.3%	8.3%	24.4%
Hartford Co. WTE Fac.	Harford	MD	0.121563	11.5%	5.1%	26.8%
Pulaski	Independent City	MD	0.236775	61.3%	21.9%	24.5%
Southwest RRF (RESCO)	Independent City	MD	0.933765	61.3%	21.9%	24.5%
Greater Portland Region RRF	Cumberland	ME	0.125010	2.6%	8.0%	23.4%
Maine Energy Recovery	York	ME	0.031207	2.0%	6.8%	26.2%
Mid Maine Waste Action Corp.	Androscoggin	ME	0.050077	1.6%	11.4%	25.7%
Penobscot Energy Recovery Co.	Penobscot	ME	0.036287	2.5%	13.0%	24.3%
Central Wayne Co. Sanitation Auth	Wayne	MI	0.192686	43.8%	20.1%	27.0%
Clinton Township	Macomb	MI	0.248931	3.9%	5.2%	24.0%

Exhibit 8A: MWCs

Unit Name	County	State	1995 Hg Emissions (metric tons/yr)[a]	County % Minority	County % Low-Income	County % Children
Greater Detroit RRF	Wayne	MI	0.171186	43.8%	20.1%	27.0%
Jackson Co. RRF	Jackson	MI	0.050076	10.1%	12.0%	25.8%
Kent Co. WTE Fac.	Kent	MI	0.156399	12.2%	9.2%	28.3%
Elk River FFR	Anoka	MN	0.077836	3.2%	5.3%	30.6%
Fergus Falls	Otter Tail	MN	0.031751	1.4%	14.2%	26.5%
Hennepin Energy Recovery Facility	Hennepin	MN	0.035199	11.2%	9.2%	23.1%
Olmstead WTE Facility	Olmstead	MN	0.082917	4.7%	6.9%	27.7%
Perham Renewable RF	Otter Tail	MN	0.038465	1.4%	14.2%	26.5%
Polk Co. Solid Waste Resource Recovery	Polk	MN	0.027034	4.7%	14.4%	28.2%
Pope-Douglas Solid Waste	Douglas	MN	0.029937	1.2%	13.4%	27.2%
Ramsey-Washington	Goodhue	MN	0.277417	1.7%	8.1%	28.3%
Red Wing Solid Waste Boiler Facility	Goodhue	MN	0.029937	1.7%	8.1%	28.3%
Richards Asphalt Co. Facility	Scott	MN	0.029030	2.4%	4.1%	31.2%
Western Lake Superior Sanitary District	St. Louis	MN	0.100153	3.5%	14.2%	24.4%
Wilmarth Plant	Blue Earth & Nicollet	MN	0.037376	2.8%	18.5%	26.2%
Pascagoula Energy Recovery Facility	Jackson	MS	0.062233	22.4%	16.2%	29.7%
Livingston/Park County MWC	Park	MT	0.024312	3.1%	15.2%	25.6%
New Hanover Co. WTE	New Hanover	NC	0.112400	21.4%	14.0%	22.7%
NIEHS	Durham	NC	0.013426	40.3%	11.9%	22.8%
University City RRF	Mecklenburg	NC	0.097432	29.4%	9.6%	24.2%
Lamprey Regional SW Coop.	Strafford	NH	0.054703	2.5%	8.2%	23.5%
SES Claremont RRF	Sullivan	NH	0.082917	1.3%	9.8%	25.8%
Wheelabrator Concord	Merrimack	NH	0.207564	1.8%	5.5%	25.4%
Camden RRF	Camden	NJ	0.262630	24.9%	10.3%	26.5%
Essex Co. RRF	Essex Co.	NJ	0.569621	54.7%	14.3%	24.3%
Fort Dix RRF	Burlington	NJ	0.026853	19.5%	4.2%	24.8%
Gloucester County	Gloucester	NJ	0.143880	11.6%	6.2%	26.8%
Union Co. RRF	Union	NJ	0.042184	34.6%	7.2%	21.8%
Warren Energy RF	Warren	NJ	0.100153	4.3%	5.4%	24.9%
Adirondack RRF	Washington	NY	0.108136	5.6%	9.6%	25.7%
Babylon RRF	Suffolk	NY	0.187606	14.2%	4.7%	24.7%
Dutchess Co. RRF	Dutchess	NY	0.166015	14.0%	5.4%	24.1%
Hempstead	Nassau	NY	0.626774	17.1%	3.7%	21.8%
Huntington RRF	Suffolk	NY	0.187515	14.2%	4.7%	24.7%
Kodak RRF	Monroe	NY	0.057788	17.1%	10.4%	24.6%
Long Beach RRF	Nassau	NY	0.083007	17.1%	3.7%	21.8%
MacArthur WTE	Suffolk	NY	0.215003	14.2%	4.7%	24.7%
Niagara Falls RDF WTE	Niagara	NY	0.847855	8.0%	10.7%	24.9%
Oneida Co. ERF	Oneida	NY	0.067494	8.4%	11.9%	24.3%
Onondaga Co. RRF	Onondaga	NY	0.029030	11.4%	10.3%	24.5%
Oswego Co. WTE	Oswego	NY	0.674945	2.1%	11.7%	27.8%
Westchester RESCO	Westchester	NY	0.933765	26.6%	6.8%	21.6%
Montgomery Co. North RRF	Montgomery	OH	0.373397	19.6%	12.6%	24.9%
Montgomery Co. South RRF	Montgomery	OH	0.373397	19.6%	12.6%	24.9%
Miami RRF	Ottawa	OK	0.035380	19.9%	20.1%	24.1%
Walter B. Hall RRF	Tulsa & Osage	OK	0.466746	25.9%	15.8%	28.1%
Coos Bay Incinerator	Coos	OR	0.042184	6.1%	16.5%	25.2%
Marion Co. WTE	Marion	OR	0.137529	11.8%	13.2%	26.4%
Delaware Co. RRF	Delaware	PA	0.672768	14.1%	7.0%	23.1%
Harrisburg WTE	Dauphin	PA	0.197403	18.3%	10.1%	23.3%
Lancaster Co. RRF	Lancaster	PA	0.300187	6.9%	8.0%	26.5%
Montgomery Co. RRF	Montgomery	PA	0.300278	9.3%	3.6%	22.5%

Exhibit 8A: MWCs

Unit Name	County	State	1995 Hg Emissions (metric tons/yr)[a]	County % Minority	County % Low-Income	County % Children
Westmoreland WTE Fac.	Westmoreland	PA	0.016874	2.7%	10.7%	22.5%
Wheelabrator Falls RRF	Bucks	PA	0.043908	6.0%	4.0%	25.6%
York Co. RR Center	York Co.	PA	0.336384	5.3%	6.3%	24.3%
Chamber Medical Tech. of SC	Hampton	SC	0.091172	54.5%	27.7%	31.8%
Foster Wheeler Charleston RR	Charleston	SC	0.150048	37.1%	17.3%	25.0%
Nashville Thermal Transfer Corp	Davidson	TN	0.435721	25.7%	13.0%	22.8%
Resource Authority in Sumner Co.	Sumner	TN	0.082917	6.2%	9.1%	27.5%
Center RRF	Shelby	TX	0.013517	24.1%	24.9%	26.6%
City of Cleburne	Johnson	TX	0.038646	11.0%	11.6%	29.3%
Panola Co. WTE	Panola	TX	0.013517	21.5%	20.7%	27.9%
Davis Co. WTE	Davis	UT	0.166015	7.1%	7.1%	40.0%
Alexandria/Arlington RRF	Alexandria City	VA	0.083279	35.7%	7.1%	15.3%
Arlington - Pentagon	Arlington	VA	0.016874	30.6%	7.1%	15.1%
Harrisonburg RRF	Rockingham	VA	0.025764	2.9%	6.9%	24.5%
I-95 Energy RRF (Fairfax)	Fairfax	VA	0.750423	22.5%	3.5%	24.4%
NASA Refuse-fired Steam Generator	Independent City	VA	0.082917	35.7%	7.1%	15.3%
Norfolk Navy Yard	Independent City	VA	0.317696	35.7%	7.1%	15.3%
Recomp Bellingham RRF	Whatcom	WA	0.033747	8.0%	12.3%	24.9%
Skagit Co. RRF	Skagit	WA	0.044452	8.6%	11.5%	26.1%
Spokane Regional Disposal Fac.	Spokane	WA	0.200125	6.2%	13.7%	26.4%
Tacoma	Pierce	WA	0.015603	16.5%	11.4%	27.2%
Barron Co. WTE Fac.	Barron	WI	0.033747	1.0%	11.6%	27.8%
LaCrosse Co.	LaCrosse	WI	0.154221	4.3%	13.4%	24.6%
Sheboygan	Sheboygan	WI	0.089630	4.2%	6.5%	26.9%
St. Croix Co. WTE Fac.	St. Croix	WI	0.038646	1.0%	6.4%	30.2%
			26.866809			

[a] Based on National Mercury Emissions Estimates for Municipal Waste Combustors (A-90-45, VII-A-2).

Summary		
Number of MWCs	129	%
Low-Income Summary		
# in Counties with > 50% low-income	0	0%
# in Counties with > 19.7% low-income	11	9%
# in Counties with > 13.1% low-income	40	31%
Minority Summary		
# in Counties with > 50% minority	9	7%
# in Counties with > 36.4% minority	15	12%
# in Counties with > 24.2% minority	34	26%
Children Summary		
# in Counties with > 50% children	0	0%
# in Counties with > 38.3% children	1	1%
# in Counties with > 30.6% children	6	5%

Numbers used national totals as reference:

NATIONAL	Average	150% Avg.
Low-Income	13.1%	19.7%
Minority	24.2%	36.4%

# in Counties with > 25.6% children	54	42%

Children	25.6%	38.4%

Exhibit 8B: Recyclers

Company Name	City and State	County	County % Minority	County % Low-Income	County % Children
Arizona					
Lighting Resources, Inc.	Phoenix, AZ 85040	Maricopa	22.7%	12.3%	26.1%
Salesco Systems USA	Phoenix, AZ 85043	Maricopa	22.7%	12.3%	26.1%
Earth Protection Services	Phoenix, AZ 85063	Maricopa	22.7%	12.3%	26.1%
California					
Allied Technology Group	Freemont, CA 94538	Alameda	46.6%	10.6%	23.7%
Lighting Resources, Inc.	Pomona, CA	Los Angeles	59.0%	15.1%	26.2%
Mercury Recovery Systems	Monrovia, CA	Los Angeles	59.0%	15.1%	26.2%
Mercury Technologies Interna	Hayward, CA 94544	Alameda	46.6%	10.6%	23.7%
Mercury Technologies Interna	Culver City, CA	Los Angeles	59.0%	15.1%	26.2%
Mercury Technologies Corpora	Benicia, CA 94510	Solano	38.9%	7.5%	28.7%
Salesco Systems USA	San Diego, CA	San Diego	34.4%	11.3%	24.5%
Earth Protection Services	Rancho Cucamonga, CA	San Bernardino	39.0%	12.7%	30.9%
Connecticut					
Northeast Lamp Recycling	East Windsor, CT 06	Hartford	19.6%	7.9%	22.6%
Florida					
Envirolight, Inc.	Riviera Beach, FL 3	Palm Beach	20.7%	9.3%	19.6%
Inter Recycling Lights, SE	Tampa, FL 33610	Hillsborough	27.1%	13.3%	24.2%
Marpan Supply Co.	Tallahassee, FL	Leon	28.2%	17.0%	22.6%
Mercury Technologies Interna	West Melbourne, FL	Brevard	12.5%	9.1%	21.9%
P-3	Tampa, FL	Hillsborough	27.1%	13.3%	24.2%
Quicksilver Environmental	Tampa, FL 33622-517	Hillsborough	27.1%	13.3%	24.2%
Recyclights	Lakeland, FL 33080	Polk	17.9%	12.9%	24.1%
Recyclights	Tallahassee, FL 323	Leon	28.2%	17.0%	22.6%
Georgia					
Ballast & Lamp Recycling	Atlanta, GA	Fulton	53.2%	18.4%	24.2%
Salesco Systems USA	Flowery Branch, GA	Hall	13.5%	10.6%	25.7%
Illinois					
Everlights	Mokena, IL	Will	17.4%	6.0%	29.8%
Salesco Systems USA	Arlington Heights, IL	Sangamon	9.6%	9.9%	25.5%
Indiana					
Ballast & Lamp Recycling	Indianapolis, IN	Marion	23.4%	12.1%	25.5%
Lighting Resources, Inc.	Greenwood, IN	Wells	1.4%	5.6%	28.2%
Iowa					
A-TEC Recycling, Inc.	Des Moines, IA	Polk	8.4%	9.2%	25.0%
Midwest Recycling & Mercury	DuBuque, IA 52001	Dubuque	1.5%	10.3%	27.2%
Louisiana					
Lamp Recyclers of Louisiana	Hammond, LA 70404	Tangipahoa	30.2%	31.5%	30.1%
Maryland					
USA Lights of Maryland	Hyattsville, MD 207	Prince George's	58.4%	5.8%	24.5%
Massachusetts					
Alta Resource Management Ser	Springfield, MA 011	Hampden	18.0%	13.0%	24.9%
Global Recycling Technologie	Stoughton, MA 02072	Norfolk	6.2%	4.5%	21.0%
Salesco Systems USA	Braintree, MA	Norfolk	6.2%	4.5%	21.0%

Exhibit 8B: Recyclers

Company Name	City and State	County	County % Minority	County % Low-Income	County % Children
Michigan					
Greenlites Lamp Recycling, I	Utica, MI	Macomb	3.9%	5.2%	24.0%
Minnesota					
Aplus Environmental Services	Lakeville, MN	Dakota	4.5%	4.3%	29.9%
Dynex Environmental, Inc.	St. Paul, MN 55112	Ramsey	13.1%	11.4%	24.7%
Light Cycle, Inc.	St. Paul, MN 55104	Ramsey	13.1%	11.4%	24.7%
Luminaire Recyclers Inc.	St. Paul, MN 55114	Ramsey	13.1%	11.4%	24.7%
Mercury Technologies of Minn	Pine City, MN 55063	Pine	5.0%	15.0%	28.1%
Mercury Waste Solutions, Inc	Roseville, MN 55113	Ramsey	13.1%	11.4%	24.7%
Recyclights	Bloomington, MN 554	Hennepin	11.2%	9.2%	23.1%
USA Lights	Roseville, MN 55113	Ramsey	13.1%	11.4%	24.7%
New Jersey					
Adrow Chemical	Wanaque, NJ	Passaic	36.8%	10.0%	24.0%
Nine West Technologies	Newark, NJ	Essex	54.7%	14.3%	24.3%
AERC/MTI	Flanders, NJ	Morris	11.4%	2.8%	22.9%
New York					
Eastern Environmental	Port Chester, NY	Westchester	26.6%	6.8%	21.6%
Mercury Refining Company	Albany, NY	Albany	12.1%	9.7%	21.5%
North Carolina					
Carolina Environmental Assoc	Burlington, NC	Alamance	20.4%	8.9%	22.1%
Ecoflo Inc.	Greensboro, NC	Guilford	28.6%	10.1%	22.5%
Envirocycle	High Point, NC	Guilford	28.6%	10.1%	22.5%
Environmental Mgmt. Solutions	High Point, NC	Guilford	28.6%	10.1%	22.5%
Ohio					
American Recycling Co., LTD	Mentor, OH 44060	Lake	3.1%	4.9%	25.0%
Ameri-waste Environmental Te	Cleveland, OH	Cuyahoga	28.3%	13.8%	24.0%
Dlubak's Glass Co.	Upper Sandusky, OH	Wyandot	0.9%	8.5%	27.4%
Environmental Enterprises, I	Cincinnati, OH	Hamilton	22.6%	13.3%	26.0%
Environmental Recycling	Toledo, OH 43612	Lucas	19.2%	15.3%	26.5%
I.G., Inc.	Cleveland, OH 44109	Cuyahoga	28.3%	13.8%	24.0%
Lightsout, Inc.	Cleveland, OH 44114	Cuyahoga	28.3%	13.8%	24.0%
Recyclights	Columbus, OH	Franklin	19.0%	13.0%	24.6%
S.D. Meyers (fluorescent lam	Tallmadge, OH 44278	Summit	13.6%	12.1%	24.5%
USA Lamp and Ballast Recycle	Cincinnati, OH	Hamilton	22.6%	13.3%	26.0%
Oregon					
Earth Protection Services In	Lake Oswego, OR	Clackamas	5.1%	6.9%	26.7%
Pennsylvania					
Advanced Environmental Recyc	Allentown, PA 18103	Lehigh	8.8%	7.3%	22.6%
American Waste Mgmt, Inc.	Coraopolis, PA 1510	Allegheny	12.9%	11.5%	21.1%
Bethlehem Apparatus	Hellertown, PA	Northampton	7.7%	7.3%	23.4%
Tennessee					
Nine West Technologies	Nashville, TN	Davidson	25.7%	13.0%	22.8%

Exhibit 8B: Recyclers

Company Name	City and State	County	County % Minority	County % Low-Income	County % Children
Texas					
Environmental Energy Group	San Marcos, TX	Hays	31.7%	20.9%	24.6%
Environmental Lamp Recyclers	Ft. Worth, TX	Tarrant	26.5%	11.0%	27.1%
NSSI, Inc.	Houston, TX	Harris	45.6%	15.7%	28.5%
Salesco Systems USA	Dallas, TX	Dallas	39.6%	13.5%	26.8%
Washington					
Ecolights Northwest	Seattle, WA	King	16.6%	8.0%	22.6%
Wisconsin					
Advanced Environmental	Menomonic Falls, WI	Waukesha	3.2%	3.1%	27.3%
Dynex Environmental Inc.	Milwaukee, WI 53129	Milwaukee	26.9%	15.9%	25.7%
Lamp Recyclers, Inc.	Green Bay, Wl 53707	Brown	4.4%	9.2%	27.0%
Recycle Technologies,Inc.	Waukesha, Wl 53186	Waukesha	3.2%	3.1%	27.3%
Superior Lamp Recycling, Inc	Port Washington, WI	Ozaukee	1.9%	2.2%	27.1%
Mercury Waste Solutions	Union Grove, WI	Racine	15.3%	10.2%	27.9%
Wyoming					
Lighting Resources, Inc.	Sheridan, WY	Sheridan	3.7%	10.4%	27.0%

Summary	
Number of Recylers	78
Low-Income Summary	
# in Counties with > 50% low-income	0
# in Counties with > 19.7% low-income	2
# in Counties with > 13.1% low-income	22
Minority Summary	
# in Counties with > 50% minority	6
# in Counties with > 36.4% minority	13
# in Counties with > 24.2% minority	31
Children Summary	
# in Counties with > 50% children	0
# in Counties with > 38.3% children	0
# in Counties with > 30.6% children	1
# in Counties with > 25.6% children	30

Numbers to left used national totals as reference:		
NATIONAL	Average	150% Avg.
Low-Income	13.1%	19.7%
Minority	24.2%	36.4%
Children	25.6%	38.4%

9. SOURCES USED IN REPORT

Audin, L., Houghton, D., Shepard, M., Hawthorne, W., E Source Technological Atlas Series, Volume I, Lighting, E Source, 1994. (Commercial lighting densities, 8 foot lamp population.)

Dutton, John M, and Annie Thomas, "Treating Progress Functions as a Managerial Opportunity," *Academy of Management Review*, 1984, Vol. 9, No. 2. (Learning-by-doing information.)

Energy Information Administration, Lighting in Commercial Buildings, March 1992. (Commercial lighted floorspace.)

ICF Kaiser, Inc., "Economic Analysis of Impacts to Mercury-Lamp Recyclers Under Proposed Regulatory Alternatives," September 10, 1997. (Used to develop understanding of regulated community behavior regarding recycling of mercury containing lamps)

SAIC, Executive Enterprises Inc., 1993. (Cost of trainer.)

U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports: Electric Lamps Summary for 1992. MQ36B(92)-5, U.S. Government Printing Office, Washington D.C., 1992. (Production data on 4 and 8 ft. Fluorescent lamps.)

U.S. Department of Commerce, Bureau of the Census, 1990 Census of the United States. (Nation-wide minority and low-income populations.)

U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1997. (Ratio of industrial to commercial floorspace, state employment.)

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U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1988. (Ratio of industrial to commercial floorspace.)

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U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards and Office of Research and Development, Mercury Study Report to Congress. Volume 1: Executive Summary, December, 1997. (Sources of mercury emissions.)

U.S. Environmental Protection Agency, Office of Solid Waste, Analysis of Potential Cost Savings and the Potential for Reduced Environmental Benefits of the Universal Waste Rule, April, 1995.

U.S. Environmental Protection Agency, Office of Solid Waste, Mercury Emissions from the Disposal of Fluorescent Lamps, Final Report, June 30, 1997. (Floorspace growth rate, lamp densities, emissions factors, partitioning of waste streams, mercury content in lamps.)

U.S. Environmental Protection Agency, Office of Solid Waste, Hazardous Waste Identification Division, "Overview of State Authorization Status," 1996.

U.S. Environmental Protection Agency Information Collection Request (ICR) # 0976, "The 1993 Hazardous Waste Report," Amendment to OMB ICR # 2050-0024. (Biennial reporting costs.)

"Analysis of Costs Under Draft Modifications to The Manifest System, Final Report," August 1, 1997. (Manifest unit costs, manifest training costs.)

"Estimating Costs for the Economic Benefits of RCRA Non-Compliance," March 1997. (Attorney labor rate.)

Global Financial Network web site, 1998. (USA consumer prices.)

IHS Environmental Information Inc., http://www.ihsenv.com. (Current state regulations for mercury-containing lamp disposal.)

Mercury Emissions Model (MS Access based model created by ICF Inc., for EPA), 1997. (Calculations of mercury emissions from disposal of lamps.)

Methodology to Estimate Static Costs Under the Definition of Solid Waste Rulemaking, 1997. (TCLP costs.)

Presentation, U.S. Environmental Protection Agency, Atmospheric Pollution Prevention Division (APPD), C&I Quarterly Meeting, January 13, 1998. (Ratio of industrial to commercial floorspace.)

Supporting Statement for Environmental Protection Agency Information Collection Request (ICR) # 261 "Reporting and Recordkeeping Requirements for Generators of Mercury-Containing Lamps," June 29, 1994. (Fixed facility costs of Subtitle C requirements.)

Supporting Statement for Environmental Protection Agency Information Collection Request (ICR) #801, "Requirements for Generators, Transporters, and Waste Management Facilities Under the RCRA Hazardous Waste Manifest System." February 13, 1997 (Administrative, technical, and managerial labor rates; exception report cost.)

"Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps," 1994. (Non-technical labor rate, LQG emergency planning costs, LQG personnel safety training, mercury testing costs, landban notification costs, transportation and disposal unit costs, Subtitle C recordkeeping.)

Personal Communications:

Personal conversation with Jim Roberts, Massachusetts Bureau of Waste Prevention, January 5, 1998. (Confirmed MA UWR.)

Personal conversation with Greg Baker, Solid Waste Bureau, State of New Mexico Environmental Department, January 5, 1998. (NM allows lamps to be treated as Universal Waste.)

Telephone conversation with Joe Howley, General Electric Lighting, January 22, 1998. (Similarities of 4 and 8 foot lamps.)

Personal conversation with Wayne Roepe, U.S. EPA, OSW, PSPD. (State UW program information.)

Recycling Facility Information Sources:

Recycling Facility	Source
Superior Lamps Recycling	Dunn and Bradstreet
Northeast Lamp Recycling	Dunn and Bradstreet
Cleansites Recycling	World Wide Web Site http://www2.greenlites.com/greenlites/cleanlites.html
Quicksilver Environmental	Company Questionnaire completed by Kelly Perich and Mike Flynn of Quicksilver Environmental, August 5, 1997
Lamp Recyclers of LA	Company Questionnaire completed by Paul Triay of Lamp Recyclers of LA., August 1997.
Mercury Technologies International	Company Questionnaire completed by Emily Beverly of Mercury Technologies International, August 5, 1997.
Mercury Technologies of Minnesota	Company Questionnaire completed by Syre E. Yarusso, CEO of Mercury Technologies of Minnesota, August, 21, 1997.
Recyclights	Company Questionnaire completed by Jan Nisiewiez, of Recyclights, August, 1997.
Salesco Systems USA	Company Questionnaire completed by Dennis Benett, James Chavex, and Lori Zito, Regulatory Compliance Manager of Salesco Systems USA, August 5, 1997.
Mercury Waste Solutions	Company Questionnaire submitted to ICF by Donald J. Wodek, Vice President, and Bernie Krzykwa, Executive Manager of Mercury Waste Solutions, August 20, 1997
Midwest Recycling and Mercury Recovery Services	Dunn and Bradstreet
A-TEC Recycling	World Wide Web Site http://www.a-tec-recycling.com
Mercury Recovery Services, Inc	Dunn and Bradstreet

APPENDIX A:
INPUTS USED FOR THE ECONOMIC MODEL

Determining the Number of Facilities that are CESQG, SQG, or LQG

A key model element impacting the total cost and total mercury emissions is the number of facilities that fall into each of the three generator categories, CESQG, SQG, and LQG. The costs and mercury emissions for facilities that are SQGs and LQGs are included in the aggregate totals, while the costs and emissions for CESQG facilities are not included since these model outputs are unaffected by the regulatory alternatives. Thus there is no net change between the three regulatory alternatives for CESQG facilities. This section of the appendix describes how the model determines the number of facilities in each generator category.

To determine the number of facilities in each generator category we first calculated facility size breakpoints between each category. We determined the facility size breakpoints by multiplying the generator breakpoints between CESQG and SQG (100 kilograms per month) and between SQG and LQG (1,000 kilograms per month) by the number of lamps per kilogram for T12s (3.5 lamps per kilogram) and for T8s (4.5 lamps per kilogram) and then dividing by the weighted average number of lamps per square foot. Exhibit A-1 contains the breakpoints for T8 and T12 lamps used in the model. The next step was to estimate the total number of facilities within each of the eight building size ranges.[1] To do this we divided the total floor space in each of the eight facility size ranges by the average facility size within that range. The facility size breakpoints were then used to determine the number of facilities above and below each breakpoint within each of the eight building size ranges using a distribution function of the number of facilities above a given building size.

To determine the distribution function we calculated the number of facilities in each of the eight building size ranges as if all of the facilities were the range's midpoint size. The midpoint of each building size range was then plotted with the cumulative total number of facilities in each size range. Exhibit A-2 presents this plot. The shape of the plot suggests a power function of the form $y=bx^m$. Using Excel's "trendline" function we fit a power curve to the data and obtained values for "b" ($b=3 \times 10^{10}$) and "m" ($m=-1.1$). The "x" in the equation is building size and "y" is the number of facilities above that building size. The number of facilities in the range A to B is the distribution function evaluated at A (y_A) minus the distribution function evaluated at B (y_B), namely $y_A - y_B$. The percentage of facilities below a building size C, in the range from A to B, is obtained with the following equation.

$$\text{Percent of facilities between A and C in the range from A to B} = \frac{y_A - y_C}{y_A - y_B} \times 100\%$$

This equation was used in the model to determine the number of facilities that fall below a breakpoint in a given building size range. For building size ranges that did not contain a breakpoint all of the facilities were allocated to one of the three generator categories.

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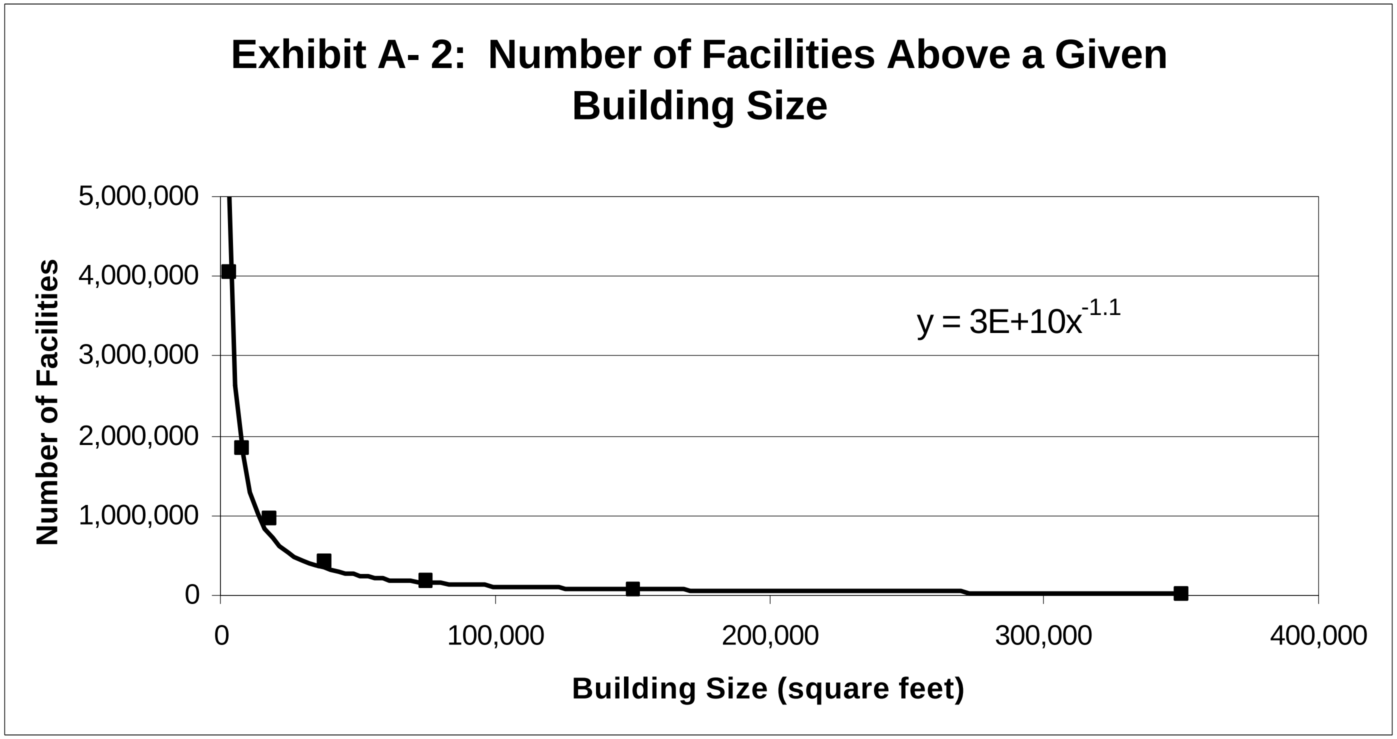
[1] The eight building size ranges in square feet are 1,000 to 5,000, 5,001 to 10,000, 10,001 to 25,000, 25,001 to 50,000, and 50,001 to 100,000 for small facilities, 100,001 to 200,000, 200,001 to 500,000 for medium facilities, and 500,001 to 10,000,000 for large facilities

Exhibit A-1: Building Size Breakpoints

Building Size Range (sq. ft.)	Breakpoint (sq. ft.)	Percent of Facilities Below Breakpoint	Breakpoint Description
Breakpoints for T12 Lamps[2]			
5,001 - 10,000	6,076	36.2 %	Small facilities that group relamp are CESQG below this breakpoint.
50,001 - 100,000	60,764	36.2 %	Small facilities that group relamp are SQG below this breakpoint.
200,001 - 500,000	380,435	79.8 %	Medium facilities that spot relamp are CESQG below this breakpoint.
200,001 - 500,000	396,286	83.3 %	Medium facilities that group relamp are SQHUW below this breakpoint.
500,001 - 10,000,000	1,918,860	80.2 %	Large facilities that spot relamp are SQHUW below this breakpoint.
500,001 - 10,000,000	4,605,264	94.8 %	Large facilities that spot relamp are SQG below this breakpoint.
Breakpoints for T8 Lamps			
5,001 - 10,000	9,191	91.5 %	Small facilities that group relamp are CESQG below this breakpoint.
50,001 - 100,000	91,912	91.5 %	Small facilities that group relamp are SQG below this breakpoint.
100,001 - 200,000	119,885	33.9 %	Medium facilities that group relamp are SQG below this breakpoint.
500,001 - 10,000,000	696,595	31.7 %	Large facilities that spot relamp are CESQG below this breakpoint.
500,001 - 10,000,000	725,619	34.9 %	Large facilities that group relamp are SQHUW below this breakpoint.
500,001 - 10,000,000	2,902,477	88.8 %	Large facilities that spot relamp are SQHUW below this breakpoint.
500,001 - 10,000,000	6,965,945	98.1 %	Large facilities that spot relamp are SQG below this breakpoint.

[2] The model assumes that facilities only use one type of lamp, either T8 or T12.

Exhibit A-1: Building Size Breakpoints (continued)



Unit Cost Inputs for the Economic Model

The following sections provide the backup calculations and sources for the unit costs used in the economic model.

Labor Rates

Labor rates were used to calculate many of the unit costs used in the economic model, since many of the activities have estimates for the amount of time to complete the activity. The labor rates used in the model are presented in Exhibit A-3. These rates are fully loaded.

Exhibit A-3: Labor Rates

Labor Category	Rate	Source
Administrative	$ 24.00	Supporting Statement for ICR #801, "Requirements for Generators, Transporters, and Waste Management Facilities Under the RCRA Hazardous Waste Manifest System." February 13, 1997
Non-Technical	$ 41.58	"Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps," 1994. Updated to 1997 dollars.
Technical	$ 47.00	Supporting Statement for ICR #801, "Requirements for Generators, Transporters, and Waste Management Facilities Under the RCRA Hazardous Waste Manifest System." February 13, 1997
Managerial	$ 72.00	Supporting Statement for ICR #801, "Requirements for Generators, Transporters, and Waste Management Facilities Under the RCRA Hazardous Waste Manifest System." February 13, 1997
Attorney	$ 99.00	"Estimating Costs for the Economic Benefits of RCRA Non-Compliance," March 1997

Transportation and Disposal Unit Costs

Transportation and disposal unit costs are provided in Exhibit A-4 for Subtitle C landfilling, recycling and retorting. In general these costs were obtained from previous reports and updated to 1997 dollars. The Subtitle D transportation cost for 200 miles was used for shipments in states using Universal Waste. The longer distance was assumed because recycling facilities and Subtitle C landfills are much less common than municipal solid waste landfills and so generally require longer transportation distances.

Under each regulatory alternative the number and tons of lamps sent to each of the disposal options was calculated. The unit costs contained in Exhibit A-4 were then multiplied by either the number of lamps or tons of lamps, depending on how the unit costs were expressed.

Manifesting Unit Costs

Manifesting costs were applied to all of the shipments in the baseline scenario, the full Subtitle C scheme. To simplify the economic model a weighted average total manifest cost was obtained and multiplied by each shipment. Exhibit A-5 and A-6 contain the details of how the high and low estimates for the weighted average total manifest cost were calculated, respectively.

Employee Manifest Training Unit Costs

Exhibit A-7 presents the methodology for calculating the employee manifest training unit cost. This cost is incurred each year.

Unit Costs by Regulatory Scheme

Exhibit A-8 and A-9 contain the unit costs for compliance with full Subtitle C scheme. Exhibits A-10 and A-11 contain the unit costs for compliance with Universal Waste. Exhibit A-12 contains the unit costs for compliance with the Conditional Exclusion. In all of these exhibits the number of new facilities is five percent of the number of regulated facilities.

Exhibit A-4: Transportation and Disposal Unit Costs

Transportation or Disposal Activity	Unit Cost (1997 dollars)	Rationale and Sources
Subtitle C Landfill Tipping Fees	$ 489.88 /ton	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124.[3] (includes stabilization and landfill)

Exhibit A-4: Transportation and Disposal Unit Costs

Transportation or Disposal Activity	Unit Cost (1997 dollars)	Rationale and Sources
Subtitle C Transportation Cost	$ 85.34 /ton	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124. Transportation cost assumes a shipping distance of 300 miles.
Subtitle D Landfill Tipping Fees	$ 42.86 /ton	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124.
Subtitle D Transportation Cost (25 miles)	$ 7.14 /ton	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124. Transportation cost assumes a 25 mile shipping distance.
Subtitle D Transportation Cost (200 miles)	$ 32.00 /ton	$0.16 per ton-mile shipping cost multiplied by 200 miles equals $32 per ton. Cost per ton-mile from the "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994,
Recycling		
Breakage Control Packaging	$ 8.62 /box	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124. Packaging, labor, and materials for a box containing 117 lamps.
Transportation and Tipping Fee	$ 0.40 /lamp	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124. This cost was also verified through conversations with recyclers.
Retorting		
Transportation & Tipping Fee	$ 1.31 /lamp	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124. Cost assumes lamps arrive at retorting facility crushed in drums.
Lamp Crushing	$ 78.67 /ton	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124.
Drum Cost	$ 44.96 /drum	Cost updated from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps" 1994, using a factor of 1.124. The factor, 1.124, is the consumer price index factor to bring 1994 dollars to 1997 dollars.

[3] The factor, 1.124, is the consumer price index factor to bring 1994 dollars to 1997 dollars.

Exhibit A-4: Transportation and Disposal Unit Costs (continued)

Exhibit A-5: Manifesting Cost - High Estimate

Activity or Cost Item	Large Quantity Generator		Small Quantity Generator		Rationale
	% in each Category	Cost per Activity	% in each Category	Cost per Activity	
Manifest Preparation		**$ 13.34**		**$ 5.19**	The total manifest preparation cost is a weighted average of the cost of preparing the manifest in-house and for a TSDF to prepare the manifest.
Manifest Prepared by TSDF	42 %	$ 1.27	80 %	$ 1.27	*
Manifest Prepared In-House	58 %	$ 22.08	20 %	$ 20.87	The unit cost is a weighted average of the cost of preparing a new manifest and a repeat manifest.
New Manifest	5 %	$ 44.98	5 %	$ 42.96	5 % of manifests are for first time shipments. The unit cost is a weighted average of the cost to prepare a manifest requiring only federal information and a manifest requiring federal and state required information.
Federal Info. Only	23 %	$ 35.19	23 %	$ 33.50	* 23 % of states use the federal manifest and require no additional information
Fed. & State Info.	77 %	$ 47.91	77 %	$ 45.79	* 77 % of states require information in addition to that required on the federal manifest
Repeat Manifest	95 %	$ 20.88	95 %	$ 19.71	95 % of manifests are for the same type of material as shipped previously. The unit cost is a weighted average of the cost to prepare a manifest requiring only federal information and a manifest requiring federal and state required information.
Federal Info. Only	23 %	$ 16.96	23 %	$ 16.11	* 23 % of states use the federal manifest and require no additional information.
Fed. & State Info.	77 %	$ 22.05	77 %	$ 20.78	* 77 % of states require information in addition to that required on the federal manifest.
Transmitting the Manifest		**$ 0.47**		**$ 0.47**	*

Exhibit A-5: Manifesting Cost - High Estimate (continued)

Activity or Cost Item	Large Quantity Generator		Small Quantity Generator		Rationale
	% in each Category	Cost per Activity	% in each Category	Cost per Activity	
Recordkeeping of Manifest		**$ 2.40**		**$ 2.40**	*
Acquiring Manifest Forms		**$ 1.70**		**$ 0.62**	The unit cost is a weighted average of the TSDF unit cost and the in-house preparation cost.
TSDF Prepares Manifest	42 %	$ 0	80 %	$ 0	* There is no cost to the generator when the TSDF acquires the manifest forms for the generator.
Manifest Prepared In-House	58 %	$ 2.93	20 %	$ 3.08	*
Submitting Manifest Copies to States		**$ 4.60**		**$ 4.60**	The unit cost is a weighted average of the cost to submit a manifest and not submit a manifest (cost is $ 0).
Generators Sending Copies	77 %	$ 5.97	77 %	$ 5.97	The unit cost is a weighted average of the cost to submit the manifest by regular mail and via registered mail.
Sending Regular Mail	20 %	$ 4.19	20 %	$ 4.19	*
Sending Certified Mail	80 %	$ 6.42	80 %	$ 6.42	*
Total Manifest Cost		**$ 22.51**		**$ 13.28**	The total manifest unit cost is a sum of the individual unit costs.

* Source: "Analysis of Costs Under Draft Modifications to The Manifest System, Final Report," August 1, 1997

Exhibit A-6: Manifesting Cost - Low Estimate

Activity or Cost Item	Large Quantity Generator		Small Quantity Generator		Rationale
	% in each Category	Cost per Activity	% in each Category	Cost per Activity	
Manifest Preparation		**$ 3.35**		**$ 2.25**	The total manifest preparation cost is a weighted average of the cost of preparing the manifest in-house and for a TSDF to prepare the manifest.
TSDF Prepares Manifest	90 %	$ 1.27	95 %	$ 1.27	*
Manifest Prepared In-House	10 %	$ 22.08	5 %	$ 20.87	The unit cost is a weighted average of the cost of preparing a new manifest and a repeat manifest.
New Manifest	5 %	$ 44.98	5 %	$ 42.96	5 % of manifests are for first time shipments. The unit cost is a weighted average of the cost to prepare a manifest requiring only federal information and a manifest requiring federal and state required information.
Federal Info. Only	23 %	$ 35.19	23 %	$ 33.50	* 23 % of states use the federal manifest and require no additional information
Fed. & State Info.	77 %	$ 47.91	77 %	$ 45.79	* 77 % of states require information in addition to that required on the federal manifest
Repeat Manifest	95 %	$ 20.88	95 %	$ 19.71	95 % of manifests are for the same type of material as shipped previously. The unit cost is a weighted average of the cost to prepare a manifest requiring only federal information and a manifest requiring federal and state required information.
Federal Info. Only	23 %	$ 16.96	23 %	$ 16.11	* 23 % of states use the federal manifest and require no additional information.
Fed. & State Info.	77 %	$ 22.05	77 %	$ 20.78	* 77 % of states require information in addition to that required on the federal manifest.
Transmitting the Manifest		**$ 0.47**		**$ 0.47**	*

Exhibit A-6: Manifesting Cost - Low Estimate (continued)

Activity or Cost Item	Large Quantity Generator		Small Quantity Generator		Rationale
	% in each Category	Cost per Activity	% in each Category	Cost per Activity	
Recordkeeping of Manifest		**$ 2.40**		**$ 2.40**	*
Acquiring Manifest Forms		**$ 0.29**		**$ 0.15**	The unit cost is a weighted average of the TSDF unit cost and the in-house preparation cost.
TSDF Prepares Manifest	90 %	$ 0	95 %	$ 0	* There is no cost to the generator when the TSDF acquires the manifest forms for the generator.
Manifest Prepared In-House	10 %	$ 2.93	5 %	$ 3.08	*
Submitting Manifest Copies to States		**$ 4.60**		**$ 4.60**	The unit cost is a weighted average of the cost to submit a manifest and not submit a manifest (cost is $ 0).
Generators Sending Copies	77 %	$ 5.97	77 %	$ 5.97	The unit cost is a weighted average of the cost to submit the manifest by regular mail and via registered mail.
Sending Regular Mail	20 %	$ 4.19	20 %	$ 4.19	*
Sending Certified Mail	80 %	$ 6.42	80 %	$ 6.42	*
Total Manifest Cost		**$ 11.11**		**$ 9.87**	The total manifest unit cost is a sum of the individual unit costs.

* Source: "Analysis of Costs Under Draft Modifications to The Manifest System, Final Report," August 1, 1997

Exhibit A-7: Calculation of Employee Manifest Training Costs

Category Description	Generator Size		Rationale and Sources
	Large Quantity Generator	Small Quantity Generator	
Number of employees to be trained	2.5	1.5	* Low estimate assumes one employee for both SQG and LQG.
Estimated number of hours for initial training	8	8	* Low estimate assumes 2 hours for both SQG and LQG.
Estimated number of hours for biennial training	1	1	* Low estimate assumes 0.5 hours for both SQG and LQG.
Percent of employees requiring initial training	20 %	20 %	*
Percent of employees requiring biennial training	80 %	80 %	*
Total wage rate (total for trainer and trainee)	$ 85	$ 85	* Low estimate assumes a rate of $96 which is the cost for a manager and administrative employee.
Biennial employee manifest training cost	$ 510	$ 306	Biennial training costs equals (number of employees to be trained) (wage rate) ((hours of initial training) (percent of employees requiring initial training) + (hours of biennial training) (percent of employees requiring biennial training))
Annualized manifest training cost	$ 282.08	$ 169.25	Biennial training cost annualized over two years at 7 %.
High Estimate of Employee Manifest Training Cost	$ 163.60	$ 33.85	Annualized cost multiplied by the percentage of facilities preparing manifests in-house, which is 58 % for LQGs and 20 % for SQGs.
Low Estimate of Employee Manifest Training Cost	$ 4.25	$ 2.12	Annualized cost multiplied by the percentage of facilities preparing manifests in-house, which is 10 % for LQGs and 5 % for SQGs.

* Source: "Analysis of Costs Under Draft Modifications to The Manifest System, Final Report," August 1, 1997

Exhibit A-8: Full Subtitle C Requirements - Fixed Initial Costs per Facility

Subtitle C Activity	Unit Cost		Facilities Affected	Rationale and Sources
	High Estimate	Low Estimate		
Notification	$ 150.35	$ 82.50	New facilities only	Assumes simple notification forms. High estimate: 0.5 hours of managerial time, 2.05 hours of technical time and 0.8 hours of administrative time. Low estimate assumes 1.5 hours of technical time and 0.5 hours of administrative time. Supporting Statement for EPA Information Collection Request (ICR) # 261 "Reporting and Recordkeeping Requirements for Generators of Mercury-Containing Lamps," June 29, 1994
Rule Familiarization			New facilities only	
with legal counsel	$ 1,106.50	$ 760.00		High estimate: 9.5 hours of legal counsel time, 1.0 hour of managerial time and 2.0 hours of technical time. Low estimate assumes 6.0 hours of legal counsel time, 1.0 hour of managerial time and 2.0 hours of technical time. Supporting Statement for EPA Information Collection Request (ICR) # 261 "Reporting and Recordkeeping Requirements for Generators of Mercury-Containing Lamps," June 29, 1994
without legal counsel	$ 332.00	$ 130.00		High estimate assumes 2.0 hour of managerial time and 4.0 hours of technical time. Low estimate assumes 0.5 hour of managerial time and 2.0 hours of technical time. Professional judgment used in estimating the amount of time required.
Emergency Planning			New facilities only	
for LQGs	$ 585.60	$ 214.40		High estimate: 0.1 hours of managerial time, 12.0 hours of technical time and 0.6 hours of administrative time. Low estimate assumes 0.2 hours of managerial time, 4.0 hours of technical time and 0.5 hours of administrative time. “Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps,” 1994

Exhibit A-8: Full Subtitle C Requirements - Fixed Initial Costs per Facility (continued)

Subtitle C Activity	Unit Cost		Facilities Affected	Rationale and Sources
	High Estimate	Low Estimate		
for SQGs	$ 395.20	$ 115.60		High estimate assumes 0.1 hours of managerial time, 8.0 hours of technical time and 0.5 hours of administrative time. Low estimate assumes 0.2 hours of managerial time, 2.0 hours of technical time and 0.3 hours of administrative time. Professional judgement used in estimating the amount of time required.
Personnel Safety Training for LQGs			All LQG facilities that group relamp using in-house personnel	"Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps," 1994
Trainer (half day)	$ 808.36	$ 0		SAIC, Executive Enterprises Inc., 1993. Cost updated to 1997 dollars using a 1.155 multiplier from the U.S. Consumer Price Index.
Personnel Time	$ 796.78	$ 705.22		High estimate: 1.0 hour of managerial time, 0.5 hours of technical time, 16.0 hours of non-technical labor, and 1.5 hours of administrative time. Low estimate assumes 1.0 hour of managerial time, 5.0 hours of technical time, 9.0 hours of non-technical labor, and 1.0 hours of administrative time.
Annualized Cost of Training	$ 473.88	$ 208.20		Annualized over 4 years at a 7 % discount rate.
Personnel Safety Training for SQGs			All SQG facilities that group relamp using in-house personnel	Professional judgement used in estimating the amount of time required.
Personnel Time	$ 249.82	$ 98.18		High estimate assumes 0.5 hours of managerial time, 0.5 hours of technical time, 4.0 hours of non-technical labor, and 1.0 hour of administrative time. Low estimate assumes 0.1 hours of managerial time, 1.0 hours of technical time, 1.0 hours of non-technical labor, and 0.1 hour of administrative time.
Annualized Cost of Training	$ 73.75	$ 28.99		Annualized over 4 years at a 7 % discount rate.
Manifest Training			All facilities, each year	Analysis of Costs Under Draft Modifications to the Manifest System, Final Report, August 1, 1997.

Exhibit A-9: Subtitle C Requirements - Variable Costs

Subtitle C Activity	Unit Cost		Facilities Affected	Rationale and Sources
	High Estimate	Low Estimate		
for LQGs	$ 163.60	$ 4.25		See Exhibit A-7 for details on calculating these costs.
for SQGs	$ 33.85	$ 2.12		See Exhibit A-7 for details on calculating these costs.
Subtitle C Recordkeeping	$ 33.10	$ 14.15	All Facilities, each year	High estimate: 0.1 hour of managerial time, 0.5 hours of technical time, and 0.1 hours of administrative time. Low estimate assumes 0.25 hours of technical time, and 0.1 hours of administrative time. "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps," 1994
Biennial Reporting	$ 129.59	$ 129.59	LQGs only, cost per year	Generators must file forms IC and GM. Form IC requires 0.5 hour of managerial time, 2.0 hours of technical time, and 0.5 hours of administrative time. Form GM requires 0.3 hour of managerial time, 1.3 hours of technical time, and 0.4 hours of administrative time. High estimate: generators file one copy of form IC and 1 copy of form GM. Low estimate assumes generators file one copy of form IC and one copy of form GM. The cost to file form IC is $ 142.00, and to file form GM is $ 92.30 The cost to file both forms was annualized over two years at a discount rate of 7 %, to obtain the yearly cost. Supporting Statement for EPA ICR # 0976 "The 1993 Hazardous Waste Report," Amendment to OMB ICR # 2050-0024
Waste Characterization	$ 312.46	$ 0	Assumes only LQGs perform waste characterization. SQGs are assumed to obtain waste characterization information from manufacturers	Assumes one TCLP metals test at $ 268.63, and one mercury-specific test at $ 43.83. TCLP cost from "Methodology to Estimate Static Costs Under the Definition of Solid Waste Rulemaking," 1997, and the mercury-specific test cost is from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps," 1994.

Subtitle C Activity	Unit Cost	Facilities Affected	Rationale and Sources

Exhibit A-9: Subtitle C Requirements - Variable Costs

	High Estimate	Low Estimate		
Landban Notification Cost per shipment.	$ 19.84	$ 19.84	All facilities	0.5 hours of managerial time, 2.1 hours of technical time and 1.0 hour of administrative time. "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps," 1994.
Subtitle C Manifest Cost per shipment.			All facilities	Analysis of Costs Under Draft Modifications to the Manifest System, Final Report, August 1, 1997. See Exhibits A-5 and A-6 for details on and methodology for calculating manifest costs.
for LQGs	$ 22.51	$ 11.11		
for SQGs	$ 13.28	$ 9.87		
Exception Report Cost per report.			0.5 % of shipments require an exception report	Supporting Statement for ICR number 801, "Requirements for Generators, Transporters, and Waste Management Facilities Under the RCRA Hazardous Waste Manifest System." February 13, 1997
for LQGs	$ 64.30	$ 32.15		0.25 hour of managerial time, and 0.25 hours of technical time.
for SQGs	$ 29.75	$ 16.60		0.5 hour of managerial time, 0.5 hours of technical time, and 0.2 hours of administrative time.

Exhibit A-10: Universal Waste Requirements - Fixed Initial Costs per Facility

Subtitle C Activity	Unit Cost		Facilities Affected	Rationale and Sources
	High Estimate	Low Estimate		
Notification	$ 150.35	$ 82.50	New facilities only LQHUW only	Assumes simple notification forms. High estimate: 0.5 hours of managerial time, 2.05 hours of technical time and 0.8 hours of administrative time. Low estimate assumes 1.5 hours of technical time and 0.5 hours of administrative time. Supporting Statement for EPA Information Collection Request (ICR) # 261 "Reporting and Recordkeeping Requirements for Generators of Mercury-Containing Lamps" June 29, 1994
Rule Familiarization			New facilities only	
with legal counsel	$ 1,106.50	$ 760.00		High estimate: 9.5 hours of legal counsel time, 1.0 hour of managerial time and 2.0 hours of technical time. Low estimate assumes 6.0 hours of legal counsel time, 1.0 hour of managerial time and 2.0 hours of technical time. Supporting Statement for EPA Information Collection Request (ICR) # 261 "Reporting and Recordkeeping Requirements for Generators of Mercury-Containing Lamps" June 29, 1994
without legal counsel	$ 166.00	$ 83.00		High estimate assumes 1.0 hour of managerial time and 2.0 hours of technical time. Low estimate assumes 0.5 hour of managerial time and 1.0 hour of technical time. Professional judgment used in estimating the amount of time required.
Personnel Safety Training for LQHUW	$ 292.22	$ 87.67	All LQHUW facilities that group relamp using in-house personnel	High estimate cost updated to 1997 dollars. Low estimate is 30 % of the high estimate. Analysis of Potential Cost Savings and the Potential for Reduced Environmental Benefits of the Universal Waste Rule, April 1995.
Annualized Cost of Training	$ 86.27	$ 25.88		Annualized over 4 years at a 7 % discount rate.
Personnel Safety Training for SQHUW	$ 112.39	$ 33.72	All SQG facilities that group relamp using in-house personnel	High estimate cost updated to 1997 dollars. Low estimate is 30 % of the high estimate. “Analysis of Potential Cost Savings and the Potential for Reduced Environmental Benefits of the Universal Waste Rule,” April 1995.

Exhibit A-10: Universal Waste Requirements - Fixed Initial Costs per Facility (continued)

Subtitle C Activity	Unit Cost		Facilities Affected	Rationale and Sources
	High Estimate	Low Estimate		
Annualized Cost of Training	$ 33.18	$ 9.95		Annualized over 4 years at a 7 % discount rate.
Waste Characterization	$ 312.46	$ 0	Assume only LQHUW perform waste characterization. SQHUW are assumed to obtain waste characterization information from manufacturers	Assumes one TCLP metals test at $ 268.63, and one mercury specific test at $ 43.83. TCLP cost from "Methodology to Estimate Static Costs Under the Definition of Solid Waste Rulemaking," 1997, and the mercury specific test cost is from "Technical Background Document, Economic Impact Analysis for the Proposed Rule for the Management of Spent Mercury-Containing Lamps," 1994.

Exhibit A-11: Universal Waste Requirements - Variable Costs

Subtitle C Activity	Unit Cost		Facilities Affected	Rationale and Sources
	High Estimate	Low Estimate		
Shipment Recordkeeping Costs (per shipment, recordkeeping only).				"Analysis of Potential Cost Savings and the Potential for Reduced Environmental Benefits of the Universal Waste Rule," April 1995.
for LQHUW	$ 8.99	$ 8.99		
for SQHUW	$ 0	$ 0		

Exhibit A-12: Conditional Exclusion Requirements

Subtitle C Activity	Unit Cost		Facilities Affected	Rationale and Sources
	High Estimate	Low Estimate		
Rule Familiarization			New facilities only	
with legal counsel	$ 1,106.50	$ 760.00		High estimate: 9.5 hours of legal counsel time, 1.0 hour of managerial time and 2.0 hours of technical time. Low estimate assumes 6.0 hours of legal counsel time, 1.0 hour of managerial time and 2.0 hours of technical time. Supporting Statement for EPA ICR # 261 "Reporting and Recordkeeping Requirements for Generators of Mercury-Containing Lamps" June 29, 1994
without legal counsel	$ 166.00	$ 83.00		High estimate assumes 1.0 hour of managerial time and 2.0 hours of technical time. Low estimate assumes 0.5 hour of managerial time and 1.0 hour of technical time. Professional judgement used in estimating the amount of time required.
Recordkeeping Cost per Shipment	$ 16.50	$ 7.10	All facilities	EPA ICR # 1569 Hazardous Waste Generator Standards

APPENDIX B:
DESCRIPTION OF THE REGULATORY CHOICES MODELED

While the Baseline, UW final action, and CE option analyzed in this report assume alternative federal standards for the management of mercury containing lamps, it cannot be assumed that states will automatically follow suit. Currently, while full Subtitle C regulations for mercury containing lamps that fail the TC is the federal standard, some states have defined mercury containing lamps as a UW. Further, even if it is determined that a state will adopt the federal standard promulgated under EPA's final action, it does not necessarily mean that the state will do so right away. Legislative debate and law-making can take years. Even the baseline is dynamic. Some states have indicated that even if the federal standard for the management of mercury containing lamps remains unchanged, they will at some point define lamps as a UW.

Because regulatory cost parameters faced by a facility and the environmental effects caused by a facility's disposal practices depend on the management scheme it operates under, it is necessary to identify the percentage of facilities that operate under each prevailing management scheme for each year analyzed. We accomplish this task by first projecting each state's choice of regulatory schemes (i.e., full Subtitle C, UW, or CE) under the baseline and prospective federal actions in each year, and then using estimates of the number of facilities in each state to estimate the percentage of lamps managed under each scheme. The proxy this analysis uses for number of facilities lighted by fluorescent lamps in a state is the relative non-farm, non-forestry, and non-mining employment in a state. For example, California possesses 11 percent of the nation's non-farm, non-forestry, and non-mining workers, and it is assumed it contains the same percentage of lighted facilities. Finally, we assume all states have the same distribution of facility sizes, allowing us to translate percentages of facilities under each scheme into percentages of lamps.

Baseline

According to the state regulatory database maintained by IHS Environmental Information Inc. (http://www.ihsenv.com/), thirty-two states have adopted EPA's Universal Waste Rule (UWR) as of October 1997. In addition, though not indicated in the IHS Environmental Information regulatory database, it has been confirmed that Massachusetts has also adopted the UWR.[1] Furthermore, while New Mexico has not formally adopted the UWR, it does allow generators to manage wastes identified in EPA's UWR as universal wastes (UWs).[2]

[1] Personal conversation with Jim Roberts, Massachusetts Bureau of Waste Prevention, January 5, 1998.

[2] Personal conversation with Greg Baker, Solid Waste Bureau, State of New Mexico Environmental Department, January 5, 1998.

Exhibit B-1: States that Have Adopted the UWR as of October, 1997

• Alabama	• Alaska	• Arizona	• Arkansas
• Colorado	• Delaware	• Florida	• Georgia
• Idaho	• Illinois	• Indiana	• Kentucky
• Louisiana	• Massachusetts	• Michigan	• Mississippi
• Montana	• Nebraska	• Nevada	• New Jersey
• New Mexico*	• North Carolina	• North Dakota	• Ohio
• Oklahoma	• Oregon	• Pennsylvania	• South Carolina
• South Dakota	• Tennessee	• Texas	• Utah
• West Virginia	• Wyoming		

*Though not formally adopted, generators of waste identified in UWR can dispose of waste as UW

The IHS Environmental Information database indicates that 15 of the 34 UWR states have amended the EPA UWR to include mercury containing lamps.[3,4] Furthermore, based on a personal conversation with a state regulator, Massachusetts also defines mercury containing lamps as UW (see footnote 1).

Exhibit B-2:
UW States that Define Mercury Containing Lamps as a UW as of October, 1997

• Alabama	• Arizona	• Florida
• Georgia	• Indiana	• Kentucky
• Massachusetts	• Michigan	• Montana
• Nebraska	• North Dakota	• Oregon
• Utah	• West Virginia	• Wyoming

It has been projected that 7 of the 19 UW states that currently do not include lamps in their UWR will amend their regulations in the near future to include lamps. A consultant for Mercury Technologies International, L.P. (MTI),[5] a mercury recycling company based in Pennsylvania, has surveyed state regulators and found that Arkansas, Illinois, Louisiana, and Nevada plan to amend their current UWRs to include mercury containing lamps. EPA sources concur on the anticipated behavior of Louisiana, and report that Delaware, Pennsylvania, and Texas are also likely to amend state UWRs to include lamps in the near future.[6] This analysis assumes both sources are correct regarding the future behavior of these states.

Exhibit B-3: UW States that are Planning to Define Mercury Containing Lamps as a UW

[3] Mercury containing lamps are never specifically mentioned in North Dakota's UWR, however it is assumed that "mercury containing devices," a term used in the State's UWR documentation, includes lamps.

[4] Florida, one of the 14 states that includes lamps in their UWR, further requires that all lamps be recycled to avoid a hazardous waste label.

[5] Paul W. Abernathy, Director of Regulatory Affairs, August 21, 1997.

[6] Based on "Overview of State Authorization Status, 1996," obtained from EPA/HWID.

• Arkansas	• Delaware	• Illinois
• Louisiana	• Nevada	• Pennsylvania
• Texas		

MTI's consultant and EPA sources also found that 12 non-UW states and the District of Columbia are planning to adopt the UWR within the next several years.[7] The MTI consultant and EPA sources both conclude that California, Connecticut, Minnesota, New York (a proposal is currently pending), Virginia, and Washington (a proposal is currently pending) are planning, or are in the process of adopting the UWR. According to the MTI consultant, the District of Columbia, Iowa, and Wisconsin are also planning to adopt the rule. EPA sources do not corroborate these claims, but indicate that Maine, New Hampshire, and Vermont will also join the ranks of states with the UWR in the near future. This analysis assumes that both sources are correct. Of these 11 states and the District of Columbia, the MTI consultant and EPA agree that California, Connecticut, and Minnesota officials have indicated that mercury-containing lamps will be included in the UWR. Furthermore, EPA projects that Maine and New Hampshire will include lamps under their UWRs. The MTI consultant also projects that Wisconsin will include lamps under its future UWR. Once again, both sources are assumed to be correct on this matter.

Exhibit B-4: States that are Planning to Adopt the UWR and Amend it to Include Mercury-Containing Lamps

• California	• Connecticut	• Maine
• Minnesota	• New Hampshire	• Wisconsin

Therefore, the baseline analysis assumes that in 1997 the following states operated under the UWR that included mercury-containing lamps.

Exhibit B-5: Baseline Scenario--States with the UWR including Lamps in 1997

• Alabama	• Arizona	• Florida
• Georgia	• Indiana	• Kentucky
• Massachusetts	• Michigan	• Montana
• Nebraska	• North Dakota	• Oregon
• Utah	• West Virginia	• Wyoming

Further, by the year 2002 it is assumed the following states also will have adopted the UWR that includes mercury containing lamps:

[7] For the purposes of this study it is assumed all states that plan to adopt the UWR and amend the rule will have completed the process by 2002.

Exhibit B-6:
Baseline Scenario--States that are Anticipated to Adopt the UWR Including Lamps by 2002

• Arkansas	• California	• Connecticut
• Delaware	• Illinois	• Minnesota
• New Hampshire	• Pennsylvania	• Texas
• Louisiana	• Maine	• Nevada
• Wisconsin		

This analysis does not assume that all the states indicated in Exhibit B-6 will adopt the UWR with lamps at the same time. Of the 13 states anticipated to add lamps as a UW by 2002, the model assumes 4 will do so in 1998, 4 in 1999, 3 in 2000, and 2 in 2001.

In the absence of any concrete evidence regarding the timing of state plans for promulgating their rules, the year a particular state identified in Exhibit 5 adopts the UWR with lamps in the economic model has been randomly assigned. It has been assumed that Arkansas, Illinois, Texas, and Wisconsin define lamps as a UW in 1998; California, Louisiana, Minnesota, and Nevada in 1999; Connecticut, Maine, and New Hampshire in 2000; and finally, Delaware and Pennsylvania in 2001. Accounting for the assumptions in Exhibits B-5 and B-6, and the random assignments shown above, the percentage of workers, and therefore facilities and lamps, that face full Subtitle C regulation when disposing of lamps and those that operate under UW regulations for lamps in the Baseline are as shown in Exhibit B-7.

Exhibit B-7:
Facility and Lamp Distributions by Regime Under the Baseline

Year	Full Subtitle C	Lamps Defined as UW
1997	75%	25%
1998	60%	40%
1999	45%	55%
2000	43%	57%
2001-2008	38%	62%

Universal Waste Final Action

Under EPA's final action, it is assumed that the 13 states preparing to adopt the UWR with lamps as identified in the baseline would go ahead with their plans regardless of EPA's action to make the UWR with lamps a federal standard. Further, we assume that the 15 states that have operated under the UWR with lamps since 1997 would maintain their programs as the UWR with mercury containing lamps becomes standardized.

Based upon a conversation with an EPA official at the PSPD office, it is assumed by EPA regional officials that Arizona, Idaho, South Dakota, Virginia, and West Virginia have state rules that prohibit state waste regulations from being more stringent than federal standards.[8] Currently, three of these states —

[8] Personal communication with Wayne Roepe, U.S. EPA, Office of Solid waste, Permits and State Programs Division.

Idaho, South Dakota, and Virginia — operate under regulations that are more stringent than a UWR that includes mercury containing lamps. Therefore, we assume these three states would adopt a federally mandated UWR that includes lamps.

Further, it is assumed every state that operates under or plans to adopt the UWR without lamps will include lamps within the scope of the regulation under EPA's UW final action. States are exempted from this assumption in this scenario if they indicated, in response to the surveys conducted by MTI's consultant and EPA, that lamps **would not** be covered by the UW scheme in their respective states. It is assumed these states decided to manage mercury from lamps separately due to compelling environmental or economic reasons which would not change in response to an alteration in EPA's rules.

Finally, we assume that states that have not yet adopted the UWR, and have not yet taken any steps to do so, will not be compelled to adopt the rule even after EPA's final action. The one exception to this assumption is Rhode Island. Currently, Rhode Island does not have the resources to develop a state authorization package for the UWR and defaults to the federal standard. It is assumed, therefore, that Rhode Island adopts by reference and will continue to do so in the future.

Therefore, under the UW final action, we assume that the 15 states identified in Exhibit B-5 operated under the UWR with lamps in 1997. By 2002, we assume that the following additional states will have adopted the UWR that includes lamps:

Exhibit B-8:
UW Final Action — States that are Anticipated to Adopt a UWR Including Lamps by 2002

• Alaska	• Arkansas	• California
• Colorado	• Connecticut	• Delaware
• Idaho	• Illinois	• Louisiana
• Maine	• Minnesota	• Nevada
• New Hampshire	• Oklahoma	• Pennsylvania
• Rhode Island	• South Dakota	• Texas
• Vermont	• Virginia	• Wisconsin

Once again, the model does not assume all the states in Exhibit B-8 will adopt the UWR including lamps at the same time. The promulgation date is assumed to be late 1998. The model assumes that Idaho, Rhode Island, South Dakota, and Virginia will adopt the law immediately after promulgation, in other words 1999. Further, all the assumptions regarding year-by-year adoption of the UWR with lamps described in the baseline apply to the final action: Arkansas, Illinois, Texas, and Wisconsin define lamps as a UW in 1998; California, Louisiana, Minnesota, and Nevada in 1999; Connecticut, Maine, and New Hampshire in 2000; and Delaware and Pennsylvania in 2001. This leaves four additional states that have been identified as UWR adoptees under the final action that need to be assigned adoption dates. Once again these states have been randomly assigned to adoption dates: Alaska and Oklahoma in 1999, Colorado in 2000, and Vermont in 2001. The percentages of facilities and lamps that are regulated to dispose of lamps under full Subtitle C and the UWR is assumed to be those shown in Exhibit B-9.

Exhibit B-9:
Facility and Lamp Distributions by Regime Under the UW Final Action

Year	Full Subtitle C	Lamps Defined as UW
1997	75%	25%
1998	60%	40%
1999	40%	60%
2000	36%	64%
2001-2008	31%	69%

CE Option

Under the CE option, it is assumed a state will not adopt the federal standard if it possesses incentives that encourage the recycling of mercury containing lamps or has indicated that lamps will not be included under their respective UWR proposals. It is assumed that these states find the disposal of mercury containing lamps to be an environmental problem and wish to avoid, as much as possible, the disposal of lamps in landfills. These states are likely to feel that the CE scheme would compromise this goal.

It is assumed that the majority of states that do not exhibit either one of these characteristics would eventually adopt CE if EPA had selected the CE option. However, some states that still require full Subtitle C disposal for mercury containing lamps and offer no recycling incentives may do so in order to completely contain the emissions of mercury from lamps. The CE scheme would not allow states to maintain such tight control over mercury emissions form lamps. For this reason this option cannot assume all states that do not display the two characteristics identified above will adopt the CE standard. Therefore, all states that include or plan to include lamps within their UWRs will be assumed to adopt CE if promulgated by EPA. Moreover, every state that has or plans to adopt the UWR but is undecided regarding the inclusion of lamps, will adopt the CE standard. For purposes of this analysis, it is assumed that these states are not strongly opposed to relaxed standards when it comes to mercury-containing lamps. Further, half of the states that indicate no plans to adopt the UWR will be assumed to adopt CE, while the remaining half that indicate no plans to adopt the UWR will find the CE standard too relaxed and will adhere to another waste management rule. Again, any state that has special recycling incentives for lamps will be assumed not to adopt CE.

EPA assumes under the CE option that EPA would have promulgated CE in late 1998. Due to their requirements that state waste regulations be no more stringent than federal standards, it is presumed that Arizona, Idaho, South Dakota, Virginia, and West Virginia would adopt CE immediately. Further, Rhode Island, unable to authorize alternative waste management regulations due to a lack of resources, would also adopt CE in 1999.

Exhibit B-10:
States that Would Adopt the CE Standard in 1999 under the CE Option

• Arizona	• Idaho	• Rhode Island
• South Dakota	• Virginia	• West Virginia

The CE option further assumes that half of the states that adopt CE will do so in the year 2000. The remaining states that are assumed to adopt CE will do so a year later.

Exhibit B-11:
States that Would Adopt the CE Standard, 50% in 2000, 50 % in 2001

• Alabama	• Alaska	• Colorado
• Connecticut	• Delaware	• Georgia
• Illinois	• Indiana	• Kentucky
• Kansas/Maryland*	• Michigan	• Montana
• Nebraska	• Oklahoma	• Oregon
• Texas	• Utah	

*full Subtitle C states that have given no indication of adopting the UWR; only one of the two will adopt the CE standard

A random assignment of states indicates that Alabama, Colorado, Delaware, Illinois, Kentucky, Michigan, Nebraska, Oregon, and Utah will adopt CE in 2000 and Connecticut, Georgia, Indiana, Maryland, Montana, Oklahoma, and Texas will adopt CE in 2001. The behavior of states not planning to adopt CE will be the same as identified in the baseline. Therefore, the percentages for the three lamp regulatory schemes under the CE option become those shown in Exhibit B-12.

Exhibit B-12: Facility and Lamp Distributions by Regime Under the CE Option

Year	Full Subtitle C	Lamps Defined as UW	Conditional Exclusion
1997	75%	25%	0%
1998	60%	40%	0%
1999	41%	53%	6%
2000	37%	41%	22%
2001-2008	30%	32%	39%

APPENDIX C:
DESCRIPTION OF THE MERCURY EMISSIONS MODELING PROCESS

Determining Mercury Emissions

Three variables were used by the economic model to estimate emissions from the management and disposal of spent lamps: the total amount and type of lamps that enter the waste management stream, the management practices that are used in the disposal of lamps, and the emission rates for the different disposal practices.

The Number of Lamps and Mercury Content of Lamps Entering Waste Stream

The first input used to measure mercury emissions — amount and type of lamps entering the waste management stream — is a function of total floorspace lit by fluorescent lamps and assumptions regarding the number of lamps per square foot, lamp lifetimes, lamp replacement methods, and proportion of lamp types.

The total number of and type of lamps entering the waste stream is calculated using the following methodology. First the total floorspace is divided by a lamp's per square foot coefficient (total floorspace is divided among small, medium, and large facilities and each of these facility sizes has different lamps per square foot coefficients) to obtain the total number of lamps. This, however, does not account for the "delamping" rate exhibited by T8 lamps (the lamp per square foot coefficients used in this equation are for T12 lamps). A facility with T8 lamps is assumed to need only 0.85 the number of lamps a similar facility that uses T12 lamps would require. In other words, if one facility uses 100 T12 lamps, an otherwise identical facility that uses T8 lamps instead would only need 85 lamps to light the same amount of floorspace. Therefore, the T8 fraction of total lamp population must be multiplied by 0.85 to account for the higher lighting efficiency of these lamps. This new "corrected" total is multiplied by the fraction of lamps that fail annually. The annual lamp failure rate is assumed to be roughly 25 percent whether the facility is a spot or group relamper. This failure rate is based on the assumed lamp lifetime of four years and the rate at which facilities group relamp (i.e., once every four years). Lamp failure rates for T8 and T12 lamps are assumed to be equal.

The Partitioning of the Waste Stream[1]

After determining the number of lamps entering the waste stream, the economic model partitioned the waste stream among different disposal options available to lamp generators. The partitioning factors

[1] For all practical purposes, the partitioning coefficients used in the economic model mirror the coefficients assumed in the Mercury Emissions Model. The two major differences between the two models are the division of lamps into CESQG and non-CESQG management schemes and the number of lamps that are recycled. The economic model calculated that 86 percent of all lamps would be disposed of as CESQG lamps in the initial year, based on assumptions made regarding the average building size in each building size category. The Emissions Model assumed 70 percent of disposed lamps would be managed as CESQG lamps in the initial year. Further, the Emissions Model assumed higher recycling rates than the economic model under the baseline, UW and CE regulatory schemes. Given that little information exists on the number of CESQG lamps and recycled lamps, EPA believes that both sets of assumptions are reasonable based on available data.

used in the economic model were not static across regulatory schemes. Coefficients changed under each regulatory option. For example, compliant behavior was assumed to be more prevalent under the UW scheme than the baseline, and therefore, under the UW scheme many more lamps were disposed of in a Subtitle C landfill than they were in the baseline (most lamps in the baseline were assumed to be disposed in Subtitle D landfills). Partitioning coefficients also changed over time in the economic model. It was assumed recycling rates would increase over time under all three regulatory schemes, albeit at different rates under each scheme. Further, the model assumed the percentage of disposed lamps classified as CESQGs would change over the years. The model calculated that the number of CESQG lamps slowly decreases due to the growing use of T8 lamps and its related “best management practice” of group relamping.

The economic model **baseline** first divided the lamps by generation category — CESQG lamps and non-CESQG lamps. The fraction of lamps partitioned into each category depended on the year; the model took into account the fact that the fraction of lamps from CESQG facilities will fall as group relamping becomes more common. Of the CESQG lamps (in the first year 86 percent of disposed lamps are CESQG), the model assumed 10 percent will be recycled. Of the remaining 90 percent of CESQG lamps, 87 percent were assumed to go to a Subtitle D landfill and the other 13 percent to a MWC. In other words, 10 percent of the CESQG lamps in the baseline were recycled, 78 percent placed in a landfill, and 12 percent destroyed at a MWC. Under the baseline 10 percent of all non-CESQG lamps are assumed to be recycled, and similarly, 10 percent of the lamps that were produced by non-CESQG facilities are assumed to be managed according to Subtitle C regulations. The remaining non-CESQG lamps, 80 percent of the total non-CESQG lamps, were assumed to be dealt with in a non-compliant manner. Specifically, the model assumed 87 percent of the non-CESQG lamps managed in a non-compliant manner were sent to a Subtitle D landfill (70 percent of all non-CESQG lamps) and the remaining lamps incinerated at a MWC (10 percent of all non-CESQG lamps).

The partitioning factors for the **Universal Waste (UW)** waste flow in the economic model assumed greater compliance. In the first year 86 percent of the lamps under the UW scheme were produced by CESQG generators (this fraction changed every year and the model projected that this fraction would decrease over time). The model assumed that 10 percent of the CESQG lamps were recycled, 78 percent were disposed of at a Subtitle D landfill, and the remainder of the CESQG lamps were assumed to be incinerated at a MWC. Of the lamps produced by non-CESQG facilities (approximately 14 percent) it was assumed that 80 percent would be managed in a compliant manner. It was assumed that 90 percent of the lamps dealt with in a compliant manner were disposed of in a Subtitle C landfill and the remaining 10 percent were recycled (recycling rates increase slowly over the 10-year period).[2] Non-CESQG lamps that were managed in a non-compliant manner, 20 percent of all non-CESQG lamps, were ultimately disposed of in a Subtitle D landfill or incinerated at a MWC. The breakdown was 87 percent to landfills, and 13 percent to MWCs.

[2] The Mercury Emissions Model, a basis for much of the economic model’s emission parameters, does not allow for the possibility of Onsite Crush-C treatment in the UW Compliance waste management paths. The economic model did assume that some lamps were crushed on-site before being disposed of in a Subtitle C landfill (specifically 7 percent of all disposed lamps in the initial year). The federal UW regulations prohibit on-site crushing as a form of treatment and the Emissions Model reflects this regulatory condition. However, the final rule includes an exception to the treatment prohibition and allows states to establish regulatory programs that permit crushing under conditions that are protective of human health and the environment. The states of Florida and Michigan allow crushing of spent lamps under UW regulatory programs designed specifically for the management of spent mercury-containing lamps, provided that specific requirements are met.

The **Conditional Exclusion (CE)** partitioning tree assumed the highest compliance rate of the three schemes; 90 percent of the non-CESQG lamps were disposed of in a CE-compliant manner. Of those lamps disposed of in a compliant matter, 10 percent were recycled, approximately 4 percent were placed in a Subtitle C landfill, and the remaining number, 86 percent, were assumed to be disposed in a Subtitle D landfill. Most non-CESQG lamps that were managed in a non-compliant matter — 10 percent of all non-CESQG lamps — were assumed to be incinerated at a MWC (90 percent). The predominance of Subtitle D disposal in this scheme was also assumed among CESQG lamps. Seventy-eight percent of the CESQG lamps were placed in a Subtitle D landfill, 12 percent were incinerated at a MWC, and the remaining 10 percent were recycled.

Waste Path Emission Coefficients

The final step in determining mercury emissions involved multiplying the number of lamps that progressed down a particular waste path (e.g., Non-CESQG to Subtitle C Management to Subtitle C transport to Recycle) by the emission coefficient for that waste path. The three emission inputs worked together in the following manner: after the total number of T8 and T12 lamps entering the waste stream was calculated, groups of T8 and T12 lamps were divided along waste disposal paths according to the appropriate partitioning coefficients. On the side, the economic model had already calculated emission rates for groups of one million T8 lamps and groups of one million T12 lamps on each waste path under each scenario. (The basis for these waste path emission rates are discussed below.) The final step in determining mercury emissions in the economic model involved multiplying the emission rate per one million T8 lamps for a particular waste path under a particular regulatory scheme with the number of one million T8 lamp groups that were disposed on that particular path under the same regulatory scheme. This process was repeated for T8 lamps on each waste path under the scheme. The final product from each waste path was then added together to produce total emissions under that regulatory scheme due to T8 lamps. This process of multiplying the number of one million lamp groups on a waste path for a given regulatory scheme by the emission rates per one million lamps for that waste path under a given regulatory option was repeated for T12 lamps. Total emissions due to T8 and T12s under a particular scenario where added together to calculate total emissions under a regulatory scheme. These emission calculations were done for each regulatory scenario.

An important factor in the determination of emission rates for a particular waste path was the assumed mercury content of the lamps that entered that waste path.

Exhibit C-1: Mercury Content of Lamps

Mercury Content of T12 Lamps (milligrams per lamp)

Year	Elemental	Divalent	Particulate	Total
pre-1992	0.082	40.918	0	41
1992-1996	0.060	29.940	0	30
1997-2007	0.042	20.958	0	21

Mercury Content of T8 Lamps (milligrams per lamp)

Year	Elemental	Divalent	Particulate	Total
pre-1996	0.060	29.940	0	30
1996-1999	0.030	14.970	0	15
2000-2007	0.020	9.980	0	10

To simplify matters, the economic model assumed all T12 lamps disposed of between 1998-2007 contained 21 milligrams of mercury and all T8 lamps disposed of between 1998-2007 contained 10 milligrams of mercury.

The section immediately below describes in detail the data that were used as a basis for the waste path emission rates. The subsequent section describes in greater detail how emission coefficients were used by the economic model to determine mercury emissions.

Emission Factors for Lamps that Enter Waste Stream[3]

A typical lamp is assumed to contain two types of mercury: elemental and divalent. Elemental, or vapor phase, mercury constitutes approximately 0.2 percent of lamp's mercury. The other 99.8 percent of the lamp's mercury is in the divalent form. It is assumed that all of the elemental mercury and between 1.1 percent and 6.8 percent of the divalent mercury escapes when a lamp breaks. It is assumed that 100 percent of the lamps discarded as part of a non-hazardous solid waste stream are shattered in the disposal process. This 100-percent breakage assumption applies to the following management activities:

- Subtitle D Transport under full Subtitle C;
- Subtitle D Transport and CE Compliant Transport in the CE option; and
- Noncompliant Transport under UW.

Exhibit C-2: Emission Rates for Subtitle D Transport under Full Subtitle C, Noncompliant Transport under UW, and Subtitle D Transport and CE Compliant Transport in under CE

Central Estimate			High Estimate			Low Estimate		
Total	Elemental	Divalent	Total	Elemental	Divalent	Total	Elemental	Divalent
2.994%	100%	2.8%	6.986%	100%	6.8%	1.298%	100%	1.1%

It is assumed the lamp breakage rate is significantly lower for lamps being transported to recycling and Subtitle C facilities: 0.2 percent to 5 percent of the lamps are assumed to break under these conditions. By multiplying these breakage percentages by the central case emission rates in Exhibit C-2, the emission factor range for lamps being transported to recycling or Subtitle C facilities is determined.

Exhibit C-3: Emission Rates for Transport to Recycling and Subtitle C Facilities

Central Estimate			High Estimate			Low Estimate		
Total	Elementa l	Divalent	Total	Elemental	Divalent	Total	Elemental	Divalent
0.03%	1%	0.028%	0.15%	5%	0.14%	0.006%	0.2%	0.006%

To reduce lamp volume for transportation and disposal, some generators under a state approved plan, may crush their lamps in a procedure called Drum Top Crushing. Once again it is assumed all elemental mercury is lost when a lamp is broken. Further, another 2.8 percent of the lamp's mercury

[3] All Information in this section is contained in Mercury Emissions from the Disposal of Fluorescent Lamps, Revised Model Final Report, March 31, 1998.

content in the form of phosphor powder is emitted during crushing. Many drum top crushers, however, have emission controls that capture 90 percent of the vapor phase mercury. The central case assumes this control is working and an emission factor of 2.8144 percent is achieved. The high estimate, 3 percent, assumes no control over vapor emissions whatsoever, and the low, 0.3 percent assumes 90 percent emission control over both the vapor and phosphor powder mercury.

Exhibit C-4: Emission Rates for Crushing Operations

Central Estimate			High Estimate			Low Estimate		
Total	Elemental	Divalent	Total	Elemental	Divalent	Total	Elemental	Divalent
2.814%	10%	2.8%	2.994%	100%	2.8%	0.299%	10%	0.28%

For lamps that are treated at recyclers, the central estimate gives an emission factor of 1.10782 percent of total mercury in the lamp, while the high estimate is 6.02 percent and the low emission factor is 0.07 percent. These rates capture all stages of recycling, including the secondary stage where the mercury containing end caps are smelted.

Exhibit C-5: Emission Rates for Recycling Units

Central Estimate			High Estimate			Low Estimate		
Total	Elemental	Divalent	Total	Elemental	Divalent	Total	Elemental	Divalent
1.108%	10%	1.09%	6.018%	15%	6%	0.070 %	0%	0.07%

Mercury is also emitted when a lamp is burned in a municipal waste combustor (MWC). The central estimate for emissions due to combustion model assumes that all the vapor phase mercury has escaped by the time the lamp reaches the combustor. Further, the central estimate assumes that the combustors are following EPA guidelines that call for mercury emission control rates of 85 percent. Therefore 15 percent of the lamp’s divalent mercury content is assumed to be released in combustion in the central estimate. The high and low estimates also assumed all vapor phase mercury had already dissipated, but control rates are 84 percent and 92 percent respectively.

Exhibit C-6: Emission Rates for MWCs

Central Estimate			High Estimate			Low Estimate		
Total	Elemental	Divalent	Total	Elementa l	Divalent	Total	Elemental	Divalent
14.97%	0%	15%	15.97%	0%	16%	7.984%	0%	8%

Finally, mercury is also emitted when a lamp is placed in a landfill. These leachate emissions are estimated to be very low, centering around 0.4 percent of the mercury contained in a lamp at Subtitle D landfills. The upper bound of this estimate is 1 percent and the lower bound, 0.2 percent. Estimates for Subtitle C disposal are assumed to be 0.2 percent; no lower or upper bounds are used.

Exhibit C-7: Emission Rates for Subtitle D Landfills

Central Estimate			High Estimate			Low Estimate		
Total	Elemental	Divalent	Total	Elemental	Divalent	Total	Elemental	Divalent
0.2%	0%[4]	0.2%	0.8%	0%	0.8%	0.001 %	0%	0.001%

Incorporation of the Mercury Emission Model into the Economic Model

Mercury emissions from the disposal of spent lamps reported in the economic model were calculated by using emission factors based on the emission rates discussed immediately above. The emission rates discussed above were pulled from the document, Mercury Emissions from the Disposal of Fluorescent Lamps, Final Report. The Report describes the Mercury Emissions Model. The Model, developed by ICF for EPA, is a Microsoft *Access* application that tallies mercury emissions from the disposal of spent lamps based on a user selected disposal scenario and waste management scheme. In addition, the user can modify certain scenario and waste management scheme parameters. Mercury emissions are provided for a ten year period, 1998-2007. Each disposal scenario makes assumptions regarding the number of lamps disposed and how the lamps are partitioned in the waste stream (i.e., what percentage of disposed lamps are managed as CESQG lamps, what fraction are recycled, etc.).

While the economic model and the Emissions Model analyze the same management schemes, the economic model contains more scenarios than the Emissions Model. To account for the greater range of analysis in the economic model, the Emissions Model was converted to a series of emission factors that were incorporated into the economic model structure. This use of the Emissions Model data allowed for emission analysis of all economic model scenarios, not just scenarios contained in the Emissions Model.

The first step in the incorporation of the Emissions Model into the economic model was the calculation of emission factors for each waste disposal data (e.g. Subtitle D transportation, Onsite Crushing, etc.). Since lamp disposal activities differ slightly under each management scheme, emission coefficients for each disposal activity in each management scheme were calculated. Emission coefficients were calculated by dividing the amount of mercury that was emitted during a certain disposal activity by the amount of mercury that entered that disposal activity. Emission amounts and mercury levels for each disposal activity under each management scheme were obtained from three Emission Model scenarios, the "Baseline CESQG/Baseline" scenario, the "UW CESQG Moderate/National Default" scenario, and the "CE/CESQG/National Default" scenario.

[4] It is assumed that all lamps will be broken and all elemental mercury released by the time the lamps reach a Subtitle D facility.

Exhibit C-8: Mercury Emission Factors by Regulatory Scheme

Full Subtitle C		Universal Waste		Conditional Exclusion	
Disposal Activity	*Emission Factor*	*Disposal Activity*	*Emission Factor*	*Disposal Activity*	*Emission Factor*
CESQG Landfill	0.0020	CESQG Landfill	0.0020	CESQG Landfill	0.0020
CESQG MWC	0.1500	CESQG MWC	0.1500	CESQG MWC	0.1500
CESQG Recycle	0.0111	CESQG Recycle	0.0111	CESQG Recycle	0.0111
CESQG Recycle Transportation	0.0003	CESQG Recycle Transportation	0.0003	CESQG Recycle Transportation	0.0003
CESQG Transport	0.0299	CESQG Transport	0.0299	CESQG Transport	0.0299
MWC	0.1499	UW MWC	0.1499	CE MWC	0.1500
Onsite Crush-C	0.0281	UW Onsite Crush-C	0.0281	CE Onsite Crush-C	0.0281
Onsite Crush-D	0.0281	UW Onsite Crush-D	0.0102	CE Onsite Crush-D	0.0281
Recycle Baseline C	0.0111	UW Recycle	0.0111	CE Recycle	0.0109
Subtitle C Transport	0.0003	UW Comply Transportation	0.0003	CE Comply Transport	0.0299
Subtitle C Landfill	0.0019	UW Subtitle C Landfill	0.0019	CE Subtitle C Landfill	0.0005
Subtitle D Transport	0.0299	UW Subtitle D Transportation	0.0299	CE Subtitle D Transportation	0.0299
Subtitle D Landfill	0.0024	UW Subtitle D Landfill	0.0024	CE Subtitle D Landfill	0.0022
				CE Noncomply Landfill	0.0022

Note: Emission factors are the same for both T8 and T12 lamps

Emission coefficients were calculated to facilitate model alignment. For purposes of this analysis, the economic model, not the Emission Model, determined the number of lamps entering the waste stream and the fraction of this total that is partitioned to each disposal activity (see the discussion earlier in this section for more information on the calculation of lamp numbers and waste partitioning coefficients). The economic model only needs emission coefficients found in the Emissions Model to determine emissions, the other complicating Emissions Model assumptions drop out. At this point, the economic model could have been structured to multiply the amount of mercury entering each disposal activity by its corresponding emission factor to produce total emissions. However, it is important to note that these emission factors do not account for mercury lost in previous disposal activities, and using emission factors without considering mercury lost in previous disposal stages would have produced erroneous figures. In other words, as the lamps in the waste stream continue from one disposal activity to another (e.g., Onsite Crush-D to Subtitle D Transportation to Subtitle D Landfill) the total amount of mercury entering each subsequent disposal activity has decreased by the amount of emissions in previous stages.[5] (Also the amount of mercury entering a subsequent activity in the disposal chain is often reduced due to further waste stream partitioning.) Therefore, if the economic/emissions model was to apply the emission factor methodology and accurately calculate emissions, mercury content entering a particular disposal activity first needed to be reduced by emissions from the previous stage.

To accomplish this task the emissions model embedded in the economic model was structured not to determine emissions from each disposal activity, but instead determine the mercury lost from disposed lamps as they journey along a certain *waste stream path* from beginning to end. This model development approach was employed so emission factors act only upon mercury content left in a lamp when it reaches a certain stage. By using this waste stream path methodology, several additional benefits in model development arose, including a simplified interaction between the economic and Emission Models and a reduction in the amount of emission information that was placed in the economic/emissions model. For example, instead of importing emission coefficients for each disposal activity along a waste stream path, the economic/emissions model only contains one emission coefficient for an entire path.

Under each management scheme there are a finite number of possible disposal paths discarded lamps can take. For example, under the UW scheme lamps can be disposed on a path that begins with "UW Compliance," continues to "Onsite Crush-C," and ends up in a "Subtitle C Landfill." In this case the cumulative mercury lost on this path due to emissions is 0.6305 kilograms (kg) per 1,000,000 T12 lamps (0.3028 kg per 1,000,000 T8 lamps). This number was calculated in several steps. First, the amount of mercury contained in 1,000,000 lamps was multiplied by the emission factor for the "Onsite Crush-C" activity. The mercury content was then reduced by the mercury emission figure. Next, the leftover mercury was multiplied by the emission factor for Subtitle C Landfill and emissions due to landfilling activities were generated. At this point the two emission figures were added together to produce the amount of mercury lost per 1,000,000 lamps (the mercury content at the initial stage and emissions along the path will differ depending whether the lamp groups are T8s or T12s). Emission totals for each possible path under each management scheme were determined in a similar fashion using the emission factors identified above. Therefore, in the end, the economic/emissions model is structured to report the number of T8 and T12 lamps in groups of 1,000,000 that follow each disposal path (number of lamps and disposal paths followed change depending on the scenario) and multiply the number of lamp groups by the appropriate emissions per 1,000,000 lamps figure to determine total emissions for each path. Finally, the emission levels from every waste path followed in a certain scenario are added together to generate total emissions. Exhibits C-9, C-10, and C-11 contain the emissions factors for each scenario, lamp type, and disposal path.

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[5] This methodology is consistent with the Mercury Emissions Model, which is available in the docket established for this action.

Exhibit C-9: Subtitle C Management Scheme

Non-CESQG, Subtitle C		Non-CESQG, Subtitle D		CESQG	
Kilograms of Hg Emitted per 1,000,000 T12 Lamps					
Disposal Path		*Disposal Path*		*Disposal Path*	
Recycle	0.2388	Subtitle D Landfill (via Crush)	0.6394	Subtitle D Landfill	0.6696
Subtitle C Landfill (via Crush)	0.6299	MWC (via Crush)	3.6512	MWC	3.6845
Subtitle C Landfill (via Transport)	0.0463	Subtitle D Landfill (via Transport)	0.6771	CESQG Recycling	0.2388
		MWC (via Transport)	3.6834		
Kilograms of Hg Emitted per 1,000,000 T8 Lamps					
Disposal Path		*Disposal Path*		*Disposal Path*	
Recycle	0.1147	Subtitle D Landfill (via Onsite Crush)	0.3070	Subtitle D Landfill	0.3214
Subtitle C Landfill (via Crush)	0.3025	MWC (via On-Site Crush)	1.7534	MWC	1.7687
Subtitle C Landfill (via Transport)	0.0222	Subtitle D Landfill (via Transport)	0.3252	CESQG Recycling	0.1146
		MWC (via Transport)	1.7688		

Exhibit C-10: Universal Waste Management Scheme

Non-CESQG, Compliance		Non-CESQG, Non-Compliance		CESQG	
Kilograms of Hg Emitted per 1,000,000 T12 Lamps					
Disposal Path		*Disposal Path*		*Disposal Path*	
UW Recycle	0.2388	Subtitle D Landfill (via Subtitle D Transport)	0.6771	Subtitle D Landfill	0.6696
Subtitle C Landfill (via Crush)	0.6305	MWC (via Subtitle D Transport)	3.6834	MWC	3.6845
Subtitle C Landfill (via Transport)	0.0469	Subtitle D Landfill (via Crush)	0.2630	CESQG Recycling	0.2388
		MWC (via Crush)	3.3306		
Kilograms of Hg Emitted per 1,000,000 T8 Lamps					
Disposal Path		*Disposal Path*		*Disposal Path*	
UW Recycle	0.1147	Subtitle D Landfill (via Crush)	0.1263	Subtitle D Landfill	0.3214
Subtitle C Landfill (via Crush)	0.3028	MWC (via On-Site Crush)	1.5994	MWC	1.7687
Subtitle C Landfill (via Transport)	0.0225	Subtitle D Landfill (via Subtitle D Transport)	0.3251	CESQG Recycling	0.1146
		MWC (via Subtitle D Transport)	1.7688		

Exhibit C-11: Conditional Exclusion Management Scheme

Non-CESQG, Compliance		**Non-CESQG, Non-Compliance**		**CESQG**	
Kilograms of Hg Emitted per 1,000,000 T12 Lamps					
Disposal Path		*Disposal Path*		*Disposal Path*	
CE Recycle	0.8509	CE Non-Compliant Landfill (via Crush)	0.6356	Subtitle D Landfill	0.6696
Subtitle C Landfill (via Crush)	0.6013	CE MWC (via Crush)	3.6518	MWC	3.6845
Subtitle D Landfill (via Crush)	0.6358	CE Non-Compliant Landfill (via Transport)	0.6733	CESQG Recycling	0.2388
Subtitle C Landfill (via Transport)	0.6390	CE MWC (via Transport)	3.6839		
Subtitle D Landfill (via Transport)	0.6735				
Kilograms of Hg Emitted per 1,000,000 T8 Lamps					
Disposal Path		*Disposal Path*		*Disposal Path*	
CE Recycle	0.0405	CE Non-Compliant Landfill (via Crush)	0.3052	Subtitle D Landfill	0.3214
Subtitle C Landfill (via Crush)	0.0286	CE MWC (via Crush)	1.7537	MWC	1.7687
Subtitle D Landfill (via Crush)	0.0303	CE Non-Compliant Landfill (via Transport)	0.3233	CESQG Recycling	0.1146
Subtitle C Landfill (via Transport)	0.0304	CE MWC (via Transport)	1.7691		
Subtitle D Landfill (via Transport)	0.0321				

APPENDIX D:
THE EFFECT OF LEARNING-BY-DOING ON LAMP RECYCLING COSTS

For decades, economists and business managers have been aware of the "learning curve" — the phenomenon that operations become markedly and predictably more efficient as experience builds up. Labor costs for a very wide variety of industrial activities have been found to fall by a relatively fixed percentage every time cumulative output doubles, though this percentage can vary from industry to industry.[1] For example, doubling the total number of airplanes of a given type that have been built might cut labor costs per unit by 20 percent — say from $10,000,000 to $8,000,000 per airplane. Doubling cumulative output again could then be predicted to cut unit labor costs by another 20 percent, or from $8,000,000 down to $6,400,000. Costs for other inputs can be expected to decline also, though generally not as fast.

There is no reason to doubt that this phenomenon applies to the process of recycling lamps, which is a relatively new, labor-intensive activity that probably has ample scope for improvements in equipment, operating efficiency, materials handling, worker training, and so forth. In support of this presumption, several commenters on the proposed lamps rule cited reductions in costs for recycling as experience has grown.[2]

A rough quantitative estimate of the extent to which recycling costs might decline over the time frame of this analysis could be obtained by comparing the total number of lamps that were recycled through 1997 to the cumulative number that will have been recycled at various points in the future. Given these comparisons, and a range of assumptions about the rate of learning (the "progress ratio") in the recycling industry, the cost in future years compared to current levels can be computed in a straightforward fashion. By the time cumulative output of the recycling industry has doubled compared to 1997 levels, we can project that unit costs will decline by between 10 and 30 percent, or from 40 cents per lamp in 1997 to between 36 and 28 cents per lamp.

[1] "Treating Progress Functions as a Managerial Opportunity," Dutton, John M. And Annie Thomas, *Academy of Management Review*, 1984, Vol. 9, No. 2, pp. 235-247. See Figure 1, p. 238, which shows that almost all of the 108 progress ratios reported in 22 studies were grouped between 0.70 and 0.90, with a mode of 0.81 to 0.82.

[2] See comments by NASA and AERC on page six of the "Response to Comments" document.

In the analysis conducted for this report, we estimated the number of lamps that will be recycled in each future year. Almost 90 million are projected to be recycled in 1998, and this number will grow steadily as the number of spent lamps grows, and the rate of recycling increases (under the UW final action). It is more difficult to estimate the total number of lamps that have already been recycled. For this exercise, we have made the simple assumption that recycling has grown in proportion to the number of recycling facilities. Exhibit D-1 shows the start-up date for a set of 17 facilities for which dates were available. Exhibit D-2 shows the percentage of all 17 facilities that were operating by the end of each year from 1989 through 1997. The exhibit also shows the assumed number of lamps recycled by the industry in each of these years, assuming that 89 million would be recycled each year if all facilities had been in operation. As can be seen, the number recycled in any given year is assumed to grow, slowly at first and then more rapidly, from about five million in 1989 up to 89 million in 1997. To the right of the column showing annual recycling levels is shown the cumulative number of lamps recycled at the end of each year.

Exhibit D-3 shows projected future recycling levels, based on the analysis presented in the body of this report, under EPA's UW final action. The exhibit also shows projected cumulative recycling volumes for the timeframe of the analysis (1998 through 2007), and the ratio of these cumulative volumes to the cumulative volume by the end of 1997. According to this analysis, cumulative volumes will more than double by 2001 and will have nearly doubled again by 2007.

Exhibit D-1: Start-up Dates for Lamp Recyclers

Recycling Facility	**Year of Establishment**
Superior Lamps Recycling	1990
Northeast Lamp Recycling	1995
Cleanites Recycling	1994
Quicksilver Environmental	1993
Lamp Recyclers of LA	1993
Mercury Technologies International	1989
Mercury Technologies of Minnesota	1993
Recyclights	
Facility in Minn	1992
Facility #1 in FL	1994
Facility #2 in FL	1997
Facility in Ohio	1996
Salesco Systems USA	1991 (only recy. Fluor. lamps since 1995)
Mercury Waste Solutions	1993
Midwest Recycling and Mercury Recovery Services	1992
A-TEC Recycling	1993
Mercury Recovery Services, Inc	1993

Sources: Personal conversations between ICF and Recycling Facility Representatives, August 1997, and Company information from World Wide Web sites identified in July-August 1997.

Exhibit D-2:
Growth in Recyclers, Estimated Recycling, and Estimated Cumulative Recycling[3,4]

Year	Percentage of Recycling Facilities in Operation	Estimated Number of Lamps Recycled in Each Year (millions)	Cumulative Number of Lamps Recycled by End of Each Year (millions)
1989	3%	3	3
1990	9%	8	11
1991	12%	10	21
1992	18%	16	37
1993	44%	39	76
1994	71%	63	139
1995	82%	73	212
1996	91%	81	293
1997	97%	86	380
1998	100%	89	469

Exhibit D-4 presents estimates of the costs of recycling in future years, assuming that the cost at the end of 1997 is 40 cents per lamp, and that costs fall by various percentages with each doubling of cumulative output.

[3] "Percentage of Recycling Facilities in Operation" is the average of the percent of facilities in operation at beginning and end of each year, for those facilities for which start-up dates were available.

[4] "Estimated Number of Lamps Recycled in Each Year" is calculated using the assumption that recycling output is proportional to the number of facilities in operations, and an estimated recycling volume 89 million lamps in 1998.

The unit costs presented in Exhibit D-4 were calculated using the following equation:

$$C_y = C_{97} * PR^{[\log(CO_y/CO_{97})/\log(2)]}$$

where

C_y is per-lamp cost of recycling in year y;
C97 was the per-lamp cost of recycling in 1997;
PR is the "progress" ratio — usually 70% to 90%, or about 80%
log(COy/CO97)/log(2) is a measure of the number of doublings of cumulative output since 1997, in which
CO_y is cumulative output of recyclers in year y; and
CO_{97} was cumulative output through 1997.

Exhibit D-3:
Projected Cumulative Recycling and Estimated Doublings in Cumulative Recycling of Four-Foot Equivalent Lamps[5]

Year	Cumulative Recycling	Ratio of Cumulative Recycling in Each Year to Cumulative Recycling at End of 1997	Number of Doublings of Cumulative Output Since 1997
1998	469	1.23	0.3
1999	561	1.48	0.56
2000	657	1.73	0.79
2001	758	2	1
2002	864	2.28	1.19
2003	976	2.57	1.36
2004	1093	2.88	1.53
2005	1217	3.21	1.68
2006	1348	3.55	1.83
2007	1486	3.91	1.97

Source: ICF calculations.

[5] "The Number of Doublings of Cumulative Output Since 1997" is calculated as the log of the ratio of cumulative recycling (from third column) divided by the log of 2.

Exhibit D-4: Projected Changes in Recycling Costs

Year	Cost per Lamp Recycled		
	Progress Ratio = 0.90	**Progress Ratio = 0.80**	**Progress Ratio = 0.70**
1998	$0.39	$0.37	$0.36
1999	0.38	0.35	0.33
2000	0.37	0.34	0.30
2001	0.36	0.32	0.28
2002	0.35	0.31	0.26
2003	0.35	0.30	0.25
2004	0.34	0.28	0.23
2005	0.34	0.27	0.22
2006	0.33	0.27	0.21
2007	0.33	0.26	0.20
10-Year Average	$0.35	$0.31	$0.26

Source: ICF calculations.

If learning is unusually slow, represented by the 90 percent progress ratio, costs might fall from $0.40/lamp in 1997 to $0.33 /lamp by 2007; if learning is relative fast, the costs might be cut in half to $0.20/lamp. Average costs over the entire period might range from $0.35/lamp to $0.26/lamp, with a central estimate of $0.31/lamp.

A drop in average recycling costs of this magnitude would result in substantial savings in lamp management. Of the $79 million in annual costs of managing lamps under the rule over the timeframe of the analysis, about 60 percent were attributable to lamp recycling and retorting. If recycling costs (including retorting as well as recovery of glass and aluminum, which might well have the same reductions in costs) fall by almost 25 percent, as suggested by this rough analysis, the total costs of lamp management could fall by over $11 million per year to only about $68 million.

Appendix E:
Comparative Lamp Management Cost Trends

This appendix discusses the methodology and cost factors used by the Agency to estimate compliance costs to facilities that generate mercury-containing lamps under the baseline, conditional exclusion (CE), and universal waste (UW) schemes. EPA derived these costs using a cost model that calculates compliance costs over a ten-year modeling period (1998 to 2007). In the following sections, the Agency discusses the model's (i) methodology and inputs (e.g., assumptions, estimates) and (ii) annual cost outputs under the regulatory schemes.

1. Inputs to the Cost Model

The model uses four broad parameters to estimate compliance costs to facilities under the regulatory schemes: the number of RCRA-regulated facilities; the number of lamps being generated/disposed; unit costs (e.g., rule familiarization, notification, safety training, transportation, and disposal); and growth-rate assumptions. Generally speaking, the model first estimates the total annual number of facilities subject to RCRA under each scheme (i.e., the number of commercial and industrial buildings that generate greater than 100 kilograms/month of lamp waste and that are thus subject to RCRA regulations). It then estimates the total annual number of four-foot equivalent lamps disposed of by these facilities. Lastly, it applies unit compliance costs to facilities' disposal activities to estimate their total aggregate yearly compliance costs during the modeling period. The following paragraphs discuss the model's methodology and assumptions in greater detail.

1.1 Parameters Used to Determine the Number of RCRA-Regulated Facilities

The number of regulated facilities is used as the basis for calculating the annual costs. Exhibit E-1 shows the number of regulated facilities by building size and generator type and the number of non-regulated facilities (CESQGs). The remainder of this section describes the parameters used to estimate the number of regulated facilities.

Exhibit E-1:
Regulated Facilities by Building Size and Generator Type*

Year	Total CESQG Facilities (thousands)	Regulated Facilities (in thousands)						
		Small		Medium		Large		Total
		SQG	LQG	SQG	LQG	SQG	LQG	
1998	4,260.99	76.79	0.41	9.19	4.32	5.16	2.80	98.65
1999	4,407.66	97.83	0.39	11.75	4.00	5.11	3.08	122.16
2000	4,551.44	118.94	0.45	13.44	4.55	5.07	3.37	145.82
2001	4,709.47	141.56	0.48	15.63	4.69	5.08	3.62	171.05
2002	4,864.63	164.22	0.55	17.36	5.38	5.10	3.90	196.52
2003	5,030.68	187.66	0.63	19.12	6.09	5.13	4.16	222.79
2004	5,203.11	211.86	0.71	20.90	6.80	5.19	4.43	249.88
2005	5,382.36	236.83	0.80	22.74	7.53	5.25	4.69	277.84
2006	5,573.63	263.39	0.89	24.66	8.30	5.34	4.95	307.53
2007	5,761.39	289.89	0.98	26.58	9.06	5.44	5.21	337.16

* Contains rounding

1.1.1 Regulatory Compliance Rate

The compliance rate parameter refers to the percentage of facilities complying with each of the three regulatory schemes. In the model, the compliance rate parameter determines what fraction of all regulated facilities are included in the cost estimates. Under the high compliance scenario the model assumes 100 percent compliance with all regulations regarding mercury lamp management. The low compliance scenario assumes 20 percent, 80 percent, and 90 percent compliance with the Baseline, Universal Waste scheme, and Conditional Exclusion scheme respectively. These rates remain constant over the modeling period. Exhibit E-2 summarizes the compliance rates for each regulatory scheme.

Exhibit E-2:
Regulatory Compliance Rate Under Each Regulatory Scheme

Regulatory Scheme	Compliance Rate	
	High	Low
Baseline	100 %	20 %
Universal Waste	100 %	80 %
Conditional Exclusion	100 %	90 %

1.1.2 Base Commercial and Industrial Floorspace Lit by Fluorescent Lamps

The model uses data from the Energy Information Administration (EIA) on total floorspace by building size category to estimate the total amount of commercial and industrial floorspace lit by fluorescent lamps. EIA estimates floorspace by type of lighting, and for the purposes of this analysis the value of 37.8 billion square feet in 1986 was used as the model's base estimate for commercial floorspace. This value does not include unlit space or space lit with high intensity discharge (HID) or incandescent lamps. The 1986 value was updated to 1998 levels using an annual growth rate of 2.4 percent (i.e., 50.30 billion square feet of commercial floorspace in 1998). EPA further assumed that the ratio between commercial and industrial floorspace is about four to one. Thus, the Agency estimates that there were approximately 12.57 billion square feet of industrial floorspace in 1998. In total, the base amount of commercial and industrial floorspace lit by fluorescent lamps in 1998 is 62.87 billion square feet. The analysis categorizes the total floorspace into three building sizes that are divided into a total of eight size ranges, as shown in Exhibit E-3.

Exhibit E-3:
Building Size Categories and Size Ranges*

Building Group	Size Range (ft^2)	Average Facility Size (ft^2)	Percentage of Total Floorspace in Size Range
Small	1,001 to 5,000	2,755	10.5 %
	5,001 to 10,000	7,397	10.6 %
	10,001 to 25,000	16,078	15.2 %
	25,001 to 50,000	35,840	14.8 %
	50,001 to 100,000	69,526	11.9 %
Medium	100,001 to 200,000	137,971	14.5 %
	200,001 to 500,000	307,920	11.5 %
Large	500,001 and over	807,889	10.9 %

* Contains rounding

1.1.3 Lamps Per Facility

The number of fluorescent lamps per facility is used to determine if a facility generates enough lamps to be regulated under RCRA (i.e., as a non-CESQG) and is used to determine the total number of lamps disposed of under RCRA. The number of lamps per facility is a function of the average facility size and the lamps per square foot. The average facility sizes are shown in Exhibit E-3, and are determined as discussed in Appendix A of this report. A weighted average lamps per square foot was calculated so that it could be applied to the total commercial and industrial floorspace. Exhibit E-4 contains the weighted average lamp densities. The number of lamps per facility is obtained by multiplying the average building size by the appropriate lamp density.

The weighted average number of lamps per square foot for T8 and T12 lamps was calculated using the T12 lamps per square foot for commercial buildings, the ratio of the number of T8 lamps required to the number of T12 lamps required to light the same space, 0.85 T8 lamps/T12 lamp, the percent of commercial floorspace of total floorspace, 80 percent, the percent of industrial floorspace to total floorspace, 20 percent, and the percentage reduction of lamp densities in industrial facilities, 80 percent. The lamp density for T8 lamps for commercial facilities was calculated using the lamp density for T12 lamps and the ratio of T8 lamps to T12 lamps.

Exhibit E-4:
Fluorescent Lamp Densities by Building Size and Lamp Type

Building Group	T12 Lamp Density (lamps/ft^2)	T8 Lamp Density (lamps/ft^2)
Lamp Densities for Commercial Buildings		
Small (1,001 - 100,000 ft^2)	0.060	0.051
Medium (100,001 - 500,000 ft^2)	0.046	0.039
Large (500,000+ ft^2)	0.038	0.032
Lamp Densities for Industrial Buildings		
Small (1,001 - 100,000 ft^2)	0.048	0.041
Medium (100,001 - 500,000 ft^2)	0.037	0.031
Large (500,000+ ft^2)	0.030	0.026
Weighted Average Lamp Densities for Commercial and Industrial Buildings		
Small (1,001 - 100,000 ft^2)	0.058	0.049
Medium (100,001 - 500,000 ft^2)	0.044	0.038
Large (500,000+ ft^2)	0.036	0.031

1.2 Parameters Used to Determine the Total Annual Number of Regulated Lamps Generated

The number of regulated lamps generated by all facilities depends on the number of regulated facilities, as discussed earlier, and the number of lamps generated by each facility. Exhibit E-5 shows the number of lamps generated by regulatory scheme assuming 100 percent compliance. It also shows how the lamps were disposed. The number of regulated lamps generated is a function of lamp lifetime, frequency of group relamping, and percentage of facilities using spot and group relamping. The remainder of this section describes how the total number of lamps generated is calculated.

Exhibit E-5:
Number of Non-CESQG Lamps Generated Per Year - High Compliance (in millions)*

	--- Year ---									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Baseline										
Lamps Sent to Subtitle C Landfill	110.8	121.7	132.3	143.7	155.0	166.5	178.3	190.2	202.8	215.1
Lamps Recycled	12.3	14.9	17.7	20.8	24.3	28.1	32.3	36.9	41.9	47.2
Total Lamps Generated	123.1	136.6	149.9	164.6	179.4	194.7	210.6	227.1	244.7	262.3
Universal Waste										
Lamps Sent to Subtitle C Landfill	110.8	121.7	132.3	143.7	155.0	166.5	178.3	190.2	202.8	215.1
Lamps Recycled	12.3	14.9	17.7	20.8	24.3	28.1	32.3	36.9	41.9	47.2
Total Lamps Generated	123.1	136.6	149.9	164.6	179.4	194.7	210.6	227.1	244.7	262.3
Conditional Exclusion										
Lamps Sent to Subtitle C Landfill	110.8	114.9	105.3	93.0	100.4	107.9	115.6	123.4	131.6	139.6
Lamps Recycled	12.3	14.8	17.1	19.2	21.9	24.8	28.0	31.5	35.3	39.3
Subtitle D Landfill	0.0	6.9	27.6	52.3	57.0	61.9	67.0	72.2	77.8	83.4
Total Lamps Generated	123.1	136.6	149.9	164.6	179.4	194.7	210.6	227.1	244.7	262.3

* Contains rounding

1.2.1 Lamp Lifetime

Fluorescent lamp lifetimes vary from three to six years based on the annual hours of use. Assuming that lamps are operated between 4,000 and 5,000 hours each year and have a typical life of 20,000 hours, their average life span is between four and five years. However, because some lamps fail before their typical end of life, the analysis assumed that some lamps will have to be replaced before their average lifespan ends. Therefore, EPA estimates the average lifespan of fluorescent lamps is four years.

1.2.2 Frequency of Group Relamping

The group relamping frequency is used to determine the number of lamps discarded by facilities that group relamp. Consistent with the assumed lamp lifetime, facilities that group relamp are assumed to group relamp every four years. The model assumes that, each year, 25 percent of facilities that group relamp will replace all of their lamps. In the years between group relamping the model assumes a spot replacement rate of 4.25 percent for both T8 and T12 lamps.

1.2.3 Percentage of Facilities Using Spot and Group Relamping Management Methods

The model assumes that when lamps are spot relamped they are replaced with new lamps of the same type (T8 or T12). The model uses a spot relamping rate of 25 percent (i.e., one-fourth of all lamps are replaced each year). However, the analysis further assumes that each year a certain percentage of facilities currently using T12 lamps will choose to switch to T8 lamps through a group relamp process. See Exhibit E-16 for the percentage of facilities that switch from using T12 lamps to T8 lamps each year. In addition, 60 percent of the facilities that use T8 lamps are assumed to group relamp and 40 percent are assumed to spot relamp. Although the total number of facilities using T8 lamps increases over time, the percent that group relamps remains constant at 60 percent. The percentage of facilities using T8s and T12s is discussed in Section 1.4 of this Appendix.

1.3 Unit Costs

For each regulatory scheme, the model assumes regulated facilities will incur certain types of compliance costs in managing and disposing of their lamps under RCRA. Note that these cost assumptions were explained in Chapter 4 of the Economic Assessment. Key cost assumptions are also summarized below.

1.3.1 Baseline Compliance Costs

Exhibits E-6 and E-7 summarize compliance costs under the baseline. Note that initial fixed costs are annualized over the ten-year modeling period using a 7 percent discount factor.

Exhibit E-6:
Facility Cost Estimates Under Baseline Full Subtitle C Scheme

Subtitle C Requirement	Unit (facility) Cost Estimates			
	Large Quantity Generators		Small Quantity Generators	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Initial Fixed Costs				
Notification of Hazardous Waste Activity	$ 150	$ 83	$ 150	$ 83
Rule Familiarization	$ 1,107	$ 332	$ 1,107	$ 130
Emergency Planning	$ 586	$ 214	$ 395	$ 116
Waste Characterization	$ 312	$ 0	$ 312	$ 0
Total Initial Fixed Costs	$ 2,155	$ 629	$ 1,964	$ 329
Annualized Initial Fixed Costs	$ 307	$ 90	$ 280	$ 47
Annual Costs				
Subtitle C Record Keeping (per year)	$ 33	$ 14	$ 33	$ 14
Biennial Reporting (annualized cost)	$ 361	$ 130	$ 0	$ 0
Personnel Safety Training (annualized costs)	$ 474	$ 208	$ 74	$ 29
Manifest Training (per year)	$ 164	$ 4	$ 34	$ 2
Subtotal Annual Costs	$ 1,032	$ 356	$ 141	$ 45
Variable Costs				
Manifesting & Landban Notification per shipment	$ 42	$ 31	$ 33	$ 30
Exception Reporting (per report)	$ 64	$ 32	$ 30	$ 17

Exhibit E-6:
Facility Cost Estimates Under Baseline Full Subtitle C Scheme

Subtitle C Requirement	Unit (facility) Cost Estimates			
	Large Quantity Generators		Small Quantity Generators	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Total Annualized Cost for New Facilities				
Facilities that Group Relamp	$1,384	$447	$454	$122
Facilities that Spot Relamp	$1,424	$508	$487	$152
Total Annualized Cost for Existing Facilities				
Facilities that Group Relamp	$1,074	$387	$174	$75
Facilities that Spot Relamp	$1,117	$418	$207	$105

The high and low-cost estimates under the full Subtitle C scheme were applied to small, medium, and large facilities according to Exhibit E-7.

Exhibit E-7:
Allocation of High and Low Unit Costs Under Baseline Full Subtitle C Scheme

Generator Category	Facility Size		
	Small	Medium	Large
SQG	Low	Low	High
LQG	Low	High	High

1.3.2 Universal Waste (UW) Compliance Costs

Exhibit E-8 and E-9 summarize compliance costs under the UW scheme. Note that initial fixed costs are annualized over the ten-year modeling period using a 7 percent discount factor.

Exhibit E-8:
Facility Cost Estimates Under the Universal Waste Scheme

Universal Waste Requirement	Unit (facility) Cost Estimates			
	Large Quantity Handlers		Small Quantity Handlers	
	High Estimate	Low Estimate	High Estimate	Low Estimate
Initial Fixed Costs				
Notification of Hazardous Waste Activity	$ 150	$ 83	$ 0	$ 0
Rule Familiarization	$ 1,107	$ 166	$ 1,107	$ 83
Waste Characterization	$ 312	$ 0	$ 312	$ 0
Total Initial Fixed Costs	$ 1,569	$ 249	$ 1,419	$ 83
Annualized Initial Fixed Costs	$ 223	$ 35	$ 202	$ 12
Annual Fixed Costs				
Personnel Safety Training (annualized)	$ 86	$ 26	$ 33	$ 10
Variable Costs				
Shipping Record Keeping (per shipment)	$ 9	$ 9	$ 0	$ 0
Total Annualized Cost for New Facilities[1]				
Facilities that Group Relamp	$318	$70	$235	$22
Facilities that Spot Relamp	$327	$79	$235	$22
Total Annualized Cost for Existing Facilities				
Facilities that Group Relamp	$95	$35	$33	$10
Facilities that Spot Relamp	$104	$44	$33	$10

The high and low-cost estimates under the UW scheme were allocated to small, medium, and large facilities according to Exhibit E-9.

Exhibit E-9:
Allocation of High and Low Unit Costs Under Universal Waste Scheme

Generator Category	Facility Size		
	Small	Medium	Large
SQHUW	Low	Low	High
LQHUW	Low	High	High

[1] Facilities that group relamp prepare one manifest and facilities that spot relamp prepare two manifests each year.

1.3.3 Conditional Exclusion (CE) Compliance Costs

Exhibits E-10 summarizes compliance costs under the CE scheme. Note that initial fixed costs are annualized over the ten-year modeling period using a 7 percent discount factor.

Exhibit E-10:
Facility Cost Estimates Under Conditional Exclusion Scheme

Conditional Exclusion Requirement	Unit (facility) Cost Estimates	
	High Estimate	Low Estimate
Initial Fixed Costs		
Rule Familiarization	$ 1,107	$ 83
Total Fixed Costs	$ 1,107	$ 83
Annualized Fixed Costs	$ 158	$ 12
Variable Costs		
Shipping Record Keeping (per shipment)	$ 17	$ 7
Total Annual Costs for New Facilities	$ 175	$ 19
Total Annual Costs for Existing Facilities	$ 17	$ 7

1.3.4 Transportation and Disposal Costs

In addition to the compliance costs discussed above, the model included the transportation and disposal unit costs in Exhibit E-11. Refer to Chapter 4 for a more detailed discussion of these costs.

Exhibit E-11:
Transportation and Disposal Unit Costs

Transportation/Disposal Activity	Unit Cost
Subtitle C Landfill Tipping Fees	$ 489.88 /ton
Subtitle C Transportation Cost (300 mile)	$ 85.34 /ton
Subtitle D Landfill Tipping Fees	$ 42.86 /ton
Subtitle D Transportation Cost (25 mile)	$ 7.14 /ton
Subtitle D Transportation Cost (200 mile)	$ 32.00 /ton
Recycling	
Breakage Control Packaging (standard box of 117 lamps going to recycling)	$ 8.62 /box
Transportation and Tipping Fee	$ 0.40 /lamp
Retorting	
Transportation and Tipping Fee	$ 1.31 /lamp
Lamp Crushing	$ 78.67 /ton
Drum Cost	$ 44.96 /drum

1.4 Growth Rate Assumptions - Parameters that Change Annually

Many of the model's inputs discussed in the previous paragraphs of this appendix change over time to approximate changes in the real world (e.g., the annual growth of lit floorspace.) This section summarizes the model inputs that change during the ten-year modeling period.

1.4.1 Percent of Facilities Using T8 and T12 Lamps

The percent of facilities using T8 lamps is assumed to increase over time as more facilities participate in group relamping programs and switch from T12 lamps to T8 lamps (e.g., the Green Lights Program). Larger facilities are expected to adopt T8 lamps at a faster rate than smaller facilities. The model assumes that each year a given percentage of facilities will switch from T12 lamps to T8 lamps (e.g., because of cost savings and environmental considerations). See Exhibit E-16 for the percentage of facilities using T12 lamps that switch to T8 lamps each year for the three building size categories.

The percent of facilities using T8 lamps and T12 lamps for each building size category (small, medium, and large) for each year is presented in Exhibit E-12. The percent of facilities using T8 and T12 lamps is constant between the high and low compliance scenarios.

Exhibit E-12:
Percent of Facilities Using T8 and T12 Lamps

Lamp Type	Year									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Small Facilities										
T12s	87.6 %	84.9 %	82.2 %	79.7 %	77.2 %	74.9 %	72.7 %	70.6 %	68.6 %	66.6 %
T8s	12.4 %	15.2 %	17.8 %	20.4 %	22.8 %	25.1 %	27.3 %	29.4 %	31.5 %	33.4 %
Medium Facilities										
T12s	82.2 %	78.9 %	75.7 %	72.7 %	69.9 %	67.2 %	64.6 %	62.2 %	60.0 %	57.8 %
T8s	17.8 %	21.2 %	24.3 %	27.3 %	30.2 %	32.9 %	35.4 %	37.8 %	40.1 %	42.2 %
Large Facilities										
T12s	49.0 %	43.0 %	37.8 %	33.4 %	29.7 %	26.4 %	23.7 %	21.3 %	19.3 %	17.5 %
T8s	51.0 %	57.0 %	62.2 %	66.6 %	70.4 %	73.6 %	76.4 %	78.7 %	80.8 %	82.5 %

1.4.2 Floorspace Growth Rate

The total amount of commercial and industrial floorspace lit with fluorescent lamps is assumed to increase at a rate of 3.8 percent per year over the modeling period. The floorspace growth rate is independent of the compliance rate and the regulatory scheme. Exhibit E-13 shows the commercial and industrial floorspace lit by fluorescent lamps for each year in the planning horizon.

Exhibit E-13:
Commercial and Industrial Floorspace by Year*

Year	Commercial Floorspace	Industrial Floorspace	Total Floorspace
	billion square feet		
1998	50.30	12.57	62.87
1999	52.21	13.05	65.26
2000	54.19	13.55	67.74
2001	56.25	14.06	70.31
2002	58.39	14.60	72.98
2003	60.61	15.15	75.76
2004	62.91	15.73	78.64
2005	65.30	16.33	81.63
2006	67.78	16.95	84.73
2007	70.36	17.59	87.95

* Contains rounding

1.4.3 Percent of States Using Each Regulatory Scheme

The model assumes the possibility that some states under the current regulatory scheme (full Subtitle C regulation) are regulating mercury lamps under a Universal Waste rule. Thus, the model assumes that, under the baseline, some states are using Subtitle C and some are using Universal Waste rules. Under the Universal Waste regulatory scheme, the model assumes that some states may not adopt the Universal Waste rule and will continue to require full Subtitle C compliance. Under the Conditional Exclusion regulatory scheme, the model assumes that some states will continue requiring full Subtitle C compliance and that some states will adopt a Universal Waste rule for mercury lamps. The percent of states using each regulatory option is independent of the assumed compliance rate.

Exhibit E-14 shows the percentage of states using each regulatory option under each of the three regulatory schemes. Under each regulatory scheme the percentage of states using the Universal Waste option increases, except for the conditional exclusion scheme where the number of states using the Universal Waste option decreases after an initial increase.

Exhibit E-14:
Percent of States Using Each Regulatory Scheme

Regulatory Scheme	--- Year ---									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Baseline										
Baseline	60 %	45 %	43 %	38 %	38 %	38 %	38 %	38 %	38 %	38 %
UW	40 %	55 %	57 %	62 %	62 %	62 %	62 %	62 %	62 %	62 %
Universal Waste										
Baseline	60 %	40 %	36 %	31 %	31 %	31 %	31 %	31 %	31 %	31 %
UW	40 %	60 %	64 %	69 %	69 %	69 %	69 %	69 %	69 %	69 %
Conditional Exclusion										
Baseline	60 %	41 %	37 %	30 %	30 %	30 %	30 %	30 %	30 %	30 %
UW	40 %	53 %	41 %	32 %	32 %	32 %	32 %	32 %	32 %	32 %
CE	0 %	6 %	22 %	38 %	38 %	38 %	38 %	38 %	38 %	38 %

1.4.4 Percent of Lamps Recycled

The percent of lamps recycled is expected to increase over time from ten percent currently to a maximum of 18 percent. The recycling rate is believed to depend on the compliance rate assumed. Thus Exhibit E-15 shows the increasing recycling rate under each regulatory scheme and for high and low compliance.

Exhibit E-15:
Percent of Lamps Recycled in Each Year

	Year									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
High Compliance										
Sub C	10.0 %	10.9 %	11.8 %	12.7 %	13.6 %	14.5 %	15.3 %	16.2 %	17.1 %	18.0 %
UW	10.0 %	10.9 %	11.8 %	12.7 %	13.6 %	14.5 %	15.3 %	16.2 %	17.1 %	18.0 %
CE	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %
Low Compliance										
Sub C	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %
UW	10.0 %	10.9 %	11.8 %	12.7 %	13.6 %	14.5 %	15.3 %	16.2 %	17.1 %	18.0 %
CE	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %

1.4.5 Percent of Facilities Switching to T8s

The percentage of facilities that use T8 lamps is assumed to increase over time as more facilities participate in group relamping programs and switch from T12 lamps to T8 lamps, as discussed above. To capture the lamps generated when a facility switches from T12 lamps to T8 lamps, the model uses the percentages in Exhibit E-16 to estimate the number of facilities in each facility size range that make this switch. The percentages in Exhibit E-16 are the differences between the percentages for each year in Exhibit E-12.

Exhibit E-16:
Annual Average Percent of Facilities Using T12s Switching to T8s

	Year									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Small Facility	2.7 %	2.7 %	2.5 %	2.5 %	2.3 %	2.2 %	2.1 %	2.0 %	2.0 %	2.0 %
Medium Facility	3.3 %	3.2 %	3.0 %	2.8 %	2.7 %	2.6 %	2.4 %	2.2 %	2.2 %	2.2 %
Large Facility	6.0 %	5.2 %	4.4 %	3.7 %	3.3 %	2.7 %	2.4 %	2.0 %	1.8 %	1.8 %

2. Comparative Lamp Management Cost Trends - Findings

This section summarizes the model's annualized and present value cost outputs under the Baseline, UW, and CE regulatory schemes. It also includes cost outputs for a "No Compliance" scheme. This scheme assumes that all facilities manage their lamps under RCRA Subtitle D and that their only costs include transportation and disposal.

2.1 High Compliance Scenario

Exhibit E-17 contains the total annual costs for each of the regulatory schemes. Exhibit E-18 provides a graphical presentation of the data in Exhibit E-17. Exhibit E-19 contains the present values of the costs in Exhibit E-17. A discount rate of seven percent was used to calculate the present value costs. These exhibits provide backup information to Exhibit 4-8 in Section 4 of this report.

Exhibit E-20 contains the cost per bulb for each of the regulatory schemes. This exhibit provides backup information to Exhibit 4-9 in Section 4 of this report.

Exhibit E-17:
Summary of Total Annual Costs - High Compliance Scenario

Scenario	Annual Total Costs (millions)									
Year ---->	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Baseline	$44	$49	$56	$63	$72	$81	$91	$101	$113	$125
UW	$44	$49	$55	$62	$70	$79	$89	$99	$111	$123
CE	$44	$49	$55	$60	$67	$74	$82	$91	$100	$110
No Compliance[2]	$23	$26	$28	$31	$34	$37	$40	$43	$46	$50

[2] The No Compliance scenario uses the Subtitle D transportation cost for 25 miles and the Subtitle D disposal (tipping) cost as presented in Exhibit E-11.

Exhibit E-18:
Graph of Total Annual Costs - High Compliance Scenario

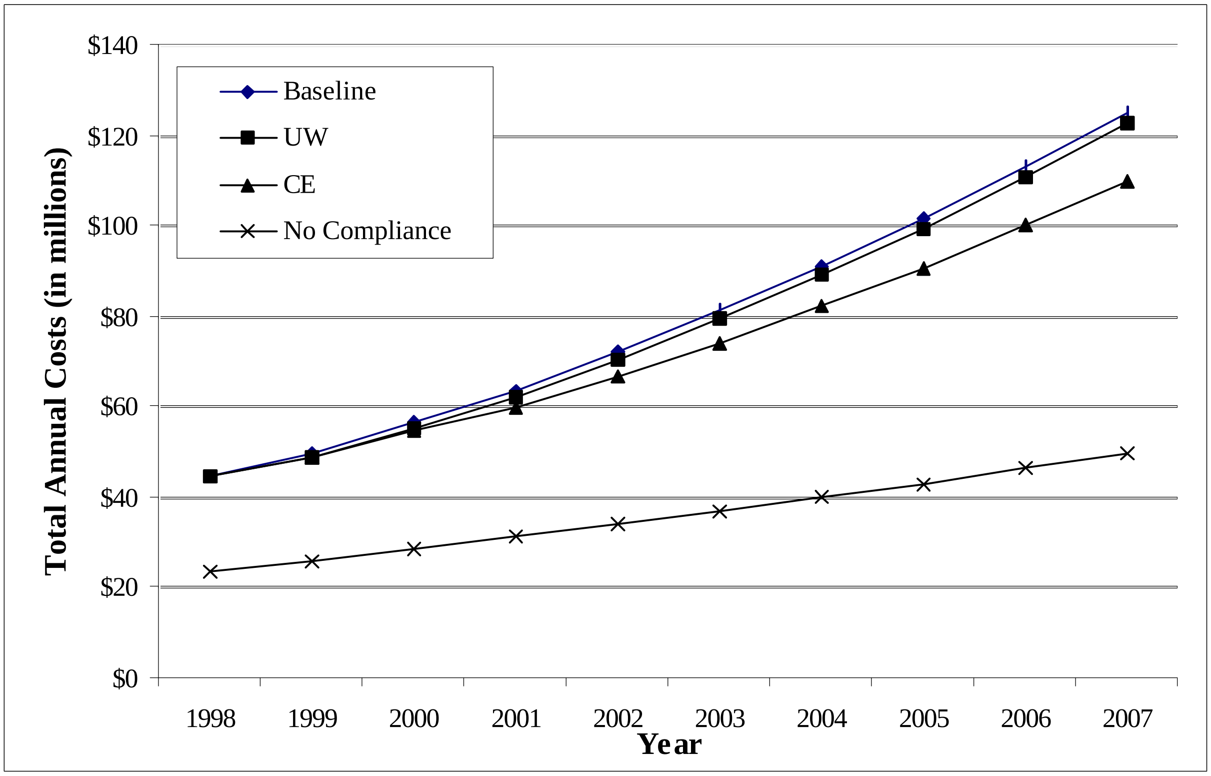

Exhibit E-19:
Summary of Total Present Value Costs - High Compliance Scenario

Scenario	**Annual Present Value Costs (millions)**									
Year ---->	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Baseline	$45	$46	$49	$52	$55	$58	$61	$63	$66	$68
UW	$45	$46	$48	$51	$54	$57	$59	$62	$64	$67
CE	$45	$46	$48	$49	$51	$53	$55	$56	$58	$60
No Compliance	$23	$24	$25	$25	$26	$26	$27	$27	$27	$27

Exhibit E-20:
Cost per Non-CESQG Compliant Bulb - High Compliance Scenario

Year	Baseline	Universal Waste	Conditional Exclusion	No Compliance
1998	$ 0.36	$ 0.36	$ 0.36	$ 0.19
1999	$ 0.36	$ 0.36	$ 0.36	$ 0.19
2000	$ 0.38	$ 0.37	$ 0.36	$ 0.19
2001	$ 0.39	$ 0.38	$ 0.36	$ 0.19
2002	$ 0.40	$ 0.39	$ 0.37	$ 0.19
2003	$ 0.42	$ 0.41	$ 0.38	$ 0.19
2004	$ 0.43	$ 0.42	$ 0.39	$ 0.19
2005	$ 0.45	$ 0.44	$ 0.40	$ 0.19
2006	$ 0.46	$ 0.45	$ 0.41	$ 0.19
2007	$ 0.48	$ 0.47	$ 0.42	$ 0.19
Average	$ 0.41	$ 0.40	$ 0.38	$ 0.19

2.2 Low Compliance Scenario

Exhibit E-21 contains the total annual costs for each of the regulatory schemes. Exhibit E-22 provides a graphical presentation of the data in Exhibit E-21. Exhibit E-23 contains the present values of the costs in Exhibit E-21. A discount rate of seven percent was used to calculate the present value costs. These exhibits provide backup information to Exhibit 4-8 in Section 4 of this report.

Exhibit E-24 contains the cost per bulb for each of the regulatory schemes. This exhibit provides backup information to Exhibit 4-9 in Section 4 of this report.

Exhibit E-21:
Summary of Total Annual Costs - Low Compliance Scenario

Scenario	Annual Total Costs (millions)									
Year ------>	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Baseline	$28	$34	$38	$44	$50	$56	$62	$69	$77	$85
UW	$28	$34	$39	$46	$51	$58	$65	$72	$80	$88
CE	$28	$34	$39	$44	$49	$54	$59	$65	$71	$77
No Compliance	$23	$26	$28	$31	$34	$37	$40	$43	$46	$49

Exhibit E-22:
Graph of Total Annual Costs - Low Compliance Scenario

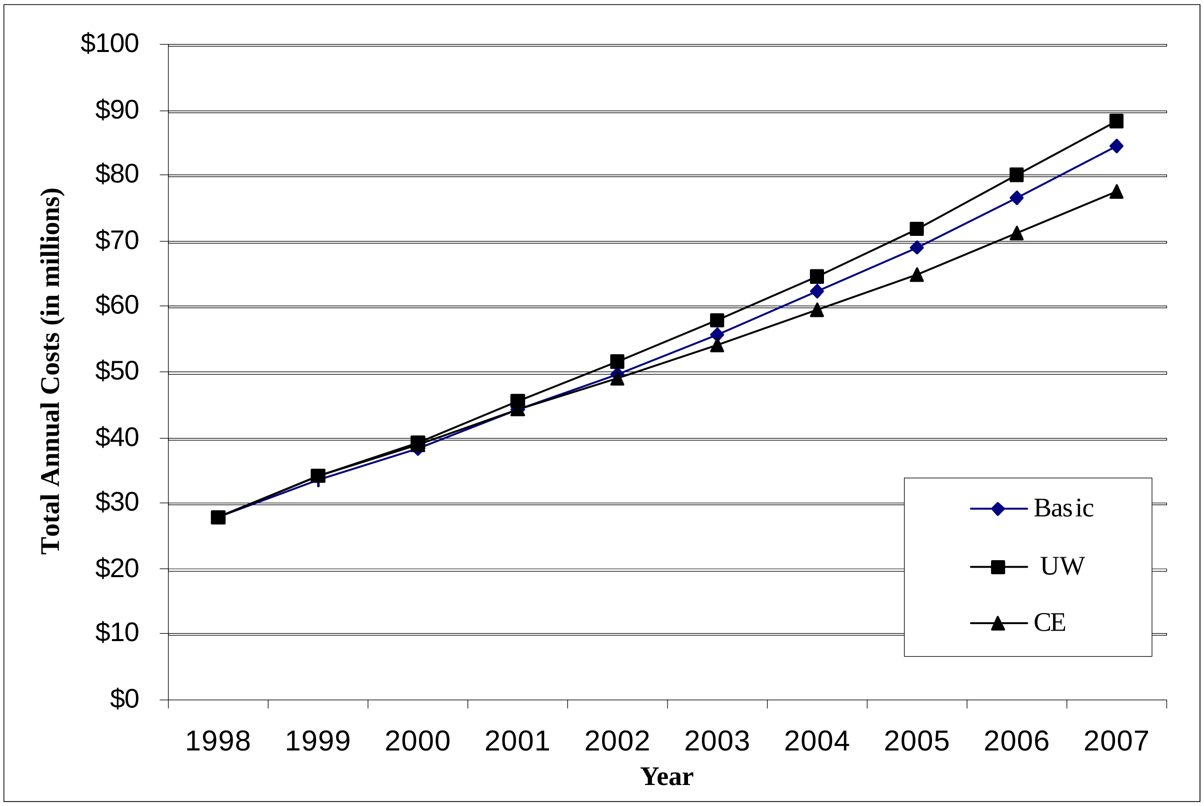

Exhibit E-23:
Summary of Total Present Value Costs - Low Compliance Scenario

Scenario	**Annual Present Value Costs (millions)**									
***Year* ----->**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Baseline	$28	$31	$33	$36	$38	$40	$41	$43	$45	$46
UW	$28	$32	$34	$37	$39	$41	$43	$45	$47	$48
CE	$28	$32	$34	$36	$37	$39	$40	$40	$41	$42
No Compliance	$23	$24	$25	$25	$26	$26	$27	$27	$27	$27

Exhibit E-24:
Cost per Non-CESQG Compliant Bulb - Low Compliance Scenario

Year	Baseline	Universal Waste	Conditional Exclusion	No Compliance
1998	$ 0.52	$ 0.52	$ 0.52	$ 0.19
1999	$ 0.46	$ 0.45	$ 0.45	$ 0.19
2000	$ 0.47	$ 0.45	$ 0.43	$ 0.19
2001	$ 0.47	$ 0.45	$ 0.41	$ 0.19
2002	$ 0.49	$ 0.47	$ 0.42	$ 0.19
2003	$ 0.50	$ 0.48	$ 0.42	$ 0.19
2004	$ 0.52	$ 0.50	$ 0.43	$ 0.19
2005	$ 0.53	$ 0.52	$ 0.44	$ 0.19
2006	$ 0.55	$ 0.53	$ 0.44	$ 0.19
2007	$ 0.56	$ 0.55	$ 0.45	$ 0.19
Average	$ 0.51	$ 0.49	$ 0.44	$ 0.19

2.3 Annualized Costs for High and Low Compliance

Exhibit E-25 contains a breakdown of the total annual costs into administrative (e.g., rule familiarization) and transportation and disposal costs for the Baseline regulatory scheme. Exhibit E-26 contains a breakdown of total annual costs into administrative and transportation and disposal costs for the Universal Waste regulatory scheme. Exhibit E-27 contains a breakdown of total annual costs into administrative and transportation and disposal costs for the Conditional Exclusion regulatory scheme. Exhibit E-28 contains a breakdown of total annual costs into administrative and transportation and disposal costs for the No Compliance regulatory scheme. These exhibits also show the annualized cost of compliance under each regulatory scheme, except for the No Compliance scheme. A discount rate of seven percent was used to calculate the annualized costs. These exhibits provide backup information to Exhibit 4-8 in Section 4 of this report.

Exhibit E-25:
Break-Down of Baseline Costs for High and Low Compliance

Year	Total Annual Cost (in millions)					
	High Compliance			Low Compliance		
	Administrative Costs	Transportation and Disposal Costs	Total Cost	Administrative Costs	Transportation and Disposal Costs	Total Cost
1998	$ 6	$ 38	$ 44	$ 0.4	$ 27	$ 28
1999	$ 6	$ 44	$ 49	$ 0.5	$ 33	$ 34
2000	$ 6	$ 50	$ 56	$ 0.6	$ 38	$ 38
2001	$ 6	$ 57	$ 63	$ 0.6	$ 44	$ 44
2002	$ 7	$ 65	$ 72	$ 0.7	$ 49	$ 50
2003	$ 8	$ 73	$ 81	$ 0.8	$ 55	$ 56
2004	$ 9	$ 82	$ 91	$ 0.8	$ 61	$ 62
2005	$ 10	$ 92	$ 101	$ 0.9	$ 68	$ 69
2006	$ 11	$ 102	$ 113	$ 1.0	$ 76	$ 77
2007	$ 12	$ 114	$ 125	$ 1.1	$ 84	$ 85
Total Cost			**$ 797**			**$ 542**
Annualized Present Value Total Cost			**$ 80.01**			**$ 54.37**

Exhibit E-26:
Break-Down of UW Costs for High and Low Compliance

Year	Total Annual Cost (in millions)					
	High Compliance			Low Compliance		
	Administrative Costs	Transportation and Disposal Costs	Total Cost	Administrative Costs	Transportation and Disposal Costs	Total Cost
1998	$ 6	$ 38	$ 44	$ 0.4	$ 27	$ 28
1999	$ 5	$ 43	$ 49	$ 0.5	$ 34	$ 34
2000	$ 5	$ 50	$ 55	$ 0.6	$ 39	$ 39
2001	$ 5	$ 57	$ 62	$ 0.6	$ 45	$ 46
2002	$ 6	$ 64	$ 70	$ 0.7	$ 51	$ 51
2003	$ 7	$ 73	$ 79	$ 0.8	$ 57	$ 58
2004	$ 8	$ 82	$ 89	$ 0.8	$ 64	$ 65
2005	$ 8	$ 91	$ 99	$ 0.9	$ 71	$ 72
2006	$ 9	$ 102	$ 111	$ 1.0	$ 79	$ 80
2007	$ 10	$ 113	$ 123	$ 1.1	$ 87	$ 88
Total Cost			**$ 782**			**$ 561**
Annualized Present Value Total Cost			**$ 78.52**			**$ 56.14**

Exhibit E-27:
Break-Down of CE Costs for High and Low Compliance

Year	Total Annual Cost (in millions)					
	High Compliance			Low Compliance		
	Administrative Costs	Transportation and Disposal Costs	Total Cost	Administrative Costs	Transportation and Disposal Costs	Total Cost
1998	$ 6	$ 38	$ 44	$ 0.4	$ 27	$ 28
1999	$ 5	$ 44	$ 49	$ 0.5	$ 34	$ 34
2000	$ 5	$ 49	$ 55	$ 0.5	$ 38	$ 39
2001	$ 5	$ 55	$ 60	$ 0.5	$ 44	$ 44
2002	$ 6	$ 61	$ 67	$ 0.5	$ 49	$ 49
2003	$ 6	$ 68	$ 74	$ 0.6	$ 53	$ 54
2004	$ 7	$ 75	$ 82	$ 0.6	$ 59	$ 59
2005	$ 8	$ 83	$ 91	$ 0.7	$ 64	$ 65
2006	$ 8	$ 92	$ 100	$ 0.7	$ 70	$ 71
2007	$ 9	$ 101	$ 110	$ 0.8	$ 77	$ 77
Total Cost			**$ 730**			**$ 521**
Annualized Present Value Total Cost			**$ 73.90**			**$ 52.60**

Exhibit E-28:
Break-Down of No Compliance Costs

Year	Total Annual Cost (in millions)		
	Administrative Costs	Transportation and Disposal Costs	Total Cost
1998	$ 0.0	$ 23	$ 23
1999	$ 0.0	$ 26	$ 26
2000	$ 0.0	$ 28	$ 28
2001	$ 0.0	$ 31	$ 31
2002	$ 0.0	$ 34	$ 34
2003	$ 0.0	$ 37	$ 37
2004	$ 0.0	$ 40	$ 40
2005	$ 0.0	$ 43	$ 43
2006	$ 0.0	$ 46	$ 46
2007	$ 0.0	$ 49	$ 49
Total Cost			**$ 358**
Annualized Present Value Total Cost			**$ 36.55**

3. Limitations of Analysis

Following are some key limitations of the model:

- In developing the model, the Agency was faced with a scarcity of data regarding certain aspects of lamp waste management. Some of the data and assumptions in the model are based on the Agency's best professional judgment or limited consultations with industry (e.g., the number of generators that recycle their lamps).

- The model assumes that a number of facilities disposing of lamps each year are conditionally exempt from RCRA because they do not generate enough lamps to qualify as RCRA-regulated generators (i.e., facilities generating greater than 100 kilograms per month of hazardous waste). However, the model does not account for the possibility that certain facilities might also generate hazardous waste streams in addition to lamps and thereby exceed the 100 kilogram per month threshold. Because of this limitation, the model potentially overestimates the number of facilities that are conditionally exempt.

- The model does not consider recent advancements in lamp manufacturing, such as low-content mercury lamps. Low-mercury lamps might not fail the TCLP as frequently as the lamps included in the model.